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DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 69-44

THE GEOCHEMISTRY OF COPPERMINE RIVER BASALTS

(Report, 11 figures and 7 tables)

W. R. A. Baragar
(with a contribution by R. N. Annells)

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DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

The Coppermine River Group, a succession of about 10,000 feet of basalt flows overlain by 4,000 feet of red sandstones and intercalated basalt flows, contains a number of copper prospects associated with faults that cut the lavas.

The amount of devitrified glass decreases upward in the succession. Silica, magnesia, and potash decrease whereas iron, manganese and titania increase upward. Copper, vanadium, scandium and zinc increase and nickel and chromium decrease.

The intercalated flows show different chemical trends and probably had an independent origin.

Copper prospects are commonly in veins and fractures and mainly comprise copper sulphides. It appears that copper was first enriched by volatile transfer in the tops of flows before solidification. Long after consolidation sulphurous hydrothermal solutions leached copper from the tops and deposited it in favourable nearby environments.

THE GEOCHEMISTRY OF COPPERMINE RIVER BASALTS

INTRODUCTION

Field work for this project was done in the summer of 1966 as part of a continuing study on volcanic rocks of the Canadian Shield. Discoveries the same year of important new copper occurrences in the late Precambrian Coppermine River lavas by M. Watts and associates led to extensive staking and exploration of the lavas in succeeding summers and many new copper occurrences have been located. The writer has seen few of these and has had little opportunity to study their relationship to the lavas. Accordingly in this report the discussions on the genesis of the copper deposits are necessarily based upon a rather broad view of their distribution and a sketchy literature of the deposits themselves.

This is a progress report as much work remains to be done, particularly on the petrography of the flows. Nevertheless the broad features of the geochemistry of the flows, the major concern of this paper, are clear and can be reported now. The discussions and proposals that arise from these data are of a preliminary nature and will require further elaboration in time.

Acknowledgments

Very able assistance was given me in the field by D. Bishop, S. Biron, G. Huff, P. Raemakers, and W. Sargent all of whom in addition to their duties contributed to a most congenial summer. To Messrs. Murray Watts and Ron Sheardown I am grateful for the opportunity of visiting some of the copper prospects discovered that summer and for many neighbourly courtesies extended in the field. I am particularly indebted to my colleagues; Dr. T.N. Irvine for his help in preparing a program to list the chemical analyses given in Table VII, and Drs. E.D. Kindle and R.I. Thorpe for information on the locations of most of the copper occurrences shown in Figure 2.

Special acknowledgment is due to the staff of the Geological Survey's analytical laboratories who provided all the analyses contained in this paper. The extent of my indebtedness can be judged by the complete dependency of this paper upon the quality and quantity of the chemical data it contains.

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METHODS

Five sections across the Coppermine River flows were mapped in detail and sampled at stratigraphic intervals of about 200 feet where exposure permitted. Each section-line was surveyed by chain-and-compass and corrected constantly by reference to topographic features appearing on air photographs and maps. Topographic profiles along section-lines were maintained by barometer readings at 300-foot intervals and at breaks in slope, and were corrected to base levels carried forward from camp to camp. The geology was recorded directly on the profiles. The section-lines, which changed course frequently in order to intersect a maximum of outcrop, have all been projected on to planes that are at right angles to the average strike of flows in the section concerned. The approximate positions of the five sections are shown in Figure 1 by the distributions of sample localities.

The geology of Figure 1 was compiled from the geology of the sections, from an interpretation of air photographs and air observations, from spot visits to interline regions, and from the reconnaissance map of north-central District of Mackenzie (Fraser, 1960).

All samples collected for analysis are chip samples taken over a range of from generally 4 to 10 feet. Flow tops were avoided except for a few samples taken especially to determine their compositions. Most samples are from the lower third of a flow.

The samples were all analyzed in the Geological Survey laboratories for thirteen major and fifteen minor elements. SiO_2, Al_2O_3, total iron, MgO, CaO, K_2O, TiO_2, and MnO were analyzed by X-ray fluorescence using a nonfusion technique and FeO, P_2O_5, Na_2O, H_2O, and CO_2 by rapid chemical methods. The minor elements were determined by spectrograph. Ten composite samples formed from different segments of the assemblage were analyzed for the major elements by classical methods as a check on the rapid analyses. The results will be discussed in a later section of the report.

GENERAL GEOLOGY

General Statement

The Coppermine River Group consists of a basal division of basaltic flows, 8,000 to 10,000 feet thick, and an upper division of red sandstones with interlayered basaltic flows. The latter has a maximum exposed thickness of about 4,500 feet. The group is underlain conformably by dolomites of the Hornby Bay Group and is overlain unconformably by a succession of shales, siltstones, quartzites, and limestones conspicuously intruded by thick gabbro sills. Previously the overlying sediments were grouped with the Coppermine River series. The presence of the unconformity makes it necessary to recognize the upper succession as a separate group. The relationship between units is shown in the Table of Formations.

The Coppermine River Group dips generally from 3 to 10 degrees northward. Near the north end of section 1 (Fig. 1) the upper part of the succession is gently folded into a broad east-west syncline that disappears easterly below the sedimentary assemblage overlying the unconformity. The basal beds of the overlying assemblage dip northward at from 3 to 9 degrees and the unconformity is not normally conspicuous. It is much more evident, however, where the synclinal axis passes beneath the younger sediments. At that point beds in the north limb of the syncline dip 40 degrees south in contrast to the gentle (3 degrees) northerly dip of the succeeding strata.

The basal part of the younger succession is marked by a thick gabbro sill that appears to persist in approximately the same stratigraphic position throughout much of the region covered by Figure 1. Thus, the sill is a useful guide to the position of the unconformity in those areas where outcrop is sparse. Just north of section 1 some 200 to 300 feet of grey siltstone and quartzite separate the sill and the unconformity.

Faults

The Coppermine River Group is intersected by a number of faults and sets of faults with generally well-marked surface expressions. The most conspicuous are the northerly trending faults that transect the strike of the lavas and produce offsets ranging from several feet to several miles. Of these the most notable are the pair (Dixon and Teshierpi faults) that meet just south of the easterly of the Dismal Lakes and bound a wedge of lavas that protrudes about five miles into the region of underlying rocks. The major copper deposit of the district is reported to be associated with the northeasterly striking member (the Teshierpi fault) of this pair.

Table of Formations

Era	Period	Group	Formation (thickness in feet)	
PROTEROZOIC	Hadrynian			Gabbro sills
		Intrusive Contact		
				Shales, siltstones, quartzite and limestones
	Unconformity			
	Neohelikian	Coppermine River	(4, 500+)	Red sandstones, siltstones
			(10, 000)	Basaltic flows; very minor pyroclastics, one thin bed of red sandstone
		Hornby Bay		Dolomites and sandstones

The northwesterly striking fault, shown along the valley of Coppermine River just north of its prominent double bend, is a projection of the Canoe Lake fault that cuts the Muskox Complex not far from the base of the lavas. Evidence for its continuation through the lavas is as follows: (1) inconspicuous, closely spaced fractures that shatter the lavas along parts of section 2 parallel the course of the projected fault (Fig. 1); (2) a topographic lineament that includes a segment of the river is continuous with the known fault; and (3) the lower boundary of the Coppermine River Group is apparently displaced at about the position of the fault.

None of the northerly trending faults seem to offset the younger sediments that overlie the unconformity. Thus the faulting seems to predate the deposition of the younger succession.

Age

The most probable age for the Coppermine River Group obtained by radiometric dating is about 1,200 m.y. Potassium-argon dates range from 1,200 to about 740 m.y. (Lowden, 1961; Wanless et al., 1965, 1966, 1968). A rubidium-strontium isochron recently determined on samples of the lavas and of the potash feldspar-rich amygdaloidal flow tops gives an age of 1,210 m.y. (Wanless and Loveridge, in preparation). The Muskox Intrusion and the Mackenzie dyke swarm, both of which are believed to be related to the Coppermine River flows give ages of 1,095-1,155 m.y. (Smith, 1961; Smith, 1965) and 1,315 m.y. (Fahrig and Wanless, 1963) respectively.

If 1,200 m.y. is the approximate age of the Coppermine River basalts then the group of younger potassium-argon ages are probably related to a later tectonic event that caused an inhomogeneous loss of argon. The disturbance that preceded the deposition of the younger sedimentary group and resulted in the presence of the unconformity would be the most likely event. A diabase sill that intrudes the younger sediments provides a minimum age of 605 m.y. (Fraser, 1966, p. 4) for this disturbance, whereas the maximum age may be close to the youngest of the Coppermine River potassium-argon ages, about 740 m.y. If this is so, the younger sedimentary sequence must be Hadrynian in age (cf. Stockwell, 1964).

Intrusive Rocks

The Coppermine River flows are cut by Mackenzie dykes and by an intrusive sheet that seems to be continuous with sills intruding the younger sedimentary sequence. The trace of the intrusive sheet as shown in the northeastern part of the group (Fig. 1) was taken from air photographs. The intrusion was not visited in the field. The Mackenzie dykes are penecontemporaneous with the Coppermine flows and presumably comagmatic; the other intrusion, if the photographic interpretation is correct, is much younger.

A sheet-like gabbro body that appears in the lower half of section 2 (Figs. 1 and 2) is of less certain relationship. It could be an intrusion that is related to either the Coppermine River lavas or the younger sills or it could be an exceedingly thick flow. It is about 900 feet thick and near section 2 is not well-exposed in its upper part. The body is distinctly differentiated; the base is olivine bearing and stratified but the upper part is olivine free and coarse grained. The silica content ranges from about 47 to 52 per cent from the base to the upper levels. This body does not appear in the adjoining section to the west, section 3, and examination of air photographs suggests that it is confined to the east side of the Canoe Lake fault. If this is so then it cannot be related to the younger sills which seem to postdate the faulting but must be either an intrusive or extrusive phase of Coppermine River volcanism.

GEOLOGY OF THE LAVA FLOWS

Physical Description

Stratigraphic projections of the Coppermine River Group along each of the section-lines are presented in Figure 2. In each case the sections should represent true thicknesses. Only in section 1 is the full thickness of the lower volcanic part of the group known to be represented. In sections 2 and 3 it is probably complete but this cannot be confirmed because of poor exposure in the upper parts of the sections. In sections 4 and 5 the volcanic part of the group may be truncated by the unconformity.

The sections are not known to be faulted but some faults may be present and it is entirely possible that parts of the sections are repeated or missing. Hopefully, any such displacements are small and the overall effects negligible. The considerably reduced thickness of the volcanic unit in section 3 compared with its thickness in adjoining sections 2 and 1 is puzzling. Possibly it is due mainly to an underestimate of the dips of flows in segments of the line where outcrop is sparse or lacking, such as the Coppermine River valley.

The volcanic assemblage is composed of a monotonous succession of plateau basalt flows ranging in thickness from 10 to about 300 feet with most of them in the range of 25 to 75 feet. In section 4 where the exposure is particularly good about 130 flows may be counted. Probably not more than 150 flows comprise the entire assemblage. Individual flows may be traced on air photographs for as much as 10 miles. They may extend much farther but the absence of distinctive characteristics makes identification of a particular flow uncertain when the continuity is broken by lack of outcrop or by faulting.

Each flow comprises a massive lower and amygdaloidal upper part. The latter may compose up to one half of the flow but is generally much less. The massive basalt is dark grey, reddish to purplish grey or greenish grey and it grades upward into brick red, oxidized flow tops. A rude columnar jointing is commonly present in the massive parts of the flows but is rarely well developed. The flow tops are generally friable and are commonly sheeted or schistose parallel with the flow margins. Amygdules are composed mainly of potash feldspar, epidote, chlorite, quartz, and calcite in approximately that order of abundance. The mineralogy of the amygdules has not yet been studied in detail and other minerals may well be present. Native copper and chalcocite are reported as amygdular fillings in a number of places where they constitute occurrences of economic interest. Pegmatitic phases of the basaltic flows are rare, unlike those of the Michigan Keweenawan (Cornwall, 1951).

Few 'marker beds' are present in the Coppermine River Group. A pillowed flow occurs at about the same stratigraphic level in sections 2 and 5

(Fig. 2) but was not observed in the intervening sections despite fairly good exposures. Both occurrences probably result from the same inundation which may have spread unevenly over the region. Therefore, where present, the pillowed horizon may be a useful marker bed. In a similar category are the thin beds (20'±) of red sandstone that occur in sections 2 and 3 at about equivalent stratigraphic levels high in the sequence. Similar beds were not evident in the other sections but the exposures are not so good that their presence can be ruled out. Pyroclastic rocks in beds 20 to 30 feet thick occur at two levels in section 4 (Fig. 2) but were not observed elsewhere. They are composed of irregular to somewhat rounded fragments of basalt, generally less than 3 inches in diameter, in an inhomogeneous matrix permeated with carbonate and epidote. They appear to be of limited regional extent and, therefore, of little value for stratigraphic correlation.

Subdivision of the Lavas

Subdivision of the volcanic part of the Coppermine River Group shown in Figures 1 and 2 is based wholly on field observations. Refinement or changes in the subdivision can be expected as the petrography becomes better known.

The volcanic assemblage comprises lower, middle, and upper members and the volcanic part of the overlying, predominantly sedimentary unit is regarded as a fourth member called the upper II. Flows characteristic of the lower member are marked by a finely granular appearance and minute clusters of pyroxene phenocrysts 1-2 mm across. They are commonly mottled with reddish and greenish colours. Both middle and upper members are composed of very fine grained or aphanitic basalts that are distinguished from one another mainly by colour. Flows of the middle member are generally reddish grey or grey whereas those of the upper member are commonly distinctly greenish. Native copper is a fairly common accessory mineral in flows of the upper member. It is rarer in the middle member and was not observed in the lower member. The lower member was recognized in all sections, but the middle and upper members could be distinguished with reasonable confidence only in sections 1 and 4. In section 3 they could not be separated and in sections 2 and 5 they were separated with difficulty. The subdivisions are too inexact to be of more than general use in regional correlation.

The basalts interbedded with red sandstones in the upper part of the group (upper II member) appear only in section 1 and are not distinctive in appearance.

Petrography

R.N. Annells

Microscopic examination of 220 thin sections of Coppermine lavas taken from sections 1 to 5 reveals that their groundmasses are plagioclase-pyroxene-ore fabrics which can be divided into four main textural types gradational into one another. Two are characterized by the presence of a cryptocrystalline dark brown mesostasis often densely charged with minute granules or needles of opaque minerals. This mesostasis is interpreted as a devitrified glass formed by congelation of residual liquid, by analogy with the glassy mesostasis common in fresh Tertiary tholeiites of the North Atlantic Province. It seems possible that the opaque bodies in the devitrified mesostasis are of iron oxide minerals, indicating some concentration of iron in the final tholeiite residuum (Edwards, 1938).

The four textural types are, in order of decreasing volume of mesostasis:

1. Intersertal type. The small (usually less than 0.5 mm) plagioclase, pyroxene and ore grains which form the bulk of the rock have euhedral to subhedral habit and are not noticeably moulded onto one another. The mesostasis may make up to 30-35 per cent by volume of the rock and is usually sufficiently abundant for the early-precipitated minerals to appear to be 'afloat' in it.

2. Intergranular type. The plagioclase, pyroxene and ore grains are more densely packed together than in (1) but are still not markedly moulded onto one another. Mesostasis material is scarce to absent.

3. Subophitic type. The plagioclase laths in this type are partly but never wholly enclosed by the pyroxene grains, which now assume a more anhedral form than in (1) and (2). Mesostasis material is usually absent.

4. Ophitic type. The plagioclase laths in this type are often entirely enclosed by anhedral pyroxene grains which are seen in thin section as plates up to about 1 mm in length. The pyroxene grains may also enclose small equant pseudomorphs after olivine. These small groundmass olivine crystals appear to be confined to lavas of this textural type. Mesostasis material is usually absent.

Each of these four main textural types may bear microphenocrysts (up to 3-4 mm greatest length) of calcic plagioclase, pyroxene, olivine and ore. These phenocrysts are commonly grouped in scattered loose clusters which occur sporadically in rocks from all parts of the succession but which are most noticeable in the lowest 25 per cent of the succession where they reach maximum diameters of about 5 mm. Elongated phenocrysts of pale green orthopyroxene are common in the clusters in this lowest part of the succession. Ore phenocrysts were rarely found in any of the clusters and appear to exist mainly as isolated crystals.

Fabrics of types (1) and (2) were often found to contain small local concentrations of the dark brown mesostasis material in the form of irregular, elongate streaks and more or less equant patches. The plagioclase and pyroxene in these bodies commonly have euhedral, columnar habits and the feldspars may have void cores and imperfect terminations. Small acicular ore crystals are also present in these patches, which are interpreted as concentrations of residual liquid within small rifts in the plagioclase-pyroxene-ore meshwork. Small glassy patches of similar aspect have been described from the tholeiitic lavas of Hakone volcano, Japan (Kuno, 1950) and Iceland (Annells, 1968).

Relative Abundances of the Four Main Textural Types

The overall abundances of the four main groundmass types in the total Coppermine section studied are:

Type 1 .... 33 per cent
Type 2 .... 57 per cent
Type 3 .... 9 per cent
Type 4 .... 2 per cent

In a preliminary statistical study of the vertical distribution of these four main textural types, the total Coppermine succession was divided into four arbitrary horizontal zones of equal thickness. The most striking result of this study is that the abundance of the once-glassy type (1) fabrics decreases upwards over the lowest 75 per cent of the total succession as shown by the following data:

	height in total succession	abundance of type 1 fabric
Zone 3	50-75 per cent	19 per cent (6:32 flows)
Zone 2	25-50 per cent	24 per cent (13:54 flows)
Zone 1	0-25 per cent	49 per cent (29:59 flows)

PETROCHEMISTRY OF THE VOLCANIC ROCKS

Reliability of Data

Composite samples were formed of equal parts of each of the individual samples from the lower, middle and upper members of sections 1, 2, and 4 and from the intersedimentary volcanics (upper II) of section 1. In Table I classical analyses of these composite samples are compared with the averages of the corresponding individual rapid analyses. The results should be equivalent. Hopefully most of the errors of precision have been eliminated in the average and the discrepency that remains is largely the bias between methods. The major systematic departures of the rapid from the classical results are as follows: SiO_2 is generally 0.2 to 0.5 per cent less, Al_2O_3 ranges from about 0.4 to 1.0 per cent greater, FeO (total) ranges from 0 to 1.0 per cent less, MgO ranges mainly from 0 to 0.8 per cent greater but has a few values outside this range, CaO ranges generally from 0.2 per cent less to 0.6 per cent greater, TiO_2 ranges from 0 to 0.5 per cent less, Na_2O is from 0 to 0.5 per cent greater, and K_2O is from 0 to 0.1 per cent greater.

The classical analyses are undoubtedly more reliable but no attempt has been made in this study to adjust the values of the rapid analyses. They are almost as consistent in their relative values, one to the other, as are the classical analyses. This is shown in Figure 8 where the classical analyses and average rapid analyses are both plotted on graphs of composition versus stratigraphic height. The variations in average composition of the two sets of data are about parallel. Thus for all comparisons of compositions within the Coppermine River volcanic province there is no need to consider the bias. However, it may have to be considered when these results are compared with classical analyses from other magmatic provinces.

The trace element analyses, except for copper, have not been tested by another method. The elements Sr, Ba, Cr, Zr, V, Ni, Cu, Y, Co, and Sc are considered by the staff of the Geological Survey's spectrochemical laboratory to be accurate to within $\pm$15 per cent and the elements Zn, Pb, Ga, Sn, and Ag to be accurate to within $\pm$30 per cent.

Copper was thought to present a special problem because of its presence in the native state in many of the samples. It seemed possible that the blebs of native copper would resist reduction during grinding and consequently be unevenly distributed through the sample. The size of the charges used for spectrographic analyses (45 mg) were thought to be too small to have much chance of being representative in these circumstances. Accordingly, most of the samples collected that had visible native copper were also analyzed in 5 gm charges by a chemical colorimetric method. The two sets of results are reported in Table II and in general they are similar. The close similarity of the two averages suggests that native copper does not present the mixing problems anticipated. Of the two sets of data the colorimetric analyses are probably the more accurate. However, because they are confined to a limited number of samples the spectrographic results are used in this report.

Bulk Composition

The bulk composition of Coppermine River flows is represented by the frequency distribution diagrams of nine major and minor oxides and fourteen trace elements shown in Figures 3 and 4 respectively. The corresponding data is given in Table IV. Gallium is not included because of its scattered distribution. Corresponding diagrams for the major oxides and copper for the Yellowknife Group lavas (Baragar, 1966) are also given for comparison[1]. In the frequency diagrams of Figure 4 the average content of trace elements in basaltic rocks of the earth's crust according to Turekian and Wedepohl (1961) is represented in each case by a vertical line. The values themselves are given in Table V. This should provide a rough means of assessing the distinctiveness of the trace element content in Coppermine River basalts.

An average analysis of Coppermine River basalts together with averages of each of the sections and members are given in Table IIIa (major elements) and IIIb (trace elements). Data for both the frequency distribution diagrams and average analyses include only the analyses of samples collected systematically through the sequence. Analyses of flow tops and samples taken for special purposes are excluded. Hopefully, therefore, these collective results are close to a true representation of the composition of the Coppermine River magma.

Major Elements

Coppermine River lavas show several notable distinctions in comparison with those of the Yellowknife Group. Potassium and titanium are distinctly higher and silica, alumina, and lime somewhat lower in the Coppermine River assemblage. There is no essential difference in the distributions of iron and magnesium but the iron is considerably more oxidized in the Coppermine than in the Yellowknife lavas.

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[1] The Yellowknife diagrams use the upper boundaries of the class whereas the Coppermine River diagrams use the midpoints. This was inadvertently not adjusted in Figures 3 and 4. Therefore the diagrams are not on an equivalent basis of comparison. However, the differences are small and not significant for the purposes of this report.

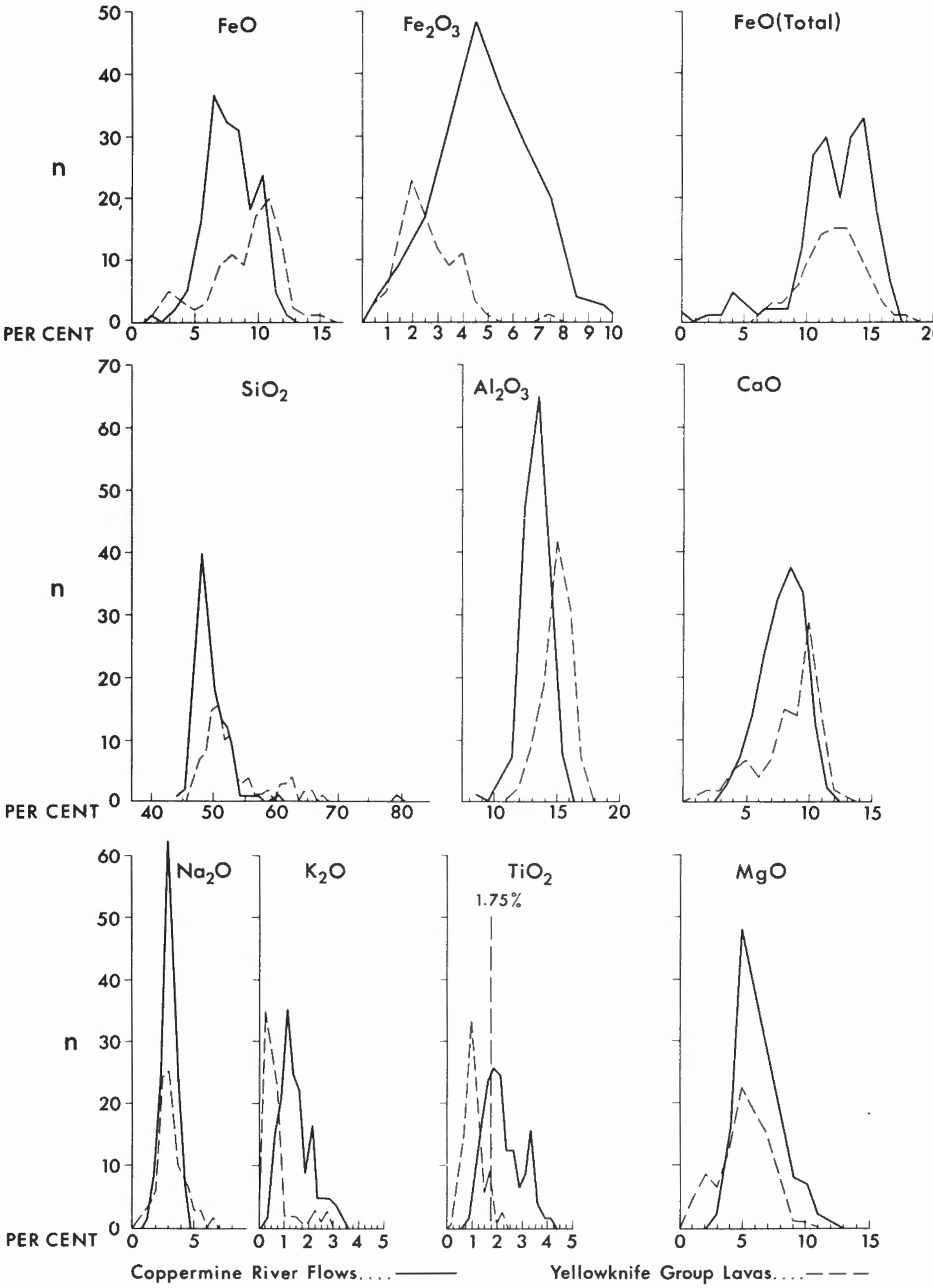

Figure 3. Frequency distribution diagrams of major oxides.

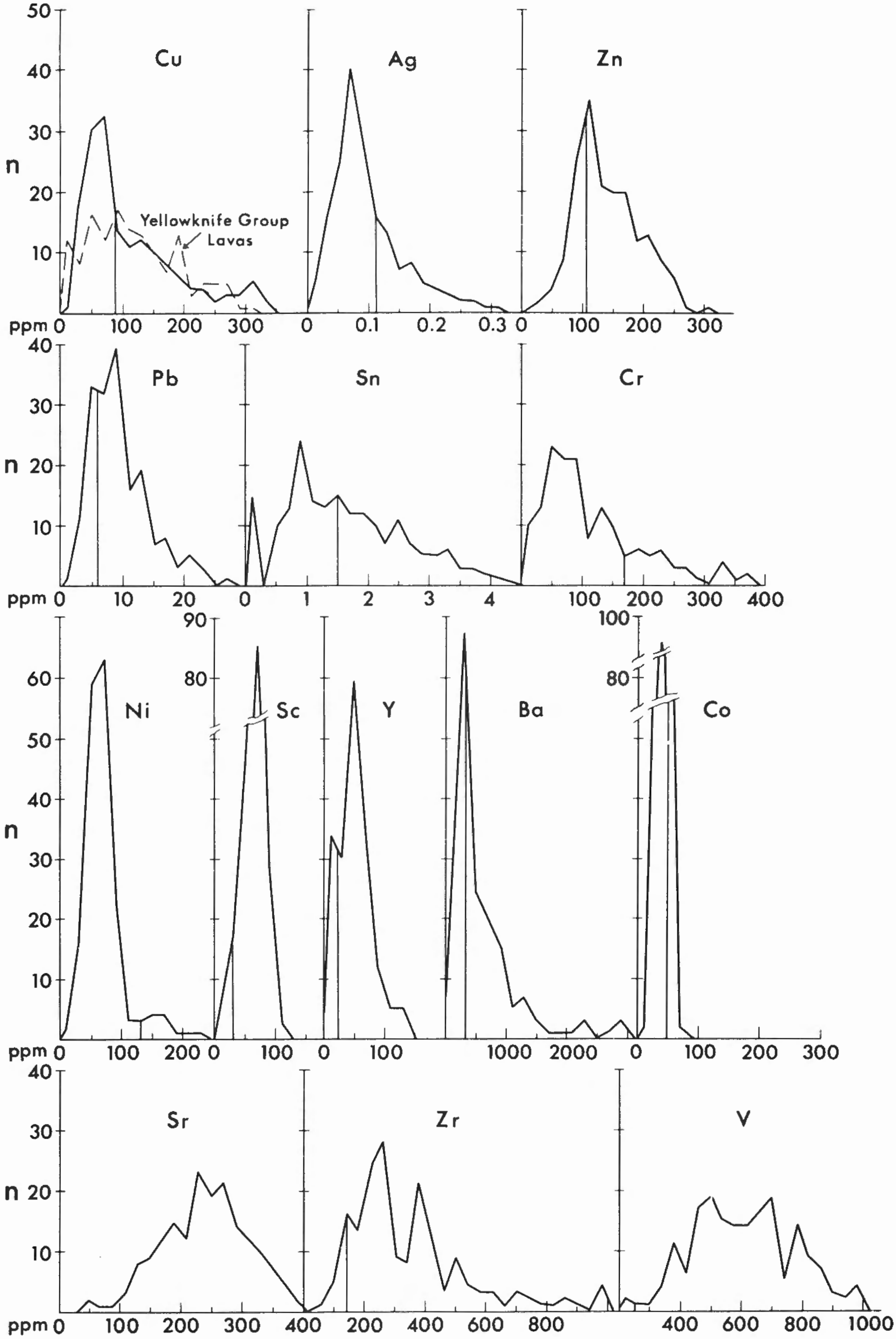

Figure 4. Frequency distribution diagrams of minor elements.

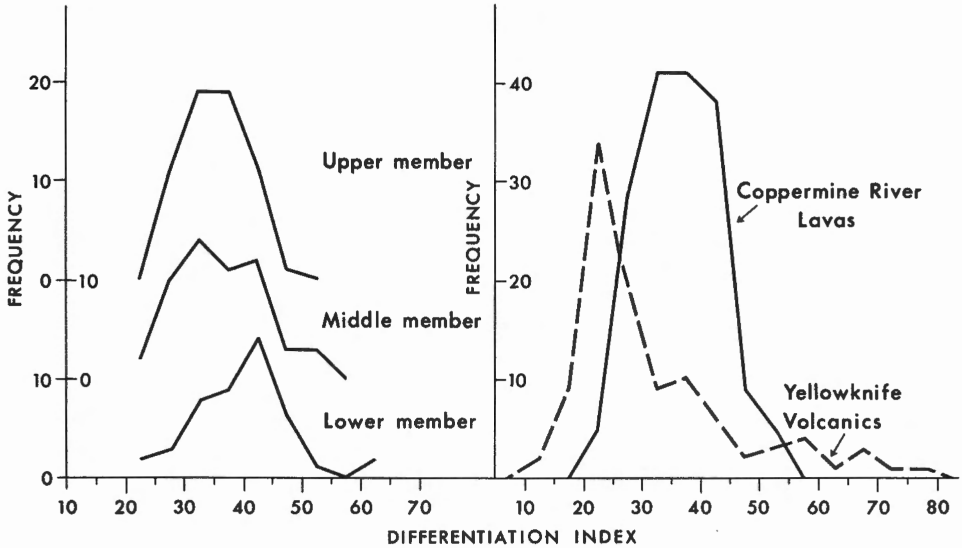

Figure 5. Frequency distribution diagrams of differentiation index.

How many of the differences between the two lava assemblages can be attributed to expectable differences between plateau basalts and geosynclinal lava sequences? The Yellowknife Group is fairly typical of Archean geosynclinal volcanic assemblages of the Canadian Shield (Baragar and Goodwin, in press). In Table V average compositions of several well-known plateau basalt sequences are compared with the average Coppermine River basalt. A considerable range of composition is evident for the plateau basalts but in general they are higher in titania and potash (in part), lower in silica, and more highly oxidized than the geosynclinal (Yellowknife) volcanics. Thus at least some of the features that distinguish Coppermine River and Yellowknife lavas are shared by other plateau basalts.

The difference in titania content between the two assemblages is of special interest because of its possible implications in regard to magma-type. Chayes (1964) found that a titanium value of 1.75 per cent separates most basalts of oceanic islands from most of those of circumoceanic belts. Since the former tended to be alkali and the latter tholeiitic (subalkaline; Chayes, 1966) basalts, the titanium content seemed to be a possible indicator of the alkalinity of basalts. In Figure 3 it is evident that the value of 1.75 per cent titania separates most of the Coppermine River (greater) from the Yellowknife (less) analyses. This coupled with a somewhat higher potash and lower silica content raises the question as to whether the Coppermine River assemblage may not be transitional between tholeiitic and alkali basalts.

The more oxidized condition of the Coppermine River compared to the Yellowknife basalts undoubtedly reflects its extrusion under subaerial as opposed to submarine conditions.

In Figure 5 distributions of the differentiation index of the two assemblages are compared. The differentiation index is a measure of the percentage of salic components in the rock (Thornton and Tuttle, 1960)[1] and is theoretically a gauge of differentiation. The Coppermine River lavas while more differentiated than the bulk of the Yellowknife Group volcanics span a much narrower range than the latter. No rocks more acid than andesite are found in the Coppermine River assemblage whereas the Yellowknife Group lavas, in common with most geosynclinal assemblages, range from basalts to rhyolites.

Minor Elements

The principal differences between the trace element contents of the Coppermine River flows and the average basalt are that Ni and Sr are probably significantly lower and Ba, Zr, V, and Sc significantly higher in the Coppermine River flows. The average values for Cu, Zn, and Pb (Table V) are somewhat higher in the Coppermine River assemblage than in the average basalt but since the mode in each case (Fig. 4) differs little from the average basalt it is doubtful that this is significant.

The distributions of copper analyses in Yellowknife and Coppermine River rocks are very similar yet there is a close association of copper prospects with the latter but not the former. It would appear than an extraordinarily higher copper content in itself is not a significant factor in the localization of copper deposits.

The strontium content has special interest as a 'finger-print' of basaltic provinces according to Turekian and Kulp (1956). They found that the distribution of strontium values tends to have a limited range in any one basaltic province but that the range varies significantly from province to province. Thus it tends to be an identifying characteristic of a basaltic province. Out of the 30 provinces surveyed by Turekian and Kulp (pp. 267-268) the average strontium content of Coppermine River basalts of 267 ppm and its range from about 150 to 350 ppm are approached closely only by the Pacific Northwest (Columbia Plateau) tholeiitic basalts. It is interesting that these are the Yakima basalts which can be seen in Table V to be also very similar to Coppermine River basalts in their major element composition.

Stratigraphic Variation in Composition

The analytical value for each element was plotted by computer against the appropriate stratigraphic level for the sample it represents. Since this amounts to a great many plots only a few are reproduced here (in Figs. 6 and 7) in order to illustrate the type of results that have been obtained. However, most of the data can be conveniently represented by using only the average result of each member plotted against the median stratigraphic position of that member. Each section has been done separately and arranged in the order that it appears in the field (Figs. 8 and 9). In Figure 8, the classical analyses of composite samples are also shown. They are equivalent to the corresponding averages of the rapid analyses and, as mentioned earlier, the discrepency is the bias between methods.

These plots greatly simplify the presentation of many data but they also give the trends a simplicity that is unrealistic. It should be borne in

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[1] (Sum of C.I.P.W. normative Q, Ab, Or, Ne, Kp, Lc).

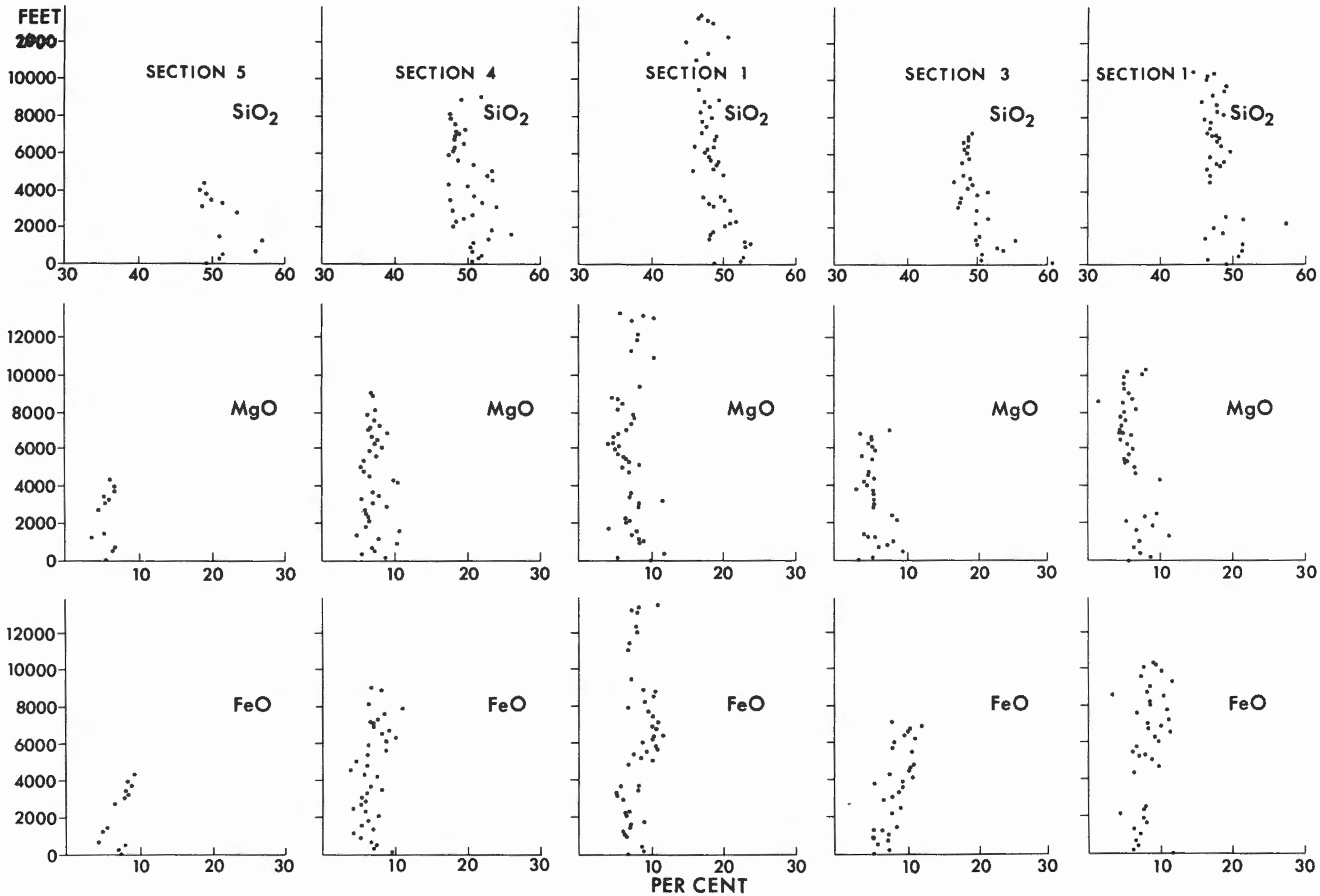

Figure 6. Plots of major oxides and stratigraphic level.

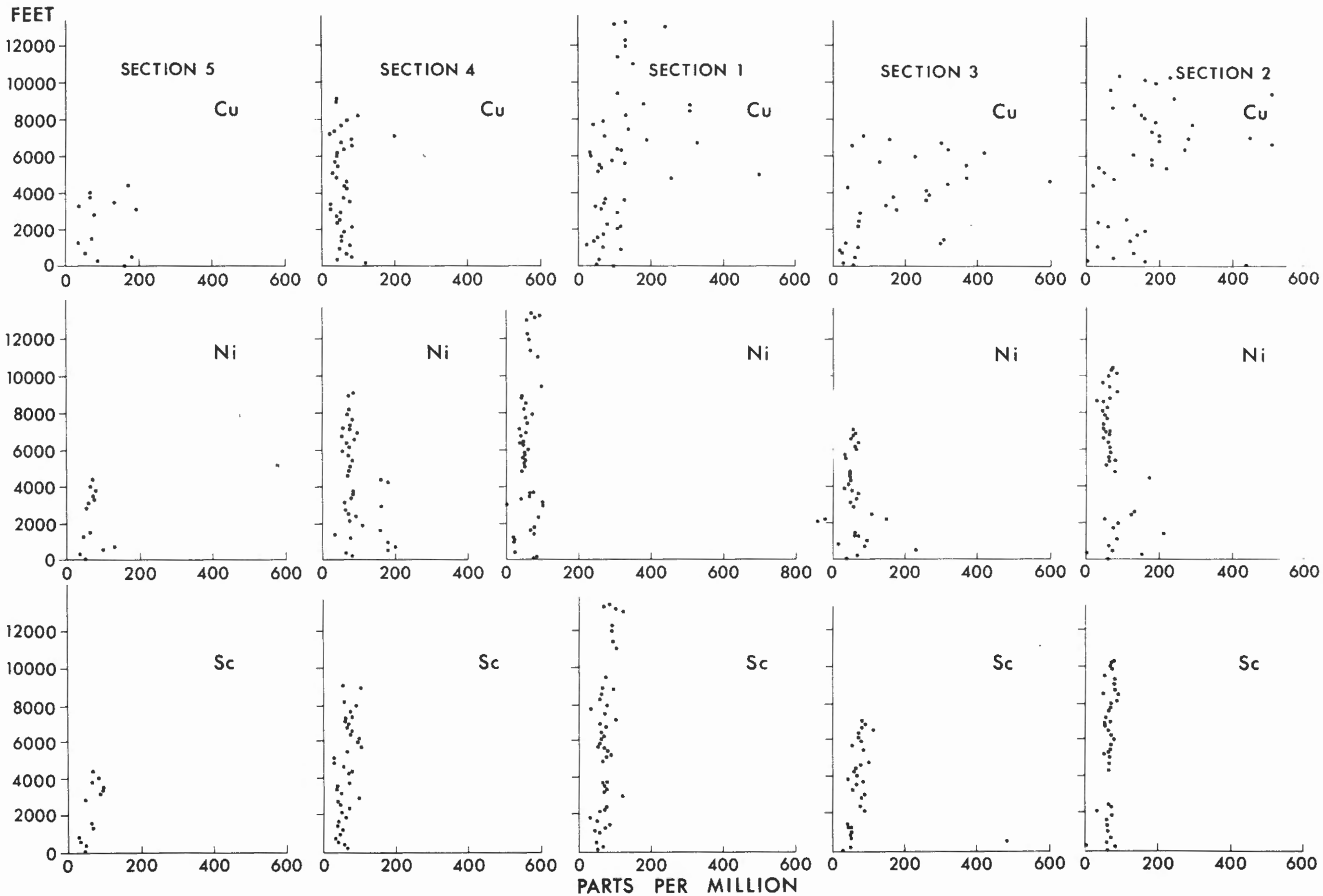

Figure 7. Plots of minor elements and stratigraphic level.

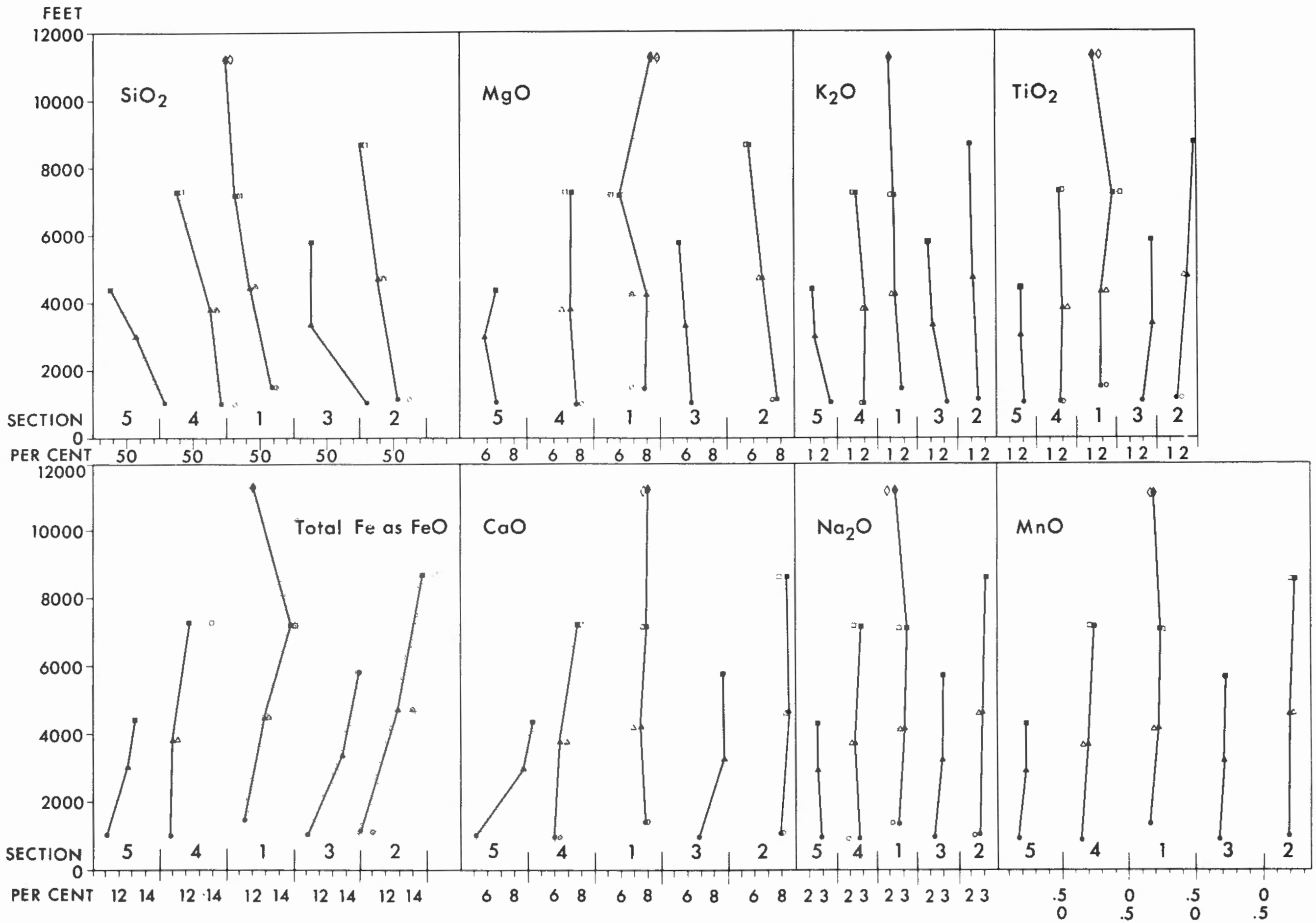

Figure 8. Stratigraphic variation in composition: major elements.

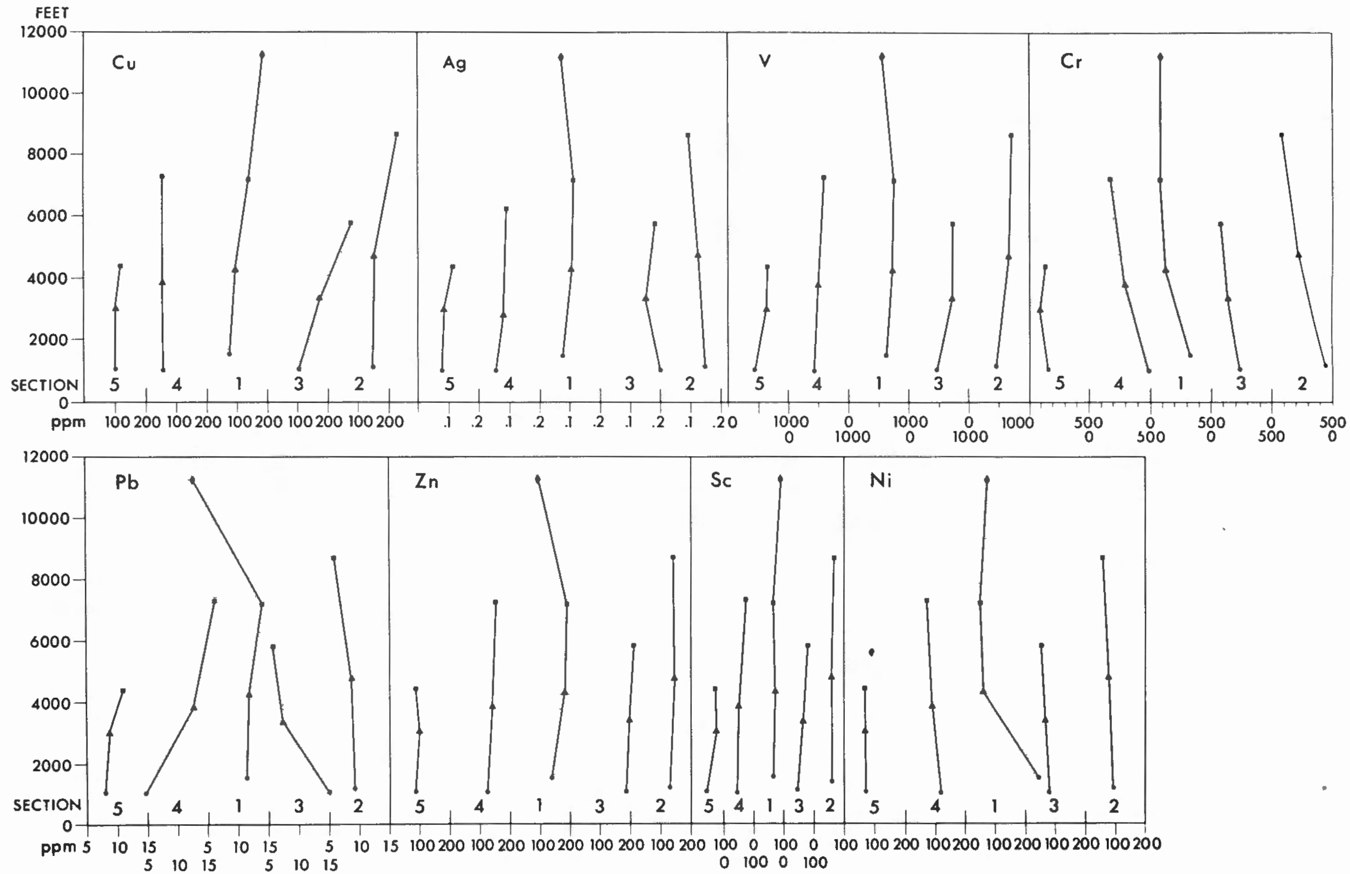

Figure 9. Stratigraphic variation in composition: minor elements.

mind that plots of the individual points do show considerable scatter, especially those of the trace elements. A number, such as silica in Figure 6, have distinct trends but others, such as gallium (not presented in Fig. 9) are so scattered that averages are meaningless. Even if trends in the original plots are not distinct but in the simplified plots of Figures 8 and 9 have the same sense in all five sections, they are assumed to be real.

A number of interesting features are evident from Figures 6 to 9.

1. Flows interbedded with red sandstones in the upper part of section 1 (upper II member) do not seem to be of the same genetic lineage as those of the main lava assemblage. Compositional trends established in the lower, middle, and upper members for a number of elements (e.g. FeO (total), Ni) are not continued into these upper lavas. In some cases the composition changes radically from that of the main assemblage. Thus in the interval of time represented by the deposition of the red sandstones the conditions of magma generation seem to have changed.

2. Silica, and to a lesser degree magnesia and potash decrease, and iron and manganese increase, upward in the stratigraphic sequence. The decrease of silica and increase of iron are especially persistent and marked. Lime increases upward in some sections and shows no variation in others. The alumina trends are distinct but vary from a slight decrease upward in section 2 to a marked increase upward in section 4. Titania generally increases upward but this is not consistent.

3. Copper, vanadium, zinc, and scandium all increase whereas nickel and chromium decrease upward in the stratigraphic sequence. The variation in copper is most marked in sections 1, 2, and 3. The upward decreases in nickel and chromium are especially marked and are persistent in all sections.

In Table III a and b average analyses for the entire lower, middle, upper and upper II members provide an overall comparison of the stratigraphic variation in composition. In addition to those elements already noted, the average content of zirconium, lead, and yttrium also changes systematically upward; zirconium increases and lead and yttrium decrease. However, this may be partly fortuitous because there is no consistency in the way these elements vary from section to section.

In Figure 5 the frequency distribution diagrams of the differentiation index for the lower, middle, and upper members are compared. It is evident that there is a slight but unmistakable shift of the differentiation index to lower values upward in the succession.

The stratigraphic variation in composition of Coppermine River flows contrasts with that in geosynclinal assemblages previously studied. In the Yellowknife (Baragar, 1966) and Noranda (Baragar, 1968) volcanic assemblages the proportion of salic constituents increases upward. The Yellowknife lavas are characterized by an upward-increasing differentiation index and those of Noranda by a sharp upward decline in the content of iron and magnesia. These are the opposite variations to those just described in the Coppermine River lavas.

Longitudinal Variation in Composition

In Figures 10 and 11 the average composition of each section is shown graphically in the order that the sections appear in the field. Figure 10 shows the section by section variation in the average content of each of the

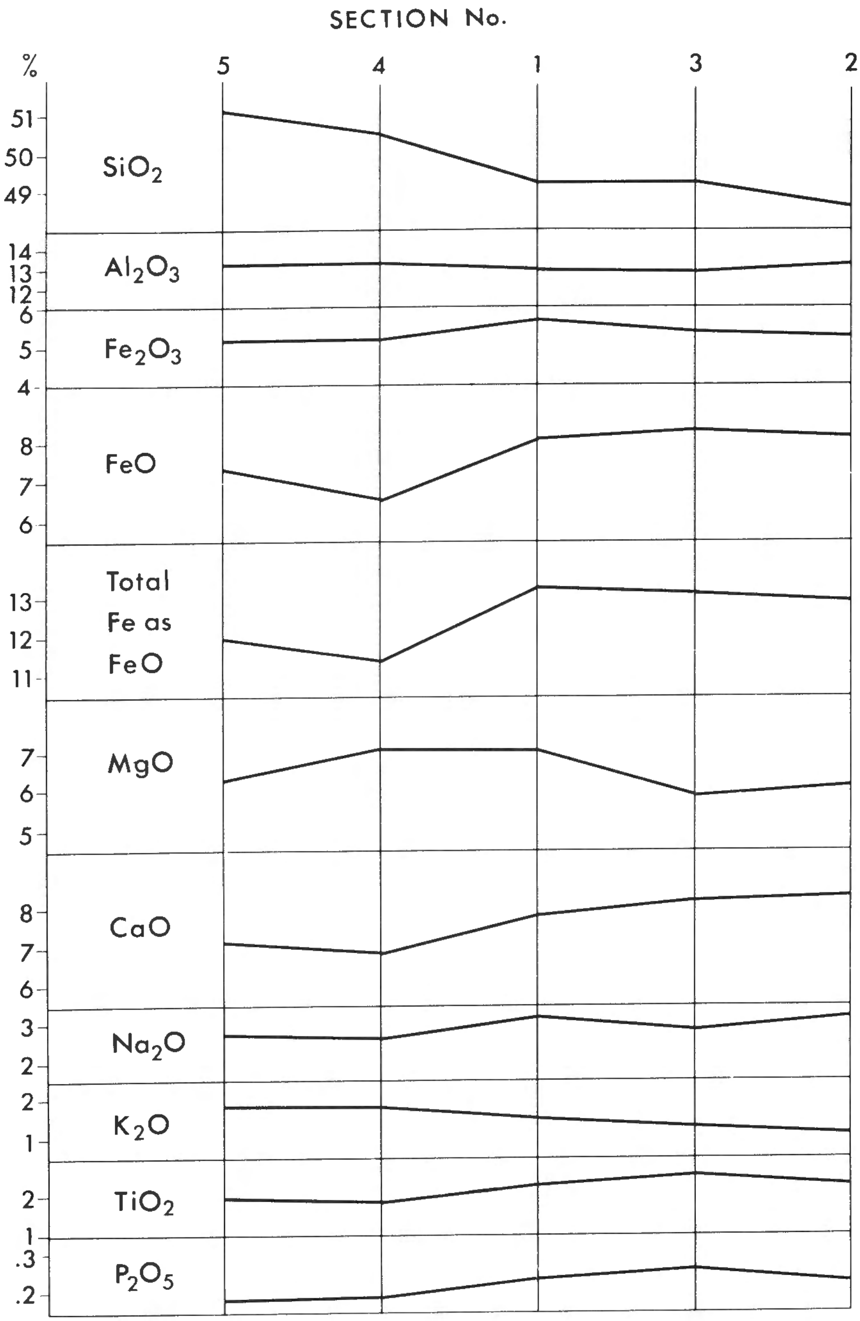

Figure 10. Longitudinal variation in composition: major elements.

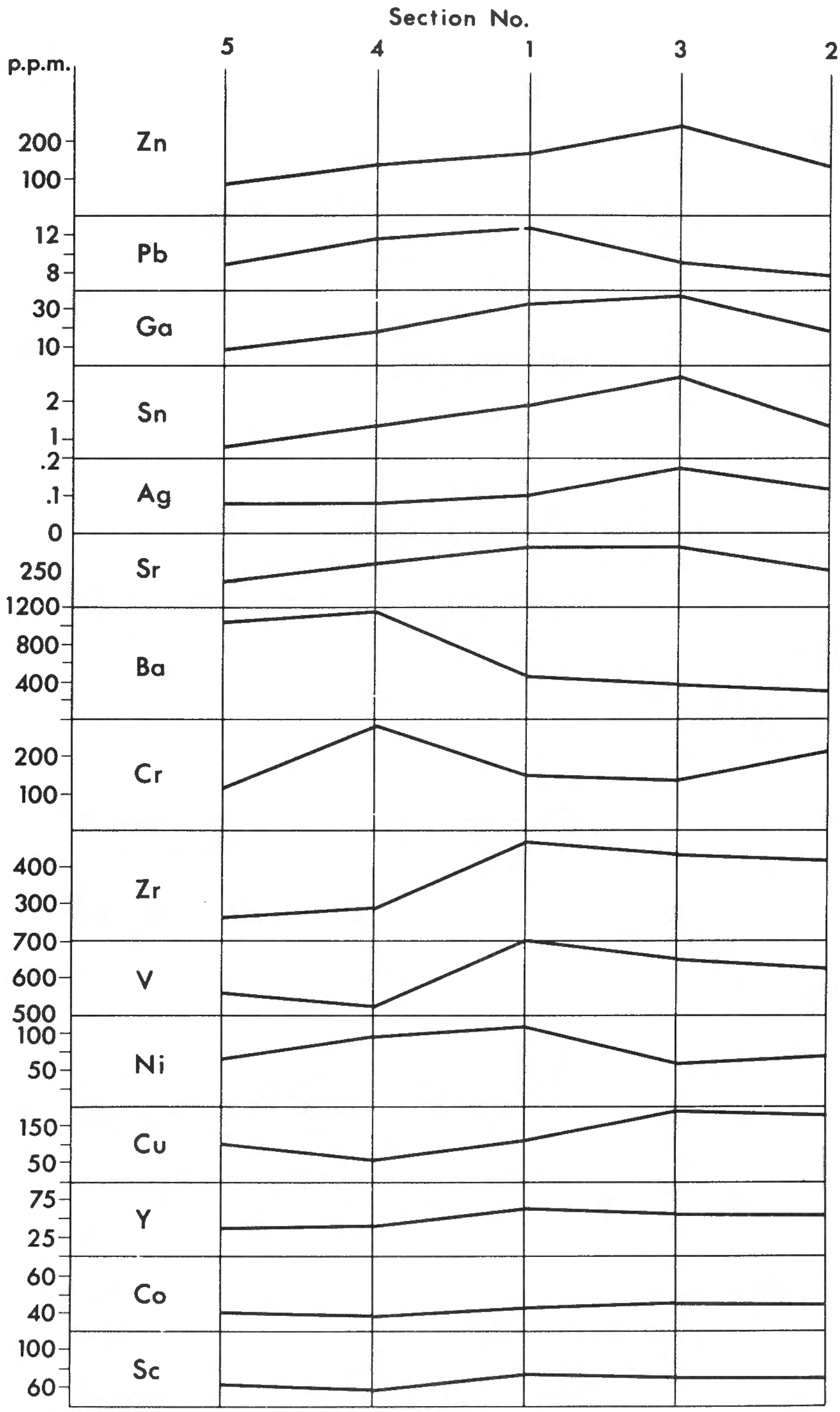

Figure 11. Longitudinal variation in composition: minor elements.

major elements and Figure 11 shows the same for the minor elements. The average compositions are listed in Table III.

The diagrams indicate that the composition of the lavas varies somewhat systematically along strike and that the variations roughly parallel the stratigraphic variations in composition previously noted. Thus silica, magnesia, and potash all generally decrease and iron and lime increase eastward. These are the same elements, varying in the same relationship to one another, that showed the most marked and persistent variations with stratigraphic height in Figure 8. The western section of Figure 10 is analogous to the base of the sequence in Figure 8. The minor elements also tend to vary along strike in a manner that is analogous to their vertical variations but not as consistently as the major elements. Copper, zinc, vanadium, and scandium, which increase upwards in the sequence, also generally increase eastward. Zirconium increases eastward and it was previously noted that the average zirconium content of each member increases upward (Table III b). The cobalt and yttrium content of the flows varies little in both vertical and lateral directions.

Thus the manner in which the magma changes composition upward in the stratigraphic sequence and eastward along the strike of the lava assemblage is somewhat analogous. If this is real, one ready explanation may be that the western sections have been truncated by the unconformity and are now biased in their average compositions towards that of the lower stratigraphic levels. However, this is not entirely satisfactory. The lava assemblage in section 4 is about as thick as in section 1 and it seems unlikely that much material could have been removed from the top. Moreover, it is difficult to explain the systematic lateral variation of silica and potash in this way. The question needs further study.

Chemistry of the Flow Tops

Oxidation is the most obvious change that has taken place in the flow tops relative to their interiors because of the brick red coloration it imparts to the rock. To investigate other possible changes, sets of samples were collected from the tops and interiors of four flows and from eleven other flow tops. The analyses of the sets of samples and the average of all fifteen flow tops together with the average Coppermine River flow are presented in Table VI.

The only consistent changes in composition between flow interiors and tops are a marked oxidation in iron, a decrease in alumina and strontium and an increase in carbon dioxide. Other changes that may be characteristic but are not invariably present are increases in copper, zinc, silver, and tin and a decrease in chromium and lime. It may be noted that the conspicuously reddened flow tops are due purely to oxidation and not to enrichment of iron.

A possible concentration of copper in the flow tops is of special interest because of its economic implications. In three of the four flows where a direct comparison may be made between the copper content of the interior and top, copper is more concentrated in the top. In the fourth flow it does not change. This contrasts with the comparison between the average flow and the average of fifteen flow tops; copper is distinctly higher in the former. Two factors may account for this discrepancy; (1) the average of 15 flow tops irregularly selected is much less likely to be representative than that of the average flow, and (2) copper may have been leached from many of the flow tops by hydrothermal or groundwater action. Samples from the tops of the individual flows given in Table VI are relatively fresh in comparison with many of the flow tops which are sheeted and friable. It is possible, therefore, that these analyses, together with those of the corresponding interiors, reflect the original distributions of copper in the flows better than the average analyses.

Differentiation of Coppermine River Magma

The Coppermine River lava assemblage exhibits several progressive changes in composition with time (that is, with increasing stratigraphic level) the most notable of which are decreases in silica, potash, and magnesia, and increases in iron and generally titanium. Chromium and nickel decrease upward in the succession and copper, zinc, vanadium, and scandium all increase.

The decrease of chromium, nickel and magnesia coupled with the increase in iron and titanium is a strong indication of crystal fractionation of the Skaergaard type (Wager and Brown, 1968, p. 167). Even silica decreases as it does in the Skaergaard for the bulk of the crystallization period. The upward increase of copper, vanadium, and scandium also accords with their behaviour in successively later liquids of the Skaergaard intrusion (Wager and Brown, 1968, Pl. X). The behaviour of potassium in the Coppermine River assemblage is the major exception to the patterns expectable for this type of differentiation. As yet no explanation can be offered for its extraordinary decrease upward in the succession.

Insufficient petrography has been done on the flows to suggest a mechanism for the differentiation. The only megascopic phenocrysts observed in the Coppermine River assemblage are in the lower member and Annells (this report) has noted that many are orthopyroxene. It is therefore possible that the settling of orthopyroxene had a major influence on the trend of differentiation. The dominant chemical variations upward in the succession – the increase in iron and decrease in silica – would not be incompatible with such a mechanism.

THE RELATION OF COPPER DEPOSITS AND COPPERMINE RIVER FLOWS: A DISCUSSION

The locations of all copper prospects reported to date are shown in Figure 1. The writer has seen very few of these and is indebted to his colleagues Drs. E. D. Kindle and R. I. Thorpe for information regarding their locations. No attempt has been made to evaluate the separate prospects and none has yet proved to be economically workable. The most encouraging prospect is the Hope Lake deposit of Coppermine River Limited which is reported to have an indicated reserve to 600 feet depth of about 3,571,000 tons grading 3.44 per cent copper (Northern Miner, 1968). Fracture-fillings and veins appear to be the major types of deposits (Kindle, 1969, p. 112) with amygdaloidal flow top concentrations an important subsidiary type. Chalcocite, bornite, and native copper, in order of abundance, are the principal minerals of economic interest.

There can be little doubt that the copper deposits are related directly or indirectly to the Coppermine River flows. They are so closely associated in space and so obviously compatible in mineralogy that it would be pointless to cast further afield for a source for the copper. Whether or not they are syngenetic deposits, however, is another question.

The copper prospects shown in Figure 1 seem to have a significant distribution. They occur within the middle and upper members of the main lava assemblage where the copper content of the flows is generally higher and where native copper is a common minor constituent. No prospects have been reported from the lower member. Moreover, most of the prospects, and certainly the most promising ones, occur east of the Dixon fault where the copper content of the flows is higher than it is farther west (Fig. 11). Thus the distribution of copper occurrences is not only coincident with the distribution of the flows but appears to be coincident to some degree with the distribution of higher copper values within the flows.

These observations might seem to indicate a syngenetic origin for the copper deposits but the association of most of the deposits with faults or fractures complicates this interpretation. The major deposit found to date is closely associated with the Teshierpi fault and the Bornite Lake deposit, which has received considerable attention in the past, is in a fracture zone subsidiary to the Dixon fault. Both major faults postdate most, and probably all, of the Coppermine River volcanic sequence. Thus at least part of the mineralization occurred when volcanism was essentially, or completely, finished.

To account for these observations a two-stage mechanism of concentration is envisaged: first, during the magmatic stage copper is concentrated in flow tops, and secondly, during a hydrothermal stage it is flushed from the flow tops by sulphurous hydrothermal solutions and reconcentrated in nearby structural traps. This follows a similar hypothesis by Cornwall (1951, pp. 197-199) for copper deposits of the Keweenawan flows of Michigan.

Some evidence that copper is concentrated in the flow tops is provided in Table VI and was discussed previously. Broderick (1935) and Cornwall (1951) also found that the copper content is enriched upward in the Kearsarge and Greenstone flows of the Keweenawan in Michigan. There, its distribution is complicated by the presence in the upper half of the flows of pegmatitic layers wherein copper is considerably enriched. Nevertheless, Cornwall did find copper enrichment in the upper amygdaloidal zone and attributed it to volatile transfer from within the flow (Cornwall, 1951, p. 199). He was able to demonstrate that a commercially workable copper deposit at the top of the Kearsarge flow could be entirely derived from the copper content of the flow beneath.

The case for volatile transfer of copper to the tops of the flows as suggested by Cornwall has been considerably enhanced by experimental work done at McGill University (Gill, 1960; MacDougal et al., 1961). MacDougal and others demonstrated that copper and other sulphides may be highly susceptible to gaseous transfer. In one set of experiments copper sulphide (CuS) powder was heated to 700-1,000° C in a tube in which there was a pronounced thermal gradient. After periods of from 48 to 69 hours, copper sulphide crystals were found to be growing as much as 4 cm from the charge along the tube in the direction of falling temperature (MacDougal et al., 1961, pp. 384-385). Thus, volatile transfer must be considered a feasible, or even probable, means of mineral transport at magmatic temperatures.

Copper that is presently dispersed through the lavas is virtually all in the form of native copper rather than sulphide. Nevertheless when the lavas were originally emitted the copper was probably present as a sulphide and, if the experience of Skinner and Peck (1966) and Desborough et al. (1968) with Hawaiian lavas is a guide, probably as a sulphide liquid. These investigators found that sulphides were dispersed through the magma as immiscible liquid droplets that solidified to blebs of pyrrhotite, magnetite, and chalcopyrite or cubanite.

Let us assume, then, that much of the initial copper content of the Coppermine River lavas was in the form of immiscible sulphide droplets at the time of extrusion. Following extrusion a steep thermal gradient would quickly develop between the interior and surface of the flow and copper sulphides would begin their migration towards the surface in the manner of the McGill experiments. Near the surface under oxidizing conditions that converted most of the magnetite to hematite, copper could be deposited directly as native copper rather than as sulphide. Garrels and Christ (1965, pp. 167-169) showed the presence of stability fields for copper with both magnetite and hematite at atmospheric total pressure, low sulphur partial pressure and at a temperature of 25 degrees centigrade. Within this region native copper occurs at oxygen pressures that overlap that at which magnetite is converted to hematite. Except for the low temperature these are conditions that might be expected at a flow top. If equivalent conditions exist at magmatic temperatures the presence of native copper near the flow tops is readily explained. Most of the flows are thin and are oxidized to some degree throughout. Thus even the residual copper sulphide blebs remaining in the interior of the flow may eventually be converted to the native state. The paucity of sulphur presently found in the flows testifies to the severity of oxidizing conditions permeating most of them. Of 18 samples analyzed for sulphur 8 contained less than the lower detection limits of 0.005 per cent and the remainder averaged 0.02 per cent.

Following consolidation of the lavas the amygdaloidal flow tops would become natural conduits for all varieties of groundwaters. Any fluids penetrating the succession of flows would have access to very extensive surfaces of copper-enriched basaltic flow tops. If these were thermal fluids related to the closing stages of volcanic activity they could be very effective in leaching copper from the flow surfaces and transporting it to other environments. They would undoubtedly be sulphurous, judging from the composition of present volcanic emanations (White and Waring, 1963), and copper deposited from them might be expected to be in the form of sulphides. Deposition would tend to take place at sites that represent fairly sharp changes of environment such as fracture zones that penetrate the flow tops and release the enclosed fluids. Thus it may be that copper deposits, comprising mainly sulphides, tend to be localized in veins and fractures in those parts of the flows where the copper content is highest. They would be syngenetic deposits only in the sense that the source of the metal is local and that the hydrothermal action is related to the same event as the flows. There is little real evidence for the latter, however, and it is not a necessary part of the hypothesis.

SUMMARY

The Coppermine River Group comprises a lower division of basalt flows, about 10,000 feet thick, and an upper division of red sandstones and intercalated basalt flows that is at least 4,000 feet thick. The entire assemblage dips generally from 3 to 10 degrees northward and is overlain unconformably by an even more gently north-dipping succession of sedimentary rocks.

The lava assemblage is dissected by a number of northerly-striking faults that postdate most or all of the volcanism but evidently predate the younger sedimentary group. A number of the copper prospects of the region are closely associated with the faults.

The Coppermine River Group is about 1,200 m.y. old and is therefore of Neohelikian age. The overlying succession may be of Hadrynian age.

The succession of lavas was divided in the field into lower, middle and upper members with the intersedimentary flows in the upper part of the group assigned to a fourth category called the upper II member. The lower member is marked by minute pyroxene phenocrysts or clusters of phenocrysts; the middle and upper members lack megascopic phenocrysts and are separated with difficulty. No well-defined 'marker' beds have yet been recognized.

Systematic sampling of the lava assemblage in five cross-sections spaced along a 60-mile strike length of the flows provided the following information:

1. The quantity of devitrified glass contained within the lavas decreases systematically upward in the succession. This may reflect an upward decreasing viscosity which permitted progressively more complete crystallization.

2. Silica, magnesia, and potash decrease whereas iron, manganese and less consistently, titania all increase upward in the stratigraphic succession of the main assemblage. Similarly copper, vanadium, scandium, and zinc increase and nickel and chromium decrease upward in the succession.

3. The upper II flows interbedded with red sandstones in the upper part of the Coppermine River Group do not continue the chemical trends established in the main lava assemblage. Presumably, therefore, they have an origin that is independent of that for the main lava assemblage.

4. The average composition of the flows in each cross-section changes more or less systematically from west to east in a manner that is analogous to the upward variation in stratigraphic sections. Thus silica, magnesia, and potash generally decrease, and iron and lime increase eastward. Similarly copper, zinc, vanadium and scandium also generally increase eastward. Possibly the explanation is that the unconformity truncates and removes parts of the western sections thus biasing the average results towards those characteristic of the lower part of the stratigraphic sequence.

Copper prospects among the Coppermine River flows are confined to the middle and upper members where the copper content of the flows is also highest. Most prospects are in fractures or veins and the minerals of interest are mainly copper sulphides. It is proposed that copper was first enriched in the tops of flows before their solidification by a process of volatile

transfer. Analyses of flow interiors and tops generally confirm this. Long after consolidation sulphurous hydrothermal solutions which gained access to the lava assemblage by fractures and porous flow tops leached copper from the enriched flow tops and deposited it as sulphides in favourable environments nearby.

REFERENCES

Annells, R.N.
1968: A geological investigation of a Tertiary intrusive centre in the Vididalur-Vatnsdalur area, Northern Iceland; Ph.D. Thesis, Univ. of St. Andrews, Scotland.

Baragar, W.R.A.
1966: Geochemistry of the Yellowknife volcanic rocks; Can. J. Earth Sci., vol. 3, pp. 9-30.

1968: Major-element geochemistry of the Noranda volcanic belt, Quebec-Ontario; Can. J. Earth Sci., vol. 5, pp. 773-790.

Baragar, W.R.A., and Goodwin, A.M.
in press: Andesites and Archean volcanism of the Canadian Shield; Oregon Dept. Geol. Mineral Ind.

Broderick, T.M.
1935: Differentiation in lavas of the Michigan Keweenawan; Bull. Geol. Soc. Am., vol. 46, pp. 503-558.

Chayes, F.
1964: A petrographic distinction between Cenozoic volcanics in and around the open oceans; J. Geophys. Res., vol. 69, pp. 1573-1588.

1966: Alkaline and subalkaline basalts; Am. J. Sci., vol. 264, pp. 128-145.

Cornwall, H.R.
1951: Differentiation in lavas of the Keweenawan series and the origin of the copper deposits of Michigan; Bull. Geol. Soc. Am., vol. 62, pp. 159-202.

Desborough, G.A., Anderson, A.T., and Wright, T.L.
1968: Mineralogy of sulphides from certain Hawaiian basalts; Econ. Geol., vol. 63, pp. 636-644.

Edwards, A.B.
1938: Tertiary tholeiitic magma in Western Australia; J. Roy. Soc. W. Aust., vol. 24, pp. 1-12.

Fahrig, W. F., and Wanless, R. K.
1963: Age and significance of diabase dyke swarms of the Canadian Shield; Nature, vol. 200, pp. 934-937.

Fraser, J. A.
1960: North-central district of Mackenzie; Geol. Surv. Can., Map 18-1960, descriptive notes.

1966: in Wanless, R. K., Stevens, R. D., Lachance, G. R., and Rimsaite, J. Y. H., Age determinations and geological studies, Report 6; Geol. Surv. Can., Paper 65-17, p. 41.

Garrels, R. M., and Christ, C. L.
1965: Solutions, minerals, and equilibria; Harper and Row, New York.

Gill, J. E.
1960: Solid diffusion of sulphides and ore formation; Proc. 21st Intern. Geol. Cong., Copenhagen, Pt. 16, pp. 209-217.

Kindle, E. D.
1969: The nature of the Coppermine River copper deposits (86 O and 86 N); in Rept. of Activities; Geol. Surv. Can., Paper 69-1, Pt. A, pp. 112-113.

Kuno, H.
1950: Petrology of Habone volcano and the adjacent areas, Japan; Bull. Geol. Soc. Am., vol. 61, pp. 957-1020.

Lowdon, J. A.
1961: Age determinations by the Geological Survey of Canada; Geol. Surv. Can., Paper 61-17.

MacDougal, J. F., Meikle, B. K., Guy-Bray, J. V., Saul, V. A., and Gill, J. E.
1961: Experimental investigation of solid diffusion and volatilization of certain metallic sulphides; Econ. Geol., vol. 56, pp. 362-391.

Northern Miner
1968: Season's end ups reserves at Coppermine; Issue of October 17, pp. 1-2.

Skinner, B. J., and Peck, D. L.
1966: The solubility of sulphur in basic magmas; Econ. Geol., vol. 61, p. 802 (abstract).

Smith, C. H.
1961: in J. A. Lowdon, Age determinations by the Geological Survey of Canada; Geol. Surv. Can., Paper 61-17, p. 22.

1965: in Wanless, R. K., Stevens, R. D., Lachance, G. R., and Rimsaite, R. Y. H., Age determinations and geological studies, Report 5; Geol. Surv. Can., Paper 64-17, Pt. 1, p. 67.

Stockwell, C. H.
1964: Fourth report on structural provinces, orogenies, and time-classification of rocks of the Canadian Precambrian Shield: in Age determinations and geological studies; Geol. Surv. Can., Paper 64-17, Pt. II, pp. 1-21.

Thornton, C. P., and Tuttle, O. F.
1960: Chemistry of igneous rocks, 1. Differentiation index; Am. J. Sci., vol. 258, pp. 664-684.

Turekian, K. K., and Kulp, J. L.
1956: The geochemistry of strontium; Geochim. Cosmochim. Acta, vol. 10, pp. 245-296.

Turekian, K. K., and Wedepohl, K. H.
1961: Distribution of the elements in some major units of the Earth's crust; Bull. Geol. Soc. Am., vol. 72, pp. 175-192.

Wager, L. R., and Brown, G. M.
1968: Layered igneous rocks; Oliver and Boyd Ltd., Edinburgh.

Wanless, R. K., Stevens, R. D., Lachance, G. R., and Edmonds, C. M.
1968: Age determinations and geological studies; Geol. Surv. Can., Paper 67-2, Pt. A.

Wanless, R. K., Stevens, R. D., Lachance, G. R., and Rimsaite, R. Y. H.
1965: Age determinations and geological studies, Report 5; Geol. Surv. Can., Paper 64-17, Pt. 1.

1966: Age determinations and geological studies; Geol. Surv. Can., Paper 65-17, Pt. 1.

White, D. E., and Waring, G. A.
1963: Data of Geochemistry, sixth edition, Chapter K, volcanic emanations; U. S. Geol. Surv., Prof. Paper 440-K.

TABLES I-VII

TABLE I. COMPARISON OF AVERAGES OF RAPID ANALYSES OF SUBUNITS WITH CLASSICAL ANALYSES OF EQUIVALENT COMPOSITE SAMPLES *

			SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	H_2O (tot.)	CO_2	Tot. Fe as FeO	Survey No.
SECTION 1	Upper II	Class.	47.70	13.58	4.90	7.52	8.82	7.55	1.90	0.99	1.78	0.16	0.17	4.08	0.92	11.93	67-1141
		Av. Rapid	47.5	13.9	4.6	7.9	8.4	7.9	2.4	1.0	1.42	.14	0.18	4.0	0.8	12.0	
	Upper	Class	48.47	12.06	6.22	9.51	5.42	7.63	2.75	1.22	3.42	0.34	0.25	2.66	0.00	15.11	67-1140
		Av. Rapid	48.07	12.7	5.7	9.8	6.0	7.9	3.3	1.3	2.82	0.30	0.24	2.6	0.2	14.9	
	Middle	Class.	49.51	12.87	7.17	6.62	6.87	6.92	2.82	1.32	2.32	0.19	0.19	3.18	0.12	13.07	67-1139
		Av. Rapid	49.2	13.2	6.8	6.7	8.0	7.4	3.1	1.4	1.87	0.18	0.23	3.1	0.3	12.8	
	Lower	Class.	51.06	12.48	5.51	6.49	6.80	7.88	2.25	1.83	2.29	0.21	0.16	2.58	0.26	11.45	67-1138
		Av. Rapid	50.9	13.3	4.8	7.1	7.9	7.8	2.7	1.85	1.86	.19	0.16	2.6	0.3	11.4	
SECTION 2	Upper	Class.	47.77	12.63	7.02	9.40	5.59	7.74	3.25	0.95	2.80	0.22	0.20	2.70	0.06	15.71	67-1147
		Av. Rapid	47.5	13.1	6.5	8.9	5.7	8.3	3.2	1.0	2.88	0.31	0.23	2.8	0.2	14.7	
	Middle	Class.	49.09	12.73	5.65	8.85	6.50	8.29	2.63	1.04	2.21	0.22	0.21	2.72	0.12	13.94	67-1146
		Av. Rapid	48.8	13.6	5.3	8.0	6.6	8.5	2.9	1.1	2.3	0.20	0.20	2.8	0.2	12.8	
	Lower	Class.	51.15	12.93	2.78	8.51	7.41	7.99	2.43	1.49	1.78	0.16	0.19	3.02	0.28	11.01	67-1145
		Av. Rapid	50.3	14.1	3.4	7.1	7.7	7.9	2.7	1.5	1.54	0.14	0.18	3.1	0.4	10.0	
SECTION 4	Upper	Class.	49.02	13.09	4.75	9.69	6.90	7.79	2.36	1.33	1.96	0.17	0.21	2.60	0.04	13.95	67-1144
		Av. Rapid	48.8	14.4	4.8	7.9	7.3	7.6	2.8	1.4	1.78	0.16	0.24	3.0	0.3	12.2	
	Middle	Class.	51.65	12.80	6.15	5.77	6.54	6.91	2.37	2.07	2.31	0.22	0.16	2.66	0.22	11.30	67-1143
		Av. Rapid	51.2	13.5	5.8	5.7	7.2	6.4	2.4	2.1	2.02	0.21	0.20	3.0	0.5	10.9	
	Lower	Class.	53.02	11.29	5.19	6.08	8.04	6.43	1.92	1.80	2.04	0.21	0.16	3.36	0.28	10.74	67-1142
		Av. Rapid	52.1	12.4	4.7	6.5	7.6	6.1	2.7	2.0	1.79	0.19	0.15	3.2	0.3	10.8	

* Analysts: – Classical analyses, L. Seymour, Geological Survey of Canada
Rapid analyses, Rapid methods group, Geological Survey of Canada

TABLE II. COMPARISON OF COPPER ANALYSES IN NATIVE COPPER-BEARING SAMPLES BY SPECTROGRAPHIC AND ATOMIC ABSORPTION METHODS*

COPPER IN P.P.M.

Number	60324	60325	60328	60329	60330	60332	60334	60364	60978	60995	61007	61013	61017	61029	61030
Spectrographic	120	110	310	130	130	95	340	75	210	270	190	450	74	790	130
Colorimetric	200	360	340	190	120	150	190	80	240	220	270	220	120	720	70

Number	61042	61046	61049	61053	61054	61057	61072	61081	61082	61115	61118	61120	61127	61129
Spectrographic	190	160	43	300	600	270	370	82	60	65	130	190	170	320
Colorimetric	270	360	140	290	380	320	290	30	50	30	140	100	160	210

Average spectrographic 216
Average colorimetric 220

* Spectrographic analyses by the Spectrochemical Laboratory of the Geological Survey
Colorimetric chemical analyses by Analytical Chemistry Subdivision, Mineral Science Division, Mines Branch.

TABLE III (a) SOME AVERAGE ANALYSES OF COPPERMINE RIVER BASALTS
MAJOR ELEMENTS

	No. Analyses	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	H_2O	CO_2	Tot. Fe as FeO
Average Coppermine basalt[1]	163	49.6	13.3	5.4	7.8	6.7	7.7	2.9	1.5	2.22	.22	.21	2.8	.3	12.7
Average Upper II Member	14	47.9	13.9	5.3	8.0	7.4	8.3	2.6	1.0	1.87	.18	.19	3.4	.6	12.7
Average Upper Member	61	47.2	13.4	5.6	9.1	6.2	8.1	3.1	1.2	2.54	.26	.23	2.7	.2	14.1
Average Middle Member	57	49.6	13.4	5.8	7.2	6.8	7.8	2.8	1.5	2.21	.22	.21	2.8	.3	12.4
Average Lower Member	45	51.2	13.1	4.6	6.8	7.3	7.0	2.7	2.0	1.84	.18	.17	3.0	.5	10.9
Average Section 2	40	48.6	13.3	5.3	8.2	6.2	8.3	3.2	1.1	2.37	.23	.21	2.9	.3	13.0
Average Section 3	31	49.3	12.9	5.4	8.4	5.9	8.2	2.8	1.3	2.54	.26	.21	2.6	.3	13.2
Average Section 1	39	49.2	13.0	5.7	8.1	7.1	7.8	3.1	1.5	2.28	.24	.21	2.8	.3	13.3
Average Section 4	40	50.5	13.3	5.2	6.5	7.1	6.8	2.6	1.8	1.88	.19	.20	3.0	.4	11.4
Average Section 5	13	51.1	13.3	5.2	7.3	6.3	7.1	2.7	1.8	1.98	.18	.20	2.8	.4	12.0

TABLE III (b) SOME AVERAGE ANALYSES OF COPPERMINE RIVER BASALTS
MINOR ELEMENTS IN P.P.M.

	No. Analyses	Zn	Pb	Ga	Sn	Ag	Sr	Ba	Cr	Zr	V	Ni	Cu	Y	Co	Sc
Average Coppermine basalt[1]	163	154	10.2	25.0	1.7	.109	267	615	193	382	615	84	126	53	41	66
Average Upper II Member	9	92	2.4	10.8	.7	.068	187	258	147	174	564	72	183	39	45	90
Average Upper Member	61	161	10.6	23.6	1.7	.110	283	586	91	438	693	59	163	63	43	72
Average Middle Member	57	155	10.0	25.2	1.8	.106	250	650	190	381	630	76	112	50	38	61
Average Lower Member	45	134	9.9	26.8	1.7	.110	269	612	333	310	496	129	94	43	43	63
Average Section 2	40	138	7.7	19.4	1.4	.111	250	301	208	410	625	73	181	54	43	64
Average Section 3	31	198	8.9	38.3	2.7	.173	279	385	136	428	650	60	189	56	44	77
Average Section 1	39	158	12.6	32.2	1.9	.098	281	453	150	470	700	112	105	67	41	67
Average Section 4	40	140	11.7	18.6	1.4	.076	260	1140	282	279	520	92	53	40	39	58
Average Section 5	13	91	8.9	8.8	.85	.082	234	1030	122	260	550	68	101	36	40	61

[1] Excludes the Upper II lavas, the Muskox Rapids section, and all flow tops.

TABLE IVa.

Frequency distribution data for Coppermine River basalts:
Major elements in per cent.

SiO_2		Al_2O_3		Fe_2O_3		FeO		MgO		CaO		Na_2O		K_2O		TiO_2		CO_2		FeO(tot.)		H_2O	
L.B.*	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.
44%	1	8%	1	1%	3	1%	1	1%	1	3%	3	1%	2	.25%	2	.75%	2	0%	90	6	1	1.0	1
45	2	9	0	2	9	2	0	2	0	4	4	1.5	9	.50	15	1.00	9	.25	33	7	1	1.5	12
46	11	10	3	3	17	3	2	3	3	5	14	2	25	.75	21	1.25	18	.50	15	8	1	2.0	40
47	27	11	7	4	48	4	5	4	16	6	24	2.5	62	1.00	35	1.50	24	.75	6	9	11	2.5	45
48	43	12	48	5	37	5	16	5	47	7	33	3	43	1.25	25	1.75	26	1.00	2	10	27	3.0	28
49	28	13	66	6	28	6	36	6	37	8	38	3.5	22	1.50	22	2.00	25	1.25	1	11	30	3.5	12
50	18	14	36	7	20	7	32	7	29	9	34	4	7	1.75	9	2.25	13	1.50	3	12	20	4.0	8
51	13	15	8	8	4	8	31	8	17	10	13	4.5	0	2.00	17	2.50	13	1.75	2	13	30	4.5	9
52	12	16	0	9	3	9	18	9	9	11	2			2.25	5	2.75	7	2.00	0	14	33	5.0	4
53	9					10	24	10	8					2.50	4	3.00	9	2.25	2	15	18	5.5	5
54	1					11	5	11	2					2.75	4	3.25	16	2.50	0	16	7	6.0	0
55	1					12	1	12	1					3.00	4	3.50	4	2.75	0	17	0	6.5	1
56	1													3.25	2	3.75	2	3.00	0			7.0	2
57	1													3.50	0	4.00	2	3.25	0			7.5	2
58	0													3.75	0							8.0	0
59	0													4.00	0							8.5	1
60	1													4.25	0							9.0	0
														4.50	2								

TABLE IV b

Frequency distribution data for Coppermine River basalts: minor elements in parts per million

Zn		Pb		Ga		Sn		Ag	
L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.
20	2	0	1	0	5	0.0	15	0	4
40	4	2	11	2	4	.2	0	.02	15
60	9	4	33	4	13	.4	10	.04	25
80	25	6	32	6	5	.6	13	.06	40
100	35	8	38	8	11	.8	24	.08	28
120	20	10	16	10	16	1.0	14	.10	16
140	20	12	19	12	10	1.2	8	.12	14
160	20	14	6	14	5	1.4	15	.14	7
180	12	16	8	16	9	1.6	7	.16	8
200	13	18	3	18	5	1.8	12	.18	5
220	9	20	5	20	8	2.0	10	.20	4
240	6	22	3	22	5	2.2	7	.22	3
260	1	24	0	24	8	2.4	11	.24	2
280	0	26	1	26	4	2.6	7	.26	2
300	1	28	0	28	8	2.8	5	.28	1
320	0	30	0	30	4	3.0	5	.30	1
340	0	32	0	32	7	3.2	6	.32	0
360	1	34	0	34	8	3.4	3	.34	0
		36	0	36	6	3.6	3	.36	0
		38	1	38	1	3.8	2	.38	1
				40	5	4.0	0	>.40	2
				42	4	4.2	0		
				44	2	4.4	1		
				46	8	4.6	0		
				48	11				
				50	2				

Sr		Ba		Cr		Zr		V	
L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.
0	0	0	31	0	10	40	1	200	2
20	0	200	67	20	13	80	5	240	1
40	2	400	24	40	23	120	16	280	1
60	1	600	19	60	21	160	13	320	4
80	1	800	15	80	21	200	24	360	12
100	3	1000	5	100	8	240	28	400	6
120	7	1200	7	120	13	280	9	440	17
140	9	1400	3	140	10	320	8	480	19
160	12	1600	1	160	5	360	21	520	15
180	15	1800	1	180	6	400	13	560	14
200	12	2000	1	200	5	440	3	600	14
220	23	2200	3	220	6	480	9	640	11
240	19	2400	0	240	3	520	4	680	19
260	21	2600	1	260	3	560	3	720	5
280	14	2800	3	280	1	600	3	760	14
300	12			300	0	640	1	800	9
320	10			320	4	680	3	840	7
340	7			340	1	720	2	880	3
360	5			360	2	760	1	920	2
380	0			380	0	800	1	960	4
400	0			>400	22	840	2		
420	2					880	1		
440	0					920	0		
>460	2					960	4		

Ni		Cu		Y		Co		Sc	
L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.	L.B.	No.
0	2	0	1	0	34	0	2	0	0
20	16	20	20	20	30	20	79	20	18
40	60	40	30	40	59	40	95	40	45
60	61	60	30	60	33	60	2	60	86
80	25	80	14	80	12	80	0	80	27
>100	17	100	11	>100	10	>100	1	100	3
		120	12						
		140	10						
		160	8						
		180	7						
		200	4						
		220	4						
		240	2						
		260	3						
		280	3						
		300	5						
		320	2						

TABLE IVc.

Frequency distribution data for Coppermine River basalts:
Differentiation Index.

Differentiation Index	< 25	25*	30	35	40	45	50	55	60
Lower member	2	3	8	9	14	6	1	0	2
Middle member	2	10	14	11	12	3	3		
Upper member		11	19	19	11	1			
Upper II member	1	5	0	2	1				
Total	5	29	41	41	38	10	4	0	2

* Lower boundary of the class.

TABLE V

AVERAGE COPPERMINE RIVER BASALTS AND OTHER AVERAGE BASALTS

	No. of analyses	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	H_2O (tot.)	CO_2	FeO (tot.)	%
Average Coppermine R. basalt	163	49.6	13.3	5.4	7.8	6.7	7.7	2.9	1.5	2.22	0.22	0.21	2.8	.3	12.7	
Average Yakma flow[1]		53.8	13.9	2.6	9.2	4.1	7.9	3.0	1.5	2.0	0.4	0.2	1.2		11.5	
Average late Yakma and Ellensburg[2]	4	50.0	13.5	1.9	12.5	4.4	8.3	2.9	1.4	3.2	0.7	0.25	0.9	.09	14.2	
Average Picture Gorge[3]	16	49.3	15.6	3.5	7.8	6.5	10.3	2.7	0.5	1.6	0.3	0.2	1.8	.04	11.0	
Average Deccan Trap[4]	10	50.56	12.79	3.23	11.28	5.40	10.29	2.55	0.59	2.78	0.31	0.22			14.19	
Average Greenstone flow[5]		47.39	16.82	3.09	7.91	6.65	9.87	2.63	0.48	1.53	0.18	0.17	3.17	.08	10.62	
Average Kearsarge flow[5]		48.57	16.34	4.73	6.13	6.43	9.68	2.68	0.55	1.47	0.18	0.16	2.96	.19	10.38	

	No. of analyses	Zn	Pb	Ga	Sn	Ag	Sr	Ba	Cr	Zr	V	Ni	Cu	Y	Co	Sc	PPM
Average Coppermine R. basalt	163	154	10.2	25.0	1.7	.109	267	615	193	382	615	84	126	53	41	66	
Average basalt[6]		105	6	17	1.5	.11	465	330	170	140	250	130	87	21	48	30	

[1] Waters, 1961, p. 593. Average of 3 analyses of composite samples representing 60 flows

[2] Waters, 1961, p. 594

[3] Waters, 1961, p. 592

[4] Sukheswala and Poldervaart, 1958, p. 1487. Considered by the authors as the best average of Deccan traps

[5] Broderick, 1935, p. 513. Composite samples of the entire flow in each case

[6] Turekian and Wedepohl, 1961.

TABLE VI(a)

Number	Flow 61037[1]	Flow Top 60990[1]	Flow 61112[1]	Flow Top 61074[1]	Flow 61093[1]	Flow Top 61076[1]	Base of Flow 61130[1]	20' above base 61131[1]	40' above base 61132[1]	Top of Flow 50' above base 61133[1]	Average Flow[2]	Average Flow Top[3]
SiO_2	55.9	52.4	54.7	59.1	49.3	57.8	54.4	56.7	55.4	49.0	49.6	50.1
Al_2O_3	14.6	13.1	14.4	12.8	14.5	12.5	13.3	13.9	14.4	9.9	13.3	11.7
Fe_2O_3	3.7	6.7	5.3	9.0	7.7	8.8	4.3	4.5	4.5	11.2	5.4	8.2
FeO	5.5	3.9	5.4	1.8	6.4	2.4	7.9	6.9	7.2	1.5	7.8	4.5
MgO	6.9	9.8	7.1	4.7	6.9	5.2	9.6	5.9	6.7	11.2	6.7	6.6
CaO	7.4	5.9	5.9	3.7	7.8	4.7	2.1	3.7	2.5	5.4	7.7	6.7
Na_2O	2.4	3.9	2.1	4.0	3.1	2.5	2.3	2.4	2.7	.5	2.9	3.6
K_2O	2.4	1.7	2.3	2.0	1.5	3.1	1.8	3.4	3.4	3.0	1.5	1.7
TiO_2	1.01	1.32	2.05	1.96	2.05	1.70	2.20	2.09	2.30	1.70	2.22	1.86
MnO	.17	0.15	0.24	0.15	0.26	0.13	0.16	0.16	0.15	.22	.21	.17
P_2O_5	.10	0.11	0.18	0.19	0.18	0.14	0.19	0.22	0.20	.16	.22	.19
CO_2	.4	1.0	0.51	0.6	0.31	1.01	1.8	0.2	0.6	6.1	.3	2.5
H_2O (tot.)	2.5	4.5	3.0	2.0	2.9	2.6	4.9	3.3	4.1	4.5	2.8	3.42
FeO (tot.)	8.8	9.9	10.2	9.9	13.3	10.3	11.8	11.0	11.3	11.5	12.7	11.9

1 Analyses recalculated 100% water-free for a better basis of comparison. H_2O content of original analysis is shown.
2 163 analyses. Not calculated on water-free basis.
3 15 analyses. Not calculated on water-free basis.

TABLE VI(b)

Number	Flow 61037	Flow Top 60990	Flow 61112	Flow Top 61074	Flow 61093	Flow Top 61076	Base of Flow 61130	20' above base 61131	40' above base 61132	Top of Flow 50' above base 61133	Average Flow[2]	Average Flow Top[3]
Zn	89	100	210	230	76	100	62	64	46	45	154	162
Pb	15	13	22	15	11	9.7	2.7	9.6	4.2	3.8	10.2	9.3
Ga	12	25	19	24	4.7	21	18	13	8.0	3.1	25	28
Sn	.72	1.5	.96	1.9	.59	2.1	.90	.60	.46	.45	1.7	2.28
Ag	<.05	.072	<.05	.089	.060	.079	.083	.091	.062	.065	.109	.132
Sr	220	95	320	210	250	220	130	370	130	51	267	116
Ba	460	530	1000	730	1200	1000	470	1300	920	920	615	1390
Cr	790	540	160	120	71	49	130	79	73	510	193	155
Zr	150	170	410	350	370	290	250	200	370	240	382	328
V	320	410	530	390	720	500	430	330	440	410	615	487
Ni	87	140	60	50	55	57	50	44	39	110	84	.59
Cu	32	110	23	48	42	42	40	120	54	150	126	96
Y	<30	<30	47	41	49	34	32	<30	41	35	53	41
Co	32	37	25	22	33	<20	36	40	35	43	41	29
Sc	46	62	44	32	92	82	49	32	40	51	66	56

<u>Footnotes to Table VII (pages 36 to 43)</u>

1 All analyses have been done in the Geological Survey's analytical laboratories; the major elements by the rapid methods group and the minor elements by the staff of the spectrochemical laboratory.

2 Notes on the table:

(a) Numbers for corresponding samples in the major- and minor- element tables differ slightly because of the requirements of different formats for the two sets of data. 66-331 is the same as 60331. In Figure 2 where the stratigraphic position of each sample is shown the samples are identified by field number and the last 4 or less digits of the laboratory number respectively; e.g. 12 (331).

(b) Stratigraphic height represents the stratigraphic distance in feet above the base of the Coppermine River Group.

(c) The analyses of many of the minor elements have been increased or decreased by powers of 10, as indicated, for the convenience of machine plotting. Since the same data cards are used for the listing these are the values given in this table and the appropriate adjustment must be made.

TABLE VII - CHEMICAL ANALYSES OF COPPERMINE RIVER BASALTS

MAJOR ELEMENTS

Section 1

	STRATIGRAPHIC HEIGHT		SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	$H_2O_{(tot.)}$	CO_2		Total
Lower member	45.	66- 351	48.9	10.8	4.6	6.7	10.1	5.4	1.10	4.5	1.42	.15	.13	4.0	.9	0	98.70
	170.	66- 352	52.6	14.1	1.8	8.8	5.6	7.4	2.70	2.7	1.76	.21	.17	2.3	.1	0	100.24
	410.	66- 353	52.9	12.5	2.8	8.6	12.0	5.1	2.80	1.6	1.59	.20	.15	3.9	.2	0	104.34
	970.	66- 354	53.2	13.0	4.0	6.5	8.6	8.4	3.00	1.5	1.32	.60	.15	2.2	.3	0	102.77
	1080.	66- 355	53.9	12.9	4.0	6.3	9.2	8.0	2.90	1.7	1.31	.16	.14	2.3	.2	0	103.01
	1200.	66- 356	53.1	12.4	4.3	6.1	8.6	7.6	3.00	2.0	1.34	.06	.17	2.1	.2	0	100.97
	1400.	66- 357	48.2	12.4	5.8	7.0	7.5	7.0	3.60	2.1	1.64	.18	.24	3.0	.1	0	98.76
	1600.	66- 358	48.4	11.6	7.8	7.1	8.2	6.1	2.80	2.0	3.13	.34	.13	3.7	1.6	0	102.90
	1650.	66- 359	45.2	11.2	8.9	5.5	5.6	10.3	4.80	.5	2.45	.25	.18	3.2	4.1	0	102.18
	1770.	66- 320	48.7	13.2	5.9	9.0	4.3	7.7	3.10	1.5	2.72	.27	.15	2.3	.0	0	98.89
	2090.	66- 321	50.4	15.2	5.9	6.5	6.7	9.2	2.70	1.2	2.08	.22	.16	1.7	.2	0	102.10
	2215.	66- 322	51.0	14.5	5.6	6.4	7.2	9.6	2.80	1.0	2.06	.21	.16	2.1	.2	0	102.83
	2330.	66- 347	51.9	15.6	4.5	6.9	6.7	9.3	2.80	1.0	2.03	.20	.15	2.0	.1	0	103.18
	2950.	66- 346	51.1	13.8	4.0	6.1	8.4	11.2	2.30	.9	1.21	.10	.15	1.8	.1	0	101.16
Middle member	3150.	66- 345	48.8	13.3	4.8	5.3	8.5	8.7	3.30	2.1	1.14	.12	.17	2.6	.5	0	99.33
	3280.	66- 344	48.2	12.7	8.8	5.2	11.7	5.2	4.30	.7	1.44	.25	.24	2.8	.9	0	102.43
	3470.	66- 342	50.3	14.5	4.7	8.1	7.2	10.1	2.70	.7	1.47	.14	.21	2.2	.2	0	102.52
	3500.	66- 343	51.7	11.8	9.7	5.1	6.7	5.2	4.30	1.4	2.49	.13	.18	4.5	.3	0	103.50
	3660.	66- 341	47.4	12.7	7.8	5.7	7.4	9.7	2.70	1.0	1.43	.14	.25	2.8	.6	0	99.62
	3700.	66- 335	49.7	14.3	4.9	8.2	7.4	9.4	2.80	.8	1.52	.15	.20	2.2	.1	0	101.67
	4415.	66- 336	46.3	13.4	5.1	10.1	7.0	7.4	3.70	.9	2.01	.17	.26	3.0	.2	0	99.54
	4850.	66- 337	50.1	12.9	8.3	6.8	7.1	5.3	3.50	2.0	2.72	.28	.27	3.4	.2	0	102.87
	5070.	66- 338	45.9	11.8	4.8	10.1	6.2	9.3	2.60	.6	2.57	.26	.21	2.8	.2	0	97.34
	5260.	66- 339	49.9	12.6	9.5	4.5	9.7	2.1	2.00	3.0	2.27	.22	.21	5.1	.1	0	101.20
	5410.	66- 348	49.2	13.7	4.7	7.5	7.1	8.3	2.80	1.2	2.24	.22	.27	2.6	.1	0	99.93
Upper member	5550.	66- 349	49.5	13.3	5.4	9.3	6.7	6.8	4.00	1.4	2.61	.27	.29	2.7	.1	0	102.37
	5650.	66- 330	48.4	12.8	5.1	10.7	6.5	6.8	3.60	1.4	3.04	.32	.36	2.7	.2	0	101.92
	5770.	66- 331	51.4	9.2	5.9	7.9	5.9	6.5	3.20	1.1	2.72	.52	.23	3.3	2.0	0	99.87
	5815.	66- 332	48.2	13.3	5.0	10.5	5.6	8.5	3.10	1.5	3.30	.32	.22	2.4	.1	0	102.04
	6050.	66- 333	47.5	13.4	5.9	8.7	5.2	9.1	3.20	1.1	3.02	.33	.24	2.1	.1	0	99.89
	6200.	66- 334	47.9	12.5	5.5	10.1	5.8	8.0	3.00	1.3	3.10	.29	.21	2.8	.1	0	100.60
	6350.	66- 324	48.8	12.9	6.5	10.2	4.3	9.3	3.00	1.0	3.41	.43	.23	2.1	.1	0	102.27
	6410.	66- 325	46.2	12.2	5.2	11.5	4.9	9.3	3.00	1.1	3.48	.45	.18	2.5	.1	0	100.11
	6725.	66- 326	48.9	12.3	6.3	10.6	5.0	9.3	2.80	.9	3.34	.34	.21	2.4	.1	0	102.49
	6910.	66- 327	49.2	12.5	5.7	10.0	5.6	8.7	3.00	1.2	3.12	.35	.24	2.1	.1	0	101.81
	7100.	66- 364	47.1	12.0	5.8	10.8	6.7	8.7	2.70	.8	2.85	.29	.23	2.8	.2	0	100.97
	7310.	66- 363	55.9	10.1	13.2	1.3	7.1	2.7	4.60	.2	2.32	.21	.07	2.8	2.4	0	102.90
	7450.	66- 362	47.8	12.6	4.7	10.1	7.4	6.6	4.10	1.7	1.91	.17	.26	2.8	.1	0	100.24
	7730.	66- 361	47.2	13.2	4.7	9.5	7.8	8.0	3.30	1.6	1.60	.16	.27	3.0	.1	0	100.43
	7935.	66- 360	48.5	12.1	7.7	6.7	7.7	5.9	4.20	2.1	2.48	.26	.20	2.8	.2	0	100.84
	8225.	66- 329	47.0	12.8	6.7	9.0	5.6	8.5	3.00	1.5	2.99	.51	.25	2.4	.2	0	100.45
	8530.	66- 328	48.2	12.5	5.2	10.2	6.2	8.2	3.20	1.2	2.33	.28	.21	2.5	.5	0	100.72
	8790.	66- 340	47.5	13.2	3.7	10.5	5.6	10.0	2.60	.6	1.93	.20	.20	1.8	.1	0	97.93
	8870.	66- 974	49.5	13.7	6.3	8.8	4.8	6.0	3.50	1.8	2.70	.23	.24	2.7	.4	0	100.67

							Section 1 (continued)										
Upper II member	9450.	66- 979	46.7	14.1	4.6	7.1	8.6	10.5	1.90	.7	1.27	.16	.20	2.9	.5	0	99.23
	11050.	66- 976	46.4	15.2	3.8	6.7	10.5	7.7	2.00	1.4	1.33	.11	.12	5.1	2.3	0	102.66
	11410.	66- 972	48.0	15.4	5.0	6.9	7.4	10.1	2.10	.5	1.38	.14	.15	3.1	1.9	0	102.07
	12000.	66- 983	45.0	13.0	6.1	8.0	8.2	6.9	2.00	.9	1.94	.14	.13	4.6	1.8	0	98.71
	12300.	66- 980	50.8	13.6	4.5	7.8	8.3	9.1	2.00	.3	1.28	.12	.19	3.3	.1	0	101.39
	13070.	66- 977	48.7	13.6	5.5	8.0	7.4	8.9	2.50	.2	1.93	.15	.22	3.1	.3	0	100.50
	13210.	66- 970	48.0	11.8	4.4	7.2	10.4	4.1	1.20	2.6	1.39	.12	.09	6.7	1.4	0	99.40
	13325.	66- 981	46.7	13.9	4.4	8.2	9.0	5.7	4.30	1.1	1.35	.10	.28	3.9	.1	0	99.03
	13440.	66- 973	47.1	14.1	3.2	10.8	5.8	8.4	3.40	1.3	1.93	.20	.20	3.4	.2	0	100.03
							Section 1A										
	12145.	66- 968	48.6	13.6	3.9	9.6	5.1	8.5	2.50	1.9	2.21	.18	.19	2.3	0	0	98.63
	12325.	66- 978	46.6	14.6	8.8	5.6	6.8	8.1	4.10	.9	2.28	.18	.21	2.7	.1	0	100.97
	12545.	66- 971	49.5	14.1	4.8	9.0	5.5	9.6	2.80	.8	2.71	.28	.19	2.0	.1	0	101.38
	12695.	66- 975	48.5	13.4	10.7	5.9	5.2	8.6	2.90	1.0	3.27	.35	.21	2.2	.2	0	102.43
	12897.	66- 982	49.2	14.2	3.8	10.7	5.5	9.5	2.60	.8	2.86	.26	.22	1.7	.2	0	101.54
							Section 2										
Lower member	30.	66- 985	49.5	13.8	3.2	11.6	5.9	9.7	2.40	.6	2.37	.20	.21	2.0	.1	0	101.58
	230.	66-1006	47.0	13.7	3.8	6.1	8.9	11.8	1.90	.6	1.35	.12	.17	3.1	1.1	0	99.64
	450.	66-1027	51.1	14.6	2.9	6.8	7.5	8.0	2.20	1.4	1.64	.16	.18	3.1	.3	0	99.88
	610.	66- 998	48.4	12.4	6.1	3.7	7.7	5.8	3.70	2.9	1.43	.15	.16	4.7	1.6	0	98.74
	715.	66-1033	51.5	15.4	3.4	6.4	6.6	6.4	3.40	2.2	1.94	.16	.20	3.2	.2	0	101.00
	870.	66- 994	42.1	10.8	6.7	4.5	9.4	11.9	2.20	.7	.99	.08	.28	5.0	4.8	0	99.45
	1080.	66-1002	51.7	14.9	3.3	7.1	7.4	7.0	3.10	2.1	1.76	.16	.20	3.3	.2	0	102.22
	1360.	66- 988	46.6	13.2	4.5	6.2	11.4	9.2	2.50	.8	.82	.08	.19	3.8	.8	0	100.09
	1690.	66-1014	49.0	14.7	2.5	7.9	7.0	6.5	3.50	1.6	1.79	.16	.15	3.2	0	0	98.05
	1925.	66-1022	47.7	12.6	3.1	7.5	9.2	7.3	3.90	.9	1.17	.10	.18	3.7	.3	0	97.65
	2180.	66-1004	57.7	13.7	3.6	4.3	5.5	5.1	1.80	3.2	1.04	.12	.12	2.3	.4	0	98.88
Middle member	2400.	66- 989	51.7	14.7	3.0	7.5	8.1	8.1	2.80	1.2	1.27	.13	.16	3.1	.3	0	102.06
	2550.	66- 997	49.3	13.5	2.5	7.8	9.7	9.5	2.20	1.0	.98	.08	.17	3.5	.3	0	100.53
	4430.	66-1003	47.2	13.0	4.3	6.2	10.2	8.4	2.90	1.1	1.56	.14	.17	4.2	0	0	99.42
	4760.	66-1017	47.2	14.3	3.9	9.6	6.8	8.3	3.90	.5	1.69	.11	.21	3.2	.1	0	99.81
	5130.	66- 999	46.8	13.1	7.0	8.6	6.7	6.4	3.60	1.0	3.26	.26	.23	3.4	.2	0	100.55
	5300.	66-1005	48.6	15.0	6.9	6.9	5.4	8.8	2.80	1.7	2.07	.17	.23	2.2	.1	0	100.87
	5390.	66-1039	48.1	13.4	6.3	7.7	5.6	9.4	3.00	.8	2.15	.18	.23	2.4	.5	0	99.76
	5520.	66- 986	49.0	14.5	7.5	6.0	5.3	9.5	2.80	1.3	1.85	.16	.20	1.9	.3	0	100.31
	5600.	66- 992	45.2	12.7	13.6	.2	1.6	12.0	6.30	0	1.97	.16	.03	1.4	5.8	0	101.01
	5800.	66-1010	47.2	13.6	7.4	6.5	5.9	9.2	3.10	1.1	2.09	.16	.24	1.9	.1	0	98.49
	6090.	66-1030	49.9	13.1	3.7	9.6	6.5	7.9	2.90	.9	2.69	.26	.21	3.4	.3	0	101.36
	6340.	66- 995	48.7	13.8	5.6	9.0	5.7	10.4	2.60	.5	2.62	.21	.18	1.9	.2	0	101.41
	6600.	66-1015	48.2	13.9	4.6	11.1	4.8	8.9	2.70	1.0	4.04	.36	.21	2.1	.3	0	102.21
	6800.	66-1024	48.4	12.6	7.4	8.1	6.2	6.7	3.60	1.2	3.35	.30	.23	3.2	.3	0	101.58
	6920.	66-1001	47.5	12.5	5.3	9.9	5.1	9.2	2.90	.9	4.08	.34	.24	3.3	.1	0	101.36
Upper member	6950.	66-1013	48.1	13.1	6.3	9.8	4.7	10.0	2.70	.7	3.98	.33	.22	2.4	.2	0	102.53
	7060.	66-1020	46.8	12.6	8.0	8.0	4.7	7.3	3.60	1.3	3.49	.38	.22	2.5	0	0	98.94
	7310.	66-1023	47.1	12.8	5.2	10.9	4.9	9.1	2.60	1.0	3.77	.41	.23	2.4	0	0	100.46
	7645.	66-1035	47.3	12.3	9.6	6.5	5.4	6.7	3.40	1.8	3.17	.28	.24	3.0	.4	0	100.09
	7830.	66-1007	46.4	12.9	5.2	10.7	4.8	10.0	2.60	.9	3.46	.39	.23	2.5	.1	0	100.18
	8060.	66-1011	49.0	12.2	6.6	8.4	5.3	8.3	3.70	1.3	3.38	.36	.23	3.2	.4	0	102.37
	8220.	66- 996	48.1	13.8	6.7	8.3	6.9	7.2	3.90	1.0	2.28	.17	.24	2.9	.1	0	101.59
	8560.	66-1029	48.0	12.8	6.2	10.2	5.1	9.6	2.60	.7	2.87	.23	.22	2.3	.2	0	101.02

Continued

Major Elements, Section 2 (continued)			SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	$H_2O_{(tot.)}$	CO_2		Total
Upper member	8630.	66-1040	34.3	8.4	7.9	3.2	1.8	22.7	3.70	.7	1.70	.18	.11	1.6	15.0	0	101.29
	8770.	66-1016	46.0	14.2	6.7	7.9	6.4	7.9	3.60	1.2	2.02	.18	.22	2.8	.2	0	99.32
	9100.	66-1038	47.5	13.6	7.2	8.3	5.9	8.0	3.50	1.0	2.67	.25	.24	2.5	.4	0	101.06
	9350.	66-1031	49.0	13.7	5.0	11.4	5.3	9.7	2.50	.7	2.39	.49	.21	2.0	.1	0	102.49
	9610.	66-1008	49.3	14.0	7.4	7.1	5.2	7.1	3.40	1.4	3.29	.51	.20	2.8	.1	0	101.80
	9945.	66-1042	46.6	13.5	4.9	9.9	5.2	8.0	3.60	1.2	2.18	.20	.22	2.2	.4	0	98.10
	10105.	66-1041	46.7	12.8	6.3	7.4	7.7	7.2	4.00	.6	2.03	.21	.21	3.4	.3	0	98.85
	10270.	66- 991	47.6	13.2	5.5	9.1	5.7	8.8	2.90	.8	2.50	.30	.21	2.5	.1	0	99.21
	10360.	66-1025	44.8	12.7	6.3	8.8	8.2	7.1	3.20	.3	2.59	.25	.30	4.6	0	0	99.19
Section 2A																	
	9840.	66-1018	50.3	12.8	7.4	8.3	4.6	7.8	3.10	1.0	2.70	.28	.26	2.6	.2	0	101.34
	10070.	66-1036	48.3	13.5	7.3	7.0	7.8	6.2	3.90	.6	2.59	.24	.23	3.4	.2	0	101.26
	10440.	66-1032	50.9	13.5	5.6	8.4	6.6	8.4	2.80	.8	2.42	.24	.24	3.0	.1	0	103.00
	10550.	66- 993	53.0	10.2	10.0	3.4	6.1	5.4	1.40	.5	4.71	.16	.16	4.3	2.4	0	101.73
Section 3																	
Lower member	45.	66-1058	60.6	13.3	1.5	5.4	3.7	4.6	1.60	4.5	1.03	.12	.12	2.6	2.4	0	101.47
	220.	66-1064	50.9	13.5	3.2	7.5	5.8	7.5	2.50	1.8	1.92	.20	.16	2.8	.3	0	98.08
	520.	66-1048	51.0	11.4	5.7	5.9	9.9	8.2	2.20	1.0	1.67	.15	.15	3.9	.7	0	101.87
	740.	66-1050	53.8	12.8	4.7	7.3	6.5	7.4	2.70	2.0	1.84	.18	.19	2.1	.2	0	101.71
	890.	66-1065	53.0	12.5	5.0	5.3	7.8	7.0	2.50	2.6	1.49	.16	.16	2.7	.8	0	101.01
	1050.	66-1070	50.3	12.0	4.4	7.4	8.5	8.7	2.20	1.2	1.78	.18	.17	2.9	.3	0	100.03
	1290.	66-1060	55.5	11.5	3.6	6.5	6.0	6.7	2.50	2.9	1.67	.19	.19	2.4	.4	0	100.05
	1310.	66-1068	50.1	13.1	9.9	5.3	5.1	4.9	3.20	1.9	3.35	.30	.17	2.1	.5	0	99.92
	1475.	66-1045	50.6	12.7	6.9	8.5	4.5	7.4	2.50	1.5	3.36	.26	.23	2.9	.2	0	101.55
Middle and Upper member	2210.	66-1051	50.1	13.8	2.5	7.9	9.0	10.7	2.30	1.2	1.24	.11	.19	2.6	.5	0	102.14
	2465.	66-1047	51.8	13.5	.8	9.0	8.4	10.3	2.40	1.4	1.37	.13	.17	2.2	.3	0	101.77
	2910.	66-1056	50.2	13.1	7.2	6.7	5.8	8.7	3.10	.8	2.09	.20	.22	2.5	.4	0	101.01
	3095.	66-1061	47.6	12.1	7.0	7.9	6.0	7.6	4.00	1.0	2.79	.26	.22	2.5	.1	0	99.07
	3325.	66-1043	47.9	12.9	7.3	8.8	5.9	7.3	3.30	1.1	3.27	.23	.23	2.8	.4	0	101.43
	3610.	66-1062	48.0	12.8	5.0	9.3	5.8	9.7	2.60	.5	2.36	.21	.22	1.4	.2	0	98.09
	3780.	66-1052	50.3	12.6	9.5	5.5	5.7	7.0	3.30	1.7	2.85	.26	.24	2.7	.3	0	101.95
	3900.	66-1057	51.7	11.8	4.6	9.3	3.4	8.7	2.90	1.3	3.43	.62	.22	3.1	.2	0	101.27
	4130.	66-1067	48.9	13.3	5.5	10.7	4.9	9.5	2.60	.8	3.72	.41	.21	1.8	.1	0	102.44
	4300.	66-1049	49.6	12.9	6.9	7.5	4.5	9.3	2.50	1.0	3.60	.47	.22	2.2	.2	0	100.89
	4480.	66-1071	47.0	12.0	6.4	10.2	5.9	6.5	3.40	1.3	3.73	.41	.20	3.1	.1	0	100.24
	4655.	66-1054	49.2	13.6	5.4	10.4	5.0	9.3	2.60	.9	3.50	.35	.20	1.8	.1	0	102.35
	4810.	66-1072	48.3	12.6	6.0	10.8	5.2	9.5	2.40	.6	3.25	.28	.22	2.0	.1	0	101.25
	5500.	66-1055	48.1	12.0	6.1	10.7	5.7	8.8	3.40	.5	2.90	.22	.25	2.7	.1	0	101.47
	5700.	66-1066	49.1	12.8	7.6	8.0	4.2	8.8	2.80	1.2	2.93	.31	.19	2.0	.1	0	100.03
	6000.	66-1059	48.8	13.7	7.0	8.2	6.0	9.5	3.00	.7	1.92	.18	.22	2.5	.2	0	101.92
	6205.	66-1069	48.4	13.7	5.0	11.1	5.7	10.3	2.30	.5	3.00	.22	.25	1.8	0	0	102.32
	6395.	66-1129	48.9	13.3	5.8	9.6	5.1	8.9	2.80	1.2	3.20	.47	.20	2.1	.1	0	101.67
	6580.	66-1063	48.3	13.1	4.3	10.1	5.6	9.0	2.90	1.2	2.18	.21	.23	3.5	.4	0	101.02
	6735.	66-1053	49.0	13.2	4.4	10.3	5.5	8.3	3.50	.9	2.30	.20	.23	2.4	.1	0	100.33
	6900.	66-1046	49.0	13.8	1.9	12.0	4.0	7.8	3.20	1.5	2.36	.25	.26	4.5	.1	0	100.67
	7100.	66-1044	49.5	12.4	6.9	7.9	8.1	4.2	3.90	.5	2.36	.22	.21	4.2	.3	0	100.69
Section 4																	
Lower member	160.	66-1073	50.7	12.2	2.5	9.5	8.8	5.8	2.90	1.2	1.72	.17	.22	3.9	.2	0	99.81
	350.	66-1109	51.6	13.3	4.0	7.0	5.5	7.5	3.00	1.9	1.88	.14	.15	2.2	.3	0	98.47
	515.	66-1106	52.0	13.9	4.1	7.3	7.3	6.3	2.40	1.7	1.74	.19	.17	3.0	.2	0	100.30
	690.	66-1114	50.8	11.1	4.5	6.6	6.9	6.7	3.10	1.3	1.56	.17	.17	4.5	1.0	0	98.40
	930.	66-1111	50.5	10.6	5.9	5.2	10.3	6.9	3.00	1.6	1.60	.20	.17	3.8	.4	0	100.17

Lower member (continued)	1175.	66-1098	50.8	13.7	7.9	4.2	7.8	3.1	3.20	2.4	2.18	.25	.18	4.0	.9	0	100.61
	1370.	66-1096	52.9	13.8	5.0	6.9	4.9	5.4	2.70	2.8	2.27	.30	.18	2.4	.2	0	99.75
	1610.	66-1105	56.1	12.0	4.3	5.3	10.7	4.8	1.80	3.1	1.55	.11	.16	2.5	.1	0	102.52
	1850.	66-1113	53.4	10.8	4.8	6.2	6.1	8.0	2.60	2.0	1.62	.18	.20	2.5	.4	0	98.80
Middle member	2100.	66-1108	48.1	13.3	7.0	7.6	6.6	5.8	3.20	2.0	3.03	.26	.21	3.1	.3	0	100.50
	2350.	66-1110	48.5	15.7	6.0	5.8	6.4	8.5	2.30	1.7	2.22	.15	.19	2.5	.6	0	100.56
	2500.	66-1097	49.6	13.9	7.7	4.1	6.1	5.9	2.90	2.8	2.51	.26	.21	2.6	.3	0	98.88
	2715.	66-1095	50.8	13.6	7.0	5.2	6.0	7.0	2.50	2.8	2.44	.25	.20	2.8	.5	0	101.09
	2900.	66-1107	48.1	14.6	4.8	5.8	9.0	9.9	2.60	1.2	1.15	.21	.23	2.9	.2	0	100.69
	3100.	66-1112	54.1	14.2	5.2	5.3	7.0	5.8	2.10	2.3	2.03	.18	.24	3.0	.5	0	101.95
	3160.	66-1074	59.1	12.8	9.0	1.8	4.7	3.7	4.00	2.0	1.96	.19	.15	2.0	.6	0	102.00
	3350.	66-1100	52.1	13.8	4.6	6.0	5.5	6.0	2.70	2.9	2.06	.22	.17	2.4	.5	0	98.95
	3500.	66-1085	47.7	12.5	5.7	6.1	7.9	6.3	2.90	1.1	2.71	.30	.22	4.0	.2	0	99.63
	3700.	66-1103	51.0	14.6	4.7	6.5	7.1	7.1	2.50	2.0	2.37	.34	.20	2.6	.1	0	101.11
	4225.	66-1087	50.1	15.1	2.8	7.5	10.5	10.4	1.70	.6	1.17	.10	.18	2.2	.1	0	102.45
	4350.	66-1101	47.5	14.3	4.9	5.7	9.9	10.8	1.80	1.5	1.09	.10	.16	2.4	.8	0	100.95
	4590.	66-1102	53.5	14.0	7.2	3.8	6.6	3.6	3.00	3.2	2.07	.22	.20	3.1	.3	0	100.79
	4800.	66-1086	52.8	13.2	4.4	6.0	5.8	4.8	2.60	3.2	2.07	.20	.28	2.8	.5	0	98.65
	5050.	66-1089	53.4	13.1	8.2	4.6	5.4	5.6	2.60	3.4	2.07	.20	.24	2.4	.3	0	101.51
	5410.	66-1104	50.9	14.1	5.8	6.1	5.8	8.0	2.60	2.2	1.82	.23	.19	1.9	.6	0	100.24
Upper member	5640.	66-1099	48.8	14.6	3.9	8.6	7.6	8.8	2.30	1.2	1.54	.14	.27	2.6	.1	0	100.45
	5930.	66-1093	47.5	14.0	7.4	6.2	6.6	7.5	3.00	1.4	1.97	.17	.25	2.9	.3	0	99.19
	5970.	66-1076	57.2	12.4	8.7	2.4	5.1	4.6	2.50	3.1	1.65	.14	.13	2.6	1.0	0	101.52
	6120.	66-1091	48.1	14.3	3.4	8.6	8.3	6.2	3.10	1.4	1.54	.13	.29	3.8	.1	0	99.26
	6320.	66-1082	48.3	14.5	2.8	10.0	7.3	7.9	3.00	1.7	1.58	.13	.20	2.3	.2	0	99.91
	6490.	66-1079	50.5	13.3	10.4	7.6	5.5	5.4	4.80	2.6	1.36	.12	.16	1.2	.8	0	103.74
	6525.	66-1077	49.6	14.5	4.5	8.0	7.7	8.2	2.60	1.3	1.57	.13	.25	2.4	.1	0	100.85
	6700.	66-1084	48.3	14.2	4.8	9.0	6.9	7.4	3.00	1.2	2.20	.20	.24	2.7	.3	0	100.44
	6900.	66-1081	48.4	15.7	4.6	7.0	9.0	7.3	3.70	1.3	1.30	.11	.22	3.1	.3	0	102.03
	7070.	66-1090	49.0	13.8	6.9	6.9	6.4	6.2	3.20	2.2	2.66	.24	.23	2.9	.1	0	100.73
	7160.	66-1094	48.6	13.7	5.2	6.5	6.7	6.9	3.30	2.2	1.79	.17	.20	2.7	.6	0	98.56
	7300.	66-1078	49.8	14.5	4.9	7.5	8.0	7.8	2.30	1.5	1.56	.14	.28	2.8	.5	0	101.58
	7600.	66-1083	48.4	14.6	4.7	8.4	7.3	8.7	2.50	.9	1.73	.16	.29	2.5	.1	0	100.28
	7900.	66-1092	47.8	14.5	2.3	10.9	6.3	9.6	2.20	.9	1.77	.14	.24	2.2	0	0	98.90
	8150.	66-1080	47.7	13.6	6.7	6.3	7.4	6.2	3.40	1.9	2.06	.19	.21	5.6	.2	0	101.46
	8910.	66-1075	49.3	14.8	5.0	8.0	7.1	9.7	2.20	.6	1.70	.14	.23	3.3	.1	0	102.17
	9050.	66-1088	52.0	14.3	5.0	6.6	6.9	6.5	2.30	2.0	1.78	.15	.20	2.8	.5	0	101.03
Section 5																	
Lower member	40.	66-1121	49.4	13.5	4.8	7.4	5.8	6.0	3.60	1.9	2.04	.21	.23	4.1	1.6	0	100.58
	300.	66-1116	51.2	12.2	4.6	7.1	10.5	3.6	2.30	2.7	2.02	.10	.13	4.5	1.5	0	102.45
	545.	66-1124	51.6	14.7	3.7	8.0	6.7	7.0	1.90	2.7	1.98	.22	.18	3.0	.2	0	101.88
	725.	66-1119	56.0	12.4	6.4	4.4	7.0	5.2	2.60	2.4	1.79	.20	.15	3.3	.4	0	102.24
	1280.	66-1126	56.9	13.8	6.6	5.0	3.8	4.2	3.70	3.1	2.46	.23	.17	2.1	.2	0	102.26
	1500.	66-1117	51.1	13.6	6.6	5.6	5.5	4.7	3.00	2.2	2.00	.21	.17	3.9	.7	0	99.28
Middle member	2800.	66-1123	53.5	13.5	6.3	6.6	4.7	7.9	2.50	2.1	2.22	.17	.23	1.8	.2	0	101.72
	3080.	66-1125	66.2	11.5	6.3	.8	3.6	1.6	1.80	4.6	1.24	.23	.10	2.3	1.3	0	101.57
	3120.	66-1120	48.8	13.9	4.8	7.9	5.7	9.5	1.70	1.2	1.99	.15	.20	1.9	.3	0	98.04
	3300.	66-1128	51.5	14.0	4.9	8.5	6.1	9.2	2.40	.9	1.90	.17	.22	2.1	.2	0	102.09
	3490.	66-1118	50.1	14.1	5.1	8.1	5.5	9.3	2.50	1.2	1.71	.22	.25	2.8	.1	0	100.98
	3780.	66-1122	49.4	14.2	4.6	8.9	6.9	7.6	3.70	1.0	1.76	.12	.23	2.8	0	0	101.26
Upper member	4010.	66-1115	48.5	13.8	4.8	8.4	6.9	8.4	2.80	1.5	1.53	.19	.25	2.5	.1	0	99.67
	4380.	66-1127	49.1	14.0	4.6	9.3	6.3	10.2	2.40	.1	2.28	.21	.21	2.0	.1	0	100.80

Table VII (continued)

MINOR ELEMENTS
Section I

		$P_2O_5 x10^{-1}$	$MnOx10^{-1}$	Zn	Pbx10	Gax10	$Snx10^2$	$Agx10^3$	Sr	$Bax10^{-1}$	Cr	Zr	V	Ni	Cu	Y	Co	Sc
Lower member	60351	150.	130.	83.	89.	440.	200.	55.	120.	97.	350.	370.	520.	73.	100.	36.	35.	52.
	60352	210.	170.	140.	180.	420.	170.	2.	370.	94.	220.	600.	650.	84.	52.	76.	39.	66.
	60353	200.	150.	160.	120.	440.	190.	62.	270.	59.	750.	370.	470.	22.	59.	00.	64.	49.
	60354	600.	150.	84.	77.	220.	400.	57.	310.	46.	470.	280.	470.	21.	120.	00.	53.	56.
	60355	160.	140.	120.	110.	500.	210.	72.	300.	55.	430.	230.	400.	22.	70.	00.	61.	44.
	60356	60.	170.	120.	120.	250.	150.	77.	320.	96.	650.	510.	650.	19.	26.	63.	47.	72.
	60357	180.	240.	150.	150.	210.	120.	53.	320.	94.	340.	520.	760.	76.	46.	130.	49.	84.
	60358	340.	130.	180.	130.	500.	270.	79.	360.	140.	000.	980.	1000.	68.	56.	130.	150.	51.
	60359	250.	180.	190.	99.	390.	250.	320.	220.	24.	27.	470.	630.	63.	150.	67.	48.	36.
	60320	270.	150.	210.	140.	500.	270.	92.	360.	34.	29.	330.	540.	77.	72.	61.	48.	30.
	60321	220.	160.	130.	100.	370.	360.	120.	300.	40.	180.	270.	530.	860.	110.	55.	34.	57.
	60322	210.	160.	170.	83.	460.	170.	88.	290.	26.	240.	440.	660.	880.	120.	75.	31.	70.
	60347	200.	150.	120.	87.	350.	160.	100.	290.	32.	210.	520.	760.	87.	83.	60.	28.	74.
	60346	100.	150.	85.	50.	220.	180.	84.	190.	33.	270.	240.	490.	100.	110.	15.	28.	120.
Middle member	60345	120.	170.	110.	110.	290.	190.	170.	180.	47.	230.	260.	510.	99.	65.	00.	35.	70.
	60344	250.	240.	230.	170.	510.	380.	73.	160.	90.	000.	390.	850.	40.	50.	72.	30.	77.
	60342	140.	210.	140.	82.	380.	200.	74.	180.	21.	170.	260.	720.	63.	75.	44.	32.	72.
	60343	130.	180.	150.	72.	230.	230.	2.	120.	21.	110.	180.	570.	66.	71.	15.	37.	51.
	60341	140.	250.	150.	140.	220.	140.	140.	170.	20.	140.	870.	570.	67.	130.	35.	39.	66.
	60335	150.	200.	160.	75.	410.	210.	170.	190.	18.	160.	240.	650.	76.	78.	34.	36.	77.
	60336	170.	260.	240.	210.	260.	180.	110.	200.	33.	98.	360.	870.	54.	22.	52.	34.	99.
	60337	280.	270.	220.	130.	300.	240.	2.	230.	51.	38.	800.	820.	43.	260.	92.	34.	65.
	60338	260.	210.	170.	93.	320.	140.	290.	240.	17.	73.	570.	980.	49.	500.	80.	34.	75.
	60339	220.	210.	210.	75.	470.	190.	91.	22.	42.	69.	520.	810.	48.	66.	74.	30.	63.
	60348	220.	270.	200.	120.	250.	210.	90.	190.	27.	71.	380.	870.	51.	65.	65.	36.	79.
Upper member	60349	270.	240.	220.	200.	190.	100.	2.	260.	36.	74.	410.	800.	45.	59.	64.	33.	70.
	60330	320.	360.	240.	190.	230.	150.	92.	190.	44.	43.	380.	610.	49.	130.	63.	46.	51.
	60331	520.	230.	420.	150.	500.	550.	57.	44.	16.	20.	910.	440.	25.	51.	69.	29.	30.
	60332	320.	220.	200.	160.	320.	250.	91.	260.	28.	56.	720.	830.	50.	95.	77.	35.	56.
	60333	330.	240.	180.	230.	330.	180.	79.	290.	40.	120.	690.	800.	59.	36.	80.	33.	61.
	60334	290.	210.	170.	150.	260.	200.	100.	240.	38.	87.	760.	800.	46.	34.	97.	30.	68.
	60324	430.	230.	220.	170.	400.	230.	110.	300.	24.	34.		980.	38.	120.	130.	33.	62.
	60325	450.	180.	230.	150.	350.	200.	100.	240.	25.	52.		800.	47.	110.	140.	34.	61.
	60326	340.	210.	200.	74.	300.	310.	140.	230.	23.	00.	920.	880.	39.	330.	130.	39.	73.
	60327	350.	240.	180.	96.	220.	130.	170.	230.	29.	38.	400.	600.	52.	190.	80.	42.	57.
	60364	290.	200.	230.	130.	350.	150.	220.	200.	31.	38.	430.	900.	36.	75.	78.	34.	100.
	60363	210.	270.	51.	55.	310.	220.	150.	37.	15.	65.	170.	370.	10.	84.	15.	10.	85.
	60362	170.	260.	170.	80.	300.	180.	60.	330.	88.	73.	220.	660.	57.	140.	52.	46.	70.
	60361	160.	70.	160.	120.	220.	150.	79.	280.	120.	110.	250.	680.	52.	42.	47.	35.	33.
	60360	260.	230.	180.	170.	300.	190.	220.	440.	54.	170.	820.		71.	70.	120.	42.	77.
	60329	510.	250.	130.	170.	270.	120.	87.	190.	37.	10.	400.	490.	48.	130.	76.	38.	55.
	60328	280.	210.	190.	130.	330.	160.	140.	220.	35.	54.	420.	630.	53.	310.	69.	42.	60.
	60340	200.	200.	200.	58.	330.	190.	190.	200.	18.	66.	410.	840.	42.	310.	72.	33.	94.
	60974	230.	240.	110.	60.	130.	110.	52.	300.	51.	10.	430.	610.	42.	180.	60.	42.	62.
Upper II member	60979	160.	200.	100.	27.	190.	160.	75.	130.	12.	160.	100.	370.	97.	110.	15.	54.	72.
	60976	110.	120.	96.	44.	140.	84.	95.	130.	20.	240.	180.	580.	87.	150.	40.	48.	100.
	60972	140.	150.	86.	16.	140.	60.	61.	130.	12.	140.	150.	530.	65.	110.	34.	44.	92.

Upper II member (continued)	60983	140.	130.	100.	19.	80.	72.	50.	110.	17.	76.	170.	650.	61.	130.	37.	49.	88.
	60980	120.	190.	110.	19.	150.	46.	67.	130.	14.	100.	140.	520.	56.	130.	33.	44.	90.
	60977	150.	220.	130.	20.	150.	20.	72.	150.	16.	100.	240.	770.	54.	240.	54.	41.	120.
	60970	120.	90.	30.	11.	10.	00.	25.	89.	32.	230.	160.	570.	78.	100.	38.	42.	100.
	60981	100.	280.	110.	25.	72.	91.	91.	490.	79.	140.	97.	400.	89.	130.	15.	53.	67.
	60973	200.	200.	64.	33.	41.	20.	25.	330.	31.	140.	330.	690.	68.	550.	50.	38.	82.

Section 1A

	60968	180.	190.	61.	50.	33.	20.	120.	340.	64.	35.	240.	630.	51.	330.	40.	39.	62.
	60978	180.	210.	120.	47.	110.	90.	110.	400.	28.	150.	310.	700.	65.	210.	48.	43.	76.
	60971	280.	190.	120.	55.	180.	130.	110.	230.	23.	110.	390.	760.	63.	710.	70.	36.	80.
	60975	350.	210.	160.	41.	180.	160.	110.	280.	28.	70.	580.	800.	58.	350.	76.	45.	75.
	60982	260.	220.	140.	45.	200.	150.	54.	270.	21.	80.	490.	810.	58.	220.	58.	41.	72.

Section 2

Lower member	60985	200.	210.	170.	59.	210.	210.	390.	240.	20.	47.	200.	500.	60.	440.	41.	57.	58.
	61006	120.	170.	140.	73.	240.	150.	120.	190.	22.	600.	180.	500.	150.	160.	35.	44.	80.
	61027	160.	180.	110.	120.	170.	20.	170.	240.	35.	330.	250.	460.	70.	75.	26.	33.	57.
	60998	150.	160.	180.	53.	260.	180.	350.	96.	58.	230.	190.	370.	67.	160.	32.	34.	45.
	61033	160.	200.	100.	73.	110.	100.	140.	160.	58.	260.	320.	620.	61.	130.	46.	30.	68.
	60994	80.	280.	150.	55.	380.	440.	280.	110.	13.	740.	120.	380.	150.	330.	15.	40.	64.
	61002	160.	200.	98.	78.	290.	150.	70.	230.	43.	390.	260.	510.	82.	30.	42.	40.	61.
	60988	150.	160.	130.	55.	430.	260.	140.	150.	20.		88.	360.	210.	120.	15.	49.	59.
	61014	160.	150.	75.	69.	110.	72.	80.	320.	37.	260.	220.	460.	72.	140.	33.	40.	56.
	61022	100.	180.	93.	38.	83.	93.	64.	230.	20.	230.	130.	450.	85.	160.	15.	41.	72.
	61004	120.	120.	190.	270.	470.	220.	140.	130.	49.	700.	190.	240.	50.	59.	34.	27.	30.
Middle member	60989	130.	160.	200.	54.	210.	120.		250.	28.	450.	240.	560.	120.	32.	36.	37.	70.
	60997	80.	170.	150.	82.	480.	310.	20.	170.	28.	580.	140.	480.	130.	110.	15.	44.	64.
	61003	140.	170.	120.	130.	360.	240.	88.	140.	25.	590.	200.	500.	170.	19.	40.	44.	63.
	61017	110.	210.	85.	46.	90.	20.	130.	230.	10.	140.	150.	540.	76.	74.	15.	45.	64.
	60999	260.	230.	157.	82.	230.	120.	68.	240.	25.	49.	390.	690.	54.	49.	59.	48.	65.
	61005	170.	230.	120.	100.	360.	260.	110.	220.	65.	55.	130.	490.	60.	220.	15.	39.	48.
	61039	180.	230.	100.	98.	110.	120.	64.	210.	19.	140.	250.	700.	76.	34.	41.	43.	61.
	60986	160.	200.	150.	100.	500.	290.	130.	230.	28.	76.	230.	690.	60.	180.	42.	39.	67.
	60992	160.	30.	84.	64.	180.	210.	150.	140.	4.8	87.	270.	570.	31.	100.	48.	10.	64.
	61010	160.	240.	240.	130.	50.	86.	96.	210.	25.	79.	270.	720.	64.	180.	50.	44.	68.
	61030	260.	210.	120.	57.	110.	45.	62.	250.	24.	90.	400.	810.	63.	130.	61.	39.	76.
	60995	210.	180.	170.	45.	320.	210.	160.	250.	13.	74.	340.	780.	58.	270.	57.	45.	69.
	61015	360.	210.	170.	54.	240.	220.	190.	280.	22.	50.	640.	800.	43.	510.	96.	41.	61.
	61024	300.	230.	120.	82.	77.	100.	70.	360.	41.	90.	480.	700.	61.	200.	63.	40.	52.
	61001	340.	240.	200.	73.	350.	260.	310.	270.	21.	49.	630.	800.	50.	280.	84.	42.	50.
Upper member	61013	330.	220.	150.	76.	140.	120.	25.	300.	19.	59.	610.	780.	60.	450.	78.	46.	53.
	61020	380.	220.	91.	44.	25.	20.	66.	330.	29.	41.	520.	720.	44.	200.	72.	40.	67.
	61023	410.	230.	120.	70.	120.	120.	95.	240.	16.	46.		770.	45.	180.	110.	38.	53.
	61035	280.	240.	34.	34.	15.	20.	25.	320.	64.	50.	430.	740.	53.	290.	53.	47.	61.
	61007	390.	230.	250.	82.	510.	330.	84.	260.	24.	22.	660.	880.	48.	190.	100.	49.	66.
	61011	360.	230.	110.	41.	64.	43.	25.	270.	31.	10.	530.	820.	41.	160.	96.	43.	67.
	60996	170.	240.	240.	92.	500.	330.	61.	330.	40.	82.	260.	700.	53.	150.	54.	47.	83.
	61029	230.	220.	140.	60.	160.	130.	290.	230.	18.	44.	450.	990.	42.	790.	77.	40.	87.
	61040	180.	110.	110.	39.	46.	77.	51.	55.	13.	39.	230.	440.	24.	73.	38.	22.	46.
	61016	220.	180.	50.	56.	11.	20.	80.	280.	24.	94.	240.	610.	61.	130.	47.	44.	78.

Continued

Minor Elements Section 2 (cont.)		$P_2O_5x10^{-1}$	$MnOx10^{-1}$	Zn	Pbx10	Gax10	$Snx10^2$	$Agx10^3$	Sr	$Bax10^{-1}$	Cr	Zr	V	Ni	Cu	Y	Co	Sc
	61038	250.	240.	54.	97.	16.	20.	53.	320.	40.	100.	250.	610.	81.	240.	52.	58.	76.
	61031	490.	210.	160.	53.	120.	120.	130.	210.	18.	71.	700.	830.	60.	510.	110.	41.	78.
Upper	61008	510.	200.	190.	14.	250.	150.	170.	310.	54.	39.	490.	540.	42.	67.	70.	44.	50.
member	61042	200.	220.	180.	82.	160.	160.	80.	280.	27.	53.	220.	580.	58.	190.	44.	51.	69.
(continued)	61041	210.	210.	130.	37.	110.	110.	50.	300.	22.	190.	200.	490.	80.	160.	30.	49.	65.
	60991	300.	210.	220.	72.	470.	240.	150.	270.	25.	90.	370.	610.	64.	230.	53.	49.	67.
	61025	250.	300.	120.	37.	58.	49.	25.	180.	14.	100.		600.	68.	89.	41.	44.	73.
Section 2A																		
	61018	280.	260.	140.	65.	110.	120.	25.	280.	41.	10.	360.	620.	47.	150.	50.	47.	63.
	61036	240.	230.	110.	51.	82.	110.	25.	290.	22.	130.	280.	700.	66.	150.	48.	40.	70.
	61032	240.	240.	94.	40.	88.	70.	69.	190.	22.	69.	330.	760.	40.	140.	63.	46.	95.
	60993	80.	170.	150.	82.	480.	310.	200.	170.	28.	580.	140.	480.	130.	110.	15.	44.	64.
Section 3																		
	61058	120.	120.	180.	380.	390.	280.	92.	110.	69.	380.	140.	210.	39.	60.	15.	26.	23.
	61064	200.	160.	130.	140.	470.	280.	76.	300.	42.	170.	270.	410.	69.	31.	30.	36.	45.
	61048	150.	150.	170.	71.	370.	250.	230.	300.	27.	130.	220.	460.	230.	62.	15.	51.	480.
	61050	180.	190.	150.	100.	300.	200.	54.	370.	46.	220.	220.	480.	88.	27.	15.	40.	48.
Lower	61065	160.	160.	160.	99.	500.	230.	90.	310.	69.	450.	280.	450.	15.	21.	34.	33.	46.
member	61070	180.	170.	160.	130.	420.	270.	130.	280.	36.	380.	170.	390.	95.	73.	15.	51.	49.
	61060	190.	190.	120.	100.	360.	340.	75.	380.	88.	280.	390.	400.	72.	38.	40.	34.	47.
	61068	300.	170.	340.	170.	340.	200.	300.	340.	75.	0	430.	630.	61.	300.	64.	42.	40.
	61045	260.	230.	230.	160.	250.	250.	710.	360.	38.	21.	580.	750.	63.	310.	75.	41.	38.
	61051	110.	190.	160.	100.	470.	370.	97.	160.	26.	690.	240.	590.	150.	73.	15.	36.	85.
	61047	130.	170.	110.	63.	410.	130.	190.	250.	27.	340.	220.	490.	110.	74.	30.	33.	73.
	61056	200.	220.	140.	65.	410.	230.	110.	220.	16.	99.	310.	760.	58.	78.	66.	36.	76.
	61061	260.	220.	160.	62.	500.	290.	76.	300.	23.	51.	420.	940.	50.	180.	65.	41.	86.
	61043	230.	230.	240.	73.	500.	390.	190.	320.	32.	46.	390.	740.	66.	150.	61.	53.	52.
	61062	210.	220.	250.	38.	470.	460.	270.	260.	15.	69.	190.	590.	70.	260.	42.	60.	64.
	61052	260.	240.	170.	92.	340.	190.	84.	330.	67.	77.	490.	880.	53.	170.	67.	36.	82.
	61057	620.	220.	260.	140.	470.	370.	150.	380.	33.	22.	200.	590.	33.	270.	100.	35.	39.
	61067	410.	210.	210.	46.	310.	170.	170.	270.	19.	41.	740.	870.	44.	260.	96.	40.	63.
Upper	61049	470.	220.	210.	45.	300.	220.	170.	270.	19.	43.	880.	810.	50.	43.	110.	36.	57.
and	61071	410.	200.	250.	66.	500.	310.	140.	340.	26.	40.	999.	800.	48.	320.	120.	43.	61.
Middle	61054	350.	200.	210.	45.	250.	260.	210.	270.	79.	72.	560.	870.	49.	600.	84.	40.	74.
member	61072	280.	220.	250.	47.	390.	350.	180.	240.	18.	55.	430.	930.	49.	370.	83.	45.	98.
	61055	220.	250.	270.	60.	380.	330.	110.	260.	19.	36.	340.	920.	37.	370.	60.	37.	84.
	61066	310.	190.	370.	86.	490.	350.	140.	240.	26.	00.	260.	580.	35.	130.	49.	48.	53.
	61059	180.	220.	160.	28.	290.	330.	130.	230.	100.	80.	150.	530.	66.	230.	35.	50.	76.
	61069	220.	250.	170.	49.	330.	280.	230.	210.	14.	81.	250.	600.	62.	420.	45.	62.	69.
	61129	470.	200.	94.	41.	58.	46.	100.	250.	22.	69.	440.	660.	71.	320.	91.	50.	69.
	61063	210.	230.	180.	92.	410.	260.	140.	220.	26.	68.	320.	850.	50.	55.	60.	44.	110.
	61053	200.	230.	210.	53.	280.	210.	210.	330.	27.	54.	280.	680.	55.	300.	51.	54.	78.
	61046	250.	260.	210.	90.	500.	340.	260.	250.	55.	130.	390.	690.	64.	160.	55.	40.	88.
	61044	220.	210.	190.	31.	350.	220.	240.	260.	12.	42.	260.	620.	57.	87.	41.	57.	78.
Section 4																		
	61073	170.	220.	220.	86.	500.	270.	260.	160.	38.	500.	370.	510.	81.	120.	44.	43.	65.
Lower	61109	140.	150.	120.	110.	250.	120.	53.	360.	57.	190.	390.	470.	64.	41.	39.	31.	57.
member	61106	190.	170.	140.	45.	32.	20.	54.	280.	58.	720.	290.	410.	180.	81.	15.	44.	40.
	61114	170.	170.	110.	45.	170.	94.	74.	200.	39.	850.	150.	320.	200.	66.	15.	46.	33.
	61111	200.	170.	88.	66.	140.	65.	60.	260.	51.	690.	220.	370.	180.	48.	15.	43.	44.

Lower member (cont.)	61098	250.	180.	120.	78.	77.	66.	25.	420.	78.	160.	440.	530.	76.	76.	54.	38.	52.
	61096	300.	180.	87.	100.	140.	94.	25.	350.	130.	39.	550.	490.	32.	53.	64.	29.	37.
	61105	110.	160.	76.	100.	180.	98.	56.	190.	83.	800.	560.	380.	160.	53.	48.	31.	40.
	61113	180.	200.	140.	68.	31.	20.	70.	320.	60.	450.	250.	400.	110.	60.	15.	43.	60.
Middle member	61108	260.	210.	110.	120.	160.	83.	25.	760.	130.	50.	510.	720.	75.	82.	63.	41.	49.
	61110	150.	190.	110.	140.	100.	60.	76.	280.	54.	250.	410.	670.	93.	42.	53.	36.	69.
	61097	260.	210.	120.	200.	120.	100.	25.	280.	85.	76.	450.	610.	69.	48.	58.	30.	48.
	61095	300.	180.	47.	70.	16.	160.	56.	270.	91.	74.	350.	560.	62.	39.	49.	29.	38.
	61107	210.	230.	91.	140.	110.	98.	51.	230.	62.	920.	160.	520.	160.	51.	15.	40.	97.
	61112	180.	240.	210.	220.	190.	96.	25.	320.	100.	160.	410.	530.	60.	23.	47.	25.	44.
	61074	190.	150.	230.	150.	240.	190.	89.	210.	73.	120.	350.	390.	50.	48.	41.	22.	32.
	61100	220.	170.	83.	150.	47.	20.	120.	270.	160.	140.	330.	480.	77.	22.	58.	32.	34.
	61085	300.	220.	190.	220.	450.	300.	100.	330.	82.	120.	220.	430.	82.	75.	34.	52.	36.
	61103	340.	200.	110.	140.	160.	160.	110.	333.	110.	210.	380.	680.	84.	59.	51.	33.	68.
	61087	100.	180.	140.	58.	360.	290.	150.	140.	19.	580.	77.	420.	180.	67.	15.	55.	68.
	61101	100.	160.	46.	33.	150.	20.	57.	150.	26.	680.	120.	450.	160.	62.	15.	38.	76.
	61102	220.	200.	130.	110.	120.	20.	25.	350.	300.	170.	380.	540.	67.	68.	41.	36.	54.
	61086	200.	280.	330.	180.	330.	250.	110.	280.	280.	110.	200.	350.	70.	40.	33.	38.	26.
	61089	200.	240.	200.	120.	110.	81.	56.	320.	230.	120.	210.	360.	75.	29.	15.	37.	26.
	61104	230.	190.	240.	140.	42.	43.	64.	230.	140.	200.	200.	540.	82.	43.	15.	40.	63.
Upper member	61099	140.	270.	110.	86.	87.	71.	72.	170.	96.	200.	240.	640.	71.	35.	42.	30.	100.
	61093	170.	250.	76.	110.	47.	59.	60.	250.	120.	71.	370.	720.	55.	42.	49.	33.	92.
	61076	140.	130.	100.	97.	210.	210.	79.	220.	100.	49.	290.	500.	57.	42.	34.	10.	82.
	61091	130.	290.	120.	72.	56.	80.	52.	150.	80.	160.	250.	600.	73.	43.	42.	40.	95.
	61082	130.	200.	120.	63.	370.	200.	68.	370.	130.	93.	160.	530.	66.	60.	37.	44.	71.
	61079	120.	160.	80.	92.	160.	230.	70.	110.	88.	82.	150.	400.	73.	71.	15.	38.	56.
	61077	130.	250.	130.	99.	170.	136.	97.	160.	160.	200.	150.	510.	87.	84.	15.	49.	75.
	61084	200.	240.	160.	170.	270.	260.	93.	230.	75.	75.	270.	700.	53.	54.	41.	40.	62.
	61081	110.	220.	120.	140.	170.	100.	50.	260.	230.	280.	91.	450.	96.	82.	15.	49.	66.
	61090	240.	230.	97.	230.	43.	76.	59.	220.	130.	82.	290.	690.	74.	200.	47.	41.	57.
	61094	170.	200.	220.	220.	76.	83.	70.	260.	200.	190.	230.	550.	55.	21.	42.	31.	58.
	61078	140.	280.	320.	210.	440.	320.	110.	170.	130.	160.	180.	510.	77.	35.	15.	46.	75.
	61083	160.	290.	170.	140.	190.	230.	82.	180.	110.	110.	140.	550.	82.	56.	32.	54.	72.
	61092	140.	240.	130.	230.	140.	180.	97.	180.	57.	160.	280.	720.	68.	69.	45.	32.	88.
	61080	190.	210.	170.	220.	300.	200.	65.	220.	150.	240.	160.	520.	72.	100.	15.	42.	54.
	61075	140.	230.	150.	130.	260.	260.	150.	190.	26.	160.	270.	740.	72.	40.	46.	44.	100.
	61088	150.	200.	170.	160.	470.	300.	160.	220.	170.	210.	140.	470.	85.	41.	15.	39.	50.
								Section 5										
Lower member	61121	210.	230.	110.	80.	110.	89.	120.	200.	63.	130.	270.	400.	49.	160.	34.	43.	43.
	61116	100.	130.	72.	43.	85.	80.	74.	180.	75.	88.	400.	500.	35.	86.	41.	28.	46.
	61124	220.	180.	67.	73.	85.	84.	84.	300.	110.	110.	230.	360.	100.	180.	33.	46.	31.
	61119	200.	150.	67.	81.	93.	82.	25.	250.	72.	330.	180.	280.	130.	52.	15.	45.	27.
	61126	230.	170.	69.	100.	43.	67.	80.	200.	71.	10.	280.	590.	45.	33.	43.	46.	64.
	61117	210.	170.	130.	98.	51.	74.	61.	300.	300.	290.	400.	590.	62.	70.	42.	34.	61.
Middle member	61123	170.	230.	110.	170.	120.	81.	57.	260.	83.	10.	180.	460.	53.	76.	15.	43.	43.
	61125	230.	100.	60.	60.	120.	100.	56.	69.	230.	00.	510.	150.	00.	54.	57.	10.	10.
	61120	150.	200.	97.	60.	110.	130.	110.	250.	29.	98.	310.	720.	60.	100.	44.	30.	84.
	61128	170.	220.	86.	59.	140.	77.	96.	180.	300.	90.	320.	790.	73.	34.	54.	41.	91.
	61118	220.	250.	90.	74.	56.	82.	91.	200.	45.	160.	300.	640.	71.	130.	48.	36.	92.
	61122	120.	230.	110.	82.	150.	89.	54.	270.	40.	100.	130.	470.	78.	65.	15.	38.	62.
Upper member	61115	190.	250.	100.	120.	62.	56.	62.	230.	11.	130.	220.	700.	63.	65.	40.	41.	80.
	61127	210.	210.	69.	110.	140.	110.	160.	220.	20.	140.	260.	600.	70.	170.	46.	46.	64.