92G-10 Boise Cr.

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A PETROGRAPHIC AND MINOR ELEMENT STUDY

of The

BOISE CREEK PROSPECT, BRITISH COLUMBIA

92-G-10

by

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INTRODUCTION

This report describes certain petrographic and chemical characteristics of diamond drill core from the Boise Creek prospect (copper-molybdenum), four miles west of Pitt River and seven miles northwest of Pitt Lake, British Columbia. Eighteen core samples are from DDH-1; seven additional samples are from DDH-6 and DDH-9. Sample numbers are listed in the appendix.

The objective of the petrographic phase of the study is the determination of possible relationships between microscopic features of the host rock and the sulfide mineralization. The minor element content was measured in pulp samples from five drill holes in order to determine the minor element distribution with depth. The objective here is to see whether there are any abrupt or noticeable changes with depth, and whether the presence and abundance of minor elements might depend upon the grade of Cu and MoS_2.

All of the core samples were studied in thin section; polished sections were not made. Chips of many of the samples were stained for potassium feldspar. The minor elements were determined by Mr. Merlyn L. Salmon, Denver, Colorado; potassium and sodium were analysed by the Coors Spectro-Chemical Laboratory, Golden, Colorado.

The petrologic and mineralogic features of the region surrounding Boise Creek were studied in detail by J.A. Roddick. His report (Roddick, 1965) is cited in the present study.

ROCK TYPES

General Statement

Approximately 80 percent of the bedrock in the region is plutonic; all of these rocks are regarded by Roddick as metasomatic in origin and of

Mesozoic and early Cenozoic age. They range mainly from hornblende diorite to biotite granite, alaskite, and pegmatite, although the most abundant types are of intermediate composition. The parent rocks, which were replaced and gave rise to the various plutonic units, are designated as hornblende granulite and amphibolite. The following diagram summarizes Roddick's paragenetic scheme:

	(	Hb/Bt granite	)
Hb granulite	(	Hb and/or Bt granodiorite	) Bt granite
Amphibolite	(	Hb and/or Bt quartz diorite	)
	(	Hb diorite	)

Boise Creek Prospect

The area of the Boise Creek prospect consists chiefly of a fine- to coarse-grained hornblende diorite; locally the rock is quartz diorite. The mafic minerals are extensively chloritized in some parts of the area.

Nearly all of the core samples that were examined are mineralized and altered. Most of the samples are of intermediate igneous composition (largely quartz diorite) and many of these rocks characteristically contain prominent mixed chlorite, sericite, and talc(?). The hydrothermal alteration and notable introduction of quartz make specific igneous classification difficult and, in some cases, impossible. The mafic minerals, which are critical to Roddick's classification, are almost completely altered. In addition, it is reasonable to assume that hydrothermal alteration has modified the composition of the plagioclase. Therefore an attempt to apply an igneous classification to these rocks, with plagioclase composition as the principal variable, would be inadviseable. Even if the plagioclase in some of the samples is representative of the pre-mineralized rock, the fact that the mafic minerals (hornblende and biotite) have been altered makes impossible classification according to

Roddick's scheme. Roddick notes (p. 100) that the composition of plagioclase in hornblende quartz diorite and biotite quartz diorite, taken together, ranges between An_9-An_{58}. Therefore, data on plagioclase composition is of limited use in Roddick's classification; knowledge of hornblende-biotite ratios is essential.

What seems of greater importance than the specific naming of these rock samples are the striking textural differences which the samples show. The most noteable difference lies in the degree of development of plagioclase porphyroblasts. This difference in plagioclase is emphasized by Roddick and is used as one line of evidence in support of a metasomatic origin. Moreover, Roddic states (p. 179) that a close genetic relationship has long been recognized between the mineral deposits and the plutonic rocks. It seems reasonable, therefore, in view of the hydrothermal alteration of these rocks, to emphasize here the degree of textural evolution, as it appears to result from their metasomatic origim, and to relate this textural development to the mineralization. (See Table 1). It should be noted, however, that these samples were not selected expressly for this purpose. For this reason, the study lacks the desired number and distribution of samples.

The samples range generally from very fine-grained, dark rocks, rich in mixed chlorite, sericite, and possible talc, to medium-grained rocks which contain much less of the mafic minerals and contain quartz and rather abundant, well-formed porphyroblasts of plagioclase. Potassium feldspar was not identified in any of the thin sections. Chips of the core samples were stained for K-feldspar, but the results are inconclusive; the stain tends to coat even the quartz vein material. Roddick states (p. 122) that much of the K-feldspar in the area is perthite. Perthite was not found in the core samples from the Boise Creek prospect.

TABLE

DEGREES OF TEXTURAL DEVELOPMENT (PLAGIOCLASE)

COMPARED WITH MINERALIZATION AND ASSAY VALUES

DDH-1 (feet)	A	B	B-C	C	C-D	D	Mineralization (Thin Section)	Cu*	MoS_2*
53				X			py, (cp)		
62			X				Q, py		
121				X			Q (Fl), py, mg, (cp)	.13	.017
125					X		Q, C, py, (mg), (cp)	.06	.005
245						X	Q, C, py, (mg), (cp)	.12	.01
393				X			Q, (Ah), py, cp	.12	.01
465	X						Q, Ah, py, cp, mo	.15	.01
476			X				Q, Ah, K, py, (cp), mg	.13	.01
490	X						Q, Ah, (Fl), (Ccl), py, cp, (mg)	.20	.01
495					X		Q, K, py, mg, cp	.15	.02
640						X	Ah, Q, py, cp	.16	.02
650						X	Q, Ah, (Ccl), (K), py, (mo), (cp)	.15	.03
737			X				Q, Ah, (Fl), py, cp	.15	.01
768						X	Q, Ah, py, cp, (mg), (mo)	.10	.03
973			X				Ah, Q, py, (mo), (cp)	.03	.08
1205					X(hb)		Q, Ah, (C), py, cp	.12	.02
1446			X				Q, Ah, py, mg, mo	.08	.005

A - Incipient
B - Low
C - Moderate
D - High

Q - Quartz
Ah- Anhydrite
K - Kaolin
C - Carbonate
Fl- Fluorite
Ccl-Clinochlore

py - Pyrite
cp - Chalcopyrite
mg - Magnetite
mo - Molybdenite
( ) - Minor importance

* Average (%) of approximately 10-foot interval which encompasses core sample.

Several of the very fine-grained, dark rocks, some of which contain a few incipient porphyroblasts, either are clearly of volcanic origin or possibly represent mafic granulite. On the other hand, there are several samples in the suite which either do not appear to fit into this metasomatic, textural progression, or probably were not derived from the fine-grained, mafic rock. A sample, 42 feet from DDH-1, is composed of an altered, granular mosaic of quartz and altered feldspar; it is extensively silicified and lacks porphyroblastic plagioclase. Samples at 393 feet and 737 feet, DDH-1, although they show a few poorly-developed plagioclase porphyroblasts, contain very little chlorite and appear to be derived either from quartzite containing a few rounded, larger quartz grains, or possibly from porphyritic felsite. In any case, these samples seem unlikely to have originated from a fine-grained, mafic rock. A sample at 125 feet from DDH-1, is comprised of two rock types: one is a very fine-grained, dark rock, possibly representing mafic granulite, in sharp contact with a diorite containing poikiloblastic hornblende. The abrupt contact in this sample suggests that the dioritic rock may not be solely of metasomatic origin.

The samples which appear to belong to this metasomatic progression are divided here into six catagories: incipient, low, low-moderate, moderate, moderate-high and high. Except in the few samples where poikiloblastic hornblende is prominent, these terms refer to the degree of textural evolution of plagioclase porphyroblasts. It should be noted, however, that Roddick's rock classification stresses that the progressive, textural development of plagioclase porphyroblasts also includes the more silicic rocks leading to, and culminating in, biotite granite. In the use of the subjective catagories erected here, this connotation should not be made. The present scheme is merely a relative classification applied to thin sections of rocks largely of intermediate composition. Additionally, many of the samples containing plagioclase porphyroblasts of high textural development also contain grains of less well-developed plagioclase. In view of this, the maximum degree of textural evolution found in a sample was considered in assigning the sample to one or another of the six catagories. The essential features of the stages of incipient, low, moderate, and high degrees of textural evolution are summarized below:

Incipient

The samples assigned to this catagory are made up largely of chlorite, sericite, and talc(?). The few plagioclase porphyroblasts that occur are less than 1 mm across and are irregular in shape. The borders of these incipient porphyroblasts are characteristically obscured and replaced by chloritic material. The porphyroblasts have a mottled, granular appearance between crossed nicols, indicating an intergrowth of several crystallographic units of plagioclase. Inclusions as such were not found, although chlorite and sericite commonly are disseminated sparsely throughout the porphyroblasts and along fractures. Compositional zoning is barely visible in a few places. This is demonstrated by slightly uneven extinction, crudely concentric, between crossed nicols. Multiple twinning is either absent or only poorly developed; the few twins which can be found have wide lamellae and some are discontinuous across the porphyroblasts. Quartz is rare and shows no crystalloblastic growth. (See Figure 1.)

Low

The plagioclase in this catagory is up to about 1 mm across. It is slightly larger than in the incipient stage, and is a little more abundant. The porphyroblasts are crudely subhedral in form and the borders are still diffuse and obscured by chlorite and sericite. The plagioclase characteristically shows a grainy texture, which appears to represent relict, granular plagioclase that has aggregated to form porphyroblasts. The porphyroblasts contain disseminated, minute shreds of chlorite and sericite, and in a few places minute grains of quartz appear as inclusions. As in the incipient stage, compositional zoning is rare and only weakly developed. Multiple twinning is crudely formed; the twin lamallae are relatively wide and are discontinuous and wedge-shaped in many of the crystals. Care was taken to distinguish between subhedral to euhedral, relict plagioclase phenocrysts in volcanic rock (sample at 973', Hole No. 1) and plagioclase of metasomatic origin. Quartz shows no tendency to aggregate into porphyroblasts; a few quartz intergrowths and veinlets replace plagioclase. (See Figures 2 and 3.)

Moderate

The plagioclase porphyroblasts here are larger than they are in less well developed stages, reaching diameters of 2-3 mm. The porphyroblasts are irregular to subhedral in form and are much more abundant. The larger porphyroblasts generally are more irregular. Contacts between adjoining plagioclase crystals commonly are somewhat intergrown and sutured. As in the low stage, these porphyroblasts characteristically are made up of coalescing, optically continuous grains of plagioclase. These aggregations trap fine grains of quartz and euhedral plagioclase, producing poikiloblastic texture. These inclusions are abundant. In addition, worm-like intergrowths of quartz are common. Inclusions of quartz along the borders of porphyroblasts give the crystal outline a ragged, irregular appearance. These porphyroblasts contain very little chloritic material, suggesting that the porphyroblasts were cleared of trapped mafic minerals (hornblende?). Compositional zoning is very rare, and where it does occur it resembles the zoning of lower stages. Some of the porphyroblasts are broadly twinned, although many are untwinned. Finely-twinned crystals are rather common, unlike the porphyroblasts of lower stages. Quartz is interstitial and coarser than in lower stages, and it is more abundant. It should be noted that in many samples it is difficult to distinguish between introduced quartz (hydrothermal) and metasomatic quartz. Quartz which is interstitial is commonly angular in form, clear, and shows even extinction between crossed nicols. In the sample at 393', DDH-6 (Fig. 5), which contains larger, rounded quartz grains (quartzite?), a mesh-like halo of granular quartz forms overgrowths in optical continuity with the rounded quartz. (See Figures 4 to 7).

High

The plagioclase at this stage of development is abundant and up to about 2 mm long. The form is largely subhedral to euhedral; contacts between adjoining plagioclase crystals are irregular. Smaller plagioclase porphyroblasts generally are more euhedral. The borders of porphyroblasts are generally sharp and more distinct than in the lower stages. There are very few inclusion at this stage in the textural development. The larger porphyroblasts generally contain a few inclusions; smaller porphyroblasts are free of inclusions. Most of the inclusions are granular quartz, although some porphyroblasts contain minute, euhedral crystals of plagioclase. Both multiple twinning and zoning are better developed and more conspicuous than in lower stages. In addition, the multiple twinning is generally both finer and more continuous within the porphyroblasts. Quartz is interstitial, clear, and shows even extinction, as in the lower stages. There is no evidence of porphyroblastic quartz. (See Figures 8 to 14).

ALTERATION

Only three samples in the entire suite contain hornblende (hb diorite: DDH-1, 125', and DDH-9, 518'; hornblendite: DDH-1, 1205'). Mafic minerals in the other samples are altered to chlorite and possibly sericite and talc. (The distinction between sericite and talc in thin section is inconclusive; the presence of abundant chlorite suggests that at least some of the associated, fine, highly birefringent material is probably talc.) Plagioclase, which occurs in all the samples except at 1205', DDH-1, is surprisingly fresh in many thin sections; in some samples it is slightly to moderately altered to sericite, very fine chlorite, carbonate, epidote and clay.

Chlorite, sericite, and talc(?) are most abundant in the fine-grained, dark greenish gray rocks. These rocks appear to represent, in part, altered hornblende granulite or fine-grained amphibolite; sample 973', DDH-1, contains definite relict volcanic texture. Samples containing the least amount of chlorite, and other alteration products, are the rocks of approximately quartz diorite composition in which the plagioclase is well-developed texturally. It appears that in the course of metasomatic evolution of these rocks the mafic components were partially expelled.

The chlorite in the dark greenish gray rocks is rather uniformily distributed. It occurs as minute, irregular shreds and clusters of fibrous crystals. In a few of the thin sections, bundles of chlorite crystals appear to be crudely pseudomorphous after hornblende, although hornblende is absent. Several thin sections containing abundant chlorite also contain brown biotite, and it is uncertain as to whether the chlorite is derived from the biotite or whether the biotite is hydrothermal in origin, or both. The biotite is fine-grained and irregular in form, and is quite similar to the secondary biotite commonly found associated with porphyry copper deposits. Where chlorite is abundant in the host rock, the chlorite is also found strung out within quartz-sulfide veinlets. This feature demonstrates the close genetic relationship between chloritization and mineralization, a relationship noted also by Roddick (p. 83). In rocks where plagioclase is prominent, the chlorite is largely interstitial to the feldspar; chlorite also occurs scattered sparsely throughout the plagioclase and along grain boundaries and in fractures. The chlorite commonly contains minute grains of disseminated magnetite and irregular patches of pyrite. This feature suggests that iron in the pyrite was derived from mafic minerals during chloritization. Here, again, is evidence that the chloritization was induced by hydrothermal processes and not by regional retrogressive metamorphism.

In addition to the possible sericite associated with chlorite in the fine-grained, dark rocks, sericite also occurs as minor, irregularly distributed replacements in plagioclase, and along cleavage fractures and plagioclase grain boundaries. There does not appear to be any significant control by compositional zoning in plagioclase. Late sericite is conspicuous in many thin sections where sericite forms thread-like veinlets surrounding kaolin, quartz and pyrite grains in the quartz-sulfide veinlets. Carbonate commonly accompanies this late sericite.

A few of the plagioclase-rich samples contain conspicuous kaolin, and, in contradiction to Roddick's contention (p. 136) that kaolin is "rarely if ever" deposited from solutions into fractures, the kaolin observed here commonly occupies fine fractures which cut the quartz-sulfide veinlets. There also are irregular areaswithin these thin sections which contain abundant kaolin. Therefore, the kaolin here forms as a direct alteration product of constituent minerals, as well as occurring in fractures. The pink alteration which Roddick describes (p. 138), and which bears a direct relation to the amount of kaolin in the altered rocks, was not found in the core samples from the Boise Creek prospect.

Traces of granular epidote were found in many of the thin sections; in general it is rare in the plagioclase-rich rocks. Conspicuous concentrations of granular epidote occur disseminated throughout lenticular masses which appear to represent relict inclusions of some former, fine-grained, mafic rock (especially a sample at 1446' from Hole No. 1). Because of the general lack of epidote in the dioritic rocks, it is suggested that the epidote of these dark inclusions is the result of earlier, retrogressive metamorphism and has no genetic relationship to the hydrothermal alteration. Two samples (DDH-6 at 584' and DDH-9 at 422') contain prominent, blade-like crystals of a mineral which is identified here tentatively as manganian zoisite (thulite). The crystals, which are found in quartz-sulfide veinlets, are faintly pleochroic (pink) and have the crystallographic and optical properties of ferroan zoisite.

MINERALIZATION

The selected core samples afford only a limited view of the mineralization revealed throughout the drill holes. Therefore, the following notes, taken primarily from the thin sections, may not constitute a valid generalization regarding the mineralization as a whole. In addition, polished sections of the opaque minerals were not studied.

Quartz and pyrite are essentially ubiquitous in the mineralized rock. These minerals are accompanied in many of the samples by white to pale pink anhydrite, chalcopyrite, and, to a lesser extent, by molybdenite. Magnetite, carbonate, fluorite, and kaolin (veinlets) are uncommon; clinochlore(?) is rare. A few samples contain veinlets rich in anhydrite, with little quartz.

These introduced minerals characteristically occur in veinlets up to 6-8 cm thick. Most are not more than 1 cm thick, and many are less than 4-5 cm. Disseminated minerals also occur, especially anhydrite and the sulfide minerals, although these are closely associated with veinlets. Several samples are intensely silicified (especially a sample at 42' DDH-1). In this sample the introduced quartz pervades much of the rock. Except for the sulfides, introduced minerals are largely fine-grained, pyrite in some samples forms irregular aggregates up to several centimeters across; some pyrite is euhedral. Many of the thin sections show chalcopyrite both as inclusions in pyrite and as interstitial fillings among grains of pyrite. Molybdenite commonly occurs as grains and in short prisms associated with quartz and pyrite. Very little chalcopyrite and molybdenite is disseminated.

MINOR ELEMENT DISTRIBUTION

Introduction

Tables 1 to 9 summarize the minor element abundance and distribution in samples from drill holes 1, 2, 3, 5 and 6. The samples, listed here in Appendix 2, are pulps representing approximately 10-foot intervals of drill core. The values are estimated percentages (semi-quantitative) for the metal equivalent of the indicated elements. The analyses are spectrographic, and no checks were made for elements with atomic numbers less than 22 (below titanium). Potassium and sodium were run by atomic absorption.

Samples from holes, 1, 5, and 6 are generally of slightly higher grade and have been divided into two catagories: those with relatively high MoS_2 (greater than 0.01% or 0.02%) and those with relatively high Cu (greater than 0.12% or 0.15%). Part of the objective here is to determine whether certain elements preferentially follow the higher grades of Cu and Mo.

The reproducibility of these values has not been tested. Therefore, it is not known what magnitude of difference constitutes a significant difference. Since the differences in element concentration here are minor, caution must be used in interpreting the results.

Summary of Results (Preliminary)

Table 9 summarizes the results. Co and Ni are slightly more abundant in association with Mo than with Cu. On the other hand, Rb, V, and Y are more abundant with Cu. It is also interesting to note that Zn is more abundant in the higher grades of both Mo and Cu, whereas Pb, along with Cr and Fe, are relatively more abundant in the lower grade holes (DDH-2 and 3). Sr and Zr are of lowest concentration in association with Mo.

Conclusions (Preliminary)

The texture of plagioclase porphyroblasts in 17 core samples from DDH-1, listed in Table 1, does not show a systematic relationship to introduced minerals present, or to the assay values. Many more core samples would be required to thoroughly test this possibility. Roddick indicates (p. 179) that the mineralization is most intense in the dioritic rocks of the area, and hence presumably there exists a broad, general correlation between the texture of plagioclase found in diorite and the intensity of mineralization. However, this is not demonstrated in the present study.

The nearly complete chloritization of hornblende and biotite, and the partial alteration of plagioclase in many of the samples, coupled with an introduction of quartz, makes it difficult or impossible to classify the metasomatic rocks of the Boise Creek prospect.

The fine-grained, dark greenish gray rocks of the area appear to represent remnants of at least some of the rock types which were replaced and gave rise to the plutonic rocks.

Hydrothermal alteration and sulfide mineralization appear to be penecontemporaneous, with sericitization and kaolinization extending beyond the period of quartz-sulfide injection.

There is no marked indication that Mo and Cu each are accompanied by unique assemblages and concentrations of minor elements.

The variation in minor element distribution with drill hole depth (length) is not marked. Minor element ratios still need to be plotted in order to test this.

MINOR ELEMENT DISTRIBUTION IN SAMPLES FROM DDH-1

TABLE 1

MoS_2 0.02%

	Cu	Zn	Sn	Pb	As	Se	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	U	Mn	Y
221-229	.11			.013			3.8	.002	.013	.008	.081	.048	.27	.014		.006	.005	.12	.12	
317-329	.092	.017					2.6	.003	.008		.099	.037	.25	.020			.010	.012	.051	.005
396-406	.13	.020		.015			2.5		.007	.004	.12	.048	.19	.022			.003		.055	
424-437	.13	.028		.023	.004		3.5		.008	.005	.072	.047	.28	.024			.009		.075	.004
452-462	.15	.020		.013			4.3	.003	.007		.072	.040	.14	.015		.002	.010		.066	.006
696-706	.15	.21		.046			6.6		.009			.076	.33	.018		.014			.17	.005
846-856	.13	.043		.024			5.4	.007	.017		.077	.11	.32	.018	.016	.004	.005		.092	.010
925-936	.048	.010		.012			2.3	.003	.006		.11	.040	.18	.021		.001	.007		.030	
1016-1030	.063	.022				.011	5.3	.003	.017		.063	.057	.29	.013		.036	.011		.10	.005
1155-1165	.081	.022	.004	.009	.002		5.5	.005	.006	.003	.053	.061	.32	.030	.024	.012	.011	.092	.092	.009
Average	.108	.043	.004	.019	.003	.011	4.18	.0037	.0098	.005	.083	.0564	.257	.0195	.020	.0107	.008	.012	.0698	.00628

MINOR ELEMENT DISTRIBUTION IN SAMPLES FROM DDH-1

TABLE 2

Cu 0.15%

	Cu	Zn	Sn	Pb	As	Se	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	U	Mn	Y
221-229	.11	.18		.013			3.8	.002	.013	.008	.081	.048	.27	.014		.006	.005		.12	
335-345	.15	.016		.026			3.9		.005		.070	.041	.25	.016		.017	.008		.066	.004
396-406	.13	.020		.015			2.5		.007	.004	.12	.048	.19	.022			.003		.055	
452-462	.15	.020		.013			4.3	.003	.007		.072	.040	.14	.015		.002	.010		.066	.006
488-495	.18	.030		.029	.004		4.4	.003	.008	.009	.070	.050	.16	.016		.014	.004		.062	.009
554-567	.15	.041		.018			3.0		.009		.092	.058	.25	.027		.014	.006		.085	
645-656	.14	.012		.029			5.0	.005	.006		.050	.070	.21	.021	.032	.021	.020		.058	
Average	.14428	.0455	[illegible]	.0204	.004	-	3.8428	.00325	.00785	.007	.07928	.0507	.21	.0187	.032	.0123	.008	-	.07314	.0063

Miscellaneous

	Cu	Zn	Sn	Pb	As	Se	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	U	Mn	Y
1297-1307	.046	.029					5.9	.009	.006			.11	.27	.034		.010			.11	.007
1397-1407	.072	.048		.018			5.5		.014		.042	.086	.23	.026		.008	.005		.16	

MINOR ELEMENT DISTRIBUTION IN SAMPLES FROM DDH-2

TABLE 3

	Cu	Zn	Pb	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	U	Mn	Y
228-238	.14	.048		5.5		.012	.012	.063	.053	.29	.019	.032	.041	.006		.16	.009
298-308	.11	.014	.023	4.1		.006	.005	.068	.063	.22	.020		.004	.006		.064	
448-458	.074	.006	.016	4.2		.014	.006	.060	.040	.23	.018		.021	.006		.039	.007
648-658	.087	.008	.014	3.9		.008	.006	.090	.056	.25	.023		.039	.007	.044	.044	.006
748-758	.083	.011	.023	4.0	.002	.005	.006	.11	.071	.27	.025	.032		.009		.064	.012
898-908	.085	.009		4.0	.003	.009		.072	.068	.23	.022		.059	.004	.005	.069	.010
Average	.0965	.016	.019	4.283	.0025	.009	.0070	.0771	.0585	.248	.0211	.032	.0328	.0063	.005	.0733	.0088

MINOR ELEMENT DISTRIBUTION IN SAPLES FROM DDH-3

TABLE 4

	Cu	Zn	Pb	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	U	Mn	Y
398-408	.10	.016	.024	3.8	.002	.009		.079	.054	.12	.018		.019	.004		.048	.005
498-508	.12	0.13	.024	3.3	.003	.006		.12	.055	.21	.020	.016		.007		.048	.002
598-608	.085	.007		2.9		.009	.008	.11	.049	.18	.016	.024	.008		.009	.048	.002
698-708	.11	.013	.013	4.0	.003	.005		.078	.063	.16	.019			.005	.009	.060	.008
798-808	.13	.011	.032	4.2	.002	.007	.006	.090	.050	.30	.020	.032	.019	.011	.011	.069	.004
898-908	.10	.014	.024	3.3		.009	.008	.084	.055	.18	.019	.032	.021			.055	.004
Average	.1075	.0123	.0234	3.583	.0025	.0075	.0073	.093	.0543	.1916	.0186	.026	.0167	.0067	.0096	.0546	.00416

MINOR ELEMENT DISTRIBUTION IN SAMPLES FROM DDH-5

TABLE 5

MoS_2 .01%

	Cu	Ag	Zn	Pb	As	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	Mn	Y
203-210	.075		.038	.066		4.1	.005	.013	.005	.054	.053	.29	.017		.025	.004	.13	.012
248-256	.10		.017			3.8		.009		.081	.072	.21	.025		.002		.085	.004
327-337	.12	.004	.014			4.8	.002	.005	.006	.021	.061	.20	.022		.012	.008	.081	.002
367-377	.071		.007			2.5		.004		.14	.051	.18	.025		.021	.036	.057	.005
487-497	.047		.007			2.8		.009		.070	.065	.16	.019			.018	.057	
587-597	.12		.012	.018		3.5		.009		.11	.058	.19	.022		.004	.013	.059	
603-613	.083		.018			4.2	.009	.017		.028	.076	.27	.022		.025		.10	.008
727-735	.16	.004	.004			3.0		.011	.008	.14	.030	.14	.016		.019	.020	.055	
Average	.097	.004	.0146	.012	3.587	3.587	.0053	.0096	.0063	.080	.0582	.205	.021		.0154	.0165	.078	.0062

MINOR ELEMENT DISTRIBUTION IN SAMPLES FROM DDH-5

TABLE 6

Cu .12%

	Cu	Ag	Zn	Pb	As	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	Mn	Y
226-235	.12		.015			4.2		.009		.088	.059	.25			.002	.007	,095	.004
327-337	.12	.004	.014			4.8	.002	.005	.006	.021	.061	.20	.022		.012	.008	.081	.002
557-567	.11		.011			4.0		.012		.062	.072	.25	.027	.031	.015	.005	.055	.006
587-597	.12		.012	.018		3.5		.009		.11	.058	.19	.022		.004	.013	.059	
603-613	.083		.018			4.2	.009	.017		.028	.076	.27	.022		.025		.10	.008
633-643	.095		.011			4.7	.003	.011		.078	.060	.31	.023		.014		.071	
703-711	.10		.010			3.7	.002	.006		.045	.099	.25	.029			.007	.074	.004
727-735	.16	.004	.004			3.0		.011	.008	.14	.030	.14	.016		.019	.020	.055	
787-797	.13		.017			3.3	.002	.006	.005	.084	.052	.13	.022		.019	.010	.069	.007
887-897	.14		.015	.032		4.5	.003	.009	.005	.078	.092	.27	.027		.004		.076	.004
951-961	.13		.011	.015	.002	3.4	.006	.011	.009	.093	.090	.22	.020			.005	.085	
1007-1017	.11		.009	.014		3.8	.003	.011	.003	.084	.076	.21	.024	.040		.006	.074	
Average	.118	.004	.0122	.0197	.002	3.925	.0037	.0097	.0135	.0759	.0687	.224	.023	.0356	.0126	.0095	.0745	.005

MINOR ELEMENT DISTRIBUTION IN SAMPLES FROM DDH-6

TABLE 7

MoS_2 .02%

	Cu	Ag	Zn	Pb	As	Se	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	Cr	Mo	U	Mn	Y
47-57	.15		.007	.014			1.9	.004	.008	.004	.11	.050	.23	.028		.061		.053	.005
396-406	.085		.005				3.0		.012		.054	.049	.12	.011	.025	.012		.044	.004
706-716	.009	.006	.030				1.7		.004		.029	.011	.16	.010		.023		.022	
736-746	.080		.004	.017			2.7	.003	.009		.053	.029	.14	.120	.005	.032		.037	.002
756-766	.10		.006				2.5	.003	.006	.002	.033	.025	.12	.012		.046		.024	.003
766-776	.11		.008				2.6	.003	.009		.017	.042	.18	.017	.004	.036	.009	.044	.004
Average	.089	.006	.010	.0155	-	-	2.4	.00325	.008	.003	.0493	.034	.158	.016	.011	.035	.009	.0373	.0036

MINOR ELEMENT DISTRIBUTION IN SAMPLES FROM DDH-6

TABLE 8

Cu .15%

	Cu	Ag	Zn	Pb	As	Se	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	Cr	Mo	U	Mn	Y
57-70	.20		.010				3.3	.003	.011		.094	.063	.27	.034		.002		.066	
216-226	.15		.008	.006			2.7	.005	.015		.060	.054	.16	.018		.010		.053	.005
276-286	.14		.005	.006			2.8	.003	.008		.070	.041	.11	.013	.012	.016		.039	.004
306-316	.11		.005				2.1		.007	.004	.075	.058	.12	.022	.005	.011		.058	.009
336-346	.17		.013				2.7		.009		.062	.050	.12	.021	.025	.013		.059	
426-436	.19		.010	.018	.005		3.8	.003	.005		.063	.074	.11	.022		.014		.048	.005
486-496	.11		.005				2.7		.009	.007	.068	.040	.16	.014	.009	.012		.042	.007
556-566	.14		.008			0012	3.3	.003	.008	.005	.028	.050	.16	.016	.008	.014	.041	.041	.006
586-596	.37		.008				4.3	.004	.012		.030	.042	.18	.018	.014	.017		.060	
756-766	.10		.006				2.5	.003	.006	.002	.033	.025	.12	.012		.046		.024	.003
Average	.168	-	.0078	.010	.005	.012	3.02	.00343	.009	.0045	.058	.0497	.151	.019	.0121	.0155	-	.049	.0055

AVERAGE ABUNDANCE OF MINOR ELEMENTS IN RELATION TO GRADE

TABLE 9

	Cu	Ag	Zn	Sn	Pb	As	Se	Fe	Co	Ni	Rb	Ba	Sr	Ti	Zr	V	Cr	Mo	U	Mn	Y
MoS_2 .01%																					
DDH-1	.108		.043	.004	.019	.003	.011	4.18	.0037	.0098	.005	.083	.0564	.257	.0195	.020	.0107	.008	.012	.0698	.0062
DDH-5	.097	.004	.0146		.012			3.587	.0053	.0096	.0063	.080	.0582	.205	.021		.0154	.0165		.078	.0062
DDH-6	.089	.006	.010		.0155			2.4	.0032	.008	.003	.0493	.034	.158	.016		.011	.035		.0373	.0036
Average%	.098	.005	.0225	.004	.0155	.003	.011	3.389	.0040	.0091	.0047	.0707	.0495	.2066	.0188	.020	.0123	.0198	.012	.0617	.0053
Cu .12%																					
DDH-1	.1442		.0455		.0204	.004		3.842	.0032	.0078	.007	.0792	.0507	.21	.0187	.032	.0123	.008		.0731	.0063
DDH-5	.118	.004	.0122		.0197			3.925	.0037	.0097	.0135	.0759	.0687	.224	.023	.035	.0126	.009		.0745	.005
DDH-6	.168		.0078		.010			3.02	.0034	.009	.0045	.058	.0497	.151	.019		.0121	.0155		.049	.005
Average	.1434	.004	.0218		.0167	.004		3.595	.0034	.0088	.0083	.071	.0563	.195	.0202	.0335	.0123	.0108		.0655	.0243
Lower Grade Holes																					
DDH-2	.0965		.016		.019			4.283	.0025	.009	.0070	.0771	.0585	.248	.0211	.032	.0328	.0063	.005	.0733	.0088
DDH-3	.1075		.0123		.0234			3.583	.0025	.0075	.0073	.093	.0543	.1916	.0186	.026	.0167	.0067	.0096	.0546	.0041
Average	.102		.0141		.0212			3.933	.0025	.0082	.00715	.085	.0564	.2198	.0198	.029	.0247	.0065	.0073	.0639	.0064

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