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CHEMICAL, PETROGRAPHICAL AND MINERALOGICAL STUDY OF FIVE
MINERALIZED DRILL HOLES CONTAINING Au-Cu-(Te-) ORE (C2-,
C3-, C4-, E- and K-ORE) AND ITS IMMEDIATE SURROUNDINGS IN
BIDJOVAGGE Au-Cu ORE, FINNMARK, NORWAY -
WITH INTERPRETATIONS OF THE ADJACENT ALTERATIONS

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ABSTRACT

Five representative ore sections were studied from Bidjovagge Au-Cu ore. C2 (drill hole S128I) and C3 (S144F) represent typical Cu ore. C4 (S154B) is a subeconomic Cu-Au mineralization hosted by metadiabase. E ore (N20E) is classified as Au ore and K ore (N95F) as Au-Te ore.

In the drill logs four rock types are reported. Albitic felsite is the most common rock type hosting all ores but C4. Metadiabase sheets are 1 to 35 metres wide and often situated close to the ore. Black shist do not occur in contact with metadiabases in studied sections. Narrow carbonate veins cut albitic felsites. Chemically those rock types (i.e. studied samples) do not differ notably. Albitic felsite and metadiabase sheets can be distinguished by immobile element ratios. Ti, P and Cl contents are higher and Cr lower in metadiabases. Albitic felsites, carbonate rocks (or veins), black shists (after Lamberg and Hautala, 1990) and ores are similar with respect to immobile element ratios and Ti, Cl, P & Cr concentrations.

Two metadiabase types can be specified by their different Al_2O_3/TiO_2 ratios. The ratio in C-type metadiabases (in C and E ores) is close to 5 and in K-type metadiabase (in K ore) about 42. Another marked difference is K content, which is higher in K type metadiabase ($K_2O = 1-3 \text{ wt.}\%$ vs. $< 1 \text{ wt.}\%$, respectively).

In all sections some specific elements are associating with each other. C, Ca, Mg and Mn are always grouped together and they are called as carbonate forming elements (CFE's). Immobile and silicate (albite and quartz) forming elements (ISE's) Si, Al, Na, Zr, Ti and Cr are accompanied together. Carbonate forming elements show negative correlation with silicate forming elements. Sulfide forming chalcophile elements (S, Cu, Fe, Ni, Co, Zn, Pb, \pm As) show a positive correlation in every ore type. K, Rb Sr and Ba and lesser degree Mg, Y and Cl are associated with each other and this element group is called phlogopite forming elements (PFE's). Phlogopite forming elements (PFE's: K, Mg, Rb, Sr, Ba, Y) are occasionally, clearly associated with Cl and P and have negative correlation with Cr showing metadiabase association (MDBA) in these cases.

All studied ores are located close to the contact between metadiabase and albitic felsite. Cu is correlation with SFE's and Au with Cu, Te, U, Mo. Ore hosting albitic felsite does not differ notably from barren albitic felsites. The mineral composition, texture and chemical compositions are almost equal. In the vicinity of each ore the Co/Ni and pyrite/pyrrhotite ratios change from pyrite dominant to pyrrhotite dominant.

According to the model for the formation of Cu-Au ore the emplacement of the metadiabases has triggered the hydrothermal system. Oxidizing fluids have dissolved graphite from black shists producing oxidized meta black shists (OMbs, albitic felsites). Au and Cu have precipitated from the oxidizing solutions penetrating to reducing environment. The plane of precipitation has been narrow and highly specific by the phase relations in Fe-S-O system. Au has precipitated in higher T (in the stability of calcite) than Cu (in the stability of dolomite).

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1 INTRODUCTION

Mine geologist Markus Ekberg of Bidjovagge mine ordered a chemical and petrological study of five Bidjovagge Au-Cu ore sections. Aim of this study is to characterise the chemical, petrographical and mineralogical features of different ore types. An effort is also made to qualify and quantify the alteration processes responsible for the formation of Au-Cu ore.

1.1 Previous studies

Following studies were used as references (complete reference is given in Section 13).

Geology: Anttonen et al. (1990), Björlykke et al. (1987, 1991), Hollander (1979), Holmsen et al. (1957)

Geochemical characteristics: Nurmi et al. (1991)

Mineralogy: Hänninen (1983 and 1990), Mathesen (1969), Sotka (1987, 1988), Sotka & Hänninen (1983) Sotka et al. (1987, 1990), Olerud (1988)

Production mineralogy and processing: Ekberg & Sotka (in press), Palosaari (1989, 1990a, 1990b), Palosaari & Hänninen (1989, 1990a, 1990b), Sotka (1987, 1988)

Datings: Björlykke et al. (1990)

Fluid inclusion studies: Björlykke and Ettner (1991)

Alteration: Lamberg & Hautala (1990)

2 SAMPLES

M. Ekberg selected five drill holes representing different type of ores for the chemical, petrographical and petrological study (Table 2.1, Fig. 2.1). These drill holes were sampled for the chemical analyses by M. Ekberg. Samples from albitic felsites and metadiabases plus minor carbonate rocks were selected. Black shists or graphitic felsites weren't sampled.

Samples for the microscopical examinations were selected by M. Ekberg, P. Lamberg and P. Toikkanen. From each drill hole at least one sample per rock type were selected. Also samples from the ore and assumed least altered rocks were chosen.

Detailed list of the samples is given for each ore type in Tables 4.1, 5.1, 6.1, 7.1 and 8.1. Drill logs are enclosed with the report (Appendices 1a, 2a, 3a, 4a and 5a).

Table 2.1. List of the samples studied in this report.

Ore type	Drill hole	Samples from interval (m)	Rock types	Ore (m)	Host rock in the ore
K	N95F	1.8-63.8	ABFST, DB, KRB	23, 35-45	ABFST, (DB)
E	N20E	40.0-219.0	ABFST, KRB, MDB	190-200	ABFST
C2	S128I	20.0-121.4	ABFST, MDB, ML	70-80	ABFST, (ML)
C3	S144F	60.0-160.0	ABFST, ML	118-122	ABFST
C4	S154B	60.0-160.0	MDB, ML, ABFST	102-110	MDB

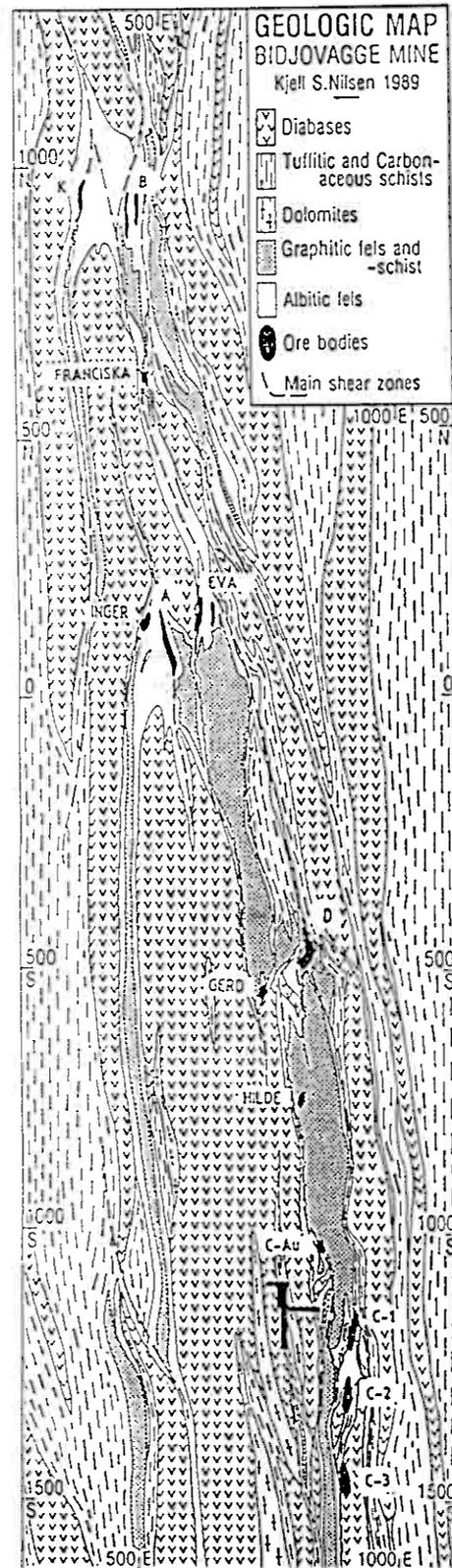


Fig 2.1 Geological map of the Bidjovagge area (Ekberg & Sotka, 1991).

3 METHODS

Polished thin sections and a few polished sections were prepared from the drill core samples in Geoanalytical Laboratory. Sample preparation for chemical analyses has mainly been made at Bidjovagge. Powdered samples were briquetted and analysed in Geoanalytical Laboratory by Philips PW-1400 XRF-spectrometer, which uses Fundamental Parameters (RRFPO) correction program (Ala-Vainio 1986). Au content of the samples was analysed at Bidjovagge except for the sample S154B/60.6, which was analysed at Geoanalytical laboratory in Outokumpu. The results of the analyses are given in Appendices 1b, 2b, 3b, 4b and 5b.

Analysed samples represent the composition of total 1 to 2 m long drill cores. Variations in chemical composition in each drill hole are represented as XY-diagrams where concentration are examined as a function of depth. The depth value is either the beginning or the end depth of the sample. Simplified rock type legends of the Figures have been drawn according to the original drill core reports, in which a few thin rock type intervals have been neglected.

Factor analyses and correlation matrixes were made for each ore type at Outokumpu Finnmines Oy. The results are given in Appendices 1c-d, 2c-d, 3c-d, 4c-d and 5c-d.

For the calculation of normative mineral composition the chemical composition of scapolite and amphibole was determined by Cameca SX-50 electron microprobe. The results are given in Appendix 6.

Abbreviations used for minerals and rock types are given in Table 3.1

Table 3.1. Abbreviations used for minerals and rock types

abb		name	abb		name
af	=	amphibole	pa	=	paragonite
ab	=	albite	phl	=	phlogopite
bt	=	biotite	plg	=	plagioclase
chl	=	chlorite	pn	=	pentlandite
cp	=	chalcopyrite	po	=	pyrrhotite
crb	=	carbonate	py	=	pyrite
da	=	davidite	qtz	=	quartz
dol	=	dolomite	ru	=	rutile
grf	=	graphite	sca	=	scapolite
ilm	=	ilmenite	sp	=	sphalerite
mt	=	magnetite	tit	=	sphene
mu	=	muscovite	zir	=	zircon
ABFST	=	albitic felsite			
DB	=	diabase			
KRB	=	carbonate rock			
MDB	=	metadiabase			
ML	=	black shist			

For each sample the one-ion percentages were calculated. This is modified version of Eskola's (1954) system (see for example Appendix 3 in Cox et al. 1979). In addition to cations S and Cl were included and therefore the name one-ion instead of one-cation percentages was adopted. First weight per cent results (oxides, metals, Cl and S) were divided by equivalent weight of the elements (oxide, metal, Cl and S) producing atomic proportions. The equivalent weight of the metals and anions is the same as the molecular weight. That of the oxide is the same as the molecular weight when only one cation is present (e.g. SiO_2 , FeO) and half the molecular weight when two cations are present (e.g. Al_2O_3 , Na_2O). The atomic proportions were then totalled and recalculated as percentages (the one-ion percentages). Thus, for example if the Si percentage is 49.5 this signifies that of every 100 (cations + S + Cl) in the rock 49.5 of them are Si. The one-ion percentages are given in Appendices 1e, 2e, 3e, 4e and 5e.

Normative mineral composition of each sample was calculated from the one-ion percentages. For amphibole and scapolite compositions determined by electron microprobe were used (Appendix 6). Other minerals were assumed to be stoichiometric in composition. Calculation procedure is given in details in Appendix 7 and the calculation LOTUS-1-2-3 worksheet is given in enclosed diskette (Appendix 8) as a file called CALC.WK1.

Calculated normative mineral composition of each sample is given in Appendices 1f, 2f, 3f, 4f and 5f. Results are also presented as cumulative XY-diagrams, where the variations in mineral composition of each section is studied as a function of depth.

Carbonatization diagrams as well as Al-carrier diagrams were drawn after Kishida & Kerrich (1987) and Lamberg & Hautala (1990) on the basis of cation proportions and normative mineral composition.

The ratio of Fe-sulfides was estimated on the basis of Co and Ni contents in the samples. Hänninen (1983) and Sotka & Hänninen (1983) have determined the composition of Fe-sulfides by electron microprobe and by calculating after selective dissolutions from C ore. Co/Ni ratio are specific for pyrite and pyrrhotite. The calculated Co/Ni ratio average in pyrite is 2.9 and in pyrrhotite 0.38. These values have been used to estimate the pyrite/pyrrhotite ratio in analysed samples. The values 0.38 and 2.9 are marked in Co/Ni ratio diagrams (e.g. Fig. 4.7) by stippled lines. Only in few samples Co/Ni ratio is less than 0.38 or greater than 2.9 justifying estimations. Pentlandite is one source of error but it occurs such a small amounts in studied polished sections that it can be neglected. If it is present the amount of pyrrhotite is overestimated, which, however, is the "right direction" because pentlandite occurs in all cases together with pyrrhotite. In K ore melonite (NiTe_2) is common telluride and can carry significant amount of Ni (Palosaari and Hänninen, 1990) (Fig. 8.7) obscuring the pyrrhotite/pyrite ratio. The calculations are, however, in agreement with microscopical observations.

The calculations of alterations were made using Gresens (1967) equations. Alterations were illustrated by Isocon diagram after Grant (1986) (see also Lamberg & Hautala, 1990).

4 CU ORE C2

4.1 Introduction

C2-ore is located on the southern part of the north-south trending Bidjovagge antiform (Fig. 2.1). C2-ore is one of the orebodies belonging to the ore type rich in Cu and named therefore as Cu ores. Ore types have recently been described by Björlykke et al. (1991) and Ekberg & Sotka (1991). Copper ore type is characterized by being rich in sulphides, mainly chalcopyrite (3-4 % Cu) and pyrite, having minor tellurides and native gold (1-2 g/t Au) (Ekberg & Sotka, 1991).

Drill hole S128I (C2-ore) intersects black schists with thin graphite felsite parts (not shown in the legends of the Figures), albitic felsite, which also hosts the Au mineralization, and metadiabase dykes (Appendix 1a). Rock type intervals and data on the samples from each rock type are given in Table 4.1.

Table 4.1. List of the samples of C2-ore.

INTERVAL metres	ROCKTYPE	CHEMISTRY n	SAMPLE	PETROGRAPHY depth (m)
20.0-21.9	metadiabase	-	-	-
21.9-30.0	albitic felsite	4	-	26.3
30.0-49.0	black schist	-	-	-
49.0-53.0	albitic felsite	2	-	51.3
53.0-59.4	metadiabase	2	-	55.5
59.4-71.5	albitic felsite	9	-	65.8, 70.3
71.5-76.3	black schist	-	-	-
76.3-118.0	albitic felsite	27	-	81.6, 91.8 112.5, 116.5
118.0-121.4	black schist	-	-	-

4.2 Chemistry

XRF-analyses are presented in Figs. 4.1-4.8, where the ratios of immobile elements and element concentrations have been presented as a function of depth. Roughly estimated averages of the most important elements in albitic felsite, metadiabase and ore are given in Table 4.2. Values for rock types high in CO₂ and low in CO₂ are given.

Table 4.2 Average chemical composition of different rock types in C2-ore.

		MgO wt.%	FeO wt.%	SiO ₂ wt.%	Al ₂ O ₃ wt.%	Na ₂ O wt.%	CaO wt.%	CO ₂ wt.%	TiO ₂ wt.%	S wt.%	Cu wt.%	Au ppm	Al ₂ O ₃ /TiO ₂
ALBITIC	low CO ₂	2	14	55	10	7.5	2	3	0.45	12	1	0.5	25
FELSITE	high CO ₂	8	14	30	10	7.5	10	12	0.45	12	1	0.5	25
ORE	low CO ₂	-	-	-	-	-	-	-	-	-	-	-	-
	high CO ₂	4	16	40	10	5.5	6	9	0.4	12	6	5	20
METADIABASE	low CO ₂	-	-	-	-	-	-	-	-	-	-	-	-
	high CO ₂	7	9	45	10	6.5	9	9	1.3	2	0	0	9

Diagrams of immobile element ratios (Figs. 4.1-4.2) point clearly the different rock types and also Au ore in drill hole S128I. $\text{Al}_2\text{O}_3/\text{TiO}_2$ ratio is approximately 25 for albitic felsites versus 9 for metadiabases. $\text{Al}_2\text{O}_3/\text{Cr}_2\text{O}_3$ ratio is about 500 vs. 750, $\text{TiO}_2/\text{Cr}_2\text{O}_3$ 20 vs. 80 and $\text{ZrO}_2/\text{TiO}_2$ 0.025 vs. 0.010, respectively. One sample within the albitic felsite (between 60-70 m) has got immobile ratios characteristic for metadiabase. In between 20-30 m metadiabase has got peculiar immobile element ratios: $\text{Al}_2\text{O}_3/\text{TiO}_2 = 30$, $\text{Al}_2\text{O}_3/\text{Cr}_2\text{O}_3 = 600$, $\text{TiO}_2/\text{Cr}_2\text{O}_3 = 20$ and $\text{ZrO}_2/\text{TiO}_2 = 0.03-0.04$.

Albitic felsite and metadiabase doesn't differ notably in chemical composition (Table 4.2). Only TiO_2 , Cl and P_2O_5 contents are clearly higher in metadiabase. TiO_2 is greater than 1 wt.% in metadiabase and about 0.5 wt.% in albitic felsite (Fig. 4.4), Cl contents are greater than 0.1 wt.% and 0.01 wt.%, respectively (Fig. 4.7) and for P_2O_5 values are 0.15 wt.% and 0.05 wt.%, respectively. Other differences in chemical composition of these rock types are obscured by the highly varying CO_2 -content in albitic felsite ($\text{CO}_2 = 1-22$ wt.%).

Au mineralization is located between 70 and 80 metres hosted by albitic felsite, the content of Au being approximately 5 ppm (Table 4.2). The mineralization doesn't differ in main element composition from barren albitic felsites. Immobile element ratios in Au ore differ slightly from the values of the albitic felsite. In the ore $\text{Al}_2\text{O}_3/\text{TiO}_2$ is lower than in albitic felsite being about 20, $\text{Al}_2\text{O}_3/\text{Cr}_2\text{O}_3$ is about 400 and $\text{ZrO}_2/\text{TiO}_2$ ratio is varying strongly in the vicinity of the ore.

If chemical variations and their relations in rock types are examined closer, it can be noticed that some elements are following each other sympathetically. These relations are not (necessarily) related to host rock, but same correlations can be noticed both in metadiabase and albitic felsite. Correlation matrix for C2 ore is given in Appendix 1c and rotated factor matrix in Appendix 1d.

CO_2 is accompanied by CaO, MgO and MnO (plus FeO in lesser degree). These carbonate forming elements (CF elements or CFE's) have positive correlation coefficients ($r=0.48-0.79$) and are grouped in the very same factor F2. Immobile and silicate (albite+quartz) forming elements (IS elements or ISE's) SiO_2 , Al_2O_3 , Na_2O , ZrO_2 , Cr_2O_3 and TiO_2 act diametrically opposite to carbonate forming elements. IS elements are grouped in the same factor F2 as CF elements but they got negative loadings.

Sulfide forming chalcophile elements (SF elements or SFE's) Fe, S, Cu, Co, Ni, Zn and Pb are grouped together (factors F8 and F6) and they have negative correlation coefficients with IS elements and positive with CF elements.

K is somewhat unique. It has got weak positive correlation ($r=0.26-0.50$) with other IS elements except Na. Potassium is associated most strongly with Rb, Ba, Sr, Y, Cl and Mg, which are grouped in the very same factor F1 with positive loadings. These elements are incorporated mainly in phlogopite (Cl in scapolite) and are thus called as phlogopite forming elements (PF elements or PFE's).

Cl show interesting features. In addition associated with PF elements it shows positive correlation with Ti, P and negative correlation with Cr. These relationships are related to metadiabase and therefore called metadiabase association (MDBA). Cl, Ti and P have positive correlation with CFE's.

Ce, La and Nb (in lesser degree) are following each other sympathetically (Fig. 4.8) (grouped in factor F9) and have positive correlation with IS elements ($r=0.30-0.63$).

Gold shows positive correlation with Cu, Mo and U, and they are all grouped in factor F3 with negative loadings. Gold has weak positive correlation with other chalcophile elements (SFE's) ($r=0.21-0.84$) and with CF elements. Weak negative correlation is noted with respect to IS elements.

Co/Ni ratio (Fig. 4.7) ranges widely, but Au ore is located in local Co/Ni minimum ($Co/Ni = 1$). Outwards the ore Co/Ni increases irregularly. However metadiabase sheet between 53-59 metres is low in Co/Ni ratio (about 1-2) and - interesting enough - rimmed by albitic felsites high in Co/Ni ratio (> 2.5).

The summary on the chemical features observed in drill hole S128I is given below:

- metadiabase can be distinguished from albitic felsite on the basis of immobile element ratios, higher Ti, Cl and P concentrations and lower Cr content (MDBA)
- other elements doesn't show any marked differences with respect to rock type
- some elements are associated with each other and they are grouped and named in the following way:
 - * carbonate forming elements (CFE's): C, Ca, Mg and Mn
 - * immobile and silicate (albite + quartz) forming elements (ISE's): Si, Al, Na, Zr, Ti, Cr
 - * sulfide forming chalcophile elements (SFE's): S, Cu, Fe, Ni, Co, Zn, Pb
 - * phlogopite forming elements (PFE's): K, Mg, Rb, Ba, Sr, Y and Cl
- CFE's shows negative correlation with ISE's
- SFE's show positive correlation with CFE's
- Au shows positive correlation with Cu, U and Mo and weak positive correlation to SFE's

BIDJOVAGGE, C2-ORE / S128I

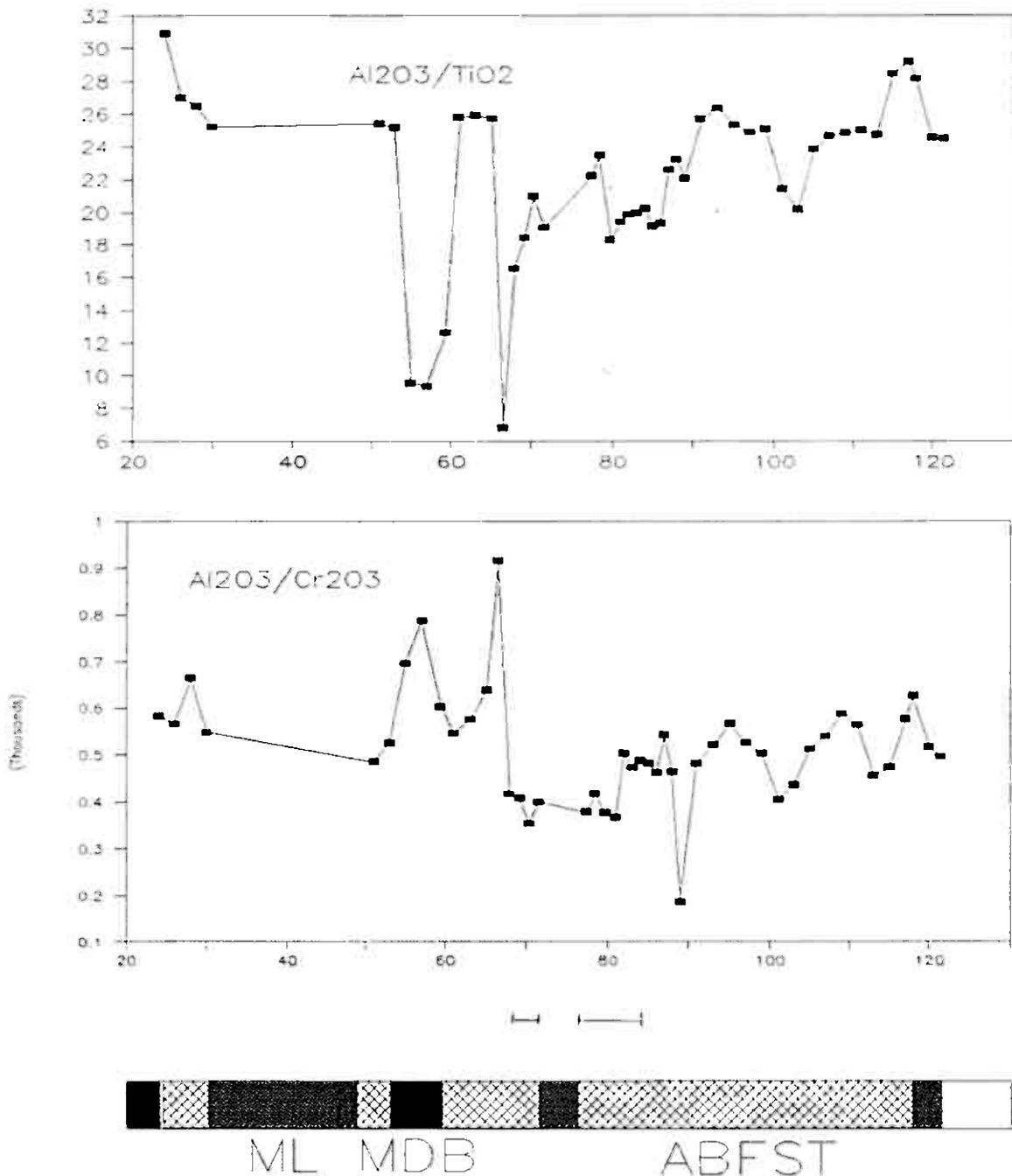


Fig. 4.1. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Ratios of immobile elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C2-ORE / S128I

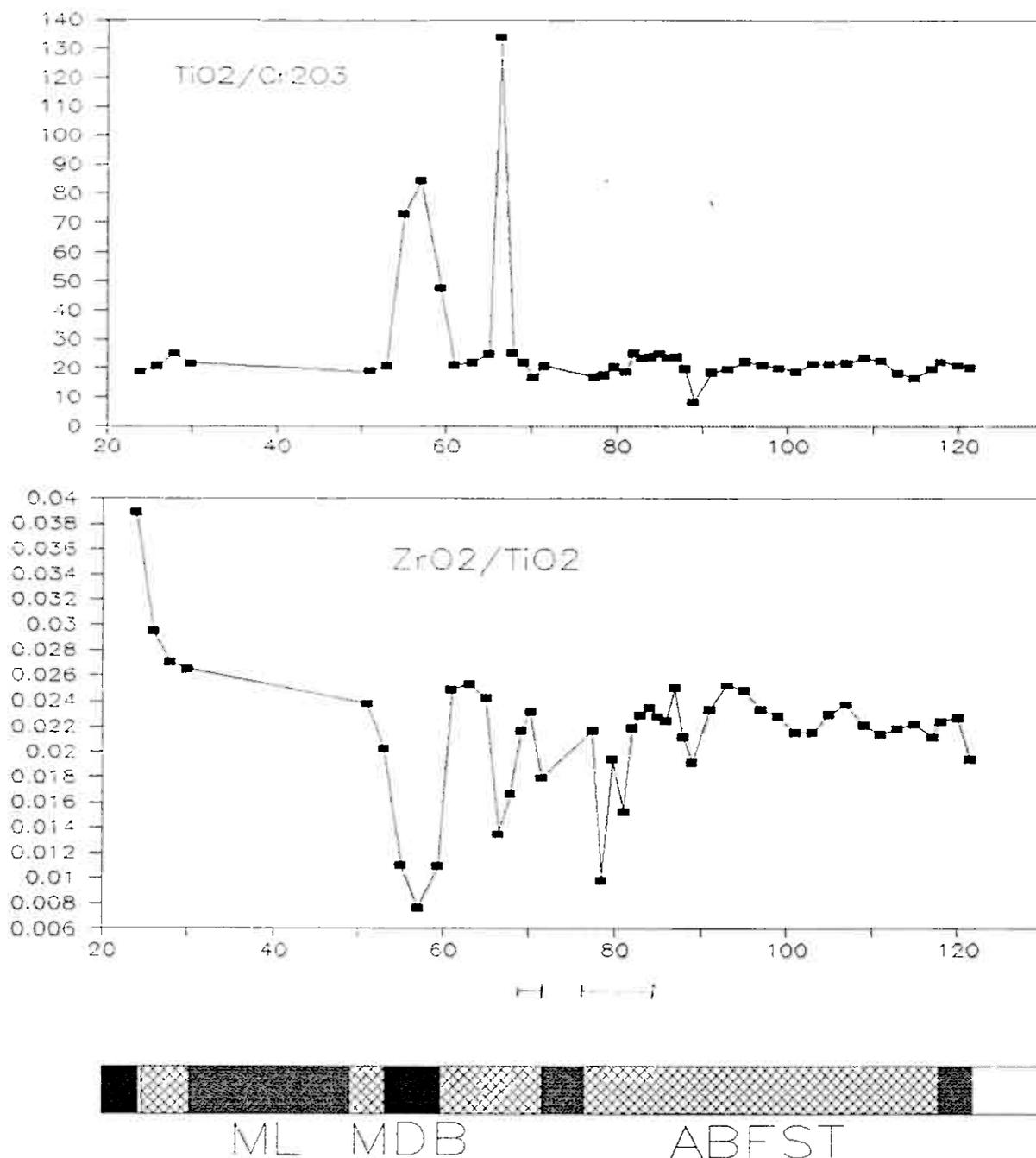


Fig. 4.2. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Ratios of immobile elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C2-ORE / S128I

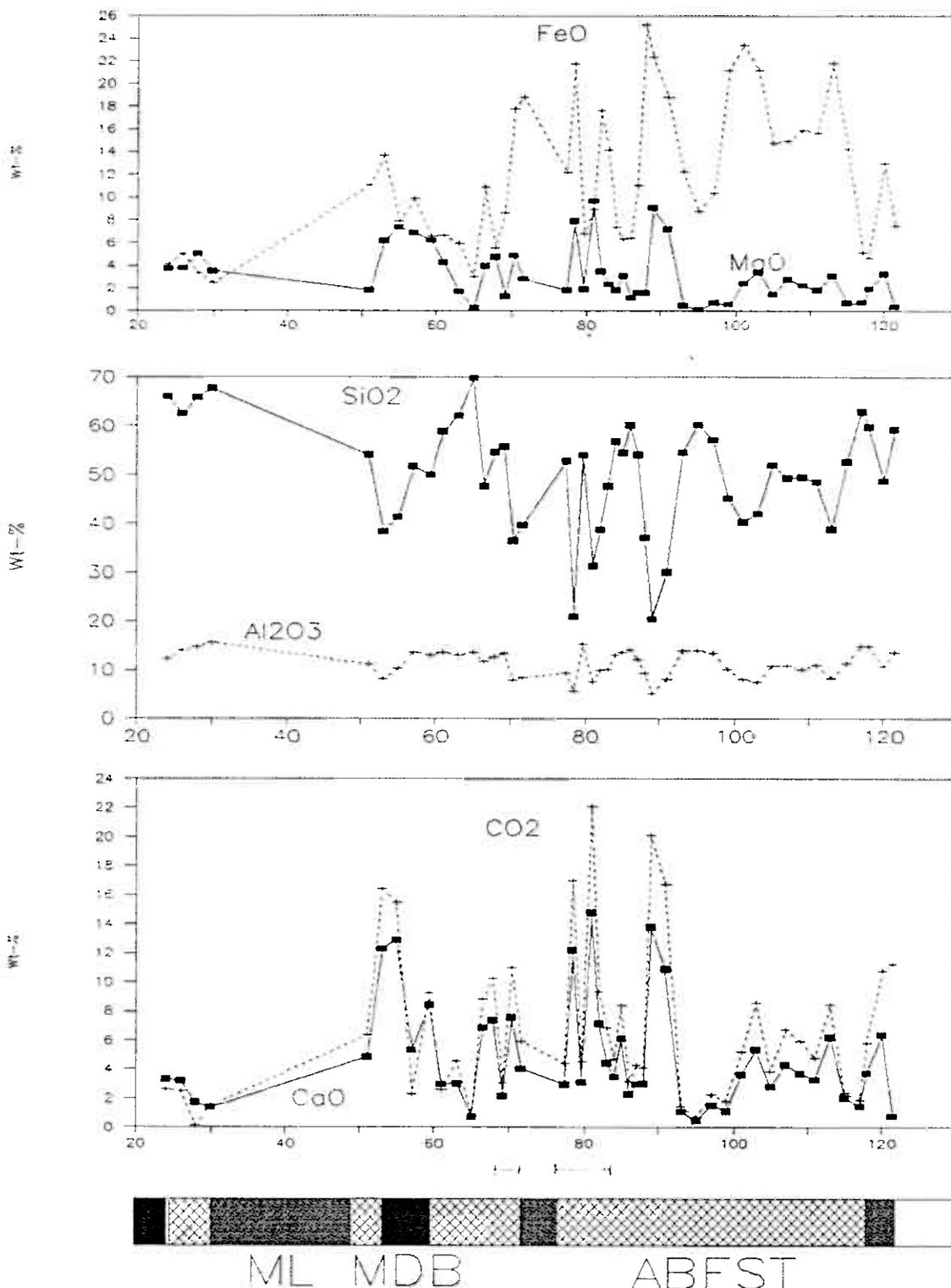


Fig. 4.3. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Named elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C2-ORE / S128I

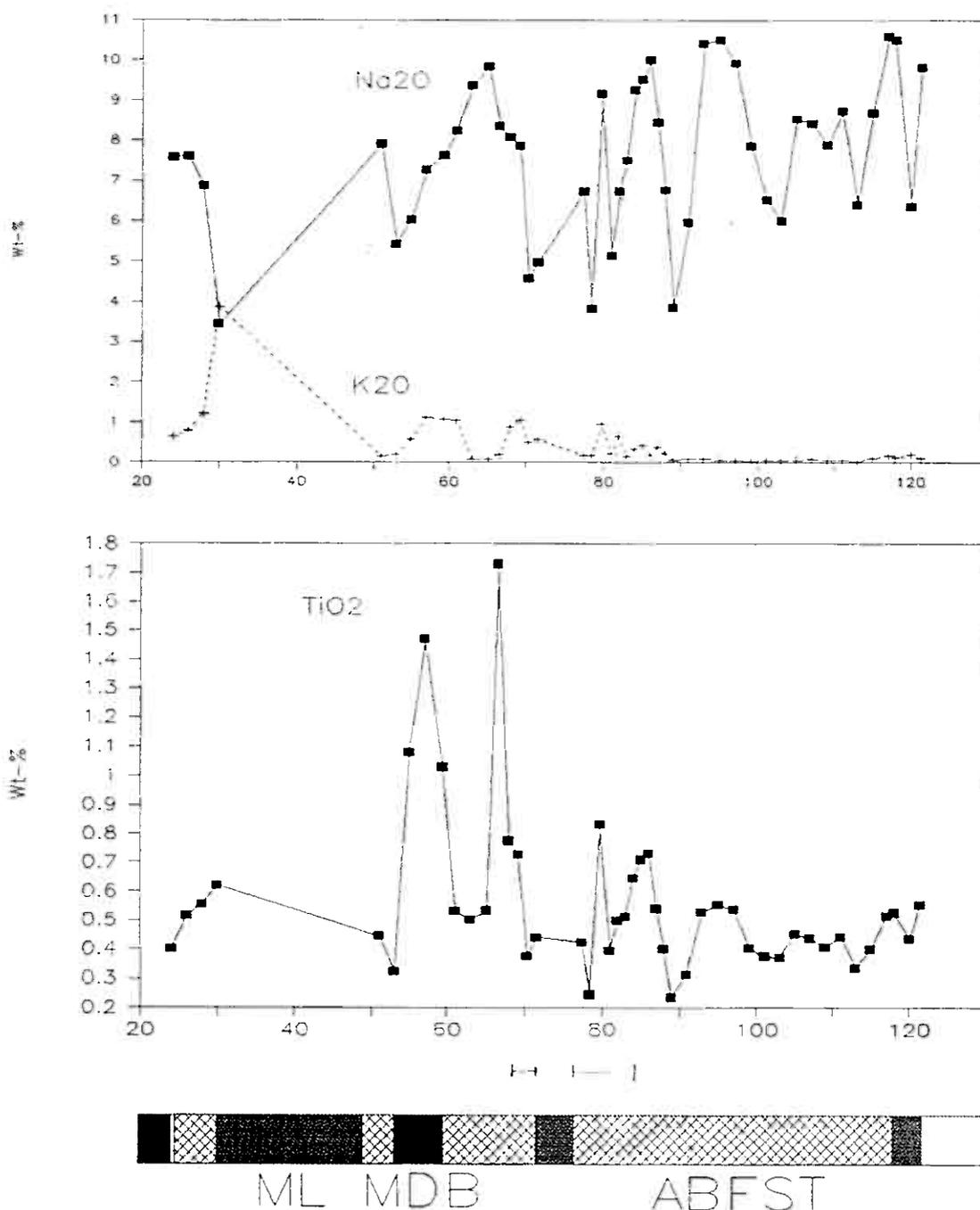


Fig. 4.4. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Named elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C2-ORE / S1281

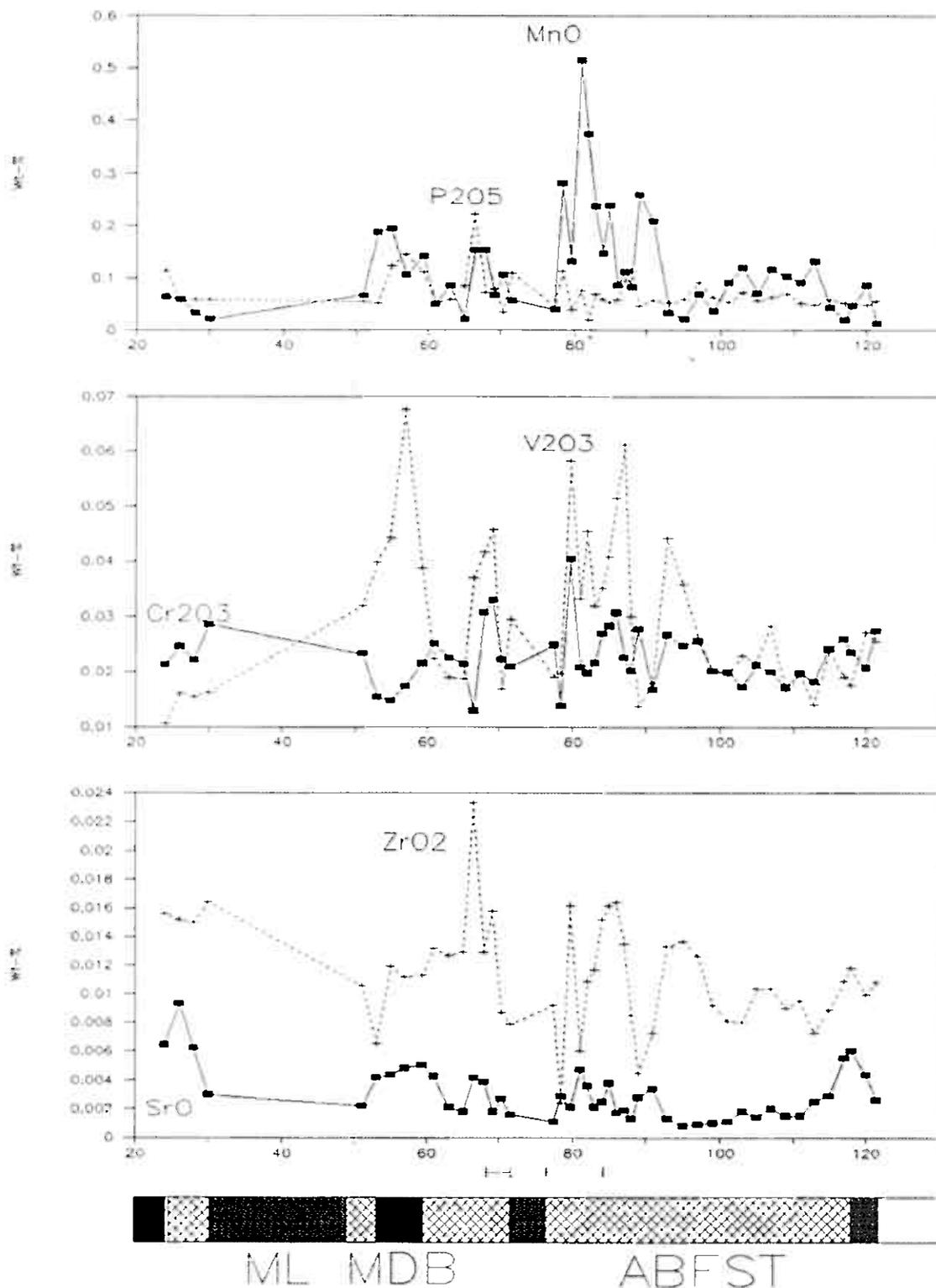


Fig. 4.5. Bidjovagge, C2-ore, drill hole S1281 (rock type legend simplified). Named elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C2-ORE / S1281

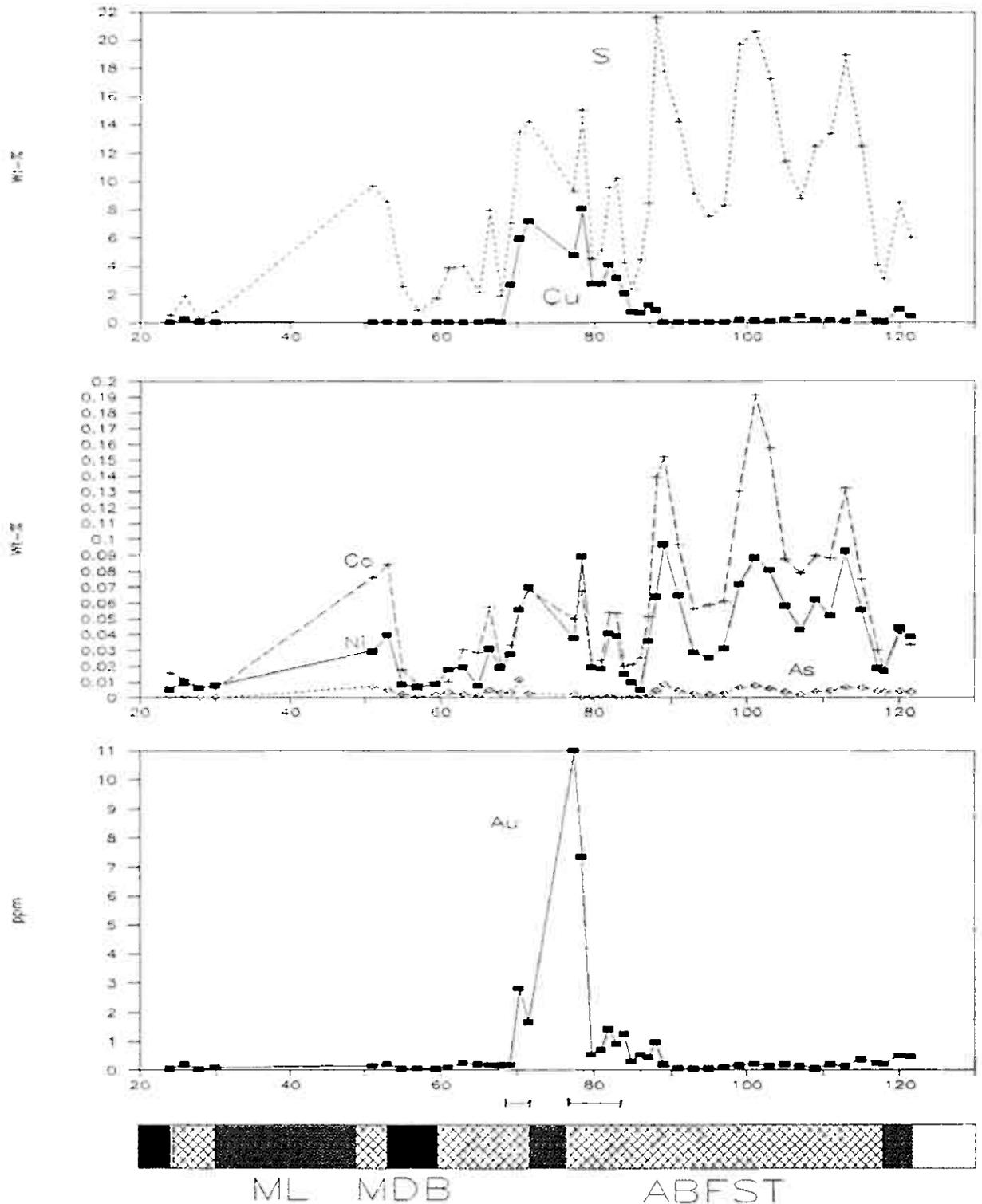


Fig. 4.6. Bidjovagge, C2-ore, drill hole S1281 (rock type legend simplified). Named elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

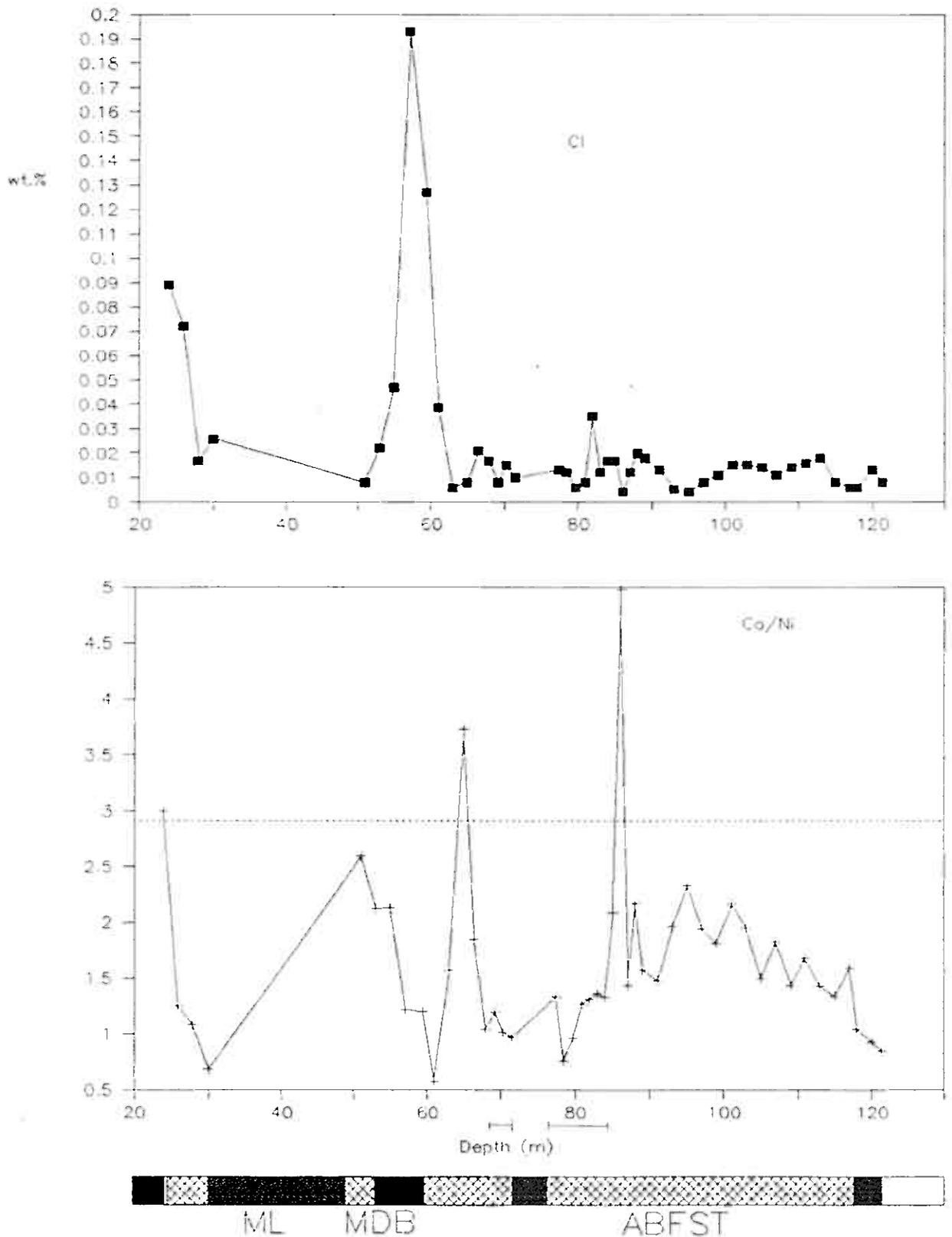


Fig. 4.7. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Named elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

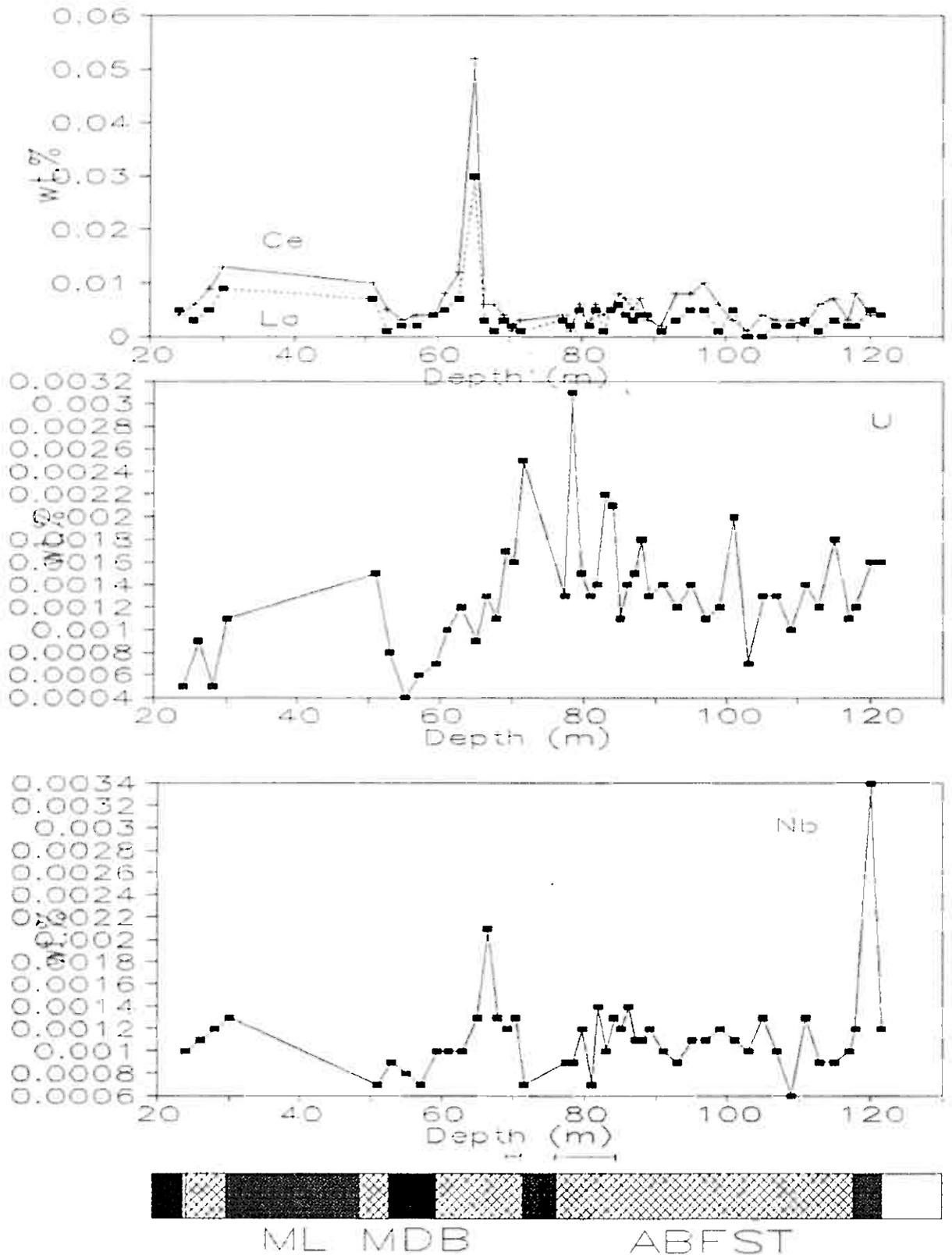


Fig. 4.8. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Named elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

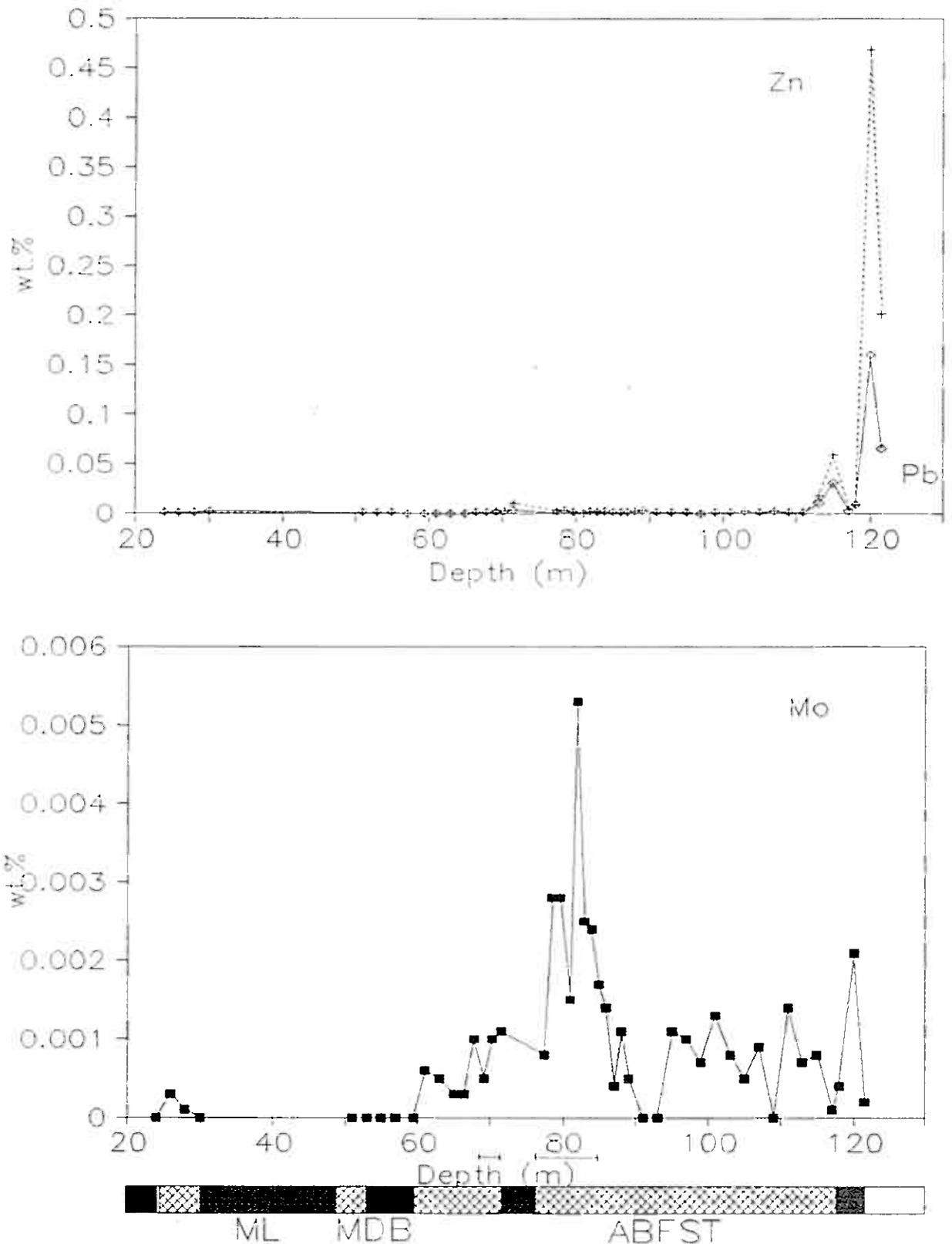


Fig. 4.9. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Named elements as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

4.3 Petrography

For the petrographical study nine samples from the drill hole S128I were selected between 26.3 and 116.5 metres. Summary on the mineral composition of the samples is given in Table 4.3.

Six samples (26.3 m, 51.3 m, 81.6 m, 91.8 m, 112.5 m and 116.5 m) are classified as albitic felsites. The groundmass of this rock type is composed of fine grained slightly lineate or polygonal albite and quartz grains. Rutile ± ilmenite are common accessories. Grain size is typically about 10 µm.

Table 4.3. Summary on the petrographical study on Bidjovagge C2 ore samples, drill hole S128I. Abbreviations for rock types and minerals are given in section 3. Minerals are given in the order of abundance. In column φ_{ab} (µm) the average diameter of albite is given in micrometres; if two values are given, the first is for groundmass and the second for veins. Ind:a(O₂) = indicative minerals for oxygen activity (fugacity) determination, Ind:pH = indicative minerals for pH determination.

Depth (m)	Rock type	Represents	"Ground mass" minerals	Vein minerals	φ _{ab} (µm)	Ind:a(O ₂)	Ind:pH	Note: reactions etc
26.3	ABFST	"least altered"	ab,qtz,ru,(ilm)	af,phl,qtz,po,cp,(pa,chl)	10	po,(ilm)	ab-pa	radial af prisms
51.3	ABFST	"least altered"	ab,qtz,ru,ilm	py,chl,crb,ab,phl,af,(sca)	10/270	py,ilm	ab	af->chl,sca->chl+crb,ilm->ru
55.5	MDB	"least altered"	ab,af,phl,chl,sca,crb,mt,ilm,py,apa,(po)	-	430	py-ilm-mt	ab	po inclusions in py
65.8	MDB	close to the ore	ab,crb,af,qtz,tit,ru,apa,mt,ilm,py,sca	(crb,af,tit)	450	py-ilm-mt	ab	ilm->ru, coarse af
70.3	CRB-v/ ABFST	Cu-Au ore	-	crb,pa,chl,qtz,cp,po,py	-	po-py	pa	sca->chl+crb ?
81.6	ABFST	Cu-Au ore	ab,qtz	crb,cp,phl,qtz,po,mt,py,ab,chl:ilm	10/300	po-mt-py	ab	sca->chl+crb ?
91.8	ABFST	close to the ore	ab,qtz,chl	ab,qtz,py,mt,crb,phl,chl,cp	10/200	py-mt	ab	phl->chl
112.5	ABFST	"least altered"	ab,qtz,chl,ru	ab,qtz,py,crb,chl,ilm,(mt)	10/200	py-ilm,(mt)	ab	
116.5	ABFST	"least altered"	ab,qtz,ru	pa,crb,qtz,py,ab,chl,apa,cp,po,ilm	10	py-po,ilm	pa-ab	chl in the contact between vein and host rock

All albitic felsite samples are cut by numerous veins ranging from < 1 µm to 4 mm in thickness. Veins are sometimes parallel but more often they are irregular in shape: branching, swelling, pinching and so on. In some cases veins are crosscutting each other but no clear evidence about veins of different age can't be found. Vein minerals occur also in groundmass, but differ from it by coarser grain size, and are included also in "vein minerals". Many mineral parageneses can be found in veins (minerals in the order of abundance):

- af-phl-qtz-po-cp-pa-chl (no crb) (26.3 m)
- py-chl-crb-ab-phl-af-(sca->chl+crb) (51.3 m)
- crb-cp-phl-qtz-po-mt-py-ab-chl±ilm-(sca->chl+crb ?) (Au-ore) (81.6 m)
- ab-qtz-py-mt-crb-phl-chl-cp (close to the ore) (91.8 m)
- ab-qtz-py-crb-chl-ilm-mt (112.5 m)
- pa-crb-qtz-py-ab-chl-apa-cp-po-ilm (116.5 m)

The dominant oxide mineral in the albitic felsite hosted Au-ore sample (81.6 m) is magnetite. It can be found in contact with all sulfides, also with pyrite, although rarely. Grain size of magnetite is typically about 300 μm . Ilmenite is not so abundant as magnetite. In some cases relics of rutile grains can be found as inclusions in ilmenite. Thus it seems that rutile is replaced by ilmenite in the ore sample 81.6 m. Two textural varieties of pyrite can be found in Au-ore sample(s) 81.6 m (and 70.3 m). The more common texture - occurring also in other samples - is eu-subhedral grains of more than 150 μm in diameter. The pyrite grains of another textural variety can be found only in ore samples. They are filling silicate interstices (can form a shell on albite), are sub-anhedral, outer faces are often extremely rugged and the grain size is typically about 50 μm .

Towards the ore the amount of vein material in albitic felsite increases. The mineral composition changes in veins towards the ore:

- the amount of sulfides - especially chalcopyrite - increases
- the dominant Fe-sulfide changes from pyrite to pyrrhotite
- magnetite becomes abundant mineral occurring as stable mineral ($\phi = 250 \mu\text{m}$) with chalcopyrite-pyrrhotite-pyrite sulfide assemblage
- the amount of carbonate(s) increases
- the amount of phlogopite + amphibole decreases as a function of depth

Metadiabase sample 55.5 m is composed of albite, amphibole, and biotite (main minerals) plus scapolite, ilmenite and magnetite with some chlorite and carbonate, apatite & pyrite as accessories. Texture is unoriented and homogeneous. Grain size is distinctly coarser than in albitic felsite ($\phi = 750 \mu\text{m}$ vs. 10 μm , respectively). Magnetite, ilmenite and pyrite occur as sub- to euhedral grains but all other minerals are anhedral. Albite laths are unoriented and numerous carbonate, biotite and amphibole inclusions can be found in them. Amphibole is green coloured clin amphibole. Scapolite occurs as large (poicilitic or porphyroblastic) grains enclosing albite, biotite and amphibole. Along the cleavage planes scapolite has altered to chlorite. Carbonate occurs as small anhedral inclusions in albite.

Sample 65.8 m (close to Au ore) is somewhat unique. It is composed:

- 1.) mainly of metadiabase like albite ($\phi = 600 \mu\text{m}$), magnetite and rutile + minor biotite, ilmenite and carbonate (as inclusions in albite). Ilmenite has altered to rutile.
- 2.) of irregular portions of albitic felsite like fine grained ($\phi = 30 \mu\text{m}$) albite \pm quartz
- 3.) of up to 3 mm wide coarse grained ($\phi = 0.7$ to 1.0 mm) veins of carbonate, amphibole, albite, pyrite + minor quartz

Au-ore sample 70.3 m is coarse grained ($\phi = 1.5 \text{ mm}$) carbonate-chalcopyrite-pyrrhotite-vein with quartz and pyrite + minor paragonite and chlorite (no oxide minerals). Chalcopyrite is often rimmed by pyrrhotite. Chalcopyrite, pyrrhotite and pyrite occur as stable mineral paragenesis.

4.4 Normative mineral composition

The mineral composition of each analysed sample was estimated on the basis of chemistry, petrography and microprobe analyses. In Fig. 4.10 a carbonatization diagram (see calculation and plotting basis in the section 3 or Lamberg & Hautala, 1990) is presented. In albitic felsites the degree of carbonatization (CarbInd) equals to $\text{Ca}+\text{Mg}/(\text{Ca}+\text{Mg}+\text{Fe})$, in other words, as atomic percentages C equals to $\text{Ca}+\text{Mg}$. Atomic relation Ca/Mg equals to 1. Thus, in albitic felsites the most likely carbonate species is dolomite. In metadiabases Ca and Mg are incorporated also in other minerals (amphibole, phlogopite, chlorite, scapolite), but dolomite is the most likely carbonate species also in metadiabase.

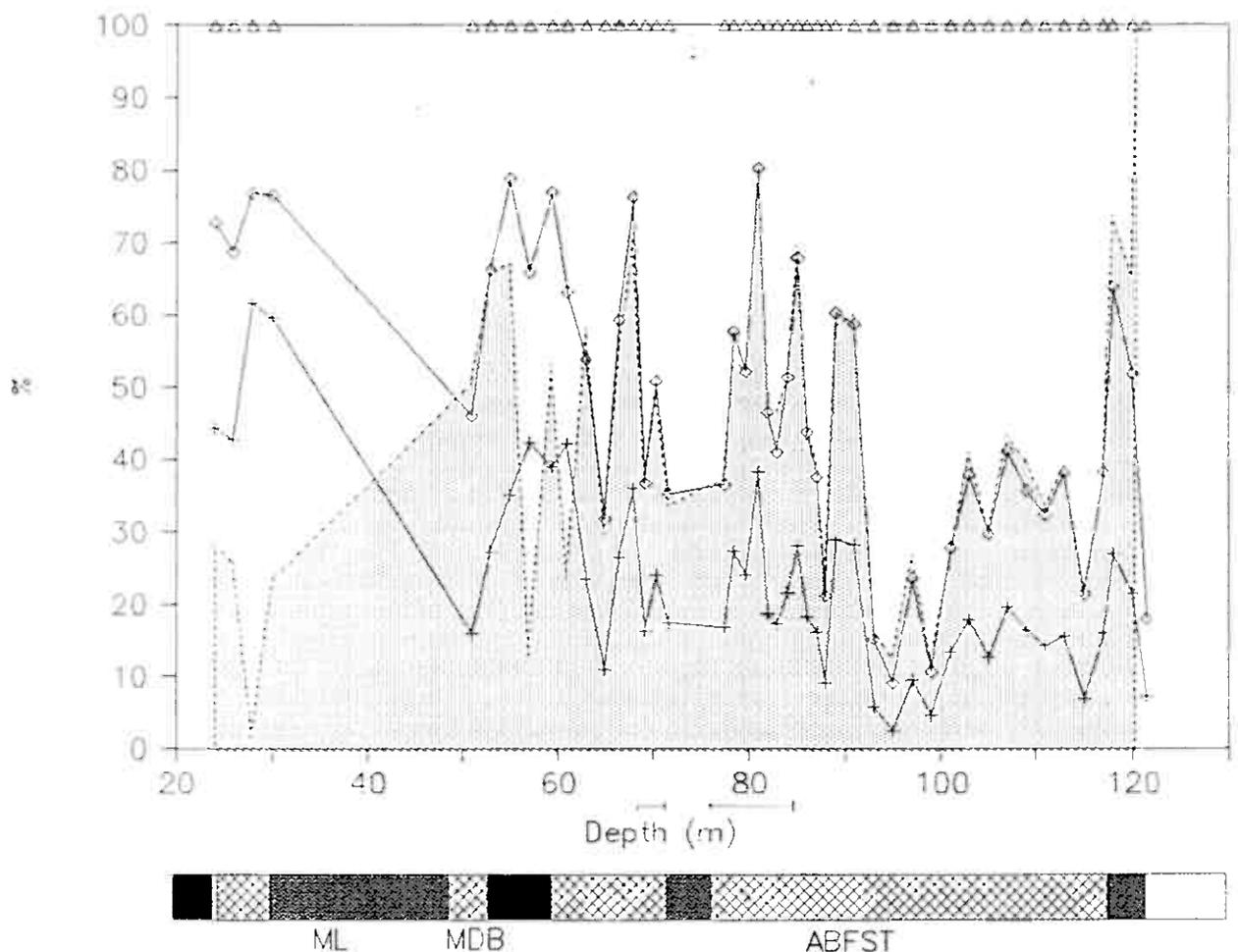


Fig. 4.10. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Carbonatization diagram, dotted field = the degree of carbonatization ($\text{C}/(\text{Ca}+\text{Mg}+\text{Fe})$), lines from bottom edge: calcite ($\text{Ca}/(\text{Ca}+\text{Mg}+\text{Fe})$), calcite + magnesite ($\text{Ca}+\text{Mg}/(\text{Ca}+\text{Mg}+\text{Fe})$) and calcite+dolomite+siderite (=100). More details see text. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albitic felsite, ML = black schist, MDB = metadiabase.

Normative mineral composition was calculated using schedule introduced in section 3. The result is given in Appendix 1f. In Fig. 4.11 the normative mineral composition of the samples is presented as cumulative XY-diagram, where depth is placed in X-axis. Normative mineral composition is in agreement with petrography.

Albite and dolomite are the dominant normative minerals in albitic felsite and in metadiabase. Phlogopite, amphibole and especially scapolite contents are higher in metadiabase. Phlogopite content is exceptionally high in metadiabase located between 20 and 22 metres. Albitic felsite is richer in albite and sulfides. Dolomite content varies widely in both rock types. Normative quartz is almost absent.

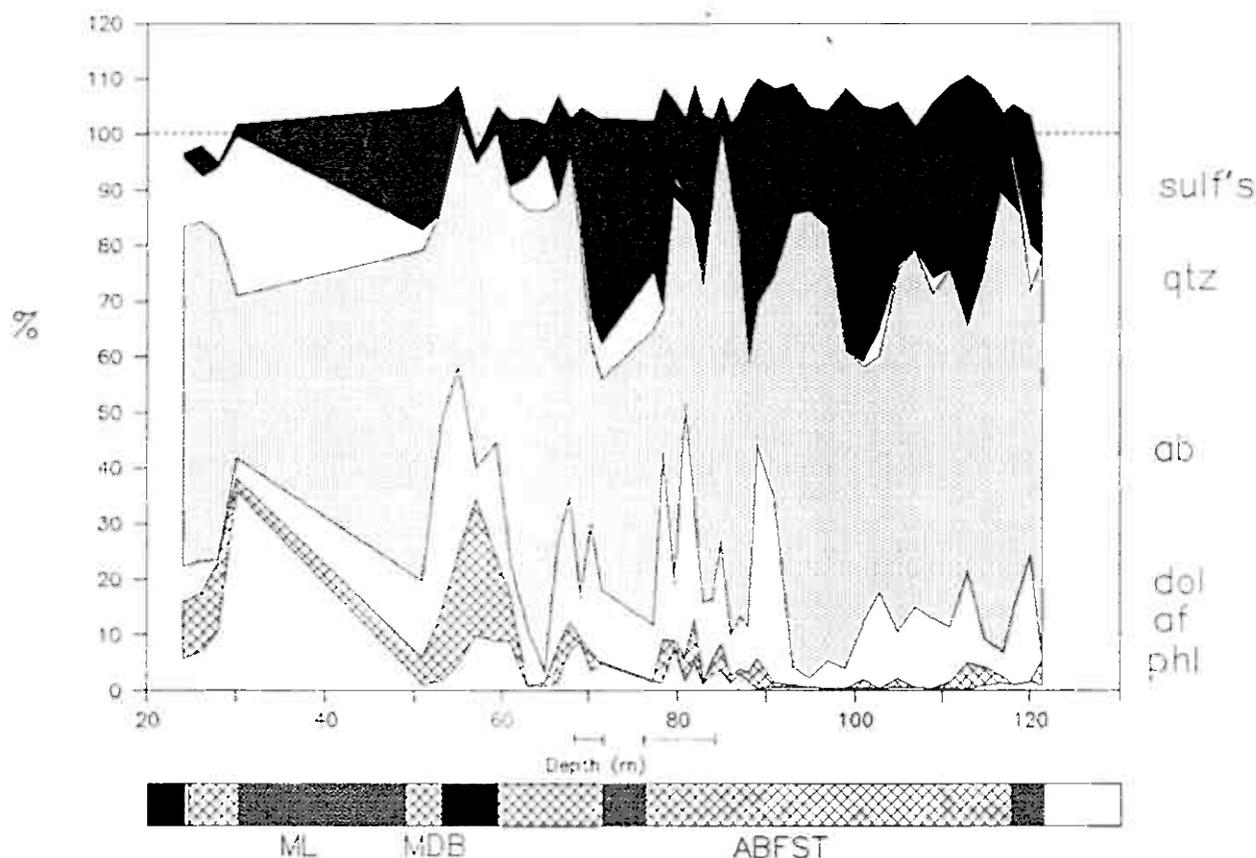


Fig. 4.11. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Normative mineral composition. Fields from lower edge to the top edge: phl = phlogopite (white), af = amphibole (cross hatched), dol = dolomite (white), ab = albite (dotted), qtz = quartz (white), sulf's = sulfides (chalcopyrite + pyrrhotite + pyrite) (black). More details see text. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations in rock type legend: ABFST = albitic felsite, ML = black schist, MDB = metadiabase.

In Fig. 4.12 Al-carrier diagram (see calculation basis in chapter 3) is shown. Aluminium is carried mainly by albite. In metadiabase scapolite, phlogopite and amphibole carry about 20 % of aluminium. In barren albitic felsite albite carries more than 95 % of aluminium, but in the ore and its immediate vicinity 5 to 10 % of aluminium is carried by amphibole, phlogopite and scapolite. In the ore phlogopite carries significant amount (about 5 %) of aluminium. In addition to changes in Al-carrier ratios gold-copper ore seems to differ from surroundings by its abnormal high normative quartz content.

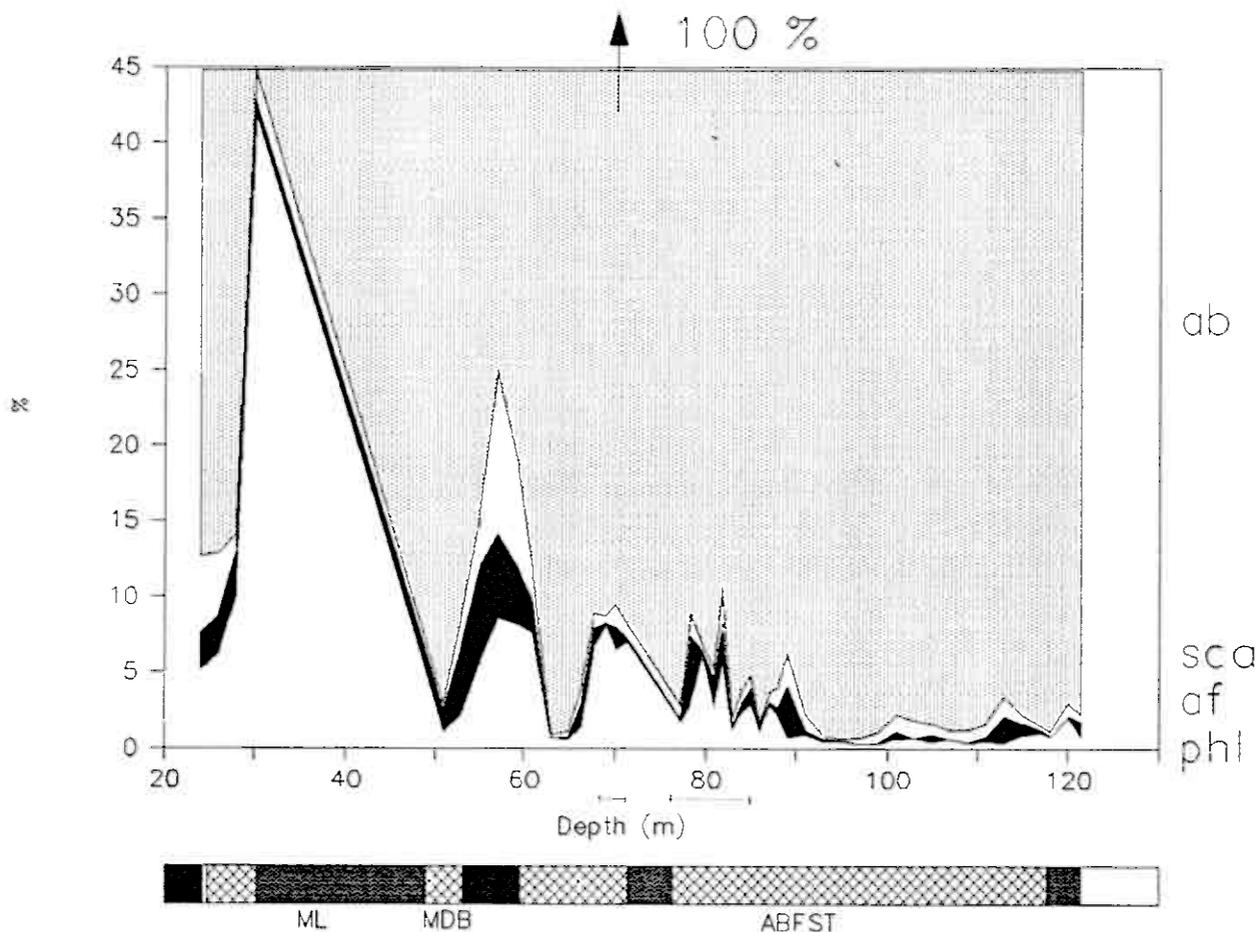


Fig. 4.12. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Normative aluminium carrier diagram. Fields from bottom edge to the top edge: phl = phlogopite (white), af = amphibole (black), sca = scapolite (white) and ab = albite (dotted). The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations in rock type legend: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

In Fig. 4.13 normative mineral composition of the Fe-Cu-sulfide phase (chalcopyrite, pyrrhotite and pyrite) is presented. In all samples both normative pyrite and pyrrhotite are present. Normative chalcopyrite content increases remarkably towards the ore. The ratio of Fe-sulfides was estimated on the basis Co/Ni (see section 3 and Fig. 4.7), and normative pyrite/(pyrite+pyrrhotite) ratio is plotted as a function of depth in Fig. 4.14. The dominant Fe-sulfide varies in both rock types. However in the contacts between albitic felsite and metadiabase

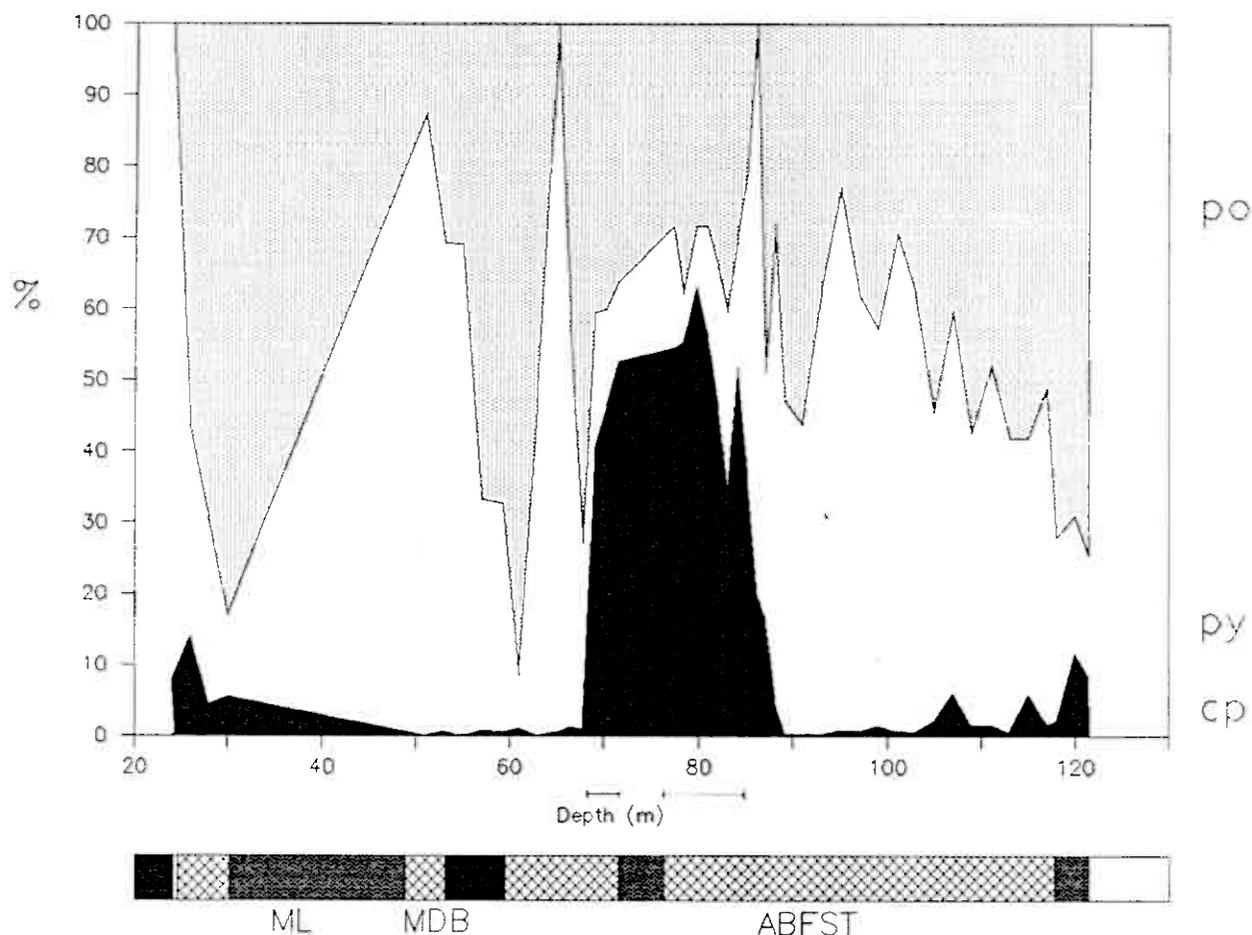


Fig. 4.13. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Normative mineral composition of the Cu-Fe-sulfide phase. Fields from bottom edge to the top edge: cp = chalcopyrite (black), py = pyrite (white), po = pyrrhotite (dotted). The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations in rock type legend: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

pyrite/(pyrrhotite+pyrite) ($=py/(py+po)$) ratio reaches its maximum ($py/(py+po) \rightarrow 1$) and ratio lowers towards the centre of the vein as well as towards the black schist ($py/(py+po) \rightarrow 0$). The ore is located in normative pyrite content minimum next to pyrite content maximum.

Chalcopyrite content correlates chiefly with pyrrhotite content. In almost all pyrite minimums chalcopyrite content in sulfide phase increases.

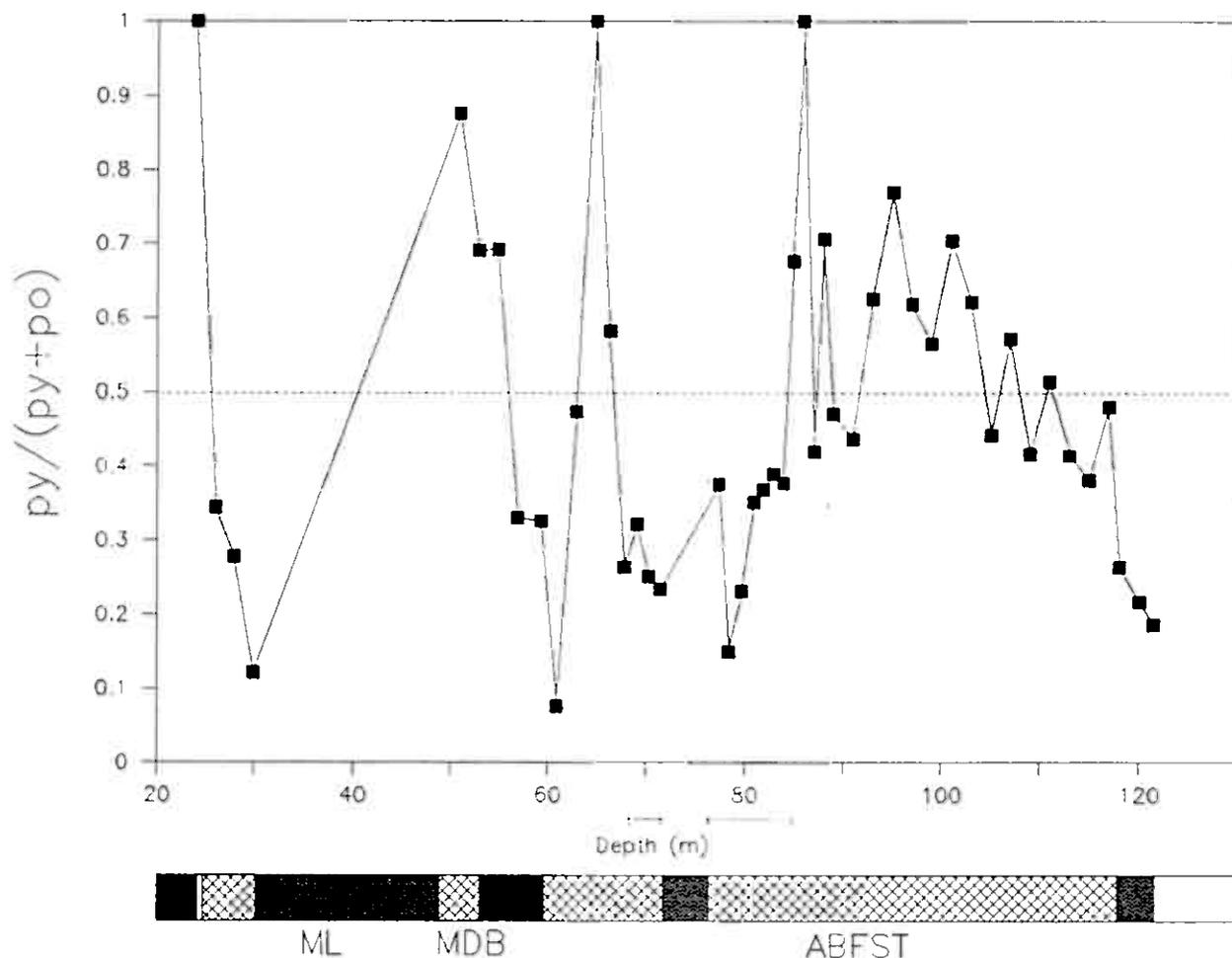


Fig. 4.14. Bidjovagge, C2-ore, drill hole S128I (rock type legend simplified). Normative pyrite/(pyrite+pyrrhotite) (py/(py+po)) ratio presented as a function of depth. The Cu-Au ore is located roughly between 70 and 80 metres on both sides of black schist (marked by lines). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

4.5 Summary of the features adjacent to the ore

The gold-copper ore C2 is hosted by albitic felsite, with abnormal immobile element ratios:

- $Al_2O_3/TiO_2 = 20$
- $Al_2O_3/Cr_2O_3 = 400$
- $ZrO_2/Cr_2O_3 =$ varies strongly 0.01-0.02

Ore hosting albitic felsite envelopes black schist and the ore is situating 10 m from the contact of wide (about 10 m) metadiabase vein and 3 m from the contact of narrow metadiabase portion (< 1 m) identified according to immobile element ratios, high TiO_2 , Cl and P_2O_5 .

Au is correlating clearly with Cu, U and Mo and weakly with chalcophile elements (SFE's).

The ore hosting albitic felsite differs from barren albitic felsite in mineral composition only slightly. "Ground mass" is composed of albite, quartz and rutile in both albitic felsites, but the amount of crosscutting veins increase and their composition change towards the ore:

- the amount of carbonate (dolomite) increases (varies widely)
- the amount of chalcopyrite increases dramatically
- the dominant iron sulfide changes from pyrite to pyrrhotite
- magnetite becomes as stable mineral with chalcopyrite, pyrrhotite and pyrite
- the amount of normative quartz is abnormally high in the ore
- the amount of Al carried by amphibole and phlogopite increases in albitic felsites towards the ore

5 CU ORE C3

5.1 Introduction

C3-ore is situated south from the C2-ore (Fig. 2.1). It is also an example of the copper ore type of Bidjovagge deposit (Björlykke et al., 1991; Ekberg & Sotka, 1991).

The rock types in drill hole S144F of C3-ore are mainly black schists and albitic felsites (Appendix 2a). In the beginning of the drill hole there are also metadiabases (not shown in Legends of the Figures), which are partly mixed with albitic felsites. The Au mineralisation is hosted by albitic felsite. Rock type intervals and data on samples in each interval are given in Table 5.1.

Table 5.1. List of the samples of C3-ore.

INTERVAL metres	ROCKTYPE	CHEMISTRY n	SAMPLE	PETROGRAPHY depth (m)
60.0-60.7	black schist	-		-
60.7-62.4	albitic felsite	1		-
62.4-88.10	black schist	-		-
88.10-160.0	albitic felsite	38		95.5, 104.4, 104.6 109.3, 119.2, 120.5 130.7, 141.5, 152.6

5.2 Chemistry

XRF-analyses are presented in Figs. 5.1-5.6, where the ratios of immobile elements and element concentrations have been presented as a function of depth in drill hole. Roughly estimated approximate values are given in Table 5.2, where the content of CO₂ has been regarded as a reference element.

Table 5.2 Average chemical composition of different rock types in C3-ore.

	MgO wt.%	FeO wt.%	SiO ₂ wt.%	Al ₂ O ₃ wt.%	Na ₂ O wt.%	CaO wt.%	CO ₂ wt.%	TiO ₂ wt.%	S wt.%	Cu wt.%	Au ppm	Al ₂ O ₃ /TiO ₂
ALBITIC FELSITE low CO ₂	6	14	45	10	7	5	5	1	6	1	1	18
ALBITIC FELSITE high CO ₂	6	14	20	10	2	15	25	0.2	6	1	1	18
ORE low CO ₂	1	18	20	10	4	3	3	0.6	13	6	14	14
ORE high CO ₂	-	-	-	-	-	-	-	-	-	-	-	-

Al₂O₃/TiO₂-ratio of true albitic felsites (Fig. 5.1) is approximately 18 (Table Y), which is clearly less than the ratio in the C2 ore and given by Lamberg & Hautala (1990) for albitic felsites. At the end of the drill hole S144F (between 125-160 m) the same ratio decreases sharply to the values usually characterizing metadiabases (average ratio about 5) (Fig. 5.1). This sharp change in ratios (also seen in Al₂O₃/Cr₂O₃- and TiO₂/Cr₂O₃-diagrams) indicate the location of the original contact of two different rock types. In the drill core log (Appendix 2a) rock type from 131 m to the end of the drill hole is called albitic felsite/metadiabase and in this report the name metadiabase is used for the rock unit from 135 metres to the end of the drill hole.

$\text{Al}_2\text{O}_3/\text{Cr}_2\text{O}_3$ ratio changes from about 500 in albitic felsite to 2500 in metadiabase and $\text{TiO}_2/\text{Cr}_2\text{O}_3$ ratio from 20 to about 500, respectively.

TiO_2 shows similar trends as immobile element ratios. The content is 0.2-1 wt.% in albitic felsites with varying CO_2 content (Table 5.2). Again the highest TiO_2 content at the end of drill hole (about 2.4 wt.%) points out the change in rock type to metadiabase. P_2O_5 is also higher in metadiabase as well as Cl, which varies quite widely, however, both in albitic felsite and metadiabase. Cl content decreases in the end of the drill hole to values typical for albitic felsite (0.01-0.02 wt.%). Cr_2O_3 content is lower in the metadiabase than in the albitic felsite (< 0.01 vs. 0.025 wt.%, respectively).

Au ore is located between 118 and 122 metres hosted by albitic felsite, the content of Au being approximately 14 ppm with low value of CO_2 (3 wt.%) (Table 5.2) (Fig. 5.6). The Au ore has slightly lower $\text{Al}_2\text{O}_3/\text{TiO}_2$ ratio than albitic felsites being about 14. Like in the case of C2-ore, the mineralization here is characterized only by having higher Cu and Au contents compared with barren albitic felsite.

Similar correlations as in the C2 ore can also be found between main elements in C3 ore (see correlation matrix and rotated factor matrix in Appendices 2c and 2d). Immobile and silicate forming (albite + quartz) elements Si, Ti, Al, Cr, Zr, Na (ISE elements or ISE's) are behaving sympathetically and have negative correlation with carbonate forming elements (CFE's) C, Mn, Ca, Mg. Phlogopite forming elements K, Rb and Ba (PFE's) are grouped together in factor F4. Sulfide forming chalcophile elements (SFE's) Fe, Cu, Ni, Co, S and As are grouped with Au and Ta in factor F3. Au and Cu have rather high positive loadings in factor F3 (Au: 0.70; Cu: 0.80). FeO, Ni, Co, S, As and Ta are in the same factor with strong positive loadings but correlation coefficient is higher for Cu - Au (0.66) compared to above mentioned elements in the same factor.

Co/Ni ratio (Fig. 5.7) increases towards the contact of albitic felsite and metadiabase from the value of 0.5 (< 100 m) to greater than 4 (125 m). In metadiabase Co/Ni decreases again. Some interesting features can be noted in relations of Cl and Co/Ni ratio. They have negative correlation but maximums are located next to each other. In other words, as soon as Co/Ni ratio decreases from its maximum, Cl reaches its maximum.

BIDJOVAGGE, C3-ORE / S144F

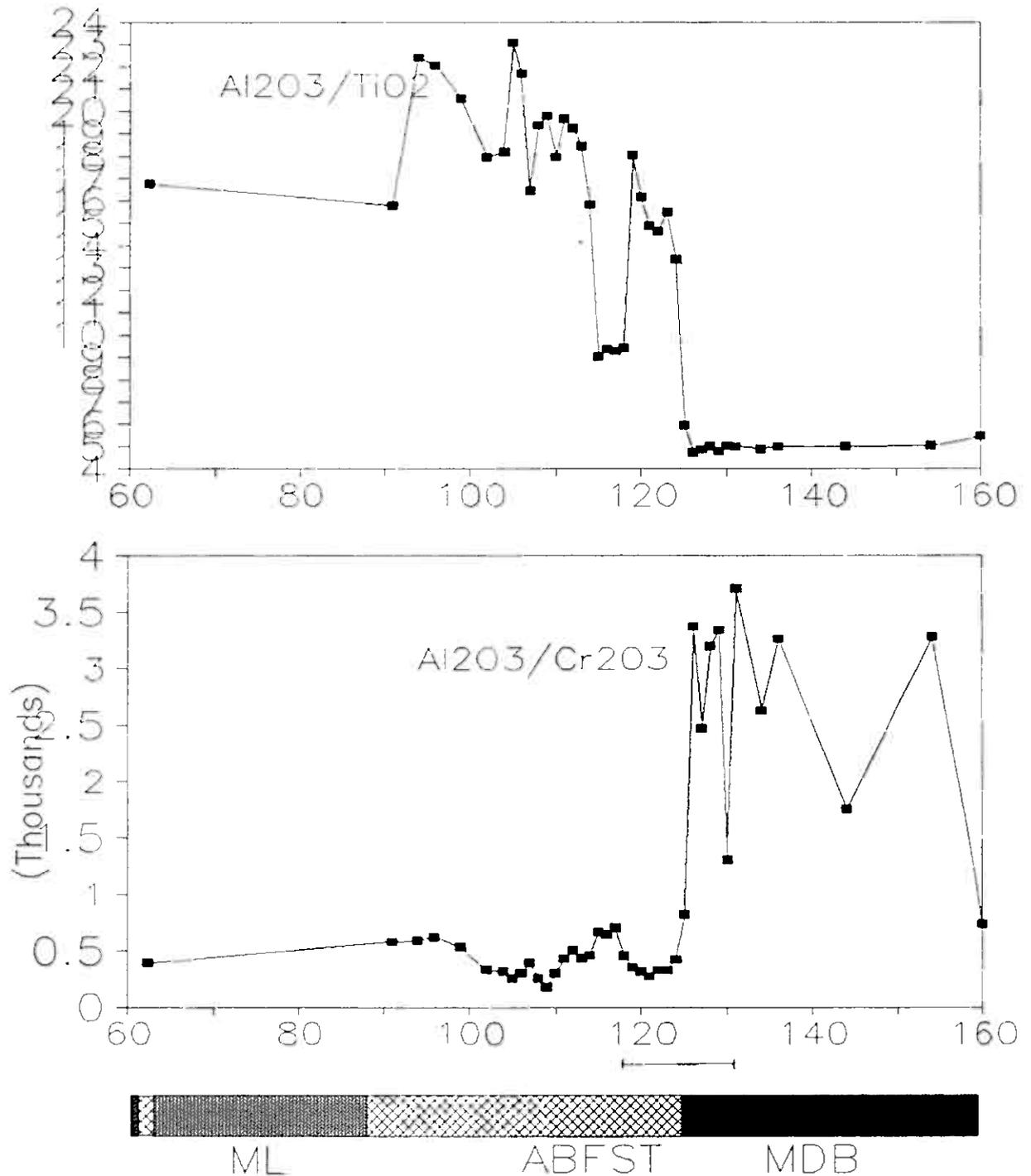


Fig. 5.1. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Ratios of immobile elements as a function of depth. The location of Cu-Au ore marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C3-ORE / S144F

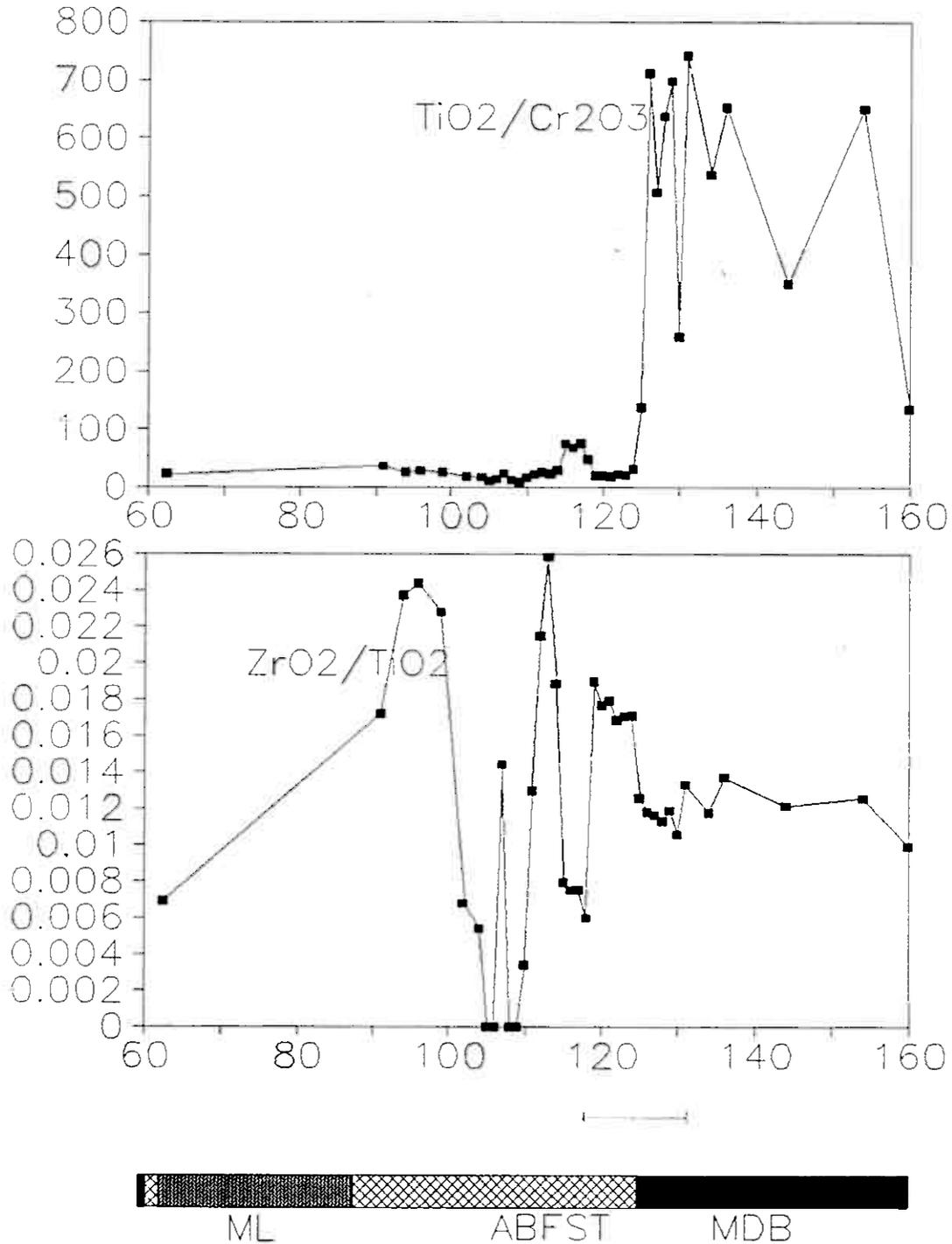


Fig. 5.2. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Ratios of immobile elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C3-ORE / S144F

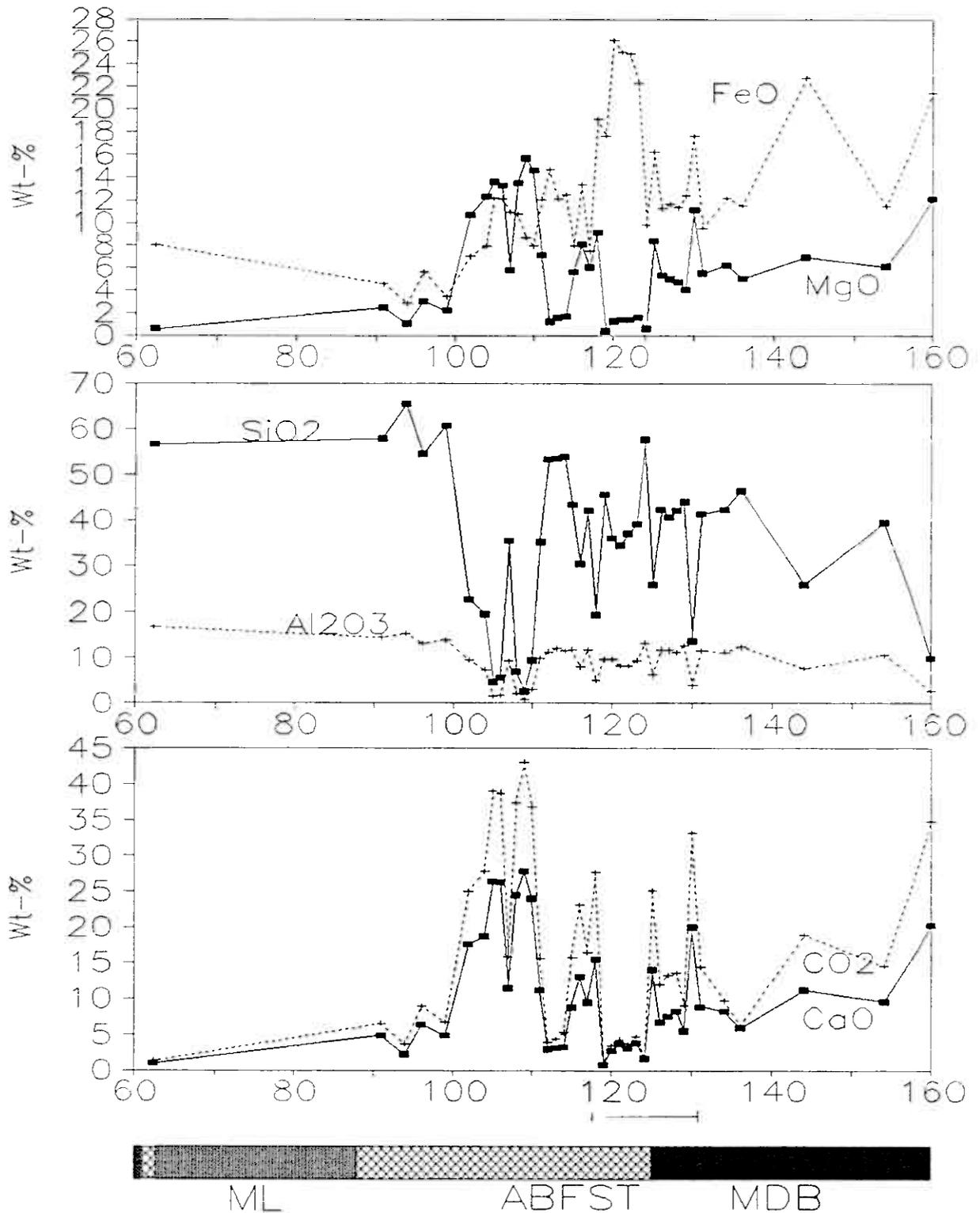


Fig. 5.3. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Named elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C3-ORE / S144F

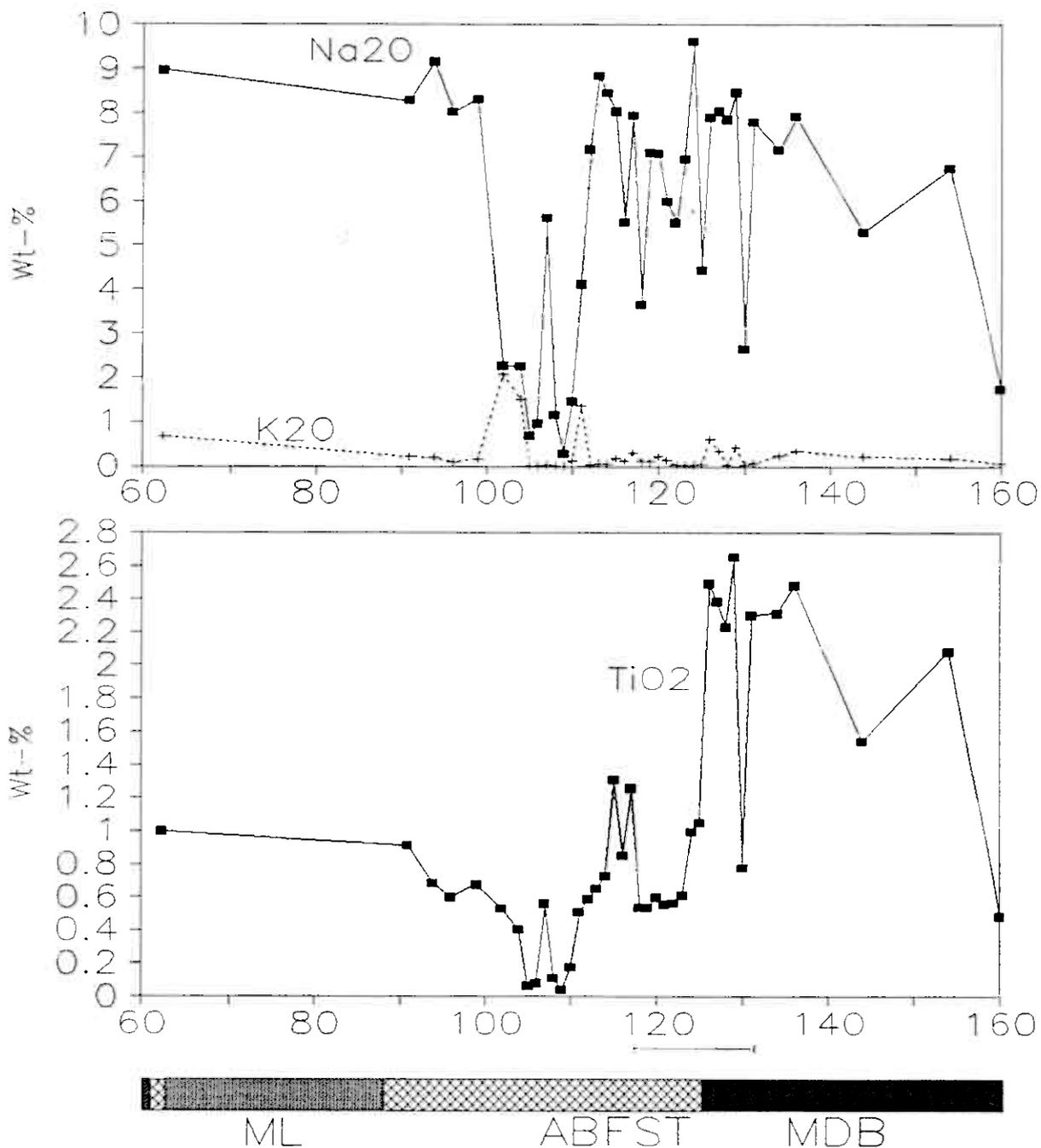


Fig. 5.4. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Named elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C3-ORE / S144F

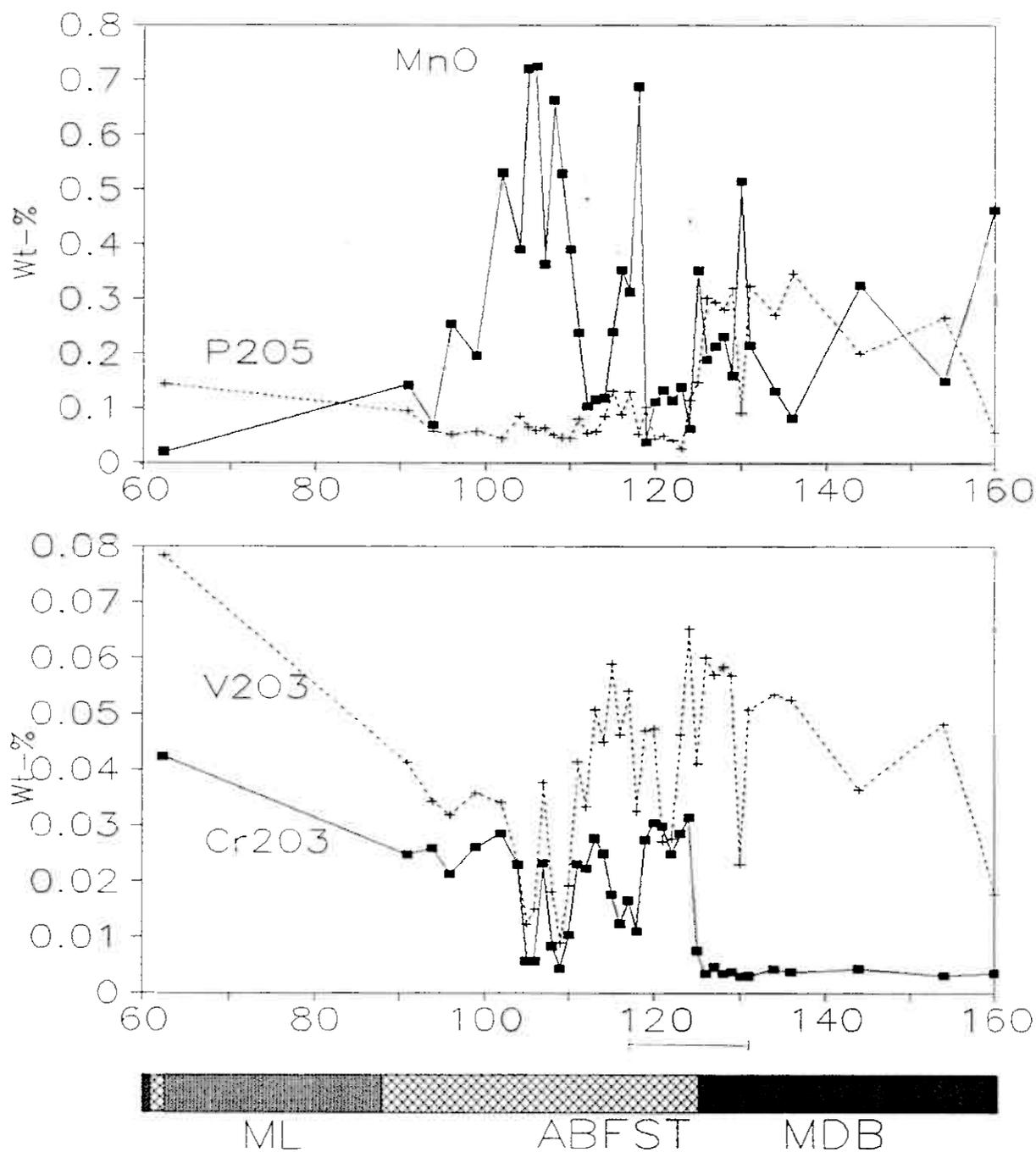


Fig. 5.5. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Named elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C3-ORE / S144F

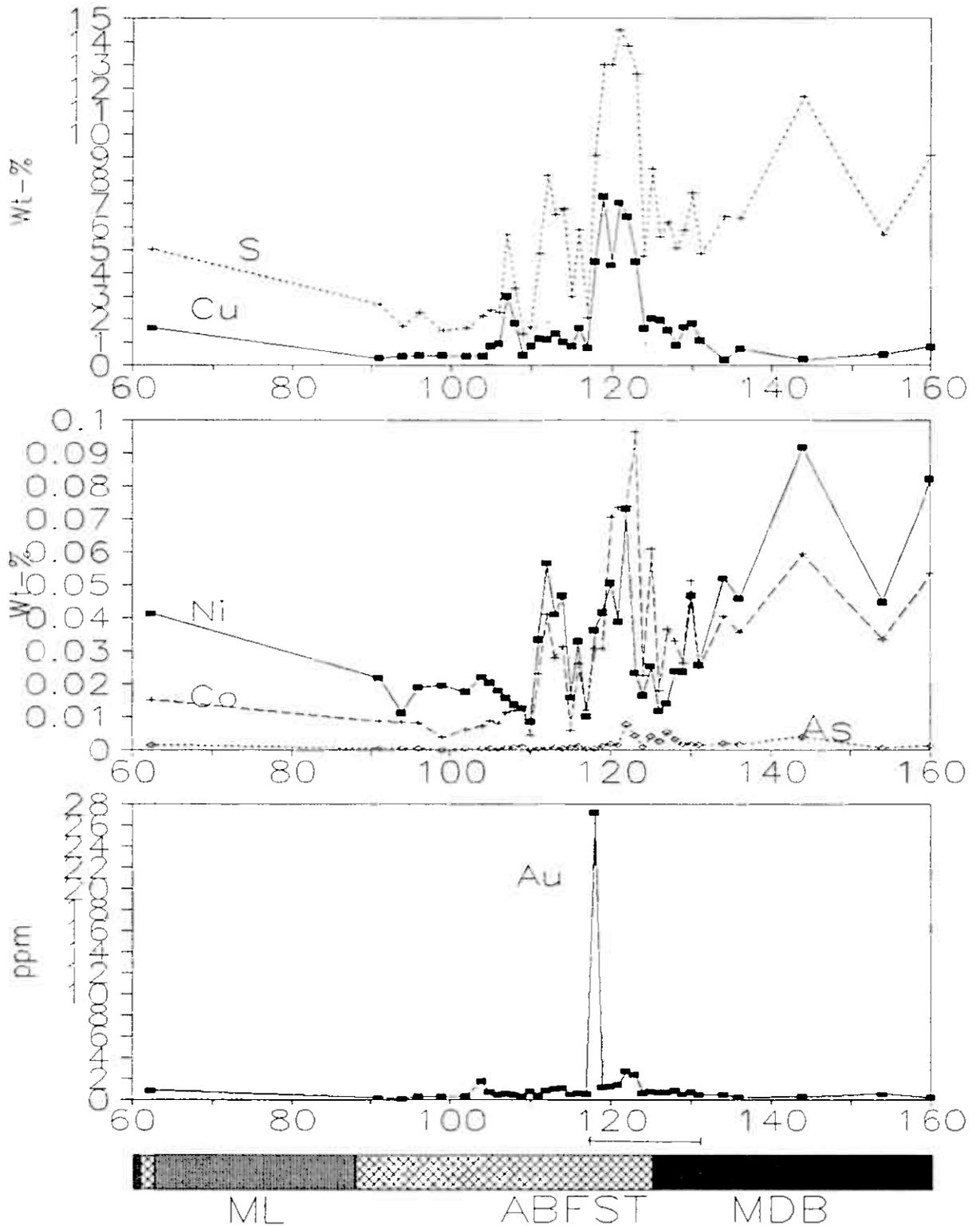


Fig. 5.6. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Named elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

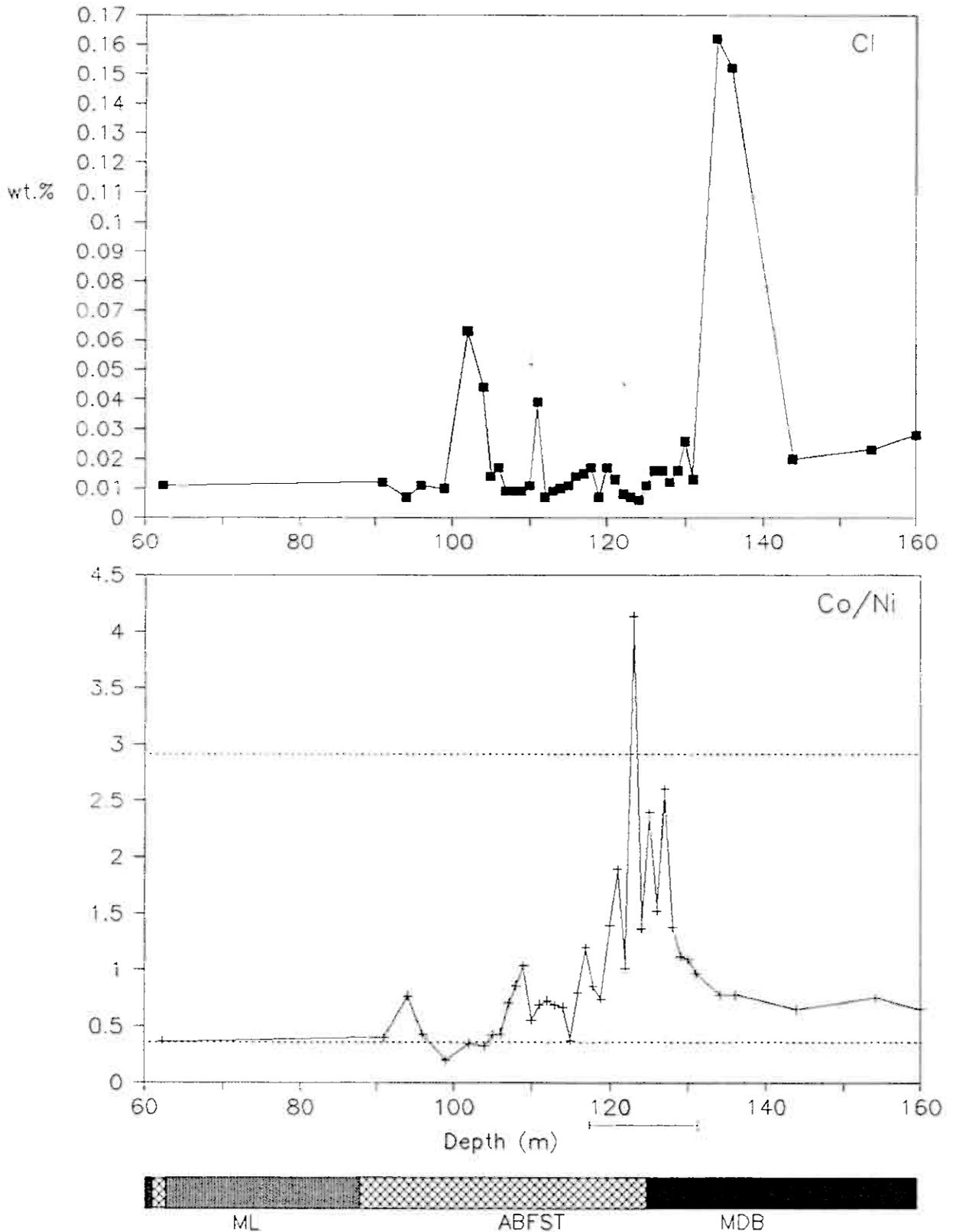


Fig. 5.7. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Named elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

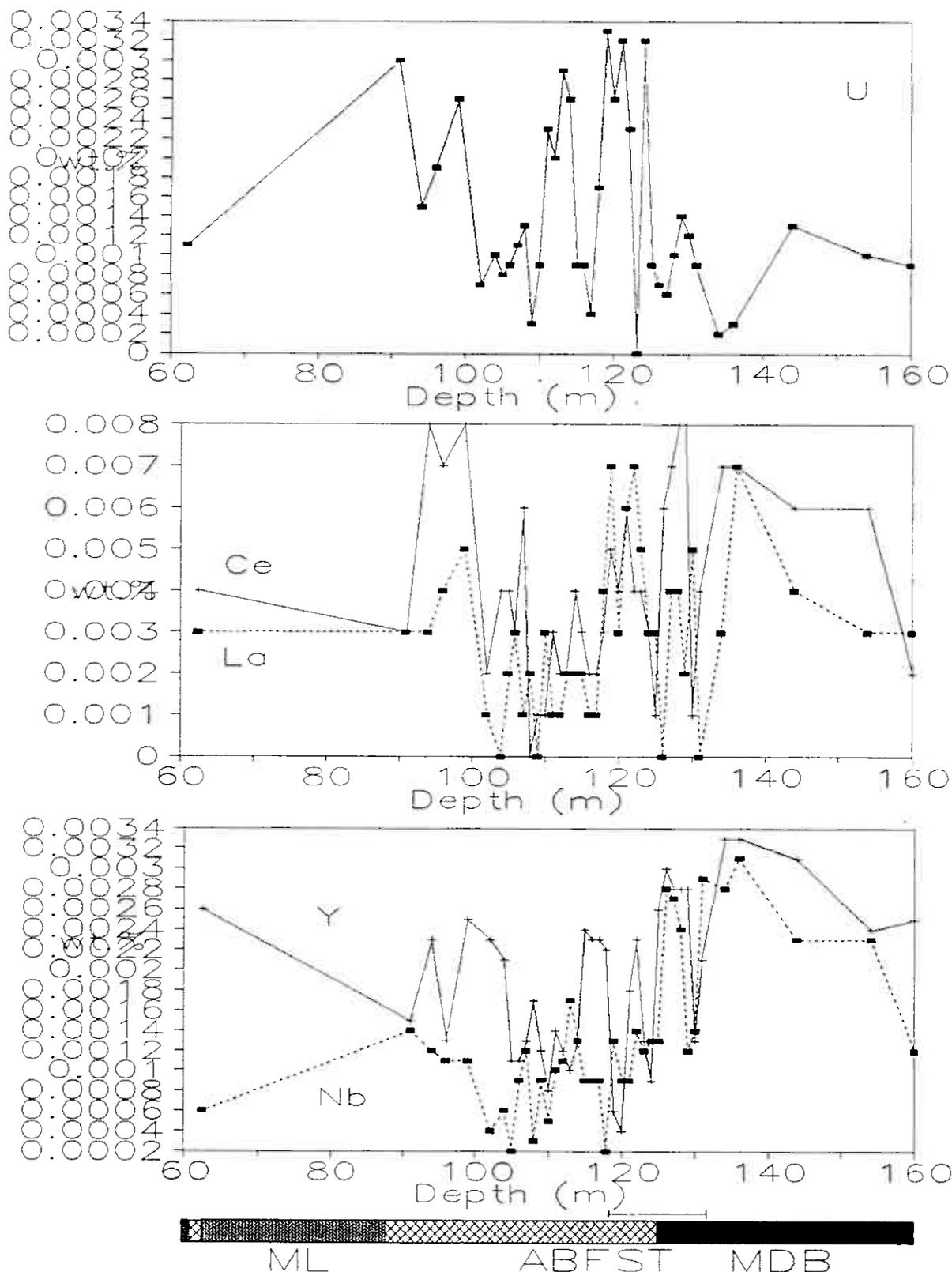


Fig. 5.8. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Named elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

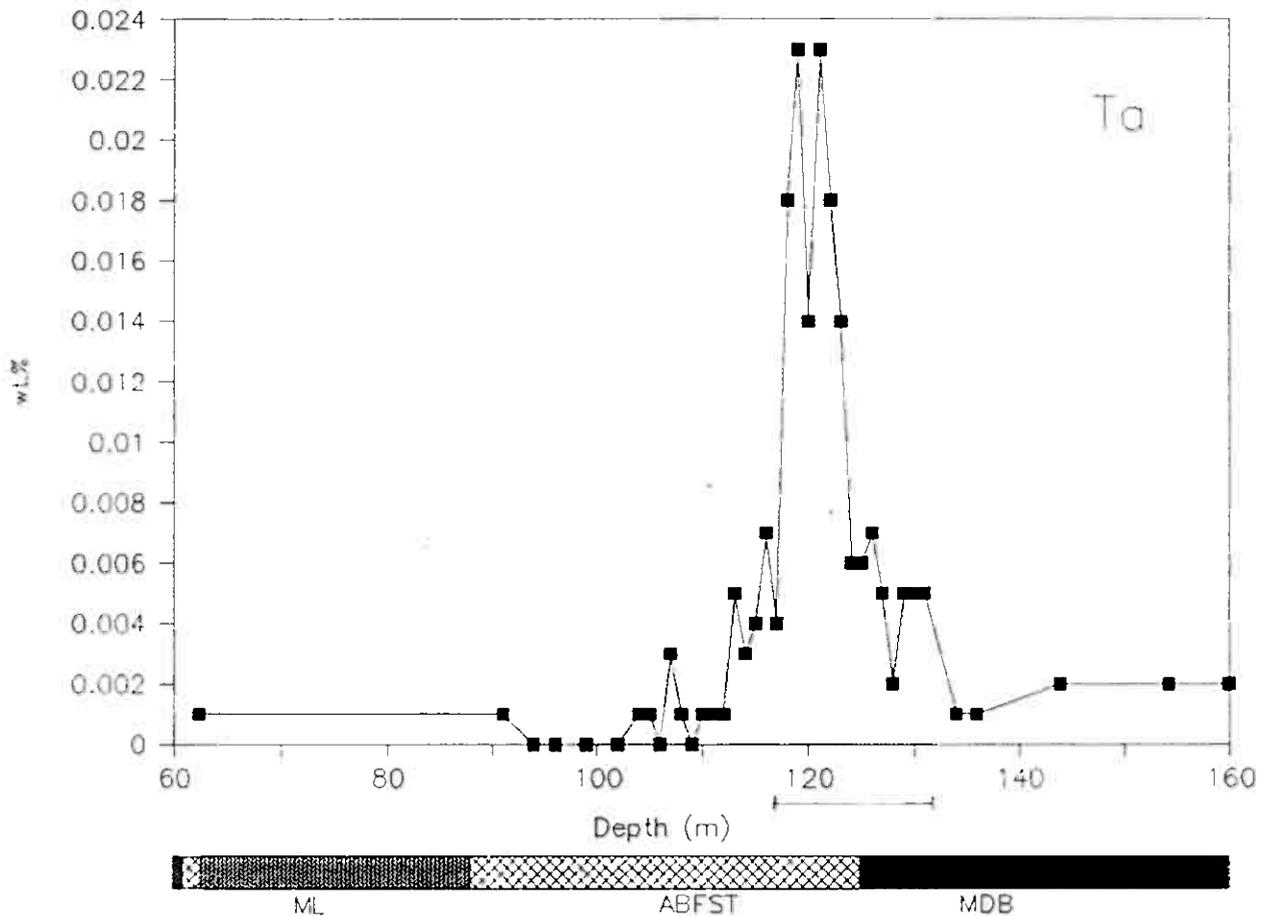


Fig. 5.9. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Named elements as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

5.3 Petrography

For the petrographical study nine samples from the drill hole S144F were selected from the interval of 95.5 to 152.6 metres. Summary on the mineral composition of the samples is given in Table 5.3.

Three samples (95.5 m, 119.2 m and 120.5 m) are classified as albitic felsites. The groundmass is composed of fine grained albite and quartz grains. Rutile is common accessory. Grain size is typically about 10 μm .

Albitic felsites are cut by numerous veins, which are much coarser than the host rock (400 μm versus 10 μm , respectively). Mineral composition in the veins varies (minerals in the order of abundance):

- qtz-crb-ab-cp-po-bt-py-tour-apa-sca+ru (95.5 m)
- crb-po-cp-ab-qtz-bt-tour-py-chl-ilm-mt (Au ore) (119.5 m)
- crb-af-cp-po-qtz-bt-mt-ab-py-chl+ilm (Au-ore) (120.5 m)

Comparing sample 95.5 m (away from the ore) to the ore samples 119.5 m and 120.5 m some differences can be seen:

- veins are more numerous in ore samples

Table 5.3. Summary on the petrographical study on Bidjovagge C3 ore samples, drill hole S144F. Abbreviations for the rock types and minerals are given in section 3. Minerals are given in the order of abundance. In column ϕ_{ab} (μm) the average diameter of albite is given in micrometres; if two values are given, the first is for groundmass and the second for veins. Ind:a(O2) = indicative minerals for oxygen activity (fugacity) determination, Ind:pH = indicative minerals for pH determination.

Depth (m)	Rock type	Represents	"Ground mass" minerals	Vein minerals	ϕ_{ab} (μm)	Ind:a(O2)	Ind:pH	Note: reactions etc
95.5	ABFST	"least altered"	ab,qtz,ru	qtz,crb,ab,cp,po,phi,py,tour,apa,sca,±ru	10/250	po-py	ab	
104.4	CRB-R/ ABFST	CO2-rich	-	crb,ab,cp,po,ru,py	700	po-py	ab	
104.6	CRB-R/ ABFST	CO2-rich	-	crb,ab,phi,cp,po,py,mt	600	po-py,mt	ab;po-py,mt	
109.3	CRB-R/ ABFST	close to the ore	-	crb,ab,phi,cp,po,py,ilm,±mt	600	po-py-ilm,±mt	ab,po-py,±mt	
119.2	ABFST (±MDB)	Cu-Au ore	ab,qtz,ru	crb,po,cp,ab,qtz,phi,tour,py,chl,ilm,mt	25/250	po-py-ilm-mt	ab	phi->chl
120.5	ABFST	Cu-Au ore	ab,qtz	crb,af,cp,po,qtz,phi,mt,ab,py,chl,±ilm	15/250	po-mt-py,±ilm	ab,po-mt-py	no ru
130.7	MDB	close to the ore	ab,crb,af,ru,po,py,±ilm	(af,crb)	700	po-py,±ilm	ab	
141.5	MDB	"least altered"	ab,crb,phi,chl,qtz,tit,ru,pa	ilm,po,cp,py,mt	500	ilm-po-py-mt	ab-pa,po-py-mt	sca->chl+crb-phi+pa
152.6	MDB	"least altered"	ab,crb,phi,qtz,ru,po,cp,py,ilm	(crb,chl,po,cp,py)	500	po-py,ilm	ab	ilm->ru,po->py

- the amount of carbonate(s) and sulfides is higher in the ore
- magnetite is abundant in ore samples
- titanium is carried by rutile in albitic felsite sample 95.5 m (far from the ore). In the ore samples rutile is rare and titanium is carried by ilmenite (and magnetite)
- pyrrhotite is almost only Fe-sulfide mineral in the ore samples, pyrite is minor sulfide

Chalcopyrite, pyrrhotite, pyrite, magnetite and ilmenite occur all as stable minerals (all in contact with each other) in the ore samples.

Samples 104.4 m, 106.4 m and 109.3 m are named as carbonate rocks. They are composed mainly of carbonate(s), albite, chalcopyrite and pyrrhotite. Biotite, chlorite, pyrite, magnetite and ilmenite occur as accessories. The grain size varies from 70 μm to 0.8 mm. Albite is typically sub- to euhedral and quite coarse ($\phi = 0.6$ mm).

Metadiabase samples (130.7 m, 141.5 m and 152.6 m) are composed of albite and carbonate plus biotite, amphibole, chlorite, pyrrhotite, chalcopyrite, ilmenite, quartz and pyrite plus minor magnetite (not in sample 152.6 m). In sample 152.6 m pyrrhotite is partly replaced by pyrite. Grain size is typically about 0.6 mm. Sulfides occur as veinlets or dissemination filling albite interstices. Amphibole occurs in veins with carbonate and sulfides, which occur also in the host rock. Metadiabase doesn't change notably in mineral composition or in texture when the ore is approached. Only amphibole and magnetite contents in diabase seem to increase towards the ore.

5.4 Normative mineral composition

The mineral composition of each analysed sample was estimated on the basis of chemistry, petrography and microprobe analyses. In Fig. 5.10 a carbonatization diagram (see calculation and plotting basis in the section 3 or Lamberg & Hautala, 1990) is presented, which shows that the most likely carbonate species is dolomite in C3 ore. In albitic felsites $Ca+Mg=C$, but in metadiabase the degree of carbonatization ranges from low values ($C < Ca+Mg$) to high values ($C > Ca+Mg$). In samples containing more than 15 % CO_2 also some iron is probably bound in carbonate(s) (i.e. 100-110 m, 115-119 m and 140- m). However in calculating normative mineral composition all carbon was assumed to form dolomite.

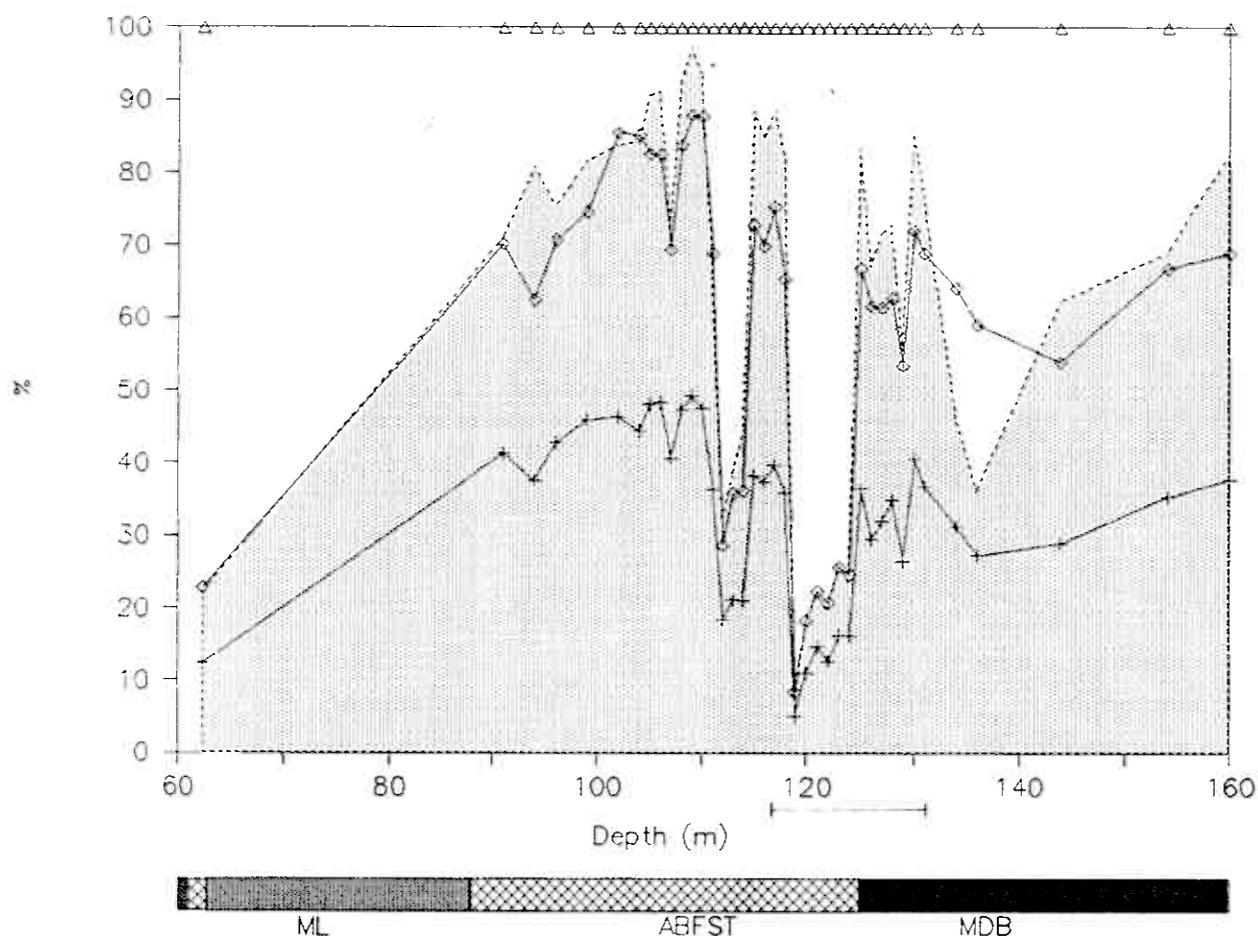


Fig. 5.10. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Carbonatization diagram, dotted field = the degree of carbonatization ($C/(Ca+Mg+Fe)$), lines from bottom edge: calcite ($Ca/(Ca+Mg+Fe)$), calcite + magnesite ($Ca+Mg/(Ca+Mg+Fe)$) and calcite+dolomite+siderite (=100). For more details see text. Named elements as a function of depth. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

Normative mineral composition was calculated using schedule introduced in section 3. The result is given in Appendix 2f. In Fig. 5.11 the normative mineral composition of the samples is presented as cumulative XY-diagram, where depth is placed in X-axis. Normative mineral composition is in agreement with petrography.

Metadiabase and albitic felsite do not differ notably in normative mineral composition from each other. Dolomite content increases in contact from less than 10 % to more than 30 %. The dolomite content, however, varies widely in the albitic felsite.

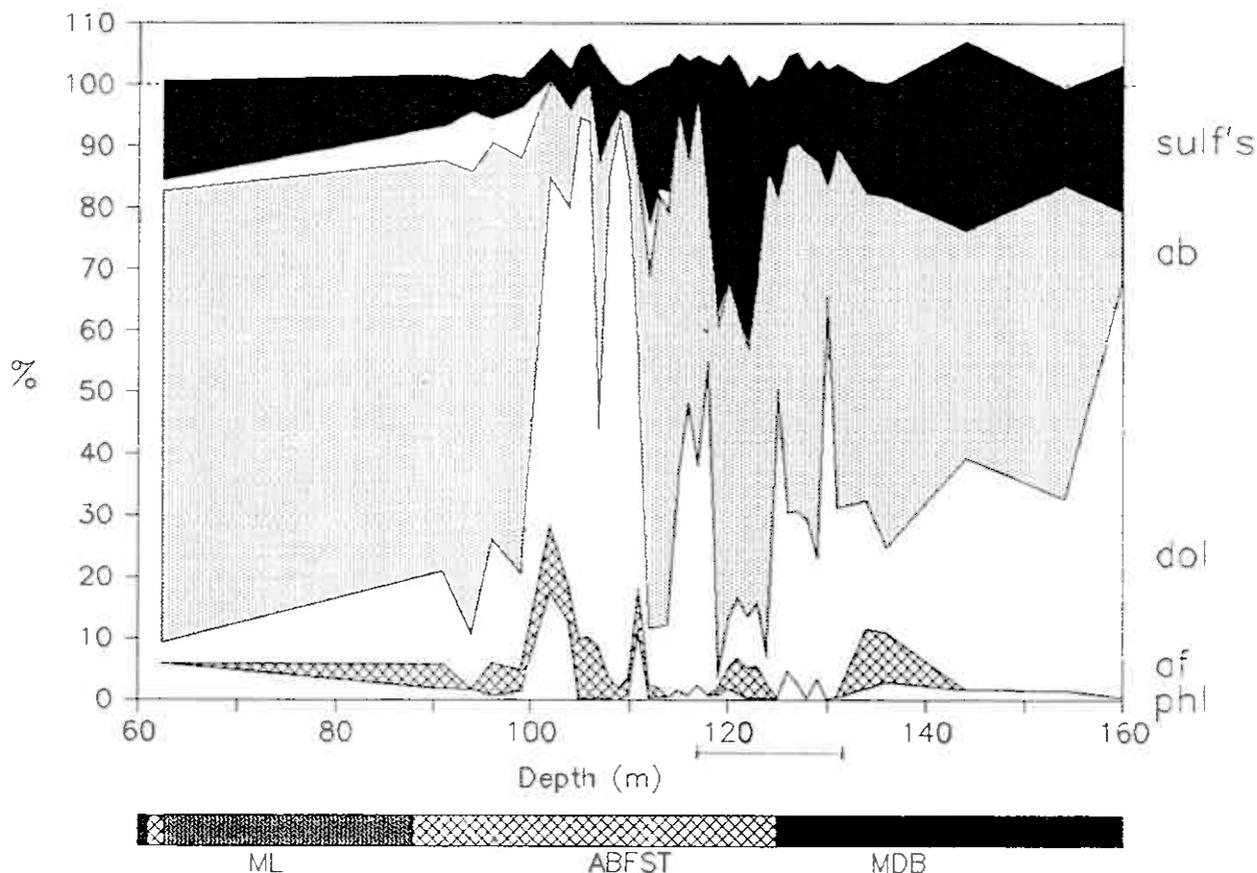


Fig. 5.11. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Normative mineral composition. The location of Cu-Au ore is marked by a line. Fields from lower edge to the top edge: phl = phlogopite (white), af = amphibole (cross hatched), dol = dolomite (white), ab = albite (dotted), qtz = quartz (white), sulf's = sulfides (chalcopyrite + pyrrhotite + pyrite) (black). For more details see text. Abbreviations in rock type legend: ABFST = albitic felsite, ML = black schist, MDB = metadiabase.

Normative aluminium carrier diagram (Fig. 5.12) shows some additional features. Scapolite becomes an important Al carrier in metadiabase from 130 metres on. The contact with albitic felsite and metadiabase can't, however, be seen in the Al carrier diagram. Albite bears more than 95 % of aluminium both in the albitic felsite and in the metadiabase near the contact. Similar ratios of the Al carrier minerals can be observed in albitic felsites in the beginning of the section (85 m, and about 90 m). In albitic felsites with high CO₂ albite carries only 20-50 % of aluminium. Scapolite is important Al bearing mineral in these rocks.

Normative mineral composition of Fe-Cu-sulfide phase is shown in Fig. 5.13. Pyrrhotite is the most abundant sulfide mineral in albitic felsites and in metadiabase far from the contact of these rock types. Towards the contact the amount of pyrite increases, which can be seen clearly in Fig. 5.14, where

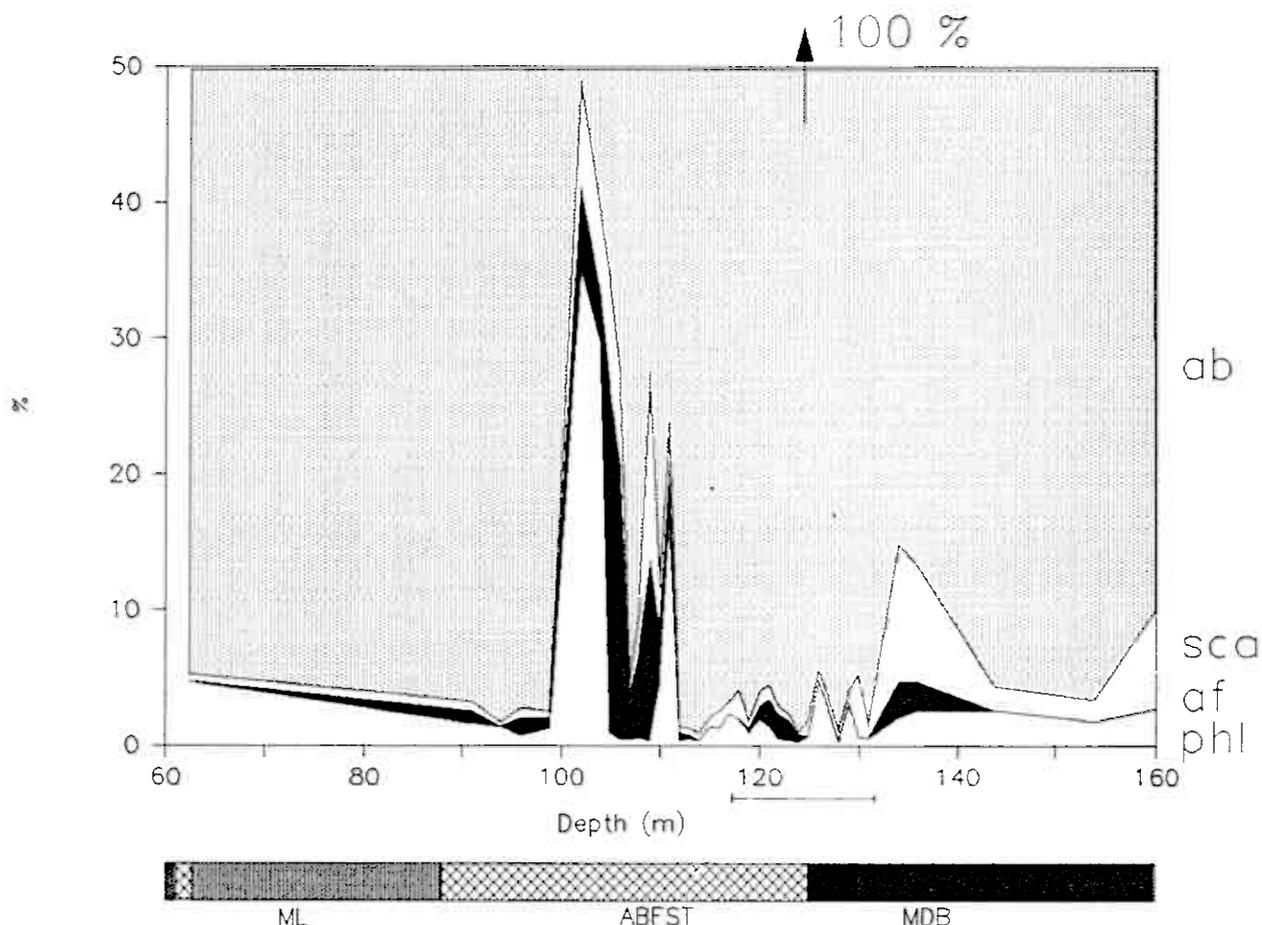


Fig. 5.12. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Normative aluminium carrier diagram. The location of Cu-Au ore is marked by a line. Fields from bottom edge to the top edge: phl = phlogopite (white), af = amphibole (black), sca = scapolite (white) and ab = albite (dotted). Abbreviations in rock type legend: ABFST = albitic felsite, ML = black schist, MDB = metadiabase.

pyrite/(pyrite+pyrrhotite) ratio is plotted as a function of depth. Cu-Au ore can be seen by the increase of normative chalcopryrite content in the sulphide phase. Gold-copper ore is located in the albitic felsite where $py/(py+po)$ changes from pyrrhotite dominant assemblage to pyrite dominant assemblage in the contact between albitic felsite and metadiabase.

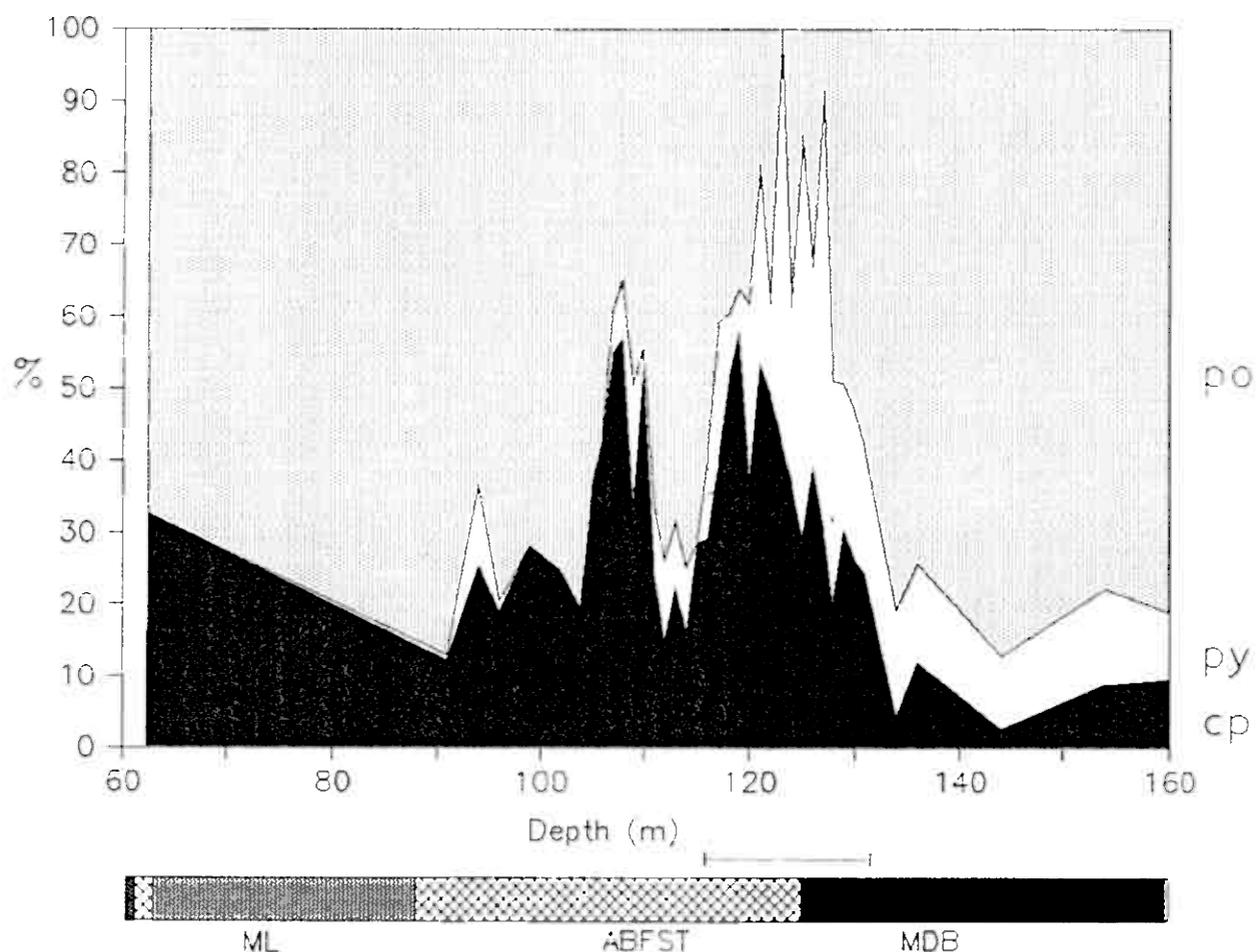


Fig. 5.13. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Normative mineral composition of the Cu-Fe-sulfide phase. The location of Cu-Au ore is marked by a line. Fields from bottom edge to the top edge: cp = chalcopyrite (black), py = pyrite (white), po = pyrrhotite (dotted). Abbreviations in rock type legend: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

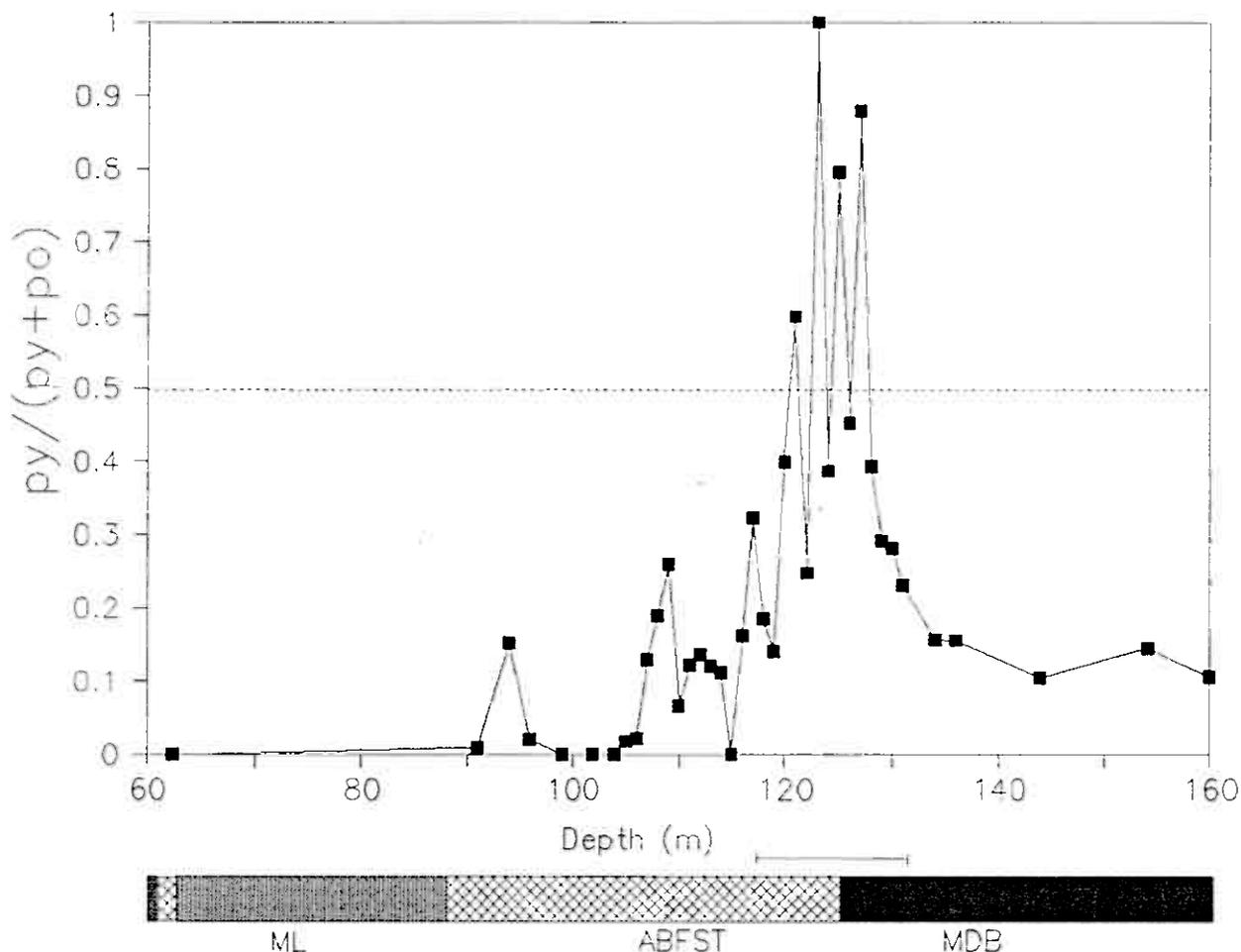


Fig. 5.14. Bidjovagge, C3-ore, drill hole S144F (rock type legend simplified). Normative pyrite/(pyrite+pyrrhotite) ($py/(py+po)$) ratio presented as a function of depth. The location of Cu-Au ore is marked by a line. Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

5.5 Summary of the features adjacent to the ore

Au ore is located between 118 and 122 metres hosted by albitic felsite close to the contact between albitic felsite and metadiabase (about 125 m). Au content in the ore is approximately 14 ppm. The Au ore has slightly lower Al_2O_3/TiO_2 ratio than albitic felsites being about 14. Gold shows positive correlation with sulfide forming chalcophile elements (SFE's) Fe, Cu, Ni, Co, S & As and with Ta.

The veins in albitic felsites becomes more abundant towards the ore. Mineral composition of the veins in albitic felsites changes towards the ore by the increase of carbonate(s) and sulfides. Magnetite and ilmenite become stable mineral with sulfides, chalcopyrite content increases and dominant Fe-sulfide changes from pyrrhotite to pyrite.

The mineral composition of metadiabase changes towards the ore by (1.) the increase of scapolite content which is towards the contact

followed by (2.) the disappearance of scapolite and (3.) simultaneous change in dominant iron sulfide from pyrrhotite to pyrite.

6 CU ORE C4

6.1 Introduction

C4-ore of the copper ore type has recently been found at Bidjovagge (Ekberg, 1991, pers. comm.). It differs from other ore types by its location in metadiabase. In further drilling the C4 ore proved out, however, to be small and thus subeconomic.

The rock types in drill hole S154B of C4-ore are mainly black schists with few thinner graphite-rich parts intruded by metadiabases (Appendix 3a). A thin part of albitic felsite is also encountered at the end of the drill hole. The Au mineralization is hosted by metadiabase. Rock type intervals and samples in each interval are shown in Table 6.1.

Table 6.1. List of the samples of C4-ore.

INTERVAL metres	ROCKTYPE	CHEMISTRY n	SAMPLE	PETROGRAPHY depth (m)
60.0-83.0	metadiabase	7		60.6, 76.3
83.0-97.5	black schist	-		-
97.5-119.0	metadiabase	11		98.5, 100.5, 102.5 103.5, 104.5, 105.5 106.5, 107.5, 108.5 109.5, 110.5, 112.5 114.5, 115.5, 116.5 117.5, 118.5
119.0-154.5	black schist	-		-
154.5-160.0	albitic felsite	3		157.8

6.2 Chemistry

XRF-analyses are presented in Figs. 6.1-6.8, where the ratios of immobile elements and element concentrations are presented as a function of depth. Roughly estimated approximate values are given in Table 6.2, where the content of CO₂ has been regarded as a reference element.

Table 6.2 Average chemical composition of different rock types in C4-ore.

	MgO wt.%	FeO wt.%	SiO ₂ wt.%	Al ₂ O ₃ wt.%	Na ₂ O wt.%	CaO wt.%	CO ₂ wt.%	TiO ₂ wt.%	S wt.%	Cu wt.%	Au wt.%	Al ₂ O ₃ /TiO ₂
ALBITIC FELSITE low CO ₂	3.5	3.5	67	15	6	3	1.5	0.6	1.5	0	0	28
high CO ₂	-	-	-	-	-	-	-	-	-	-	-	-
ORE low CO ₂	-	-	-	-	-	-	-	-	-	-	-	-
high CO ₂	5	15	35	10	5.5	8	8	2	7	3	11	5.5
METADIABASE low CO ₂	5	10	35	10	5	7	3	1.6	5	0.05	0.05	5
high CO ₂	5	15	35	10	5	7	11	1.6	5	0.05	0.05	20

Al₂O₃/TiO₂-ratio of albitic felsites (Fig. 6.1) is approximately 28 (Table 6.2), which is slightly higher than the ratio in C2 and C3 ores and given by Lamberg & Hautala (1990) for albitic felsites. The ratio for metadiabase is about 5 (Table 6.2). Also other immobile element ratios show familiar values for both rock types.

$\text{Al}_2\text{O}_3/\text{Cr}_2\text{O}_3$ is about 4500 in metadiabase versus 500 in albitic felsite, $\text{TiO}_2/\text{Cr}_2\text{O}_3$ values are 900 and < 50 in albitic felsites and $\text{ZrO}_2/\text{TiO}_2$ ratio 0.04 vs. 0.01, respectively.

Some peculiar features are observed in immobile element ratio diagrams. Rock type between 60 and 82 metres is named as metadiabase, but immobile element ratios indicate that it would rather be an albitic felsite than a metadiabase. P_2O_5 , TiO_2 , Cr_2O_3 and Cl imply the same, although high Cl content in the beginning of the section (60-65 m) display values typical for metadiabase. Also according to similar observations it seems that in between metadiabase and black shist (118-120 metres) there is thin albitic felsite intercalation.

Au mineralization located between 102 and 110 metres shows variable immobile element ratios. $\text{Al}_2\text{O}_3/\text{TiO}_2$ and $\text{ZrO}_2/\text{TiO}_2$ ratios indicate metadiabase host, whereas $\text{Al}_2\text{O}_3/\text{Cr}_2\text{O}_3$ and $\text{TiO}_2/\text{Cr}_2\text{O}_3$ indicate rather albitic felsite host. Other indicative elements TiO_2 , Cr_2O_3 , P_2O_5 and Cl show intermediate values. As a conclusion it seems that Au mineralization is hosted by mixture a of albitic felsite and metadiabase. Au content is approximately 11 ppm (Fig. 6.6). Like in the cases of C2- and C3-ores the mineralization here is best characterized by having higher Cu content (3 wt.%) compared to barren metadiabase (0.05 wt.%).

The relationships observed between elements in C2 and C3 ores can be seen also in C4 ore (see correlation matrix in Appendix 3c and inverted factor matrix in Appendix 3d). Immobile and silicate forming elements (ISE's) are grouped together and they have a negative correlation with carbonate forming elements (CFE's). Again, phlogopite forming elements (PFE's) K, Rb, Sr and Ba are behaving similarly as well as chalcophile sulfide forming elements (SFE's), which form clearly a group of their own.

Factor analysis shows again a correlation between Cu and Au. They both have rather strong positive loadings in factor F5 (Au: 0.93; Cu: 0.94). Correlation coefficient is 0.89 between the same metals.

Co/Ni ratio forms trend opposite to Cl, as stated also in C2 and C3 ores. Highest Au and Cu content coincide with Co/Ni maximum in the central part of the metadiabase sheet.

BIDJOVAGGE, C4-ORE / S154B

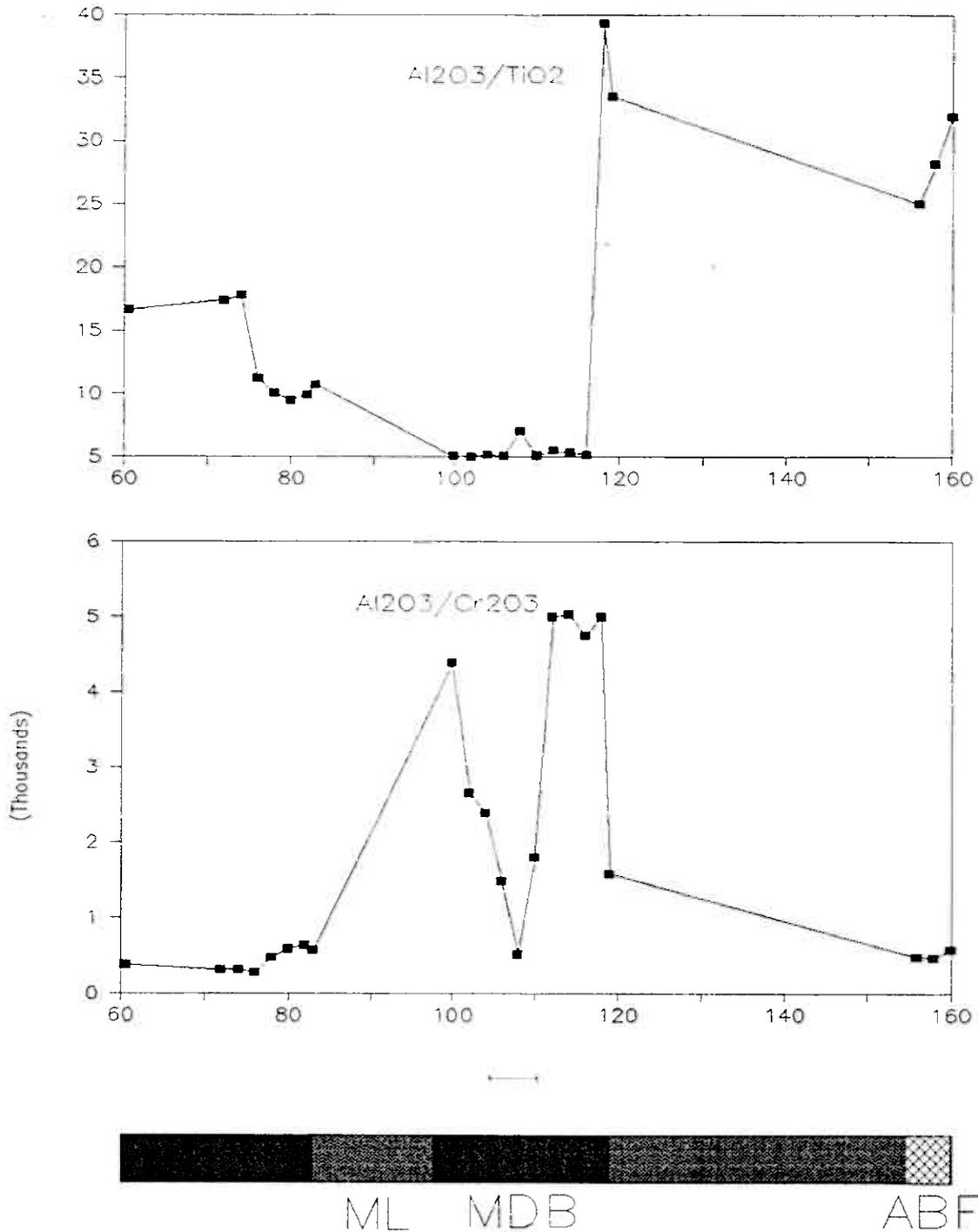


Fig. 6.1. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Ratios of immobile elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFT = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C4-ORE / S154B

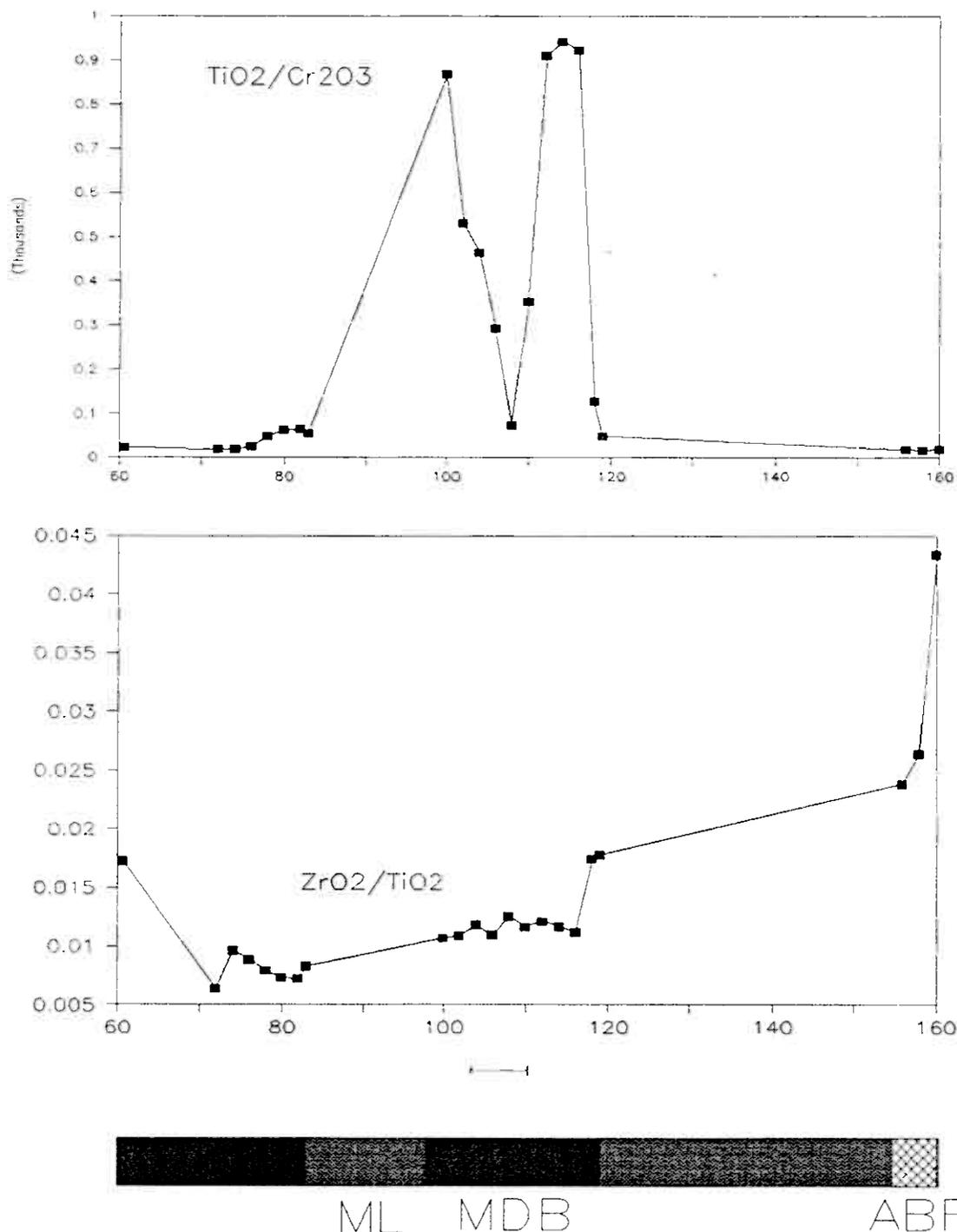


Fig. 6.2. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Ratios of immobile elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFT = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C4-ORE / S154B

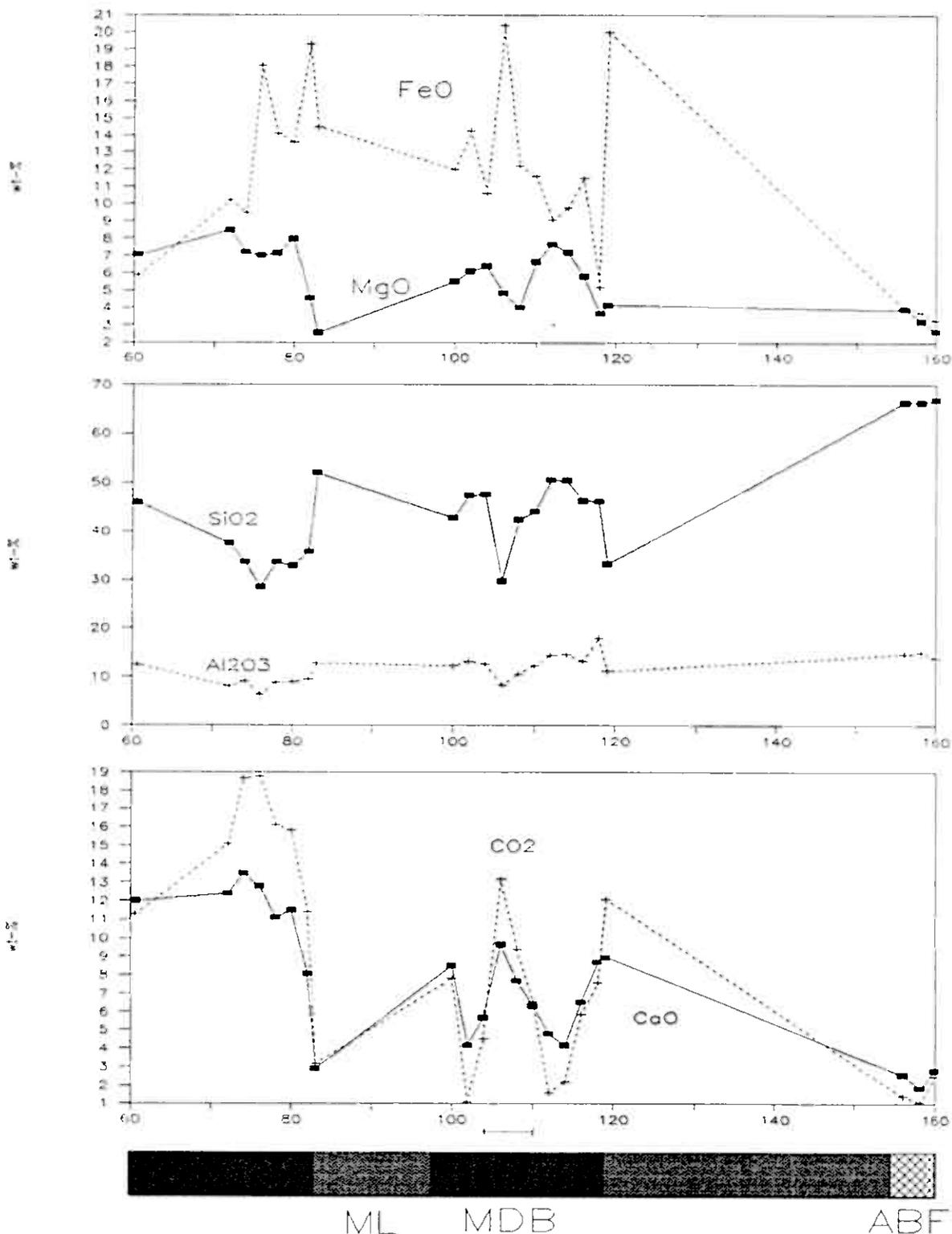


Fig. 6.3. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Named elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFT = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C4-ORE / S154B

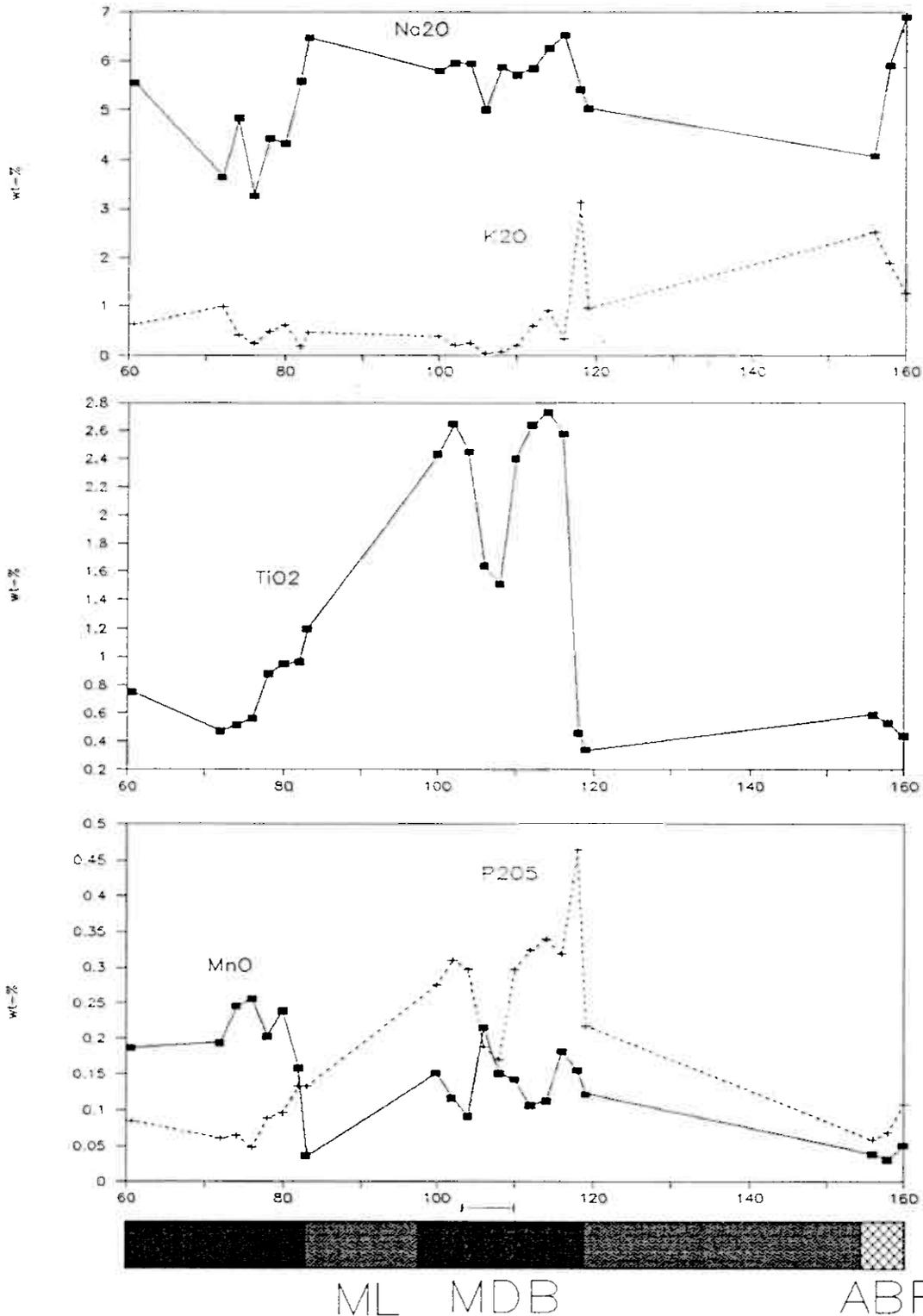


Fig. 6.4. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Named elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFT = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C4-ORE / S154B

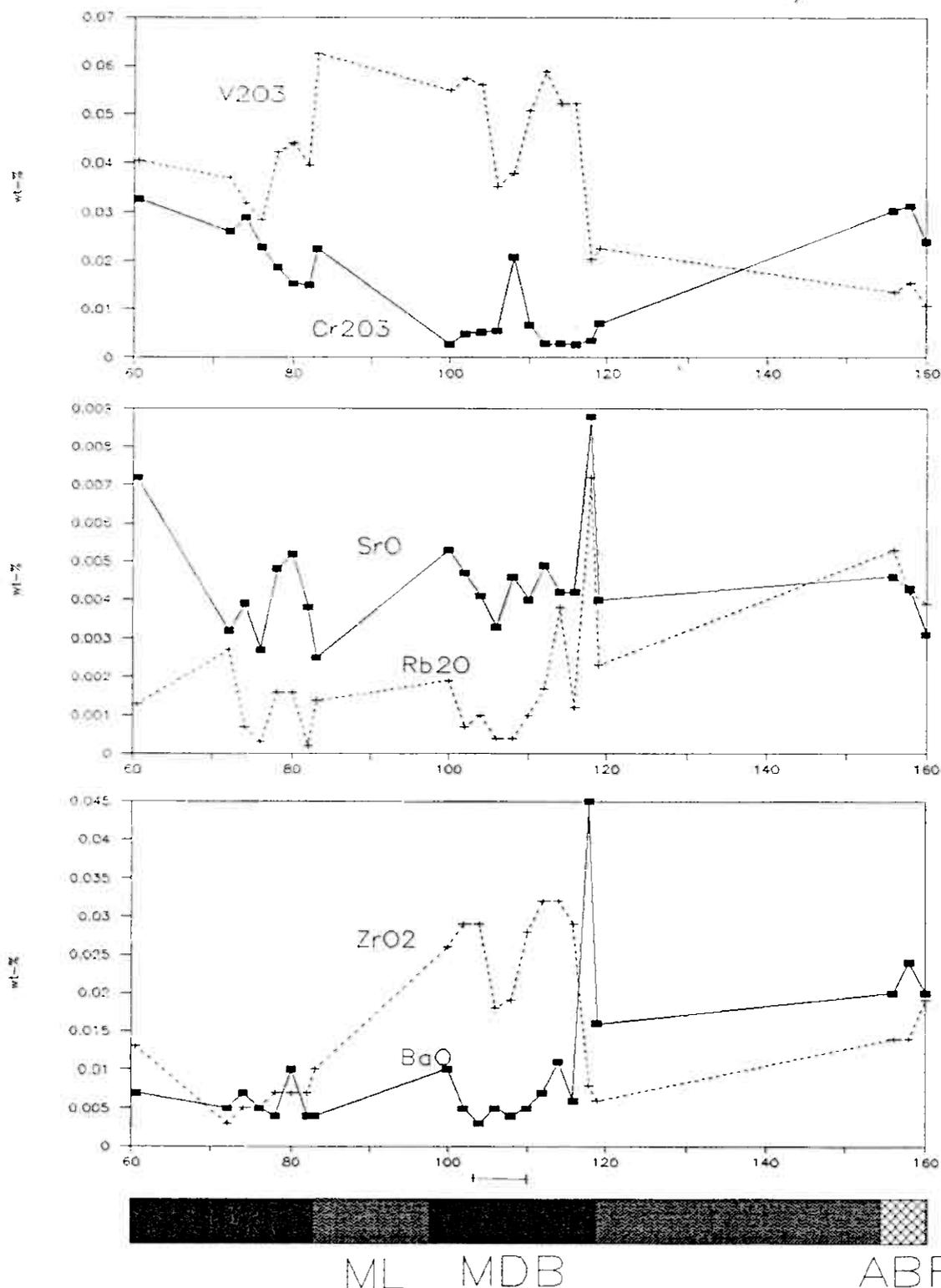


Fig. 6.5. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Named elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFT = albite felsite, ML = black schist, MDB = metadiabase.

BIDJOVAGGE, C4-ORE / S154B

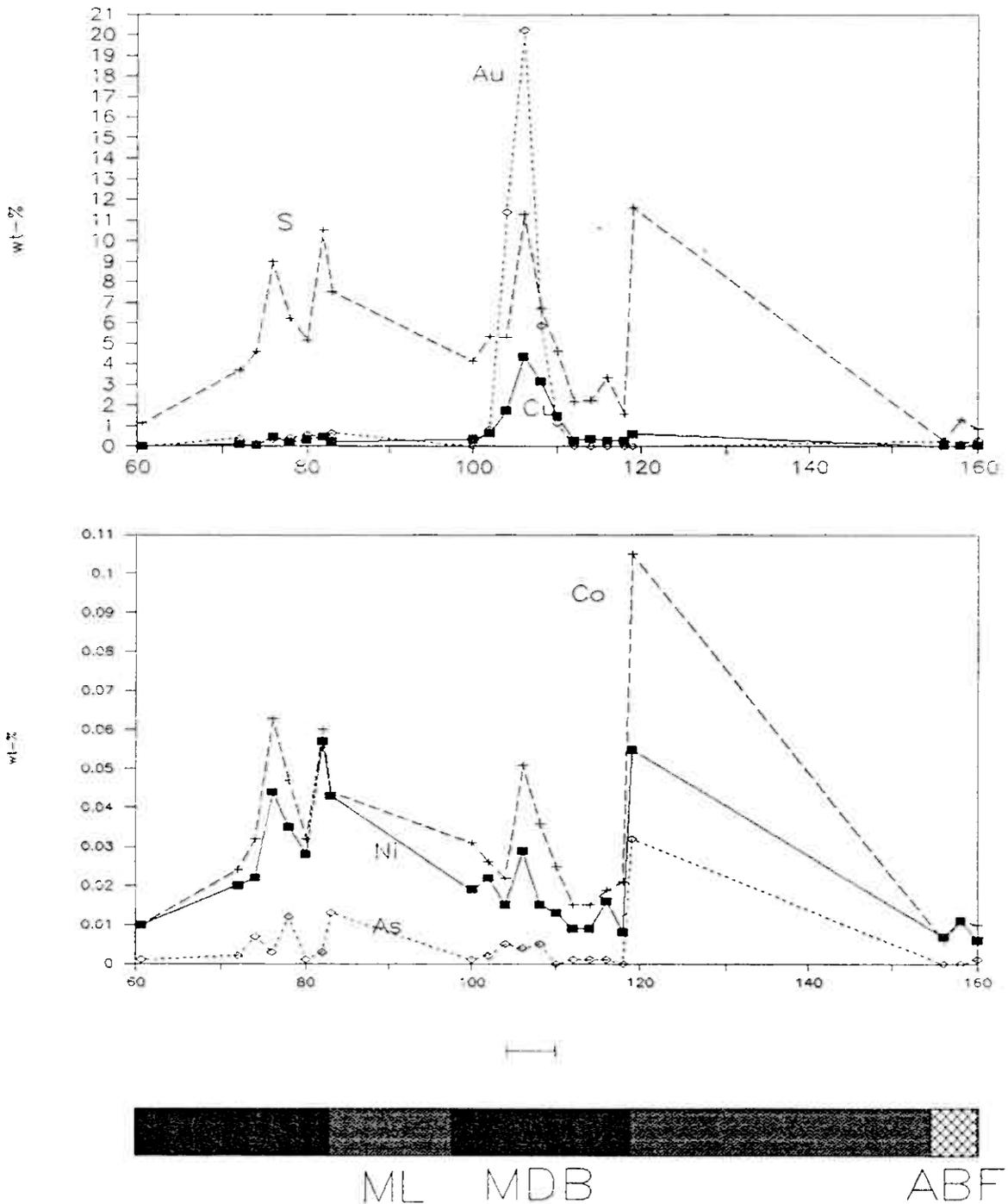


Fig. 6.6. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Named elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFT = albite felsite, ML = black schist, MDB = metadiabase.

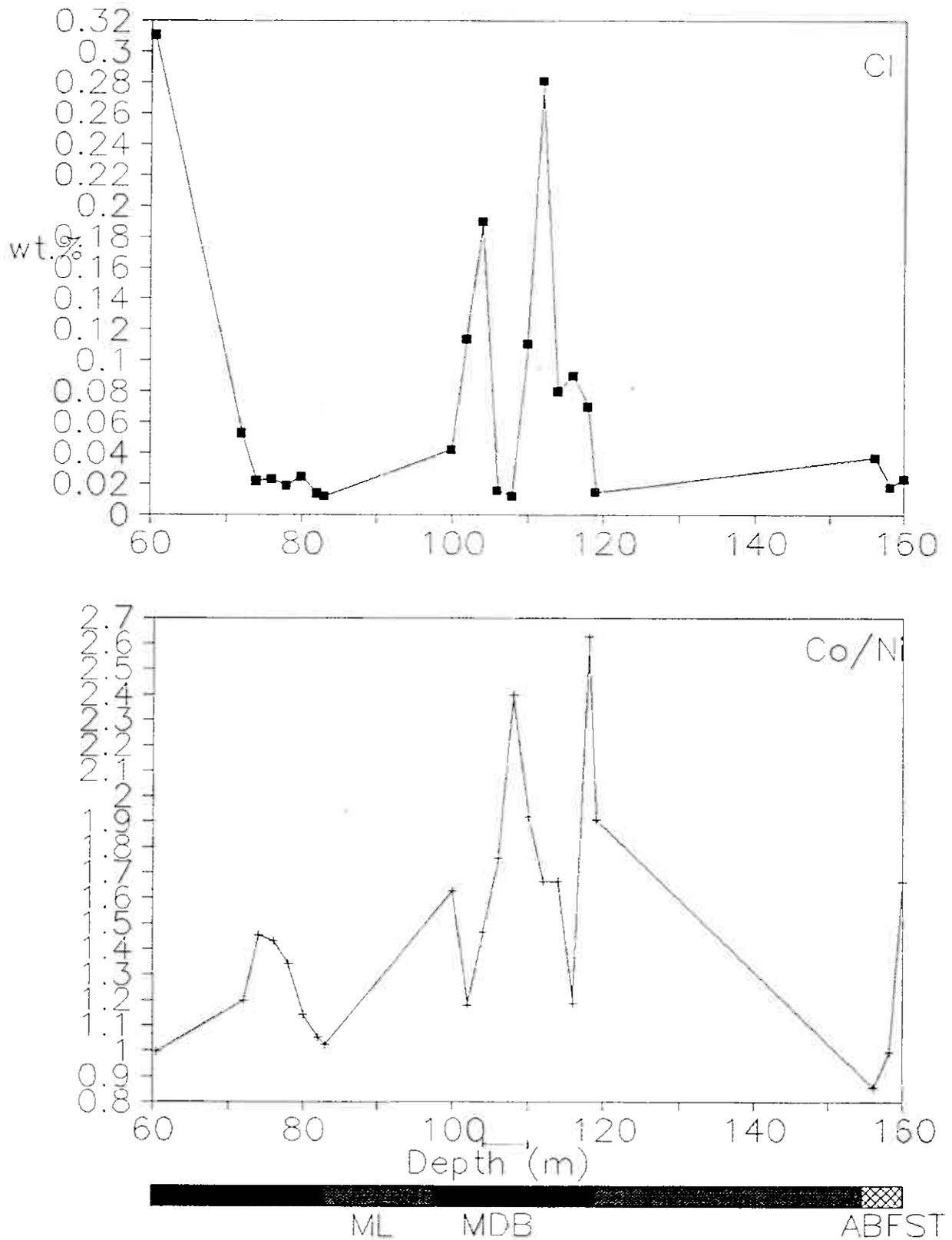


Fig. 6.7. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Named elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

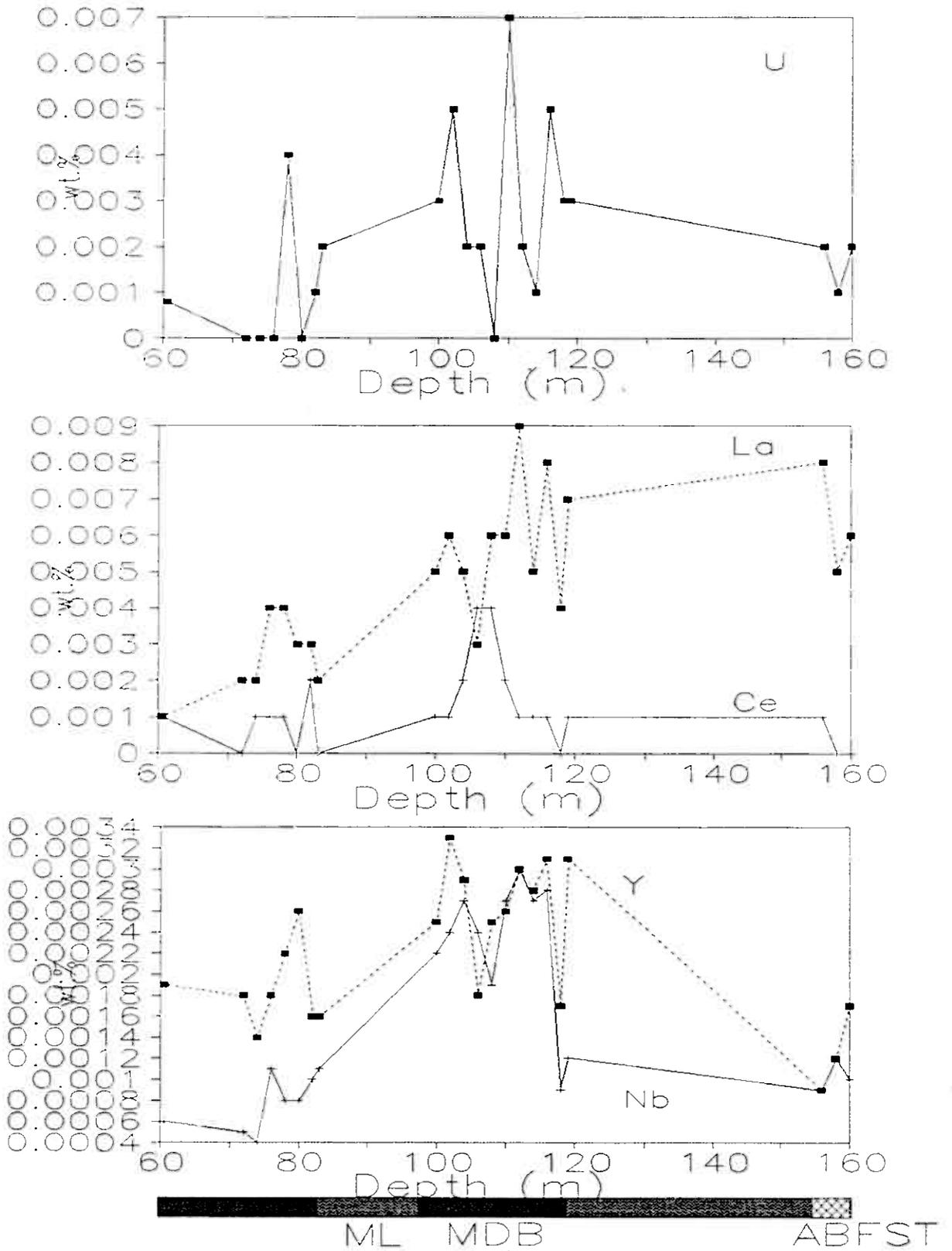


Fig. 6.8. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Named elements as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

6.3 Petrography

For the petrographical study twenty samples from the drill hole S154B were selected from the interval of 60.6 to 157.8 metres. Summary on the mineral composition of the samples is given in Table 6.3.

Sixteen samples (60.6 m, 98.5 m, 100.5 m, 102.5 m, 103.5 m, 104.5 m, 105.5 m, 107.5 m, 108.5 m, 109.5 m, 110.5 m, 112.5 m, 114.5 m, 115.5 m, 116.5 m, 117.5 m) are named as metadiabase. Albite is the main mineral in all metadiabase samples. Other common main minerals are amphibole, scapolite, biotite and carbonate. Rutile, ilmenite, chlorite, titanite occur as accessories. Pyrrhotite, chalcopyrite and pyrite are the sulfides.

Metadiabase situating far away from the Au-ore (60.6 m) is composed of albite, biotite, amphibole, scapolite (main minerals), chlorite, ilmenite and pyrite (accessories). Scapolite occurs as large anhedral grains ($\phi = 4$ mm) enclosing numerous albite, biotite, amphibole, ilmenite and pyrite grains, but not carbonate(s). Also amphibole occurs as anhedral grains of about 1 mm in diameter enclosing albite, biotite and carbonate grains. Carbonate vein with minor amphibole, albite and pyrite cuts the rock

In sample 102.5 carbonate rock is in contact with metadiabase rich in albite and scapolite. In between these rock types a very coarse grained ($\phi = 7$ mm) amphibole-sulfide (cp-po-py) rock can be found.

Towards the ore the mineral composition of metadiabase changes:

- albite content increases
- grain size of albite decreases from 1800 μm via 300 μm (in metadiabase) to 10 μm in albitic felsite sample 106.5 μm
- amphibole content decreases. In the ore Ca is carried by carbonate(s) and aluminium & sodium by albite
- scapolite disappears

Three samples (76.3 m, 106.5 m and 157.8 m) are classified as albitic felsites. Thus chemical features, which showed the possibility of the rock units between 65 and 80 metres & 106 and 108 metres to be albitic felsites, are justified. The groundmass of albitic felsite is composed of fine grained albite and quartz grains. Rutile (in samples 106.5 m and 157.8 m) or ilmenite (in sample 60.6 m) is a common accessory. Grain size is typically about 10 μm .

Albitic felsites are cut by numerous veins. Grain size is much coarser in the veins than in the host rock (>100 μm versus 10 μm , respectively). The mineral composition in the veins varies (minerals given in the order of abundance):

- crb-ab-qtz-po-cp-ilm±ru (in sample 76.3 m)
- ab-crb-po-cp-chl-bt-py-ru-bt-tit-(relic af, totally altered to chl) (in Au-ore sample 106.5 m)
- ab-bt-qtz-py-cp-sca-po±ru (no crb) (in sample 157.8 m)

In the Au-ore sample 106.5 m (albitic felsite) rutile occurs as small grains ($\phi = 110$ μm) in clusters of about 1.5 mm in diameter. In the clusters tens of rutile grains ± albite, carbonate, quartz and titanite are enclosed by chlorite (alteration product of

Table 6.3. Summary on the petrographical study on Bidjovagge C4 ore samples, drill hole S154B. Abbreviations for rock types and minerals are given in section 3. Minerals are given in the order of abundance. In column ϕ ab (μ m) the average diameter of albite in micrometres is given; if two values are given the first is for groundmass and the second for veins. Ind:a(O2) = indicative minerals for oxygen activity (fugacity) determination, Ind:pH = indicative minerals for pH determination.

Depth (m)	Rock type	Represents	"Ground mass" minerals	Vein minerals	ϕ (ab) (μ)	Ind:a(O2)	Ind:pH	Note: reactions etc
60.6	MDB	"least altered"	ab,af,sca,phl,chl, ilm,py,ru	(crb-ab:qtz)	1000	ilm-py	ab	sca->chl:crb,af->crb
76.3	ABFST	"least altered"	ab,qtz,ru	crb,ab,po,cp,ilm,mt, phl,(py)	100	po,ilm,mt,(py)	ab;po,mt	
98.5	MDB	close to the ore	ab,crb,sca,phl,ilm, chl,po,cp,py	-	1800	po-py	ab	phl->chl,sca->chl, po>py
100.5	MDB	close to the ore	ab,af,phl,ilm, po,cp,py,±sca	(crb,chl)	1200	ilm-po-py	ab	af->chl
102.5	MDB	close to the ore	af,crb,sca,cp,po, py,ru	-	270	po,py	ab	po&py not in contact
103.5	MDB(±AB FST)	close to the ore	ab,crb,chl,ru,cp,po	-	600	po,(py)	ab	py intrudes in po, sca->chl
104.5	MDB	close to the ore	ab,crb,af,phl,chl,ru, cp,po,ilm,mt	(crb,cp,po,ilm,mt)	600	po,ilm-mt	ab;po,mt	af->chl
105.5	MDB	Cu-Au ore	ab,crb,phl,cp,po,ru, mt,ilm,(py)	(crb,cp,po)	300	po-mt,(py)	ab	
106.5	ABFST	Cu-Au ore	ab,ru,±qtz	ab,qtz,crb,chl,ru,phl, po,cp,(py),±il	10/50	po-py	ab	phl->chl, chl>phl
107.5	MDB	close to the ore	ab,crb,chl,phl,ru, po,cp,py,chl	-	300	po,py	ab	af->chl, phl>chl, py veinlets
108.5	MDB	close to the ore	ab,af,crb,chl,phl,sca, ilm,cp,po,py	(cp,po,py,ab,chl, ±ilm)	800	po,(py)	ab	af->chl, sca->chl
109.5	MDB	close to the ore	ab,crb,chl,af,sca, ilm,po,cp,(py)	-	800	po-(py),ilm	ab	af->chl, sca->chl
110.5	MDB	close to the ore	ab,phl,af,sca,crb,ilm, po,cp,py,pa,±mu	-	900	po-py,ilm	ab,pa	sca->chl
112.5	MDB	close to the ore	ab,af,phl,chl,sca, ru,po,cp,ilm,py	(po,cp,py,ilm,crb, chl)	900	po-py,ilm	ab	phl->chl,ru->ilm,af incl. in sca
114.5	MDB	close to the ore	ab,af,crb,sca,chl,phl, apa,ilm,cp,po,py	-	400	po,(py),ilm	ab	
115.5	MDB	close to the ore	ab,crb,chl,phl, ilm,po,cp,(py)	-	300	po,ilm,(py)	ab	
116.5	MDB(±AB FST)	close to the ore	ab,phl,crb,pa/mu, ru,py,cp	-	100	py	ab,pa/mu	pa surrounded by ab shell
117.5	MDB	close to the ore	ab,phl,crb,pa/mu,sca, chl,ru,py,cp,po	-	100	py-(po)	ab,pa/mu	sca->chl, pa incl. in sca
118.5	CRB-R	close to the ore	crb,ab,pa/mu,po, cp,py	-	<100	po,py	ab,pa/mu	
157.8	ABFST	"least altered"	ab,ru	ab,phl,qtz,py,cp, sca,po,±ru	10/200	py-po	ab	

amphibole [or scapolite?]). Clusters are located in vein(s) and they have relic outlines of ilmenite. Thus rutile is an alteration product of ilmenite located in vein.

Carbonate rock sample 118.5 m is composed of carbonate(s), albite, pyrrhotite, chalcopyrite and some pyrite & paragonite. Grains are coarse, carbonate(s) up to 6 mm and albite up to 3 mm in diameter. No oxides were found in the carbonate rock.

6.4 Mineral composition

The mineral composition of each analysed sample was estimated on the basis of chemistry, petrography and microprobe analyses. In Fig. 6.9 a carbonatization diagram (see calculation and plotting basis in the section 3 or Lamberg & Hautala, 1990) is presented. In the albitic felsites in the beginning of the drill hole (between about 70-85 metres) and in the ore all Ca and Mg are bonded in carbonate, which is - according to atomic ratio Mg/Ca equating unity - dolomite. In the metadiabase and in the albitic felsite in the end of the drill hole (> 157 m) Mg and Ca are carried also by other minerals.

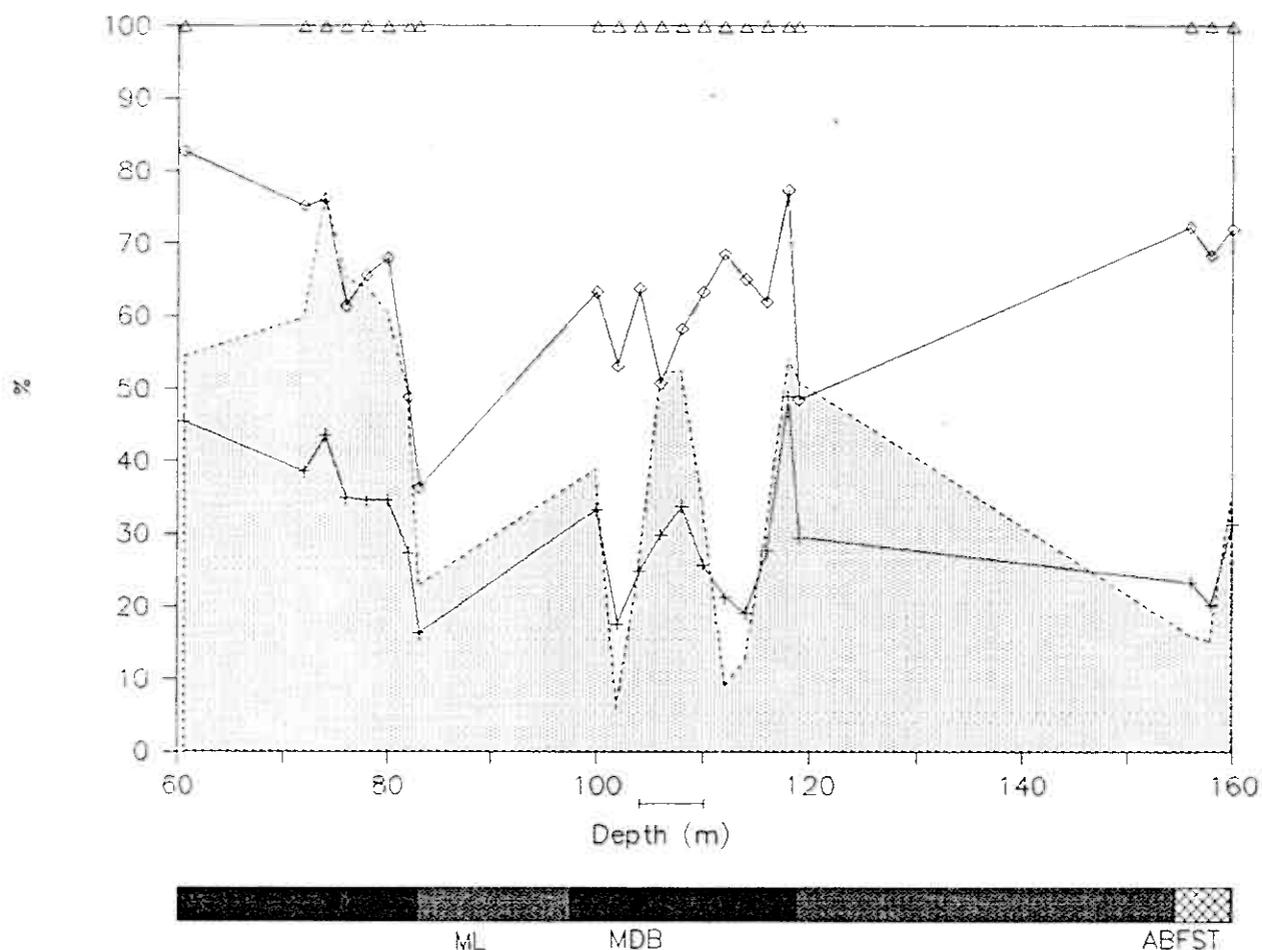


Fig. 6.9. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Carbonatization diagram, dotted field = the degree of carbonatization ($C/(Ca+Mg+Fe)$), lines from bottom edge: calcite ($Ca/(Ca+Mg+Fe)$), calcite + magnesite ($Ca+Mg/(Ca+Mg+Fe)$) and calcite+dolomite+siderite (=100). Cu-Au mineralization is located between 102 and 110 metres (marked by a line). More details see text. Abbreviations: ABFST = albitic felsite, ML = black schist, MDB = metadiabase.

Normative mineral composition was calculated using schedule introduced in section 3. The result is given in Appendix 3f. In Fig. 6.10 the normative mineral composition of the samples is presented as cumulative XY-diagram, where depth is placed in

X-axis. Normative mineral composition is in agreement with petrography, except for chlorite, which shows too small contents (because of calculation basis, see section 3).

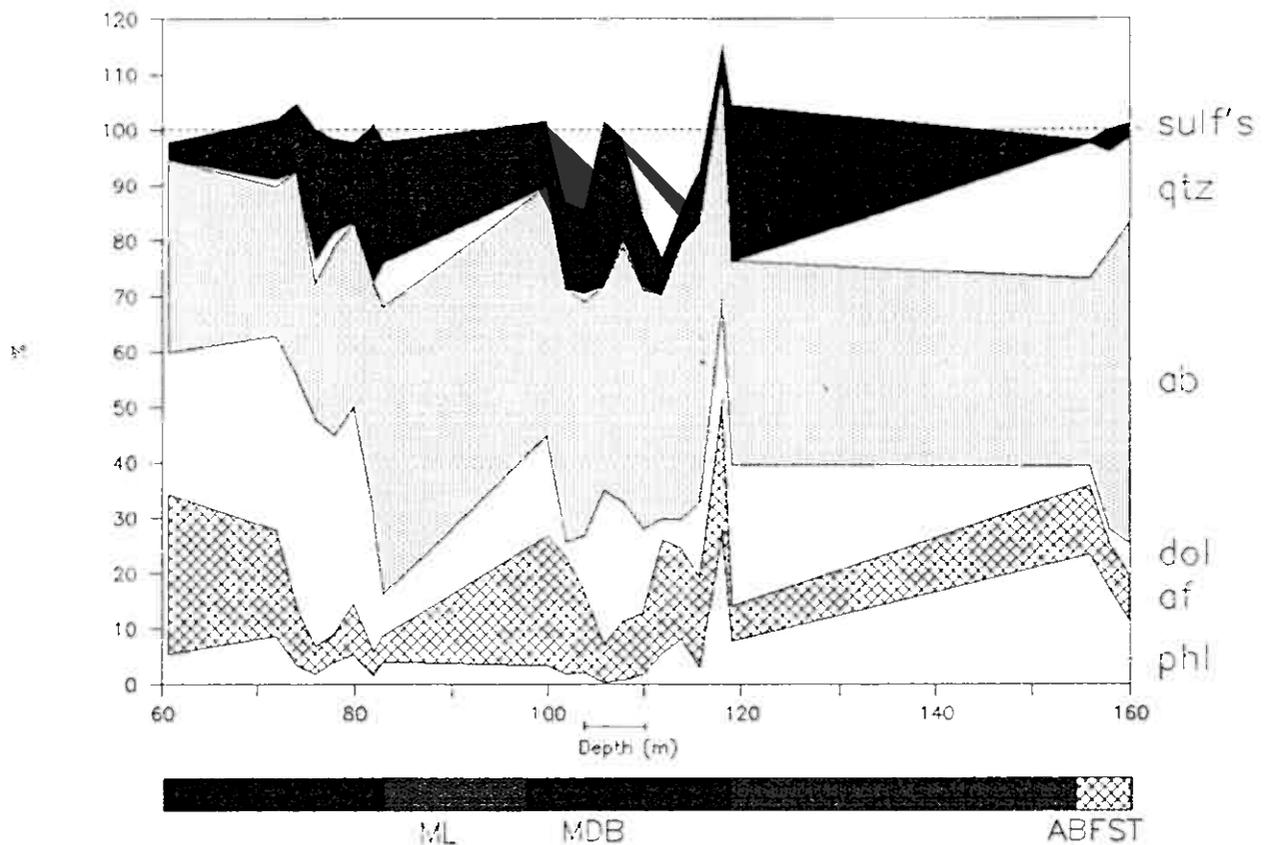


Fig. 6.10. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Normative mineral composition. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Fields from lower edge to the top edge: phl = phlogopite (white), af = amphibole (cross hatched), dol = dolomite (white), ab = albite (dotted), qtz = quartz (white), sulf's = sulfides (chalcopyrite + pyrrhotite + pyrite) (black). For more details see text. Abbreviations in rock type legend: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

Metadiabase and albitic felsite are almost similar in normative mineral composition (Fig. 6.10). Scapolite content is clearly higher in metadiabase (Appendix 3f and Fig. 6.11), as well as amphibole content. In metadiabases significant amount of aluminium is carried by amphibole, phlogopite and scapolite. In albitic felsites aluminium is mainly carried by albite.

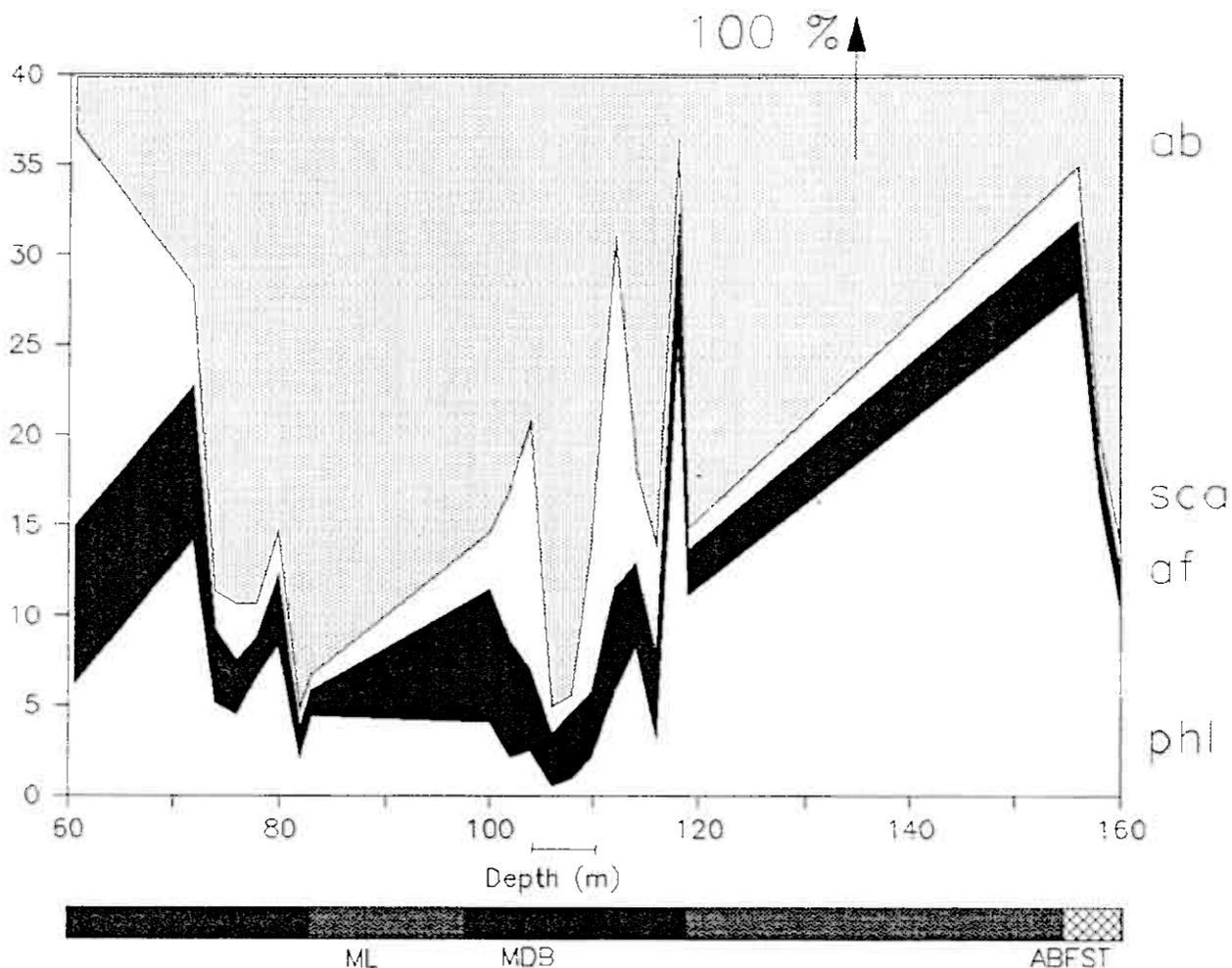


Fig. 6.11. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Normative aluminium carrier diagram. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Fields from bottom edge to the top edge: phl = phlogopite (white), af = amphibole (black), sca = scapolite (white) and ab = albite (dotted). Abbreviations in rock type legend: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

Au-Cu mineralization can be seen in Al carrier diagram (Fig. 6.12) by decreasing scapolite and phlogopite contents to zero. In Al carrier diagram the mineralization shows clearly an albitic felsite-like composition. It differs from barren albitic felsites by low phlogopite content.

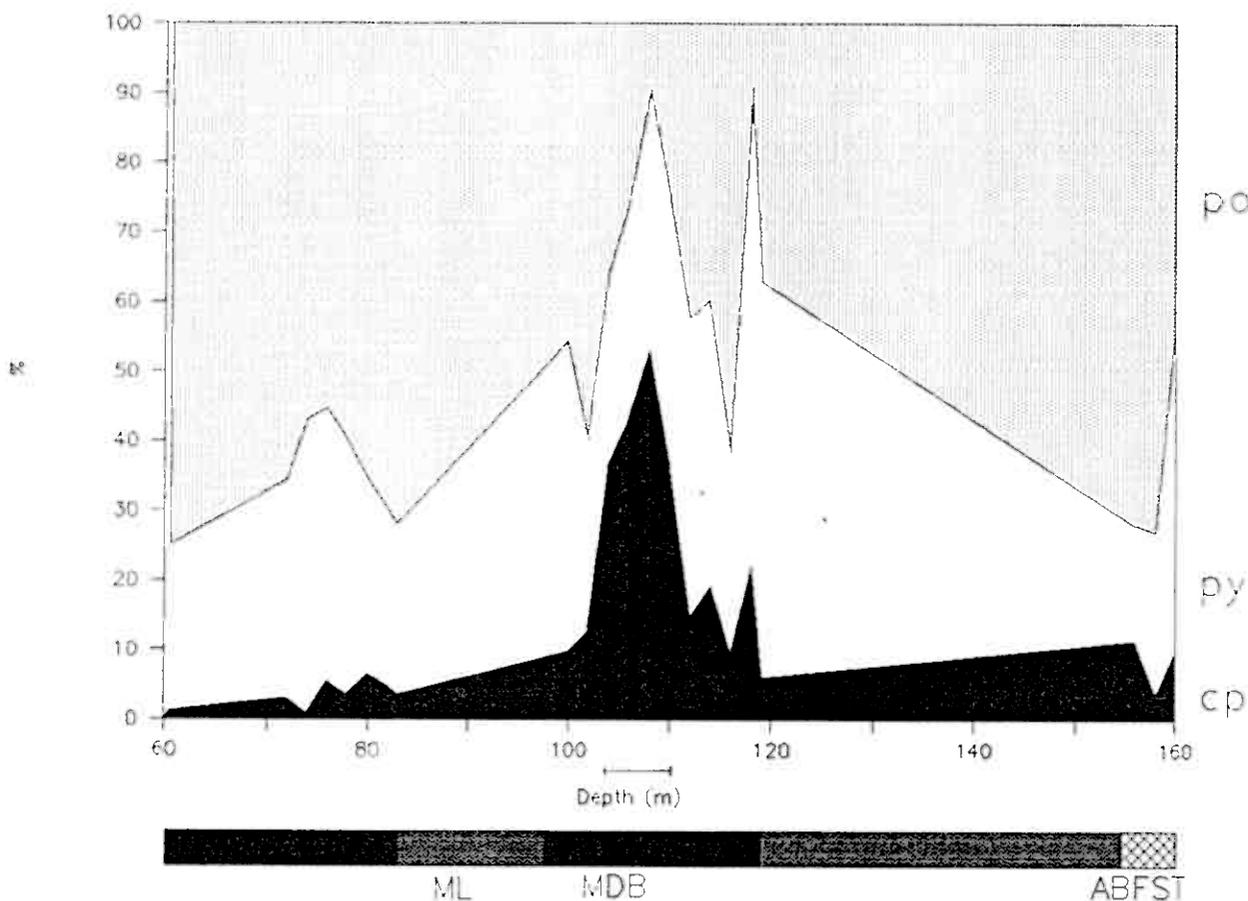


Fig. 6.12. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Normative mineral composition of the Cu-Fe-sulfide phase. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Fields from bottom edge to the top edge: cp = chalcopyrite (black), py = pyrite (white), po = pyrrhotite (dotted). Abbreviations in rock type legend: ABFST = albitic felsite, ML = black schist, MDB = metadiabase.

Normative mineral composition of Cu-Fe-sulfide phase is shown in Fig. 6.13. Au-Cu mineralization is characterized by high normative chalcopyrite content as well as symmetric variations in the ratios of Fe-sulfides. In the contact between metadiabase and black schist (proposed albitic felsite between 118 and 120 metres) the dominant iron sulphide is pyrite changing to pyrrhotite inwards the sheet, but being again pyrite in the ore.

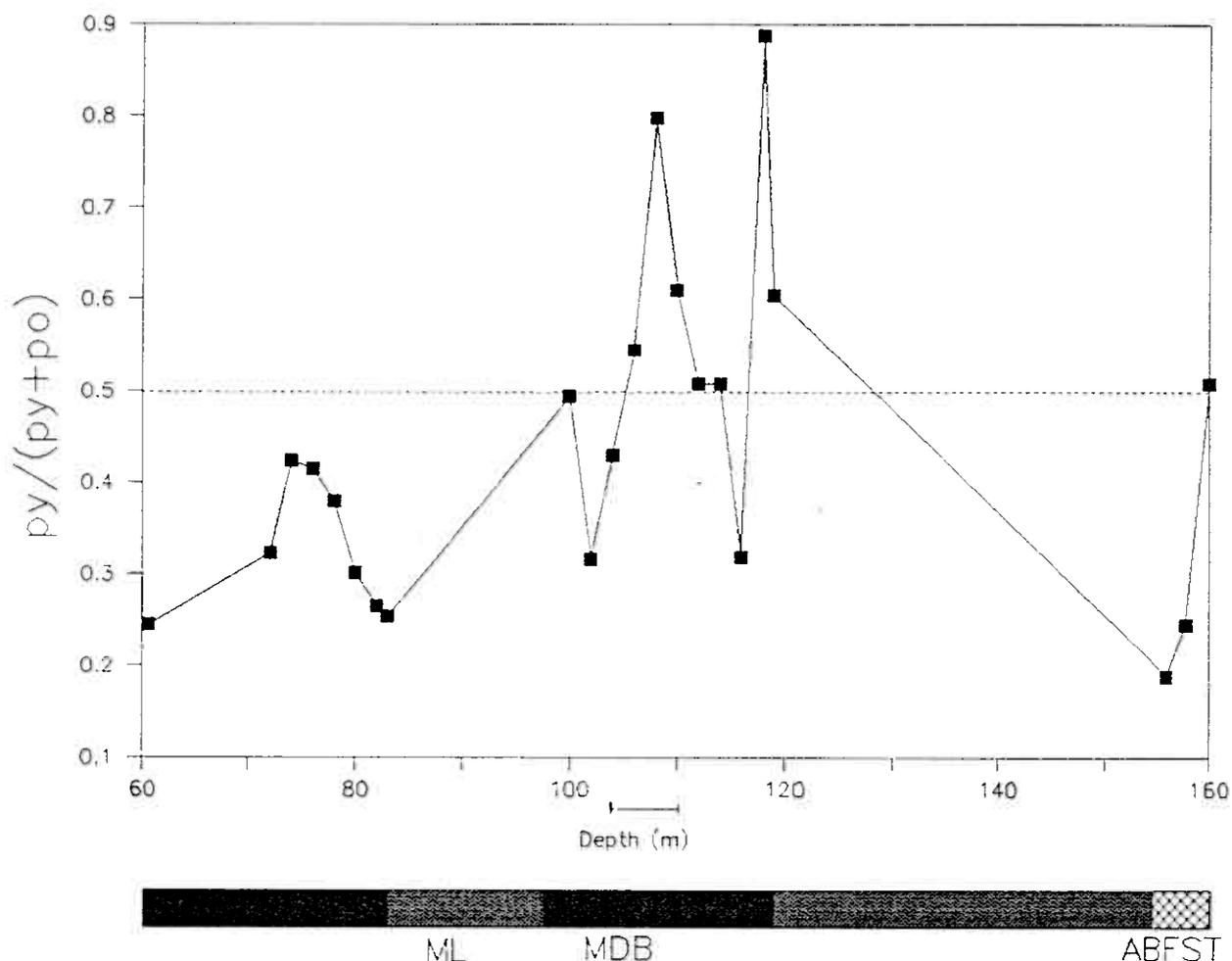


Fig. 6.13. Bidjovagge, C4-ore, drill hole S154B (rock type legend simplified). Normative pyrite/(pyrite+pyrrhotite) (py/(py+po)) ratio presented as a function of depth. Cu-Au mineralization is located between 102 and 110 metres (marked by a line). Abbreviations: ABFST = albite felsite, ML = black schist, MDB = metadiabase.

6.5 Summary of the features adjacent to the ore

Cu-Au mineralization is located between 102 and 110 metres hosted by mixture of albitic felsite and metadiabase according to the ratios of immobile elements and other chemical features, namely Cl, Cr, Ti and P contents. Au content is approximately 11 ppm. Cu and Au show strong positive correlations ($r=0.89$).

Co/Ni ratio forms a trend opposite to Cl, as stated also in C2 and C3 ores. Highest Au and Cu content coincide with Co/Ni maximum in the central part of metadiabase sheet.

According to petrographical observations the mineral composition of metadiabase changes towards the ore by the following way:

- albite content increases
- grain size of albite decreases from 1800 μm via 300 μm (in metadiabase) to 10 μm in albitic felsite sample 106.5 μm

- amphibole content decreases
- scapolite disappears

Au-ore sample 106.5 m is classified also according to petrographic observation as albitic felsite.

Ratios of normative Al carriers change towards the ore. Scapolite and phlogopite contents decrease to zero.

Au-Cu mineralization is characterized by high normative chalcopyrite content as well as symmetric variations in the ratios of Fe-sulfides, which change from pyrite in the metadiabase - albitic felsite / black shist contact via pyrrhotite in the inner part of the metadiabase sheet again to pyrite in the central part of the metadiabase sheet, which is composed of albitic felsite.

7 Au ORE E

7.1 Introduction

E-ore is a representative of the gold ore type of Bidjovagge deposit (Björlykke et al., 1991; Ekberg & Sotka, 1991). It is located about 1 km to north from C-ores as shown on the map in Figure 2.1. Gold ore type is characterized by having less sulphides than copper ore type, mainly pyrrhotite and pyrite, also minor chalcopyrite (0.1-0.5 % Cu), and having tellurides, davidite and gold (5-20 g/t Au) (Ekberg & Sotka, 1991).

Rock types of the drill hole N20E are mainly albitic felsites with few thin and highly carbonatized parts. These are intruded by metadiabase dykes at the top and bottom of the drill hole (Appendix 4a). The Au mineralization is hosted by albitic felsite. Rock type intervals and the samples in each interval are shown in Table 7.1.

Table 7.1. List of the samples of E-ore.

INTERVAL metres	ROCKTYPE	CHEMISTRY n	SAMPLE	PETROGRAPHY depth (m)
40.0-43.0	metadiabase	-	-	-
43.0-149.0	albitic felsite	11	-	46.5, 62.5 106.6, 140.6
149.0-155.0	carbonate rock	-	-	-
155.0-211.5	albitic felsite	19	-	165.5, 185.5 189.5, 195.4
211.5-219.0	metadiabase	1	-	-

7.2 Chemistry

XRF-analyses are presented in Figs. 7.1-7.9, where the ratios of immobile elements and element concentrations have been presented as a function of depth in the drill hole. Roughly estimated approximate values are given in Table 7.2, where the content of CO₂ has been regarded as a reference element.

Table 7.2 Average chemical composition of different rock types in E-ore.

	MgO wt.%	FeO wt.%	SiO ₂ wt.%	Al ₂ O ₃ wt.%	Na ₂ O wt.%	CaO wt.%	CO ₂ wt.%	TiO ₂ wt.%	S wt.%	Cu wt.%	Au ppm	Al ₂ O ₃ /TiO ₂
ALBITIC FELSITE low CO ₂	5	5	60	15	8.5	5	5	0.6	3	0	0.1	25
ALBITIC FELSITE high CO ₂	5	12	35	15	5.5	13	13	0.35	9	0	0.1	25
ORE low CO ₂	1	6	55	15	8	3	3	0.6	4	2	1.5	20
ORE high CO ₂	-	-	-	-	-	-	-	-	-	-	-	-
METADIABASE low CO ₂	7	15	50	10	4.5	6	3	0.65	5	0	0.2	15
METADIABASE high CO ₂	-	-	-	-	-	-	-	-	-	-	-	-

Al₂O₃/TiO₂-ratio of albitic felsites (Fig. 7.1) is approximately 25 (Table 7.2). The same ratio for metadiabase is 15, which is clearly higher than typical values in C₂, C₃ and C₄ ores and given by Lamberg & Hautala (1990) for metadiabases. Also other contents for immobile element ratios and characteristic elements show intermediate values between typical albitic felsite and metadiabase

for metadiabase in the end of the drill hole (211-219 m). In this study, however, only one metadiabase sample was included (Table 7.1).

Au mineralization is located between 190 and 200 metres hosted by albitic felsite of Al_2O_3/TiO_2 ratio about 20. Au content is approximately 1.5 ppm (Table 7.2) (Fig. 7.6). The mineralization is best characterized by having higher Cu content (2 wt.%) compared to barren albitic felsite (0 wt.%). Also the content of vanadium seems to be higher in the mineralized part (0.04 wt.%) than in barren albitic felsite (0.02 wt.%) (Fig. 7.5).

Elements show similar affinities as in the C ores stated before. Immobile and silicate-forming (ab + qtz) elements (ISE's) behave identically and have negative correlation with carbonate-forming elements (CFE's). Phlogopite-forming elements (PFE's) K, Ba and Rb are grouped together. Chloride is accompanied with CFE's. Th and Ce have positive correlation with ISE's. U and Mo resembles SFE's. Au has much similarities with SFE's especially with Cu ($r=0.69$) and Pb ($r=0.53$).

BIDJOVAGGE, E-ORE / N20E

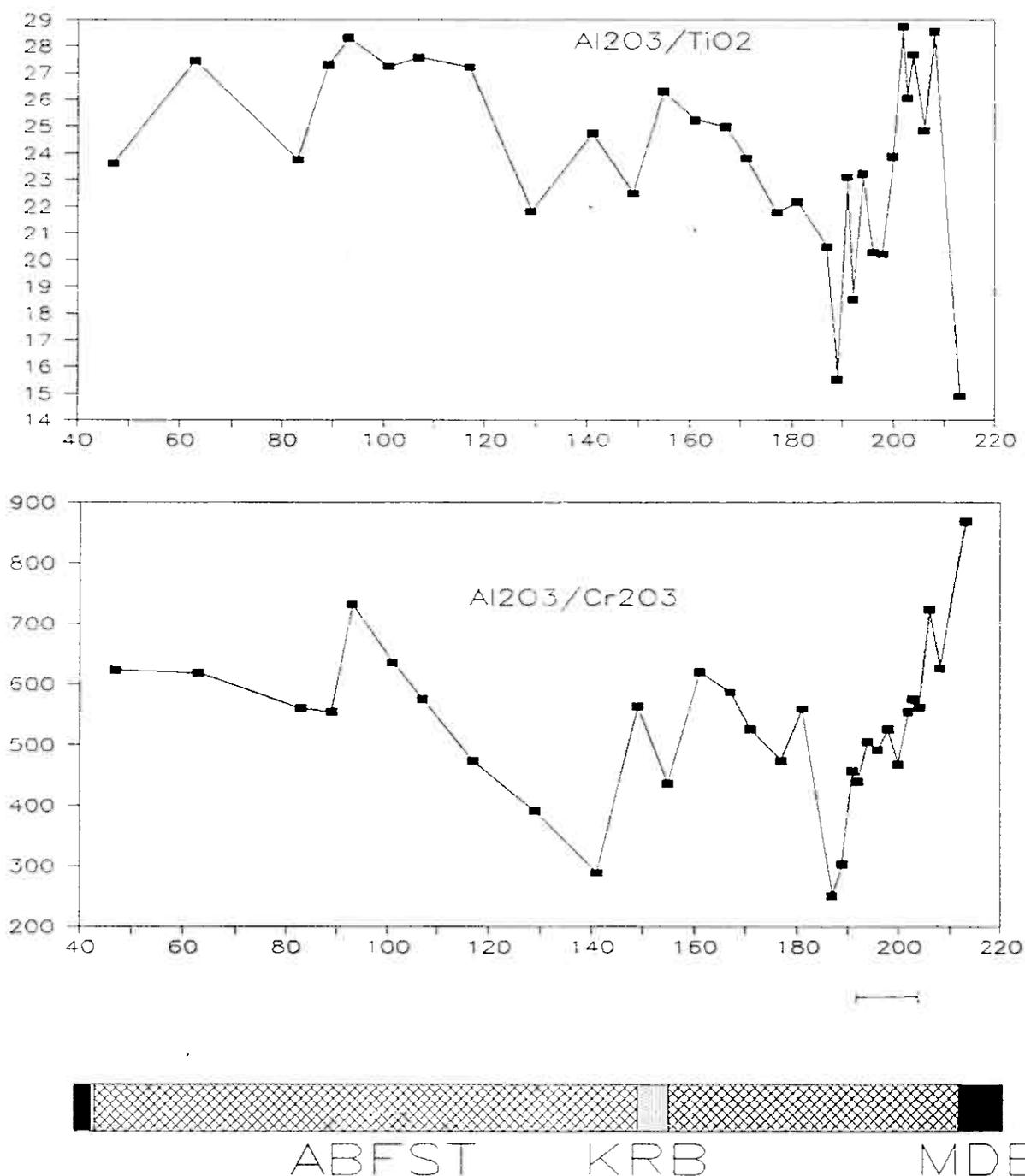


Fig. 7.1. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Ratios of immobile elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

BIDJOVAGGE, E-ORE / N20E

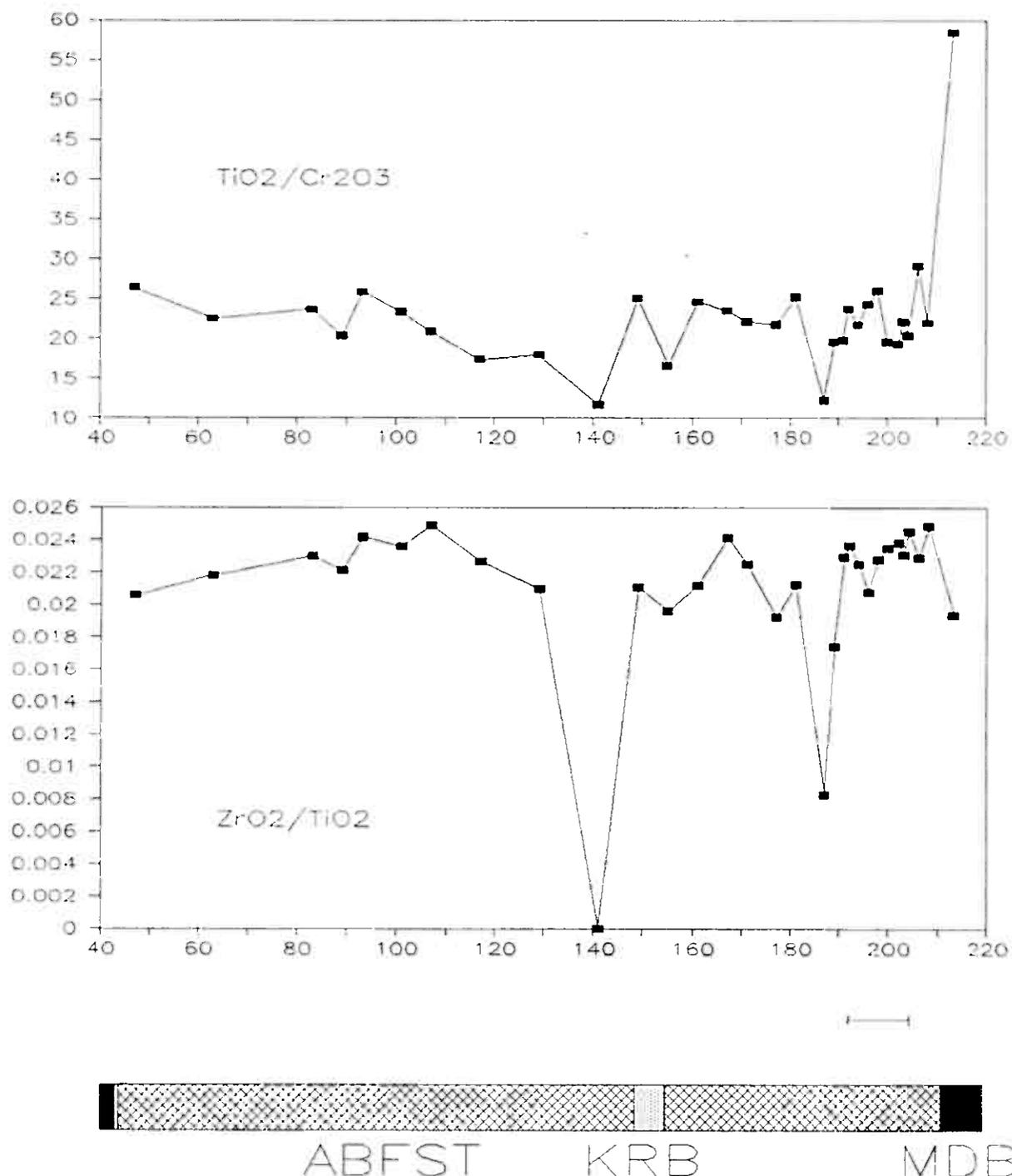


Fig. 7.2. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Ratios of immobile elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

BIDJOVAGGE, E-ORE / N20E

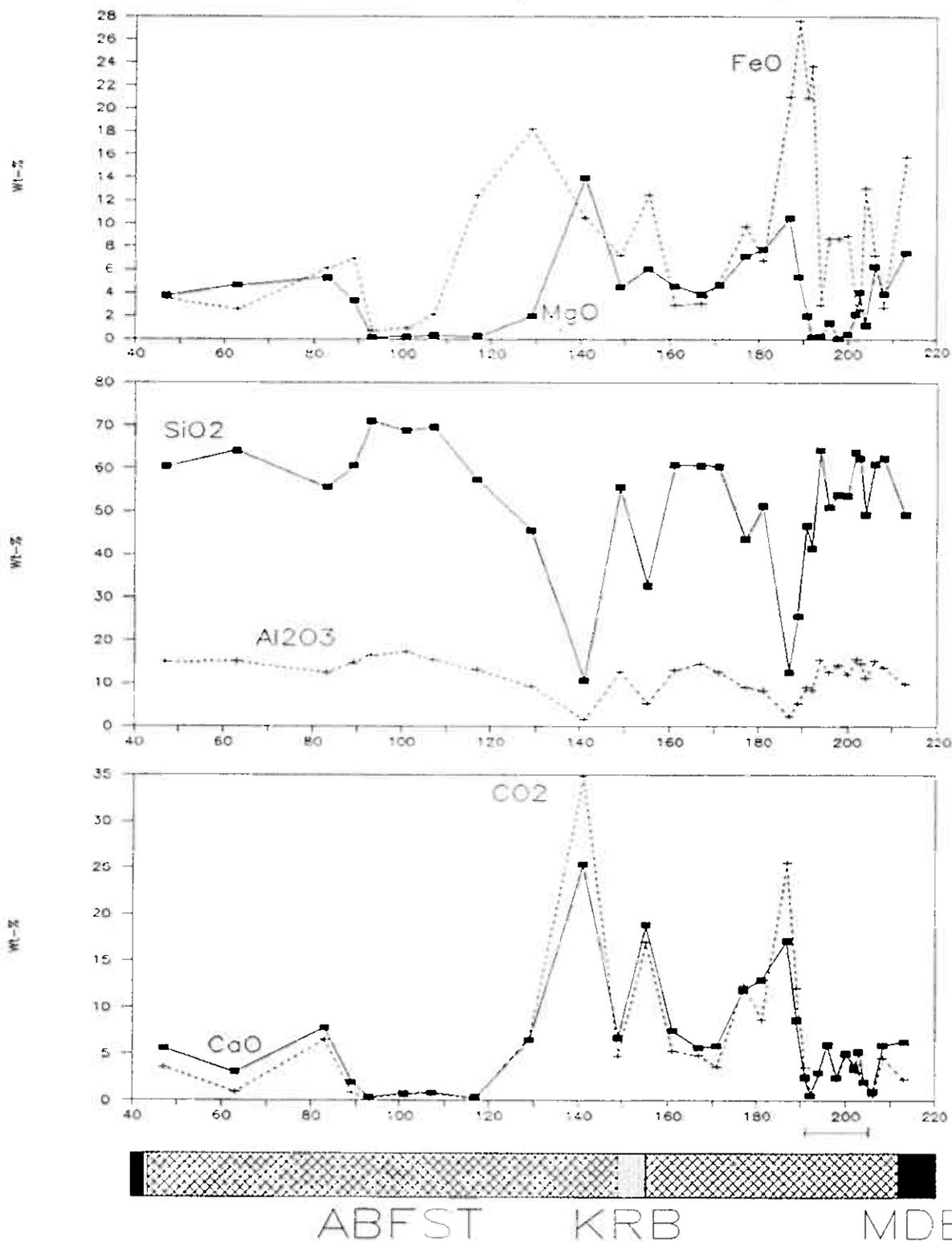


Fig. 7.3. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Named elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

BIDJOVAGGE, E-ORE / N20E

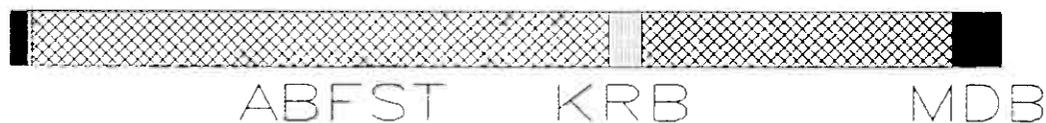
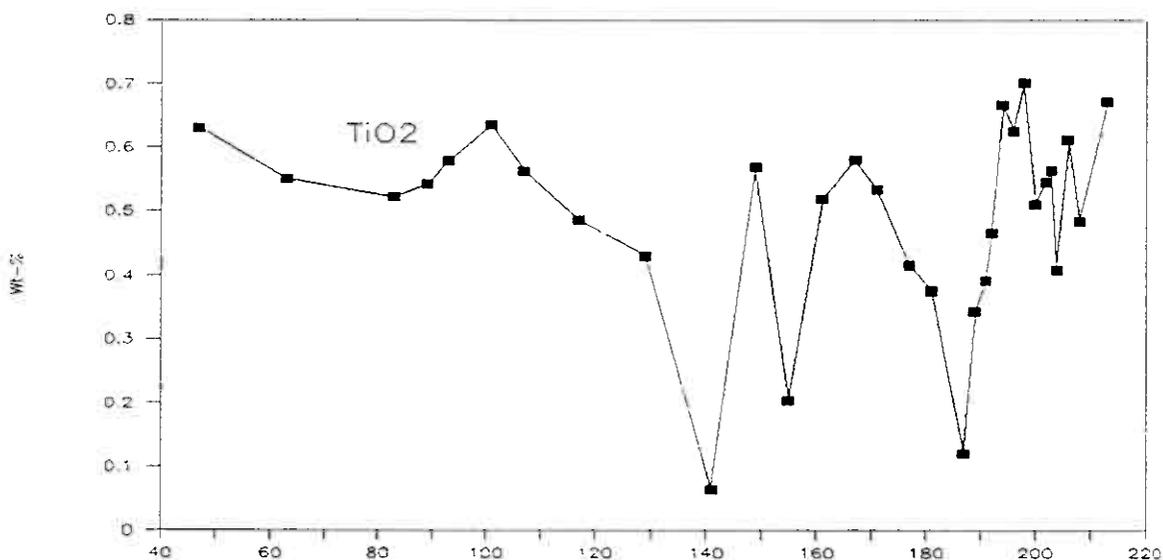
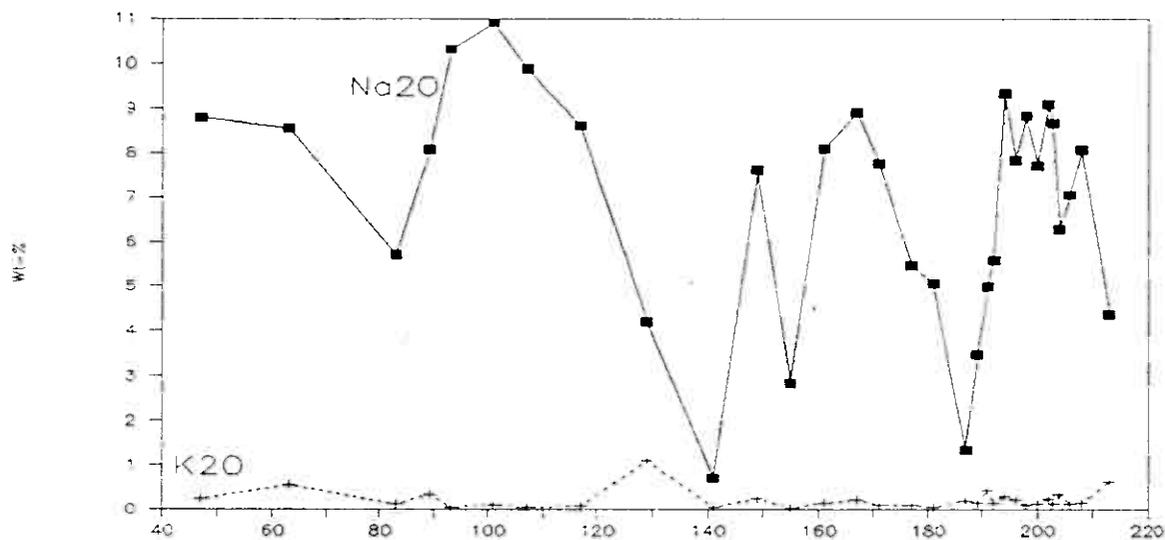


Fig. 7.4. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Named elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

BIDJOVAGGE, E-ORE / N20E

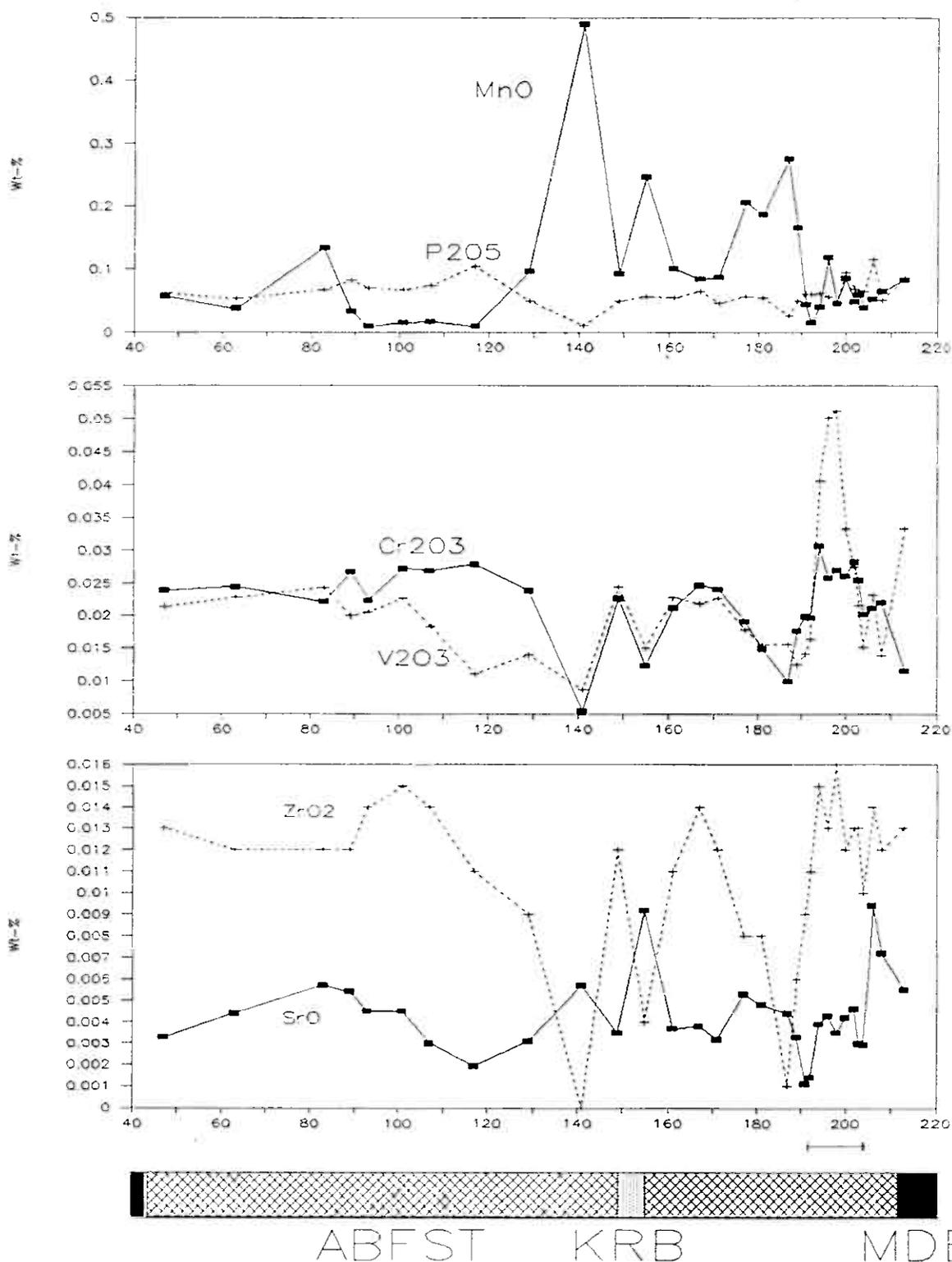


Fig. 7.5. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Named elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

BIDJOVAGGE, E-ORE / N20E

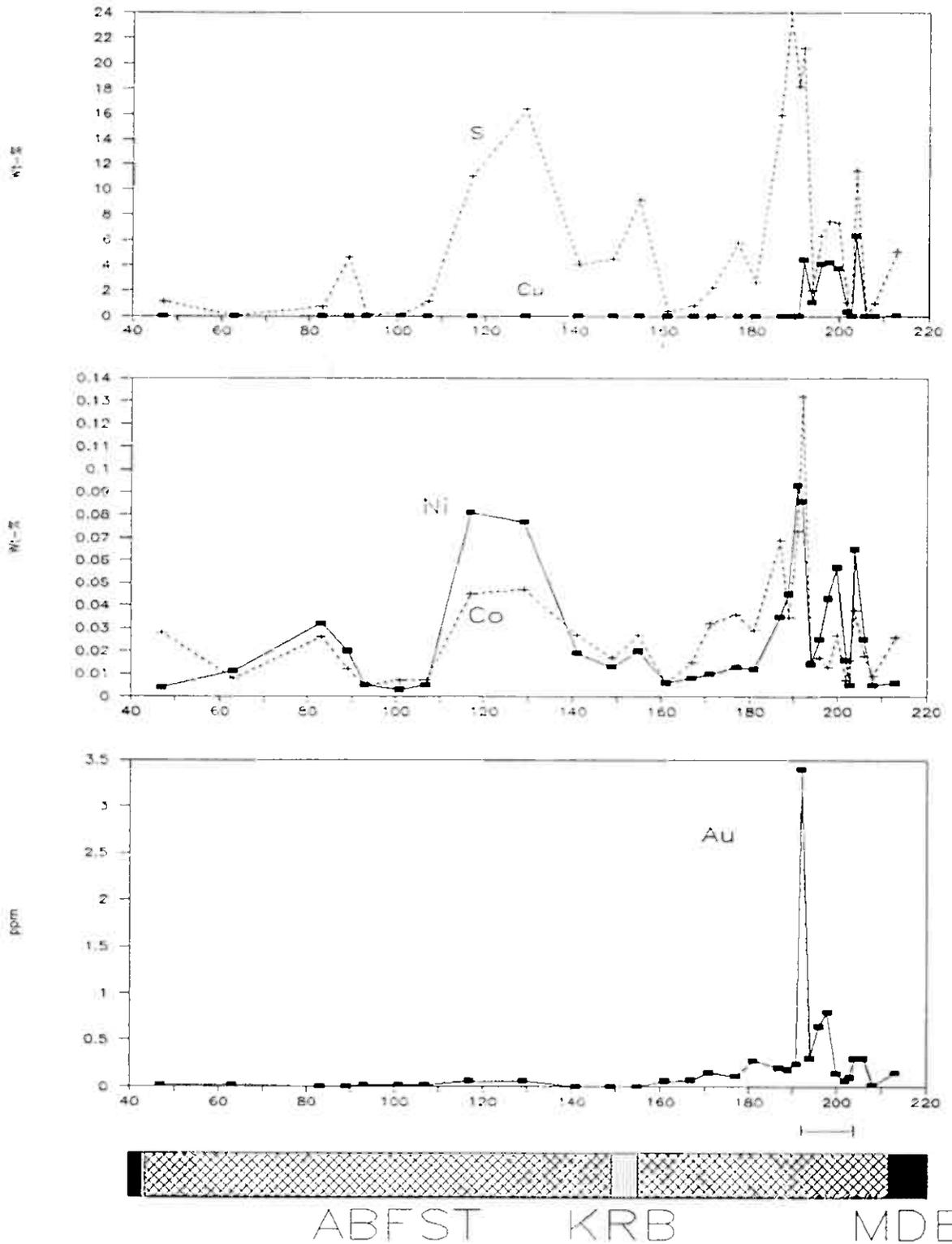


Fig. 7.6. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Named elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

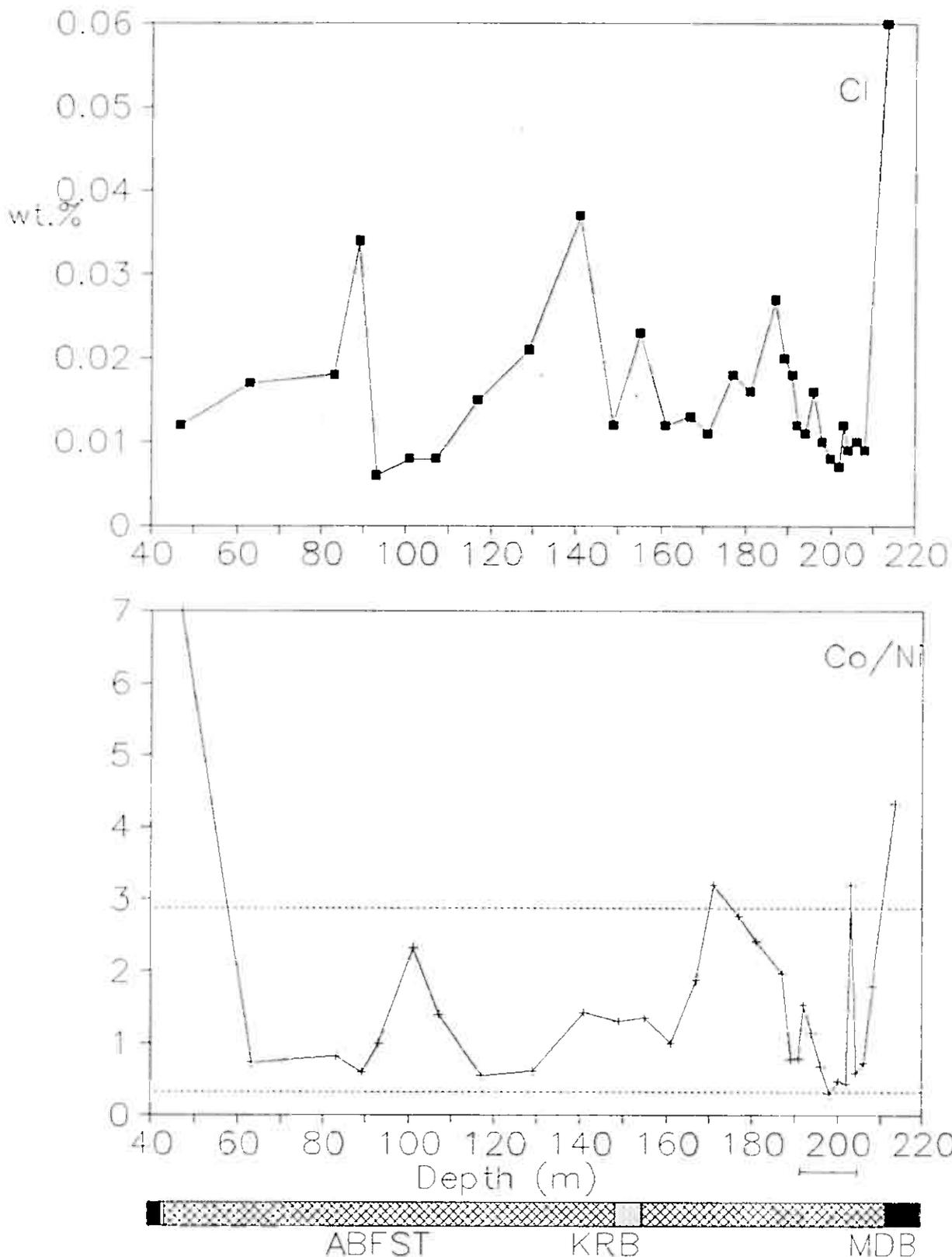


Fig. 7.7. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Named elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

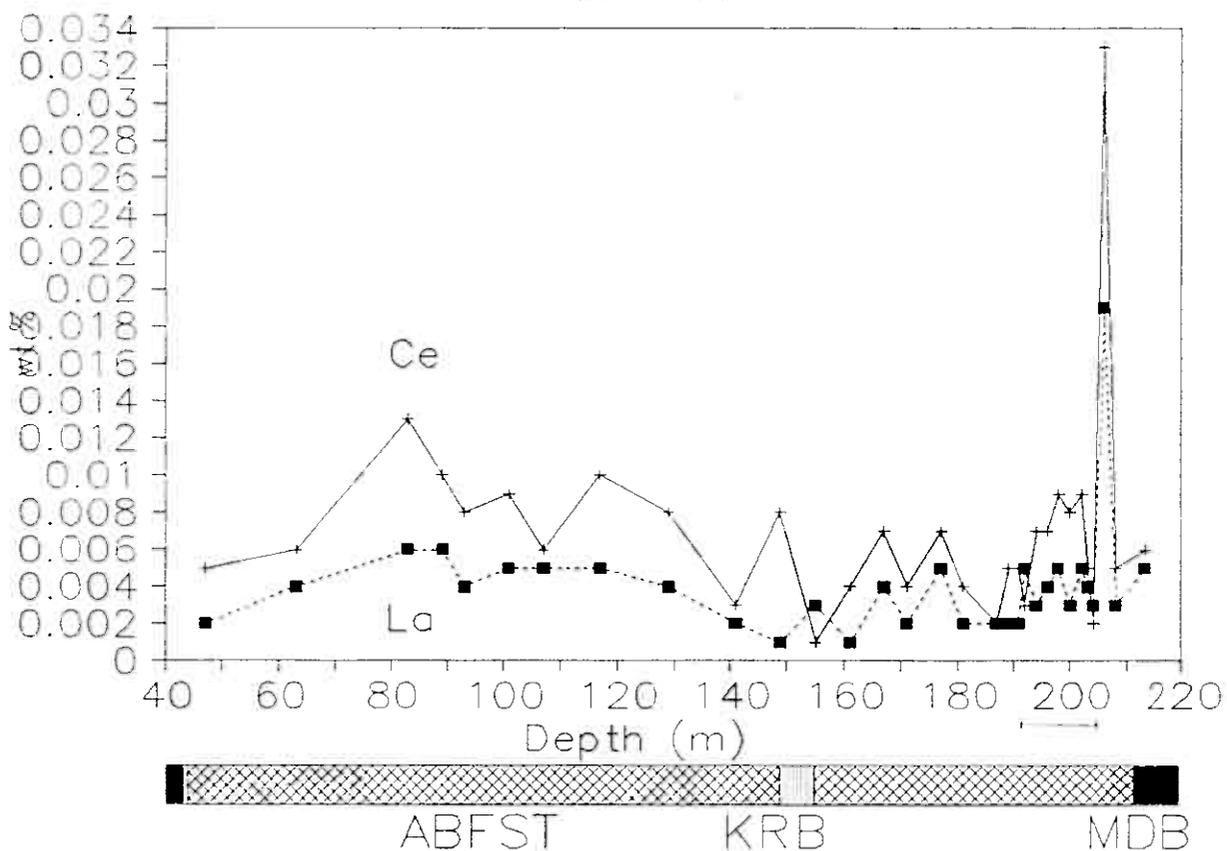
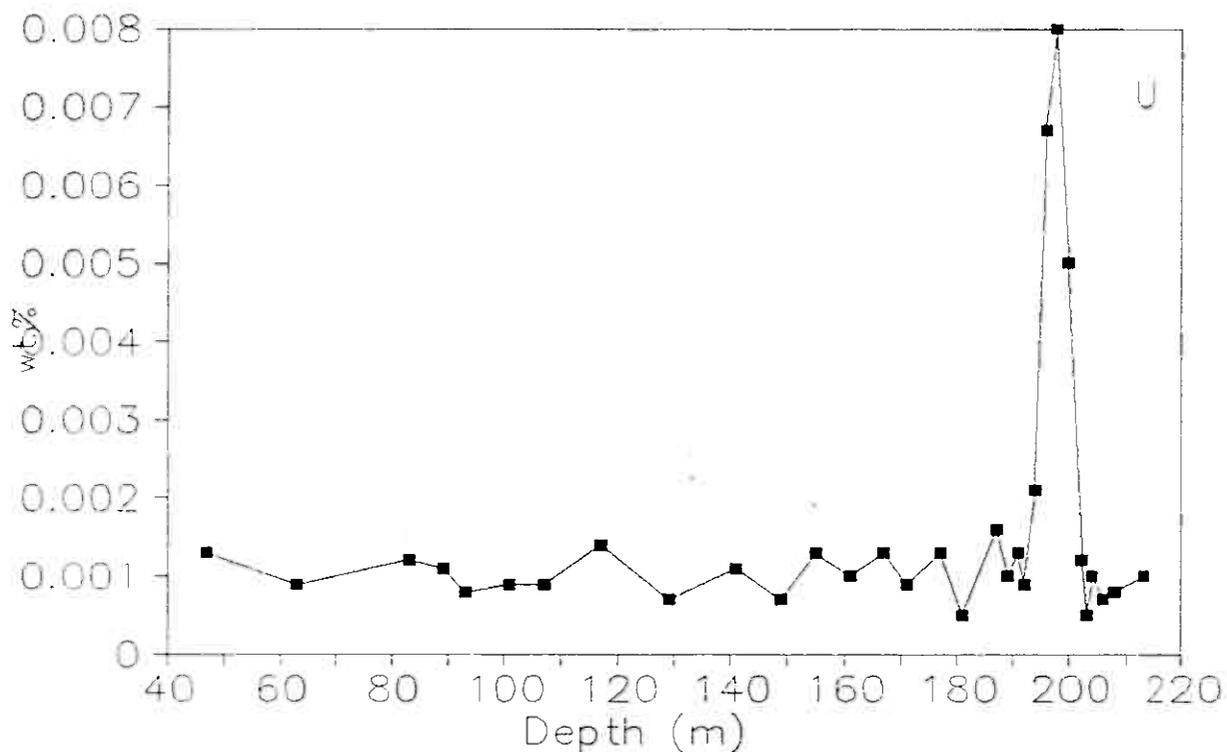


Fig. 7.8. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Named elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

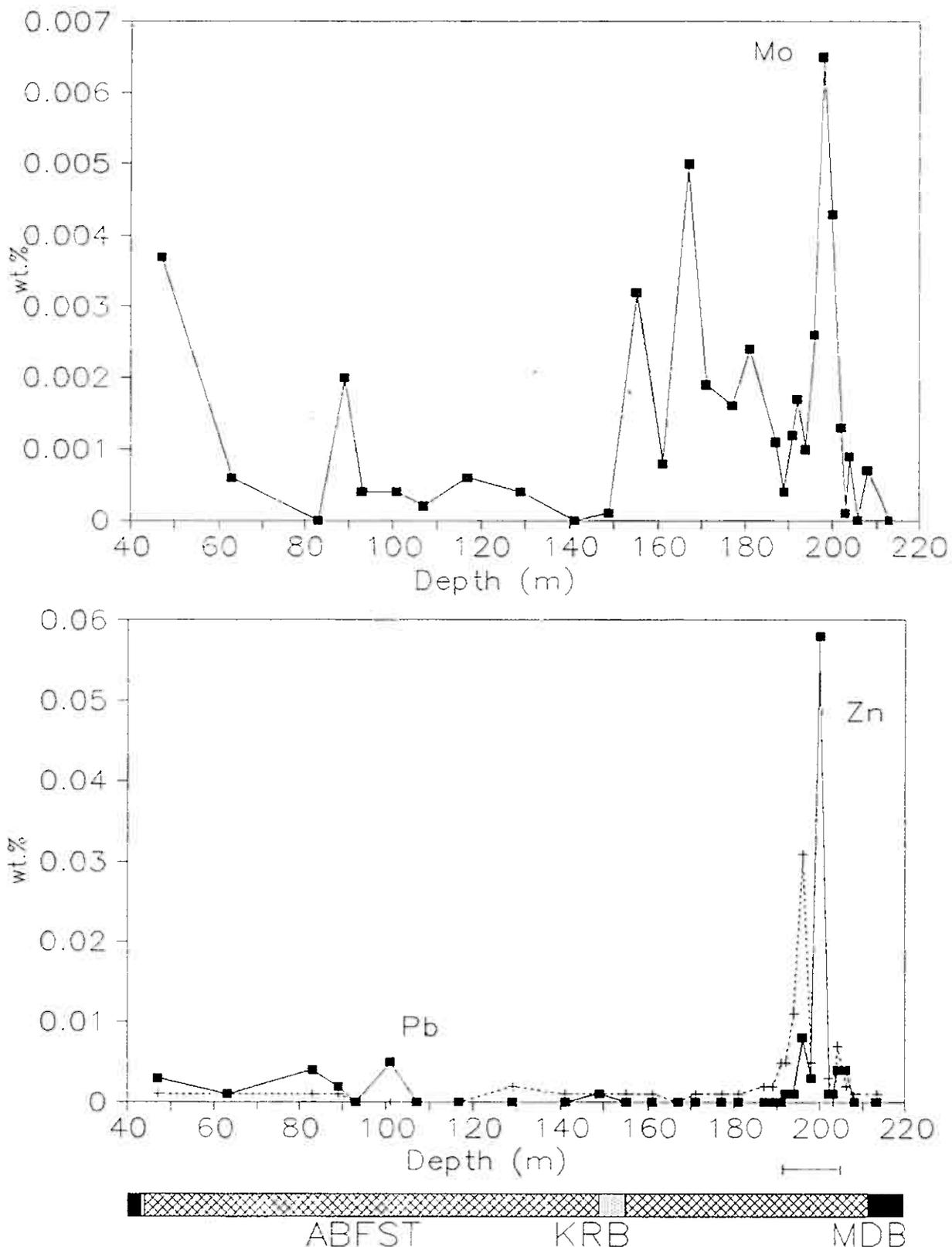


Fig. 7.9. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Named elements as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

7.3 Petrography

For the petrographical study eight samples from the drill hole N20E were selected from the interval of 46.5 to 195.4 metres. Summary on the mineral composition of the samples is given in Table 7.3.

Seven samples (46.5 m, 62.5 m, 106.6 m, 165.5 m, 185.5 m, 189.5 m and 195.4 m) are named as albitic felsites. Albite forms with quartz the fine grained ($\phi = 10 \mu\text{m}$) groundmass of albitic felsites. Rutile is common accessory. Biotite is an accessory mineral in the sample 46.5 m.

Ground mass is cut by numerous veins of about 0.4 mm in width. Grains are much coarser in the veins than in the groundmass. Veins are not always continuous but vein minerals can be found in the groundmass as coarse grained lenses or eyes. Mineral composition in the veins varies from sample to sample (list of minerals given in the order of abundance):

- af-crb-ab-qtz-tit (46.5 m)
- af-bt-crb-qtz-ab-ru-py-cp (62.5 m)
- qtz-ab-chl-(rare py & ilm) (106.6 m)
- crb-af-ab-tit-ru-bt-ilm-py (165.5 m)
- crb-py-bt-af-qtz-ab-ru-ilm-pa (near the ore) (185.5 m) quartz and albite rims the vein and their grain size is coarser than in the groundmass (100 μm vs. 10 μm , respectively)
- py-qtz-(minor pa-chl-af-ilm-ru+mt) (189.5 m)
- py-cp-bt-crb-ab-ilm-qtz-mt-chl-pa (Au-ore) (195.4 m)

Towards the ore the mineral composition of the veins changes:

- amphibole disappears
- carbonate content increases
- the amount of sulfides in the vein increases

In the Au-ore sample 195.4 m veins, veinlets and lenses are composed mainly of pyrite, chalcopyrite, biotite, carbonate albite and ilmenite. The grain size in vein is about 0.3 mm. In the groundmass rutile is a common accessory.

Sample 140.6 m is named as carbonate rock. It is composed of carbonate and pyrite. Grains are coarse, commonly more than 0.5 mm in diameter. Some chalcopyrite inclusions can be found in pyrite.

Table 7.3. Summary on the petrographical study on Bidjovagge C4 ore samples, drill hole S154B. Abbreviations for rock types and minerals are given in section 3. Minerals are given in the order of abundance. In column ϕ ab (μ m) the average diameter of albite is given in micrometres; if two values are given the first is for groundmass and the second for veins. Ind:a(O2) = indicative minerals for oxygen activity (fugacity) determination, Ind:pH = indicative minerals for pH determination.

Depth (m)	Rock type	Represents	"Ground mass" minerals	Vein minerals	ϕ (ab) (μ)	Ind:a(O2)	Ind:pH	Note: reactions etc
46.5	ABFST	"least altered"	ab,qtz,ru	af,crb,ab,qtz,tit	10/100	-	ab	
62.5	ABFST	"least altered"	ab,qtz,ru	af,phl,crb,qtz,ab,py,cp	10/100	py	ab	
106.6	ABFST		ab,qtz,ru	qtz,ab,chl,(py,ilm)	10/60	py,ilm	ab	
140.6	CRB-R		crb,py,(cp)		-	py	-	
165.5	ABFST		ab,qtz,ru	crb,af,ab,tit,ru,phl,ilm,py	10/120	py,ilm	ab	
185.5	ABFST	Close to the ore	ab,qtz,ru	crb,py,phl,af,qtz,ab,ru,ilm,pa	10/130	py,ilm	ab	
189.5	ABFST	Close to the ore	ab,qtz,ru	py,qtz,pa,chl,af,ilm,ru,smt	10/150	py,ilm,smt	ab,pa	sca->chl
195.4	ABFST	Au-ore	ab,qtz,ru	py,cp,phl,crb,ab,ilm,qtz,mt,chl,pa	10/100	py,ilm,mt	ab	

7.4 Mineral composition

The mineral composition of each analysed sample was estimated on the basis of chemistry, petrography and microprobe analyses (Appendix 7). In Fig. 7.10 a carbonatization diagram is presented, which shows that the most likely carbonate species in E ore are calcite and dolomite. In most of the samples C equals with Ca indicating rather calcite than dolomite. In some albitic felsite samples poor in amphibole, however, C equals with Ca+Mg (Ca/Mg ratio about 1) indicating dolomite. Ore shows interesting features. Ca/Mg ratio is close to zero and C equals with Ca showing that calcite is the most likely carbonate species in the ore. Dolomite is of minor importance if present at all. In the mineral composition calculations, however, all C is assumed to be bound in dolomite affecting overestimation in amphibole content (see Appendix x).

Normative mineral composition of each sample was calculated using the schedule introduced in Section 3 and given in Appendix x. The result is given in Appendix 4f and in Fig. 7.10, which shows cumulative percentages of each mineral as a function of depth. Normative mineral composition is in agreement with petrography.

The normative mineral composition of albitic felsite varies widely. Albite is always the main mineral. Amphibole content is typically about 25 % but in ore and between 90 and 120 metres it decreases to less than 5 %. Normative dolomite content is quite high between 130 and 190 metres but in other samples it is accessory. Quartz is often absent. Sulfide content is quite low (10-20 %) in the ore with respect to samples in the nearhood (about 190 metres) containing about 40 % sulfides. Towards the metadiabase, phlogopite content together with amphibole increases.

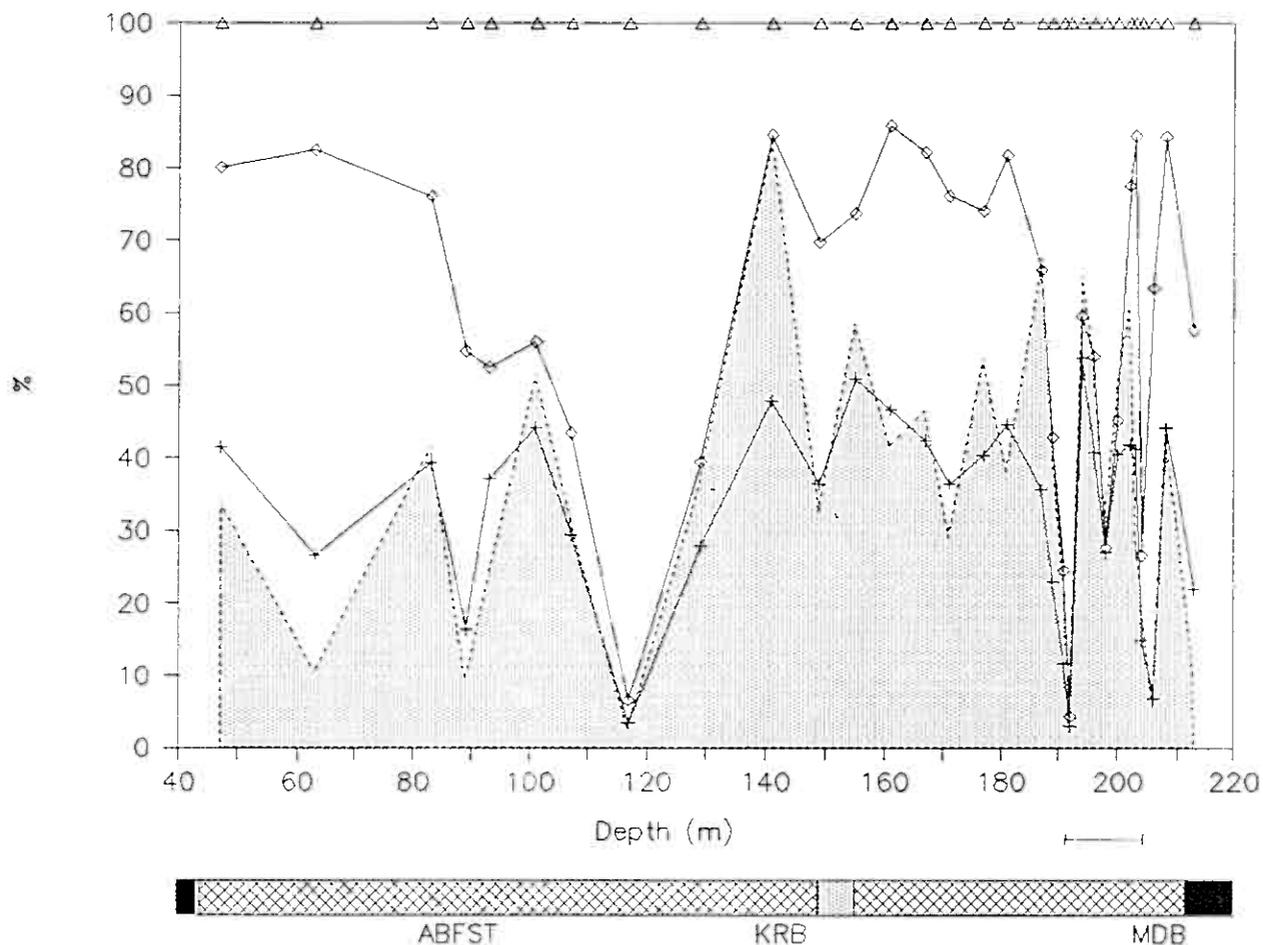


Fig. 7.10. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Carbonatization diagram, dotted field = the degree of carbonatization ($C/(Ca+Mg+Fe)$), lines from bottom edge: calcite ($Ca/(Ca+Mg+Fe)$), calcite + magnesite ($Ca+Mg/(Ca+Mg+Fe)$) and calcite+dolomite+siderite (=100). For more details see text. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

The ore does not differ by any specific way from barren albitic felsites in normative mineral composition. Microscopically observed decrease in the amphibole content towards the ore is justified by normative mineral composition, but carbonate and phlogopite contents do not show any significant increase towards the ore.

Al-carrier diagram is shown in Fig 7.12. Albite is the dominant Al-carrier in all samples. Amphibole becomes important in the interval between 130 and 190 metres rich in CO_2 . Scapolite is negligible. Phlogopite is of minor importance in albitic felsites but towards metadiabase its amount as Al-carrier increases. Au ore is characterized by high albite content (carrying more than 95 % of aluminium) with low amphibole and phlogopite contents.

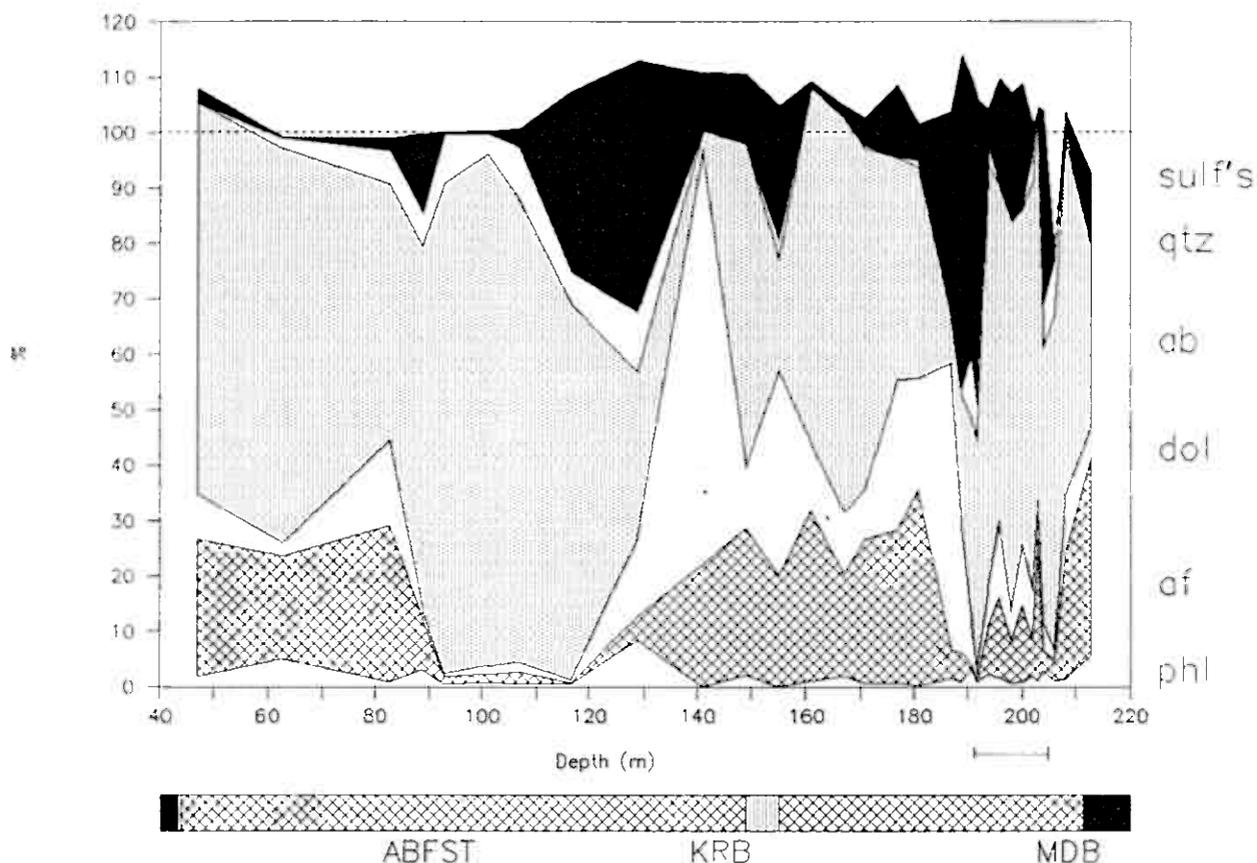


Fig. 7.11. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Normative mineral composition. Fields from lower edge to the top edge: phl = phlogopite (white), af = amphibole (cross hatched), dol = dolomite (white), ab = albite (dotted), qtz = quartz (white), sulf's = sulfides (chalcopyrite + pyrrhotite + pyrite) (black). For more details see text. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

Normative mineral composition of the Cu-Fe-sulfide phase is shown in Fig. 7.13. Ore is characterized by high chalcopyrite content with low pyrite/(pyrite+pyrrhotite) ratio (Fig. 7.14). In albitic felsites pyrrhotite is typically the dominant Fe-sulfide, but the ore is rimmed by albitic felsites with pyrite clearly predominating over pyrrhotite. Pyrite is the only Fe-sulfide in the metadiabase sample.

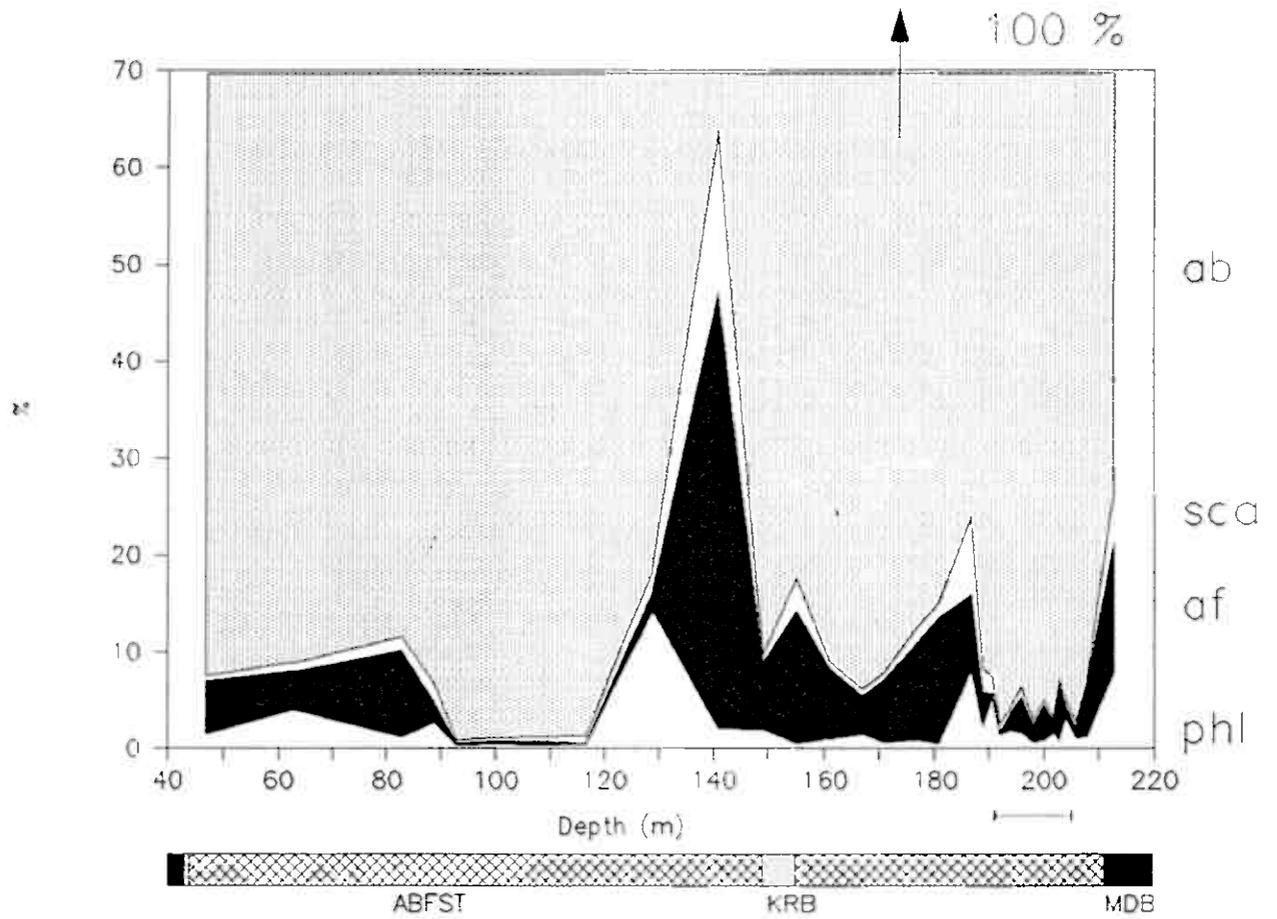


Fig. 7.12. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Normative aluminium carrier diagram. Fields from bottom edge to the top edge: phl = phlogopite (white), af = amphibole (black), sca = scapolite (white) and ab = albite (dotted). The location of Au ore is marked by a line. Abbreviations in rock type legend: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

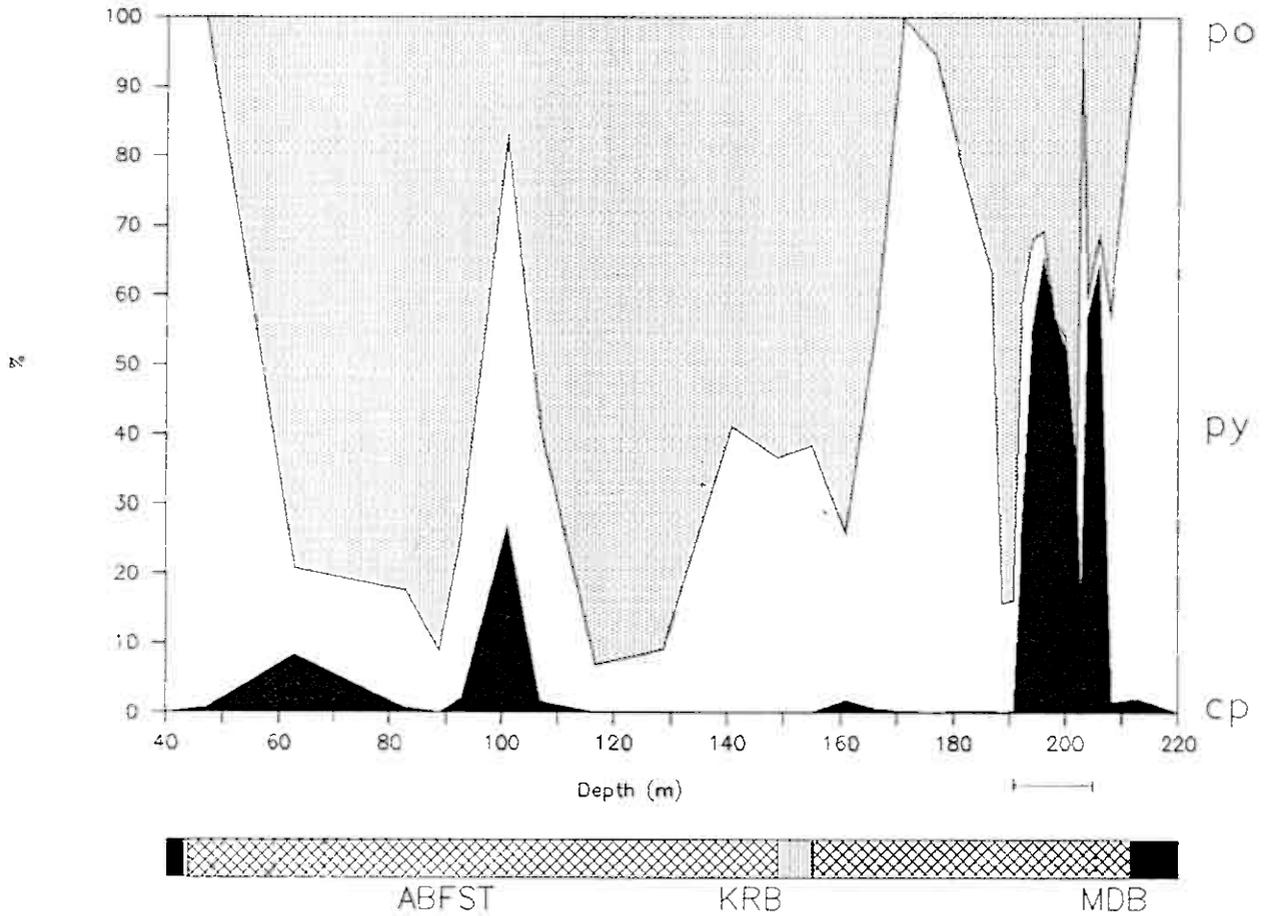


Fig. 7.13. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Normative mineral composition of the Cu-Fe-sulfide phase. Fields from bottom edge to the top edge: cp = chalcopyrite (black), py = pyrite (white), po = pyrrhotite (dotted). The location of Au ore is marked by a line. Abbreviations in rock type legend: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

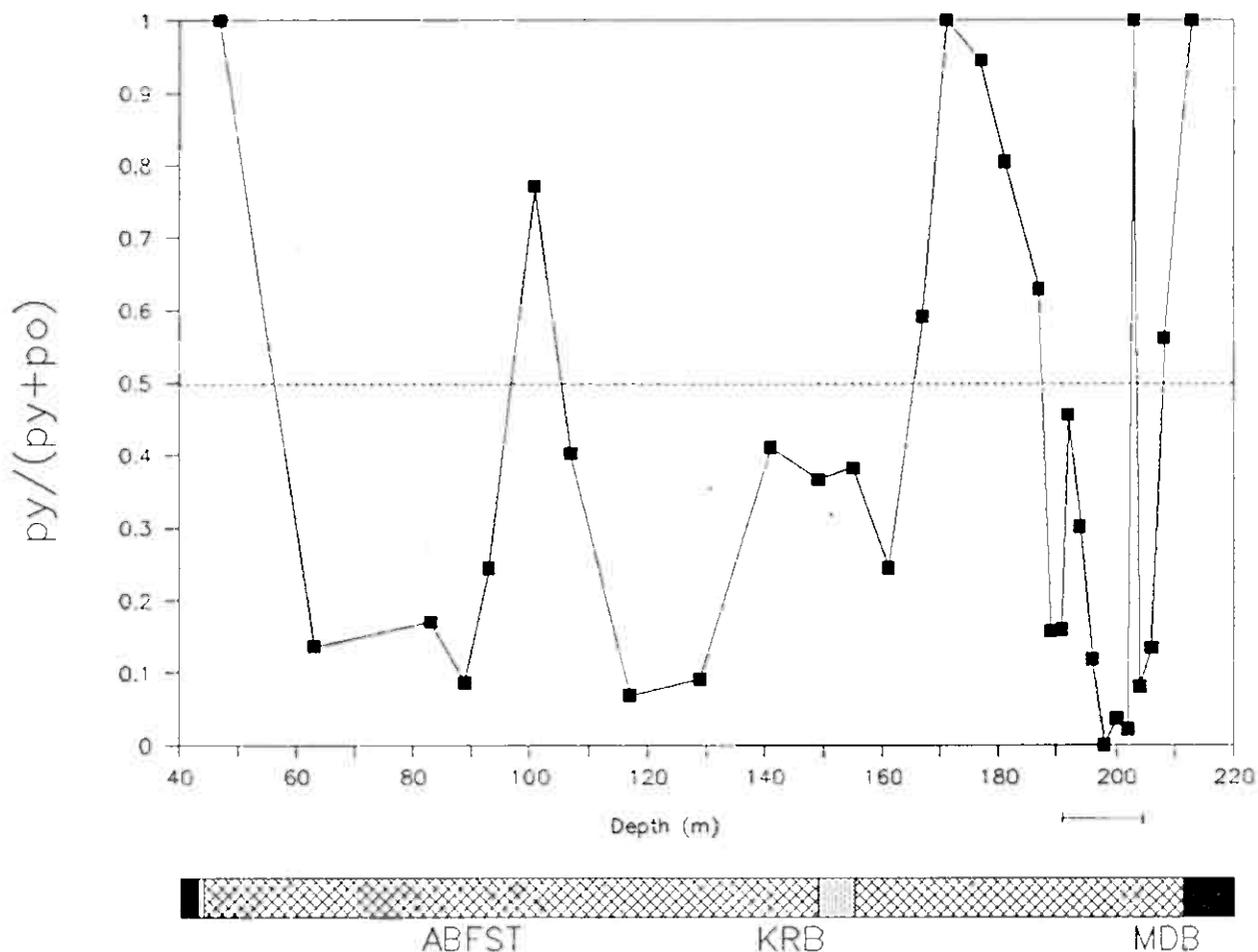


Fig. 7.14. Bidjovagge, E-ore, drill hole N20E (rock type legend simplified). Normative pyrite/(pyrite+pyrrhotite) (py/(py+po)) ratio presented as a function of depth. The location of Au ore is marked by a line. Abbreviations: ABFST = albite felsite, KRB = rock rich in carbonate, MDB = metadiabase.

7.5 Summary of the features adjacent to the ore

E gold ore is located between 190 and 200 metres hosted by albitic felsite having Al_2O_3/TiO_2 ratio about 20. The ore lies about 15 metres from the metadiabase vein (211.5-219.0 m). Au content is approximately 1.5 ppm (max 3.5 ppm). Vanadium with Cu and Pb show strongest positive correlation with Au. Also SFE's with Mo and U show weak positive correlation with Au.

Towards the ore the vein mineral composition in albitic felsites changes:

- amphibole disappears
- carbonate content increases
- phlogopite content increases
- the amount of sulfides in the vein increases

According to the carbonatization degree diagram (Fig. 7.10) calcite is the most probable carbonate species in the section. In the ore Mg content is so low with respect to C and Ca, that dolomite is of minor importance if present at all. Calcite can explain alone C and is the most likely species.

The ore is located in pyrite/(pyrite+pyrrhotite) minimum ("a hole") in the section. Generally pyrrhotite is predominating over pyrite in albitic felsites but the ore is rimmed by albitic felsites rich in pyrite. Ore itself is characterized by low pyrite/pyrrhotite ratio. In the contact between metadiabase and albitic felsite pyrite is again the only Fe-sulfide.

8 Au-Te ORE K

8.1 Introduction

K-ore is located less than 1 km to north from E-ore, on the west side of B-ore (Figure 2.1). It is a pure member of gold-telluride ore type, which is similar in structure with the gold ore type, but it has a different mineralogy. Gold occurs mainly as tellurides, calaverite (AuTe₂) being the dominant Au-carrier (Ekberg & Sotka, 1991).

Rock types of the drill hole N95F of K-ore are albitic felsites intruded by diabase dykes (Appendix 5a). There are also a few highly carbonatized parts within albitic felsite. Rock type intervals and the samples in each interval are given in Table 8.1.

Table 8.1. List of the samples of E-ore.

INTERVAL metres	ROCKTYPE	CHEMISTRY n	SAMPLE	PETROGRAPHY depth (m)
1.8-5.8	carbonate rock	4		
5.8-23.0	albitic felsite	17		10.5, 20.5
23.0-26.2	diabase	4		24.5
26.2-29.3	albitic felsite	3		
29.3-32.0	carbonate rock	2		30.5
32.0-43.2	albitic felsite	12		42.1
43.2-50.0	diabase	6		46.6
50.0-62.9	albitic felsite	13		53.5, 61.6
62.9-63.8	diabase	1		

8.2 Chemistry

XRF-analyses are presented in Figs. 8.1-8.6, where the ratios of immobile elements and element concentrations have been presented as a function of depth in drill hole. Roughly estimated approximate values are given in Table 8.2, where the content of CO₂ has been regarded as a reference element.

Table 8.2 Average chemical composition of different rock types in E-ore.

	MgO wt. %	FeO wt. %	SiO ₂ wt. %	Al ₂ O ₃ wt. %	Na ₂ O wt. %	CaO wt. %	CO ₂ wt. %	TiO ₂ wt. %	S wt. %	Cu wt. %	Au ppm	Al ₂ O ₃ /TiO ₂
CARBONATE ROCK												
low CO ₂	-	-	-	-	4.5	15	25	0.4	2	0	0	22
high CO ₂	10	6	35	10	4.5	15	25	0.4	2	0	0	22
ALBITIC FELSITE												
low CO ₂	3	3	50	10	8	5	5	0.6	5	0	0	25
high CO ₂	10	10	30	10	3	20	25	0.2	5	0	0	25
ORE												
low CO ₂	1	3	50	10	8	4	4	0.5	1	0	6	25
high CO ₂	-	-	-	-	-	-	-	-	-	-	-	-
METADIABASE												
low CO ₂	-	-	-	-	-	-	-	-	-	-	-	-
high CO ₂	3	3	50	10	7	8	8	0.4	1	0	0	45

Al₂O₃/TiO₂-ratio of albitic felsites (Fig. 8.1) is again 25 with fluctuating CO₂ content (Table 8.2). The Al₂O₃/TiO₂ ratio is exceptionally high for metadiabase being 45 (CO₂ = 8 wt.%). Note that in C and E ore sections Al₂O₃/TiO₂ ratio for metadiabase is typically about 6. Carbonate rock and the ore have the same Al₂O₃/TiO₂ ratio as albitic felsites.

Metadiabase can be distinguished from albitic felsites in addition to its exceptional high Al_2O_3/TiO_2 ratio (Fig. 8.1) by its

- higher Al_2O_3/Cr_2O_3 ratio (Fig. 8.1),
- higher TiO_2/Cr_2O_3 ratio (Fig. 8.2)
- higher K content (Fig. 8.4),
- higher P content (Fig. 8.5),
- higher Cl content (Fig. 8.7), and
- lower Cr_2O_3 content (Fig. 8.5).

TiO_2 content keeps rather steady from a rock type to another.

Au mineralization is located at 23 m and between 35 and 45 metres hosted by albitic felsite, the content of Au being approximately 6 ppm with low value of CO_2 (4 wt.%) (Table 8.2) (Fig. 8.6). Co/Ni ratio is exceptional low in the ore with respect to other rock types (Fig. 8.7). U, Ce and Te show exceptionally high concentrations in the ore (Figs. 8.8-8.9). Also MgO content is remarkably low with respect to barren albitic felsites.

The relationships between the elements are roughly the same as observed in C and E ores. Immobile and silicate forming elements (ISE's) are accompanied together and have negative correlation with carbonate forming elements (CFE's) (F1). Phlogopite forming elements (PFE's) (Rb, Sr, Ba and K) are grouped together with P and Cl (F2). This element group (K, Cl, P, Ba, Sr, Rb with negative correlation with Cr) points to metadiabase and is called metadiabase association (MDBA). Sulfide forming elements (SFE's) have strong positive correlation coefficients (especially Ni, Co, Fe and S) and they are grouped together in factor F3 with positive loadings. Gold is accompanied with Bi, Te and lesser degree with U, Y and Ce (F4 & F6).

K ore differs from other ores by exceptional weak positive correlation with Au and Cu ($r=0.26$) and high concentrations of Bi and Te with strong positive correlations with Au. Also metadiabase is extraordinary with high Al_2O_3/TiO_2 ratio and high K_2O content.

BIDJOVAGGE, K-ORE / N95F

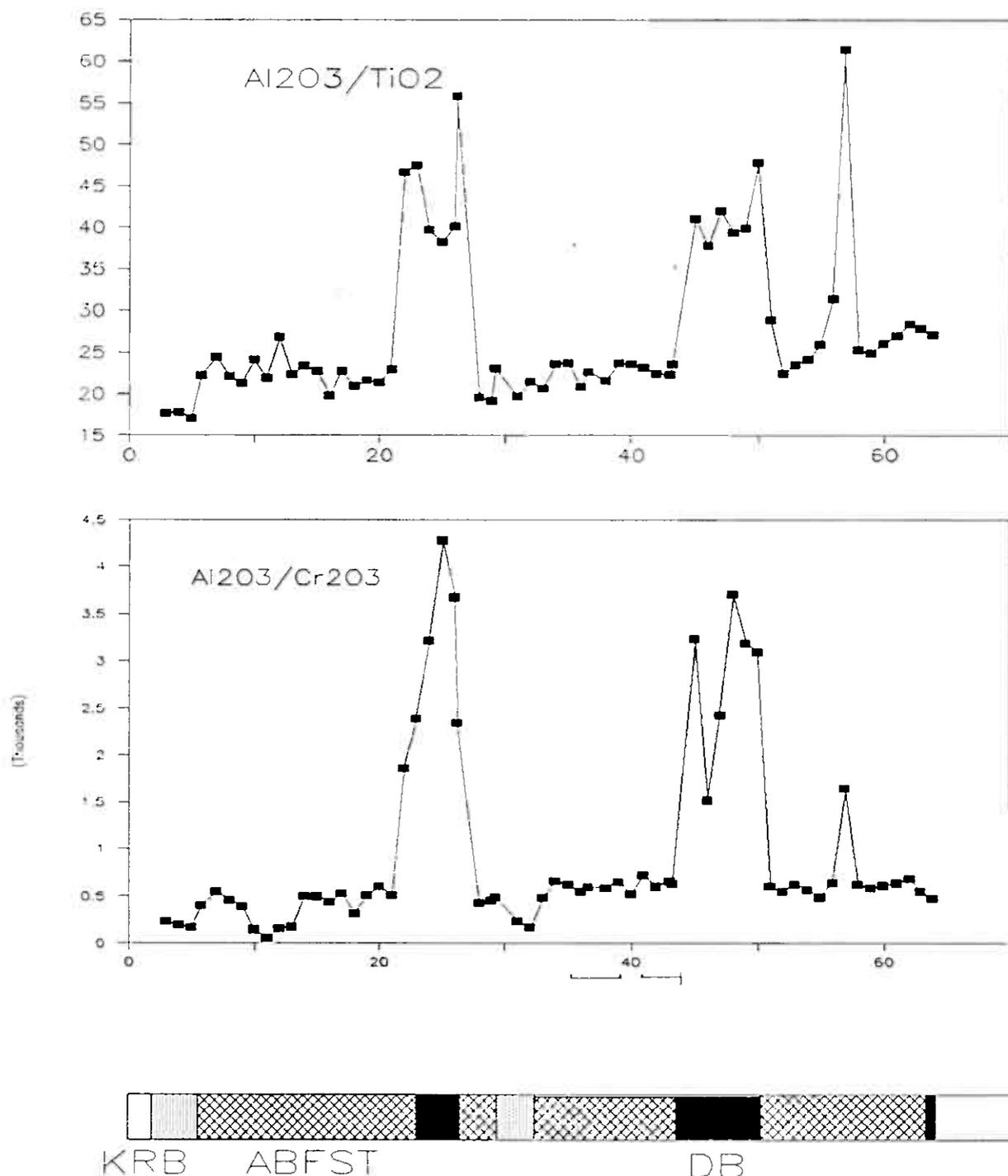


Fig. 8.1. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Ratios of immobile elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

BIDJOVAGGE, K-ORE / N95F

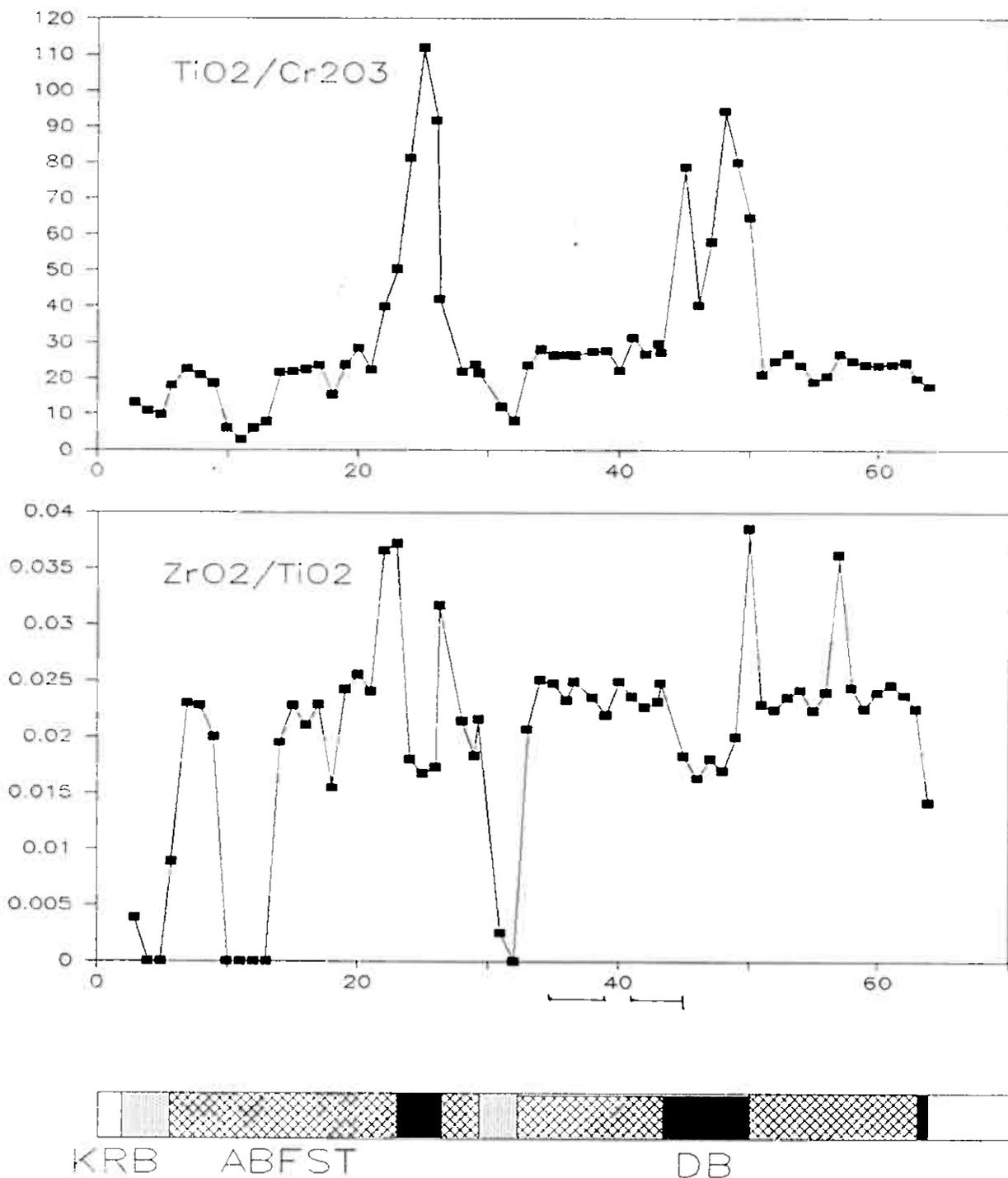


Fig. 8.2. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Ratios of immobile elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

BIDJOVAGGE, K-ORE / N95F

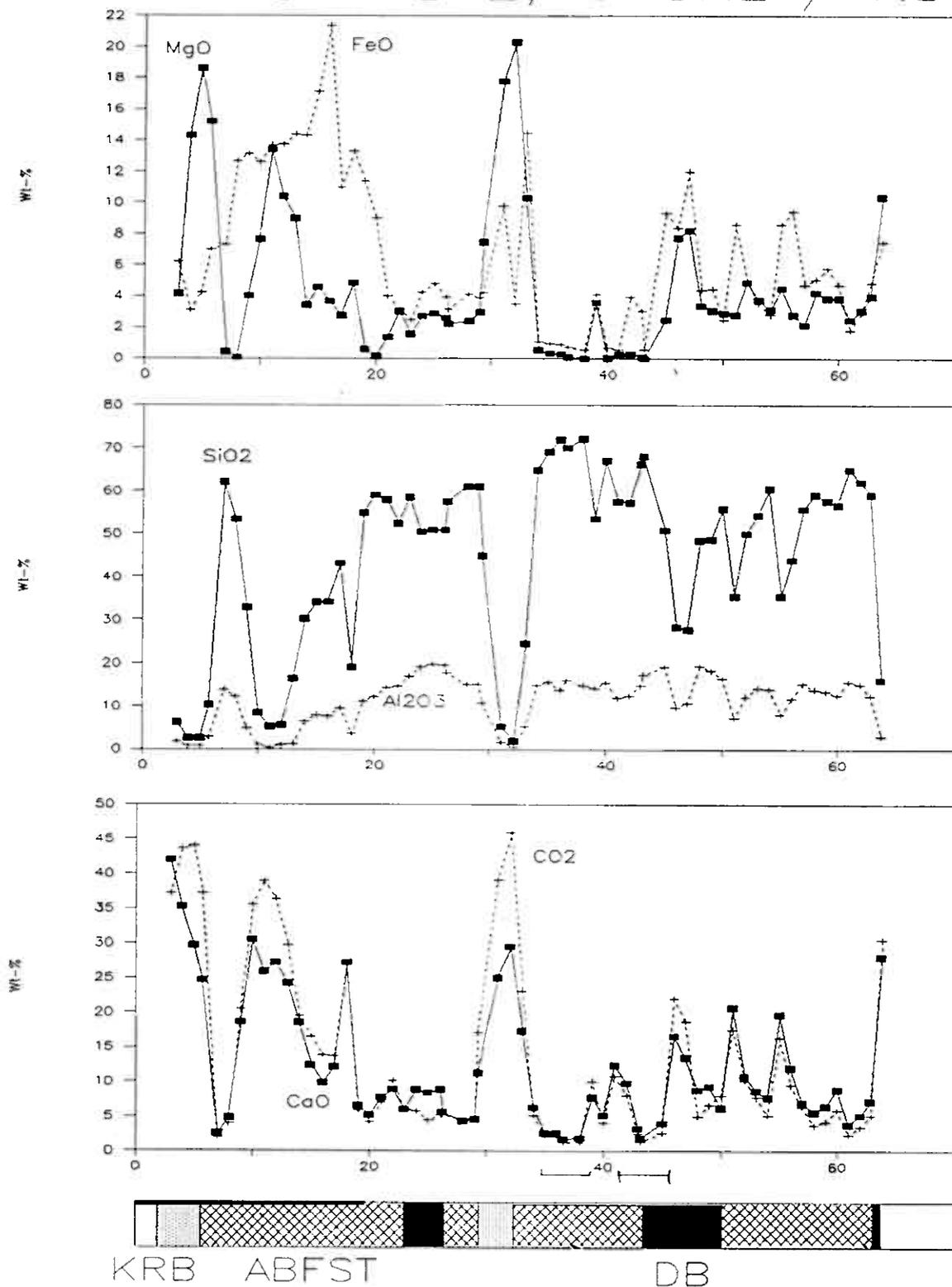


Fig. 8.3. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Named elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

BIDJOVAGGE, K-ORE / N95F

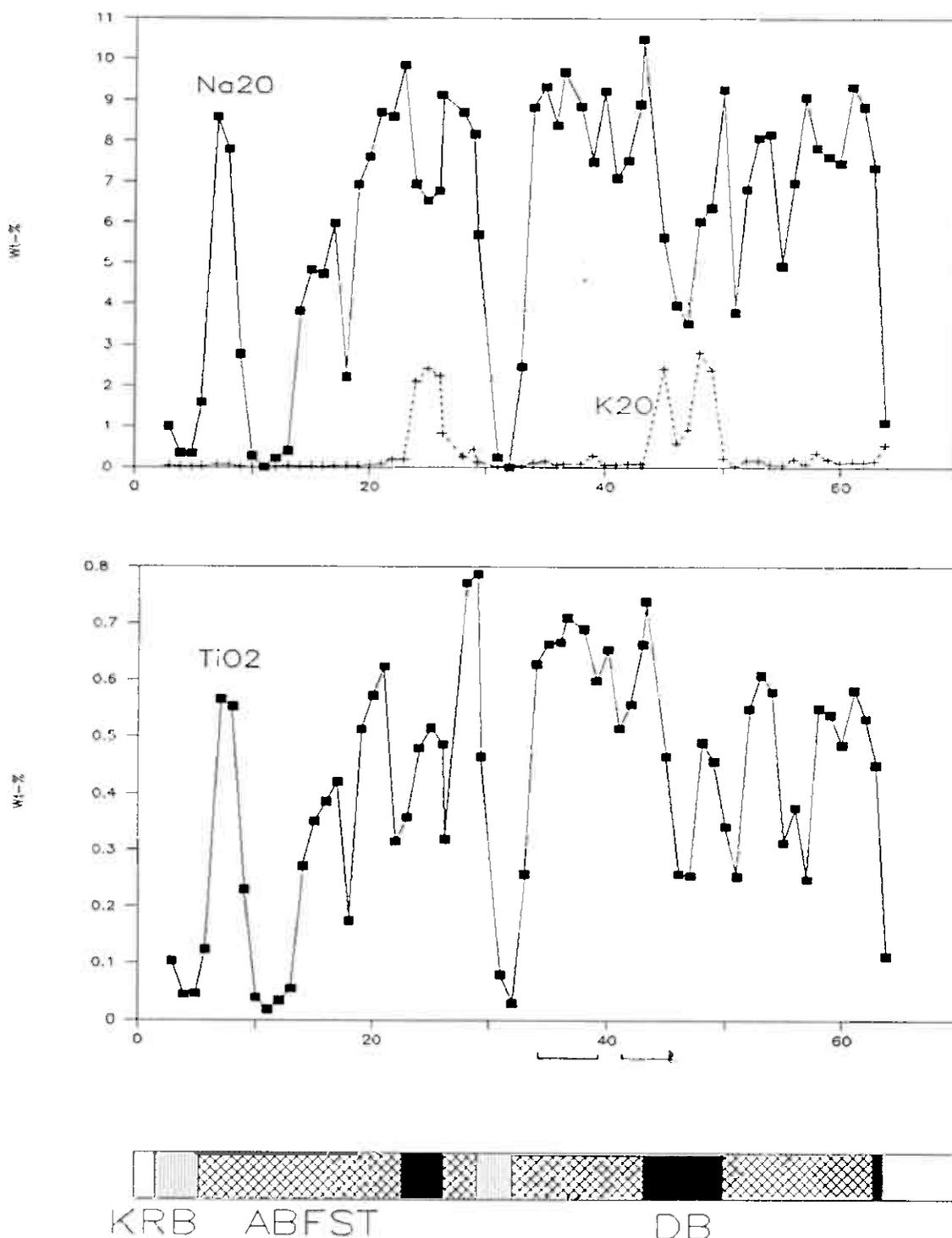


Fig. 8.4. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified).
 Named elements as a function of depth. The location of Au-Te ore is marked by a
 line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in
 carbonate.

BIDJOVAGGE, K-ORE / N95F

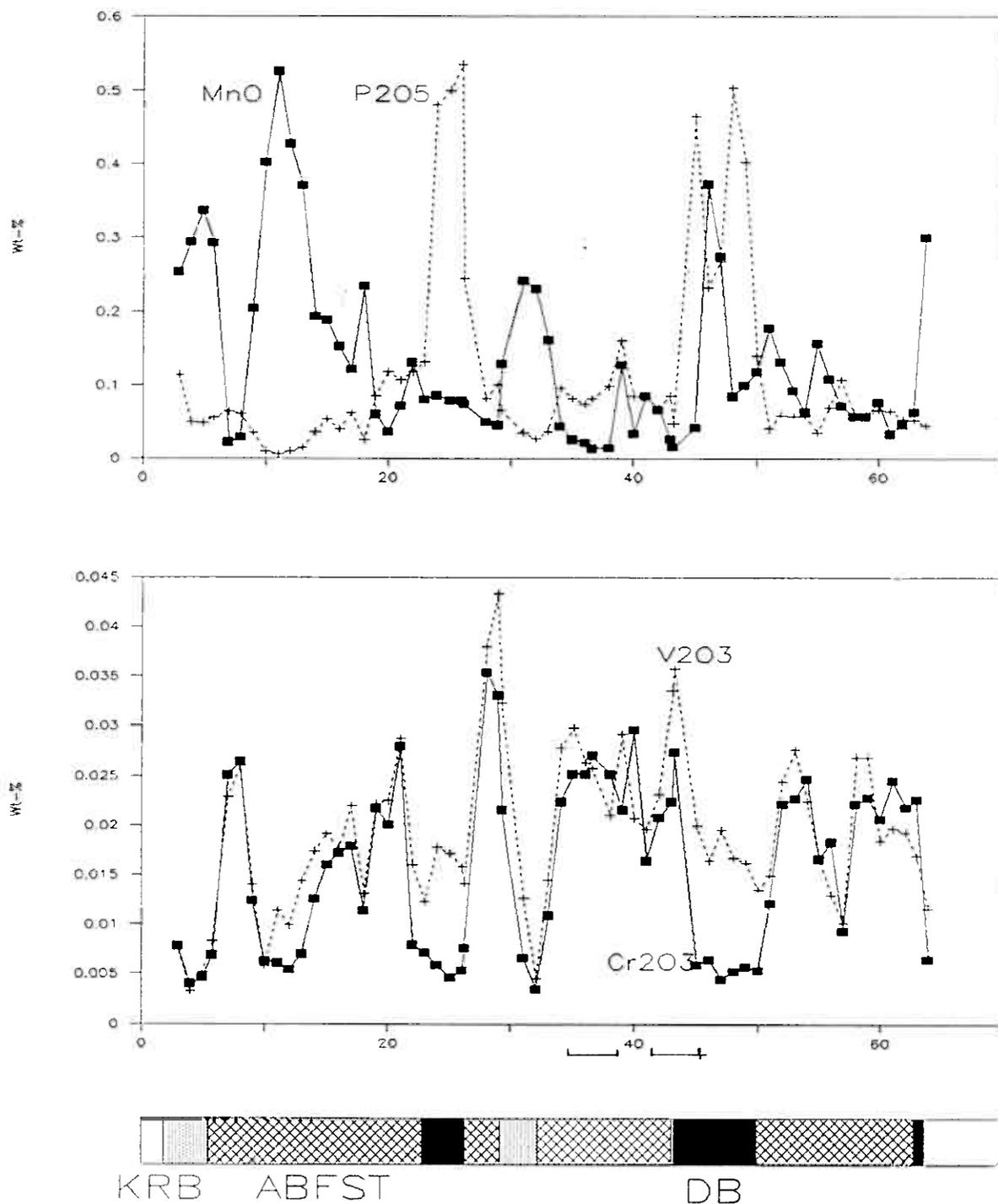


Fig. 8.5. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Named elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

BIDJOVAGGE, K-ORE / N95F

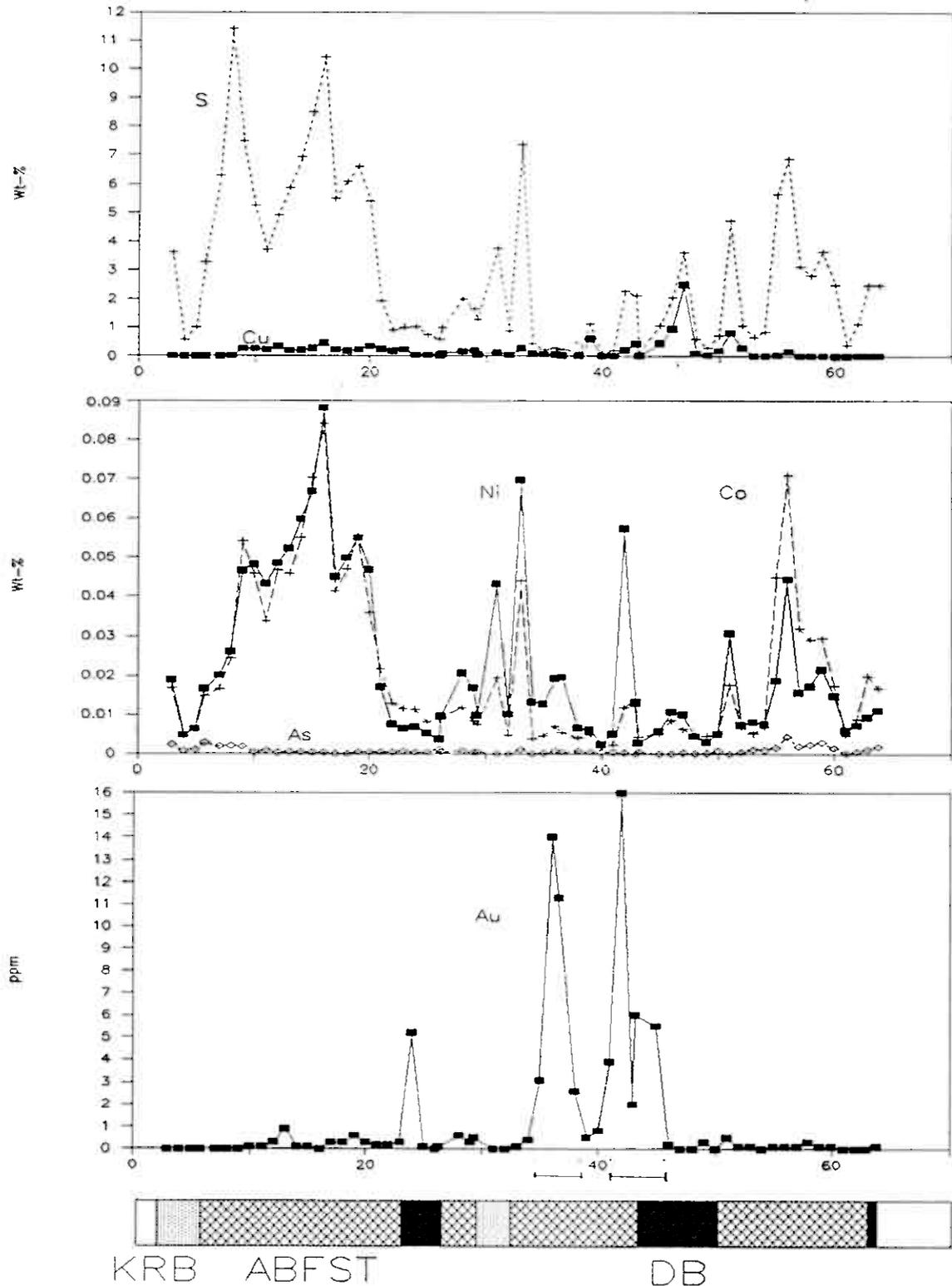


Fig. 8.6. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Named elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

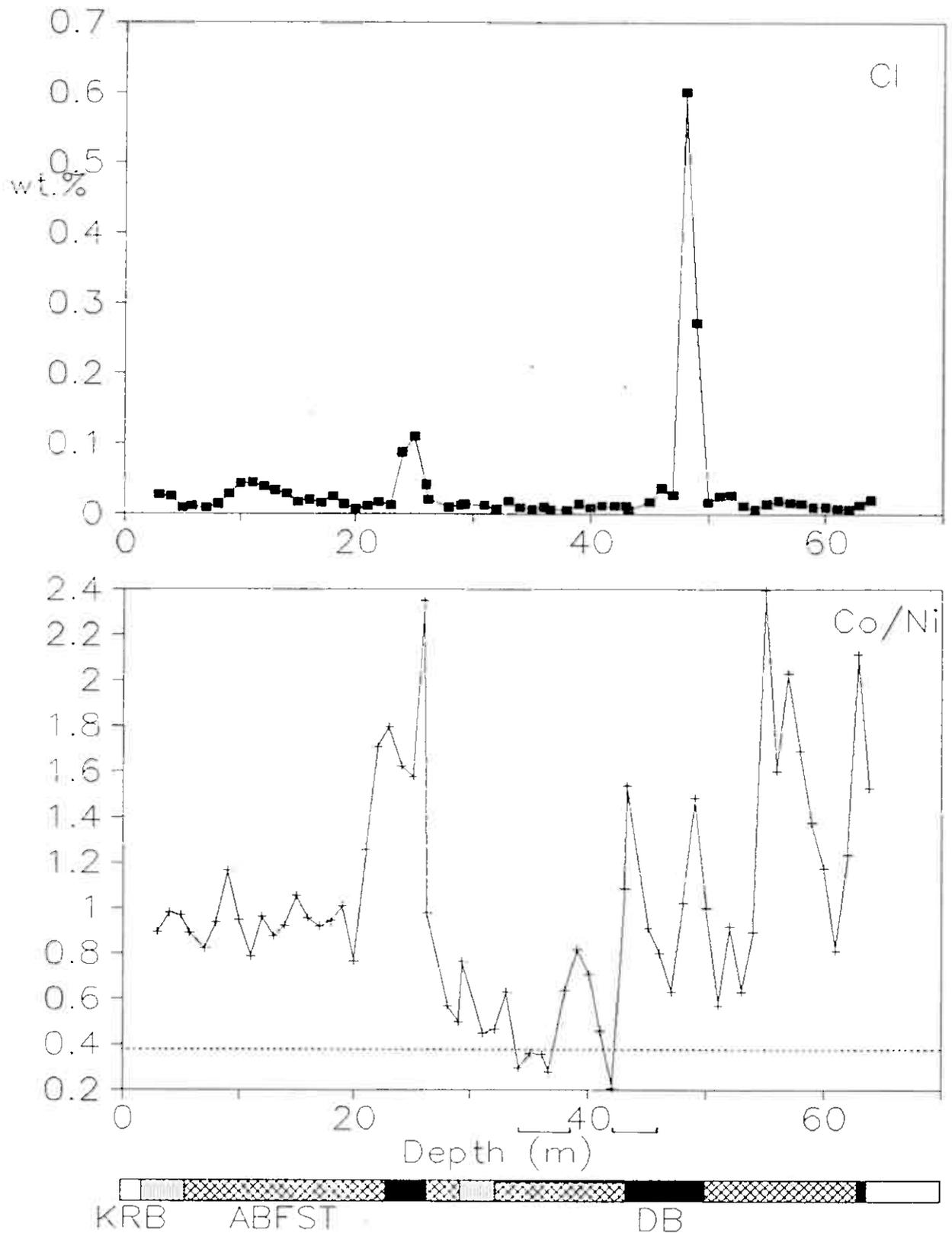


Fig. 8.7. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Named elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

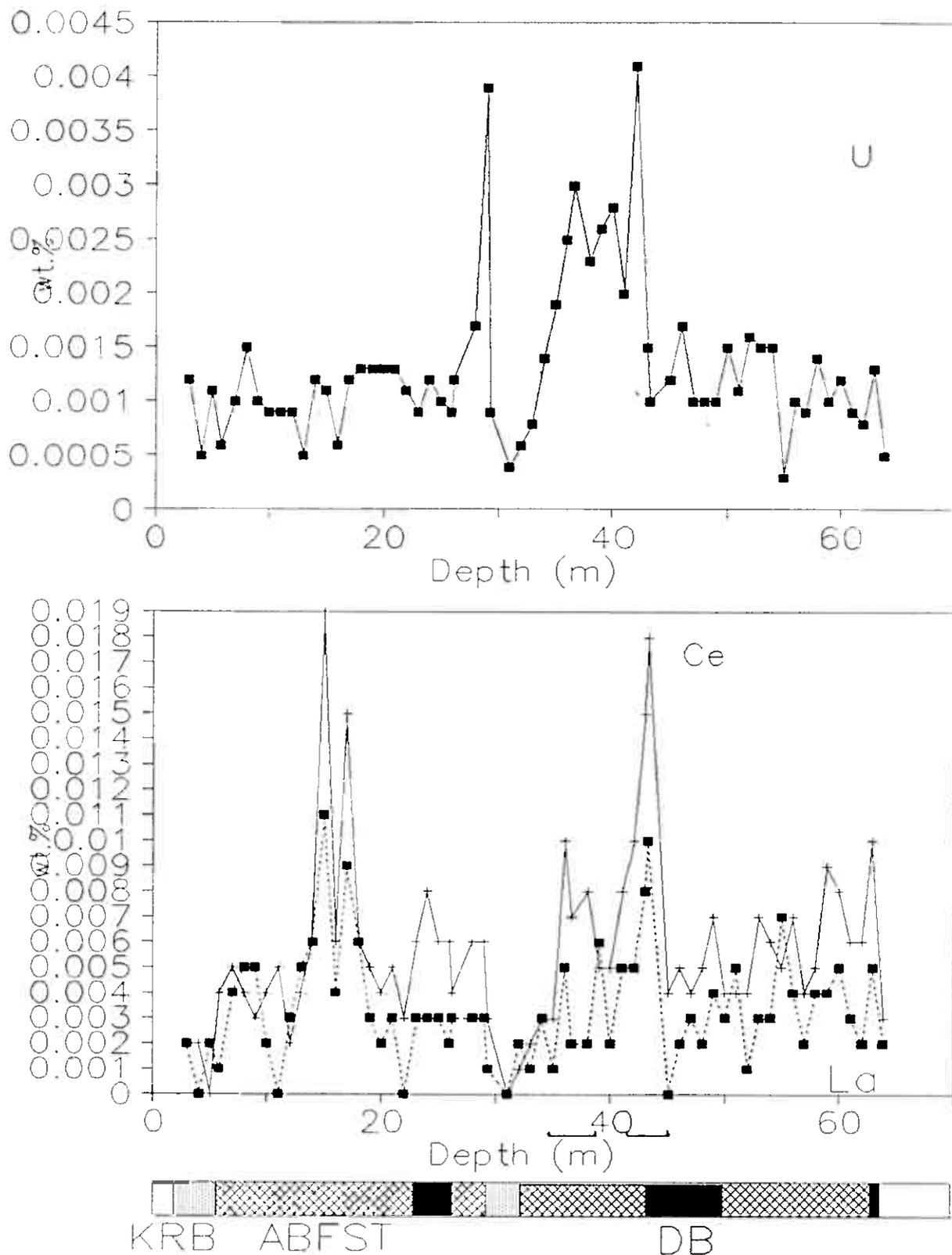


Fig. 8.8. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Named elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

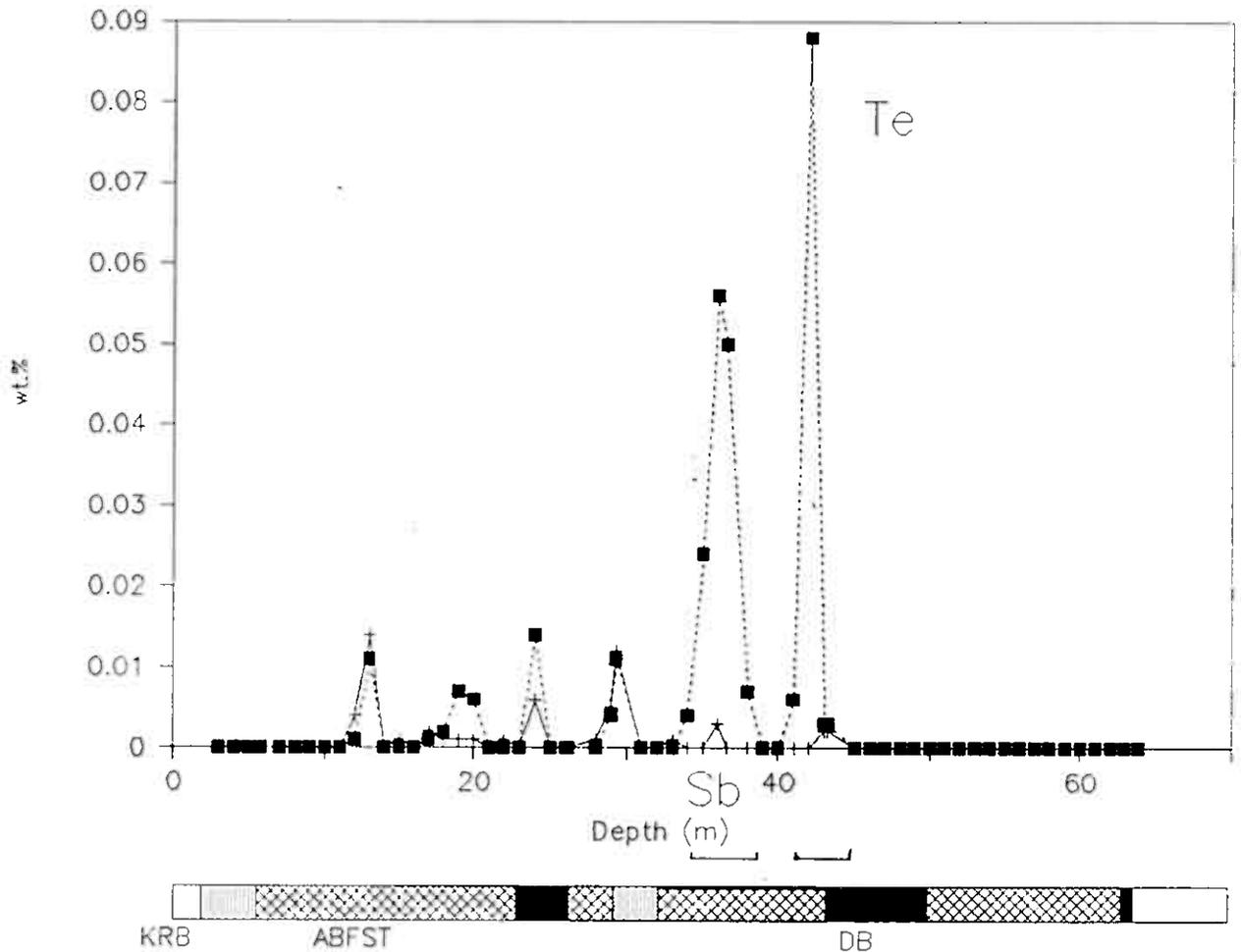


Fig. 8.9. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Named elements as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albitic felsite, DB = diabase, KRB = rock rich in carbonate.

8.3 Petrography

For the petrographical study eight samples from the drill hole N95F were selected from the section between 10.5 and 61.6 metres. Summary of the mineral composition of the samples is given in Table 8.3.

Four samples (20.5 m, 42.1 m, 53.5 m and 61.6 m) are albitic felsites. Mineralogy and textures of the groundmass are identical to albitic felsites in other ores (C2-, C3-, C4- and E-ore). Polygonal albite and quartz plus accessory rutile grains ($\phi = 10 \mu\text{m}$) forms the groundmass of albitic felsites. Numerous veins of about mm in width cut the host rock (minerals given in the order of abundance):

- qtz-crb-po-py-bt-chl-cp-ru (20.5 m)
- qtz-cp-po-py-crb-ab-chl-ru-pa-ilm±mt (Au-ore, 42.1 m)
- af-crb-py-qtz-bt-ru-tit (53.5 m)
- af-crb-py-qtz-ab-pa-bt-ru (61.6 m)

In the Au-ore albitic felsite sample 42.1 m the main minerals in the veins are quartz, chalcopyrite and pyrrhotite. Quartz grains in the veins are coarse (ϕ up to 6 mm) and they got numerous small ($\phi = 10 \mu\text{m}$) albite \pm quartz inclusions.

No clear change in the mineral composition of the veins can not be found when the ore is approached. Some remarks, however, are listed below.

- chalcopyrite is the dominant sulfide in Au-ore and in other samples it is Fe-sulfide (pyrrhotite or pyrite)
- Fe-sulfide ratio pyrrhotite/pyrite changes from about 1 in 20.5 m via 2 in Au-ore (42.1 m) to 0 in 53.5 m and in 61.6 m.

Table 8.3. Summary on the petrographical study on Bidjovagge C4 ore samples, drill hole S154B. Abbreviations for rock types and minerals are given in section 3. Minerals are given in the order of abundance. In column ϕ_{ab} (μm) the average diameter of albite is given in micrometres; if two values are given the first is for groundmass and the second for veins. Ind:a(O2) = indicative minerals for oxygen activity (fugacity) determination, Ind:pH = indicative minerals for pH determination.

Depth (m)	Rock type	Represents	"Ground mass" minerals	Vein minerals		Ind:a(O2)	Ind:pH	Note: reactions etc
10.5	CRB-R	"least altered"	crb, ab, chl, qtz, cp, py, ilm	-		270 py, ilm	ab	sca \rightarrow crb + chl
20.5	ABFST	"least altered"	ab, qtz, ru	qtz, crb, po, py, phi, chl, cp, ru	10/120	po-py	ab	phi \rightarrow chl
24.5	MDB	metadiabase	ab, phi, crb, sca, pa, chl, po, py, ru, cp	-		450 po-py	ab, pa	sca \rightarrow chl, pa incl. in ab
30.5	CRB-R	high CO2	crb, qtz, chl, ab, phi, po, py, cp	-		- po-py	ab	sca \rightarrow chl + crb + qtz
42.1	ABFST	Au ore	ab, qtz, ru	qtz, cp, po, py, crb, ab, chl, ru, pa, ilm, smt	10/150	po-py, ilm, smt	ab, pa	
46.6	CRB-R	close to the ore	crb, qtz, cp, py, po	-		- py, po	ab	
53.5	ABFST		ab, qtz, ru	af, crb, py, qtz, phi, ru, tit	10/200	py	ab	
61.6	ABFST	"least altered"	ab, qtz, ru	af, crb, py, qtz, ab, pa, phi, ru	10/150	py	ab, pa	

Samples 10.5 m, 30.5 m and 46.6 m are named as carbonate rocks. They are composed of carbonate and quartz plus sulfides. In samples 10.5 m and 30.5 m also chlorite and minor albite can be found. Chlorite has replaced tourmaline totally. Grain size varies strongly in all samples, from 0.1 mm to 3.0 mm. Sulfide and oxide mineral composition varies:

- cp-py-ilm in 10.5 m
- po-py-cp (no oxides) in 30.5 m
- cp-py-(minor po) (no oxides) in Au-ore 46.6 m

Sample 24.5 m is named as metadiabase. It is composed of albite, biotite, quartz, carbonate, paragonite, pyrrhotite and pyrite plus some chlorite, scapolite and chalcopyrite. Albite grains are about 1.3 mm in diameter and they are enclosing numerous biotite and paragonite flakes of 0.1-0.3 mm in diameter. Scapolite has altered along cleavage planes to carbonate + chlorite. Sulfides occur as medium-coarse grained dissemination. About equal amounts of

pyrrhotite and pyrite can be found. Also portions resembling albitic felsite can be found in the sample 24.5 m. These irregular parts are composed of fine grained ($\phi = 15-50 \mu\text{m}$) albite, quartz and rutile.

8.4 Mineral composition

The mineral composition of each analysed sample was estimated on the basis of chemistry, petrography and microprobe analyses. In Fig. 8.10 is shown a carbonatization diagram (see Chapter 3 and Hautala & Lamberg, 1991 for calculation and plotting basis). The degree of carbonatization varies widely from 25 to 90 %. In carbonate rocks C equals to Ca+Mg with Ca/Mg ratio close to 1 indicating dolomite. In other rock types Mg and Ca are carried also by other minerals. Carbonatization degree is extraordinarily low in the ore (< 50 %) with respect to high Ca content (Mg/Ca close to 0) indicating that carbonate species would be calcite. In mineral calculation, however, all C was calculated to be bound in dolomite.

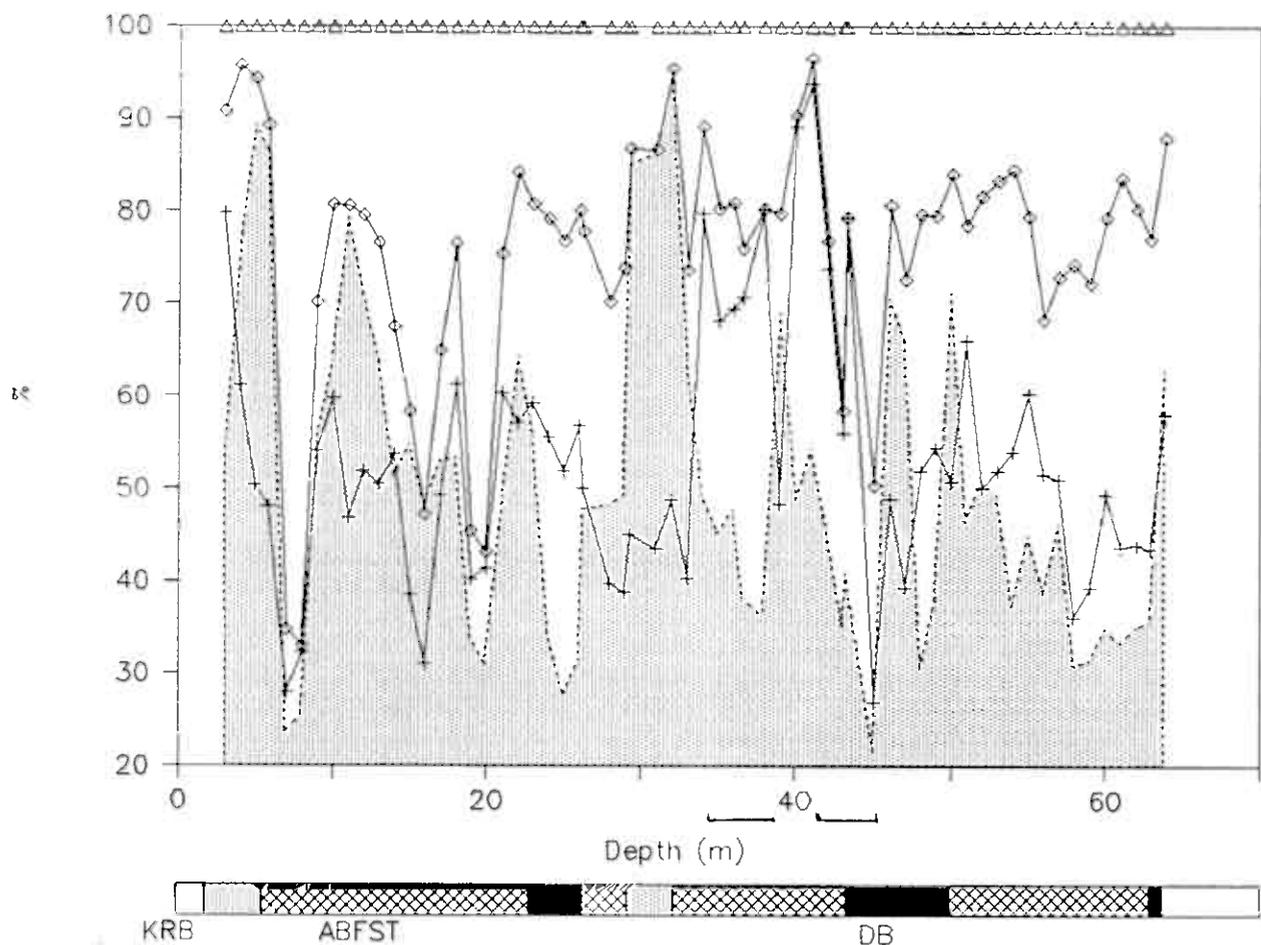


Fig. 8.10. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Carbonatization diagram, dotted field = the degree of carbonatization ($C/(Ca+Mg+Fe)$), lines from bottom edge: calcite ($Ca/(Ca+Mg+Fe)$), calcite + magnesite ($Ca+Mg/(Ca+Mg+Fe)$) and calcite+dolomite+siderite (=100). For more details see text. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albitic felsite, DB = diabase, KRB = rock rich in carbonate.

The normative mineral composition of the analysed samples are presented in Fig. 8.11. Amphibole content might be overestimated because all C was assumed to be bound in dolomite instead of calcite. Albite is the dominant mineral in almost all rock types. Dolomite dominates in rocks rich in carbonate. Amphibole content is quite high in albitic felsites. Metadiabase is distinguished from albitic felsite by its high phlogopite content. The ore is characterized by low dolomite content and high quartz content. Sulfides are accessory minerals in the ore.

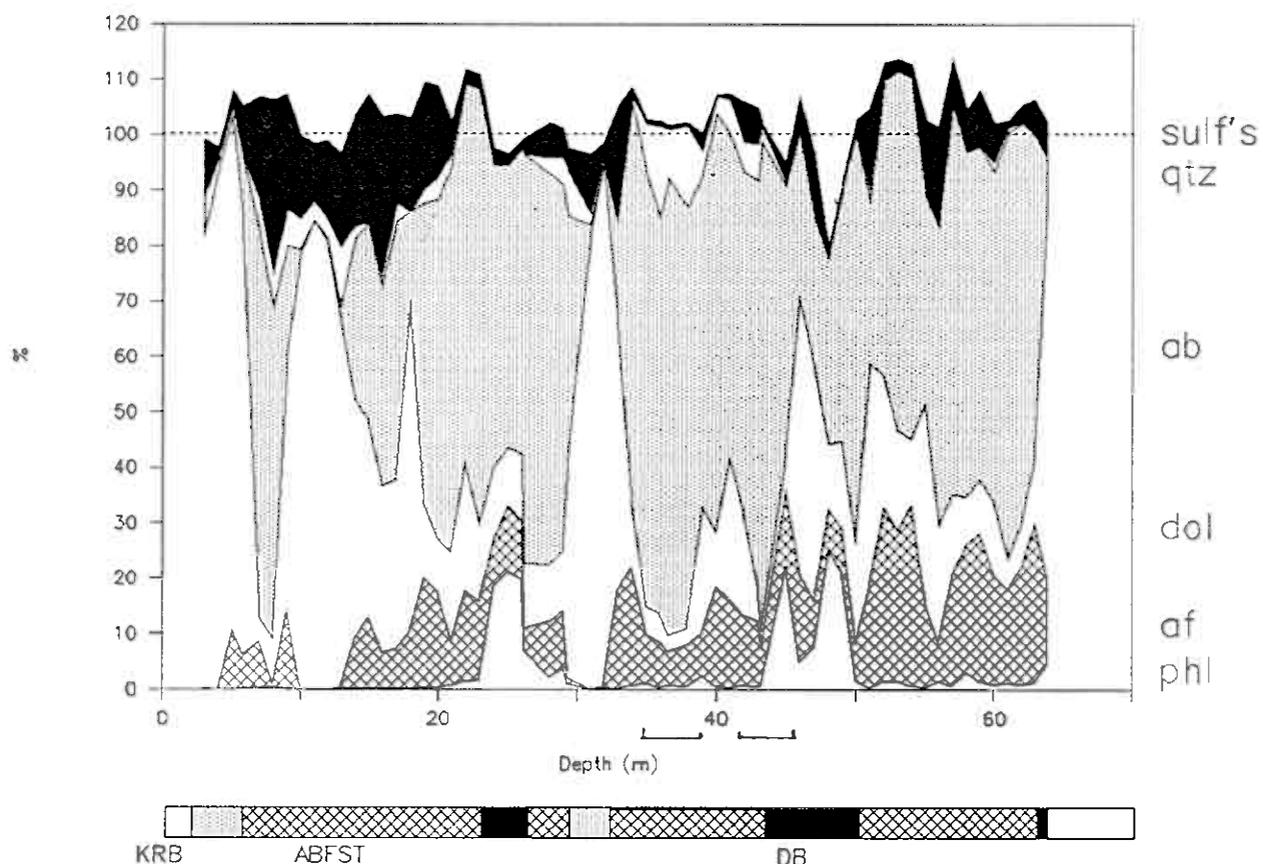


Fig. 8.11. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Normative mineral composition. Fields from lower edge to the top edge: phl = phlogopite (white), af = amphibole (cross hatched), dol = dolomite (white), ab = albite (dotted), qtz = quartz (white), sulf's = sulfides (chalcopyrite + pyrrhotite + pyrite) (black). For more details see text. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

Al-carrier diagram is shown in Fig. 8.12. Albite is the dominant Al-carrier. In the rocks rich in carbonate, however, scapolite becomes an important mineral. Phlogopite carries about 15 % of Al in metadiabase with respect to less than 1 % in albite felsite. Ore is characterized by very high albite content with respect to other Al-carriers (albite carries > 95 % of Al).

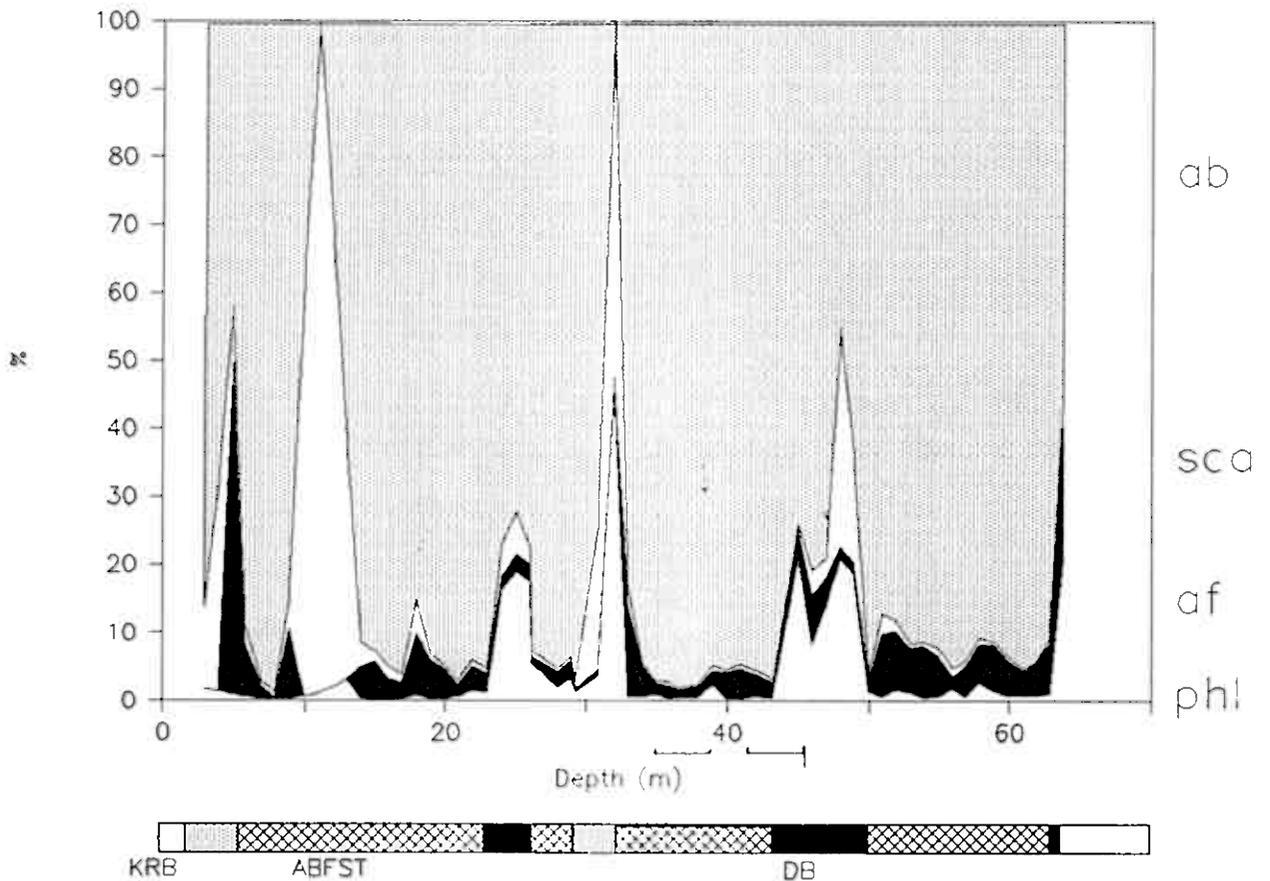


Fig. 8.12. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Normative aluminium carrier diagram. Fields from bottom edge to the top edge: phl = phlogopite (white), af = amphibole (black), sca = scapolite (white) and ab = albite (dotted). The location of Au-Te ore is marked by a line. Abbreviations in rock type legend: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

Normative mineral composition of the sulfide phase is shown in Fig. 8.13. K ore differs from C and E ores by having poor correlation with Cu and Au. This is seen also in Fig. 8.13. Chalcopyrite is quite abundant sulfide mineral between 8 and 52 metres. Ore is characterized by low normative chalcopyrite content in the sulfide phase (< 10 %) and pyrite dominating over pyrrhotite (Fig. 8.14). Metadiabase between 42 and 50 metres show typical feature for wider diabase sheets. Pyrite/pyrrhotite ratio minimum is located in the centre of the vein and maximums in the contact between albitic felsite and metadiabase. Ore is hosted by albitic felsite locating next to metadiabase in pyrite/pyrrhotite (ratio) minimum (Fig. 8.14).

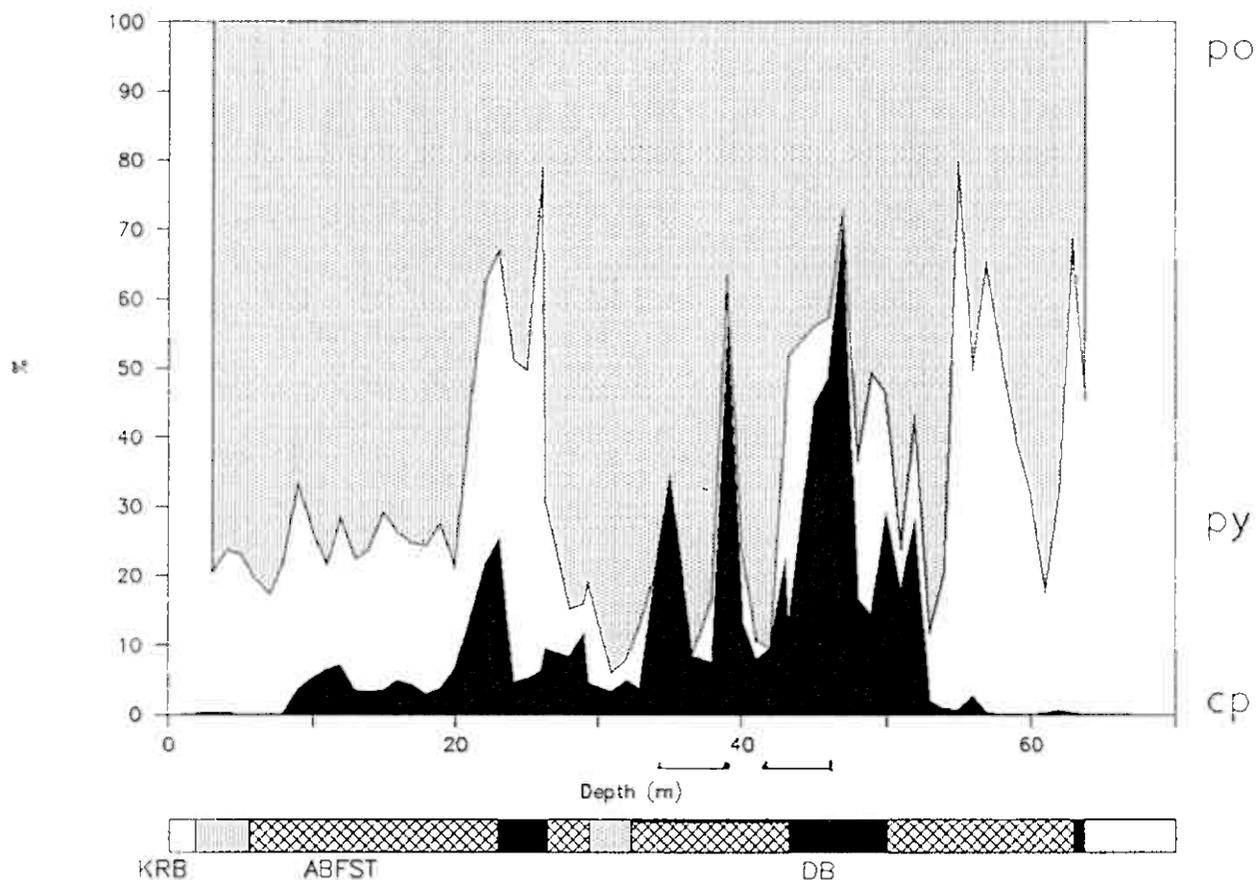


Fig. 8.13. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Normative mineral composition of the Cu-Fe-sulfide phase. Fields from bottom edge to the top edge: cp = chalcopyrite (black), py = pyrite (white), po = pyrrhotite (dotted). The location of Au-Te ore is marked by a line. Abbreviations in rock type legend: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

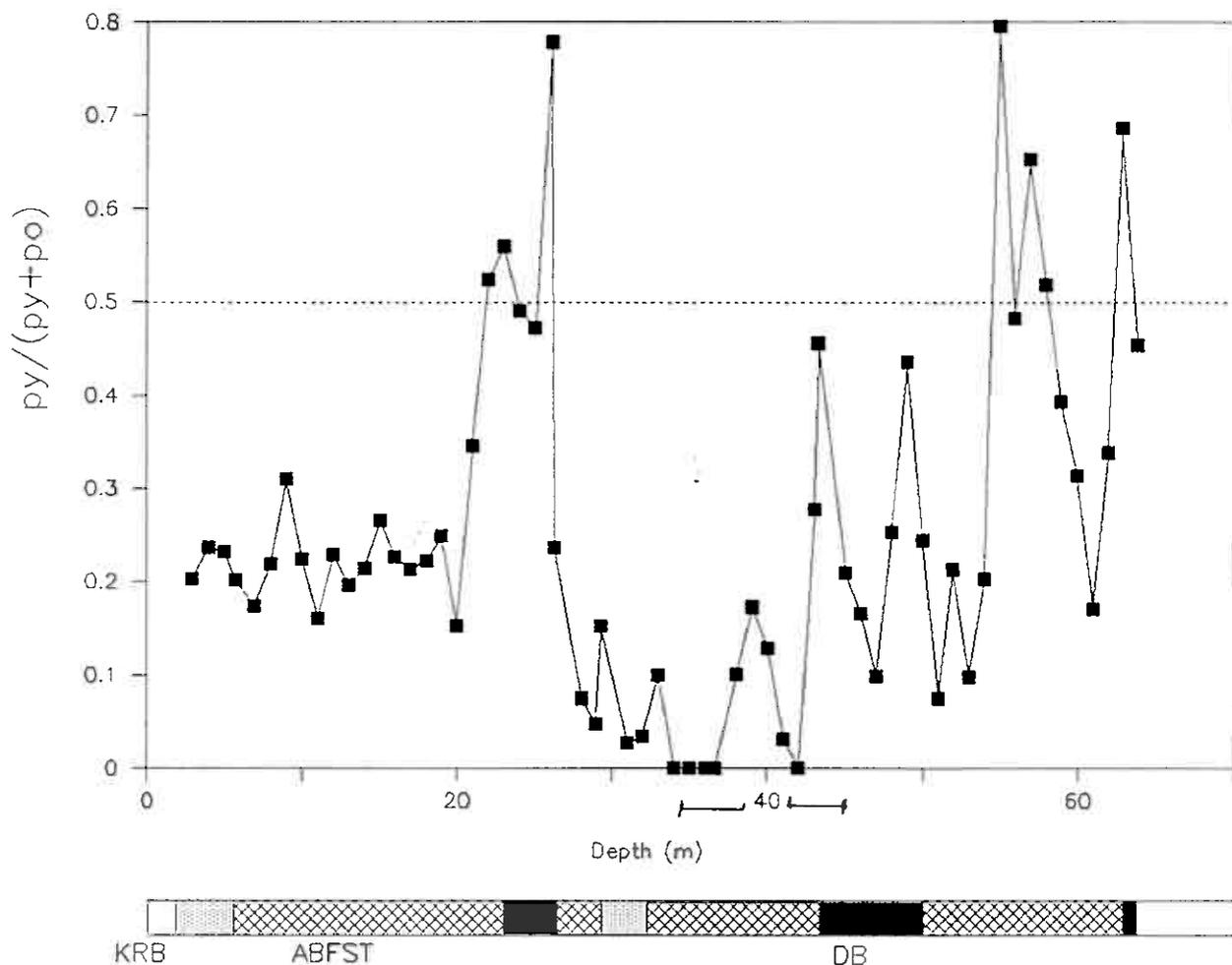


Fig. 8.14. Bidjovagge, K-ore, drill hole N95F (rock type legend simplified). Normative pyrite/(pyrite+pyrrhotite) (py/(py+po)) ratio presented as a function of depth. The location of Au-Te ore is marked by a line. Abbreviations: ABFST = albite felsite, DB = diabase, KRB = rock rich in carbonate.

8.5 Summary of the features adjacent to the ore

Au mineralization is located at 23 m and between 35 and 45 metres hosted by albitic felsite. The nearest metadiabase sheets are located (1) between 23 and 26 metres and (2) between 43 and 50 metres. Au content in the ore is approximately 6 ppm with low value of CO₂ (4 wt.%) (Table 8.2) (Fig. 8.6). Co/Ni ratio is exceptional low in the ore with respect to other rock types in the section (Fig. 8.7). U, Ce and Te show high concentrations in the ore (Figs. 8.8-8.9). Also MgO content is remarkably low with respect to barren albitic felsites.

K ore differs from other ores by exceptionally weak positive correlation with Au and Cu ($r = 0.26$) and high concentrations of Bi and Te with strong positive correlations with Au. Also metadiabase is extraordinary with high Al₂O₃/TiO₂ ratio and high K₂O content.

No clear change in the mineral composition of the veins in albitic felsites can be found when the ore is approached. Some remarks are, however, listed below.

- chalcopyrite is the dominant sulfide in Au-ore and in other samples it is Fe-sulfide (pyrrhotite or pyrite)
- Fe-sulfide ratio pyrrhotite/pyrite changes from about 1 in 20.5 m via 2 in Au-ore (42.1 m) to 0 in 53.5 m and in 61.6 m.

Carbonatization degree is low in the ore (< 50 %) with respect to low Mg and high Ca content (Mg/Ca close to 0) indicating that carbonate species would be calcite. The ore is characterized by low normative dolomite content and high normative quartz content. Sulfides are accessory minerals in the ore. Pyrite/pyrrhotite ratio changes from about 0.5 in metadiabase sheets to 0 in ore symmetrically on both sides of the ore.

9 SUMMARY OF THE OBSERVATIONS

Five representative ore sections were studied from Bidjovagge Au-Cu ore. C2 (drill hole S128I) and C3 (S144F) represent typical Cu ore. C4 (S154B) is a subeconomic Cu-Au mineralization hosted by metadiabase. E ore (N20E) is classified as Au ore and K ore (N95F) as Au-Te ore.

In the drill logs four rock types are reported. Albitic felsite is the most common rock type hosting all ores but C4. Metadiabase sheets are 1 to 35 metres wide and often situated close to the ore. Black shist do not occur in contact with metadiabases in studied sections. Narrow carbonate veins cut albitic felsites.

Albitic felsites and metadiabases were analysed systematically in 1 to 2 metres interval. No black shist samples were selected in this study. Thin sections were prepared from selected samples representing each rock type, ore and "least altered rocks".

Chemically those rock types (i.e. studied samples) do not differ notably. Albitic felsite and metadiabase sheets can be distinguished by immobile element ratios which are given for both rock types in Table 9.1. Ti, P and Cl contents are higher and Cr lower in metadiabases (Table 9.1).

Albitic felsites, carbonate rocks (or veins), black shists (after Lamberg and Hautala, 1990) and ores are similar with respect to immobile element ratios and Ti, Cl, P & Cr concentrations (Tables 4.2, 5.2, 6.2, 7.2, 8.2 and 9.1).

Two metadiabase types can be specified. In C2, C3, C4 and E ores the Al_2O_3/TiO_2 ratio is close to 5 in metadiabases (note that in Table 9.1 the "pure" metadiabase sample is lacking in the E ore). This ratio is clearly lower than in the albitic felsites (about 25) (Table 9.1). In the metadiabase of the K ore section Al_2O_3/TiO_2 ratio is higher than in the albitic felsite, being about 42. Another marked difference is K content, which is higher ($K_2O = 1-3$ wt.%) in the metadiabase of the K ore section than in other ores (typically $K_2O < 1$ wt.%). In the beginning of C2 ore section (depth 20-30 m in the drill hole S128I) a metadiabase sheet resembling those in K ore with high K content (up to 4 wt.%) and high Al_2O_3/TiO_2 ratio (up to 31) is observed.

In all ores some specific elements are associating with each other. C, Ca, Mg and Mn are always grouped together and they are called as carbonate forming elements (CFE's). Immobile and silicate (albite and quartz) forming elements (ISE's) Si, Al, Na, Zr, Ti and Cr are accompanied together. Carbonate forming elements show negative correlation with silicate forming elements.

Sulfide forming chalcophile elements (S, Cu, Fe, Ni, Co, Zn, Pb, ± As) show a positive correlation in every ore type. K, Rb Sr and Ba and lesser degree Mg, Y and Cl are associated with each other and this element group is called phlogopite forming elements (PFE's). Phlogopite forming elements (PFE's: K, Mg, Rb, Sr, Ba, Y) are occasionally, clearly associated with Cl and P and have negative correlation with Cr showing metadiabase association (MDBA) in these cases.

Table 9.1. Summary on the immobile element ratios and concentrations of characteristic elements (as wt.%) in metadiabase, albitic felsite and ore in each studied ore types.

Rock type	Ore	$\frac{Al_2O_2}{TiO_2}$	$\frac{Al_2O_3}{Cr_2O_3}$	$\frac{TiO_2}{Cr_2O_3}$	$\frac{ZrO_2}{TiO_2}$	TiO2	P2O5	Cr2O3	Cl	K
META DIABASE	C2	6	900	135	0.014	1.7	0.15	0.015	>0.050	1
	C3	5	3000	600	0.012	2.4	0.30	0.005	>0.020	0.2
	C4	5	4500	900	0.010	2.6	0.30	0.003	>0.080	0.6
	E	15	850	60	0.020	0.6	0.05	0.010	0.060	0.5
	K	42	4000	80	0.035	0.5	0.50	0.005	>0.080	1-3
ALBITIC FELSITE	C2	25	500	20	0.026	0.5	0.05	0.030	0.010	<0.1
	C3	22	500	20	0.020	0.8	0.08	0.025	0.010	<0.1
	C4	27	600	20	0.040	0.4	0.05	0.030	0.020	-
	E	26	600	20	0.023	0.5	0.05	0.025	0.015	0.1
	K	23	500	20	0.023	0.5	0.05	0.020	0.010	<0.1
ORE	C2	20	400	20	0.020	0.4	0.07	0.020	0.010	0.5
	C3	15	500	20	0.008	0.6	0.05	0.010	0.010	<0.1
	C4	7	500	20	0.010	1.6	0.15	0.020	0.02-0.2	<0.1
	E	20	500	20	0.022	0.6	0.05	0.020	0.010	0.1
	K	23	500	20	0.023	0.6	0.05	0.020	0.010	<0.1

Albitic felsite is a very fine grained ($\phi = 10 \mu m$) rock type which is composed of albite, rutile and quartz. Homogeneous "ground mass" is cut by numerous veins, which are irregular in shape. They branch, swell, pinch, fill cracks and so on. "Veins" are composed variably of albite, carbonate, quartz, sulfides (pyrite, pyrrhotite and chalcopyrite), magnetite, ilmenite, phlogopite and chlorite + occasionally some scapolite and paragonite. The very same minerals occur in "ground mass" but differ from it by coarser grain size (about $100 \mu m$ vs. $10 \mu m$).

Metadiabases are medium grained altered rocks which show relic diabasic texture (plagioclase predominates, clinopyroxene fills the interstices). Plagioclase is totally replaced by albite (+ scapolite) and (clino)pyroxene by amphibole (+phlogopite +chlorite). Other common minerals in metadiabases are the very same occurring as "vein" minerals in albitic felsites: carbonate, scapolite, sulfides, phlogopite, chlorite, magnetite, ilmenite + occasionally paragonite.

Carbonate rocks (or veins) are composed of carbonate, albite, quartz and sulfides. Paragonite is quite common accessory. Magnetite is rarely encountered. Pyrite predominates over pyrrhotite.

Mineral composition of the analysed samples was estimated on the basis of microscopical observations (list of the minerals), stoichiometric compositions and some microprobe analyses (composition of the minerals) and chemical analyses (chemical composition of the samples). "Normative mineral composition" of each sample was calculated using procedure given in Appendix 7 and saved as calculation LOTUS 1-2-3 worksheet (file CALC.WK1) in diskette enclosed in the report.

On the basis of carbonate forming element ratios the dominant carbonate species in Bidjovagge metadiabase and albitic felsite is dolomite. In C ores dolomite can explain alone C, Mg and Ca ratios, but in K and E ores Mg is much less than Ca and Ca equals to C, both indicating, that carbonate species would rather be calcite. Albite dominates in each rock type and quartz is almost absent. Metadiabases have higher normative amphibole, phlogopite and scapolite contents than albitic felsites. Carbonate and sulfide contents vary widely.

Pyrite/pyrrhotite ratio was estimated on the basis of Co/Ni ratio and chemical compositions of Fe-sulfides given by Hänninen (1983), Sotka and Hänninen (1983). Variations in the composition of Fe-sulfides, two (or more) generations of pyrite (Hänninen 1983) and additional Ni-carriers (pentlandite, melonite) can cause some errors in calculations. However, some peculiar features come out in every section. Metadiabase is enveloped by albitic felsite, where pyrite is the dominant or only Fe-sulfide. In the middle of the metadiabase vein pyrrhotite dominates. Towards the black shist via albitic felsite pyrite/pyrrhotite ratio decreases and ores are in all studied sections (except C4) situating right there where dominant Fe-sulfide changes from pyrite to pyrrhotite. In albitic felsites pyrite/pyrrhotite ratio varies with gradual, smooth changings.

In every ore studied zoning was observed. From the middle of the metadiabase sheet via Au-Cu ore to black shist following zoning was observed (minimums and maximums).

Co/Ni	min	in the centre of the metadiabase sheet
Cl, K, P	max	in metadiabase close to the contact
Co/Ni	max	contact
Ce-La-Nb-Zr	max	in albitic felsite
(Pb-Zn)	max	in E ore
Cu	max	ore
Au-U-Mo-Te-Ta	max	ore
Zn-Pb	max	in the contact with albitic felsite and black shist (C2 ore)

All ores are located close to the contact between metadiabase and albitic felsite. Features adjacent to each studied ore section are summarized briefly below.

9.1 C2 ore

The gold-copper ore C2 is hosted by albitic felsite, with abnormal immobile element ratios: $Al_2O_3/TiO_2 = 20$, $Al_2O_3/Cr_2O_3 = 400$ and $ZrO_2/Cr_2O_3 =$ varying from 0.01 to 0.02.

Ore hosting albitic felsite envelopes black shist and the ore is situating 10 m from the contact of wide (about 10 m) metadiabase vein and 3 m from narrow metadiabase portion (< 1 m) identified according to immobile element ratios, high TiO_2 , Cl and P_2O_5 .

Au is correlating clearly with Cu, U and Mo and weakly with chalcophile elements (SFE's).

The ore hosting albitic felsite differs from barren albitic felsite in mineral composition only slightly. "Ground mass" is composed of albite, quartz and rutile in both albitic felsites, but the amount of crosscutting veins increase and their composition change towards the ore:

- the amount of carbonate (dolomite) increases (varies widely)
- the amount of chalcopyrite increases dramatically
- the dominant iron sulfide changes from pyrite to pyrrhotite
- magnetite becomes as stable mineral with chalcopyrite, pyrrhotite and pyrite
- the amount of normative quartz is abnormally high in the ore
- the amount of Al carried by amphibole and phlogopite increases in albitic felsites towards the ore

9.2 C3 ore

C3 Cu-Au ore is located between 118 and 122 metres hosted by albitic felsite close to the contact between albitic felsite and metadiabase (contact locating at 125 m). Au content in the ore is approximately 14 ppm. The Au ore has slightly lower Al_2O_3/TiO_2 ratio than albitic felsites being about 14. Gold shows positive correlation with sulfide forming chalcophile elements (SFE's) Fe, Cu, Ni, Co, S & As and with Ta.

The veins in albitic felsites become more abundant towards the ore. Mineral composition of the veins in albitic felsites changes towards the ore by the increase of carbonate(s) and sulfides. Magnetite and ilmenite become stable minerals with sulfides, chalcopyrite content increases and dominant Fe-sulfide changes from pyrrhotite to pyrite.

The mineral composition of the metadiabase changes towards the ore by (1.) the increase of scapolite content which is towards the contact followed by (2.) the disappearance of scapolite and simultaneously (3.) change in dominant iron sulfide from pyrrhotite to pyrite.

9.3 C4 ore

C4 Cu-Au mineralization is located between 102 and 110 metres hosted by a mixture of albitic felsite and metadiabase according to the ratios of immobile elements and other chemical features, namely Cl, Cr, Ti and P contents. Au content is approximately 11 ppm. Cu and Au show a strong positive correlation ($r=0.89$).

Co/Ni ratio forms trend opposite to Cl, as stated also in C2 and C3 ores. Highest Au and Cu content coincide with Co/Ni maximum in the central part of metadiabase sheet.

According to petrographic observations the mineral composition of metadiabase changes towards the ore the following way:

- albite content increases
- grain size of albite decreases from 1800 μm via 300 μm (in metadiabase) to 10 μm in albitic felsite sample 106.5 μm
- amphibole content decreases
- scapolite disappears

Au-ore sample 106.5 m is classified also according to petrographic observation as albitic felsite.

Ratios of normative Al carriers change towards the ore. Scapolite and phlogopite contents decrease to zero. Ore hosted albitic felsite differs from barren albitic felsites by a low normative phlogopite content.

Au-Cu mineralization is characterized by a high normative chalcopyrite content as well as symmetric variations in the ratios of Fe-sulfides. Pyrite dominates in the metadiabase - albitic felsite / black shist contact. In the inner part of the metadiabase sheet dominant Fe-sulfide changes to pyrrhotite, and in the centre of the sheet, which is composed of albitic felsite, the dominant Fe sulfide is again pyrite.

9.4 E ore

E gold ore is located between 190 and 200 metres hosted by albitic felsite having $\text{Al}_2\text{O}_3/\text{TiO}_2$ ratio about 20. The ore lies about 15 metres from the metadiabase vein (211.5-219.0 m). Au content is approximately 1.5 ppm (max 3.5 ppm). Vanadium with Cu and Pb show strongest positive correlation with Au. Also SFE's with Mo and U show weak positive correlation with Au.

Towards the ore the vein mineral composition in albitic felsites changes:

- amphibole disappears
- carbonate content increases
- phlogopite content increases
- the amount of sulfides in the vein increases

According to the Ca, Mg and C ratios the most probable carbonate species is calcite. The ore is located in pyrite/(pyrite+pyrrhotite) minimum in the section. Generally pyrrhotite is predominating over pyrite in albitic felsites but ore is rimmed by albitic felsites rich in pyrite. Ore itself is characterized by low pyrite/pyrrhotite ratio. In the contact between metadiabase and albitic felsite pyrite is again the only Fe-sulfide.

9.5 K ore

K Au-Te mineralization is located at 23 m and between 35 and 45 metres hosted by albitic felsite. The nearest metadiabase sheets are located (1) between 23 and 26 metres and (2) between 43 and 50 metres. Au content in the ore is approximately 6 ppm with low value of CO₂ (4 wt.%) (Table 8.2) (Fig. 8.6). Co/Ni ratio is exceptional low in the ore with respect to other rock types in the section (Fig. 8.7). U, Ce and Te show high concentrations in the ore (Figs. 8.8-8.9). Also MgO content is remarkable low with respect to barren albitic felsites.

K ore differs from other ores by exceptional weak positive correlation with Au and Cu ($r = 0.26$) and high concentrations of Bi and Te with strong positive correlations with Au. Also metadiabase is extraordinary with high Al₂O₃/TiO₂ ratio and high K₂O content.

No clear change in the mineral composition of the veins in albitic felsites can't be found when the ore is approached. Some remarks are, however, listed below.

- chalcopyrite is the dominant sulfide in Au-ore and in other samples it is Fe-sulfide (pyrrhotite or pyrite)
- Fe-sulfide ratio pyrrhotite/pyrite changes from about 1 in 20.5 m via 2 in Au-ore (42.1 m) to 0 in 53.5 m and in 61.6 m.

Carbonatization degree is low in the ore (< 50 %) with respect to low Mg and high Ca content (Mg/Ca close to 0) indicating that carbonate species would be calcite. The ore is characterized by low normative dolomite content and high normative quartz content. Sulfides are accessory minerals in the ore. Pyrite/pyrrhotite ratio changes from about 0.5 in metadiabase sheets to 0 in ore symmetrically on both sides of the ore.

10 DISCUSSION

The following discussion is just an outline and the aim of it is to point out some noteworthy features rather than give answers and conclusions to the formation of Bidjovagge ore(s).

10.1 Origin and chemical alteration of different rock types

10.1.1 Albitic felsites vs. black shists

Albitic felsites are the alteration product of graphitic felsites. Evidences come from:

- Lamberg & Hautala (1990) showed that immobile element ratios for black shist, graphitic felsites and albitic felsites are equal.
- Vik (1985) has published REE patterns for the rocks from the Kveneangen area. The patterns for albitic felsites and for graphitic felsites are the same
- Björlykke et al. (1987) noticed that near the orebodies the contacts between the albitic felsite and graphitic felsite are often discordant with the primary bedding
- Björlykke et al. (1990) specified that graphitic shists are both albitized and oxidized with a gradational bleaching of the graphitic felsite.

Although graphitic felsites or black shists were not included in this study, similar immobile elements ratios that were given for black shist - albitic felsite samples by Lamberg & Hautala (1990) indicate that also albitic felsites studied here are alteration products of graphitic felsites and black shists.

Losses and gains of the most important elements in the alteration of black shist to albitic felsite have been calculated in Table 10.1. Alterations are illustrated by the Isocon diagrams after Grant (1986) in Figs. 10.1-10.3. Initial sample has been taken from Lamberg and Hautala (1990). Oxidized black shist (albitic felsite poor in CO₂) has altered mainly by dissolution of graphite with about 25 % loss in mass and volume (Lamberg & Hautala 1990). Barren albitic felsite (C2 ore, S128I/63.0 m) shows similar alteration. However increase in SFE's and CFE's can be noticed. Ore hosting albitic felsite can be distinguished from barren only by Cu. Ti, Al, Na has stayed as immobile elements in alterations.

Table 10.1. Calculated alterations of the black shist (Bidjo/5, Lamberg & Hautala 1990) via barren albitic felsite (oxidized meta black shist (OMbs))(Bidjo/3, Lamberg & Hautala 1990 and C2 S128I/63.00 m) to ore hosted albitic felsite (OMbs) (C2 S128I/77.43). The composition of the initial sample (black shist), altered samples, normalized compositions (NORM) (with respect to Ti) and the per centage of alteration (%).

Sample	5/Bidjo.	3/Bidjo.	NORM	%	63.00	NORM	%	77.43	NORM	%
Anal. no.	ML 8930094	ABFST 8930092			ABFST 8877962			ABFST 8877969		
SiO2	60.200	66.700	54.985	-8.7	62.100	79.542	32.1	52.800	80.072	33.0
TiO2	0.643	0.780	0.643	0.0	0.502	0.643	0.0	0.424	0.643	0.0
Al2O3	15.800	19.100	15.745	-0.3	13.000	16.651	5.4	9.420	14.286	-9.6
Cr2O3	0.017	0.027	0.022	30.6	0.023	0.029	69.3	0.025	0.038	120.8
V2O3	0.017	0.031	0.026	50.0	0.019	0.024	41.5	0.019	0.029	68.4
FeO	0.663	0.581	0.479	-27.8	5.960	7.634	1051.4	12.240	18.562	2699.7
MnO	0.009	0.022	0.018	106.1	0.085	0.109	1140.1	0.039	0.059	573.8
MgO	0.270	0.070	0.058	-78.6	1.690	2.165	701.7	1.820	2.760	922.2
CaO	0.412	1.540	1.270	208.1	3.040	3.894	845.1	2.960	4.489	989.5
BaO	0.007	0.003	0.002	-64.7	0.001	0.001	-81.7	0.008	0.012	73.3
Na2O	8.300	10.500	8.656	4.3	9.360	11.989	44.4	6.730	10.206	23.0
K2O	0.242	0.168	0.138	-42.8	0.093	0.119	-50.8	0.181	0.274	13.4
ZrO2	0.016	0.019	0.016	1.9	0.013	0.016	3.6	0.009	0.014	-11.1
P2O5	0.048	0.073	0.060	25.4	0.058	0.074	54.8	0.046	0.070	45.3
CO2	78.004	2.133	1.758	-97.7	4.583	5.870	-92.5	4.400	6.673	-91.4
C	21.288	0.582	0.480	-97.7		0.000	-100.0		0.000	-100.0
Cl	0.005	0.003	0.002	-50.5	0.006	0.008	53.7	0.013	0.020	294.3
Cu	0.005	0.008	0.006	25.3	0.004	0.006	10.2	4.760	7.219	144272
Zn	0.001	0.002	0.001	14.1	0.000	0.000	-100.0	0.003	0.004	226.6
Ni	0.002	0.001	0.001	-48.5	0.019	0.025	1453.1	0.038	0.057	3454.3
Co	0.000	0.001	0.001	271.0	0.031	0.039	19497.4	0.050	0.076	37736.9
Pb	0.000	0.006	0.005	100.0	0.000	0.000	0.0	0.001	0.002	100.0
S	0.100	0.015	0.012	-87.6	3.990	5.111	5010.7	9.320	14.134	14033.9
Au (ppm)	<0.1	<0.1	0.000	0.0	0.240	0.307	0.0	11.000	16.682	0.0
Sum	164.761	101.783	83.906	-49.1	104.577	133.950	-18.7	105.306	159.697	-3.1

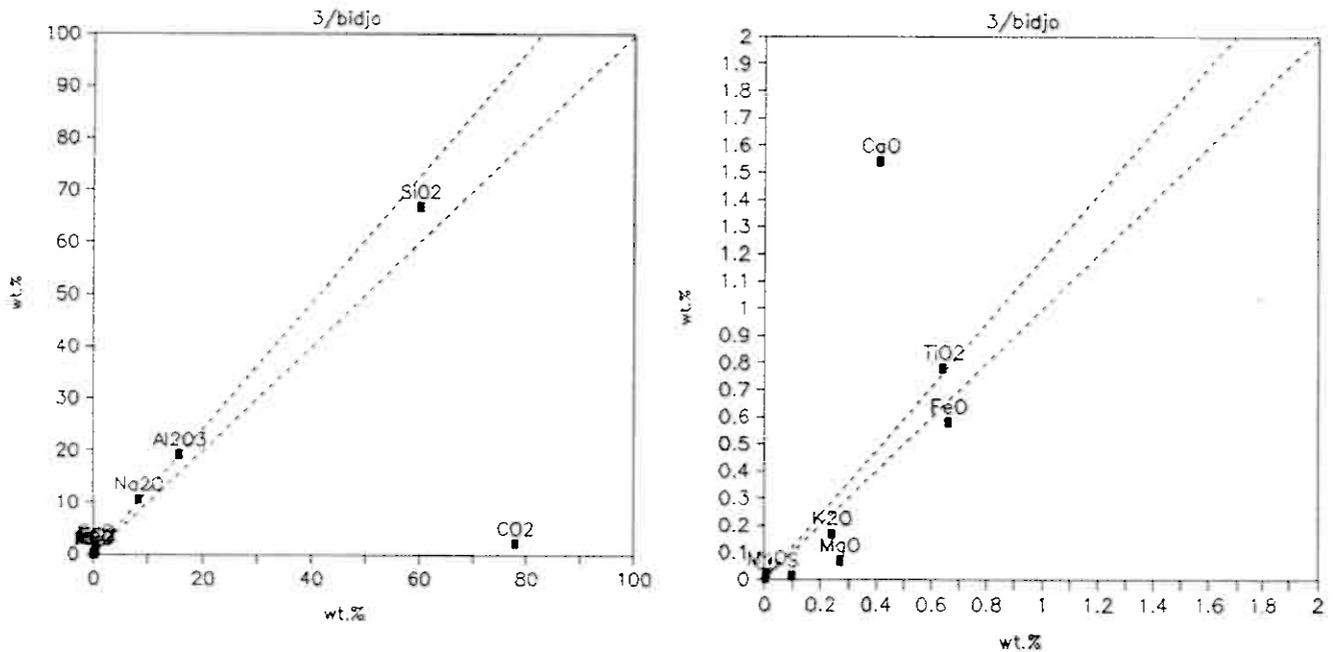


Fig. 10.1. Isocon diagram after Grant (1986) showing initial sample (meta black shist (Bidjo/5, Lamberg & Hautala, 1990)) and altered sample (oxidized black shist (Bidjo/3, Lamberg & Hautala, 1990)). Lines for constant Al, Ti and mass are drawn.

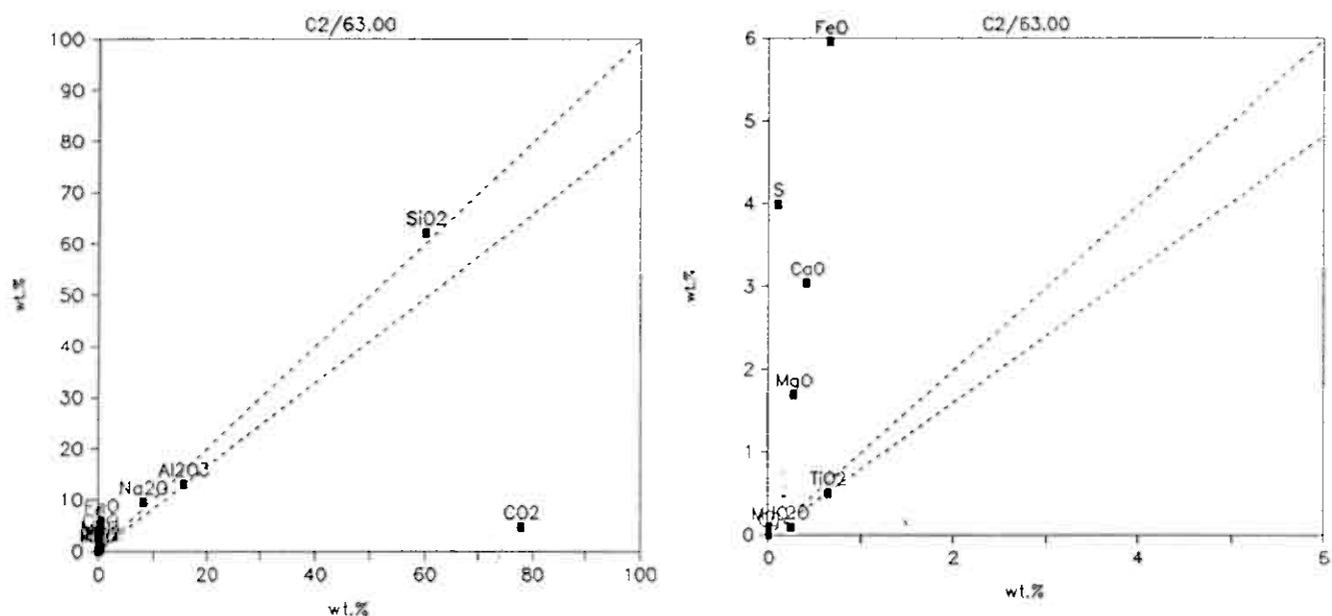


Fig. 10.2. Isocon diagram after Grant (1986) showing initial sample (meta black shist (Bidjo/5, Lamberg & Hautala, 1990)) and altered sample (oxidized barren black shist (C2 ore, S128I/63.0 m)). Lines for constant Al, Ti and mass are drawn.

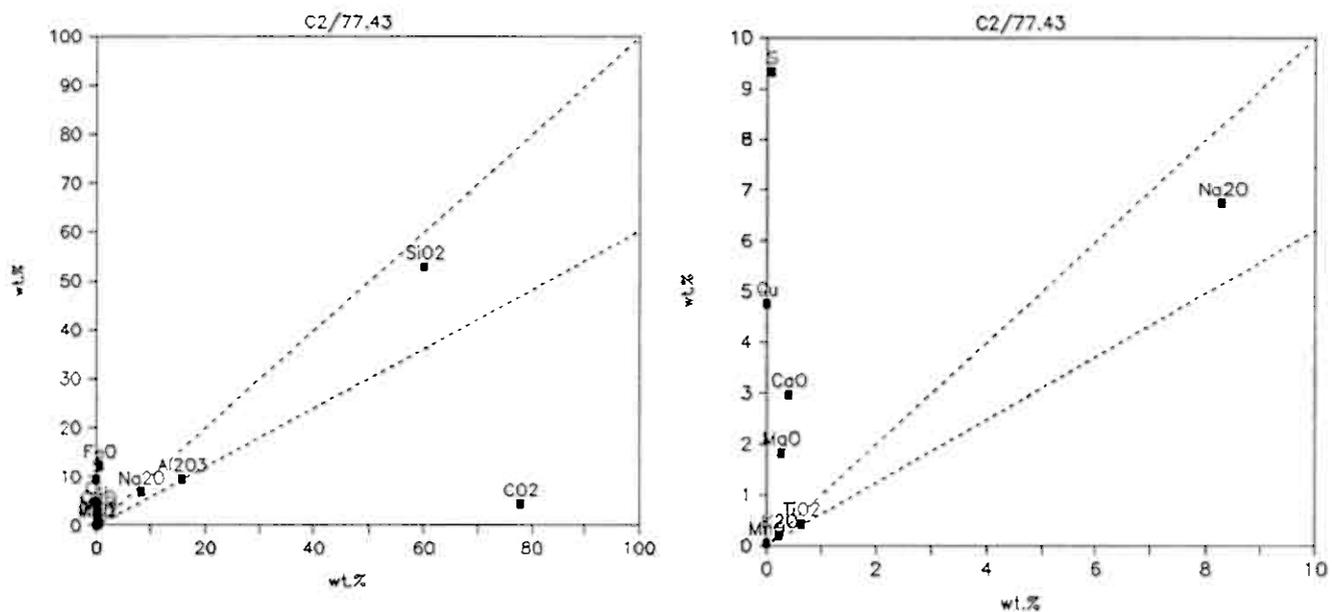


Fig. 10.3. Isocon diagram after Grant (1986) showing initial sample (meta black shist (Bidjo/5, Lamberg & Hautala, 1990)) and altered sample (oxidized ore hosted black shist (C2 ore, S128I/77.43 m)). Lines for constant Al, Ti and mass are drawn.

10.1.2 Metadiabase(s)

Diabasic texture indicates that primary minerals in diabase have been plagioclase (as eu- to subhedral laths) and clinopyroxene ± orthopyroxene (as an- to subhedral grains filling interstices).

Losses and gains of the most important elements in the alteration of metadiabase have been calculated in Table 10.2. Alterations are illustrated by the Isocon diagrams after Grant (1986) in Figs. 10.4-10.3. Initial sample has been taken from Lamberg and Hautala (1990). The alterations in metadiabase samples given in Table 10.2 are almost equal showing increase in CFE's and SFE's except Fe.

Table 10.2. Calculated alterations of the metadiabases from the proposed initial composition (metadiabase) (Bidjo/7, Lamberg & Hautala 1990) to various types of metadiabases 126.0 m (close to the ore: C3 ore, S144F/126.0 m), 134.0 m (high Cl content, C3 ore, S144F/134.0 m) and 154.0 m ("inner part" of the metadiabase sheet, C3 ore, S144F/154.0 m). The composition of the initial sample, altered samples, normalized compositions (NORM) (with respect to Ti) and the relative alteration (%) is shown.

Sample	7/Bidjo. MDB 8930096	126.0 MDB 9056729	NORM	%	134.0 MDB 9056735	NORM	%	154.0 MDB 9056738	NORM	%
Anal. no.										
SiO2	49.400	42.300	34.825	-29.5	42.300	37.539	-24.0	39.500	38.930	-21.2
TiO2	2.050	2.490	2.050	0.0	2.310	2.050	0.0	2.080	2.050	0.0
Al2O3	13.700	11.800	9.715	-29.1	11.300	10.028	-26.8	10.500	10.349	-24.5
Cr2O3	0.004	0.004	0.003	-20.0	0.004	0.004	6.0	0.003	0.003	-12.4
V2O3	0.124	0.060	0.049	-60.2	0.054	0.047	-61.7	0.048	0.048	-61.7
FeO	15.650	11.290	9.295	-40.6	12.220	10.845	-30.7	11.460	11.295	-27.8
MnO	0.094	0.189	0.156	65.7	0.131	0.116	23.8	0.149	0.147	56.4
MgO	5.840	5.310	4.372	-25.1	6.240	5.538	-5.2	6.100	6.012	2.9
CaO	4.920	6.780	5.582	13.5	8.310	7.375	49.9	9.520	9.983	90.7
BaO	0.006	0.009	0.007	23.5	0.007	0.006	3.5	0.000	0.000	-100.0
Na2O	6.100	7.900	6.504	6.6	7.150	6.345	4.0	6.740	6.643	8.9
K2O	0.200	0.600	0.494	147.0	0.236	0.209	4.7	0.188	0.185	-7.4
ZrO2	0.012	0.029	0.024	101.7	0.027	0.024	101.2	0.026	0.026	114.4
P2O5	0.118	0.303	0.249	111.4	0.270	0.240	103.1	0.266	0.262	122.2
CO2	0.147	12.063	9.931	6656.0	9.680	8.590	5743.9	14.556	14.346	9659.2
Cl	0.031	0.016	0.013	-57.5	0.162	0.144	363.8	0.023	0.023	-26.9
Cu	0.005	1.980	1.630	35337.4	0.250	0.222	4723.1	0.477	0.470	10120.0
Zn	0.004	0.001	0.001	-78.3	0.000	0.000	-100.0	0.001	0.001	-76.7
Ni	0.003	0.012	0.010	203.6	0.052	0.046	1342.1	0.045	0.044	1279.8
Co	0.002	0.018	0.015	680.0	0.040	0.036	1787.0	0.034	0.033	1637.7
Pb	0.000	0.001	0.001	311.6	0.001	0.001	343.7	0.001	0.001	392.8
S	0.126	5.590	4.602	3552.5	6.450	5.724	4442.9	5.660	5.578	4327.3
Au (ppm)	<0.1	0.750	0.617		0.480	0.426		0.530	0.522	
Sum	98.535	108.745	89.529	-9.1	107.194	95.129	-3.5	107.377	105.828	7.4

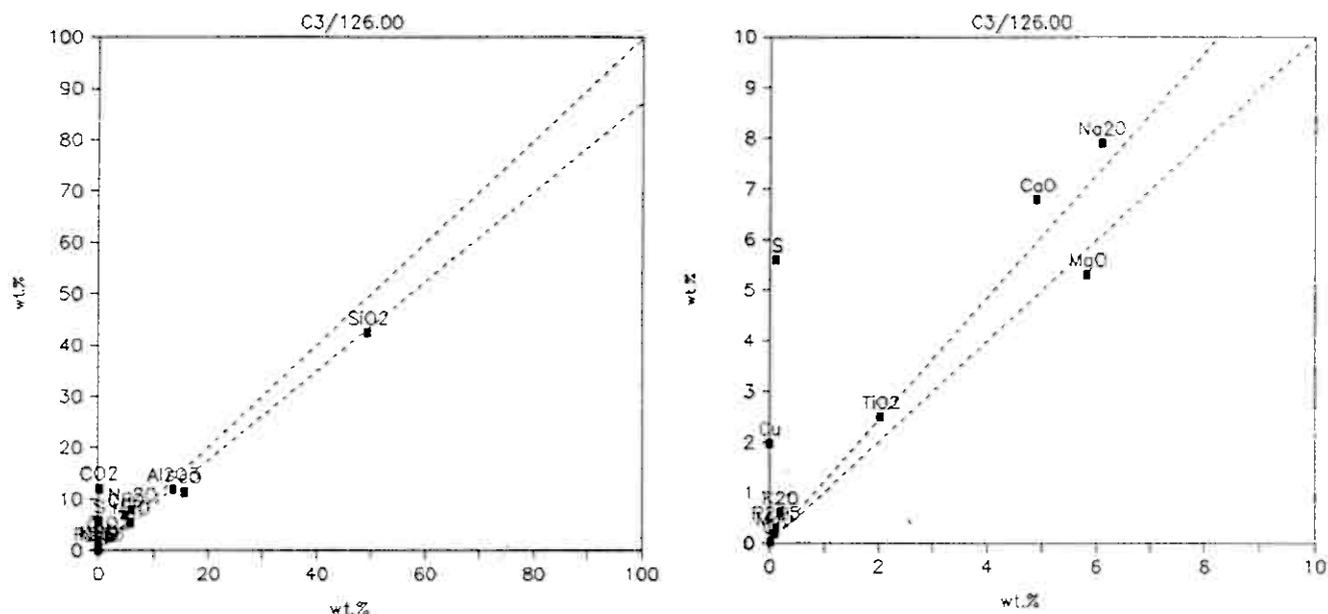


Fig. 10.4. Isocon diagram after Grant (1986) showing initial sample (C type metadiabase (CMdb) (Bidjo/7, Lamberg & Hautala, 1990)) and altered sample (C type metadiabase (CMdb) locating close to the albitic felsite metadiabase contact, C3 ore, S144F/126.0 m). Lines for constant Al, Ti and mass are drawn.

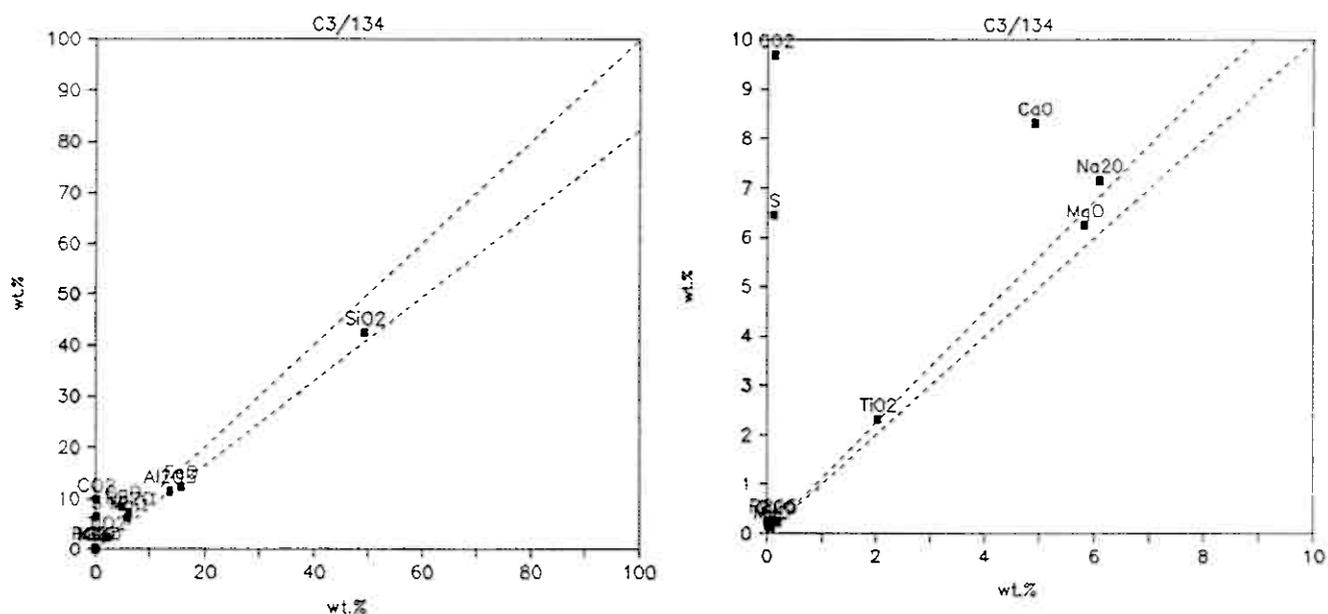


Fig. 10.5. Isocon diagram after Grant (1986) showing initial sample (C type metadiabase (CMdb) (Bidjo/7, Lamberg & Hautala, 1990)) and altered sample (C type metadiabase (CMdb) having high Cl content, C3 ore, S144F/134.0 m). Lines for constant Al, Ti and mass are drawn.

According to immobile element ratios and Cr & P contents metadiabases can be related to T1 Fe-tholeiites occurring in Northern Carelia described by Vuollo (1991). In Figs. 10.7-10.8 metadiabase samples from C2 and C3 ores are plotted on Jensens

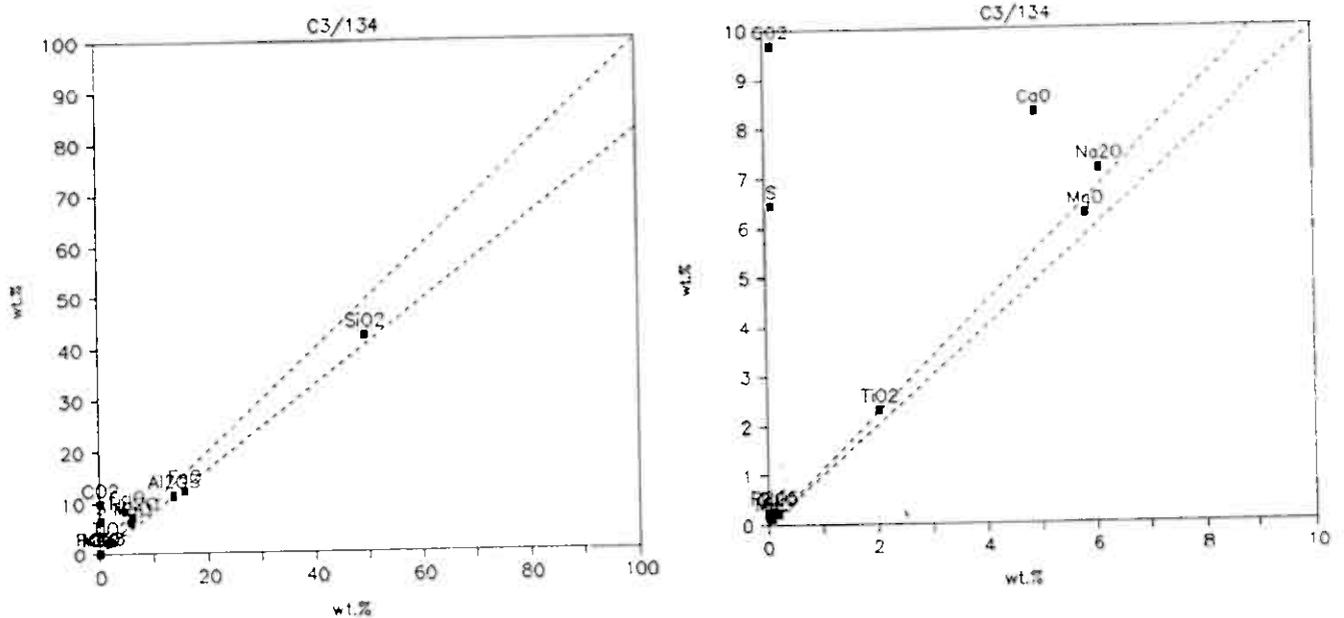


Fig. 10.6. Isocon diagram after Grant (1986) showing initial sample (C type metadiabase (CMdb) (Bidjo/7, Lamberg & Hautala, 1990)) and altered sample (C type metadiabase (CMdb) locating in the central part of the sheet, C3 ore, S144F/154.0 m). Lines for constant Al, Ti and mass are drawn.

cation plot. It can be seen that the majority of metadiabase samples from Bidjovagge are located in the field of Fe-tholeiites and differ notably from karjalites (differentiated albitic sills, Vuollo, 1988 and 1991; Vuollo & Piirainen, 1989; Hanski, 1985). In Northern Carelia these T1 Fe-tholeiites have been dated to be formed about 2.1 Ga (Huhma, 1986; Pekkarinen, 1979). These datings are in harmony with cutting relations (Vuollo, 1988 and 1991).

Fig. 10.7. Samples from C2 ore plotted on Jensens cation plot (Jensen, 1976). A = albitic felsite, M = metadiabase, O = ore.

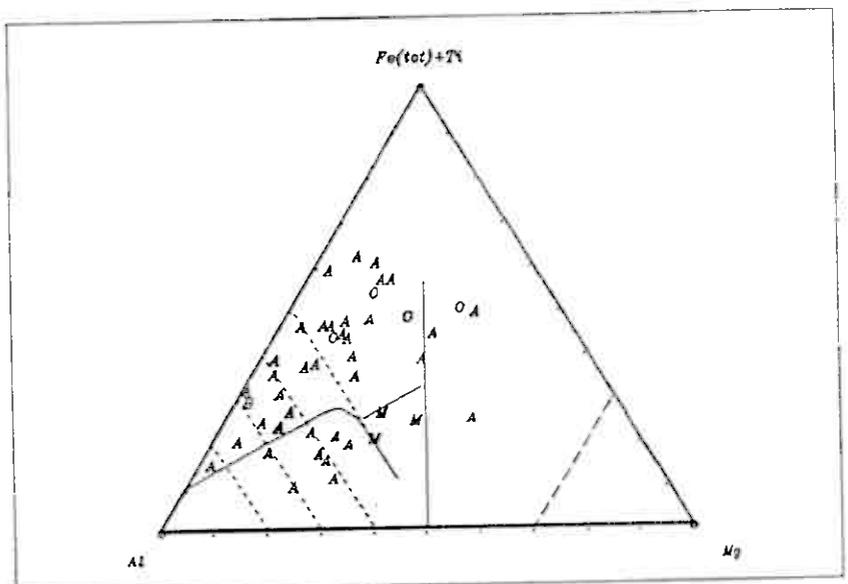
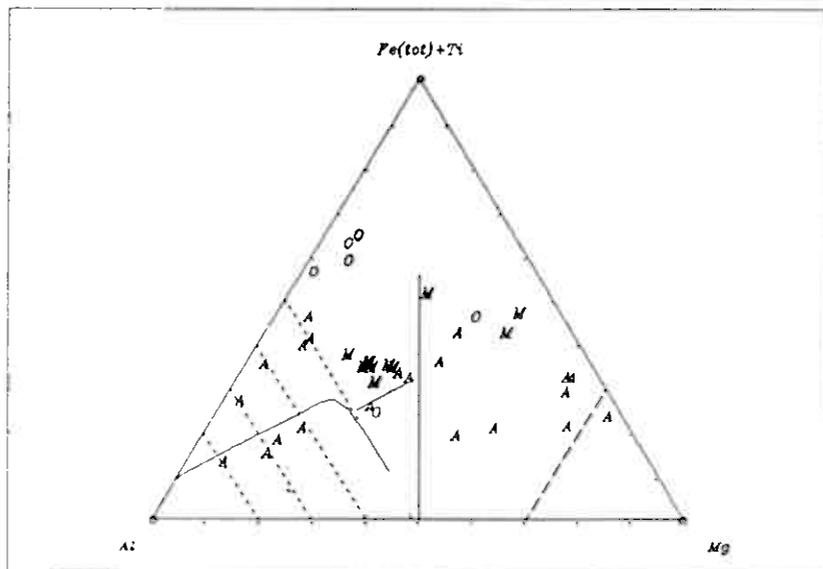


Fig. 10.8. Samples from C3 ore plotted on Jensens cation plot (Jensen, 1976). A = albitic felsite, M = metadiabase, O = ore.



Adjacent to T1 Fe-tholeiitic diabbases some weak Cu enrichments have been found in Northern Karelia, namely Kyykkä and Hokka. Also boulder from Markenlampi (in Northern Karelia) with high Cu and Ni content and slight increased Ag + Pd contents was related to T1 Fe-tholeiites (Lamberg 1990). This Markenlampi boulder contains scapolite (Lamberg 1990).

10.1.3 Recommended names for the rock types occurring in studied drill core sections

The name albitic felsite has been used for long for rocks rich in albite. Väyrynen (1938) spoke of albite-fels with carbonate, albite, quartz, chlorite, a pale-coloured amphibole and sulfides + oxides. He suggested a specific name to such a distinct rock and called it Karjalite. Holmsen et al. (1957) used name albite-carbonate rock for the light-coloured rocks especially rich in albite and carbonate. They suggested that the albite-carbonate rocks showing concentrations along or close to faulting or brecciation are metasomatic in origin. Hollander (1979) used name fels for felsic, fine grained, massive, metamorphic rock consisting of albite, quartz and calcite. Björlykke et al. (1987) used name albitic felsite for totally albitized argillite. The graphitic felsite is according to Björlykke et al. (1987) altered carbonaceous argillite containing up to 40 percent C as very fine grained graphite.

The sediments on the upper side of the gabbroic or diabase sills are strongly metasomatized to a "cherty looking" albitic felsite (Björlykke et al. (1990)). Björlykke et al. (1990) used name albitic fels for strongly altered tuffites and carbonaceous shales.

According to AGI Glossary (Gary et al., 1974) felsite means a light-coloured, fine-grained extrusive or hypabyssal rock with or without phenocrysts and composed chiefly of quartz and feldspar; a rock characterized by felsitic texture. Felsitic is a synonym of aphanitic and felsitic term is sometimes applied only to the light-coloured dense rocks. However felsitic term is not

recommended because in its original use it was applied to a mineral substance now known to be a mixture of quartz and feldspar (Gary et al. 1974).

Albitic felsite seems to cover a whole serie of rocks, which are light-coloured, dense rocks rich in albite. Both coarse and fine-grained occur (Holmsen et al. 1957). Recently Vuollo (1988) has proposed karjalite name for the magma type (and also for the products, the rocks), which produced differentiation series of cumulates rich in albite. Name albitic diabase has been used widely in Lapland for diabasic or ophitic sheets rich in albite (e.g. Mikkola, 1941).

In Bidjovagge name albitic felsite has been used for light coloured fine grained rocks occasionally showing relic diabasic texture (Ekberg, pers. comm. 1991). In the nomenclature used, albitic felsite can be an alteration product of both black shist and (meta)diabase. Because of its inaccurate nature it is recommended that name albitic felsite should not be used.

A following nomenclature is recommended to be used in future, because it points to unaltered rock type, which is important in understanding the ore genesis as well as in exploring Bidjovagge type ores. Also it tells about the alteration.

For every rock the initial (unaltered) name is given in the end of the final name. For the altered rocks prefixes are added in the order from the youngest alteration to the oldest. For the alterations as definite and indicative names as possible are used. Because of the length of the names the abbreviations are given. Small letters are used for the initial rock types and prefixes written in capitals points to the alteration. Summary on the proposed and used nomenclature is given in Table 10.3

According to immobile element ratios rock types (tuffites etc. excluded) are divided into black shists and diabases. Inexact prefix meta is used for albitic black shist (meta black shist, Mbs) and diabase composed mainly of albite and amphibole (metadiabase, Mdb), because alteration reactions, losses and gains of this alteration stage are still poorly known.

Rock type with "black shist like" immobile element ratios and no graphite ($C = 0$, $CO_2 > 0$ wt.%) is called oxidized meta black shist (OMbs).

According to Al_2O_3/TiO_2 ratio as well as K content (and Cu & Te contents) metadiabases can be divided into two classes. Metadiabase with Al_2O_3/TiO_2 ratio lower than in black shist and its derivatives (bs, Mbs, OMbs), typically about 6, is called C type (altered) metadiabase (CMdb). These diabases occur adjacent to C ores and other ores with high Cu content. Metadiabase(s) with Al_2O_3/TiO_2 ratio clearly higher than in black shist and its derivatives (bs, Mbs, OMbs) is called K type (altered) metadiabase (KMdb), because it occurs adjacent to K ore. It seems that these metadiabases are adjacent generally to Au-Te ores because also altered metadiabases studied by Lamberg & Hautala (1990) showed

Table 10.3. Recommended nomenclature for the rock types adjacent to ore in Bidjovagge.

Abbr	Recommended name	$\frac{Al_2O_2}{TiO_2}$	$\frac{Al_2O_3}{Cr_2O_3}$	$\frac{TiO_2}{Cr_2O_3}$	indicative element concentrations	indicative minerals	Note
bs	black shist	25	500	20	C > 0 wt.%	graphite	
Mbs	meta black shist	25	500	20	C > 0 wt.%	graphite + albite	
OMbs	oxidized meta black shist	25	500	20	C = 0 wt.%, CO ₂ > 0 wt.%	no graphite	
db	diabase	6	>800	>50	TiO ₂ >, P ₂ O ₅ >, Cr ₂ O ₃ <	plagioclase, pyroxene(s)	doesnt exist?
CMdb	C type metadiabase	6	>800	>50	TiO ₂ >, P ₂ O ₅ >, Cr ₂ O ₃ <	albite, amphibole	
KMdb	K type metadiabase	>35	>800	>50	TiO ₂ >, P ₂ O ₅ >, Cr ₂ O ₃ <, K ₂ O >	albite, amphibole, phlogopite, paragonite	

high Al₂O₃/TiO₂ ratio together with high Te content. K affix is suitable also because of high K content is characteristic for this metadiabase derivative.

10.2 Alteration reactions

According to the microscopic observations the sequence of alterations has taken place in order given in Table 10.4. These reactions are written also by elements in reactions 10.1 - 10.10.

10.3 Transportation of metals

Au and Cu are reported to be transported in fluids mainly by bisulfide and chloride complexes (Seward 1991).

The pH of hydrothermal ore fluids is typically in the range from 5 to 6.5 because of buffering by mineral equilibria (Seward 1991). In Bidjovagge reactions (10.1-10.10) buffer the system in former mentioned restricted pH range. At high T (> 300 °C) $Au(HS)_2^-$ solubility maximum migrates to higher pH with increasing T (Seward 1991).

In weakly acidic solutions CuCl predominates at 250-350 °C up to S=0.1 and bisulfide complexing becomes relative more important below 250 °C (Barnes, 1979). Because of the increasing stability of the chloride complex at T > 250 °C solubility as CuCl may easily reach into thousands of parts per million (Crerar & Barnes 1976).

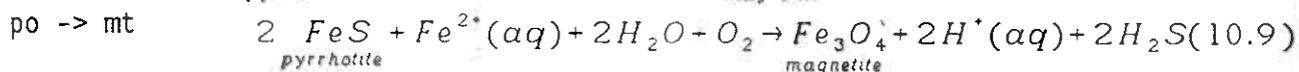
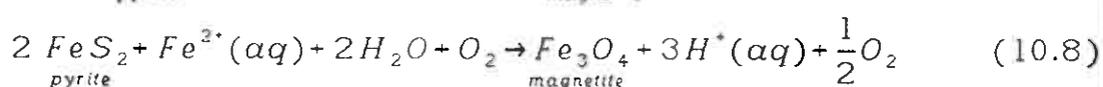
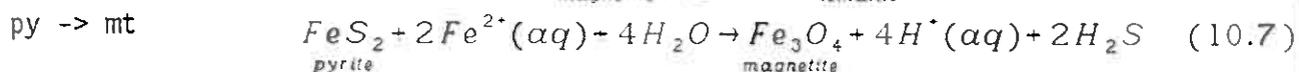
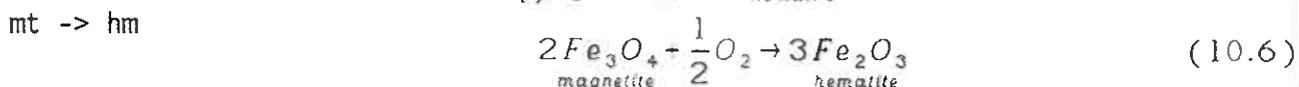
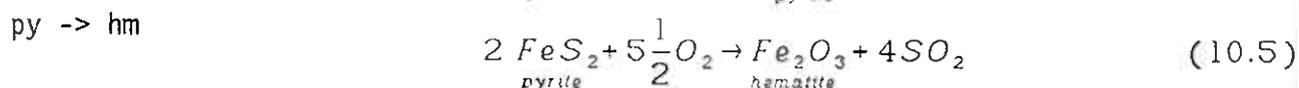
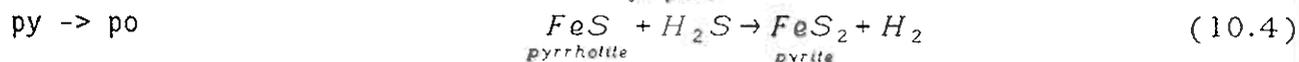
Gold is highly soluble as $AuCl_2^-$ only in equilibrium with hematite. In general transport as chloride complex is favoured by low pH, high chloride concentrations and elevated temperatures (Shenberger and Barnes 1989)

10.4 Stability of minerals in aO₂-pH diagram and precipitation of metals

Critical minerals to define the aO₂ and pH conditions in fluid - rock interaction in Bidjovagge ore are graphite, pyrite, pyrrhotite, magnetite, hematite, albite and paragonite.

In black shist graphite points reducing conditions and the most propable sulfide mineral is pyrrhotite. When oxidizing fluid is penetrating through black shist the change in aO₂ condition in the rock is buffered by the oxidation of graphite (reaction 10.1). This can be seen in Bidjovagge as the disappearance of graphite from albitized black shist to oxidized albitized black shist (graphite out, carbonate in). If aO₂ in the fluid is still higher than in the rock the next reaction which takes place is the oxidation of pyrrhotite to pyrite (10.4). In Bidjovagge this can be seen near the contact between metadiabases and oxidized albitized black shists (OAbs) where Fe sulfide changes often from pyrrhotite via pyrrhotite-pyrite to pyrite. If equilibrium isn't achieved by this reaction the next buffering reaction will be replacing pyrite (and/or magnetite) by hematite (10.6). According to Björlykke et al. (1987) hematite is stable mineral in the footwall rocks ("albitic felsites") of the main mineralization.

In the Cu-Au ore magnetite and/or ilmenite is often stable mineral with pyrite and pyrrhotite. This indicates that aO₂-pH conditions are buffered by the reactions (10.7-10.9) and rock is situated in the mt-po-py invariant point in aO₂-pH diagram (Fig. 10.9).



Albite is the most abundant Na-Al silicate but however minor quantities of paragonite can be observed in many oxidized albitized black shists (OAbs). In carbonate veins, where magnetite is absent, paragonite is often observed and it can be dominant Na-Al silicate. Paragonite replaces albite if fluid is acidic (reaction 10.10, Fig. 10.9) and vice versa. In carbonate veins stable sulfide mineral is almost without exceptions pyrite, magnetite is absent and albite-paragonite occur as stable mineral paragenesis indicating quite restricted oxidizing and acidic aO₂-pH conditions (Fig. 10.10).

In the metadiabase samples from K ore quite numerous paragonite flakes occur as inclusions in quite big albite grains indicating changes in pH of the fluid phase. First fluid has been quite acidic stabilizing paragonite and then gradually inverting more basic resulting paragonite replaced by albite (reaction 10.10 from right to left). However paragonite has survived as metastable mineral due to covering albite corona.

Metals are transported either as chloride complexes or as bisulfide complexes and the precipitation reactions are written in reactions 10.11-10.12.

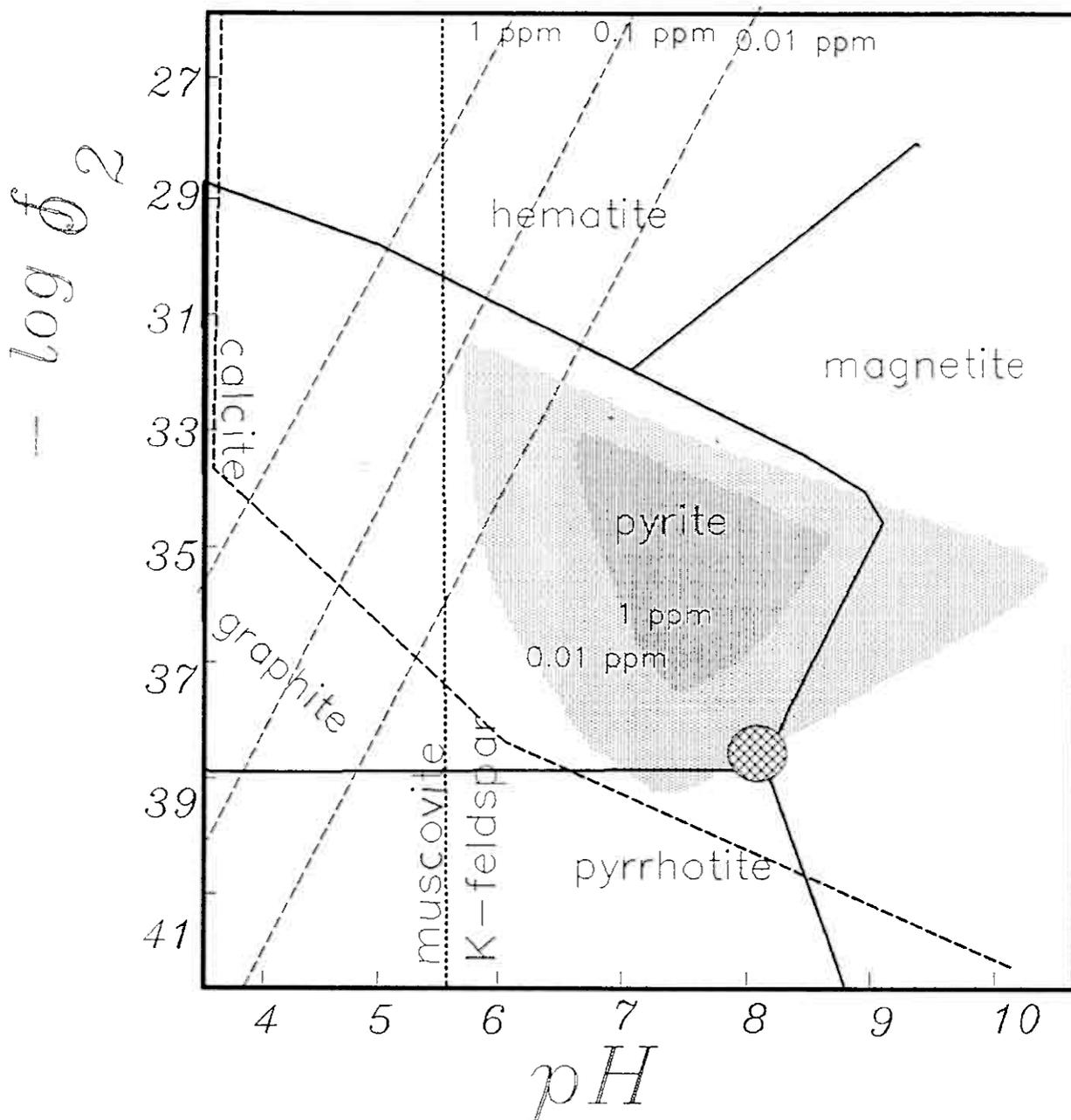


Fig. 10.9. Schematic oxygen fugacity-pH diagram for the Fe-S-O system showing phase relations at 300 °C and 1 kbar after Walsh et al. (1988). Stability fields for calcite, sericite and K-feldspar are also shown. Solution compositions used in this diagram, $(Tot)S = 0.01$ m, $f(CO_2+CH_4) = 750$ bars, $\log mCa^{2+} = -3$, $\log mK = -1.3$. The solubility of gold as $AuCl_2^-$ (Henley, 1973) and $Au(HS)_2^-$ (Seward, 1973) are also shown. The hatched circle indicates the probable f_{O_2} -pH conditions during mineralization based on mineral stabilities (see text).



In Table 10.5 is summarised the changes in hydrothermal system, which could influence the precipitation of gold.

Table 10.5. Changes in the hydrothermal system, which could produce the precipitation of gold after Barnes (1979).

Complex	δm_{S_2-}	O_2	δpH	dilution	δT	δP
Sulfide	-	+	-	yes	-	-
Chloride	+	-	+	yes	-	-

11 CONCLUSIONS

11.1 The model for the formation of Bidjovagge (and related) Au-Cu ores

The Cu-Au mineralizations in Bidjovagge are in all studied cases locating close to the metadiabase - albitic felsite contact. Björlykke et al. (1987) state that Bidjovagge as well as Bidjovagge-type mineralizations in Kautokeino greenstone belt are all related to diabase sills and associated albitic felsites. Björlykke et al. (1990) interpreted that felsite alteration is related to the diabase intrusion.

Albitic felsites are oxidized black shists. The dissolution of graphite has produced CO₂ in solutions and space for reactions by the loss in mass and volume. The most propable source of the oxidizing fluids are the metadiabase sheets, because black shists are only rarely in direct contact with metadiabase.

The oxidation of metadiabase has affected the dissolution of graphite and after that the change in Fe-sulfide to pyrite. In some ultimate (high fO₂) cases hematite is the one and only stable mineral of the Fe-S-O system. Field observations suggest that the main mineralizations are restricted to the oxidized part of the albitic felsite where hematite deposition has occurred in the footwall rocks (Björlykke et al. 1979). The maximum solubility of Au is reached in the presence of pyrite. Au has precipitated when solutions has migrated to more reducing conditions (pyrrhotite-pyrite-magnetite present).

Poulson and Ohmoto (1989) have calculated the proportions of species in a C-O-H fluid in equilibrium with graphite, pyrite and pyrrhotite. They stated that the production of H₂S-bearing fluids provides a mechanism for the selective transfer of sulfur from a graphite-pyrite-pyrrhotite bearing pelite into a pluton via a fluid phase, without requing wholesale melting and assimilation of rocks. Such a process allows a significant volume of pelite country rock to be raised rapidly to temperatures approaching that of the magma. H₂S-bearing fluids produced from graphite-pyrite-pyrrhotite pelites due to magmatic intrusion (or metamorphism) may mobilize ore-forming metals as sulfide complexes.

The fluid inclusion study by Ettner and Björlykke (1991) support the model, that metadiabase has been a triggerer in the precipitation of gold. Determined temperatures (250-375 °C in Cu ores, 300-450 °C in Au ore) are in harmony with observed differences in carbonate species. The lower temperature stabilates dolomite (Winkler 1976) (reaction: 3 dolomite + 4 quartz + 1 water -> 3 calcite + 1 talc + 3 carbon dioxide)..

Several occurrences of Bidjovagge-type mineralization have been found in the Kautokeino greenstone belt, and they are all related to diabase sills and associated albitic felsites (Björlykke et al. 1987). Also Cu-Au mineralizations in Finland have many similarities with Bidjovagge, namely Saattopora, Pahtavuoma Cu, Zn and U deposit (Inkinen 1979), Viscaria (Godin), Tuonganoja (Huhtelin, pers. comm. 1991). Also mineralizations adjacent to T1 diabbases have many similarites (e.g. Misi, Nuutilainen 1968).

11.2 Tools for prospecting

According to observations and interpretations made here the Bidjovagge-type Au-Cu mineralizations are always located in oxidized meta black shists near the contact with metadiabase. This simply restricts the prospecting for Bidjovagge-type mineralizations to the 20 to 50 metres thick stratigraphic unit of albitized argillites in the Cas'kejas formation. Cu-Au ores are adjacent to C type metadiabases (CMdb) and Au-Te ores adjacent to K type metadiabases (KMdb). The distinctive ratios of the immobile elements can be used in identification of different rock types.

The carbonate species is dolomite in Cu-Au ore and calcite in Au ore. This observation could be used as tool in exploration.

Field observations suggest that orebodies are situated at discontinuities in the self-potential anomalies and in low magnetic anomalies (Mathiesen, 1972). This is justified by mineralogical observations made here. Geophysical properties of different rock types could be used as an exploration tools. Oxidized albitized black shists could be located by electric conductivity unconformities. Albitized diabase sills could be identified due to their high magnetic values because of magnetite (Björlykke et al. 1990). Anomalous high uranium content adjacent to high Au content observed here and also by Björlykke et al. (1987) could be used as exploration tool by measuring radioactivity.

It could be possible - and it is at least worth of trying - to build up an oxygen fugacity map on the basis of geophysical (electromagnetic and electrical conductivity) maps. Magnetite may somewhat obscure the variations in Fe-sulfide but at least in some districts it could be possible to locate the surface where dominant Fe-sulfide change from pyrite to pyrrhotite and vice versa. This would be the critical place for the mineralization to occur.

Proper understanding on the conditions where gold and copper have precipitated is the aim we are heading. Goal has reached when one who is working in the field can directly read pH-a₀₂ conditions from the rock (its mineral paragenesis) and predict the suitable places for the mineralization to occur.

11.3 Proposal for further studies

This study points out some interesting features, which should be checked.

Mineralogical features:

- the composition of carbonate in the different type of ores
- the observed change in Fe-sulfide ratios (could be analysed more precisely i.e. by bromine methanol dissolution (Penttinen et al. 1977))

The diabase sheets should be dated in order to find out if they are "T1" diabases, and if C type and K type diabases have common origin. Also more datings on the ore should be made to uncover the relationship between the ore and diabases.

Carbon isotopic study could give some clues on the origin of the fluids, namely CO₂ (from the deeper source or from the black shists) (Ohmoto & Rye 1979).

12 ACKNOWLEDGMENT

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KAIRAUSRAPORTTI

Sivu no. 1

ALUE ⁶ [N] KAIRAUS ⁷ [S] KARTTALEHTI ⁸ [0,0,0,0,1A] VUOSI ¹⁵ [8,8]
 REIÄN TUNNUS ²⁰ [B,1,0,0,0] - REIÄN NO ²⁰ [5,1,2,8,7]
 KOORDINAATIT ³⁶ [1,2,79] ⁴⁴ [8,1,5] ⁵¹ [5,7,8] [3,7]
 ~44° ACS x/k m y/l m z m cm

SUUNTA } KAIRAUSKOORDINAATISTOSSA ¹⁷ [9,0] °
 VALTAK. KOORDINAATISTOSSA ³³ [9,0] °
 GEOLOGI [EK] PVM [29.12.88]

T. HOLMEN TT YK

Kollektio- mittaukset	0m	44.3	10m	44.0	20m	43.5	30m	43.5	40m	43.2	50m	42.7	60m	42.3	70m	42.1	80m	41.6	90m	41.2	100m	40.6	110m	40.3	120m
130m	140m	150m	160m	170m	180m	190m	200m	210m	220m	230m	240m	250m	260m												
270m	280m	290m	300m	310m	320m	330m	340m	350m	360m	370m	380m	390m	400m												
410m	420m	430m	440m	450m	460m	470m	480m	490m	500m	510m	520m	530m	540m												

SYVYYS	PITUUS	KIVILAJI	LISÄTIEDOT	Sydän- kulma	Cu	Au	Cu+Au	Sät.	ANAL. NO	AAS EiK. EiK.
21	9,0	M, D, B	Vihreä, keskivale. homog. Alaosassa Cähellä jelsittin kantaletia glap- littituumista. Heikkona späta- pirott. Hieman SK ja FEM					0,3-0,4		
24	0,0	A, B, F, S, T	Harmaa hionorak. selvästi		0,04	0,06		0,5	8, 8, 7, 7, 9, 5, 2	
26	0,0	A, B, F, S, T	raitainen. Leikkaavien KRB-juo- mien liittyen sat. hieman SK ja	52°	0,31	0,20		0,6	9, 5, 3	
28	0,0	A, B, F, S, T	CuK		0,01	0,04		0,6	9, 5, 4	
30	0,0	A, B, F, S, T	Hieman GRF:ia sis. selvästi rait.	52°	0,04	0,10		0,6	9, 5, 5	
35	3,0	G, R, F, F, S, T	Leikkaavissa KRB-juonissa yk. SK ja CuK							
49	0,0	M, L	Ei kovin GRF-pikas. Sat. juonina hieman FEM, SK ja CuK. Välillä 45,70-49,00 luvun tyvin rikkonaista (Kl metria luvun suurempi kuin 20)							
51	0,0	A, B, F, S, T	Harmaa hiuk. rait. Hionorak. SK-pirote		0,02	0,16		0,5	8, 8, 7, 7, 9, 5, 6	

FLU = 1 RAD = 2 FLU+RAD = 3 AAS = 1 XRF = 2 AAS+XRF = 3

APPENDIX 1a/1

SYVYYS	PITUUS	KIVILAJI	LISÄTIEDOT	Sydän kulmo	Cu	Au	Cu+Au	Sät.	ANAL. NO	ASBE	ELIK	OR
53.00		A.B.F.S.T.	Ruusaasti sk-pirott. karsi/KRB-juomia		0.05	0.22		0.6	8,8,7,7,9,5,7			
55.00		M.D.B.	} Harmaa pienirak. albitis. Heikko epätas. sk-pirote		0.003	0.06		0.5	9,5,8			
57.00		M.D.B.				0.01	0.08		0.4	9,5,9		
59.40		M.D.B./A.B.F.S.T.	Karsijuoimien liittyen hieman sk		0.01	0.06		0.4	9,6,0			
61.00		A.B.F.S.T.	} Harmaa hiukosti raitainen chert-timäinen. Epätas. pirotteena hieman sk		0.03	0.09		0.5	9,6,1			
63.00		A.B.F.S.T.				0.01	0.24		0.5-0.4	9,6,2		
65.00		A.B.F.S.T.				0.01	0.20		0.4	9,6,3		
66.45		A.B.F.S.T.				0.07	0.19		0.4	9,6,4		
67.85		A.B.F.S.T.				0.02	0.18		0.4	9,6,5		
69.17	1.32	A.B.F.S.T.	Brakioioivina juomina hieman cull ja sk		3.27	0.19	3.46	0.6	9,6,6			
70.32	1.15	A.B.F.S.T. CUMA	Cu-brakioimalmi felsiitissä ja karkarek. KRB-liässä		6.63	2.82	9.45	0.5	9,6,7			
71.54	1.22	A.B.F.S.T. CUMA	Ruusas veltkomainen cull-pirote ulovittisilmäkkeitä sis. felsiitissä		9.43	1.66	11.09	0.7	9,6,8			
76.27		KL	Vorvattain GRF-kuoppa, Leikkauksessa KRB-suonissa hieman sk ja cull KL metriä luvden n. 10	65°	-	-		0.8				
77.43	1.16	A.B.F.S.T. CUMA	} Cu-brakioimalmi chertim. felsiitissä. cullin ohella hieman FEK		7.37	11.06	18.37	0.6	8,8,7,7,9,6,9			
78.43	1.00	A.B.F.S.T. CUMA				8.83	7.36	16.19	0.5	9,7,0		
79.70	1.27	A.B.F.S.T. CUMA	Cu-pirotteimalmi chertim.		2.68	0.53	3.21	0.6	9,7,1			
81.00	1.30	A.B.F.S.T. CUMA	felsiitissä		2.71	0.71	3.42	0.6	9,7,2			
82.00	1.00	A.B.F.S.T. CUMA	cullin ohella karkarek. FEK-pirote		4.81	1.43	6.24	0.7	9,7,3			
83.00	1.00	A.B.F.S.T. CUMA	} Tasainen hiensake. cull/sk-pirote.		3.95	0.92	4.87	0.7	9,7,4			
84.00	1.00	A.B.F.S.T. CUMA				2.51	1.27	3.78	0.7	9,7,5		
85.09	1.00	A.B.F.S.T. (CUMA)			0.78	0.30	1.08	0.5	9,7,6			

APP. 12/2

SYVYYS	PITUUS	KIVILAJI	LISÄTIEDOT	Sydän kulma	Cu	Au	Cu+Au	Sät.	ANAL. NO	AAE ETK. OH.
8,6	0,0	A,B,F,S,T (KUMMIN)	SK-pirotteen ohella	53°	0,76	0,54	1,30	0,5	8,8, 7,7, 9,7,7	
8,7	0,0	A,B,F,S,T	hieman Cu		1,24	0,45	1,69	0,7	9,7,8	
8,8	0,0	A,B,F,S,T			1,11	0,97	2,08	0,5	9,7,9	
8,9	0,0	A,B,F,S,T			0,04	0,20		0,5	9,8,0	
9,1	0,0	A,B,F,S,T			0,04	0,08		0,5-0,6	9,8,1	
9,3	0,0	A,B,F,S,T			0,03	0,06		0,5	9,8,2	
9,5	0,0	A,B,F,S,T			0,07	0,06		0,5-0,6	9,8,3	
9,7	0,0	A,B,F,S,T	Valkea tiivis cherttimäinen	45°	0,03	0,09		0,5	9,8,4	
9,9	0,0	A,B,F,S,T	Tas. hiemaksi pirotteen ja		0,20	0,18		0,6	9,8,5	
10,1	0,0	A,B,F,S,T	pirotekasta SK, KRB-juonilla		0,17	0,21		0,7-1,0	9,8,6	
10,3	0,0	A,B,F,S,T	liittyen sat. Cu ja FEM		0,06	0,14		0,5	9,8,7	
10,5	0,0	A,B,F,S,T			0,23	0,20	0,43	0,5	9,8,8	
10,7	0,0	A,B,F,S,T			0,54	0,14	0,68	0,5	9,8,9	
10,9	0,0	A,B,F,S,T		60°	0,21	0,06	0,27	0,4	9,9,0	
11,1	0,0	A,B,F,S,T			0,25	0,20	0,45	0,5	9,9,1	
11,3	0,0	A,B,F,S,T			0,11	0,16	0,27	0,4	9,9,2	
11,5	0,0	A,B,F,S,T			0,78	0,38	1,16	0,4	9,9,3	
11,7	0,0	A,B,F,S,T			0,07	0,25	0,32	0,4-0,5	9,9,4	
11,8	0,0	A,B,F,S,T	Tiivis cherttim. Heikko SK-pirote.		0,11	0,22	0,33	0,6	9,9,5	
12,0	0,0	G,R,F,F,S,T	Pirotekasta juonilla ja juonilla SK,		1,35	0,50	1,85	0,5	9,9,6	
			kuu ja FEM							
12,1	4,0	ML	Ei. GRF-rikkas. KRB-juonissa hieman	50°	0,65	0,48	1,13	0,6	9,9,7	
			SK ja Cu							
			Loppu!							

67,85-71,54 = 3,69m @ 6,35% Cu 1,50 g/l Au

76,27-84,00 = 7,73m @ 4,60% Cu 3,23 g/l Au 1,52 g/l Ag (6,9%)

APP. 10/3

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. APPENDIX 1 b/1

C-2, S1291

Depth (m)	24.00	25.00	28.00	30.00	51.00	53.00	55.00	57.00	59.40	61.00	63.00	65.00
RockType	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST	MDR	MDR	MD/ABFST	ABFST	ABFST	ABFST
Anal.no.	8877952	8877953	8877954	8877955	8877956	8877957	8877958	8877959	8877960	8877961	8877962	8877963
SiO2	66	62.5	65.9	67.7	54.1	38.4	41.4	51.7	50	58.9	62.1	69.3
TiO2	0.401	0.515	0.555	0.519	0.445	0.321	1.06	1.47	1.03	0.531	0.502	0.533
Al2O3	12.4	13.9	14.7	15.6	11.3	8.08	10.3	13.7	13	13.7	13	13.7
Cr2O3	0.0213	0.0246	0.0221	0.0285	0.0233	0.0154	0.0148	0.0174	0.0215	0.0251	0.0226	0.0214
V2O3	0.0167	0.0181	0.0155	0.0163	0.0319	0.0397	0.0443	0.0576	0.0389	0.0224	0.019	0.0188
FeO	4.1	4.96	3.37	2.47	11.13	13.74	7.99	9.91	6.56	6.7	5.96	3.02
MnO	0.0629	0.0594	0.0333	0.0201	0.0659	0.188	0.194	0.106	0.142	0.05	0.0952	0.0209
MgO	3.74	3.75	5.02	3.51	1.84	6.19	7.4	6.89	6.22	4.29	1.69	0.27
CaO	3.35	3.21	1.73	1.39	4.85	12.3	12.9	5.33	6.44	2.99	3.04	0.723
Rb2O	0.0024	0.0019	0.0035	0.0093	0.0007	0.0007	0.0015	0.0033	0.003	0.0025	0.0005	0.0004
SrO	0.0064	0.0093	0.0052	0.003	0.0022	0.0042	0.0044	0.0048	0.005	0.0043	0.0021	0.0012
BaO	0.007	0.01	0.009	0.033	0.001	0.003	0.008	0.01	0.018	0.012	0.001	0.001
Na2O	7.57	7.59	6.66	3.45	7.9	5.41	6.02	7.27	7.62	8.24	9.36	9.84
K2O	0.649	0.79	1.2	3.88	0.141	0.191	0.585	1.12	1.08	1.05	0.093	0.088
ZrO2	0.0156	0.0152	0.015	0.0164	0.0106	0.0065	0.0119	0.0112	0.0113	0.0132	0.0127	0.0129
P2O5	0.114	0.054	0.059	0.058	0.055	0.052	0.123	0.145	0.111	0.052	0.058	0.088
CO2	2.603	2.493	0.147	1.503	6.38	16.426	15.473	2.31	9.276	2.603	4.583	0.807
OxSum	99.5	99.5	99.6	99.7	98.7	94	93.6	99	97.8	99.3	99.3	99.7
Cu	0.03	0.237	0.0119	0.0368	0.012	0.0377	0.0016	0.0061	0.0075	0.038	0.0043	0.0083
Ni	0.0052	0.0095	0.005	0.0083	0.0292	0.0395	0.0084	0.0069	0.0068	0.0178	0.0194	0.0077
Co	0.0156	0.0119	0.0065	0.0057	0.0758	0.084	0.0179	0.0084	0.0106	0.0102	0.0306	0.0287
Zn	0	0.0001	0.0003	0.0007	0	0	0	0	0	0	0	0
Pb	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0	0	0	0	0
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	0.501	1.65	0.297	0.74	9.7	8.58	2.53	0.97	1.72	3.86	3.99	2.11
As	0.0008	0.0008	0.0005	0.0005	0.007	0.0048	0.0023	0.0007	0.002	0.0035	0.0024	0.0011
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0	0	0
Te	0	0	0	0	0	0	0	0	0	0	0	0
Y	0.0019	0.0014	0.0014	0.0021	0.0014	0.0018	0.0024	0.0024	0.0017	0.0017	0.0007	0.0009
Nb	0.001	0.0011	0.0012	0.0013	0.0007	0.0009	0.0008	0.0007	0.001	0.001	0.001	0.0013
Mo	0	0.0003	0.0001	0	0	0	0	0	0	0.0005	0.0005	0.0003
Sn	0.001	0.001	0	0.001	0	0.001	0.002	0	0.001	0.001	0.002	0.001
W	0.001	0	0.001	0.001	0	0	0.001	0	0	0	0.001	0.001
Cl	0.069	0.072	0.017	0.026	0.008	0.022	0.047	0.193	0.127	0.039	0.006	0.009
Th	0.0006	0.0005	0.0006	0.0005	0.0005	0.0008	0	0	0	0.0002	0.0003	0.0008
U	0.0005	0.0009	0.0005	0.0011	0.0015	0.0008	0.0004	0.0006	0.0007	0.001	0.0012	0.0009
Cs	0.004	0.002	0	0.001	0.003	0.004	0.003	0.003	0.004	0.001	0.001	0.004
La	0.005	0.003	0.005	0.009	0.007	0.001	0.002	0.002	0.004	0.005	0.007	0.03
Ce	0.004	0.006	0.009	0.013	0.01	0.005	0.003	0.004	0.004	0.008	0.012	0.052
Ta	0	0.001	0.001	0	0	0.001	0	0	0	0.001	0.001	0
Au	0.06	0.2	0.04	0.1	0.16	0.22	0.06	0.08	0.06	0.09	0.24	0.2

C-2, S1261

Depth (m)	66.45	67.65	69.17	70.32	71.54	77.43	78.43	79.70	81.00	82.00	83.00	84.00
Rock Type	ABFST											
Anal. no.	8877964	8877965	8877966	8877967	8877968	8877969	8877970	8877971	8877972	8877973	8877974	8877975

SiO2	47.7	54.7	55.6	36.5	39.7	52.8	21	54	31.4	38.8	47.7	56.9
TiO2	1.73	0.774	0.728	0.375	0.44	0.424	0.245	0.833	0.393	0.498	0.511	0.647
Al2O3	11.8	12.3	13.4	7.66	8.39	9.42	5.75	15.2	7.63	9.9	10.2	13.1
Cr2O3	0.0129	0.0307	0.0329	0.0222	0.021	0.0249	0.0138	0.0404	0.0208	0.0197	0.0216	0.0269
V2O3	0.037	0.0416	0.0457	0.017	0.0297	0.0191	0.0197	0.0583	0.0332	0.0455	0.0319	0.0351
FeO	10.94	5.6	8.66	17.83	18.83	12.24	21.8	6.82	8.92	17.67	14.2	7.36
MnO	0.153	0.154	0.0676	0.107	0.0561	0.0391	0.281	0.131	0.515	0.374	0.239	0.147
MgO	2.98	4.75	1.25	4.88	2.83	1.82	7.91	1.92	9.7	3.47	2.32	1.83
CaO	6.87	7.39	2.17	7.58	4.05	2.96	12.2	3.11	14.8	7.15	4.44	3.49
Rb2O	0.0004	0.0021	0.0016	0.0013	0.002	0.001	0.0006	0.0021	0.0002	0.0023	0.0008	0.0009
StrO	0.0042	0.0039	0.0018	0.0027	0.0016	0.0011	0.0029	0.0021	0.0047	0.0036	0.0021	0.0025
BaO	0.005	0.02	0.019	0.008	0.007	0.006	0.007	0.015	0.011	0.01	0.004	0.004
Na2O	2.34	8.06	7.86	4.57	4.99	6.73	3.62	9.16	5.14	6.72	7.49	9.24
K2O	0.194	0.892	1.06	0.495	0.581	0.181	0.179	0.938	0.227	0.661	0.142	0.348
ZrO2	0.0233	0.0129	0.0159	0.0087	0.0079	0.0092	0.0024	0.0162	0.006	0.0109	0.0117	0.0152
P2O5	0.222	0.072	0.079	0.035	0.11	0.046	0.113	0.039	0.075	0.019	0.069	0.058
CO2	8.836	10.256	3.06	11	5.977	4.4	16.976	4.547	22.073	9.313	6.893	4.73
OnSua	98.7	99.2	99.1	97.7	97.9	98.7	95.8	99.3	91	92	98.4	99.2
Cu	0.0799	0.0183	2.64	5.93	7.15	4.76	8.05	2.74	2.72	4.11	3.14	2.05
Ni	0.0309	0.0191	0.0275	0.056	0.0703	0.0375	0.0889	0.0195	0.0184	0.0409	0.0391	0.0149
Co	0.0572	0.02	0.0329	0.0569	0.0683	0.0499	0.0673	0.0188	0.0234	0.0537	0.0534	0.0199
Zn	0.0002	0	0.0027	0.0021	0.01	0.0028	0.0032	0.0016	0.0011	0.0015	0.0013	0.0005
Pb	0.001	0.001	0.001	0.002	0.003	0.001	0.003	0.001	0	0.002	0.001	0.002
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	7.96	1.88	7.04	13.5	14.2	9.32	15	4.5	5.14	9.54	10.2	4.24
As	0.0046	0.003	0.0034	0.0116	0.0028	0.0021	0	0.0007	0.0008	0.0012	0.0007	0.0002
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0	0	0
Te	0	0	0	0	0	0	0	0	0	0	0	0
Y	0.0019	0.0017	0.0019	0.0009	0.0011	0.0005	0.0017	0.0022	0.0015	0.001	0.0014	0.0012
Nb	0.0021	0.0013	0.0012	0.0013	0.0007	0.0009	0.0009	0.0012	0.0007	0.0014	0.001	0.0013
Mo	0.0003	0.001	0.0005	0.001	0.0011	0.0008	0.0028	0.0028	0.0015	0.0053	0.0025	0.0024
Sn	0.001	0.001	0	0	0.001	0.001	0	0	0.002	0.001	0.001	0.001
H	0	0.001	0.001	0	0.001	0.001	0.001	0.001	0.001	0	0	0
Cl	0.021	0.017	0.008	0.015	0.01	0.013	0.012	0.006	0.008	0.035	0.012	0.017
Th	0.0005	0.0003	0.0007	0	0.0012	0.0004	0.0004	0	0	0.0002	0.0008	0.0005
U	0.0013	0.0011	0.0017	0.0016	0.0025	0.0013	0.0031	0.0015	0.0013	0.0014	0.0022	0.0021
Cs	0.003	0	0.003	0.002	0	0.001	0.005	0.004	0.003	0.001	0	0.003
La	0.003	0.001	0.003	0.002	0.001	0.003	0.002	0.005	0.002	0.005	0.001	0.005
Ce	0.006	0.006	0.004	0.001	0.003	0.004	0.001	0.006	0.002	0.006	0.004	0.005
Ta	0	0.001	0.002	0.005	0.003	0.005	0.007	0.002	0.002	0.003	0.002	0
Au	0.19	0.18	0.19	2.82	1.66	11	7.36	0.53	0.71	1.43	0.92	1.27

C-2, S1281

Depth (m)	85.00	86.00	87.00	88.00	89.00	91.00	93.00	95.00	97.00	99.00	101.00	103.00
RockType	ABFST											
Anal.no.	8877976	8877977	8877978	8877979	8877980	8877981	8877982	8877983	8877984	8877985	8877986	8877987
SiO2	54.5	60.2	54.1	37.1	20.4	30.1	54.6	60.3	57.2	45.2	40.4	42.1
TiO2	0.71	0.73	0.54	0.401	0.235	0.313	0.528	0.553	0.539	0.403	0.376	0.372
Al2O3	13.6	14.1	12.2	9.31	5.18	8.04	13.9	14	13.4	10.1	8.05	7.5
Cr2O3	0.0283	0.0306	0.0225	0.0201	0.0278	0.0167	0.0267	0.0247	0.0255	0.0201	0.0199	0.0172
V2O3	0.0407	0.0515	0.0612	0.0301	0.0137	0.0179	0.0441	0.0357	0.0261	0.0201	0.0194	0.0229
FeO	6.34	6.42	11.13	25.24	22.35	18.84	12.3	8.77	10.39	21.23	23.44	21.24
MnO	0.239	0.0856	0.111	0.082	0.26	0.209	0.0331	0.0202	0.0685	0.0365	0.0908	0.12
MgO	3.09	1.17	1.61	1.61	9.1	7.21	0.47	0.13	0.72	0.61	2.43	3.42
CaO	6.12	2.26	2.58	3.04	13.8	10.9	1.06	0.497	1.51	1.12	3.64	5.35
Rb2O	0.0015	0.0007	0.0011	0.0004	0.0005	0.001	0.0003	0.0005	0.0001	0.0002	0.0006	0.0004
SrO	0.0038	0.0017	0.0019	0.0013	0.0028	0.0034	0.0013	0.0008	0.0009	0.001	0.0011	0.0018
BaO	0.009	0.003	0.013	0.005	0.002	0.004	0.002	0.001	0.003	0.002	0.002	0.002
Na2O	9.5	9.99	8.44	6.76	3.84	5.94	10.4	10.5	9.92	7.86	6.51	6
K2O	0.444	0.168	0.384	0.23	0.048	0.08	0.081	0.072	0.051	0.043	0.064	0.063
ZrO2	0.0162	0.0164	0.0135	0.0085	0.0045	0.0073	0.0133	0.0137	0.0126	0.0092	0.0081	0.008
P2O5	0.054	0.058	0.095	0.114	0.047	0.057	0.052	0.059	0.09	0.062	0.054	0.072
CO2	8.396	3.153	4.29	4.07	20.129	16.756	1.467	0.733	2.237	1.797	5.207	8.56
OxSum	99.2	99.3	98.8	97.2	90.1	93.7	98.7	99.1	98.9	97.7	97.4	97.7
Cu	0.753	0.707	1.22	0.856	0.0436	0.0328	0.0225	0.0447	0.0478	0.209	0.128	0.0829
Ni	0.0099	0.0051	0.0359	0.0641	0.0967	0.0649	0.0227	0.0253	0.0313	0.0718	0.0882	0.0809
Co	0.0207	0.0254	0.0517	0.139	0.152	0.0963	0.0564	0.0589	0.0609	0.13	0.191	0.158
Zn	0.0003	0	0.0004	0.0003	0	0	0	0	0	0	0	0
Pb	0.001	0.001	0.001	0.002	0.003	0.001	0.001	0.001	0	0.001	0.001	0.002
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	2.38	4.46	8.49	21.6	17.8	14.2	9.16	7.51	8.31	19.7	20.6	17.2
As	0.0006	0.0007	0.0012	0.0046	0.0084	0.0046	0.0027	0.0019	0.0028	0.0065	0.0079	0.0061
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0	0.001	0
Te	0	0	0	0	0	0	0	0	0	0	0	0
Y	0.0019	0.001	0.0006	0.0007	0.0006	0.0007	0.0006	0.0011	0.001	0.0007	0.001	0.0009
Nb	0.0012	0.0014	0.0011	0.0011	0.0012	0.001	0.0009	0.0011	0.0011	0.0012	0.0011	0.001
Mo	0.0017	0.0014	0.0004	0.0011	0.0005	0	0	0.0011	0.001	0.0007	0.0013	0.0008
Sn	0.001	0.001	0.001	0	0.001	0	0.001	0.001	0.001	0.001	0	0.001
H	0	0.001	0	0.001	0	0.001	0	0	0.001	0	0.001	0
Cl	0.017	0.004	0.012	0.02	0.013	0.013	0.005	0.004	0.003	0.011	0.015	0.015
Th	0.0009	0.0001	0.0003	0.0005	0.0007	0.0004	0.0009	0.0007	0.0004	0.0015	0	0.0004
U	0.0011	0.0014	0.0015	0.0018	0.0013	0.0014	0.0012	0.0014	0.0011	0.0012	0.002	0.0007
Cs	0.004	0.002	0.004	0.004	0.004	0.003	0.002	0.001	0.002	0	0.006	0.001
La	0.006	0.004	0.003	0.004	0.004	0.001	0.003	0.005	0.005	0.001	0.005	0
Ce	0.008	0.007	0.005	0.007	0.003	0.002	0.008	0.008	0.01	0.006	0.003	0.001
Ta	0	0.001	0	0.001	0.001	0	0	0.001	0.001	0.001	0.002	0
Au	0.3	0.54	0.45	0.97	0.2	0.08	0.06	0.06	0.09	0.18	0.21	0.14

C-2, S1281

Depth (m)	105.00	107.00	109.00	111.00	113.00	115.00	117.00	118.00	120.00	121.40
RockType	ABFST	GRFFST	ML							
Anal.no.	8877988	8877989	8877990	8877991	8877992	8877993	8877994	8877995	8877996	8877997
SiO2	52	49.4	49.5	48.5	38.9	52.7	63	59.8	48.7	59.3
TiO2	0.453	0.438	0.407	0.444	0.335	0.401	0.514	0.526	0.436	0.555
Al2O3	10.8	10.8	10.1	11.1	8.28	11.4	15	14.8	10.7	13.6
Cr2O3	0.0211	0.02	0.0172	0.0197	0.0182	0.0241	0.026	0.0236	0.0207	0.0274
V2O3	0.0219	0.0283	0.0166	0.0193	0.014	0.0236	0.0191	0.0176	0.0272	0.0256
FeO	14.85	14.96	15.89	15.71	21.88	14.25	5.15	4.68	13.04	7.54
MnO	0.0702	0.116	0.102	0.0903	0.132	0.0427	0.0194	0.0462	0.0864	0.0117
MgO	1.49	2.79	2.26	1.84	3.09	0.71	0.75	1.95	3.25	0.37
CaO	2.82	4.3	3.71	3.29	6.23	2.05	1.45	3.72	6.38	0.778
Rb2O	0.0005	0.0004	0.0001	0.0005	0.0005	0.0003	0.0005	0.0006	0.0007	0.0003
SrO	0.0014	0.002	0.0015	0.0015	0.0025	0.0023	0.0055	0.006	0.0044	0.0025
BaO	0.004	0.002	0.002	0	0.001	0.005	0.005	0.002	0.004	0.002
Na2O	8.53	8.42	7.87	8.73	6.39	8.68	10.6	10.5	6.35	7.81
K2O	0.065	0.081	0.049	0.064	0.04	0.12	0.168	0.136	0.207	0.117
ZrO2	0.0104	0.0104	0.009	0.0095	0.0073	0.0089	0.0109	0.0118	0.0099	0.0108
P2O5	0.056	0.063	0.049	0.051	0.049	0.059	0.051	0.05	0.049	0.055
CO2	3.887	6.746	5.977	4.767	8.47	2.347	1.907	5.83	10.78	11.256
OxSum	98.4	98.4	98.3	98.3	97.6	98.5	99.5	99.6	98.6	99.3
Cu	0.206	0.45	0.153	0.166	0.102	0.653	0.056	0.0575	0.931	0.472
Ni	0.0582	0.043	0.0624	0.052	0.0924	0.0557	0.0187	0.0167	0.0443	0.0386
Co	0.0873	0.0786	0.0895	0.0874	0.132	0.0749	0.0298	0.0175	0.0412	0.0329
Zn	0	0.0019	0	0	0.0177	0.0594	0.0033	0.0085	0.468	0.201
Pb	0.001	0.002	0.001	0.001	0.011	0.031	0.002	0.009	0.16	0.066
Ag	0	0	0	0	0	0	0	0	0	0
S	11.4	8.8	12.5	13.4	18.9	12.5	4.06	3.09	8.49	6.02
As	0.0036	0.0019	0.0039	0.0046	0.0067	0.0063	0.004	0.0037	0.0042	0.0037
Sb	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0.001	0	0	0	0	0.001	0
Te	0	0	0	0	0	0	0	0	0	0
Y	0.0004	0.0009	0.0008	0.0005	0.0008	0.001	0.0005	0.0007	0.0013	0.001
Nb	0.0013	0.001	0.0006	0.0013	0.0009	0.0009	0.001	0.0012	0.0034	0.0012
Mo	0.0005	0.0009	0	0.0014	0.0007	0.0008	0.0001	0.0004	0.0021	0.0002
Sn	0	0	0.001	0.002	0	0	0.001	0.001	0.001	0.002
W	0	0	0	0.001	0	0.001	0	0.001	0.001	0.001
Cl	0.014	0.011	0.014	0.016	0.018	0.008	0.006	0.006	0.013	0.008
Th	0.0009	0.0006	0	0	0	0.0006	0.0007	0.0002	0	0.0004
U	0.0013	0.0013	0.001	0.0014	0.0012	0.0018	0.0011	0.0012	0.0016	0.0016
Cs	0.003	0	0.001	0.004	0.004	0.002	0.004	0.004	0.001	0.002
La	0	0.002	0.002	0.003	0.001	0.003	0.002	0.002	0.005	0.004
Ce	0.004	0.003	0.003	0.002	0.006	0.007	0.003	0.008	0.004	0.004
Ta	0	0	0	0	0	0.001	0.001	0	0	0
Au	0.2	0.14	0.06	0.2	0.16	0.38	0.25	0.22	0.5	0.48

Bidjovagge ore types / correlation matrix

C2-ORE / CORRELATION COEFFICIENTS

	SiO2	TiO2	Al2O3	Cr2O3	V2O3	FeO	MnO	MgO	CaO	Rb2O	SrO	BaO	Na2O	K2O	ZrO2	P2O5	CO2	Cu	Ni	Co	Zn	Pb	S	As	Au	Y	Mo	Cl	Th	U	Cs	La	Ce			
SiO2	1.00																																			
TiO2	0.50	1.00																																		
Al2O3	0.92	0.45	1.00																																	
Cr2O3	0.45	0.12	0.51	1.00																																
V2O3	0.08	0.61	0.27	0.15	1.00																															
FeO	-0.73	-0.48	-0.77	-0.44	0.01	1.00																														
MnO	-0.65	-0.06	-0.55	-0.34	0.28	0.41	1.00																													
MgO	-0.53	-0.03	-0.47	-0.37	-0.05	0.13	0.71	1.00																												
CaO	-0.69	-0.11	-0.63	-0.45	0.09	0.37	0.88	0.89	1.00																											
Rb2O	0.19	0.35	0.27	0.22	0.15	-0.44	0.02	0.43	0.16	1.00																										
SrO	0.03	0.22	0.14	-0.12	-0.08	-0.46	0.21	0.59	0.44	0.50	1.00																									
BaO	0.03	0.35	0.15	0.22	0.30	-0.31	0.17	0.41	0.22	0.63	0.43	1.00																								
Na2O	0.69	0.40	0.71	0.34	0.27	-0.32	-0.38	-0.67	-0.57	-0.29	-0.17	-0.30	1.00																							
K2O	0.26	0.50	0.38	0.27	0.30	-0.54	0.03	0.40	0.13	0.87	0.55	0.81	-0.22	1.00																						
ZrO2	0.84	0.73	0.86	0.42	0.30	-0.64	-0.35	-0.32	-0.46	0.31	0.10	0.19	0.61	0.39	1.00																					
P2O5	-0.01	0.42	0.02	-0.42	0.18	-0.07	0.05	0.13	0.09	-0.04	0.06	0.16	-0.03	0.11	0.07	1.00																				
CO2	-0.67	-0.19	-0.63	-0.31	0.13	0.48	0.70	0.54	0.79	-0.14	0.16	0.03	-0.40	-0.14	-0.50	-0.01	1.00																			
Cu	-0.29	-0.27	-0.29	0.16	0.13	0.38	0.23	-0.01	0.09	-0.07	-0.22	0.21	-0.18	0.04	-0.23	-0.25	0.26	1.00																		
Ni	-0.63	-0.62	-0.71	-0.30	-0.21	0.88	0.19	-0.02	0.19	-0.51	-0.49	-0.36	-0.29	-0.60	-0.64	-0.19	0.43	0.40	1.00																	
Co	-0.55	-0.58	-0.67	-0.34	-0.15	0.86	0.19	-0.18	0.11	-0.66	-0.61	-0.56	-0.12	-0.79	-0.54	-0.11	0.35	0.26	0.89	1.00																
Zn	-0.05	-0.16	-0.05	0.12	-0.06	0.10	-0.16	-0.10	-0.04	-0.04	0.13	0.10	-0.08	0.03	-0.18	-0.22	0.19	0.53	0.26	0.03	1.00															
Pb	-0.14	-0.30	-0.17	0.03	-0.18	0.25	-0.17	-0.11	-0.02	-0.10	0.07	-0.12	-0.12	-0.16	-0.19	-0.28	0.21	0.36	0.40	0.27	0.77	1.00														
S	-0.58	-0.51	-0.63	-0.24	-0.02	0.88	0.23	-0.16	0.15	-0.62	-0.60	-0.43	-0.13	-0.68	-0.54	-0.19	0.45	0.44	0.91	0.92	0.18	0.30	1.00													
As	-0.15	-0.23	-0.26	-0.12	-0.22	0.45	-0.15	-0.13	0.03	-0.38	-0.24	-0.38	0.03	-0.46	-0.14	-0.16	0.21	-0.20	0.54	0.58	0.04	0.22	0.53	1.00												
Au	-0.35	-0.27	-0.39	0.04	0.06	0.32	0.22	0.06	0.20	-0.02	-0.15	0.14	-0.27	0.03	-0.37	-0.20	0.36	0.81	0.33	0.21	0.47	0.27	0.39	-0.21	1.00											
Y	0.08	0.50	0.20	-0.01	0.36	-0.37	0.25	0.40	0.27	0.52	0.47	0.54	-0.21	0.67	0.24	0.35	0.07	-0.10	-0.50	-0.57	-0.03	-0.16	-0.52	-0.43	-0.16	1.00										
Mo	-0.26	-0.18	-0.25	0.18	0.17	0.36	0.37	-0.06	0.11	-0.14	-0.32	-0.05	-0.01	-0.12	-0.17	-0.30	0.23	0.71	0.35	0.28	0.29	0.17	0.43	-0.18	0.63	-0.07	1.00									
Cl	-0.06	0.29	-0.04	-0.34	-0.02	-0.08	0.27	0.60	0.41	0.54	0.53	0.38	-0.31	0.50	0.05	0.29	0.11	-0.27	-0.30	-0.37	-0.26	-0.23	-0.42	-0.15	-0.22	0.43	-0.30	1.00								
Th	0.12	-0.19	0.05	0.10	-0.13	-0.05	-0.33	-0.36	-0.37	-0.09	-0.17	-0.02	0.08	-0.12	0.06	0.09	-0.32	0.02	0.09	0.16	-0.08	0.05	0.03	-0.05	-0.01	-0.16	-0.12	-0.23	1.00							
U	-0.32	-0.34	-0.29	0.16	0.07	0.46	0.09	-0.22	-0.04	-0.26	-0.43	-0.12	-0.08	-0.25	-0.32	-0.19	0.26	0.72	0.59	0.46	0.44	0.36	0.64	0.00	0.66	-0.26	0.63	-0.53	0.13	1.00						
Cs	-0.15	0.01	-0.06	-0.06	0.03	-0.01	0.13	0.03	0.16	-0.09	0.12	-0.09	0.03	-0.08	-0.11	0.06	0.24	-0.09	-0.06	0.04	-0.08	-0.05	0.07	0.03	0.01	-0.02	-0.15	0.10	-0.31	-0.02	1.00					
La	0.32	0.20	0.40	0.33	0.02	-0.48	-0.25	-0.23	-0.30	0.17	0.07	0.01	0.17	0.26	0.33	-0.05	-0.32	-0.12	-0.45	-0.39	0.02	-0.14	-0.37	-0.28	-0.02	0.24	-0.03	-0.03	-0.10	0.01	0.21	1.00				
Ce	0.62	0.30	0.63	0.35	0.08	-0.57	-0.44	-0.48	-0.55	0.07	-0.06	-0.05	0.46	0.10	0.56	-0.03	-0.57	-0.38	-0.47	-0.33	-0.15	-0.22	-0.39	-0.13	-0.29	0.08	-0.16	-0.14	0.27	-0.17	-0.04	0.59	1.00			

APPENDIX 1c

APPENDIX 1d.

Bidriwagge ore types / factor analysis

CB-ORE / ROTATED FACTOR MATRIX

	F1	F2	F3	F4	F5	F6	F7	F8	F9
SiO2		-0.702						-0.430	
TiO2				-0.782					
Al2O3		-0.623		-0.515				-0.469	
Cr2O3		-0.448					0.522		
V2O3				-0.819					
FeO								-0.734	
MnO		0.913							
MgO	0.440	0.800							
CaO		0.945							
Rb2O	0.852								
SrO								-0.575	
BaO	0.832								
Na2O	-0.473	-0.497		-0.570					
K2O	0.888								
ZrO2		-0.465		-0.527					
P2O5								-0.620	
CO2		0.787							
Cu			-0.887						
Ni								0.752	
Co	-0.530							0.747	
Zn						0.868			
Pb						0.875			
S	-0.438							0.761	
As			0.428					0.712	
Au			-0.843						
Y	0.530								
Mo			-0.791						
Cl	0.537								
Th					-0.654				
U			-0.774						
Cs					0.849				
La								0.781	
Ce								0.641	

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. APPENDIX 1f, . Normative mineral composition.

C-2, S1281

Depth (m)	24.00	26.00	28.00	30.00	51.00	53.00	55.00	57.00	59.40	61.00	63.00	65.00
RockType	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST	MOB	MOB	MO/ABFST	ABFST	ABFST	ABFST
Anal.no.	8877952	8877953	8877954	8877955	8877956	8877957	8877958	8877959	8877960	8877961	8877962	8877963
ab	61.2	60.9	59.4	29.3	59.5	38.5	44.3	54.6	55.9	65.5	74.9	83.0
qtz	12.3	8.3	12.3	28.5	3.7	0.0	0.0	0.0	0.0	1.7	5.9	10.5
ru	0.3	0.3	0.4	0.4	0.3	0.2	0.7	1.0	0.6	0.2	0.3	0.3
sf	10.2	10.5	12.1	2.2	4.8	11.6	19.7	24.6	14.9	8.7	0.2	0.6
phl	5.8	7.0	11.0	35.8	1.1	1.5	4.3	10.0	9.0	9.0	0.8	0.8
chl	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	3.0	2.4	0.3	0.9	0.2	0.6	1.5	6.5	4.0	1.3	0.2	0.3
apa	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.1	0.2
dol	6.2	5.9	0.4	3.7	13.6	34.0	33.9	5.5	20.7	6.0	10.4	1.9
cp	0.1	0.8	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
py	1.2	1.6	0.2	0.3	19.3	13.6	4.3	0.8	1.5	0.9	5.0	5.3
po	0.0	3.1	0.6	2.0	2.7	6.1	1.9	1.7	3.2	10.9	5.6	0.0
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.5	100.9	100.0	103.5	105.4	106.4	111.2	105.1	110.1	104.4	103.5	102.7
py/(py+po)	1.00	0.34	0.28	0.12	0.88	0.69	0.69	0.33	0.33	0.08	0.47	1.00

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. APPENDIX 1f/2. Normative mineral composition.

C-2, S1281

Depth (m)	66.45	67.85	69.17	70.32	71.54	77.43	78.43	79.70	81.00	82.00	83.00	84.00
RockType	ABFST											
Anal.no.	8877964	8877965	8877966	8877967	8877968	8877969	8877970	8877971	8877972	8877973	8877974	8877975
ab	61.6	61.9	63.1	33.0	37.9	53.2	26.0	73.2	37.4	49.7	56.9	73.7
qtz	0.0	1.1	4.7	4.5	6.4	10.4	0.0	0.0	0.0	0.0	2.8	0.3
ru	1.0	0.5	0.5	0.2	0.3	0.3	0.1	0.5	0.2	0.3	0.3	0.4
af	6.2	5.1	0.6	3.3	0.5	0.4	7.8	1.1	4.2	7.7	0.0	2.6
phi	1.5	7.3	9.0	3.3	4.7	1.5	1.3	7.9	1.8	5.3	1.1	2.9
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.6	0.5	0.3	0.4	0.3	0.4	0.3	0.2	0.2	1.1	0.4	0.5
apa	0.4	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.0	0.1	0.1
dol	18.7	22.5	7.0	22.7	12.9	9.9	33.6	10.3	45.8	20.0	14.8	10.7
cp	0.2	0.1	8.3	17.0	21.4	14.5	22.0	8.6	7.8	12.2	9.4	6.4
py	11.1	1.4	4.0	4.9	4.5	4.6	2.6	1.2	2.1	5.2	7.2	2.3
po	6.0	3.8	8.3	14.7	14.7	7.7	15.1	3.8	4.0	8.9	11.2	3.7
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	109.3	104.2	105.8	104.7	105.8	103.3	109.1	106.8	103.6	110.4	104.3	103.8
py/(py+po)	0.52	0.26	0.32	0.25	0.23	0.38	0.15	0.23	0.35	0.37	0.39	0.38

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Laaberg. APPENDIX 1f/3. Normative mineral composition.

C-2, S1281

Depth (m)	85.00	86.00	87.00	88.00	89.00	91.00	93.00	95.00	97.00	99.00	101.00	103.00
Rock type	ABFST											
Anal.no.	8877976	8877977	8877978	8877979	8877980	8877981	8877982	8877983	8877984	8877985	8877986	8877987
ab	73.8	80.5	65.7	47.7	25.3	40.9	81.7	84.0	77.9	57.2	45.8	42.4
qtz	0.0	0.8	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.1
ru	0.4	0.5	0.3	0.2	0.1	0.2	0.3	0.3	0.3	0.3	0.2	0.3
af	4.7	1.2	0.6	1.6	5.4	0.7	0.3	0.0	0.0	0.0	1.4	0.0
phl	3.7	1.4	3.2	1.7	0.3	0.6	0.7	0.6	0.4	0.3	0.5	0.5
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.5	0.1	0.4	0.6	0.5	0.4	0.2	0.1	0.5	0.3	0.4	0.4
apa	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.1
dol	16.6	7.2	9.5	8.2	38.5	32.8	3.3	1.7	5.0	3.7	10.4	17.3
cp	2.3	2.2	3.7	2.4	0.1	0.1	0.1	0.1	0.1	0.6	0.4	0.2
py	2.7	8.8	8.1	32.7	19.0	14.5	14.4	14.2	12.9	28.2	32.1	24.3
po	1.3	0.0	11.2	13.6	21.3	18.7	8.6	4.2	8.0	20.2	13.4	14.8
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	105.1	102.6	105.3	108.6	110.7	108.9	109.6	105.3	105.1	105.9	105.9	105.3
py/(py+po)	0.56	1.00	0.42	0.71	0.47	0.44	0.63	0.77	0.62	0.56	0.71	0.62

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. APPENDIX 1f/4. Normative mineral composition.

C-2, S1291

Depth (m)	105.00	107.00	109.00	111.00	113.00	115.00	117.00	118.00	120.00	121.40
RockType	ABFST	GRFFST	ML							
Anal.no.	8877988	8877989	8877990	8877991	8877992	8877993	8877994	8877995	8877996	8877997
ab	64.9	64.2	58.4	64.4	44.0	66.3	85.9	82.6	47.4	72.6
qtz	0.9	0.1	2.7	0.0	0.0	0.0	0.0	0.0	8.5	0.0
ru	0.3	0.3	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3
af	1.6	0.0	0.0	1.0	4.6	3.2	1.1	0.0	0.0	4.7
phi	0.5	0.7	0.4	0.5	0.3	1.0	1.4	1.1	1.6	0.9
chi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.4	0.3	0.4	0.5	0.5	0.2	0.2	0.2	0.4	0.2
apa	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
dol	8.4	14.5	12.6	10.0	16.7	5.1	4.4	12.9	22.8	0.0
cp	0.6	1.3	0.4	0.5	0.3	2.0	0.2	0.2	2.7	1.4
py	12.8	11.9	13.0	16.7	18.5	11.9	5.2	2.2	4.4	2.8
po	16.1	8.9	16.3	15.8	26.2	19.3	5.7	6.3	16.0	12.2
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8
Total	106.6	102.3	106.7	109.6	111.4	109.3	104.6	106.0	104.2	95.2
py/(py+po)	0.44	0.57	0.42	0.51	0.41	0.38	0.48	0.26	0.22	0.19

OUTOKUMPU OY

Kunta: KAUKOKIEMO

Leikkaus n:o

Esiintymä: B1DJO

Suunta:

Sijainti: C (UT7)

Kaltevuus:

Kairattu aikana: 4/90

Geologi: DAL

Lisätietoja:

X = -1440

81440
87,68
44,5

Reikä n:o

Koordinaatit X:

S144F ¹²
-1440,01
805,88
-554,7

KAIRAUSRAPORTTI

Kaltevuusmittaukset	0 ¹⁶ m ¹⁷ 44,5°	10 ²⁴ m ²⁵ 44,3°	20 ³² m ³³ 43,9°	30 ⁴⁰ m ⁴¹ 43,6°	40 ⁴⁸ m ⁴⁹ 43,0°	50 ⁵⁶ m ⁵⁷ 42,8°	60 ⁶⁴ m ⁶⁵ 42,8°	70 ⁷² m ⁷³ 42,7°
	80 m 42,7°	90 m 42,6°	100 m 42,4°	110 m 42,4°	120 m 42,4°	130 m 42,4°	140 m 42,2°	m °

Syvyys m	Kivilaji-lyhennys	Kivilajiseloste	Analyysit													
			Katkosluu	Säily	Pituus	Cu	Am	Cu+Am	S ₁	S ₂	S ₃	S ₄	N:O			
25,0	MDB	HIEMAN ALBITTUTUUN, SK-PIROTETTA	8	70												
33,0	ARBST/MDB	ALBITTUTUUNIN RYHMÄÄN PÄÄ, YLÄISSÄ PAIKOIN GRF -PIKINTA RAITOJA JÄÄNTEITÄ MORAUSTA VÄHÄN SK-PAIKOIN VÄHÄISESTI Cuk	6-10													
55,70	ML	ALB-RAIDOISSA SK+MAKKE. ALBITTUTUUNIT JONKIN VER-	6													
58,4	ARBST/MDB	PÄÄ, MDB:N JÄÄNTEITÄ														
59,8	ML															
59,65	ARBST/MDB															
60,70	ML															
62,40	ARBST	JONKIN VERÄN Cuk				1,92	0,9									56701
88,10	ML	ALBITTUTUUNIN, JOISSA MUUTAMISSA Cuk	10													
91,0	ARBST	SIS. GRF KIISSUA VÄHÄN	5-8			0,33	0,9									56702

Reikä n:o

Leikkaus n:o

APPENDIX 2014

S 144 F

Leikkaus n:o 5 1440

(2)

Kivilaji lyhennys	Kivilajiseloste	Analyysit											N:o
		Katkosluo	Sisältö	Puus	Cu	As	Cu+As						
19 20		26	31	36	41	46	51	56	61	66			
940	ABFST	SIS. JONKIN VERRAN SPAT.	5-8	80	0,45	0,1						56703	
960	ABFST	JONKIN VERRAN MAGNK + Cuk		1	0,45	0,3						56704	
990	ABFST	VÄHÄN MAGNK + HYVIN VÄHÄN Cuk		70	0,45	0,3						56705	
1020	ABFST	KOHTI. KPS, VÄHÄN GRAT., VÄHÄN Cuk			0,43	0,3						56706	
1040	ABFST	- II -			0,44	1,8						56707	
		MAGNK ESK VÄHÄNEN JOI- TAIN KU-RIKKAITA KERROK- SIA, PAIKOIN HOBIN MÄKÖIS- TÄKIN (JÄÄNTEITÄ?). Cukin MÄÄRÄ VAIHTUEE VÄLILLÄ VÄHÄNEN - KOHTI. RUNKAS Cuk ES. ENNENK- SITEN PIROOTTIA, MUTTA MYÖS PIELIÄ LÄISKILLÄ JA											
1050	ABFST	KAPPA SUOMIAKIN.			0,84	0,7						56708	
1060	ABFST	- II -			0,95	0,5						56709	
1070	ABFST	- II -			3,33	0,6	3,93					56710	
1080	ABFST	- II -			2,02	0,5						56711	
1090	ABFST	- II -			0,44	0,3						56712	
1100	ABFST	- II -			0,92	0,8			1,37/0,67			56713	
1110	ABFST	- II -			1,23	0,4			15 n			56714	
1120	ABFST	- II -			1,7	0,9						56715	
1130	ABFST	- II -			1,45	1,03						56716	
1140	ABFST	- II -			1,07	1,16						56717	

APPENDIX 2/2.

Kivilaji lyhennys	Kivilajiseloste	Analyysit											N:o
		K	S	P	Ca	Al	Ca+Al						
19 20		26	31	36	41	46	51	56	61	66			
1150	ABFST	- 11 -			0,9	0,53						56718	
1160	ABFST	- 11 -			1,64	0,61						56719	
1170	ABFST	- 11 -			0,92	0,56						56720	
		ERKKELISIN VERRATTUNA LUKIN JA MÄRKIN MÄÄRÄ SUUREMPI. LUKIN RUMSAS- TIKIN. LUK ES. LAISKIMÄ,											
1180	ABFST	RÄMPÖNÄ JA PIROTTENA.	5	80	1	4,80	27,2					56721	
1190	ABFST	- 11 -			1	7,08	1,21					56722	
1200	ABFST	- 11 -			1	4,22	1,32					56723	
1210	ABFST	- 11 -			1	6,54	1,43					56724	
1220	ABFST	- 11 -			1	6,44	2,70					56725	
1230	ABFST	- 11 -			1	4,04	2,38					56726	
1240	ABFST	- 11 -			1	1,56	0,65					56727	
1250	ABFST	- 11 -			1	1,96	0,81					56728	
1260	ABFST	- 11 -			1	2,30	0,75					56729	
1270	ABFST	- 11 -			1	1,78	0,73					56730	
		Luk - PIROTTETA KOMP.											
1280	ABFST	MÄRK. VÄHÄISESTI		50		1,18	0,91					56731	
1290	ABFST	- 11 -				1,76	0,53					56732	
1300	ABFST	- 11 -				1,70	0,76					56733	
		KELI VAIHETTUU SEURASTI RUMSASTI MDR:IN JÄÄNTÖNÄ 6 IS. KIVESTI, JOSSA KISSUA											
1310	ABFST/MDR	ON VÄHÄN.				1,13	0,46					56734	
1340	ABFST/MDR	- 11 -				0,27	0,48					56735	

3,92
4,07 - 1,159
10m

APPENDIX 1973

S144F

Leikkaus n:o

S 1440

(4)

Kivilaji lyhennys	Kivilajiseloste	Analyysit											N:o
		Katkosluu	Sitely	Puus	Cu	As	Cu+As						
		25	31	36	41	45	51	55	61	66			
1360	APST/MDB - 11 -	5-7	50		0,71	0,26					56736		
1410	APST/MDB - 11 -												
1440	APST/MDB KOHTE MAENK. MORIN JÄÄNTEITÄ, PÄIKÖIN VÄHÄN VÄHÄN CUK, JONKIN VÄHÄN MAENK. 142-146 m: KAPPALE ML - KAPPALE	8-10			0,27	0,33					56737		
1520	APST/MDB MAENK. 142-146 m: KAPPALE ML - KAPPALE	8-10											
1540	APST/MDB - 11 -	6-7			0,56	0,53					56738		
1570	APST/MDB - 11 -												
1600	APST/MDB - 11 -				0,80	0,26					56739		
16335	APST/MDB - 11 -												
1647	ML ALBITTIRATTOJA SIS. ENEMMÄN APST/KLO KUN EDellä OLEVA APST/ MDB. MDB. MÄKÖISTÄ (JÄÄNTEITÄ)												
1690	APST/MDB VÄHÄN SK												

APR. 20/4

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Leimberg. Appendix 25/ Chemical composition.

C3, S144F

Depth (m)	82.4	91.0	94.0	96.0	99.0	102.0	104.0	105.0	106.0	107.0	108.0	109.0
RockType	ABFST											
Anal.no.	9056701	9056702	9056703	9056704	9056705	9056706	9056707	9056708	9056709	9056710	9056711	9056712
SiO2	56.7	57.9	65.5	54.6	60.7	22.8	19.1	4.59	5.57	35.5	6.95	2.58
TiO2	0.996	0.912	0.683	0.599	0.676	0.53	0.405	0.0633	0.0793	0.561	0.111	0.0387
Al2O3	16.7	14.4	15.3	13.2	13.9	9.51	7.36	1.46	1.72	9.22	2.15	0.766
Cr2O3	0.0424	0.0249	0.026	0.0213	0.0261	0.0286	0.023	0.0057	0.0057	0.0233	0.0084	0.0043
V2O5	0.0784	0.0413	0.0344	0.032	0.0358	0.0343	0.0231	0.0124	0.0152	0.0377	0.0182	0.0089
FeO	8.05	4.54	2.86	5.62	3.46	7.04	7.95	12.24	12.17	10.95	10.75	8.7
MnO	0.0206	0.142	0.0694	0.255	0.196	0.531	0.39	0.721	0.725	0.363	0.664	0.529
MgO	0.61	2.46	1.06	3.01	2.19	10.7	12.3	13.6	13.3	5.79	13.5	15.7
CaO	1.01	4.91	2.24	6.44	4.89	17.6	18.7	26.4	26.3	11.4	24.5	27.8
Rb2O	0.0016	0.0006	0.0006	0.0004	0.0004	0.0043	0.0037	0.0002	0.0004	0.0003	0.0006	0.0004
SrO	0.0019	0.0028	0.0024	0.0032	0.003	0.0058	0.0041	0.0056	0.0061	0.0038	0.0057	0.0067
BaO	0.008	0.005	0.004	0.004	0.005	0.026	0.012	0.001	0.003	0.003	0.004	0
Na2O	8.95	8.28	9.15	8.02	9.31	2.27	2.26	0.69	0.96	5.62	1.15	0.27
K2O	0.673	0.21	0.2	0.098	0.159	2.07	1.52	0.013	0.008	0.041	0.01	0.002
ZrO2	0.0069	0.0157	0.0162	0.0146	0.0154	0.0036	0.0022	0	0	0.0081	0	0
P2O5	0.145	0.095	0.058	0.053	0.058	0.045	0.085	0.065	0.06	0.064	0.051	0.047
CO2	1.43	6.636	3.777	8.873	6.82	24.969	27.829	39.049	38.829	15.876	37.509	43.082
OxSum	99.1	97.6	99.7	96.2	97.9	21.4	50	72.2	73.9	90.5	74.1	69.5
Cu	1.63	0.319	0.416	0.429	0.428	0.404	0.414	0.922	0.933	3.01	1.83	0.426
Ni	0.0413	0.0218	0.0111	0.019	0.0195	0.0175	0.0221	0.0204	0.0179	0.0158	0.0137	0.0125
Co	0.0152	0.0088	0.0085	0.0082	0.0039	0.0061	0.0072	0.0057	0.0078	0.0112	0.0118	0.013
Zn	0.0098	0.0017	0.0011	0.0005	0.0131	0.0012	0.0002	0.0006	0.0001	0.0017	0.001	0
Pb	0.002	0.002	0.001	0.003	0.011	0.002	0.001	0.001	0.001	0	0.001	0.001
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	5.05	2.66	1.72	2.32	1.53	1.64	2.16	2.4	2.28	5.64	3.33	1.39
As	0.0015	0.0005	0.0005	0.0004	0	0.0003	0.0004	0.0004	0.0002	0.0007	0.0009	0.0011
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0.001	0.014	0.019	0	0	0	0	0
Te												
Y	0.0026	0.0015	0.0023	0.0013	0.0025	0.0023	0.0021	0.0011	0.0011	0.0013	0.0017	0.0012
Nb	0.0006	0.0014	0.0012	0.0011	0.0011	0.0004	0.0006	0.0002	0.0009	0.0012	0.0003	0.0009
Mo	0.0002	0.0025	0.0015	0.0022	0.004	0.0005	0.0003	0	0.0007	0.0044	0.0001	0.0002
Sn	0.004	0.002	0.001	0.001	0.001	0.001	0.001	0	0.001	0.902	0.001	0
H	0	0	0	0	0	0	0	0.001	0	0.001	0.001	0.001
Cl	0.011	0.012	0.007	0.011	0.01	0.053	0.044	0.014	0.017	0.009	0.009	0.009
Th	0	0.0003	0.0002	0.0006	0.0011	0	0.0009	0	0	0	0	0.0002
U	0.0011	0.003	0.0015	0.0019	0.0026	0.0007	0.001	0.0008	0.0009	0.0011	0.0013	0.0003
Cs	0.003	0.003	0.001	0.002	0.002	0.003	0.002	0.004	0.005	0	0.001	0
La	0.003	0.003	0.003	0.004	0.005	0.001	0	0.002	0.003	0.001	0.002	0
Ce	0.004	0.003	0.008	0.007	0.008	0.002	0.004	0.004	0.003	0.006	0	0.001
Ta	0.001	0.001	0	0	0	0	0.001	0.001	0	0.003	0.001	0
Au	0.9	0.2	0.1	0.3	0.3	0.2	1.8	0.7	0.5	0.6	0.5	0.3

CG, S144F

Depth (m)	110.0	111.0	112.0	113.0	114.0	115.0	116.0	117.0	118.0	119.0	120.0	121.0
RockType	ABFST											
Anal.no.	9056713	9056714	9056715	9056716	9056717	9056718	9056719	9056720	9056721	9056722	9056723	9056724
SiO2	9.39	35.2	53.4	53.6	53.9	49.4	30.4	42.2	19.4	45.6	36.1	34.5
TiO2	0.176	0.508	0.587	0.65	0.726	1.31	0.852	1.26	0.535	0.537	0.6	0.553
Al2O3	3.16	9.99	11.3	12	11.5	11.6	7.97	11.7	5.04	9.69	9.71	8.22
Cr2O3	0.0104	0.0231	0.0223	0.0277	0.025	0.0176	0.0124	0.0166	0.011	0.0274	0.0305	0.0299
V2O3	0.0193	0.0415	0.0334	0.0507	0.0449	0.055	0.0463	0.0542	0.0326	0.0471	0.0474	0.0272
FeO	7.91	12.1	14.67	12.15	12.51	7.93	13.37	7.46	19.12	17.63	26.1	25.04
MnO	0.391	0.238	0.103	0.116	0.119	0.24	0.353	0.313	0.689	0.0376	0.112	0.133
MgO	14.6	7.1	1.19	1.57	1.67	5.64	8.1	5.03	9.12	0.37	1.28	1.39
CaO	24	11.1	2.95	3.12	3.22	8.71	13	9.4	15.5	0.759	2.78	3.7
Rb2O	0.0007	0.0034	0.0006	0.0005	0.0005	0.0009	0.0003	0.0012	0.0004	0.001	0.0006	0.0007
StrO	0.0058	0.0043	0.0012	0.0019	0.002	0.0041	0.0047	0.0039	0.006	0.0016	0.0019	0.0016
BaO	0.005	0.015	0.002	0.004	0.002	0.005	0.004	0.008	0.005	0.009	0.004	0.011
Na2O	1.46	4.11	7.17	8.83	8.44	8.03	5.52	7.94	3.66	7.1	7.08	5.99
K2O	0.116	1.37	0.04	0.064	0.051	0.178	0.111	0.29	0.11	0.104	0.221	0.137
ZrO2	0.0006	0.0066	0.0126	0.0169	0.0137	0.0104	0.0064	0.0095	0.0032	0.0102	0.0106	0.0099
P2O5	0.045	0.081	0.055	0.058	0.085	0.131	0.089	0.129	0.053	0.102	0.044	0.049
CO2	26.959	15.656	4.033	4.437	5.353	15.203	23.099	16.426	27.646	0.733	3.52	4.4
OxSum	73.3	90.2	98.3	98.6	98.6	94.4	91.2	93.3	91.1	98.1	97.2	97.3
Cu	0.849	1.16	1.12	1.4	1.02	0.241	1.23	0.777	4.51	7.32	4.33	7.04
Ni	0.0084	0.0335	0.0567	0.041	0.0469	0.0159	0.033	0.0101	0.0363	0.0417	0.0506	0.0388
Co	0.0046	0.0231	0.0411	0.0281	0.0311	0.006	0.0261	0.0121	0.0308	0.0308	0.0704	0.0735
Zn	0.0007	0.0008	0.0011	0.0012	0.0005	0.0005	0.0003	0.0009	0.0025	0.0041	0.0019	0.0045
Pb	0.001	0.002	0.001	0.002	0.002	0.001	0.001	0	0.001	0	0.001	0.002
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	1.65	4.84	8.2	6.52	6.78	2.97	5.66	2.09	9.1	13	13	14.5
As	0.0001	0.0004	0.0005	0.0008	0.0004	0.0006	0.0013	0.0004	0.0003	0.0012	0.0019	0.0015
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0	0	0
Te												
Y	0.0008	0.0014	0.0012	0.001	0.0013	0.0024	0.0023	0.0023	0.0022	0.0006	0.0004	0.0018
Nb	0.0005	0.001	0.0011	0.0017	0.0013	0.0009	0.0009	0.0009	0.0002	0.0013	0.0009	0.0009
Hf	0	0.0007	0.0009	0.0033	0.0022	0	0	0	0	0.0036	0.0026	0.0027
Sn	0	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0	0.001	0
W	0	0	0.001	0	0	0	0	0	0.001	0	0.001	0.001
Cl	0.011	0.039	0.007	0.009	0.01	0.011	0.014	0.015	0.017	0.007	0.017	0.013
Th	0	0.0001	0.0005	0	0	0	0	0	0.0005	0.0015	0.0015	0
U	0.0009	0.0023	0.002	0.0029	0.0026	0.0009	0.0009	0.0004	0.0017	0.0033	0.0026	0.0032
Cs	0.003	0	0.003	0	0	0.002	0.003	0.004	0.003	0.004	0.002	0.003
La	0.003	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.004	0.007	0.003	0.006
Ce	0.001	0.003	0.002	0.002	0.004	0.003	0.002	0.002	0.003	0.005	0.004	0.006
Ta	0.001	0.001	0.001	0.005	0.003	0.004	0.007	0.004	0.018	0.023	0.014	0.023
Au	0.8	0.4	0.9	1.03	1.16	0.53	0.61	0.56	27.2	1.21	1.32	1.43

C3, S144F

Depth (m)	122.0	123.0	124.0	125.0	126.0	127.0	128.0	129.0	130.0	131.0	134.0	136.0
RockType	ABFST	ABFST/MDB	ABFST/MDB	ABFST/MDB								
Anal.no.	9056725	9056726	9056727	9056728	9056729	9056730	9056731	9056732	9056733	9056734	9056735	9056736
SiO2	37.1	39.2	57.7	26	42.3	40.7	42.1	44.1	13.7	41.4	42.3	45.5
TiO2	0.563	0.61	0.994	1.05	2.49	2.38	2.23	2.65	0.776	2.3	2.31	2.48
Al2O3	8.25	9.45	13.3	6.25	11.8	11.6	11.2	12.7	3.91	11.5	11.3	12.4
Cr2O3	0.0249	0.0285	0.0315	0.0076	0.0035	0.0047	0.0035	0.0038	0.003	0.0031	0.0043	0.0038
V2O3	0.0277	0.0462	0.0652	0.0412	0.06	0.057	0.0584	0.0569	0.0232	0.0507	0.0535	0.0526
FeO	24.26	22.31	9.79	16.28	11.29	11.7	11.35	12.45	17.59	9.51	12.22	11.51
MnO	0.114	0.139	0.0829	0.352	0.189	0.213	0.232	0.16	0.515	0.215	0.131	0.0828
MgO	1.4	1.59	0.62	8.35	5.31	5.01	4.74	4.04	11.1	5.52	6.24	5.02
CaO	3.12	3.8	1.65	14	6.76	7.56	8.33	5.52	20	8.81	8.31	6
Rb2O	0.0008	0.0004	0.0001	0.0001	0.0019	0.0012	0.0001	0.0012	0.0002	0.0004	0.0005	0.0016
SrO	0.0015	0.0008	0.0015	0.0052	0.0038	0.0039	0.0045	0.0044	0.0072	0.0048	0.0049	0.0034
BaO	0.009	0.006	0.002	0.005	0.009	0.007	0.002	0.011	0.002	0.003	0.007	0.002
Na2O	5.51	5.95	9.62	4.44	7.9	8.03	7.84	8.46	2.66	7.8	7.15	7.91
K2O	0.038	0.04	0.042	0.05	0.6	0.341	0.033	0.42	0.028	0.068	0.236	0.335
ZrO2	0.0095	0.0104	0.017	0.0132	0.0294	0.0277	0.0252	0.0315	0.0082	0.0306	0.0272	0.034
P2O5	0.041	0.027	0.115	0.148	0.303	0.294	0.281	0.319	0.092	0.324	0.27	0.347
CO2	3.74	4.767	1.87	25.079	12.063	13.273	13.603	9.093	33.219	14.41	9.68	6.233
OxSum	97.3	97.6	99	90.9	97.8	96.6	95.9	98.5	85.7	95.3	97	98.7
Cu	6.44	4.48	1.59	2.05	1.98	1.55	0.883	1.66	1.82	1.09	0.25	0.718
Ni	0.0732	0.0233	0.0166	0.0254	0.0118	0.0141	0.0239	0.0237	0.0468	0.0258	0.052	0.0459
Co	0.0738	0.0964	0.0226	0.0608	0.018	0.0367	0.0329	0.0265	0.0511	0.0249	0.0404	0.0356
Zn	0.0029	0.0015	0.0007	0.0008	0.001	0.0004	0.0003	0.0007	0.0004	0	0	0.0003
Pb	0.004	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0	0.001	0
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	13.8	12.6	4.73	8.51	5.59	6.2	5.09	5.88	7.48	4.82	6.45	6.39
As	0.0077	0.0043	0.001	0.0042	0.0027	0.0055	0.0033	0.0019	0.0017	0.0016	0.002	0.0017
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0	0	0
Te												
Y	0.0023	0.0013	0.0009	0.0026	0.003	0.0028	0.0028	0.0028	0.0013	0.0021	0.0033	0.0033
Nb	0.0014	0.0012	0.0013	0.0013	0.0028	0.0027	0.0024	0.0012	0.0014	0.0029	0.0028	0.0031
Mo	0.0024	0.0029	0.0022	0.0003	0	0	0.0001	0	0.0002	0	0	0
Sn	0	0.002	0.001	0.001	0.001	0	0.001	0.001	0	0.001	0.001	0.001
W	0	0	0	0.001	0.001	0	0.001	0	0.001	0.001	0	0
Cl	0.008	0.007	0.006	0.011	0.016	0.016	0.012	0.016	0.026	0.013	0.162	0.152
Th	0.0012	0.0006	0.0002	0	0	0	0	0	0	0	0	0.0005
U	0.0023	0	0.0032	0.0009	0.0007	0.0006	0.001	0.0014	0.0012	0.0009	0.0002	0.0003
Cs	0.002	0.006	0.005	0.004	0	0.004	0.003	0.005	0.002	0.004	0.002	0.005
La	0.007	0.005	0.003	0.003	0	0.004	0.004	0.002	0.005	0	0.003	0.007
Ce	0.004	0.004	0.003	0.001	0.006	0.007	0.008	0.008	0.001	0.004	0.007	0.007
Ta	0.018	0.014	0.006	0.006	0.007	0.005	0.002	0.005	0.005	0.005	0.001	0.001
Au	2.7	2.38	0.65	0.81	0.75	0.73	0.91	0.53	0.76	0.46	0.48	0.26

C3, S144F

Depth (m)	144.0	154.0	160.0
RockType	ABFST/MDBABFST/MDBABFST/MDB		
Anal.no.	9056737	9056738	9056739

SiO2	26	39.5	9.82
TiO2	1.54	2.08	0.485
Al2O3	7.72	10.5	2.65
Cr2O3	0.0044	0.0032	0.0036
V2O3	0.0365	0.0482	0.0179
FeO	22.78	11.46	21.43
MnO	0.325	0.149	0.463
HgO	6.92	6.1	12.1
CaO	11.2	9.52	20.3
Rb2O	0.0006	0.0007	0.0003
SrO	0.0054	0.0052	0.0046
BaO	0.006	0	0.003
Na2O	5.29	6.74	1.74
K2O	0.213	0.188	0.074
ZrO2	0.0187	0.0261	0.0048
P2O5	0.201	0.266	0.056
CO2	18.883	14.556	34.869
OxSum	93.8	94.2	84.5
Cu	0.295	0.477	0.821
Ni	0.0918	0.0448	0.0821
Co	0.0594	0.0335	0.0534
Zn	0.0002	0.0009	0
Pb	0.001	0.001	0.001
Ag	0	0	0
S	11.6	5.66	9.1
As	0.004	0.0006	0.0012
Sb	0	0	0
Bi	0	0	0
Te			
Y	0.0031	0.0024	0.0025
Nb	0.0023	0.0023	0.0012
Mo	0.0004	0	0
Sn	0	0.001	0
W	0	0.001	0.001
Cl	0.02	0.023	0.028
Th	0	0	0.0005
U	0.0013	0.001	0.0009
Cs	0.007	0.005	0
La	0.004	0.003	0.003
Ce	0.006	0.006	0.002
Ta	0.002	0.002	0.002
Au	0.33	0.53	0.26

Bidjovagge ore types / correlation matrix

C3-ORE / CORRELATION COEFFICIENTS

	SiO2	TiO2	Al2O3	Cr2O3	V2O3	FeO	MnO	MgO	CaO	Rb2O	SrO	BaO	Na2O	K2O	ZrO2	P2O5	CO2	Cu	Ni	Co	Zn	Pb	S	As	Au	Y	Mo	Cl	Th	U	Cs	La	Ce	Ta				
SiO2	1.00																																					
TiO2	0.79	1.00																																				
Al2O3	0.98	0.82	1.00																																			
Cr2O3	0.41	-0.16	0.39	1.00																																		
V2O3	0.88	0.87	0.89	0.18	1.00																																	
FeO	-0.18	0.02	-0.22	-0.19	-0.05	1.00																																
MnO	-0.72	-0.46	-0.68	-0.43	-0.64	0.06	1.00																															
MgO	-0.70	-0.29	-0.62	-0.63	-0.52	-0.01	0.90	1.00																														
CaO	-0.75	-0.39	-0.69	-0.56	-0.62	0.01	0.95	0.98	1.00																													
Rb2O	0.16	0.12	0.26	0.21	0.15	-0.16	-0.16	0.00	-0.08	1.00																												
SrO	-0.58	-0.15	-0.50	-0.68	-0.38	-0.15	0.75	0.89	0.85	-0.03	1.00																											
BaO	0.36	0.26	0.42	0.40	0.33	0.03	-0.12	-0.18	-0.21	0.46	-0.20	1.00																										
Na2O	0.98	0.85	0.96	0.30	0.91	-0.08	-0.69	-0.67	-0.73	0.08	-0.54	0.34	1.00																									
K2O	0.55	0.58	0.66	0.22	0.53	-0.20	-0.30	-0.12	-0.23	0.72	-0.04	0.61	0.50	1.00																								
ZrO2	0.90	0.93	0.88	0.06	0.83	0.02	-0.58	-0.50	-0.57	0.07	-0.38	0.25	0.91	0.53	1.00																							
P2O5	0.33	0.73	0.38	-0.59	0.57	-0.05	-0.22	0.07	-0.06	0.08	0.28	-0.05	0.40	0.33	0.52	1.00																						
CO2	-0.72	-0.35	-0.66	-0.57	-0.58	-0.02	0.94	0.98	0.99	-0.09	0.86	-0.21	-0.68	-0.21	-0.53	-0.03	1.00																					
Cu	0.08	-0.03	0.01	0.25	0.13	0.64	-0.20	-0.38	-0.34	-0.11	-0.44	0.24	0.15	-0.17	0.04	-0.24	-0.35	1.00																				
Ni	0.18	0.25	0.13	-0.05	0.12	0.64	-0.27	-0.24	-0.26	-0.05	-0.24	-0.01	0.21	0.06	0.33	0.06	-0.28	0.17	1.00																			
Co	0.19	0.36	0.12	-0.18	0.24	0.83	-0.26	-0.26	-0.27	-0.22	-0.34	-0.03	0.27	-0.10	0.41	0.15	-0.27	0.51	0.70	1.00																		
Zn	0.43	0.05	0.39	0.67	0.29	-0.07	-0.44	-0.59	-0.56	0.15	-0.52	0.31	0.38	0.23	0.18	-0.32	-0.56	0.48	0.00	-0.04	1.00																	
Pb	0.04	-0.14	0.03	0.27	-0.12	-0.14	-0.00	-0.11	-0.06	-0.03	-0.13	0.10	-0.02	0.05	-0.05	-0.32	-0.04	-0.14	0.07	-0.09	0.27	1.00																
S	0.29	0.38	0.23	-0.03	0.34	0.85	-0.34	-0.38	-0.39	-0.15	-0.42	0.14	0.39	0.00	0.44	0.12	-0.39	0.67	0.73	0.92	0.16	-0.12	1.00															
As	0.18	0.45	0.16	-0.29	0.33	0.56	-0.26	-0.19	-0.23	-0.14	-0.21	0.07	0.27	-0.05	0.40	0.39	-0.22	0.38	0.36	0.75	-0.12	-0.11	0.67	1.00														
Au	-0.01	-0.04	-0.04	0.18	0.06	0.57	0.03	-0.11	-0.09	-0.06	-0.22	0.15	0.04	-0.07	-0.04	-0.21	-0.09	0.66	0.23	0.38	0.30	0.03	0.49	0.13	1.00													
Y	0.20	0.53	0.25	-0.41	0.27	-0.16	0.07	0.28	0.19	0.19	0.33	0.16	0.22	0.36	0.34	0.56	0.23	-0.33	0.06	0.04	-0.15	0.05	-0.03	0.29	-0.16	1.00												
Mo	0.37	-0.15	0.29	0.74	0.05	-0.03	-0.39	-0.66	-0.56	-0.08	-0.69	0.17	0.29	-0.08	0.48	0.11	0.37	0.30	-0.39	0.27	0.06	-0.41	-0.15	-0.01	0.01	-0.16	0.40	-0.42	1.00									
Cl	-0.07	0.26	0.03	-0.38	0.05	0.07	0.17	0.44	0.35	0.41	0.44	0.15	-0.08	0.48	0.11	0.37	0.30	-0.39	0.27	0.06	-0.41	-0.15	-0.01	0.01	-0.16	0.40	-0.42	1.00										
Th	0.16	-0.10	0.10	0.37	-0.09	0.10	-0.26	-0.40	-0.36	0.07	0.48	0.08	0.10	0.03	0.09	-0.38	-0.41	0.21	0.28	0.12	0.29	0.07	0.19	-0.02	0.25	-0.29	0.45	-0.09	1.00									
U	0.28	-0.04	0.23	0.44	0.06	-0.03	-0.25	-0.45	-0.40	-0.06	-0.26	0.15	0.25	0.06	0.13	-0.20	-0.38	0.23	0.23	-0.05	0.45	0.33	0.14	-0.25	0.10	-0.36	0.51	-0.40	0.20	1.00								
Cs	0.13	0.22	0.16	-0.06	0.19	0.04	-0.11	-0.11	-0.10	-0.08	-0.04	0.12	0.18	0.11	0.10	0.22	-0.12	0.01	0.03	0.07	0.10	-0.08	0.06	0.11	0.12	0.12	-0.16	0.06	0.11	-0.11	1.00							
La	0.22	0.12	0.17	0.16	0.15	0.22	-0.27	-0.35	-0.32	-0.27	-0.28	0.11	0.28	-0.05	0.19	-0.13	-0.35	0.24	0.35	0.30	0.36	0.22	0.37	0.10	0.10	-0.06	0.27	-0.04	0.19	0.21	0.40	1.00						
Ce	0.57	0.53	0.57	0.04	0.46	-0.08	-0.44	-0.39	-0.43	0.13	-0.27	0.11	0.56	0.41	0.60	0.37	-0.43	-0.08	0.18	0.10	0.09	0.01	0.17	0.14	-0.03	0.24	0.22	0.16	0.19	0.03	0.15	0.15	1.00					
Ta	0.26	0.37	0.22	0.03	0.40	0.70	-0.23	-0.29	-0.31	-0.12	-0.33	0.20	0.38	0.04	0.37	0.16	-0.29	0.77	0.35	0.68	0.24	-0.25	0.80	0.55	0.64	-0.10	0.01	-0.18	0.07	0.13	0.11	0.16	0.04	1.00				

APPENDIX 2C

APPENDIX 2d.

Bidjovagge ore types / factor analysis

OE-ORE / ROTATED FACTOR MATRIX

	F1	F2	F3	F4	F5	F6	F7	F8
SiO2	0.855	0.435						
TiO2	0.751							
Al2O3	0.870							
Cr2O3		0.743						
V2O3	0.890							
FeO			0.926					
MnO	-0.536	-0.743						
MgO		-0.386						
CaO	-0.486	-0.836						
Rb2O				0.945				
SrO		-0.905						
BaO				0.744				
Na2O	0.889							
K2O	0.546			0.768				
ZrO2	0.915							
P2O5	0.730	-0.405						
CO2	-0.432	-0.862						
Cu			0.796					
Ni			0.549	0.686				
Co			0.630					
Zn		0.551						
Pb						0.862		
S			0.900					
As			0.616					0.553
Au			0.695					
Y	0.457	-0.476						0.441
Mo		0.769						
Cl		-0.471		0.611				
Th		0.559						
U								-0.761
Cs						-0.884		
La						-0.641		
Ce	0.584							
Ta			0.974					

GOUTORUMFU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. Appendix 2a/4. One-ion percentages.

CG, S144F

Depth (m)	144.0	154.0	160.0
RockType	ABFST/MDBABFST	MDBABFST/MDB	ABFST/MDB
Anal.no.	9056737	9056738	9056739

Si	19.03	31.08	6.99
Ti	0.85	1.23	0.26
Al	6.66	9.74	2.22
Cr	0.00	0.00	0.00
V	0.02	0.03	0.01
Fe	13.94	7.54	12.75
Mn	0.20	0.10	0.28
Mg	7.55	7.15	12.83
Ca	8.78	8.03	15.47
Rb	0.00	0.00	0.00
Sr	0.002	0.002	0.002
Ba	0.002	0.000	0.001
Na	7.51	10.28	2.40
K	0.20	0.19	0.07
Zr	0.013	0.020	0.003
P	0.12	0.18	0.03
C	19.87	15.64	33.86
Cu	0.20	0.35	0.55
Ni	0.07	0.04	0.06
Co	0.04	0.03	0.04
Zn	0.00	0.00	0.00
Pb	0.00	0.00	0.00
S	15.91	8.35	12.13
Cl	0.02	0.03	0.03

SUM	100.00	100.00	100.00
-----	--------	--------	--------

CALCULATED

Al2O3/TiO2	5.0	5.0	5.5
Al2O3/Cr2O3	1754.5	3281.3	736.1
TiO2/Cr2O3	350.0	650.0	134.7
ZrO2/TiO2	0.012	0.013	0.010
Co/Ni	0.647	0.748	0.650

CarbInd	62.3	68.8	82.5
cc	24.9	31.5	31.3
+mgs	53.9	66.8	68.9
+sid	100.0	100.0	100.0

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. Appendix 2f/ . Normative mineral composition.

CS, S144F

Depth (m)	82.4	91.0	94.0	96.0	99.0	102.0	104.0	105.0	106.0	107.0	108.0	109.0
Rock Type	ABFST											
Anal.no.	9056701	9056702	9056703	9056704	9056705	9056706	9056707	9056708	9056709	9056710	9056711	9056712
ab	73.6	66.7	75.4	64.4	67.6	15.3	16.3	4.3	6.2	43.4	8.3	1.7
qtz	1.8	5.6	9.8	3.9	8.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ru	0.6	0.6	0.4	0.4	0.4	0.3	0.2	0.0	0.0	0.3	0.1	0.0
af	0.0	3.9	0.0	5.1	3.3	10.8	5.4	9.9	10.1	8.5	3.6	1.9
phl	5.9	1.6	1.7	0.8	1.4	17.5	12.6	0.1	0.1	0.3	0.1	0.0
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.4	0.4	0.2	0.4	0.3	2.0	1.4	0.4	0.5	0.2	0.3	0.3
apa	0.3	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
dol	3.3	15.2	8.8	20.3	15.8	56.6	61.2	34.7	33.7	35.2	20.6	22.7
cp	5.3	1.0	1.3	1.4	1.4	1.2	1.3	2.5	2.8	9.2	5.4	1.3
py	0.0	0.1	0.6	0.1	0.0	0.0	0.0	0.1	0.1	1.0	0.8	0.7
po	10.9	7.3	3.4	5.8	3.5	3.8	5.3	4.5	3.8	6.6	3.3	1.9
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	102.0	102.7	101.8	102.6	102.2	108.4	104.5	106.7	107.6	105.0	102.6	100.6
py/(py+po)	0.00	0.01	0.15	0.02	0.00	0.00	0.00	0.02	0.02	0.13	0.19	0.26

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. Appendix 2f/2. Normative mineral composition.

C3, S144F

Depth (m)	110.0	111.0	112.0	113.0	114.0	115.0	116.0	117.0	118.0	119.0	120.0	121.0
RockType	ABFST											
Anal.no.	9056713	9056714	9056715	9056716	9056717	9056718	9056719	9056720	9056721	9056722	9056723	9056724
ab	10.9	31.3	57.3	70.3	68.7	61.1	39.9	60.9	25.1	57.1	55.4	46.3
qtz	0.0	1.8	8.6	1.0	3.8	0.0	0.0	0.0	0.0	2.8	0.0	0.0
ru	0.1	0.3	0.4	0.4	0.4	0.8	0.5	0.8	0.3	0.3	0.4	0.3
af	2.6	6.7	2.1	1.4	0.0	0.0	0.0	0.0	0.0	1.0	3.2	5.8
phl	0.9	11.5	0.3	0.5	0.4	1.4	0.9	2.4	0.8	0.9	1.8	1.1
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.3	1.2	0.2	0.3	0.3	0.3	0.4	0.5	0.5	0.2	0.5	0.4
apa	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1
dol	80.7	35.1	9.1	10.0	12.0	34.0	47.4	35.7	54.3	1.7	7.9	9.7
cp	2.6	3.6	3.5	4.4	3.2	2.5	4.6	2.3	12.3	23.1	13.4	21.6
py	0.2	1.3	2.9	1.8	1.9	0.0	1.8	1.1	2.1	2.4	9.3	11.2
po	2.2	9.5	18.2	15.4	15.1	6.3	9.4	2.4	9.4	14.4	14.0	7.5
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.5	102.5	102.7	102.6	104.0	105.7	105.1	105.3	104.9	104.0	106.0	104.0
py/(py+po)	0.07	0.12	0.14	0.12	0.11	0.00	0.16	0.32	0.18	0.14	0.40	0.60

GUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg, Appendix 2f/3. Normative mineral composition.

CS, S144F	122.0	123.0	124.0	125.0	126.0	127.0	128.0	129.0	130.0	131.0	134.0	136.0
Depth (m)	122.0	123.0	124.0	125.0	126.0	127.0	128.0	129.0	130.0	131.0	134.0	136.0
RockType	ABFST	ABFST/MDBARFST/MDBARFST/MDB	ABFST/MDBARFST/MDBARFST/MDB	ABFST/MDB								
Anal.no.	9056725	9056726	9056727	9056728	9056729	9056730	9056731	9056732	9056733	9056734	9056735	9056736
ab	43.4	53.8	79.4	31.2	59.3	59.3	59.4	64.7	18.0	58.9	50.1	57.2
qtz	1.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ru	0.3	0.4	0.6	0.6	1.5	1.4	1.2	1.6	0.4	1.4	1.4	1.5
af	4.9	5.1	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	8.3
phl	0.3	0.3	0.4	0.4	4.8	2.7	0.3	3.4	0.2	0.5	1.9	2.8
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.3	0.2	0.2	0.3	0.5	0.5	0.4	0.5	0.7	0.4	5.0	4.7
apa	0.1	0.0	0.2	0.2	0.5	0.5	0.5	0.6	0.1	0.6	0.5	0.6
dol	8.4	10.5	4.4	50.1	25.7	28.0	29.2	19.7	65.5	30.8	20.9	13.7
cp	20.0	13.7	5.1	5.7	5.8	4.5	2.6	5.0	5.0	3.2	0.7	2.2
py	5.1	18.3	3.4	11.1	4.1	9.1	4.3	3.3	3.9	2.3	2.7	2.5
po	15.5	0.0	5.4	2.9	5.0	1.3	6.6	8.1	10.0	7.8	14.8	13.7
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.2	102.3	101.8	102.5	107.3	107.8	104.6	106.9	103.9	105.8	107.5	107.3
py/(py+po)	0.25	1.00	0.39	0.80	0.45	0.88	0.39	0.29	0.28	0.23	0.16	0.16

C3, S144F

Depth (m)	144.0	154.0	160.0
RockType	ABFST/MDB	ABFST/MDB	ABFST/MDB
Anal.no.	9056737	9056738	9056739
ab	37.1	50.8	11.3
qtz	0.0	0.0	0.0
ru	0.8	1.2	0.3
af	0.0	0.0	0.0
phl	1.6	1.5	0.5
chl	0.0	0.0	0.0
sca	0.6	0.7	0.8
apa	0.3	0.5	0.1
del	37.7	31.3	67.7
cp	0.8	1.4	2.2
py	3.1	2.1	2.3
po	26.8	12.5	19.0
gra	0.0	0.0	0.0
Total	108.9	102.0	104.2
py/(py+po)	0.10	0.14	0.11

OUTOKUMPU OY

Kunta: Kaivotekeino
 Esiintymä: Bidjeragge
 Sijainti: C3
 Kairattu aikana: 1/91
 Geologi: ME

Leikkaus n:o x = -1540
 Suunta: 300g
 Kaltevuus: 58.9

Reikä n:o S154B
 Koordinaatit X: -1540.4
 Y: 957.3
 Z: 483.3

KAIRAUSRAPORTTI

Lisätietoja: _____

Kaltevuus- mittaukset	0 ¹⁶ _m 58.9°	10 ²⁴ _m 58.6°	20 ³² _m 58.9°	30 ⁴⁰ _m 57.1°	40 ⁴⁸ _m 57.1°	50 ⁵⁶ _m 58.3°	60 ⁶⁴ _m 58.7°	70 ⁷² _m 58.5°
	80 _m 58.1°	90 _m 58.1°						

Syvyys m	Kivilaji- lyhennys	Kivilajiseloste	Analyysit								N:o			
			KATKOSL	SÄTEILY	PITUUS	Cu	Au	Cu+Au						
0-11 ¹⁹ ₂₀	mlb		6											
17	mlb	alb runsaasti												
24 ⁴	mlb													
26.6	leuceb													
35.5	mlb													
38.8	mlb	alb kiht												
47	mlb	bt täpliä												
70.0	mlb	paikoin alb												
72.0	mlb	alb ss+Fe ₂ sat Cu ₂				0.13	0.36	0.48				90	58781	
74		albt kiht m. sat Cu ₂ Fe ₂ sat				0.05	0.17	0.22						2
76						0.47	0.32	0.79						3
78						0.22	0.40	0.62						5
80						0.34	0.55	0.89						5
82						0.53	0.47	1.00						9
83						0.29	0.65	0.94						7
97.5	mp													
100.0	mlb													
102	mlb	Cu ₂ pr. m. vaara Fray to				0.71	0.81	1.52	0.596	0.31			91-7034	8

APPENDIX 58/1

Reikä n:o

Leikkaus n:o

S15415

n:o I kkaus n:

Syvyys m	Kivilaji lyhennys	Kivilajiseloste	Analyysit											
			Pituus m	KATKOSI 26	SÄTEILY 31	CU 36	AU 41	CU+AU 46	CU 51	Aufixamay 56	61	66	N:o	
104 ¹⁹ 20	mdb	CuE pr kelle				1.76	11.37	13.13	1.88	8.96	19.66	0.54	58729	
106	} / abpt	aut alb				4.36	20.25	24.61	4.45	2.02	7.77	8.02	2.81/6.57	90
108						3.18	5.87	9.05	3.20	4.23	8m	8m		1
110							1.78	1.16	2.94	1.69	0.58			
219	mdb	puoleen mahan CuE FeE + alb												
153.5	ml													
154.5	grdpt													
153	abpt	mdb graut				0.06	0.26	0.32					3	
158	}	}				0.07	0.16	0.23					4	
160						0.11	0.27	0.38						5
174	mdb													
↓														
97.5	ml													
100	mdb/alb												91-71034	
2														
110	ktsedelli													
112	mdb	} alb karkti											91-71035	
114	mdb												6	
116	mdb												7	
118	mdb												8	
119	mdb/abpt												9	
	ml													

APPENDIX 3A

OUTOKUMPU MINING SERVICES. Geoanalytical laboratory, F. Laaberg. Appendix 3b/ . Chemical composition.

C4, S1548

Depth/m	50.00	72.00	74.00	76.00	78.00	80.00	82.00	83.00	100.00	102.00	104.00	106.00
RockType	MDB	MDB/ALB	MDB	MDB	MDB							
Anal.no.	9058788	9058781	9058782	9058783	9058784	9058785	9058786	9058787	9171034	9058788	9058789	9058790
SiO2	45.9	37.5	33.7	28.4	33.7	32.9	35.8	51.9	42.7	47.3	42.5	39.7
TiO2	0.752	0.470	0.518	0.562	0.879	0.952	0.984	1.200	2.430	2.650	2.450	1.640
Al2O3	12.5	8.17	9.22	6.32	8.85	9.05	9.57	12.90	12.30	13.30	12.70	8.32
Cr2O3	0.0327	0.0261	0.0290	0.0228	0.0186	0.0153	0.0150	0.0225	0.0028	0.0050	0.0053	0.0056
V2O3	0.0405	0.0372	0.0318	0.0284	0.0423	0.0441	0.0397	0.0624	0.0550	0.0574	0.0561	0.0354
FeO	5.8	10.2	9.5	18.1	14.1	13.6	19.3	14.5	12.0	14.3	10.6	20.4
MnO	0.187	0.194	0.246	0.256	0.203	0.239	0.158	0.036	0.151	0.117	0.091	0.215
MgO	7.06	2.46	7.22	7.01	7.14	7.98	4.55	2.56	5.50	6.11	6.40	4.84
CaO	12.00	12.40	13.50	12.90	11.10	11.50	2.07	2.90	8.50	4.16	5.69	9.66
Rb2O	0.0013	0.0027	0.0007	0.0003	0.0016	0.0013	0.0002	0.0014	0.0019	0.0007	0.0010	0.0004
SrO	0.0072	0.0032	0.0039	0.0027	0.0046	0.0052	0.0032	0.0025	0.0053	0.0047	0.0041	0.0032
BaO	0.007	0.005	0.007	0.005	0.004	0.010	0.004	0.004	0.010	0.005	0.003	0.005
Na2O	5.55	3.65	4.83	2.26	4.41	4.31	5.58	6.47	5.79	5.95	5.94	5.00
K2O	0.839	1.000	0.412	0.241	0.487	0.623	0.161	0.459	0.403	0.214	0.253	0.046
ZrO2	0.013	0.003	0.005	0.005	0.007	0.007	0.007	0.010	0.026	0.029	0.029	0.018
P2O5	0.085	0.061	0.064	0.048	0.029	0.096	0.133	0.132	0.275	0.310	0.296	0.182
CO2	11.3	15.1	13.7	18.8	16.1	15.8	11.4	3.2	7.8	1.1	4.5	13.2
OxSum	94.6	86.5	86.7	97.4	88.9	88.7	93.5	98.4	94.9	98.4	98.2	95.0
Cu	0.014	0.0990	0.0350	0.4360	0.2020	0.3080	0.4700	0.2520	0.3450	0.6160	1.7500	4.3900
Ni	0.010	0.020	0.022	0.044	0.025	0.028	0.057	0.043	0.019	0.022	0.015	0.029
Co	0.010	0.024	0.032	0.063	0.047	0.032	0.060	0.044	0.031	0.026	0.022	0.051
Zn	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.027	0.000	0.001	0.002
Pb	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.008	0.002	0.001	0.001
Ag	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S	1.13	3.70	4.58	9.00	6.23	5.17	10.50	7.54	4.14	5.34	5.28	11.30
As	0.001	0.0020	0.0070	0.0030	0.0120	0.0010	0.0030	0.0130	0.0010	0.0020	0.0050	0.0040
Sb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Te	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Y	0.0019	0.0016	0.0014	0.0012	0.0022	0.0025	0.0016	0.0016	0.0025	0.0033	0.0029	0.0018
Nb	0.0005	0.0005	0.0004	0.0011	0.0005	0.0005	0.0010	0.0011	0.0022	0.0024	0.0027	0.0024
Mo	0.0000	0.0007	0.0000	0.0003	0.0003	0.0000	0.0006	0.0005	0.0000	0.0000	0.0018	0.0007
Sn	0.001	0.001	0.002	0.002	0.001	0.002	0.002	0.002	0.003	0.002	0.002	0.001
W	0.001	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.001
Cl	0.311	0.053	0.022	0.023	0.013	0.025	0.014	0.012	0.042	0.114	0.190	0.016
Th	0.0000	0.0011	0.0003	0.0011	0.0013	0.0003	0.0017	0.0006	0.0007	0.0006	0.0008	0.0008
U	0.0008	0.0000	0.0000	0.0000	0.0040	0.0000	0.0010	0.0020	0.0030	0.0050	0.0020	0.0020
Cs	0.000	0.001	0.000	0.002	0.004	0.001	0.002	0.000	0.003	0.003	0.002	0.004
La	0.001	0.002	0.002	0.004	0.004	0.003	0.003	0.002	0.005	0.006	0.005	0.003
Ce	0.001	0.000	0.001	0.001	0.001	0.000	0.002	0.000	0.001	0.001	0.002	0.004
Ta	0.000											
Au	< 0.1	0.36	0.17	0.32	0.40	0.55	0.47	0.65	n.d	0.81	11.37	20.25
Br	-	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000

C4, S1543										
Depth/m	106.00	110.00	112.00	114.00	116.00	118.00	119.00	156.00	158.00	160.00
RockType	MDB	MDB	MDB	MDB	MDB	MDB	MDB/ABFT	ABFT	ABFT	ABFT
Anal.no.	9058771	9058772	9171035	9171036	9171037	9171038	9171039	9058773	9058774	9058775
SiO2	42.3	44.0	50.5	50.4	49.2	46.1	33.3	66.3	66.3	66.8
TiO2	1.510	2.400	2.640	2.730	2.520	0.458	0.337	0.587	0.529	0.438
Al2O3	10.70	12.30	14.50	14.50	13.30	16.00	11.30	14.70	14.90	14.00
Cr2O3	0.0200	0.0068	0.0029	0.0029	0.0028	0.0035	0.0071	0.0303	0.0313	0.0239
V2O3	0.0391	0.0507	0.0587	0.0522	0.0528	0.0203	0.0226	0.0136	0.0155	0.0107
FeO	12.2	11.6	9.1	9.8	11.5	5.2	20.0	4.0	3.7	3.2
MnO	0.150	0.142	0.107	0.113	0.122	0.155	0.123	0.035	0.031	0.051
MgO	4.01	6.65	7.66	7.19	5.81	3.65	4.13	3.90	3.16	2.83
CaO	7.71	8.36	4.81	4.18	6.55	8.73	8.96	2.59	1.66	2.82
Rb2O	0.0004	0.0010	0.0017	0.0032	0.0012	0.0072	0.0023	0.0053	0.0042	0.0029
SrO	0.0045	0.0040	0.0049	0.0042	0.0042	0.0086	0.0040	0.0046	0.0043	0.0031
BaO	0.004	0.005	0.007	0.011	0.006	0.045	0.016	0.020	0.024	0.020
Na2O	5.67	5.71	5.84	6.25	6.53	5.41	5.02	4.07	5.91	6.90
K2O	0.087	0.201	0.203	0.193	0.343	3.130	0.981	2.520	1.890	1.270
ZrO2	0.019	0.028	0.032	0.032	0.029	0.006	0.006	0.014	0.014	0.019
P2O5	0.170	0.296	0.324	0.339	0.319	0.463	0.217	0.059	0.066	0.109
CO2	9.4	6.8	1.6	2.2	5.9	7.6	12.1	1.4	1.1	2.5
OxSum	94.7	95.1	95.3	98.9	97.2	94.8	94.6	99.5	99.6	99.6
Cu	3.1600	1.4700	0.2210	0.3790	0.2800	0.2810	0.5870	0.0300	0.0410	0.0710
Ni	0.015	0.013	0.009	0.009	0.016	0.008	0.055	0.007	0.011	0.006
Co	0.036	0.025	0.015	0.015	0.019	0.021	0.105	0.006	0.011	0.010
Zn	0.002	0.185	0.001	0.000	0.007	0.072	0.022	0.023	0.007	0.000
Pb	0.002	0.030	0.002	0.001	0.003	0.035	0.013	0.019	0.007	0.000
Ag	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S	6.73	4.82	2.20	2.26	3.33	1.58	11.60	0.28	1.31	0.86
As	0.0050	0.0000	0.0010	0.0010	0.0010	0.0000	0.0320	0.0000	0.0000	0.0010
Sb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Te	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Y	0.0025	0.0026	0.0030	0.0028	0.0031	0.0017	0.0031	0.0009	0.0012	0.0017
Nb	0.0019	0.0027	0.0030	0.0027	0.0028	0.0009	0.0012	0.0009	0.0012	0.0010
Mo	0.0010	0.0004	0.0000	0.0000	0.0001	0.0000	0.0028	0.0003	0.0011	0.0006
Sn	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
W	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.000
Cl	0.012	0.111	0.261	0.080	0.090	0.070	0.015	0.037	0.018	0.023
Th	0.0010	0.0017	0.0006	0.0008	0.0005	0.0010	0.0128	0.0005	0.0009	0.0006
U	0.0000	0.0070	0.0020	0.0010	0.0050	0.0030	0.0030	0.0020	0.0010	0.0020
Cs	0.005	0.005	0.002	0.002	0.005	0.004	0.005	0.005	0.001	0.004
La	0.006	0.006	0.009	0.005	0.009	0.004	0.007	0.008	0.005	0.006
Ce	0.004	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.000	0.000
Ta										
Au	5.87	1.16	n.d	n.d	n.d	n.d	n.d	0.26	0.16	0.27
Br	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0006	0.0008

Bidjovagge ore types / correlation matrix

C4-ORE / CORRELATION COEFFICIENTS

	SiO2	TiO2	Al2O3	Cr2O3	V2O3	FeO	MnO	MgO	CaO	Rb2O	SrO	BaO	Na2O	K2O	ZrO2	P2O5	CO2	Cu	Ni	Co	Zn	Pb	S	As	Au	Y	Mo	Cl	Th	U	Cs	La	Ce			
SiO2	1.00																																			
TiO2	0.06	1.00																																		
Al2O3	0.78	0.24	1.00																																	
Cr2O3	0.22	-0.73	-0.27	1.00																																
V2O3	-0.23	0.80	-0.06	-0.56	1.00																															
FeO	-0.80	0.10	-0.68	-0.30	0.35	1.00																														
MnO	-0.88	-0.09	-0.72	-0.11	0.09	0.50	1.00																													
MgO	-0.52	0.32	-0.45	-0.21	0.45	0.19	0.63	1.00																												
CaO	-0.89	-0.32	-0.75	0.05	-0.04	0.47	0.93	0.56	1.00																											
Rb2O	0.59	-0.34	0.70	0.11	-0.55	-0.72	-0.45	-0.36	-0.35	1.00																										
SrO	0.06	0.04	0.54	-0.38	-0.09	-0.35	0.04	-0.03	0.04	0.56	1.00																									
BaO	0.43	-0.42	0.66	0.03	-0.64	-0.58	-0.30	-0.47	-0.22	0.90	0.68	1.00																								
Na2O	0.52	0.51	0.62	-0.38	0.31	-0.25	-0.58	-0.46	-0.69	0.04	0.04	0.07	1.00																							
K2O	0.54	-0.48	0.63	0.23	-0.64	-0.68	-0.40	-0.39	-0.28	0.97	0.57	0.92	-0.09	1.00																						
ZrO2	0.39	0.91	0.48	-0.62	0.53	-0.20	-0.35	0.09	-0.57	-0.10	0.06	-0.19	0.65	-0.24	1.00																					
P2O5	0.07	0.65	0.61	-0.88	0.42	-0.07	-0.12	0.02	-0.25	0.20	0.59	0.26	0.52	0.09	0.65	1.00																				
CO2	-0.87	-0.45	-0.84	0.21	-0.14	0.53	0.88	0.44	0.96	-0.40	-0.12	-0.26	-0.71	-0.31	-0.69	-0.44	1.00																			
Cu	-0.31	0.26	-0.27	-0.26	0.11	0.41	0.18	-0.10	0.10	-0.41	-0.12	-0.30	0.07	-0.41	0.22	0.13	0.12	1.00																		
Ni	-0.63	-0.31	-0.61	0.05	0.07	0.84	0.32	-0.03	0.41	-0.50	-0.37	-0.36	-0.31	-0.41	-0.55	-0.34	0.54	0.02	1.00																	
Co	-0.69	-0.30	-0.55	-0.09	-0.05	0.84	0.36	-0.06	0.48	-0.42	-0.25	-0.23	-0.31	-0.35	-0.48	-0.18	0.57	0.20	0.90	1.00																
Zn	0.04	0.15	0.25	-0.25	0.01	-0.12	-0.04	-0.01	-0.06	0.16	0.27	0.22	0.06	0.14	0.18	0.37	-0.11	0.08	-0.22	-0.09	1.00															
Pb	0.09	0.09	0.29	-0.20	-0.06	-0.17	-0.09	-0.05	-0.09	0.23	0.30	0.28	0.02	0.23	0.14	0.35	-0.13	0.05	-0.23	-0.10	0.99	1.00														
S	-0.74	-0.10	-0.67	-0.14	0.15	0.95	0.41	-0.01	0.45	-0.67	-0.38	-0.48	-0.23	-0.59	-0.34	-0.17	0.54	0.48	0.87	0.90	-0.13	-0.16	1.00													
As	-0.34	-0.30	-0.22	-0.01	-0.07	0.50	-0.01	-0.18	0.19	-0.17	-0.21	-0.19	-0.09	-0.14	-0.37	-0.12	0.27	0.02	0.65	0.81	-0.13	-0.11	0.60	1.00												
Au	-0.24	0.20	-0.25	-0.22	0.08	0.33	0.13	-0.07	0.08	-0.32	-0.18	-0.25	0.02	-0.32	0.18	0.07	0.10	0.89	0.00	0.11	-0.10	-0.12	-0.42	-0.01	1.00											
Y	-0.24	0.71	0.07	-0.77	0.63	0.32	0.12	0.40	-0.01	-0.36	0.12	-0.34	0.32	-0.47	0.60	0.61	-0.14	0.15	-0.01	0.14	0.07	0.01	0.14	0.19	0.02	1.00										
Mo	-0.06	-0.24	-0.08	0.01	-0.25	0.26	-0.26	-0.30	-0.05	-0.07	-0.23	0.00	0.03	-0.03	-0.16	-0.08	0.03	0.26	0.35	0.55	-0.06	-0.04	0.44	0.71	0.27	0.15	1.00									
Cl	0.19	0.66	0.38	-0.54	0.51	-0.21	-0.19	0.40	-0.28	-0.04	0.20	-0.12	0.27	-0.09	0.67	0.59	-0.45	-0.03	-0.42	-0.39	0.14	0.13	-0.33	-0.26	0.04	0.54	-0.09	1.00								
Th	0.80	-0.33	0.38	0.52	-0.63	-0.67	-0.64	-0.53	-0.58	0.49	-0.12	0.39	0.17	0.50	0.04	-0.35	-0.48	-0.16	-0.44	-0.48	-0.09	-0.04	-0.52	-0.23	-0.05	-0.48	0.14	-0.14	1.00							
U	-0.26	-0.27	-0.08	-0.15	-0.24	0.40	-0.04	-0.17	0.14	0.00	-0.06	0.11	-0.10	0.03	-0.26	0.04	0.18	-0.01	0.51	0.75	0.09	0.12	0.48	0.86	-0.10	0.27	0.77	-0.17	-0.14	1.00						
Cs	0.11	0.46	0.34	-0.53	0.30	0.03	-0.16	-0.05	-0.28	-0.01	0.20	0.01	0.35	-0.07	0.47	0.54	-0.34	0.01	-0.12	-0.05	0.63	0.62	-0.07	0.05	-0.07	0.43	-0.07	0.29	-0.13	0.12	1.00					
La	0.03	0.07	0.18	-0.33	-0.26	0.10	-0.07	-0.31	-0.12	0.12	0.23	0.18	0.11	0.11	0.20	0.31	-0.12	0.32	-0.04	0.21	0.38	0.41	0.12	0.21	0.12	0.25	0.27	-0.06	0.13	0.42	0.55	1.00				
Ce	0.46	0.40	0.51	-0.33	-0.02	-0.28	-0.42	-0.12	-0.52	0.17	0.18	0.13	0.32	0.15	0.61	0.39	-0.58	-0.05	-0.40	-0.22	0.16	0.20	-0.35	-0.03	-0.17	0.44	0.11	0.51	0.32	0.20	0.44	0.60	1.00			

APPENDIX 3C

Bidjovagge ore types / factor analysis

CA-DRE / ROTATED FACTOR MATRIX

	F1	F2	F3	F4	F5	F6
SiO2	0.895					
TiO2		0.845				
Al2O3	0.677			0.568		
Cr2O3		-0.998				
V2O5		0.745		-0.499		
FeO	-0.495		-0.524	-0.424		
MnO	-0.942					
MgO	-0.627					
CaO	-0.950					
BaO				0.845		
SrO				0.821		
BaO				0.928		
Na2O	0.680	0.437				
K2O				0.851		
ZrO2	0.489	0.721				
P2O5		0.888				
CO2	-0.590					
Cu				0.935		
Ni			-0.720			
Co	-0.408		-0.873			
Zn						0.988
Pb						0.931
S	-0.915		-0.680	-0.411		
As			-0.918			
Au				0.928		
Y		0.888				
Mo			-0.763			
Cl		0.715				
Th	0.708	-0.540				
U			-0.915			
Ce						0.785
La			-0.884			0.611
Ce	0.548					

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Laaberg. Appendix 3f/1. Normative mineral composition.

04. 5154B

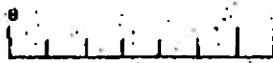
Depth/m	60.60	72.00	74.00	75.00	78.00	80.00	82.00	83.00	100.00	102.00	104.00	106.00
RockType	MDB	MDB/ALB	MDB	MDB	MDB							
Anal.no.	9058782	9058783	9058783	9058783	9058784	9058785	9058786	9058787	9171034	9058786	9058789	9058790
ab	34.6	27.2	35.9	24.2	34.0	33.2	42.1	51.5	45.1	45.5	42.2	36.7
qtz	0.0	1.4	0.0	4.4	2.7	0.0	0.1	3.0	0.0	0.0	1.6	0.0
rd	0.5	0.3	0.3	0.3	0.5	0.6	0.6	0.6	1.6	1.7	1.5	1.0
af	26.7	19.3	10.5	5.0	4.9	9.1	4.2	4.9	23.2	21.3	14.4	5.5
phi	5.5	8.6	3.4	2.0	4.1	5.3	1.5	3.9	3.5	1.9	2.2	0.4
chl	0.0	0.0	0.0	0.0	0.2	0.5	0.0	0.3	0.0	5.2	5.9	0.0
sca	10.1	1.7	0.7	0.7	0.6	0.8	0.4	0.4	1.4	3.2	5.2	0.5
apa	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.5	0.6	0.6	0.3
dol	25.8	34.2	41.7	40.9	35.9	35.5	24.6	7.3	12.1	2.6	10.3	27.9
cp	0.0	0.3	0.1	1.3	0.6	1.0	1.4	0.8	1.1	2.0	5.6	12.8
py	0.8	3.3	5.2	9.3	6.2	4.1	7.2	5.4	5.1	4.4	4.1	9.2
po	2.5	7.0	7.0	13.1	10.1	9.6	20.0	15.8	5.3	5.5	5.5	7.7
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	106.7	104.0	106.0	101.3	100.0	100.0	102.4	100.0	104.9	100.0	100.0	103.2
py/(py+po)	0.24	0.32	0.42	0.42	0.38	0.30	0.27	0.25	0.49	0.32	0.43	0.54

C4, S154B										
Depth/m	108.00	110.00	112.00	114.00	116.00	118.00	119.00	156.00	158.00	160.00
RockType	MDR	MDR	MDR	MDR	MDR	MDR	MDR/ABFT	ABFT	ABFT	ABFT
Anal.no.	9058791	9058792	9171035	9171036	9171037	9171038	9171039	9058793	9058794	9058795
ab	46.0	43.1	40.5	49.5	50.3	41.8	36.7	34.0	50.0	57.7
qtz	1.3	0.6	0.0	0.0	0.0	0.0	0.0	24.2	18.2	15.4
ru	0.9	1.5	1.8	1.9	1.7	0.3	0.2	0.4	0.4	0.3
af	10.8	11.1	20.5	16.5	16.2	23.8	6.4	12.4	8.1	3.0
phl	0.7	1.7	5.4	8.1	3.0	27.6	7.7	23.4	17.2	11.4
chl	0.0	9.5	11.4	8.9	1.9	0.0	0.0	0.0	0.0	0.0
scs	0.4	3.6	9.6	2.7	3.0	2.3	0.4	1.3	0.6	0.8
apa	0.3	0.6	0.6	0.7	0.6	0.9	0.4	0.1	0.1	0.2
sol	21.2	15.3	3.9	5.2	13.7	17.9	25.5	3.5	2.7	6.0
cp	9.9	4.7	0.9	1.3	0.9	0.9	1.7	0.1	0.1	0.2
py	6.9	5.0	2.7	2.7	2.6	2.9	16.0	0.2	1.0	1.1
po	1.8	3.3	2.7	2.6	6.0	0.4	10.5	0.7	3.0	1.1
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.4	100.0	100.0	100.0	100.0	118.9	105.5	100.2	101.3	102.3
py/(py-po)	0.80	0.61	0.51	0.51	0.32	0.89	0.60	0.19	0.24	0.51



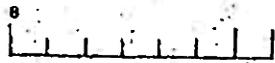
APPENDIX 40/1

SYVYYS	PITUUS m	KIVILAJI	LISÄTIEDOT	Cu	Pu	Cu+Au	Sät.	FINN 100
41.00								
42.00	H.D.B.			0.01	0.02		44	8711434
42.47	H.D.B.			0.01	0.02		35	8711435
42.52	AB-sang			0.03	0.10		80	8711436
43.00	H.D.B.			0.01	0.19		31-36	8711437
43.42	AB.F.S.T			0.01	0.15		30	8711438
44.00	AB.F.S.T			0.01	0.08		35	8711439
44.28	AB.F.S.T			0.01	0.05		30	8711440
44.55	AB-sang			0.01	0.04		80	8711441
45.00	AB.F.S.T			0.01	0.17		32	8711442
47.00	AB.F.S.T			0.01	0.02			8711443
49.00	AB.F.S.T			0.01	0.05		31	8711444
51.00	AB.F.S.T			0.01	0.06		31	8711445
53.00	AB.F.S.T			0.01	0.02		31	8711446
55.00	AB.F.S.T			0.01	0.03	0.04	32	8711453
57.00	AB.F.S.T			0.01	0.02	0.03	32	8711454
59.00	AB.F.S.T			0.01	0.02	0.03	35	8711455
61.60	AB.F.S.T			0.01	0.06	0.07	30	8711456
63.00	AB.F.S.T			0.01	0.02	0.03	31	8711457
65.00	AB.F.S.T			0.01	0.04		33	8711458
67.00	AB.F.S.T			0.01	0.05		30	8711471
69.00	AB.F.S.T			0.01	0.05		30	8711472
71.00	AB.F.S.T			0.01	0.05		30	8711473
73.00	AB.F.S.T			0.01	0.05		28	8711474
75.00	AB.F.S.T			0.01	0.05		27	8711475



APP. 40/2

SYVYYS	PITUUS	KIVILAJI	LISÄTIEDOT	Cl	Am	Cu+Au	Sät.	AINAK. NO	
7.7.0.0	A.B.F.S.T			0.013	0.07		28	87.1.1476	X
7.9.0.0	A.B.F.S.T			0.024			33	87.1.1477	
8.1.0.0	A.B.F.S.T			0.025			35	87.1.1478	
8.3.0.0	A.B.F.S.T			0.026			35	87.1.1479	X
8.5.0.0	A.B.F.S.T			0.024			33	87.1.1480	
8.7.0.0	A.B.F.S.T			0.017			32	87.1.1481	
8.9.0.0	A.B.F.S.T			0.016			34	87.1.1482	X
9.1.0.0	A.B.F.S.T			0.01	0.02		32	87.1.1498	
9.3.0.0	A.B.F.S.T			0.01	0.02		34	87.1.1499	X
9.5.0.0	A.B.F.S.T			0.01	0.08	1.09	36	87.1.1500	
9.7.0.0	A.B.F.S.T			0.01	0.02	0.03	35	87.1.1501	
9.9.0.0	A.B.F.S.T			0.01	0.02	0.03	36	87.1.1502	
1.01.0.0	A.B.F.S.T			0.01	0.02	0.03	35	87.1.1503	X
1.03.0.0	A.B.F.S.T			0.01	0.06	0.07	37	87.1.1504	
1.05.0.0	A.B.F.S.T			0.01	0.04	0.05	36	87.1.1505	
1.07.0.0	A.B.F.S.T			0.01	0.02	0.03	37	87.1.1506	X
1.09.0.0	A.B.F.S.T			0.01	0.05		33	87.1.1507	
1.1.1.0.0	A.B.F.S.T				0.05		35	87.1.1508	
1.1.3.0.0	A.B.F.S.T				0.12		28	87.1.1509	
1.1.5.0.0	A.B.F.S.T				0.07		26	87.1.1510	
1.1.7.0.0	A.B.F.S.T				0.06		27	87.1.1511	
1.1.9.0.0	A.B.F.S.T				0.06		28	87.1.1512	
1.2.1.0.0	A.B.F.S.T				0.31		28	87.1.1513	
1.2.3.0.0	A.B.F.S.T				0.05		29	87.1.1514	
1.2.5.0.0	A.B.F.S.T				0.05		29	87.1.1515	



APP 40/3

SYVYYS	PITUUS m	KIVILAJI	LISÄTIEDOT	Cu	Au	Cu+Au	Sät.	FINNRA 100		
1.27.00	A.B.F.S.T									
1.29.00	A.B.F.S.T				0.07		28	87.1.15.16		
1.31.00	A.B.F.S.T				0.06		29	87.1.15.17	X	
1.33.00	A.B.F.S.T				0.05		29	87.1.15.18		
1.35.00	A.B.F.S.T				0.05		29	87.1.15.19		
1.37.00	A.B.F.S.T				0.21		28	87.1.15.20		
1.39.00	A.B.F.S.T				0.16		28	87.1.15.21		
1.41.00	A.B.F.S.T				0.40		25	87.1.15.22		
1.43.00	A.B.F.S.T						25	87.1.15.23	X	
1.45.00	A.B.F.S.T						26	87.1.15.24		
1.47.00	A.B.F.S.T						29	87.1.15.25		
1.49.00	A.B.F.S.T						30	87.1.15.26		
1.51.00	K.A.R.B.						32	87.1.15.27	X	
1.53.00	K.A.R.B.						28	87.1.15.28		
1.55.00	K.A.R.B.						29	87.1.15.29		
1.57.00	A.B.F.S.T						29	87.1.15.30	X	
1.59.00	A.B.F.S.T			0.02	0.09		39	87.1.15.31		
1.61.00	A.B.F.S.T			0.01	0.09		35	87.1.15.32		
1.63.00	A.B.F.S.T			0.01	0.06		33	87.1.15.33	X	
1.65.00	A.B.F.S.T			0.01	0.05		30-35	87.1.15.34		
1.67.00	A.B.F.S.T			0.01	0.23		35	87.1.15.35		
1.69.00	A.B.F.S.T			0.01	0.07		34	87.1.15.36	X	
1.71.00	A.B.F.S.T			0.05	0.16		30-35	87.1.15.37		
1.73.00	A.B.F.S.T			0.01	0.15		37	87.1.15.38	X	
1.75.00	A.B.F.S.T			0.01	1.53	1.54	37-40	87.1.15.39		
				0.01	0.32		28-38	87.1.15.40		

APP 40/4

SYVYYS	PITUUS m	KIVILAJI	LISÄTIEDOT	Cu	Am	Cu+Am	Sät.	ANAL NO	
177.00		A.B.F.S.T.		0.01	0.11		36	8711541	X
179.00		A.B.F.S.T.		0.01	0.26		34	8711542	
181.00	2	A.B.F.S.T.		0.007	0.28	0.29	30	8711550	X
183.00	2	A.B.F.S.T.		0.005	0.90	0.91	30	8711551	
185.00	2	A.B.F.S.T.		0.009	0.72	0.73	30	8711552	
187.00	2	A.B.F.S.T.		0.009	0.20	0.21	28	8711553	X
189.00	2	A.B.F.S.T.		0.031	0.18	0.21	29	8711554	X
190.95	1.95	A.B.F.S.T.		0.30	0.24	0.54	30	8711555	X
192.00	1.06	A.B.F.S.T. CumA		3.30	3.40	6.70	38	8711556	X
193.00	1	A.B.F.S.T. CumA		5.16	0.54	5.70	46-45	8711557	
194.00	1	A.B.F.S.T. CumA	2.19/0.69	0.68	0.30	0.98	50-60	8711558	X
195.00	1	A.B.F.S.T. CumA	14.05 m	1.14	1.04	2.18	60-80	8711559	
196.00	1	A.B.F.S.T. CumA		1.34	0.64	1.98	60-70	8711560	X
197.00	1	A.B.F.S.T. CumA		1.45	1.00	2.45	60	8711561	
198.00	1	A.B.F.S.T. CumA		3.70	0.80	4.50	60-70	8711568	X
199.00	1	A.B.F.S.T. CumA		5.88	0.64	4.72	80-90	8711569	
200.00	1	A.B.F.S.T. CumA		1.83	0.14	1.97	60-70	8711570	X
201.00	1	A.B.F.S.T. CumA		1.32	0.24	1.56	50-60	8711571	X
202.00	1	A.B.F.S.T. CumA		0.16	0.06	0.22	45	8711572	X
203.00	1	A.B.F.S.T. CumA		0.99	0.10	1.09	38	8711573	
204.00	1	A.B.F.S.T. CumA		4.90	0.30	5.20	32	8711574	X
205.00	1	A.B.F.S.T. CumA		0.69	0.34	1.03	32	8711575	
206.00		A.B.F.S.T. ITU		0.012	0.30	0.31	33	8711576	
207.00		A.B.F.S.T. ITU		0.15	0.02		30	8711577	
208.00		A.B.F.S.T.		0.01	0.02		29	8711578	X

E, #557 N20E													
Depth (m)	47.00	83.00	83.00	89.00	93.00	101.00	107.00	117.00	129.00	141.00	149.00	155.00	
Rock Type	ABSFT												
Anal. no.	9123558	9123559	9123560	9123561	9123588	9123562	9123563	9123564	9123565	9123566	9123567	9123568	
SiO2	60.4	64.1	55.8	50.8	71	68.8	69.8	57.4	45.6	10.6	55.7	32.7	
TiO2	0.631	0.55	0.522	0.542	0.579	0.635	0.562	0.425	0.429	0.063	0.559	0.204	
Al2O3	14.9	15.1	12.4	14.8	16.4	17.3	15.5	13.2	9.36	1.56	12.8	5.37	
Cr2O3	0.0239	0.0244	0.0221	0.0267	0.0224	0.0272	0.0269	0.0279	0.0239	0.0054	0.0227	0.0123	
V2O3	0.0213	0.0228	0.0243	0.0199	0.0205	0.0226	0.0183	0.0111	0.0139	0.0087	0.0245	0.015	
FeO	3.46	2.61	6.11	6.89	0.71	0.92	2.15	12.4	18.2	10.5	7.23	12.5	
MnO	0.057	0.038	0.134	0.033	0.01	0.015	0.017	0.01	0.096	0.489	0.092	0.246	
MgO	3.76	4.65	5.27	3.28	0.13	0.14	0.3	0.24	1.95	14	4.47	6.08	
CaO	5.64	3.1	7.85	1.94	0.433	0.72	0.872	0.354	6.54	25.4	6.79	18.9	
Rb2O	0.0009	0.002	0.0009	0.0008	0.0004	0.0003	0.0004	0.0004	0.0012	0.0009	0.0003	0.0004	
SrO	0.0033	0.0044	0.0057	0.0054	0.0045	0.0045	0.003	0.0019	0.0031	0.0057	0.0035	0.0092	
SeO	0.01	0.01	0.007	0.004	0.003	0.007	0.002	0.003	0.007	0.005	0.004	0.005	
Na2O	8.79	8.54	5.7	8.03	10.3	10.9	9.88	8.61	4.2	0.7	7.62	2.83	
K2O	0.228	0.555	0.109	0.34	0.058	0.08	0.051	0.027	1.09	0.025	0.241	0.03	
ZrO2	0.013	0.012	0.012	0.012	0.014	0.015	0.014	0.011	0.009	0	0.012	0.004	
P2O5	0.052	0.053	0.067	0.083	0.07	0.067	0.074	0.104	0.05	0.011	0.049	0.057	
CO2	3.6	0.95	6.5	0.64	0.22	0.66	0.73	0.22	6.8	34.8	4.8	17	
OxSum	99.6	99.8	96.1	99.3	100	100	99.8	98.7	97.9	75	99.2	86.2	
Cu	0.006	0.005	0.004	0.004	0.002	0.036	0.016	0.009	0.01	0.002	0.004	0.004	
Ni	0.004	0.011	0.032	0.02	0.005	0.003	0.005	0.001	0.077	0.019	0.013	0.02	
Co	0.028	0.008	0.026	0.012	0.005	0.007	0.007	0.045	0.047	0.027	0.017	0.027	
Zn	0.003	0.001	0.004	0.002	0	0.005	0	0	0	0	0.001	0	
Pb	0.001	0.001	0.001	0.001	0	0	0	0	0.002	0.001	0.001	0.001	
Ag	0	0	0	0	0	0	0	0	0	0	0	0	
S	1.19	0.063	0.718	4.63	0.102	0.16	1.15	11	16.4	4.07	4.53	9.19	
As	0.001	0	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.001	0.001	0.001	
Sb	0	0	0	0	0	0	0	0	0	0	0	0	
Bi	0	0	0	0	0	0	0	0	0	0	0	0	
Te	0	0	0	0	0	0	0	0	0	0	0	0	
Y	0.0015	0.0018	0.0025	0.0019	0.002	0.0015	0.0016	0.0005	0.0007	0.0019	0.002	0.0012	
Nb	0.0011	0.0009	0.001	0.001	0.0013	0.0013	0.001	0.0011	0.0011	0.0004	0.0013	0.0007	
Mo	0.0037	0.0006	0	0.002	0.0004	0.0004	0.0002	0.0006	0.0004	0	0.0001	0.0022	
Sn	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	
H	0.001	0	0	0.001	0.001	0	0	0	0	0.001	0	0.001	
Cl	0.012	0.017	0.018	0.034	0.006	0.008	0.008	0.015	0.021	0.037	0.012	0.023	
Th	0.0008	0.0008	0.0009	0.0008	0.0002	0.0007	0.0006	0.0008	0.0008	0	0	0	
U	0.0013	0.0009	0.0012	0.0011	0.0008	0.0009	0.0009	0.0014	0.0007	0.0011	0.0007	0.0013	
Ce	0.003	0.003	0.001	0.005	0.003	0	0.003	0.004	0	0.001	0.002	0.001	
La	0.002	0.004	0.006	0.006	0.004	0.005	0.005	0.005	0.004	0.002	0.001	0.003	
Ce	0.005	0.006	0.013	0.01	0.008	0.009	0.006	0.01	0.008	0.003	0.008	0.001	
Ta	0.001	0	0	0	0	0.001	0	0	0.001	0.001	0	0	
Au	0.02	0.02	n.d	n.d	0.02	0.02	0.02	0.06	0.06	n.d	n.d	n.d	

E. W255 N20E

Depth (m)	161.00	167.00	171.00	177.00	181.00	187.00	189.00	190.95	192.00	194.00	196.00	198.00
RockType	ABFST											
Anal. no.	9123569	9123570	9123571	9123572	9123573	9123574	9123575	9123576	9123577	9123578	9123579	9123580
SiO2	60.8	60.7	60.5	43.5	51.3	12.6	25.6	46.7	41.4	64.3	51	54
TiO2	0.519	0.58	0.529	0.416	0.376	0.121	0.344	0.392	0.465	0.667	0.626	0.702
Al2O3	13.1	14.5	12.7	9.06	6.34	2.48	5.34	9.06	3.61	15.5	12.7	14.2
Cr2O3	0.0211	0.0247	0.0241	0.0191	0.0149	0.0099	0.0176	0.0198	0.0196	0.0307	0.0258	0.027
FeO	0.0229	0.0217	0.0227	0.0178	0.0156	0.0155	0.0125	0.0141	0.0164	0.0406	0.0501	0.0512
MnO	2.94	3.06	4.94	9.78	6.6	21.1	27.5	21	23.7	2.95	6.72	8.73
MgO	0.101	0.084	0.087	0.205	0.186	0.274	0.195	0.044	0.015	0.04	0.119	0.045
CaO	4.56	3.25	4.62	7.15	7.76	10.5	5.28	1.95	0.19	0.23	1.41	0.04
Na2O	7.54	5.7	5.9	11.9	13	17.2	8.67	2.55	0.582	3.06	6.04	2.54
K2O	0.0007	0.0005	0.0005	0.0004	0.0004	0.0005	0.001	0.0003	0.0003	0.0005	0.0005	0.0003
SO2	0.0037	0.0038	0.0032	0.0053	0.0046	0.0044	0.0033	0.0011	0.0014	0.0039	0.0042	0.0035
BaO	0.002	0.003	0.002	0.003	0	0.004	0.004	0.002	0.005	0.008	0.009	0.005
Na2O	8.1	8.9	7.76	5.46	5.07	1.33	3.49	4.98	5.59	9.33	7.93	8.83
K2O	0.141	0.211	0.092	0.082	0.05	0.197	0.129	0.432	0.128	0.272	0.21	0.09
DrO2	0.011	0.014	0.012	0.008	0.008	0.001	0.005	0.009	0.011	0.015	0.013	0.016
P2O5	0.055	0.064	0.047	0.057	0.055	0.026	0.05	0.061	0.061	0.082	0.056	0.047
CO2	5.3	4.9	3.7	12.4	8.7	25.6	12.1	3.6	0.73	2.9	6.2	2.3
OxSum	99.3	99.6	99.4	94.1	96.8	91	92.2	97.7	97.4	99.7	99	99
Cu	0.007	0.003	0.003	0.006	0.004	0.019	0.011	0.03	4.41	1.06	4.06	4.21
Hf	0.006	0.006	0.01	0.013	0.012	0.035	0.045	0.099	0.086	0.014	0.025	0.043
Co	0.006	0.015	0.032	0.036	0.029	0.069	0.035	0.073	0.132	0.016	0.017	0.013
Zn	0	0	0	0	0	0	0	0	0.001	0.001	0.002	0.003
Pb	0.001	0	0.001	0.001	0.001	0.002	0.002	0.005	0.005	0.011	0.031	0.005
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	0.428	0.332	2.24	5.79	2.66	15.9	24	18.2	21.2	2.06	6.36	7.45
As	0.001	0.001	0	0.003	0.001	0.003	0.003	0.007	0.002	0	0	0
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0	0.001	0
Te	0	0	0	0	0	0	0	0	0	0	0	0
Y	0.0012	0.0015	0.0013	0.0013	0.0013	0.0009	0.0003	0.0029	0.001	0.0022	0.0015	0.002
Nb	0.0012	0.0012	0.0012	0.0011	0.0009	0.0009	0.0012	0.001	0.0014	0.0013	0.0012	0.0014
Mo	0.0003	0.005	0.0019	0.0016	0.0024	0.0011	0.0004	0.0012	0.0017	0.001	0.0023	0.0065
Sn	0.001	0	0.001	0.001	0.003	0	0.002	0.001	0.001	0.001	0.002	0.002
W	0	0.001	0	0.001	0	0.001	0	0.001	0.001	0	0	0
Cl	0.012	0.013	0.011	0.018	0.016	0.027	0.02	0.018	0.012	0.011	0.016	0.01
Th	0.0008	0.0005	0	0.0004	0.0003	0	0.0006	0	0	0.0006	0.0006	0.0004
U	0.001	0.0013	0.0009	0.0013	0.0005	0.0016	0.001	0.0013	0.0009	0.0021	0.0027	0.008
Cs	0	0.002	0.003	0.006	0	0.004	0.005	0.004	0.005	0.001	0.002	0.002
La	0.001	0.004	0.002	0.005	0.002	0.002	0.002	0.002	0.005	0.003	0.004	0.005
Ce	0.004	0.007	0.004	0.007	0.004	0.002	0.005	0.005	0.003	0.007	0.007	0.009
Te	0	0	0	0	0	0	0	0	0.003	0.002	0.007	0.008
Au	0.05	0.07	0.15	0.11	0.28	0.20	0.18	0.24	3.40	0.30	0.64	0.80

E. ~~MSF~~ *N2OE*

Depth (m)	200.00	202.00	203.00	204.00	206.00	208.00	213.00
Rock Type	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST	MOE
Ana! . no.	9123581	9123582	9123583	9123584	9123585	9123586	9123587
SiO2	53.7	53.9	52.5	49.3	61.1	62.5	49.3
TiO2	0.511	0.543	0.564	0.402	0.612	0.483	0.572
Al2O3	12.2	15.7	14.7	11.3	15.2	13.8	10
Cr2O3	0.0261	0.0283	0.0255	0.0201	0.021	0.022	0.0115
V2O3	0.0333	0.0275	0.0215	0.0152	0.0232	0.0138	0.0333
FeO	6.93	2.39	2.59	13.1	7.23	2.73	15.8
MnO	0.085	0.049	0.059	0.039	0.052	0.065	0.083
MgO	0.43	2.14	4.02	1.18	6.28	3.92	7.45
CaO	5.14	3.48	5.33	2.07	1.06	5.99	6.37
Rb2O	0.0003	0.0009	0.0005	0.0011	0.0011	0.0006	0.0023
SrO	0.0042	0.0042	0.003	0.0029	0.0094	0.0072	0.0055
BaO	0.004	0.003	0.007	0.01	0.009	0.003	0.009
Na2O	7.72	9.1	8.67	6.27	7.05	8.02	4.36
K2O	0.115	0.221	0.125	0.332	0.119	0.151	0.633
ZrO2	0.012	0.013	0.015	0.01	0.014	0.012	0.013
P2O5	0.095	0.039	0.066	0.065	0.116	0.051	0.085
CO2	4.9	4	3	3.3	0.62	4.6	2.3
OxSua	99	99.7	99.7	98.2	99.2	99.7	98.3
Cu	3.76	0.346	0.002	6.34	0.014	0.014	0.073
Ni	0.057	0.016	0.005	0.065	0.025	0.005	0.005
Co	0.027	0.007	0.016	0.038	0.018	0.009	0.026
Zn	0.052	0.001	0.001	0.004	0.004	0	0
Pb	0.056	0.003	0	0.007	0.032	0.001	0.001
Ag	0	0	0	0	0	0	0
S	7.32	1.1	0.085	11.5	0.022	1.01	5.15
As	0	0	0.001	0.001	0	0	0
Sb	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0
Te	0	0	0	0	0	0	0
Y	0.0012	0.0017	0.0019	0.0003	0.0024	0.0012	0.0023
Nb	0.0013	0.0012	0.0012	0.0014	0.0008	0.0009	0.0009
Mo	0.0043	0.0013	0.0001	0.0009	0	0.0007	0
Sn	0.002	0.001	0.001	0.001	0.001	0.003	0.001
W	0.001	0.001	0.001	0	0	0	0.001
Cl	0.002	0.007	0.012	0.009	0.01	0.009	0.06
Th	0	0.0007	0.0008	0.0004	0.0005	0	0
U	0.005	0.0012	0.0005	0.001	0.0007	0.0008	0.001
Cs	0	0.002	0.003	0.003	0.001	0.003	0.003
La	0.003	0.005	0.004	0.003	0.019	0.003	0.005
Ce	0.006	0.009	0.005	0.002	0.033	0.005	0.006
Ta	0.006	0	0.001	0.012	0	0	0.001
Au	0.14	0.06	0.10	0.30	0.30	0.02	0.15

Bidjovagge ore types / correlation matrix

E-ORE / CORRELATION COEFFICIENTS

	SiO2	TiO2	Al2O3	Cr2O3	V2O3	FeO	MnO	MgO	CaO	Rb2O	SrO	BaO	Na2O	K2O	ZrO2	P2O5	CO2	Cu	Ni	Co	Zn	Pb	S	As	Au	Y	Mo	Cl	Th	U	Cs	La	Ce		
SiO2	1.00																																		
TiO2	0.93	1.00																																	
Al2O3	0.98	0.95	1.00																																
Cr2O3	0.86	0.86	0.90	1.00																															
V2O3	0.48	0.64	0.55	0.49	1.00																														
FeO	-0.59	-0.42	-0.59	-0.44	-0.28	1.00																													
MnO	-0.65	-0.61	-0.67	-0.64	-0.13	0.42	1.00																												
MgO	-0.40	-0.43	-0.45	-0.54	-0.34	0.27	0.75	1.00																											
CaO	-0.54	-0.52	-0.58	-0.56	-0.08	0.32	0.96	0.74	1.00																										
Rb2O	-0.09	-0.04	-0.09	-0.22	-0.10	0.15	0.18	0.18	0.20	1.00																									
SrO	-0.09	-0.15	-0.09	-0.27	0.15	-0.25	0.43	0.40	0.39	0.22	1.00																								
BaO	-0.02	0.11	0.09	0.10	0.26	0.06	-0.14	-0.11	-0.14	0.37	0.05	1.00																							
Na2O	0.96	0.94	0.98	0.93	0.53	-0.59	-0.70	-0.51	-0.60	-0.20	-0.16	0.01	1.00																						
K2O	0.18	0.32	0.23	0.25	0.22	0.20	-0.08	0.14	0.01	0.58	-0.24	0.41	0.15	1.00																					
ZrO2	0.92	0.97	0.93	0.87	0.55	-0.35	-0.60	-0.42	-0.51	-0.10	-0.17	0.04	0.93	0.30	1.00																				
P2O5	0.78	0.79	0.78	0.69	0.35	-0.19	-0.60	-0.33	-0.59	-0.02	-0.06	0.06	0.75	0.17	0.85	1.00																			
CO2	-0.65	-0.61	-0.67	-0.57	-0.15	0.41	0.95	0.63	0.95	0.07	0.26	-0.13	-0.67	-0.04	-0.58	-0.65	1.00																		
Cu	0.09	0.25	0.16	0.26	0.51	0.23	-0.23	-0.55	-0.24	-0.16	-0.27	0.29	0.19	0.21	0.24	0.19	-0.10	1.00																	
Ni	-0.35	-0.25	-0.32	-0.08	-0.19	0.79	0.07	-0.13	-0.05	-0.01	-0.40	0.10	-0.32	0.18	-0.17	-0.02	0.11	0.42	1.00																
Co	-0.51	-0.39	-0.52	-0.37	-0.38	0.85	0.27	0.18	0.19	-0.02	-0.44	0.02	-0.51	0.12	-0.30	-0.17	0.31	0.17	0.70	1.00															
Zn	0.30	0.38	0.39	0.42	0.58	-0.11	-0.20	-0.32	-0.22	-0.08	0.08	0.44	0.37	0.14	0.33	0.33	-0.20	0.58	0.14	-0.11	1.00														
Pb	-0.18	-0.04	-0.15	-0.02	0.37	0.50	0.29	-0.03	0.25	0.07	-0.04	0.19	-0.15	0.32	-0.03	-0.06	0.34	0.71	0.57	0.35	0.48	1.00													
S	-0.48	-0.35	-0.48	-0.27	-0.22	0.79	0.28	-0.03	0.26	-0.16	-0.39	-0.10	-0.43	0.11	-0.28	-0.25	0.41	0.34	0.65	0.69	-0.18	0.46	1.00												
As	-0.35	-0.36	-0.38	-0.23	-0.67	0.35	-0.01	0.05	-0.05	-0.21	-0.50	-0.18	-0.33	-0.09	-0.26	-0.16	0.08	-0.29	0.30	0.51	-0.39	-0.31	0.38	1.00											
Au	-0.04	0.16	-0.01	0.09	0.29	0.44	-0.07	-0.28	-0.14	-0.15	-0.41	-0.05	0.04	0.15	0.18	0.13	-0.03	0.69	0.46	0.47	0.15	0.53	0.32	-0.04	1.00										
Y	0.26	0.22	0.24	0.06	0.50	-0.38	-0.04	-0.03	-0.00	-0.06	0.22	0.05	0.17	-0.01	0.11	0.02	-0.10	-0.11	-0.36	-0.37	0.17	-0.05	-0.44	-0.38	-0.17	1.00									
Mo	0.09	0.10	0.10	0.24	0.23	0.08	0.02	-0.23	0.07	-0.36	-0.14	-0.24	0.19	-0.03	0.18	0.07	0.13	0.34	0.18	0.13	0.13	0.37	0.36	-0.07	0.33	-0.12	1.00								
Cl	-0.57	-0.47	-0.60	-0.65	-0.25	0.60	0.53	0.57	0.51	0.46	0.15	0.09	-0.67	0.24	-0.50	-0.35	0.42	-0.28	0.19	0.42	-0.33	0.05	0.40	0.21	-0.10	0.01	-0.17	1.00							
Th	0.43	0.43	0.48	0.55	0.18	-0.35	-0.28	-0.15	-0.26	0.23	-0.00	0.15	0.46	0.16	0.39	0.35	-0.29	-0.06	-0.14	-0.39	0.23	-0.25	-0.37	-0.00	-0.12	-0.09	-0.06	-0.19	1.00						
U	-0.07	0.08	0.02	0.16	0.59	0.19	0.07	0.41	0.05	-0.27	-0.03	0.25	0.06	-0.01	0.04	-0.01	0.13	0.63	0.33	0.03	0.46	0.59	0.35	-0.35	0.34	0.13	0.55	-0.05	-0.02	1.00					
Cs	-0.10	-0.01	-0.04	-0.02	-0.11	0.17	-0.17	0.06	-0.16	0.11	-0.21	0.26	-0.02	0.08	-0.00	-0.01	-0.16	-0.02	0.07	0.18	-0.19	-0.12	0.15	0.11	0.08	-0.02	-0.02	0.15	-0.11	0.01	1.00				
La	0.30	0.33	0.34	0.27	0.20	-0.10	-0.39	-0.26	-0.50	0.15	0.26	0.32	0.26	-0.00	0.31	0.51	-0.51	0.17	0.09	-0.11	0.31	-0.10	-0.34	-0.23	0.13	0.21	-0.14	-0.08	0.34	0.06	0.15	1.00			
Ce	0.51	0.58	0.57	0.53	0.39	-0.28	-0.36	-0.22	-0.43	0.09	0.12	0.14	0.51	0.18	0.47	0.50	-0.48	-0.02	-0.04	-0.34	0.37	-0.08	-0.45	-0.31	-0.04	0.38	-0.27	-0.24	0.46	0.07	-0.09	0.58	1.00		

APPENDIX 4c,

APPENDIX Yd.

Bidjovagge ore types / factor analysis

E-ORE / ROTATED FACTOR MATRIX

	F1	F2	F3	F4	F5	F6	F7	F8
SiO2	0.913							
TiO2	0.932							
Al2O3	0.908							
Cr2O3	0.853							
V2O3	0.481		0.721					
FeO		-0.865						
MnO	-0.508				0.815			
MgO					0.754			
CaO	-0.409				0.841			
Rb2O				-0.822				
SrO		0.522			0.513	-0.450		
BaO			0.432	-0.648				
Na2O	0.902							
K2O				-0.775				
ZrO2	0.958							
P2O5	0.807							
CO2	-0.502				0.720			
Cu		-0.406	0.762					
Ni		-0.839						
Co		-0.801						
Zn			0.698					
Pb		-0.497	0.711					
S		-0.741						
As			-0.569					
Au		-0.668						
Y							0.622	
Mo			0.426	0.508				
Cl	-0.422				0.502			
Th	0.426						-0.649	
U			0.859					
Ce								-0.849
La					-0.864			
Ce	0.479				-0.632			

E. ~~N20E~~ N20E

Depth (m)	47.00	63.00	82.00	99.00	93.00	101.00	107.00	117.00	129.00	141.00	149.00	155.00
RockType	ABSF1											
Anal. no.	9123558	9123559	9123560	9123561	9123562	9123562	9123563	9123564	9123565	9123566	9123567	9123568
ab	70.4	71.1	48.2	65.2	82.3	92.3	83.3	67.8	30.0	2.9	58.7	50.0
qtz	0.0	2.0	6.1	6.1	9.0	3.8	9.4	5.6	10.8	0.0	0.0	3.5
ru	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.3	0.2	0.0	0.4	0.1
af	24.5	19.7	28.0	9.2	1.5	1.5	2.3	0.3	4.2	22.0	23.7	19.8
phl	2.0	3.0	1.0	3.0	0.5	0.7	0.5	0.6	6.4	0.6	2.0	0.2
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.4	0.5	0.5	1.1	0.2	0.2	0.3	0.5	0.6	1.1	0.4	0.7
eps	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.0	0.1	0.1
dol	6.4	2.3	15.6	2.0	0.5	1.6	1.7	0.5	14.1	75.1	10.8	37.1
cp	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
py	2.8	0.0	0.4	1.2	0.1	0.2	1.3	2.3	4.1	4.4	4.6	9.2
pe	0.0	0.2	1.8	13.1	0.2	0.1	2.0	30.6	41.1	6.3	7.2	15.0
gfs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	109.1	100.3	100.3	101.4	100.2	101.1	101.6	108.6	113.8	112.2	111.5	105.3
py/(py+pe)	1.00	0.14	0.17	0.09	0.24	0.77	0.40	0.07	0.09	0.41	0.37	0.38

E, NDEF NZOE												
Depth (m)	161.00	167.00	171.00	177.00	181.00	187.00	189.00	190.95	192.00	194.00	195.00	198.00
RockType	ABFST											
Anal. no.	9123569	9123570	9123571	9123572	9123573	9123574	9123575	9123576	9123577	9123578	9123579	9123580
ab	64.1	71.1	51.8	40.1	38.3	6.5	23.1	36.5	41.7	76.7	60.7	70.6
qtz	0.0	0.0	0.4	0.0	1.4	0.6	0.3	11.9	6.5	3.7	0.0	0.0
ru	0.3	0.4	0.3	0.3	0.2	0.1	0.2	0.2	0.3	0.4	0.4	0.4
af	30.7	16.5	25.1	27.7	25.3	5.2	5.3	0.9	0.0	6.4	14.4	7.3
phi	1.2	1.6	0.7	0.7	0.4	1.5	0.9	3.4	1.0	2.4	1.9	0.8
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
scs	0.4	0.4	0.4	0.6	0.5	0.8	0.5	0.5	0.4	0.4	0.5	0.3
apa	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
dol	12.2	11.3	3.6	27.1	19.9	51.6	23.4	7.5	1.5	3.6	13.3	5.2
cp	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	12.7	3.4	12.6	13.3
py	0.3	1.3	5.3	12.5	5.3	22.8	3.5	7.9	19.3	0.9	0.3	0.0
po	0.9	0.9	0.0	0.7	1.3	13.5	51.0	41.6	23.0	2.0	5.9	10.0
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	110.3	105.8	103.8	109.7	102.8	104.7	114.9	110.7	108.8	105.2	110.9	106.1
py/(py+po)	0.24	0.59	1.00	0.54	0.30	0.33	0.12	0.16	0.46	0.30	0.12	0.00

E, ~~MSF~~ *N20E*

Depth (m)	200.00	202.00	203.00	204.00	206.00	208.00	213.00
RockType	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST	MDB
Anal. no.	9123581	9123582	9123583	9123584	9123585	9123586	9123587
ab	60.4	74.3	70.7	49.6	61.0	64.7	32.6
qtz	0.4	5.6	0.0	7.8	9.8	2.0	0.3
ru	0.3	0.3	0.4	0.3	0.4	0.3	0.4
af	13.7	6.2	25.5	3.6	3.9	22.5	35.9
phl	1.0	1.9	1.1	2.6	1.1	1.3	5.6
chl	0.0	0.0	0.0	0.0	21.6	0.0	4.9
sca	0.3	0.8	0.4	0.3	0.3	0.3	2.0
apa	0.2	0.1	0.1	0.1	0.2	0.1	0.2
dol	11.0	9.3	7.1	5.2	1.5	10.7	5.5
cp	11.7	1.1	0.0	19.8	0.0	0.0	0.2
py	0.4	0.1	0.2	1.2	0.0	1.5	12.4
po	10.4	2.2	0.0	14.1	0.0	1.2	0.0
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	109.7	101.6	105.5	104.2	100.0	104.6	100.0
py/(py+po)	0.04	0.02	1.00	0.08	0.13	0.56	1.00

OUTOKUMPU OY

5.10.89

KAIRAUSRAPORTTI

Kunta:
 Esintymä: B1030
 Sijainti: K. (=B-VIESTI)
 Kairattu aikana: 9/89
 Geologi: M.R.

Leikkaus n:o
 Suunta:
 Kaltevuus:
 Lisätietoja:

8	N 95°
14	90°
20	69.4 70°

Reikä n:o
 Koordinaatit X:
 Y:
 Z:

12	N 95 F
25	949.20
33	929.40
41	608.38

Kaltevuusmittaukset	16	17	24	25	32	33	70	30	40	41	68.7	40	49	68.3	50	56	57	64	65	72	73
	0	69.4°	10	69.2°	20	70	30	68.7	40	68.3	50										
	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m
	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m	°	m

Syvyys m	Kivilaji-lyhennys	Kivilajiseloste	Analyysit										N:o
			KATKOSLUK	SÄTELY	PITUUS	Cu	As	Cu+As	59	61	63	65	
0-1.8	JORB		26	31	36	41	46	51	56	61	66		
3.0	KEB	"/ PYRITTI + ALBIITTI	60			0.01	0					89.76	154
4.0	"	"				0.07	0						155
5.0	"	"	60			0.07	0						156
5.8	"	"				0.02	0						157
6.0	ABFST	SVANT BREWS + FOULERT 50	60										
7.0	"	"/ PYRITTI				0.02	0						158
8.0	"	"	60			0.02	0						159
9.0	"	"	80			0.27	0						160
10.0	ABFST/KEB	"/ JORBON CC. + PY + CHPY	80			0.28	0.11						161
11.0	"	PYRITTI + KLOORITTI	80			0.25	0.1						162
12.0	"	PY + KLOORITTI + PO.	70			0.36	0.3						163
13.0	"	PY + KLOORITTI + PO + CHPY				0.22	0.9						164
14.0	ABFST	"/ KEB + PY + PO.				0.25	0.1						165
15.0	"	"				0.28	0.1						166
16.0	"	" + CHPY				0.47	0						167
17.0	"	"				0.24	0.3						168

APPENDIX 5

Leikkaus n:o

N 95 F

Leikkaus n:o

N 950

2

Syvyys m	Kivilaji lyhennys	Kivilajiseloste	Analyysit										N:o
			Karkeusluokka	Siite	Puus	Ch	An	Cu+An					
19.0	ABFST	BREKS. P.O + PY	80			0.25	0.6					89-76	170
20.0	"	"	80			0.37	0.3						171
21.0	"	SVANT FOLIOIT $\sim 30^\circ$	90			0.26	0.2						172
22.0	"	" LIT P.O.	80			0.20	0.2						173
23.0	"	SULFIDRI	80			0.23	0.3						174
24.0	DB	UHAONNITISK. AMFIOOLIT.	80			0.06	5.2						175
25.0	"	"	80			0.05	0.1						176
26.0	"	"	80			0.04	0						177
26.2	"	"	80			0.09	0.1						178
27.0	ABFST	SULFIDRI SEMIOTTISERI	80			0.17	0.6						179
28.0	"	"	80			0.21	0.3						180
29.0	"	SVANT BRENS PYRIT	80			0.08	0.5						181
29.3	"	" M/KLORIIT	80			0.14	0						182
30.0	KRB	CC + DOLOMIT	80			0.06	0						183
31.0	"	M/KLORIIT + PU + CHAPY	80			0.28	0.1						184
32.0	"	DOLOMIT FOL $\sim 30^\circ$ + CHAPY	80			0.10	0.4						185
33.0	ABFST	STEENT BRENS. PO + CHAPY + KLORIIT	80			0.09	3.1						186
34.0	"	SVANT BRENS + FOL. KRB PA SÄLH.	80			0.07	14.0						187
35.0	"	" SULFIDRI FO $\sim 30^\circ$	10	90		0.03	11.3						188
36.0	"	" + KLORIIT	10	100									189
36.6	"	"	10	100									190
37.1	"	KJERNE TAP		100									191
38.0	ABFST	SOM FORAN	115	100		0.03	2.6						192
39.0	"	"	2215	110		0.54	0.5						193
39.3	"	KJERNE TAP											194
40.0	ABFST	BRENS. SULFIDRI KRB		90		0.02	0.8						195

(6.38)
0.15 / 4.15
10

182
183
184
185
186
187
188
189
190
191
192
193
194
195

2

Reikä n:o

N95F

Leikkaus n:o

N950

3

Syvyys m	Kivilaji lyhennys	Kivilajiseloste	Analyysit										N:o		
			K	CaO	SiO ₂	Fe ₂ O ₃	MgO	Al ₂ O ₃	Ca+Al						
41.0	ABFST	BRENS MURRA ANTIPIRITIN SUURIPERA	3		90			0.03	3.9					8776	192
42.0	"	" " " " FOL 45°	}					0.23	16.6						193
43.0	"	" " " "						0.46	6.0						194
43.2	"	" " " "						0.02	5.5						195
44.0	DB	M/ULORITTAGREGATER													
45.0	"	"	}					0.48	0.2						196
46.0	"	LITTE CHRY						1.64	0.2						198
47.0	"	HYE CHRY						2.59	0						198
48.0	"	UMAGNETISU AMFIBOLITTE						0.10	0						199
49.0	"	" " " "	}					0.05	0.3						200
50.0	"	STERIIT ALMITTIN VERT + ULORIT		215				0.21	0						201
51.0	ABFST	STERIIT BRENS + ULORITINER		215				0.84	0.5						202
52.0	"	" " " " CHRYT AYT		215				0.29	0.1						203
53.0	"	" " " "	}					0.03	0.1						204
54.0	"	" " " " ANTI + PYRIT						0.02	0						205
55.0	"	"						0.04	0.1						206
56.0	"	"						0.17	0.1						207
57.0	"	"	}					0.01	0.1						208
58.0	"	"		8				0.01	0.3						209
59.0	"	"						0.02	0.1						210
60.0	"	" " " "						0.07	0.1						211
61.0	"	"	}					0.01	0						212
62.0	"	"						0.02	0						213
62.9	"	"						0.02	0						214
63.0	DB	FOL 45° + ULORITTAGREGATER													
63.8	"	" " " "						0.01	0.1						215

APPENDIX 5

K, N95F

Depth (m)	3.00	4.00	5.00	5.80	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00
RockType	KRB	KRB	KRB	KRB	ABFST	ABFST	ABFST	ABFST/KRB	ABFST/KRB	ABFST/KRB	ABFST/KRB	ABFST
Anal.no.	8976154	8976155	8976156	8976157	8976158	8976159	8976160	8976161	8976162	8976163	8976164	8976165
SiO2	6.23	2.56	2.55	10.3	62.1	53.4	32.9	8.43	5.26	5.68	16.4	30.3
TiO2	0.103	0.0436	0.0451	0.124	0.566	0.553	0.23	0.0385	0.0171	0.0332	0.0546	0.272
Al2O3	1.82	0.774	0.77	2.75	13.8	12.2	4.89	0.927	0.374	0.891	1.22	6.35
Cr2O3	0.0078	0.004	0.0046	0.0069	0.0251	0.0265	0.0124	0.0063	0.0061	0.0054	0.007	0.0126
V2O3	0.0079	0.0033	0.0051	0.0083	0.0229	0.0261	0.014	0.0058	0.0114	0.0099	0.0144	0.0174
FeO	6.19	3.1	4.23	7	7.33	12.67	13.13	12.59	13.71	13.72	14.39	14.33
MnO	0.253	0.294	0.337	0.293	0.0225	0.029	0.205	0.403	0.527	0.423	0.371	0.194
MgO	4.15	14.3	18.6	15.2	0.43	0.05	4	7.53	13.4	10.4	8.99	3.4
CaO	42	35.2	29.7	24.7	2.46	4.79	18.5	30.5	25.9	27.2	24.2	18.5
Rb2O	0.0006	0.0004	0.0004	0.0002	0.0007	0.0004	0	0.0003	0.0002	0.0005	0.0005	0.0002
SrO	0.0117	0.0076	0.0075	0.0065	0.0029	0.0032	0.0042	0.0058	0.0055	0.0053	0.0046	0.0036
BaO	0.004	0.001	0.004	0.001	0.003	0.001	0.003	0.003	0.001	0.002	0.002	0.002
Na2O	1.01	0.34	0.33	1.59	8.6	7.8	2.77	0.27	0	0.22	0.41	3.82
K2O	0.029	0.008	0.008	0.016	0.053	0.045	0.015	0.003	0.004	0.009	0.029	0.02
ZrO2	0.0004	0	0	0.0011	0.013	0.0126	0.0046	0	0	0	0	0.0053
P2O5	0.114	0.05	0.047	0.056	0.064	0.061	0.025	0.01	0.005	0.01	0.014	0.037
CO2	37.179	43.706	44.036	37.216	1.98	3.923	20.533	35.566	33.939	38.336	29.773	19.433
OxSum	74	69	69.2	73.9	99.2	98.6	86.6	73.7	72.2	71.6	77.6	86.4
Cu	0.0097	0.0013	0.0009	0.0031	0.0029	0.0071	0.248	0.257	0.23	0.322	0.195	0.209
Ni	0.0188	0.0047	0.0063	0.0165	0.02	0.0261	0.0466	0.0482	0.0432	0.0425	0.0522	0.0597
Co	0.0168	0.0046	0.0061	0.0147	0.0164	0.0244	0.0543	0.0457	0.034	0.0456	0.0458	0.055
Zn	0.0005	0.0002	0	0	0	0	0	0.0001	0	0	0	0
Pb	0.001	0	0	0	0	0.001	0.001	0	0	0.002	0.001	0.001
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	3.61	0.575	0.999	3.29	6.29	11.4	7.46	5.27	3.7	4.9	5.89	6.91
As	0.0022	0.0007	0.001	0.0028	0.0019	0.002	0.0018	0.0004	0.0009	0.0003	0.0006	0.0004
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0.004	0.014	0
Te	0	0	0	0	0	0	0	0	0	0.001	0.011	0
Y	0.002	0.0007	0.0004	0.0004	0.0005	0.0007	0.0025	0.004	0.0034	0.0031	0.0029	0.0025
Nb	0	0	0	0	0	0	0	0	0	0	0	0
Mo	0	0	0	0	0.0007	0.0006	0.0002	0	0	0	0.0003	0.0002
Sn	0.001	0.001	0	0.001	0.001	0	0	0.002	0.001	0.001	0	0.001
H	0	0	0.001	0	0	0	0	0	0	0.001	0.001	0
Cl	0.027	0.025	0.009	0.011	0.009	0.014	0.029	0.044	0.045	0.039	0.034	0.029
Th	0.0001	0	0	0	0.0005	0.0002	0	0.0001	0.0002	0.0007	0	0
U	0.0012	0.0005	0.0011	0.0006	0.001	0.0015	0.001	0.0009	0.0009	0.0009	0.0005	0.0012
Cs	0	0.002	0	0	0.003	0.006	0.004	0.004	0.001	0.002	0.002	0.001
La	0.002	0	0.002	0.001	0.004	0.005	0.005	0.002	0	0.003	0.005	0.006
Ce	0.002	0.002	0	0.004	0.005	0.004	0.003	0.004	0.005	0.002	0.004	0.006
Ta	0	0	0	0	0	0.001	0.001	0.001	0	0	0	0
Au	0	0	0	0	0	0	0	0.1	0.1	0.3	0.9	0.1

K. N95F												
Depth (m)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00
RockType	ABFST	DB	DB	DB								
Anal.no.	8976166	8976167	8976168	8976169	8976170	8976171	8976172	8976173	8976174	8976175	8976176	8976177
SiO2	34.1	34.2	43.2	19.1	54.9	59.1	58	52.5	52.6	50.5	50.9	50.9
TiO2	0.351	0.386	0.42	0.175	0.513	0.572	0.624	0.315	0.358	0.479	0.515	0.466
Al2O3	7.99	7.63	9.54	3.66	11.1	12.2	14.3	14.7	17	19	19.7	19.5
Cr2O3	0.016	0.0172	0.0179	0.0114	0.0217	0.0201	0.0279	0.0079	0.0071	0.0059	0.0046	0.0053
V2O3	0.0192	0.0177	0.022	0.0131	0.0222	0.0225	0.0227	0.016	0.0123	0.0178	0.0172	0.0153
FeO	17.11	21.37	11	13.31	11.36	9.46	3.95	3.13	2.48	4.24	4.6	3.95
MnO	0.189	0.153	0.122	0.234	0.0603	0.0365	0.0723	0.131	0.0307	0.0858	0.0793	0.0785
MgO	4.57	3.67	2.75	4.64	0.6	0.11	1.36	3.02	1.57	2.7	2.88	2.6
CaO	12.4	9.85	12.1	27.2	5.56	5.14	7.64	8.89	5.99	8.83	8.36	8.83
Rb2O	0.0001	0.0002	0.0006	0.0003	0.0004	0	0.0003	0.0009	0.0004	0.0066	0.0069	0.0065
SrO	0.0042	0.0029	0.0044	0.0083	0.0023	0.0044	0.0066	0.0093	0.0087	0.0193	0.0248	0.0268
BaO	0.003	0	0.004	0.003	0.002	0.001	0.002	0.006	0.004	0.032	0.031	0.025
Na2O	4.84	4.74	5.98	2.22	5.94	7.62	8.72	8.61	9.95	6.95	6.54	6.78
K2O	0.019	0.017	0.03	0.032	0.04	0.042	0.032	0.191	0.198	2.12	2.42	2.25
ZrO2	0.008	0.0081	0.0096	0.0027	0.0124	0.0146	0.015	0.0115	0.0133	0.0086	0.0086	0.0084
P2O5	0.054	0.04	0.062	0.026	0.065	0.113	0.107	0.118	0.131	0.481	0.501	0.536
CO2	16.426	13.823	13.64	27.133	5.947	4.217	7.113	10.23	6.087	5.623	4.437	5.133
OxSum	91	91.9	92.2	81.7	97.7	93.3	95.3	95.1	96.8	97.7	98.6	97.8
Cu	0.27	0.452	0.225	0.172	0.229	0.351	0.241	0.172	0.223	0.0411	0.0329	0.0296
Ni	0.0668	0.0882	0.0449	0.0498	0.055	0.0466	0.0171	0.0075	0.0064	0.0069	0.0052	0.0037
Co	0.0704	0.0842	0.0413	0.0469	0.0555	0.0359	0.0215	0.0128	0.0115	0.0112	0.0082	0.0087
Zn	0	0	0	0	0	0	0	0.0004	0.0002	0.0001	0.0003	0.0003
Pb	0.001	0.001	0.001	0.001	0	0.001	0.001	0.001	0	0	0.001	0
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	8.51	10.4	5.49	6.08	6.63	5.4	1.92	0.915	1.01	1.03	0.736	0.585
As	0.0003	0.0003	0.0001	0	0.0005	0.0005	0.0005	0.0004	0.0007	0.0005	0.0005	0.001
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0.001	0	0.002	0.001	0.001	0.001	0	0.001	0	0.006	0	0
Te	0	0	0.001	0.002	0.007	0.006	0	0	0	0.014	0	0
Y	0.0017	0.0012	0.0021	0.0052	0.0016	0.0024	0.0015	0.0011	0.0011	0.0012	0.0014	0.0014
Nb	0	0	0	0	0	0	0	0	0	0	0	0
Mo	0.0008	0.0022	0.002	0.0004	0.0016	0.001	0.0015	0.0006	0.0019	0.0002	0	0
Sn	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0	0.001
H	0	0	0.001	0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cl	0.017	0.02	0.016	0.025	0.014	0.008	0.011	0.017	0.013	0.088	0.111	0.042
Th	0	0.0006	0.0003	0.0001	0	0.0009	0.0002	0.0002	0	0.0007	0.0001	0.0002
U	0.0011	0.0006	0.0012	0.0013	0.0013	0.0013	0.0013	0.0011	0.0009	0.0012	0.001	0.0009
Cs	0.003	0.004	0.004	0.001	0	0.004	0.001	0	0.001	0.001	0.004	0
La	0.011	0.004	0.009	0.006	0.003	0.002	0.003	0	0.003	0.003	0.003	0.002
Ce	0.019	0.006	0.015	0.006	0.005	0.004	0.005	0.003	0.006	0.008	0.006	0.006
Ta	0	0.001	0	0	0	0.001	0	0.001	0	0	0	0
Au	0.1	0	0.3	0.3	0.6	0.3	0.2	0.2	0.2	5.2	0.1	0

K, WPSF												
Depth (m)	26.00	26.00	29.00	29.30	31.00	32.00	32.00	34.00	35.00	35.00	36.50	38.00
Fac:Type	08	ABFST	ABFST	ABFST	Y98	163	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST
Anal.no.	8976178	8976179	8976180	8976181	8976182	8976183	8976184	8976185	8976186	8976187	8976188	8976189
SiO2	59.3	61.1	61	44.9	5.29	1.66	24.5	64.9	69.2	72	70.1	72.3
TiO2	0.219	0.272	0.228	0.464	0.0793	0.0282	0.257	0.528	0.264	0.367	0.711	0.67
Al2O3	17.8	15.1	15.1	10.7	1.56	0.605	5.29	14.9	15.7	13.9	16.1	14.9
Cr2O3	0.0076	0.0254	0.0321	0.0215	0.0066	0.0037	0.0107	0.0224	0.0252	0.0252	0.027	0.0252
V2O3	0.0141	0.038	0.0434	0.0323	0.0137	0.0045	0.0145	0.0276	0.0299	0.0293	0.0258	0.021
FeO	3.13	4.12	3.9	4.21	9.32	3.52	14.5	1.06	0.953	0.89	0.723	0.573
MnO	0.0743	0.0501	0.0457	0.129	0.242	0.231	0.162	0.0425	0.0264	0.0216	0.0133	0.0145
MgO	2.2	2.36	2.95	7.42	17.9	20.3	10.3	0.52	0.33	0.3	0.09	0
CaO	5.51	4.3	4.53	11.2	25	29.5	17.3	6.24	2.57	2.53	1.47	1.83
Pb2O	0.0023	0.0008	0.0016	0.0001	0	0.0005	0.0005	0.0003	0.0004	0.0002	0.0003	0.0002
SrO	0.0051	0.0047	0.005	0.0046	0.0045	0.0054	0.0044	0.0035	0.0027	0.003	0.0032	0.0036
BaO	0.011	0.004	0.006	0.004	0.001	0	0.001	0	0.003	0.002	0.005	0.001
Na2O	9.12	8.72	8.19	5.71	0.24	0	2.47	3.94	9.33	8.4	9.59	3.37
K2O	0.227	0.227	0.441	0.121	0.015	0.046	0.022	0.092	0.133	0.051	0.074	0.069
ZrO2	0.0101	0.0165	0.0144	0.01	0.0002	0	0.0033	0.0157	0.0164	0.0155	0.0177	0.0122
P2O5	0.244	0.082	0.101	0.066	0.033	0.027	0.027	0.096	0.082	0.074	0.082	0.098
CO2	5.06	4.473	4.393	17.13	29.086	45.579	23.099	5.17	2.09	2.163	1.173	1.173
OxSum	99.9	99.5	99.5	90.6	72.9	69.2	25.4	99.2	99.9	99.9	99.9	99.9
Cu	0.0359	0.161	0.159	0.0565	0.121	0.0419	0.27	0.0906	0.0772	0.0562	0.0136	0.0103
Ni	0.0095	0.0207	0.0166	0.0092	0.0432	0.0101	0.0497	0.0132	0.0127	0.0193	0.0196	0.0066
Co	0.0093	0.0118	0.0054	0.0075	0.0195	0.0047	0.0441	0.0039	0.0046	0.0069	0.0055	0.0042
Zn	0	0.0002	0.0002	0.0003	0	0	0.0004	0.0003	0.0004	0.0003	0.0003	0.0004
Pb	0.001	0	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.006	0.003	0.001
Ag	0	0	0	0	0	0	0	0	0	0	0	0
C	0.992	1.98	1.54	1.29	3.78	0.691	7.36	0.45	0.224	0.296	0.227	0.142
As	0.0005	0.0007	0.0004	0.0005	0.0001	0	0.0011	0	0.0002	0.0002	0.0005	0.0008
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0.001	0.005	0.012	0	0	0.001	0	0	0.003	0	0
Te	0	0	0.004	0.011	0	0	0	0.004	0.024	0.052	0.05	0.007
Y	0.0005	0.002	0.0031	0.0011	0.0007	0.0007	0.001	0.0012	0.0009	0.002	0.0025	0.0017
Nb	0	0	0	0	0	0	0	0	0	0	0	0
Mo	0.001	0.0024	0.0007	0.0007	0.0002	0	0	0.0015	0.0011	0.0022	0.0007	0.0005
Sn	0.001	0.001	0.001	0.001	0.001	0.001	0	0.001	0.001	0.001	0.001	0.001
W	0	0.001	0.001	0	0	0	0.001	0.001	0	0	0	0
Cl	0.021	0.01	0.013	0.014	0.012	0.007	0.012	0.009	0.007	0.01	0.007	0.006
Ti	0.0002	0.0002	0.0008	0.0003	0	0	0.0003	0	0.0003	0.0003	0.0002	0
U	0.0012	0.0017	0.0039	0.0009	0.0004	0.0003	0.0003	0.0014	0.0019	0.0025	0.0003	0.0022
Cs	0	0.002	0	0	0	0	0.001	0.004	0	0	0	0
La	0.003	0.003	0.002	0.001	0	0.002	0.001	0.003	0.001	0.005	0.002	0.002
Ce	0.004	0.004	0.003	0.002	0	0.001	0.002	0.003	0.003	0.01	0.007	0.003
Ta	0	0	0.001	0	0.001	0	0.001	0.001	0.001	0	0.001	0
Au	0.1	0.3	0.2	0.5	0	0	0.1	0.4	3.1	14	11.3	2.3

% N75F												
Depth (m)	39.00	40.00	41.00	42.00	43.00	43.20	45.00	46.00	47.00	48.00	49.00	50.00
RockType	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST	DB	DB	DB	DB	DB	DB
Anal.no.	8976190	8976191	8976192	8976193	8976194	8976195	8976196	8976197	8976198	8976199	8976200	8976201
SiO2	53.6	57.2	57.9	57.4	56.3	56.2	50.9	29.5	27.9	49.5	46.3	53
TiO2	0.598	0.654	0.514	0.557	0.663	0.739	0.465	0.258	0.255	0.45	0.456	0.343
Al2O3	14.2	15.4	13.9	12.5	14.3	17.4	19.1	9.74	10.7	19.3	18.2	18.4
Cr2O3	0.0216	0.0296	0.0164	0.0202	0.0224	0.0272	0.0059	0.0064	0.0044	0.0052	0.0057	0.0053
MgO	0.0291	0.0207	0.0195	0.0232	0.0336	0.0357	0.02	0.0154	0.0195	0.0167	0.0162	0.0135
FeO	4.12	0.706	0.575	3.93	3.04	0.591	5.25	6.39	12.01	4.4	4.47	2.48
MnO	0.128	0.034	0.0638	0.0675	0.0265	0.016	0.0439	0.373	0.275	0.085	0.1	0.116
MgO	3.6	0.05	0.27	0.28	0.1	0	2.49	7.76	2.23	3.37	3.08	2.91
CaO	7.7	5.1	12.4	9.75	3.2	1.77	3.97	15.6	15.5	2.76	9.27	6.12
Rb2O	0.0003	0.0001	0.0003	0	0.0002	0.0003	0.0057	0.0018	0.0028	0.0053	0.007	0.0005
BrO	0.0057	0.0046	0.005	0.0038	0.0034	0.003	0.007	0.0075	0.0065	0.0172	0.0239	0.0062
BaO	0.008	0.002	0.002	0.005	0.003	0.003	0.021	0.01	0.012	0.034	0.03	0.005
Na2O	7.5	9.28	7.1	7.54	3.92	10.5	5.64	3.97	3.51	5.04	6.37	9.26
K2O	0.287	0.059	0.049	0.076	0.069	0.073	2.42	0.584	0.919	2.81	2.37	0.201
ZrO2	0.0131	0.0163	0.0121	0.0124	0.0153	0.0183	0.0025	0.0042	0.0046	0.0093	0.0091	0.0132
FeO5	0.161	0.085	0.063	0.059	0.095	0.046	0.465	0.232	0.267	0.504	0.403	0.14
CO2	10.083	4.107	10.72	7.992	2.42	1.233	2.567	22.036	16.81	4.997	6.563	7.993
DxSum	96.1	99.9	93.8	96	99.7	100	96.8	84.8	87.6	96.7	95.9	97
Cu	0.311	0.0094	0.0152	0.217	0.434	0.0153	0.455	0.96	2.49	0.0923	0.0391	0.192
Ni	0.0061	0.0024	0.005	0.0574	0.013	0.0022	0.0057	0.0106	0.01	0.0049	0.0031	0.0051
Co	0.005	0.0017	0.0022	0.0118	0.0141	0.0043	0.0052	0.0095	0.0063	0.0046	0.0044	0.0051
Zn	0.0004	0	0	0.0003	0.0001	0.0001	0.0047	0.0013	0.002	0.0003	0	0.0006
Pb	0.001	0.001	0.002	0.004	0.005	0.003	0.001	0.002	0.001	0.001	0.001	0.001
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	1.12	0.072	0.192	2.27	2.11	0.15	1.07	2.04	3.52	0.612	0.299	0.706
As	0.0005	0.0004	0.0004	0.0003	0	0.0003	0	0.0001	0.0002	0.0001	0.0002	0.0007
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0.002	0.002	0	0	0	0	0	0
Te	0	0	0.001	0.028	0.003	0.002	0	0	0	0	0	0
Y	0.0029	0.0019	0.0041	0.0043	0.003	0.0025	0.0021	0.0029	0.0017	0.0015	0.0015	0.0013
Nb	0	0	0	0	0	0	0	0	0	0	0	0
Mo	0.0009	0.001	0.0006	0.0011	0.0007	0.0006	0	0.0004	0.0002	0	0.0007	0.0023
Sn	0.001	0	0	0.002	0.001	0.001	0.001	0	0.001	0.001	0.001	0.001
H	0.001	0	0	0	0.001	0	0	0.001	0.001	0	0	0
Cl	0.014	0.009	0.011	0.011	0.011	0.003	0.017	0.036	0.026	0.601	0.272	0.016
Th	0.001	0.0007	0.0004	0.0001	0.0002	0.0002	0.0003	0	0	0.0003	0.0007	0.0003
U	0.0026	0.0022	0.002	0.0041	0.0015	0.001	0.0012	0.0017	0.001	0.001	0.001	0.0015
Cs	0.004	0.001	0.002	0	0.001	0	0.002	0.002	0.005	0.003	0.005	0.001
La	0.006	0.002	0.005	0.005	0.003	0.01	0	0.002	0.003	0.002	0.004	0.003
Ce	0.005	0.005	0.008	0.01	0.015	0.012	0.004	0.005	0.004	0.005	0.007	0.004
Te	0	0	0	0	0.001	0	0.002	0.001	0.001	0	0	0
Au	0.5	0.3	3.9	16	2	2	5.5	0.2	0	0	0.3	0

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg, Appendix 5b/5, Chemical analyses.

X, NYSF												
Depth (m)	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00	61.00	62.00
RockType	ABFST											
Anal.no.	8976202	8976203	8976204	8976205	8976206	8976207	8976208	8976209	8976210	8976211	8976212	8976213
SiO2	35.6	50.1	54.4	60.6	35.5	44	55.8	59.2	57.8	56.8	65	62.2
TiO2	0.254	0.549	0.609	0.58	0.314	0.376	0.249	0.55	0.539	0.485	0.582	0.532
Al2O3	7.31	12.3	14.2	14	6.13	11.8	15.3	13.9	13.4	12.6	15.7	15.1
Cr2O3	0.0121	0.0222	0.0237	0.0247	0.0155	0.0183	0.0093	0.0222	0.0228	0.0206	0.0245	0.0218
V2O3	0.0149	0.0244	0.0276	0.0224	0.0153	0.0129	0.0101	0.0269	0.0269	0.0184	0.0197	0.0193
FeO	8.6	5.07	3.54	2.81	3.63	9.44	4.75	5.08	5.78	4.75	1.82	2.95
MnO	0.178	0.132	0.0924	0.0626	0.157	0.109	0.0722	0.0569	0.0577	0.0764	0.0335	0.0444
HgO	2.81	4.89	3.75	3.11	4.51	2.8	2.15	4.24	3.84	3.87	2.43	3.06
CaO	20.7	10.8	9.92	7.64	15.7	12	6.98	5.56	6.37	8.86	3.78	5.12
Rb2O	0.0007	0.0006	0.0005	0.0003	0.0005	0.0007	0.0006	0.0009	0.0008	0.0003	0.0006	0.0007
SrO	0.0101	0.0044	0.0049	0.0041	0.0075	0.0067	0.0045	0.004	0.0051	0.0043	0.0034	0.0033
BaO	0.004	0.003	0	0.002	0.002	0.003	0.002	0.002	0.001	0.001	0	0.002
Na2O	3.79	6.83	6.09	8.17	4.74	6.98	9.07	7.85	7.62	7.47	9.32	8.85
K2O	0.038	0.177	0.171	0.074	0.047	0.19	0.085	0.344	0.156	0.104	0.132	0.109
ZrO2	0.0058	0.0123	0.0143	0.014	0.007	0.009	0.009	0.0134	0.0121	0.0116	0.0143	0.0126
P2O5	0.041	0.059	0.057	0.059	0.035	0.069	0.102	0.062	0.059	0.066	0.065	0.054
CO2	17.526	10.193	7.736	5.097	16.22	9.533	6.416	3.667	4.252	5.867	2.347	3.447
OxSum	87.6	94.6	95.3	99.1	89.4	94.3	98	99.4	93.9	98.1	99.8	99.7
Cu	0.816	0.281	0.0124	0.0067	0.0306	0.16	0.0061	0.0035	0.0046	0.0053	0.0012	0.0053
Ni	0.0307	0.0074	0.0081	0.0076	0.0137	0.0444	0.0157	0.0172	0.0215	0.0148	0.0059	0.0072
Co	0.0175	0.0069	0.0051	0.0068	0.0448	0.0711	0.0319	0.0291	0.0296	0.0174	0.0048	0.0089
Zn	0.0009	0.0002	0.0015	0.0004	0	0	0	0	0.0003	0	0.0002	0
Pb	0.002	0.001	0.001	0	0.001	0.001	0.002	0	0.001	0	0.001	0.001
Ag	0	0	0	0	0	0	0	0	0	0	0	0
S	4.73	1.06	0.372	0.843	5.66	6.84	3.13	2.8	3.55	2.49	0.361	1.13
As	0	0.0005	0.0011	0.001	0.0015	0.0044	0.0019	0.0022	0.0029	0.0014	0.0002	0.0006
Sb	0	0	0	0	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	0	0	0	0	0	0
Te	0	0	0	0	0	0	0	0	0	0	0	0
Y	0.005	0.0022	0.0023	0.0019	0.0027	0.0023	0.0012	0.0022	0.0021	0.0025	0.0016	0.0017
Nb	0	0	0	0	0	0	0	0	0	0	0	0
Mo	0.0011	0.0049	0.0023	0.0019	0.0007	0.0031	0.0029	0.0013	0.0021	0.0124	0.0002	0.0006
Sn	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Hf	0.001	0	0.001	0	0.001	0.001	0.001	0.001	0.001	0.001	0	0
Cl	0.025	0.026	0.011	0.007	0.014	0.019	0.016	0.015	0.01	0.01	0.008	0.007
Th	0	0.0005	0.0006	0.0007	0.0001	0.0002	0.0004	0	0.0004	0.0004	0.0006	0
U	0.0011	0.0016	0.0015	0.0015	0.0003	0.001	0.0009	0.0014	0.001	0.0012	0.0009	0.0008
Cs	0.002	0	0	0	0.004	0.001	0.003	0.004	0.001	0.002	0.002	0
La	0.005	0.001	0.003	0.003	0.007	0.004	0.002	0.004	0.004	0.005	0.003	0.002
Ce	0.004	0.004	0.007	0.006	0.005	0.007	0.004	0.005	0.009	0.003	0.006	0.005
Ta	0.001	0	0	0	0	0	0	0.001	0	0	0	0
Au	0.5	0.1	0.1	0	0.1	0.1	0.1	0.3	0.1	0.1	0	0

W. N55F
 Depth (m) 52.90 53.80
 Rock Type 48F9T 08
 Anal. no. 8976214 8976215

SiO2	57.2	16.1
TiO2	0.45	0.113
Al2O3	12.5	3.06
Cr2O3	0.0226	0.0054
VO3	0.0157	0.0116
FeO	4.86	7.43
MnO	0.0629	0.3
MgO	3.95	10.4
CaO	7.15	28
Pb2O	0.0007	0.0022
SnO	0.0044	0.0022
BaO	0.001	0.005
Ni2O	7.36	1.1
K2O	0.146	0.546
ZnO2	0.0101	0.0018
FeO5	0.053	0.045
CO2	5.06	30.487
OxSum	98.5	76.6
Cu	0.0066	0.0041
Ni	0.0094	0.011
Co	0.0199	0.0128
Zn	0	0
Pb	0.001	0.001
Hg	0	0
S	2.48	2.47
As	0.0012	0.0013
Sb	0	0
Bi	0	0
Te	0	0
Y	0.002	0.0023
Rb	0	0
Mo	0.0005	0.0015
Sn	0.001	0.001
H	0	0
Cl	0.012	0.02
Th	0.0006	0
U	0.0013	0.0005
Ce	0	0.002
La	0.005	0.002
Ce	0.01	0.002
Te	0	0
Pu	0	0.1

Bidjovagge ore types / correlation matrix

K-ORE / CORRELATION COEFFICIENTS

	SiO2	TiO2	Al2O3	Cr2O3	V2O3	FeO	MnO	MgO	CaO	Rb2O	SrO	BaO	Na2O	K2O	ZrO2	P2O5	CO2	Cu	Ni	Co	Zn	Pb	S	As	Au	Bi	Te	Y	Mo	Cl	Th	U	Cs	La	Ce				
SiO2	1.00																																						
TiO2	0.94	1.00																																					
Al2O3	0.95	0.96	1.00																																				
Cr2O3	0.65	0.70	0.52	1.00																																			
V2O3	0.83	0.84	0.75	0.77	1.00																																		
FeO	-0.37	-0.43	-0.40	-0.33	-0.27	1.00																																	
MnO	-0.75	-0.80	-0.73	-0.68	-0.67	0.64	1.00																																
MgO	-0.50	-0.51	-0.44	-0.51	-0.46	0.61	0.75	1.00																															
CaO	-0.79	-0.79	-0.77	-0.62	-0.72	0.60	0.95	0.71	1.00																														
Rb2O	0.12	0.11	0.28	-0.43	-0.02	0.07	0.03	0.23	-0.04	1.00																													
SrO	-0.17	-0.17	-0.01	-0.66	-0.35	0.12	0.35	0.34	0.35	0.70	1.00																												
BaO	0.18	0.14	0.27	-0.33	0.08	0.05	0.03	0.34	0.04	0.59	0.62	1.00																											
Na2O	0.82	0.85	0.85	0.51	0.61	-0.27	-0.57	-0.37	-0.58	0.13	-0.06	0.26	1.00																										
K2O	0.53	0.54	0.68	-0.09	0.38	-0.22	-0.32	-0.03	-0.39	0.80	0.52	0.56	0.44	1.00																									
ZrO2	0.95	0.97	0.96	0.66	0.80	-0.38	-0.74	-0.48	-0.76	0.09	-0.16	0.12	0.81	0.53	1.00																								
P2O5	0.49	0.57	0.69	-0.12	0.27	-0.28	-0.37	-0.14	-0.40	0.64	0.52	0.58	0.54	0.85	0.54	1.00																							
CO2	-0.82	-0.82	-0.80	-0.60	-0.69	0.60	0.96	0.70	0.97	-0.14	0.23	-0.10	-0.61	-0.46	-0.78	-0.46	1.00																						
Cu	0.08	-0.01	0.03	-0.12	0.20	0.38	0.25	0.12	0.12	0.01	0.05	0.26	-0.04	0.05	0.04	0.04	0.19	1.00																					
Ni	-0.20	-0.27	-0.36	0.14	-0.04	0.66	0.30	0.23	0.32	-0.45	-0.38	-0.28	-0.10	-0.58	-0.24	-0.58	0.36	0.39	1.00																				
Co	-0.17	-0.27	-0.29	0.00	-0.14	0.79	0.38	0.30	0.37	-0.24	-0.14	-0.13	-0.12	-0.43	-0.21	-0.47	0.37	0.28	0.85	1.00																			
Zn	0.19	0.23	0.28	-0.10	0.21	-0.13	-0.10	-0.02	-0.18	0.30	0.13	0.21	0.20	0.40	0.22	0.42	-0.17	0.30	-0.27	-0.41	1.00																		
Pb	0.26	0.25	0.24	0.22	0.32	-0.21	-0.22	-0.30	-0.20	-0.11	-0.19	-0.04	0.20	0.09	0.26	0.05	-0.18	0.31	0.06	-0.12	0.25	1.00																	
S	-0.26	-0.32	-0.33	-0.08	-0.16	0.91	0.48	0.46	0.48	-0.15	-0.12	-0.09	-0.17	-0.36	-0.27	-0.39	0.49	0.31	0.81	0.90	-0.23	-0.15	1.00																
As	0.04	0.01	-0.01	0.16	-0.09	0.06	-0.03	0.01	0.00	-0.08	-0.06	-0.08	0.10	-0.10	0.03	-0.14	-0.03	-0.51	0.04	0.25	-0.27	-0.36	0.20	1.00															
Au	0.40	0.34	0.31	0.33	0.47	-0.41	-0.41	-0.51	-0.42	-0.09	-0.15	0.23	0.25	0.13	0.32	0.10	-0.41	0.26	0.00	-0.18	0.16	0.35	-0.35	-0.25	1.00														
Bi	0.06	0.02	-0.03	0.13	0.27	0.09	-0.02	-0.07	-0.06	-0.09	-0.11	0.13	0.05	-0.08	-0.02	-0.14	0.01	0.28	0.24	0.21	-0.11	0.16	0.13	-0.17	0.42	1.00													
Te	0.25	0.24	0.15	0.33	0.37	-0.40	-0.40	-0.47	-0.36	-0.26	-0.30	0.04	0.16	-0.06	0.18	-0.02	-0.32	0.13	0.15	-0.13	0.00	0.35	-0.26	-0.22	0.74	0.55	1.00												
Y	0.22	0.10	0.06	0.25	0.29	0.07	0.04	-0.12	0.05	-0.08	-0.05	0.11	0.06	-0.03	0.11	-0.22	-0.02	0.38	0.23	0.18	0.14	0.34	0.09	-0.17	0.44	0.16	0.24	1.00											
Mo	0.59	0.56	0.52	0.62	0.52	-0.22	-0.39	-0.23	-0.42	-0.21	-0.37	-0.18	0.49	0.12	0.61	0.05	-0.39	0.01	0.05	0.03	-0.06	0.13	-0.04	0.16	0.27	-0.00	0.13	0.17	1.00										
Cl	-0.15	-0.22	-0.09	-0.59	-0.25	0.38	0.42	0.36	0.38	0.60	0.73	0.55	-0.11	0.34	-0.22	0.30	0.28	0.27	-0.06	0.11	0.01	-0.06	0.12	-0.18	-0.15	0.02	-0.22	0.10	-0.38	1.00									
Th	0.41	0.42	0.39	0.38	0.45	-0.23	-0.41	-0.22	-0.44	0.07	-0.13	-0.05	0.28	0.21	0.39	0.16	-0.43	-0.04	-0.26	-0.22	0.03	0.17	-0.26	-0.01	0.17	0.24	0.10	0.10	0.28	-0.07	1.00								
U	0.51	0.55	0.48	0.51	0.54	-0.47	-0.52	-0.45	-0.54	-0.09	-0.22	0.17	0.38	0.20	0.51	0.28	-0.51	0.13	-0.13	-0.38	0.28	0.27	-0.38	-0.11	0.52	0.05	0.45	0.32	0.32	-0.22	0.31	1.00							
Cs	0.05	-0.04	0.01	-0.14	-0.03	0.40	0.19	0.16	0.15	0.17	0.12	0.07	0.06	0.03	0.00	0.03	0.12	0.20	0.18	0.30	-0.08	-0.04	0.35	-0.08	-0.08	-0.09	-0.29	0.21	0.03	0.38	0.01	-0.22	1.00						
La	0.40	0.39	0.34	0.40	0.35	-0.03	-0.23	-0.26	-0.20	-0.05	-0.14	-0.01	0.39	0.06	0.38	0.01	-0.23	0.02	0.14	0.18	-0.23	0.23	0.14	0.09	0.13	0.14	0.17	0.32	0.36	-0.07	0.14	0.24	0.23	1.00					
Ce	0.67	0.57	0.57	0.45	0.53	-0.16	-0.43	-0.40	-0.47	0.08	-0.09	0.12	0.43	0.27	0.61	0.18	-0.52	0.11	-0.03	0.05	0.06	0.18	-0.08	0.05	0.39	0.17	0.23	0.48	0.38	0.03	0.31	0.36	0.18	0.51	1.00				

APPENDIX 5c.

APPENDIX 5d.

Biogeochemical types / factor analysis

K-MRE / ROTATED FACTOR MATRIX

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
SiO2	0.950									
TiO2	0.942									
Al2O3	0.945									
Cr2O3	0.683	-0.567								
FeO	0.916									
FeO			0.986							
MnO	-0.720									
MgO	-0.455								0.499	
CaO	-0.895									
P2O5		0.852								
P2O5		0.877								
SeO		0.819								
Na2O	0.845									
K2O		0.723								
ZnO	0.961									
P2O5	0.519	0.630								
CO2	-0.818									
Cu			0.431		0.640					
KI			0.816							
Ca			0.415							
Zn								0.781		
Pb									0.770	
S			0.947							
As					-0.643					
Au				-0.571		0.415				
Di				-0.752						
Te				-0.831						
Y						0.951				
Mo	0.541									
Cl		0.784								
Th							0.827			
U	0.434		-0.313	-0.303		0.400				
Ce				0.407	0.441			-0.432		
La	0.401							-0.520	0.454	
Ce	0.534					0.574				

K. N95F
 Depth (m) 62.90 63.80
 RockType ABFS1 DB
 Anal.no. 3976214 8976215

Si	50.11	13.31
Ti	0.29	0.07
Al	12.47	2.98
Cr	0.02	0.00
V	0.01	0.01
Fe	3.44	5.18
Mn	0.05	0.21
Mg	5.02	12.81
Ca	8.48	24.79
Rb	0.00	0.00
Sr	0.002	0.004
Ba	0.000	0.002
Na	12.08	1.76
K	0.16	0.58
Zr	0.009	0.001
P	0.04	0.03
C	5.85	34.38
Cu	0.01	0.00
Ni	0.01	0.01
Co	0.02	0.01
Zn	0.00	0.00
Pb	0.00	0.00
S	3.93	3.83
Cl	0.02	0.03
SUM	100.00	100.00

CALCULATED

Al2O3/TiO2	27.6	27.1
Al2O3/Cr2O3	553.1	478.1
TiO2/Cr2O3	19.9	17.7
ZrO2/TiO2	0.032	0.014
Co/Ni	2.117	1.527
Carbind	39.1	80.4
cc	33.6	29.9
+mgs	77.0	87.9
+sid	100.0	100.0

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. Appendix 5f/ . Normative mineral composition.

K, N95F												
Depth (m)	3.00	4.00	5.00	5.80	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00
RockType	KRB	KRE	KRB	KRB	ABFST	ABFST	ABFST	ABFST/KRB	ABFST/KRB	ABFST/KRB	ABFST/KRB	ABFST
Anal.no.	8976154	8976155	8976156	8976157	8976158	8976159	8976160	8976161	8976162	8976163	8976164	8976165
ab	7.1	2.0	1.5	11.3	68.9	59.6	20.0	1.0	0.0	0.7	2.3	28.9
qtz	0.2	0.0	0.0	0.0	6.1	6.1	6.6	5.5	3.4	3.5	10.7	2.2
ru	0.1	0.0	0.0	0.1	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.2
af	0.0	0.0	10.7	6.1	6.1	0.2	14.5	0.0	0.0	0.0	0.0	8.9
phl	0.2	0.1	0.1	0.1	0.5	0.4	0.1	0.0	0.0	0.1	0.2	0.2
chl	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	2.2	0.0
sca	0.8	0.8	0.3	0.3	0.3	0.4	0.9	1.4	1.4	1.2	1.1	0.9
apa	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1
dol	81.4	94.0	92.6	78.7	4.5	9.5	45.3	78.4	64.5	80.7	56.4	43.4
cp	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.7	1.0	0.6	0.5
py	2.1	0.4	0.6	1.8	3.2	6.9	6.1	3.2	1.6	3.0	3.2	4.1
po	8.1	1.2	2.1	7.1	15.4	24.7	13.7	11.0	8.2	10.0	13.2	15.1
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.2	100.0	106.2	105.7	107.5	107.2	108.3	101.2	100.0	100.2	100.0	104.6
py/(py+po)	0.20	0.24	0.23	0.20	0.17	0.22	0.31	0.22	0.16	0.23	0.20	0.21

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. Appendix 5f/2. Normative mineral composition.

K. N95F												
Depth (m)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00
RockType	ABFST	DB	DB	DB								
Anal.no.	8976166	8976167	8976168	8976169	8976170	8976171	8976172	8976173	8976174	8976175	8976176	8976177
ab	35.6	35.6	46.6	16.0	54.2	61.0	69.8	68.1	78.4	54.6	50.9	54.9
qtz	0.0	2.1	3.4	0.0	2.6	4.2	2.1	0.0	0.0	0.0	0.0	0.0
ru	0.2	0.2	0.3	0.1	0.3	0.4	0.4	0.2	0.2	0.3	0.3	0.3
af	12.8	6.6	7.1	10.2	19.8	17.1	7.8	16.2	14.2	8.2	11.8	10.5
phl	0.2	0.1	0.3	0.3	0.3	0.4	0.7	1.6	1.7	18.5	21.3	19.8
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.5	0.6	0.5	0.8	0.5	0.3	0.4	0.5	0.4	2.9	3.7	1.4
apa	0.1	0.1	0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.9	1.0	1.0
dol	35.4	30.0	30.5	59.6	13.3	9.7	15.2	25.3	13.9	13.3	10.5	12.1
cp	0.2	1.4	0.7	0.5	0.7	1.1	0.6	0.5	0.7	0.1	0.1	0.1
py	6.0	6.2	3.2	3.7	4.6	2.3	1.6	1.0	1.2	1.3	0.9	1.1
po	16.4	21.3	11.9	12.9	13.9	12.9	3.1	0.9	0.9	1.4	1.1	0.3
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	103.2	104.2	104.5	104.1	110.4	109.6	103.1	112.3	111.9	101.6	101.6	101.8
py/(py+po)	0.27	0.23	0.21	0.22	0.25	0.15	0.35	0.52	0.56	0.49	0.47	0.78

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Laaberg. Appendix 5/3. Normative mineral composition.

K. WRF												
Depth (m)	25.20	28.00	29.00	29.30	31.00	32.00	33.00	34.00	35.00	36.00	36.60	38.00
Rock type	DB	ABFST	ABFST	ABFST	KRB	KRB	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST
Anal.no.	8976172	8976179	8976180	8976181	8976182	8976183	8976184	8976185	8976186	8976187	8976188	8976189
ab	73.7	70.4	66.1	45.0	1.5	0.0	17.1	71.8	78.5	71.3	62.3	76.0
qtz	0.0	3.2	5.0	8.2	2.1	0.3	0.0	1.1	8.5	16.5	8.9	14.7
ru	0.2	0.5	0.5	0.3	0.0	0.0	0.2	0.4	0.4	0.4	0.5	0.5
af	4.0	9.9	10.4	1.0	0.1	0.0	17.4	21.4	8.7	8.1	6.3	7.5
phl	7.1	2.3	3.8	1.0	0.1	0.4	0.2	0.8	1.2	0.5	0.7	0.6
chl	0.0	0.0	0.0	1.7	2.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.7	0.3	0.4	0.4	0.4	0.2	0.5	0.3	0.2	0.3	0.2	0.2
ape	0.5	0.2	0.2	0.1	0.1	0.0	0.1	0.2	0.2	0.1	0.2	0.2
dol	11.7	10.3	10.8	38.4	82.0	94.9	49.4	12.1	5.0	5.2	2.8	2.9
cp	0.3	0.5	0.6	0.2	0.4	0.1	0.8	0.3	0.3	0.2	0.1	0.0
py	0.6	0.4	0.2	0.5	0.3	0.1	2.0	0.0	0.0	0.0	0.0	0.0
po	2.0	5.2	4.3	3.1	10.2	2.3	18.1	1.2	0.5	0.8	0.7	0.4
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.8	103.2	102.3	100.0	100.0	100.0	105.8	109.6	103.5	103.5	102.6	103.0
py/(py+po)	0.24	0.07	0.05	0.15	0.03	0.03	0.10	0.00	0.00	0.00	0.00	0.10

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Lamberg. Appendix 5f/4. Normative mineral composition.

K. N25F												
Depth (m)	39.00	40.00	41.00	42.00	43.00	43.20	45.00	46.00	47.00	48.00	49.00	50.00
RockType	ABFST	ABFST	ABFST	ABFST	ABFST	ABFST	DB	DB	DB	DB	DB	DB
Anal.no.	8976190	8976191	8976192	8976193	8976194	8976195	8976196	8976197	8976198	8976199	8976200	8976201
ab	59.9	75.7	58.3	61.3	73.7	89.4	48.3	39.9	26.9	33.4	45.5	74.2
qtz	3.8	3.0	6.4	5.3	6.7	2.8	0.7	0.0	0.0	0.0	0.0	0.0
ru	0.4	0.4	0.3	0.4	0.4	0.5	0.3	0.2	0.2	0.3	0.3	0.2
sf	7.7	18.1	15.9	12.7	11.7	6.8	13.6	16.0	8.1	7.4	8.0	6.4
phl	2.4	0.5	0.4	0.7	0.6	0.7	22.4	4.9	7.8	25.0	21.1	1.7
chl	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	2.0	0.0	0.0	0.0
eca	0.5	0.3	0.4	0.4	0.4	0.2	0.6	1.2	0.8	20.3	9.2	0.5
apa	0.3	0.2	0.2	0.1	0.2	0.1	1.0	0.4	0.5	1.0	0.8	0.3
dol	23.0	9.7	25.5	16.6	5.7	3.1	6.4	50.0	42.5	11.9	15.6	19.3
cp	1.9	0.0	0.1	0.2	1.4	0.1	1.8	3.0	7.2	0.3	0.1	0.6
py	0.3	0.0	0.0	0.0	1.4	0.2	0.4	0.5	0.3	0.4	0.3	0.4
po	1.3	0.2	0.6	6.6	3.6	0.2	1.5	2.6	3.0	1.2	0.5	1.1
gra	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	101.4	108.0	108.1	106.7	105.6	102.9	100.0	108.6	100.0	101.2	101.4	103.7
py/(py+po)	0.17	0.12	0.03	0.00	0.28	0.46	0.21	0.17	0.10	0.25	0.44	0.24

OUTOKUMPU MINING SERVICES, Geoanalytical laboratory, P. Leberg. Appendix 5/5. Normative mineral composition.

K, N95F												
Depth (m)	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00	61.00	62.00
RockType	ABFST											
Anal.no.	8976202	8976203	8976204	8976205	8976206	8976207	8976208	8976209	8976210	8976211	8976212	8976213
ab	28.9	53.3	64.6	65.1	37.5	54.0	70.6	62.2	59.9	59.4	75.9	71.6
qtz	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.9	0.0
ru	0.2	0.3	0.4	0.4	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3
af	18.5	31.5	27.3	32.7	15.1	6.7	19.9	23.3	26.6	19.5	16.8	21.6
phl	0.3	1.5	1.5	0.6	0.4	1.6	0.7	3.0	1.6	0.9	1.2	0.9
chl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sca	0.3	0.9	0.4	0.2	0.4	0.6	0.5	0.5	0.3	0.3	0.3	0.2
apa	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
dol	40.1	23.6	18.0	11.9	36.1	21.1	14.4	3.4	9.7	12.5	5.5	3.0
cp	2.6	0.9	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0
py	0.9	0.5	0.2	0.5	10.8	8.4	5.2	3.9	4.0	2.2	0.2	1.1
po	11.1	1.8	1.8	2.0	2.8	9.1	2.8	3.6	6.1	4.9	0.9	2.1
gra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	106.0	114.4	114.4	113.5	103.4	102.3	114.7	105.4	108.8	102.8	103.3	105.1
py/(py+po)	0.07	0.21	0.10	0.20	0.80	0.48	0.65	0.52	0.39	0.31	0.17	0.34

K, N95F		
Depth (m)	62.90	63.90
RockType	ABFST	DB
Anal.no.	8976214	8976215
ab	58.1	7.3
qtz	0.0	0.0
ru	0.3	0.1
ef	28.9	15.1
phl	1.3	4.6
chl	0.0	0.0
sca	0.4	0.6
apa	0.1	0.1
del	11.7	58.8
cp	0.0	0.0
py	4.4	3.0
po	2.0	3.6
gra	0.0	0.0
Total	107.2	103.2
py/(py+po)	0.69	0.45

Electron microprobe analyses of amphibole

- 1 C2 ore S1221/55.5 μ
- 2 C2 ore S1251/65.8 μ
- 3 C4 ore S1548/60.6 μ
- 4 C4 ore S1548/100.5 μ

Programme by NMS Rock to classify amphiboles using IMA (1978) scheme (Mineral. Mag. 42, 533-543)

SIDJOVAGGE AMPHIBOLE ANALYSES

	1	2	3	4
SiO2	53.31	55.21	50.70	48.84
Al2O3	3.56	1.76	5.64	9.93
Fe2O3	0.00	0.00	0.00	0.00
FeO	10.69	8.59	11.51	10.80
MgO	16.81	18.58	15.50	15.04
CaO	11.79	11.81	11.61	11.03
Na2O	0.73	0.43	1.13	2.24
K2O	0.06	0.06	0.11	0.10
TiO2	0.19	0.14	0.24	0.37
MnO	0.16	0.17	0.18	0.16
Cr2O3	0.01	0.00	0.12	0.01
NiO	0.02	0.03	0.00	0.02
ZnO	0.04	0.01	0.00	0.01
TOTAL	97.39	96.73	96.74	96.59

CATIONS PER FORMULA UNIT

O=	23.0	23.0	23.0	23.0
Si	7.636	7.845	7.363	6.839
Al	0.500	0.295	0.965	1.707
Fe	0.000	0.000	0.000	0.000
Fe	1.279	1.014	1.398	1.319
Mg	3.585	3.936	3.356	3.279
Ca	1.807	1.798	1.807	1.725
Na	0.202	0.119	0.318	0.640
K	0.015	0.011	0.020	0.019
Ti	0.020	0.015	0.026	0.041
Mn	0.019	0.020	0.022	0.020
Cr	0.001	0.000	0.014	0.001
Ni	0.002	0.003	0.000	0.002
Zn	0.004	0.001	0.000	0.001
TOTAL	15.160	15.060	15.290	15.590

CHECK ON OXYGEN(+Cl,F) EQUIVALENCE OF ABOVE CATIONS

OXEG=	23.0	23.0	23.0	23.0
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IMA(1978) CLASSIFICATION PARAMETERS

CaNa	1.863	1.970	1.855	1.790
NaF	0.056	0.072	0.048	0.064
NaKa	0.161	0.057	0.290	0.594
AlVI	0.226	0.140	0.329	0.548
MgFe	0.727	0.795	0.706	0.713

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals

No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted

IMA(1978) Names for above Table:

Analysis number 1 1

WARNING: Si>9; excess ignored, not transferred to C

ACTINOLITE

Analysis number 2 2

WARNING: Si>8; excess ignored, not transferred to C

ACTINOLITE

Analysis number 3 3

WARNING: Si>8; excess ignored, not transferred to C

ACTINOLITIC HORNBLENDE

Analysis number 4 4

WARNING: Si>8; excess ignored, not transferred to C

EDEHITE

Electron microprobe analyses of scapolite

Mineral	SCA	SCA
Sample	S1281	S1548
	55.50	50.50

SiO2	55.94	54.95
TiO2	0.02	0.01
Al2O3	22.15	22.66
Cr2O3	0.00	0.02
V2O3	-	-
Fe2O3	-	-
FeO	0.11	0.05
MnO	0.00	0.00
MgO	0.00	0.00
ZnO	0.02	0.01
NiO	0.01	0.01
CaO	7.54	8.73
Na2O	9.52	9.16
K2O	0.32	0.23
H2O+	-	-
H2O-	-	-
CO2	-	-
SO3	0.32	0.24
F	-	-
Cl	3.05	2.80
Total	99.00	98.93

O=Cl,F	0.69	0.63
Total	98.31	98.30

NUMBER OF THE IONS ON THE BASIS OF 12(Si,Al)

Si	3.182	3.070
Ti	0.002	0.001
Al	3.818	3.930
Cr	0.000	0.002
V	-	-
Fe(III)	-	-
Fe(II)	0.013	0.006
Mn	0.000	0.000
Mg	0.000	0.000
Zn	0.002	0.001
Ni	0.001	0.001
Ca	1.192	1.373
Na	2.700	2.613
K	0.020	0.054
H	-	-
C	-	-
S	0.035	0.027
F	-	-
Cl	0.754	0.698

CatSum	15.950	16.056
Me(Ca/Na)	30.4	34.5
Me(OH2)	30.3	34.3

APPENDIX 7. CALCULATION OF NORMATIVE MINERAL COMPOSITION

Following procedure have been used to calculate the normative mineral composition for the samples from Bidjovagge Cu-Au ore. Results are given in Appendices 1f, 2f, 3f, 4f and 5f. Calculation LOTUS 1-2-3 worksheet has been saved in enclosed discette (Appendix 8, file CALC.WK1)

- 1.) Analyses as weigh percentages
- 2.) Weight percentages converted to one-ion percentages (Section 3)
- 3.) Following compositions of minerals were used in calculations
 - analysed (Appendix 6): amphibole, scapolite, pyrite, pyrrhotite
 - stoichiometric: quartz, dolomite, albite, rutile, phlogopite, chalcopyrite, apatite,
- 4.) Calculation proceeded in the following way
 - Cu → cp (all Cu was assumed to be bound in chalcopyrite)
 - P → apa
 - Cl → sca
 - K → phl
 - Ti → ru
 - C if CarbInd > 100 → grf
if CarbInd < 100 → dol
 - Ca-Ca(sca)-Ca(dol)-Ca(apa)
→ af (excess Ca in amphibole)
 - S-S(cp) → Fe-sulfide → py, po
pyrite/pyrrhotite ratio was estimated on the basis of Co/Ni ratio in sample.
According to microprobe determinations and calculations after selective dissolutions it was estimated that
 - Co/Ni in pyrite = 2.9
 - in pyrrhotite = 0.38
 - Si-Si(af)-Si(ab)-Si(sca)-Si(phl)-Si(chl)
→ qtz
 - 100-others → chl
- 5.) Equations were solved by Lotus 1-2-3 iteration.
- 6.) Some problems arose with the samples
 - high in K
 - high in C
 - from E ore
 - from K ore

Totals were too high (> 110). Amphibole content was set the way that sum = 100, and after that equations were recalculated by iteration

Calculation is quite reliable for chalcopyrite, scapolite, phlogopite and albite. Major errors comes from

- the assumption that dolomite is the only carbonate
- the variations in the composition of amphibole
- the variations in the composition of other minerals

Because amphibole, quartz and chlorite were calculated from the excess concentrations errors are accumulating to them. This can be the reason why quartz is almost absent in the majority of the samples.

All these affect that the mineral composition is only an estimation and is titled by normative mineral composition. It points, however, some variations in the composition of samples better than elements only.