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APPENDIX A

DESCRIPTION OF THE CATION NORM EMPLOYED IN CHAPTER 5, AND SOME GENERAL COMMENTS ON CHEMICAL ALTERATION OF OLIVINE-BEARING OPHIOLITIC MEMBERS OF THE PBOC

With the exception of some low-Ti basaltic extrusives (see Section 5.7), almost all ophiolitic members of the PBOC have experienced varying degrees of secondary alteration, namely serpentinization ± amphibolitization ± saussuritization. With few exceptions (e.g. some olivine-bearing orthopyroxenites, samples 489 and 509) PBOC peridotites are highly serpentinized and, where present, modal plagioclase is typically saussuritized (hydrogarnet ± prehnite). On the other hand, alteration in the olivine norites and related cumulates is quite variable and, on occasion, may be almost negligible (e.g. sample 440).

In most olivine norites and related cumulates at least some olivine is partially serpentinized. Alteration of other phases is largely a function of their proximity to shear zones. Even microshears, which are typically abundant in these rocks, possess broad alteration halos characterized by amphibolitization of pyroxenes and saussuritization of plagioclase (see Sections 5.3 and 5.4). For the most part only the freshest available samples have been analysed and in most of these amphibolitization and saussuritization are minimal. However, many contain abundant serpentine minerals after olivine and, to a lesser extent, after orthopyroxene. These rocks display clear petrographic evidence of volume increases during serpentinization (e.g. expansion cracks through non-serpentinized phases , *cf.* Thompson, 1968; Clark and Greenwood, 1972) and original modal compositions are difficult to determine accurately. Consequently a normative calculation (CATION norm) has been devised to determine the wt% modal variation in these rocks. This norm (see below) utilizes the fact that the great majority of these rocks is composed of simple 4- or 5-phase primary assemblages whose constituent minerals are essentially unzoned (see Sections 5.3 and 5.4). Therefore a wt% 'mode' can be calculated for the primary phases actually present in the sample rather than for theoretical end-members as, for

example, in the C.I.P.W. norm. Normative minerals calculated in this manner are abbreviated in upper case (i.e. PL, CPX, OPX, OL, SP) to distinguish them from analogous C.I.P.W. normative components. When the mineral chemistry of a sample is unknown the average mineral chemistry of several analogous samples possessing similar whole-rock Mg^* values has been substituted. In general olivine-bearing intrusives in the PBOC display very close relationships between whole-rock Mg^* and olivine Mg^* (Tables A-1 and A-2) and regular variations in mineral chemistry as a function of olivine Mg^* (see Figs D-1,D-2 and 5.6; Appendices B and C). Less emphasis is placed on normative results obtained in this manner.

The CATION norm is an iterative calculation which progressively modifies estimates of the compositions of PL, CPX, OPX and SP until the phases are identical in their calculated compositions to the primary phases in the analysed sample (whole-rock analyses are listed in Appendix B and representative mineral analyses are listed in Appendix C). The remaining chemical components form OL, and the degree of compositional similarity between OL and primary olivine is a useful indication of the extent to which alteration may have modified the Si:Fe:Mg relations in these rocks. This calculation also has the potential to assess alteration-induced modifications to the pristine Na and Ca contents of appropriate rocks. However, such modifications in the PBOC olivine-bearing intrusives are not reliably assessed by this method because:-

(i) Whole-rock Na_2O contents are generally very low and hence slight errors in estimations of the representative plagioclase composition and the Na_2O content of clinopyroxene may produce gross errors in estimates of Na gains or losses.

(ii) Losses or gains in Ca are determinable only in samples essentially free of Ca-rich pyroxene. In the PBOC, such determinations are therefore restricted to the tectonized harzburgites where they are qualitative at best.

Possible modifications to the pristine chemistry of peridotites and related rocks as a result of serpentinization processes are difficult to evaluate quantitatively. Some workers (e.g. Page 1967a,b, 1976;

Engin and Hirst, 1970; Coleman and Keith, 1971) maintain that, except for the introduction of H_2O and some loss of Ca, the bulk chemistry of peridotites (particularly those containing only small amounts of Ca-rich pyroxene) is not significantly modified by serpentinization, and original Si:Fe:Mg relations are maintained. On the other hand, Moeskops (1977) and Labotka and Albee (1979) argue that Si is added to peridotites during serpentinization and other workers (e.g. Grubb, 1962; Thayer, 1966; Condie and Madison, 1969; Moody 1976a,b) suggest that Fe and Mg are also mobilized to a significant degree. Obviously it cannot be assumed that the chemical effects of serpentinization observed in a particular peridotite or partially serpentinized mafic rock are necessarily indicative of what may have occurred in another. Thus, it is more prudent to assess specific occurrences individually rather than attempt to apply generalizations based on the conclusions of other workers.

On average, tectonized harzburgites in the PBOC are significantly enriched in modal orthopyroxene (+ bastite pseudomorphs after orthopyroxene) relative to analogous peridotites in other ophiolitic complexes (see Section 5.1), and they are also enriched in SiO_2 relative to less orthopyroxene-rich variants. The observed similarities between modal orthopyroxene and normative OPX in these PBOC rocks suggest that their SiO_2 contents, at least, might not have been significantly affected by serpentinization. To a large extent the retention of pristine Si:Mg ratios and, to a lesser extent, Si:Mg:Fe ratios following serpentinization of the PBOC peridotites and mafic cumulates is confirmed by the CATION norm (see below).

CATION NORM

Procedure for calculation of the cation norm employed in Chapter 5. The following procedure is summarized in Figure A-1.

1. From the whole-rock major and minor element analysis calculate the absolute proportions of each cation and sum the cations (Σ cations + Σ oxygens = Σ wt% oxides).
2. Sum Mn, Fe^{2+} and Fe^{3+} to form Fe'.
3. Add Ni to Mg to form Mg'.

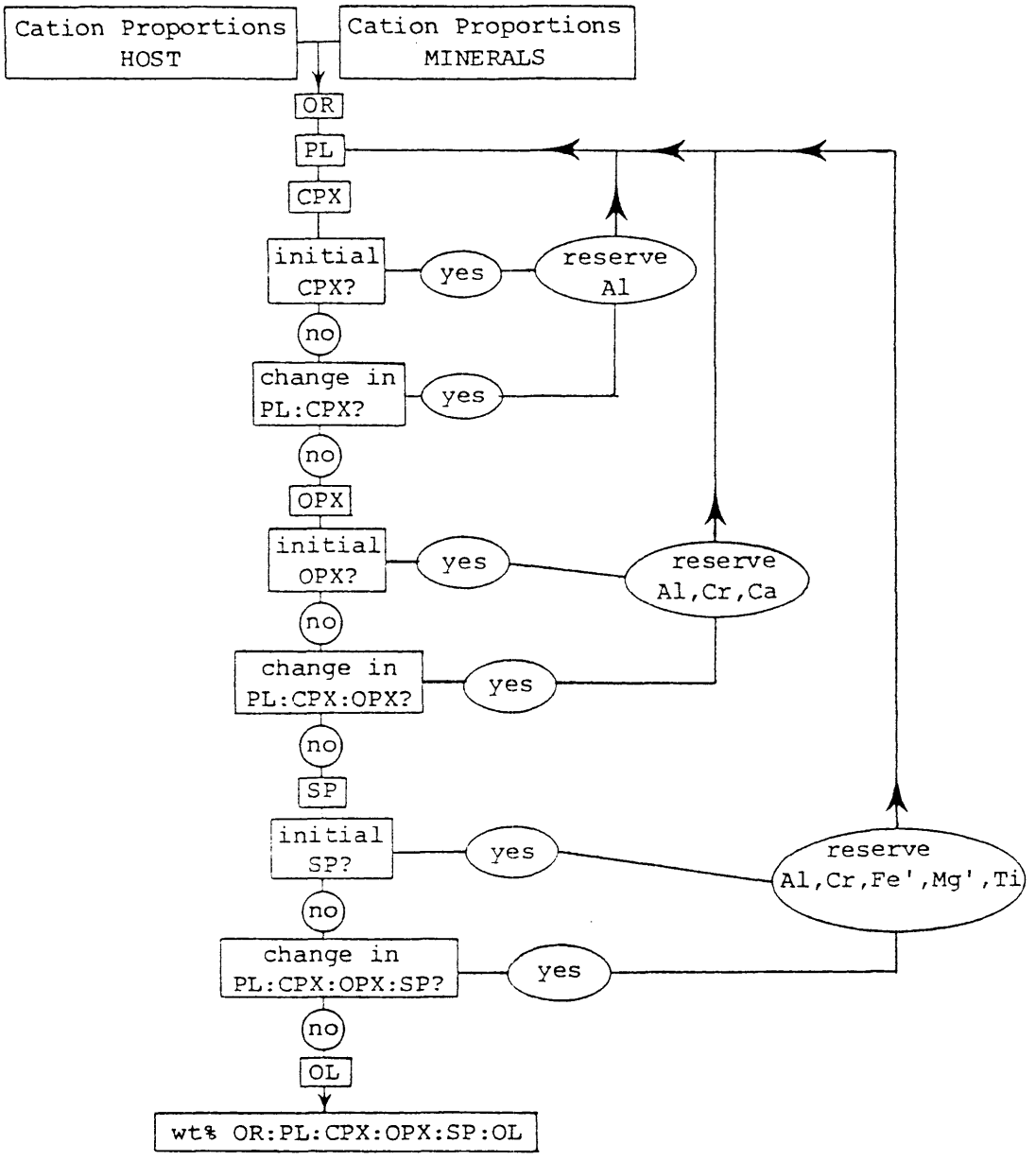


Fig. A-1: Simplified flow sheet for calculation of the CATION norm.

4. Allocate Si and Al to K in the proportions 3:1:1 to form orthoclase (OR).

5. To the remaining Al allocate Si, Fe', Ca and Na in proportions identical to those in analysed plagioclase. The sum of these cations forms provisional plagioclase (PL').

6. To the remaining Ca allocate Si, Al, Cr, Fe', Mg', Na and Ti in proportions identical to those in analysed clinopyroxene. The sum of these cations forms provisional clinopyroxene (CPX').

7. From the total Al in the host subtract an amount of Al equal to that in CPX' and reserve it for subsequent CPX' (see below).

8. Repeat steps 5,6 and 7 until the change in the ratio PL':CPX' for successive determinations becomes negligible (e.g. ± 0.01).

9. Calculate OPX':OL' ratio by apportioning the remaining Si, Fe' and Mg' according to the Si:(Fe'+Mg') ratios of the analysed primary olivine and orthopyroxene.

10. To complete the OPX' cation sum, in the same proportions as in the analysed orthopyroxene, allocate appropriate amounts of Al, Ca and Cr to the Si, Fe' and Mg' already allocated to OPX' in step 9.

11. From the initial Al, Ca and Cr in the host subtract amounts of Al, Ca and Cr equal to those allocated to OPX' in step 9. Reserve these amounts for OPX', to be modified with each successive determination of OPX'.

12. Repeat steps 5-10 (inclusive) until the change in the proportions of PL':CPX':OPX' for successive determinations becomes negligible (e.g. ± 0.01).

13. Allocate amounts of Al, Fe', Mg' and Ti to the remaining Cr in proportions identical to those displayed by the analysed Cr-Al spinel. The sum of these cations froms SP'.

14. From the initial Al, Fe', Mg' and Ti in the host subtract amounts of Al, Fe', Mg' and Ti equal to those allocated to SP' in step 13. Reserve these amounts for SP', to be modified with each successive determination of SP'.

15. Repeat steps 5-14 (inclusive) until the change in PL':CPX':OPX':SP'. Once this is achieved the proportions OR':PL':CPX':OPX':SP' are finalized.

16. Allocate all remaining cations (i.e. residual Si, Fe' and Mg') to OL'.

17. Weight percent proportions of OR:PL:CPX:OPX:OL = 100 OR'/Σ cations : 100 PL'/Σ cations, and so on.

NOTE:

None of the rocks to which this norm has been applied contain modal K-feldspar. In these rocks normative OR is typically negligible and it has been added to PL. Where there has been significant mobility of Na and/or K, PL is calculated on the assumption that Al is relatively immobile and Σ cations is adjusted to compensate for the alkali excess or deficiency. In the more Na-deficient samples (see, for example, analyses 2,3,4 and 7, Table B-2) plagioclase is largely saussuritized and some Ca might have been introduced (see below). Consequently, CPX values in these rocks should be regarded as maximum values. However, because normative CPX abundances are relatively low, and *mg* values of the modal clinopyroxene are only several percent higher than *mg* values of the coexisting olivine and orthopyroxene (Fig. D-2), the effects of moderate discrepancies in normative CPX on the Mg^* of OL are negligible (see discussion of Mg^* below).

Alteration Factors

As an adjunct to the CATION norm calculation a number of alteration factors have been devised to aid in the selection of whole-rock analyses which most closely reflect the chemistry of their relict component minerals (i.e. identify those rocks whose chemistry has been modified least during alteration). With the exception of Mg^* these factors have been designed mainly to amplify alteration trends and their direct petrological application is limited.

In an ideal situation where, for a given sample; (i) analyses of the various minerals are truly representative, and (ii) the host behaved as a closed system during alteration, then the cations remaining

at step 16 of the CATION norm calculation should constitute a stoichiometric olivine equivalent in composition to that in the sample. The factors Fe':Mg, Fe':Si, Mg':Si and ±r (these factors are defined below) reflect relative deviations from this ideal situation as a function of the proportion of OL in the sample. Nickel is generally considered to be relatively immobile during serpentinization (e.g. Coleman and Keith, 1971; Golightly and Arancibia, 1979) and, as Ni is largely located in olivine, the positive correlation between normative OL and Ni in the PBOC cumulates (Fig. A-2) strongly suggests that normative OL is at least proportional to modal olivine. The Ni:Co ratio in these rocks also remains relatively constant over a broad range of normative OL abundances (Fig. A-2), suggesting minimal (or coherent) mobilization of these elements.

Mg^*

$Mg^* = 100\ Mg'/(Mg'+Fe')$. In practice this ratio is almost identical to *mg* and analysed Fo (see Appendix L for key to abbreviations). Mg^* values for host, olivine and OL are listed in Table A-1. On average, Mg^* OL is 1%-2% greater than Mg^* olivine in the PBOC olivine norites and other PBOC olivine-bearing cumulates, and Mg^* OL is ~1%-2% less than Mg^* olivine in the tectonized harzburgites (Fig. A-3). Overall, the Mg^* values of the host, modal olivine and OL are generally very similar. This indicates that for most of the analysed rocks, such alteration as has occurred has not substantially modified their Fe:Mg ratios.

Fe':Mg', Fe':Si, Mg':Si and r

It must be emphasized that these alteration factors are not simple cation ratios as their titles might suggest. They are underlined to distinguish them from normal cation ratios. As outlined above, these factors give an indication of relative deviations from ideal stoichiometry in OL as a function of the proportion of OL in the rock and the amount of the element in question in that OL relative to the rock as a whole. It should be noted that the "elements" from which these alteration factors are derived (i.e. Si, Fe', Mg') constitute more than 75% and up to 99% of the cations present in the rocks concerned.

For an alteration factor X:Y; X:Y = (100+OL)[X in OL-(ideal X in OL relative to Y in OL](X in OL/X in rock). Thus, negative values of X:Y

indicate that there is insufficient X available for OL relative to the amount of Y available for OL to form a stoichiometric olivine identical in composition to the modal olivine. Similarly, positive values of X:Y indicate that there is an excess of X relative to Y. The magnitude of the absolute value of X:Y reflects both the non-stoichiometry of OL and the proportion of OL in the rock; in other words, it provides an indication of the relative extent to which any non-stoichiometry of OL in a sample causes the chemistry of that sample to deviate from the "ideal" situation described above. Thus, the chemistries of altered rocks with low modal olivine and large alteration factors are given less emphasis in this study. Because these alteration factors are specifically designed to amplify deviations from ideal Si:Fe'Mg' relations in the olivine norites and related cumulates (see above) they over-emphasize such deviations in the tectonized harzburgites which have comparatively high OL and low Fe relative to Mg.

The Fe':Mg' and Fe':Si alteration factors vary systematically in the PBOC intrusives (Fig. A-4) and their distribution indicates that for these rocks non-stoichiometry in OL is almost entirely due to discrepancies in Fe' relative to Si and Mg'. In other words, at step 16 in the CATION norm calculation the Si and Mg available to form OL are in similar proportions to Si and Mg in the analysed modal olivine. Figure A-4 also suggests that there is a slight but systematic change in Mg':Si with increasing magnitude of the Fe' discrepancy. This is illustrated in Figure A-5 where $\pm r$ represents the magnitude of the polar coordinates for each point in Fe':Mg'/Fe':Si rectangular space in Figure A-4. In fact, variation in the Mg':Si factor is so regular that it is quite possible that a large component of this variation simply reflects slightly different calibrations of Si and Mg in the microprobe and the XRF used for analysis. Nevertheless, allowing for reasonable analytical constraints, these data strongly suggest that; (i) alteration processes have not significantly modified the pristine Si:Mg' ratios of the PBOC olivine-bearing intrusives, and (ii) during alteration slight mobility of Fe' relative to Mg' (and Si) is almost entirely responsible for the variation in Mg^* OL relative to Mg^* olivine. This mobility of Fe does not appear to be systematically related to the level of Fe oxidation in these rocks or to the level of serpentinization as reflected in their volatile contents (compare Figs A-6 and A-7).

The apparent immobility of Si and Mg in the PBOC tectonized harzburgite might simply be a reflection of the relatively high Si:Mg ratios of these rocks. It is not possible to convert olivine to serpentine without the addition of SiO_2 or the subtraction of MgO (e.g. Coleman, 1977). Excess MgO released during the serpentinization of olivine-rich peridotites may be retained as brucite $Mg(OH)_2$. However, this phase is relatively unstable (Hostetler *et al.*, 1966) and Mg may be leached from the peridotite following the dissolution of brucite in groundwater (Nesbitt and Bricker, 1978). However, during serpentinization of harzburgites containing ~40 wt% orthopyroxene (i.e. similar to those in the PBOC) sufficient silica is available to produce serpentine + magnetite without an excess of MgO (Coleman and Keith, 1971; Moody, 1976), brucite is not formed and the Si:Fe:Mg relations of the fresh peridotite may be maintained. The fact that brucite was sought by petrographic, X-ray diffraction and microprobe examinations but was not found in any PBOC serpentinized harzburgites reinforces the modal and normative data indicating an average of 35%-40% orthopyroxene in these rocks (see Section 5.1).

Ca and Na

Although trace amounts of neoblastic diopside are present in most PBOC harzburgites, these rocks typically contain insufficient Ca to form CPX. This is because the CATION norm allocates Ca to OPX prior to CPX and much of the original Ca in the orthopyroxene has been lost during serpentinization. Microprobe analyses of bastites in these rocks (analyses not listed) suggest that Al_2O_3 is retained following serpentinization, although the distribution of Al_2O_3 in individual bastites is quite irregular (e.g. 0.5%-4.9% Al_2O_3, sample 496). In all bastite and serpentine after olivine CaO was below the microprobe detection limit (0.07%). Because Ca-bearing secondary phases are absent from these rocks, and because they contain insufficient Ca to form normative OPX despite the presence of a trace of modal diopside, there can be little doubt that Ca has been removed from these peridotites during or following serpentinization (*cf.* Page, 1967b; Engin and Hirst, 1970; Coleman and Keitch, 1971).

In the plagioclase-bearing peridotites, however, at least some Ca

is retained in hydrogarnet and rarely in prehnite. These hydrogarnets are enriched in Ca relative to Si and Al in the original plagioclase (Fig. A-8). In fact, hydrogarnets from PBOC plagioclase-bearing peridotites and associated olivine norites display a general trend of increasing Ca at a relatively constant Si:Al ratio which more-or-less corresponds to that of the original plagioclase of ~An_{90-85} (Fig. A-8). A significant proportion of this excess Ca might be derived from that released during serpentinization of coexisting pyroxenes. Although the possibility that some Ca might have been introduced cannot be entirely ruled out, comparison of analyses of a fresh olivine norite (sample 440, analysis 1, Table B-3) and its altered equivalent (sample 326, analysis 1, Table B-7) reveals that significant K, Ba and Sr may be introduced, (*cf.* analyses 2 and 4, Table B-7) but Ca remains relatively constant. However, Ca is enriched in the highly amphibolitized olivine norites (e.g. analyses 5-8, Table B-7).

Sodium is also mobilized during alteration of the olivine norites, especially in the vicinity of shear zones where it is released during saussuritization of plagioclase and concentrated in secondary amphiboles (see Table B-7, for analyses of highly amphibolitized and saussuritized samples, and Tables C-7 and C-8 for analyses of secondary phases). As previously mentioned, the CATION norm calculation is somewhat unreliable in detecting small to moderate Na discrepancies in these rocks and, bearing in mind the extremely restricted range of plagioclase compositions in the PBOC olivine norites and peridotites (An_{90-85}, see Table C-1), simple inspection of the analyses (Appendix B) is sufficient to reveal the more significant Na discrepancies. Of the samples analysed, 440 (analysis 1, Table B-3) is the least likely to have experienced significant Na-mobility. In fact, this sample contains 98% (0.58% Na_2O) of the Na required to ideally satisfy its particular CATION norm.

TABLE A - 1

Normative Alteration Factors for Olivine Norites and Peridotites for which Mineral Probe Data are Available

SAMPLE	HOST Mg*	OL Mg*	OL† Mg*	Fe':Mg'	Fe':Si	Mg':Si	r
440	81.2	80.3	81.4	- 2.04	-1.57	0.44	- 2.6
441	81.2	80.4	81.4	- 2.11	-1.61	0.47	- 2
443	83.1	81.9	83.6	- 5.51	-4.39	1.02	- 7.0
444	83.8	82.5	84.7	- 7.25	-5.86	1.26	- 9.3
445	83.1	82.7	83.6	- 3.91	-3.02	0.86	- 4.9
447	84.6	82.8	85.4	-10.64	-8.60	1.79	-13.6
448	83.5	82.9	84.0	- 4.82	-3.84	0.94	- 6.2
449	83.9	82.9	84.3	- 6.82	-5.45	1.27	- 8.7
450	83.8	83.1	84.6	- 6.89	-5.57	1.25	- 8.9
451	83.7	83.1	83.7	- 2.34	-1.82	0.50	- 3.0
452	83.5	83.3	83.7	- 2.25	-1.72	0.53	- 2.8
453	84.4	83.6	84.5	- 3.52	-2.76	0.72	- 4.5
455	84.3	83.8	85.0	- 4.10	-3.28	0.79	- 5.3
456	84.1	83.8	84.8	- 4.61	-3.73	0.86	- 5.9
457	84.3	84.0	85.0	- 4.94	-3.98	0.95	- 6.4
458	83.9	84.1	84.2	- 0.63	-0.53	0.10	- 0.8
459	85.5	84.2	85.7	- 7.89	-6.50	1.25	-10.2
460	84.6	84.3	85.3	- 5.93	-4.74	1.15	- 7.6
461	85.2	84.6	85.4	- 3.83	-3.08	0.72	- 4.9
462	83.5	84.8	83.6	5.83	5.10	-0.81	7.8
463	85.5	84.9	86.3	- 6.89	-5.63	1.19	- 8.9
465	83.9	84.9	84.2	- 5.32	-4.27	1.00	- 6.8
466	85.8	85.0	86.8	- 4.96	-4.12	0.78	- 6.5
467	85.0	85.2	85.4	- 1.61	-1.17	0.45	- 2.0
469	86.0	85.4	93.6	- 4.93	-4.19	0.70	- 6.5
470	86.2	85.5	87.2	- 7.33	-6.11	1.15	- 9.5
471	85.4	85.5	85.1	1.12	1.18	0.02	1.6
472	85.7	85.6	86.2	- 3.82	-3.02	0.80	- 4.9
473	85.7	85.7	86.1	- 3.13	-2.44	0.70	- 4.0
476	86.5	86.1	87.4	- 6.42	-5.41	0.97	- 8.4
477	87.1	86.1	88.2	-10.72	-9.14	1.45	-14.1
478	86.4	86.5	86.7	- 1.78	-1.37	0.41	- 2.3
479	86.5	86.4	87.0	- 4.90	-4.02	0.87	- 6.3
480	87.5	86.4	87.8	- 6.98	-5.89	0.99	- 9.1
482	86.8	86.7	87.1	- 3.76	-3.02	0.73	- 4.8
486[1]	87.7	88.0	-	37.1	34.1	-	-
489	90.7	90.4	91.5	- 2.19	-1.95	0.24	- 2.9
492	90.3	91.5	89.9	12.28	11.43	-0.99	16.8
493	91.7	91.6	91.8	- 2.31	-1.89	0.41	- 3.0
495	90.6	91.6	90.3	9.67	9.04	-0.71	13.2
496	91.5	92.1	91.4	5.50	5.26	-0.26	7.6
497	91.8	92.2	91.6	5.58	5.31	-0.28	7.7
498	91.5	92.3	91.2	9.89	9.37	-0.59	13.5

$Mg^* = 100(Mg+Ni)/(Mg+Ni+\Sigma Fe+Mn)$. $OL^\dagger$ = Normative olivine composition.

For definitions and calculation procedures for other parameters see text of Appendix A.

[1] insufficient SiO_2 to form normative OL

TABLE A - 2

Normative Alteration Factors for Olivine Norites and Peridotites whose Mineral Chemistry has been Estimated

SAMPLE	HOST	OL†				
	Mg*	Mg*	Fe':Mg'	Fe':Si	Mg':Si	r
532	82.4	82.5	3.48	3.07	-0.44	4.6
530	83.3	83.1	0.51	0.55	0.05	0.8
514	83.4	84.2	-5.70	-4.54	1.10	-7.3
516	83.4	84.0	-4.56	-3.66	0.85	-5.9
521	83.6	83.3	-0.72	-0.48	0.23	-0.9
529	83.6	84.2	-5.58	-4.48	1.07	-7.2
517	83.8	84.8	-7.62	-6.16	1.32	-9.8
515	83.8	84.9	-8.24	-6.67	1.43	-10.6
519	83.9	84.2	-4.51	-3.61	0.85	-5.8
513	84.0	84.4	1.90	1.79	-0.18	2.6
499	84.2	84.5	-4.75	-3.79	0.94	-6.1
510	84.2	84.3	5.70	5.05	-0.71	7.6
512	84.3	84.2	3.70	3.33	-0.39	5.0
527	84.5	-	13.28	11.35	-2.08	17.5
524	85.1	84.7	2.79	2.54	-0.25	3.8
520	85.2	85.5	-4.21	-3.36	0.82	-5.4
511	85.3	85.9	-4.46	-3.60	0.85	-5.7
518	85.4	85.7	-5.16	-4.17	0.94	-6.6
500	85.5	85.9	-1.99	-1.44	0.55	-2.5
522	85.7	86.4	-7.86	-6.48	1.32	-10.2
523	86.1	86.3	-1.24	-0.97	0.27	-1.6
526	86.1	95.2	-8.34	-7.04	1.16	-11.0
531	86.5	85.7	-0.95	-0.68	0.25	-1.2
509	88.1	88.5	-0.23	-0.14	0.10	-0.3
502	90.4	90.0	11.94	11.11	-0.95	16.3
503	90.6	90.2	10.16	9.48	0.76	13.9
506	90.6	90.1	9.82	9.30	-0.58	14.5
504	90.7	90.4	9.31	8.72	-0.66	12.8
505	90.8	90.7	6.73	6.36	-0.40	9.3
507	91.2	92.4	-88.5	-73.8	7.27	115
508	91.6	91.7	-1.58	-1.21	0.37	-2.0

Mg* = 100(Mg+Ni)/(Mg+Ni+ΣFe+Mn). OL† = Normative olivine composition

For definitions and calculation procedures for other parameters see text of Appendix A.

TABLE A - 3

Normative Alteration Factors for Amphibolitized and Saussuritized Olivine Norites

SAMPLE	HOST	OL†						
	Mg*	Mg*	Fe':Mg'	Fe':Si	Mg':Si	r	Host	Locality
326[1]	81.3	80.9	- 0.96	- 0.70	0.24	- 1.2	440	1
325[1]	82.7	85.6	-15.39	-12.24	2.69	-19.7	440	1
323[2]	84.6	82.5	1.12	0.99	-0.12	1.5	-	1
324[3]	83.0	84.3	- 6.82	- 5.45	1.27	- 8.7	440	1
322[3]	83.2	81.5	- 1.30	- 0.99	0.25	- 1.6	441	1
327[3]	84.4	83.6	- 2.86	- 2.20	0.60	- 3.6	-	1
330[3]	86.2	74.4	10.98	9.43	-1.48	14.5	-	
321[1]	86.4	86.9	- 3.71	- 3.00	0.71	- 4.8	479	
328[2]	88.8	89.0	-12.46	-10.71	1.59	-16.4	-	
329[4]	85.4	82.0	27.49	23.95	-2.94	36.5	448	1

1 Numerous thin amphibolitized shears

2 Amphibolitized plagioclase-rich horizon

3 Amphibolite

4 Completely saussuritized plagioclase horizon

OL† = Normative olivine composition (see text)

Mg* = 100(Mg+Ni)/(Mg+Ni+ΣFe+Mn)

For definitions and calculation procedures for other parameters see text of Appendix A.

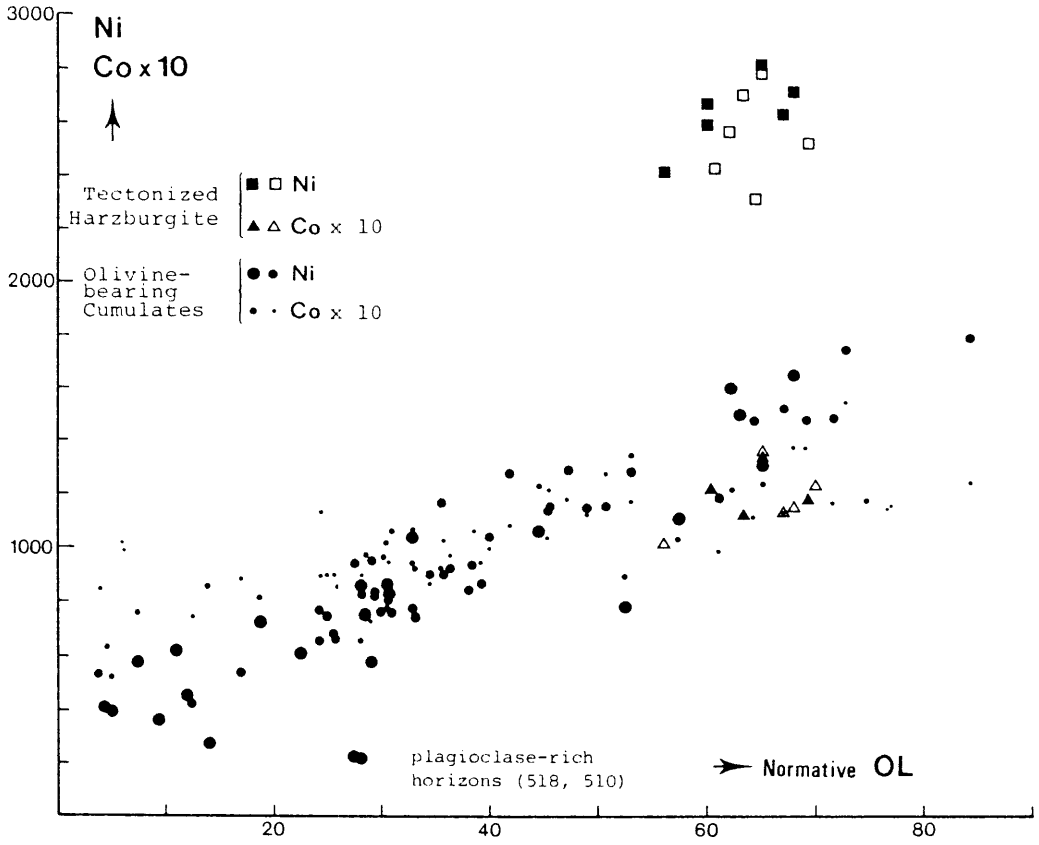


Fig. A-2 : Whole-rock Ni and Co *vs* normative OL in PBOC tectonized harzburgites and olivine-bearing cumulates. Smaller dots and hollow symbols represent samples whose mineral chemistry was estimated prior to the calculation of their CATION norms.

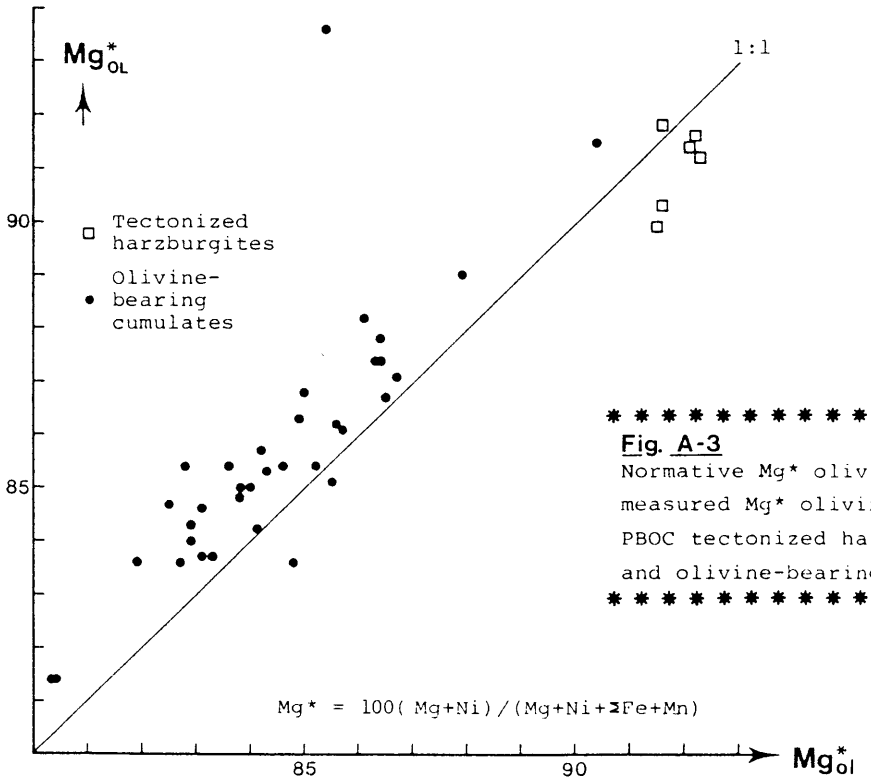


Fig. A-3
Normative Mg* olivine *vs* measured Mg* olivine in PBOC tectonized harzburgites and olivine-bearing cumulates

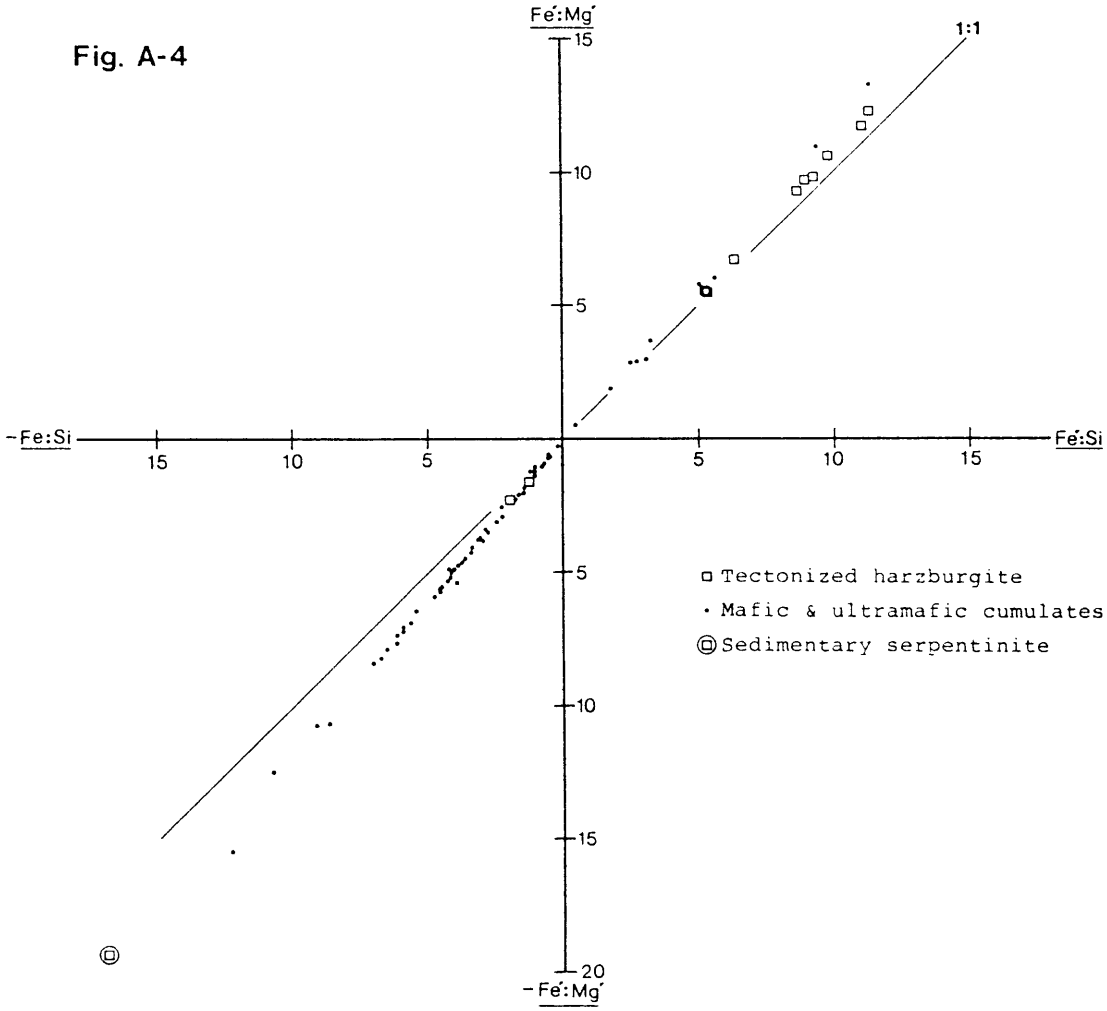


Fig. A-4: Co-variation of normative alteration factors Fe':Mg' and Fe':Si in some PBOC mafic and ultramafic rocks.

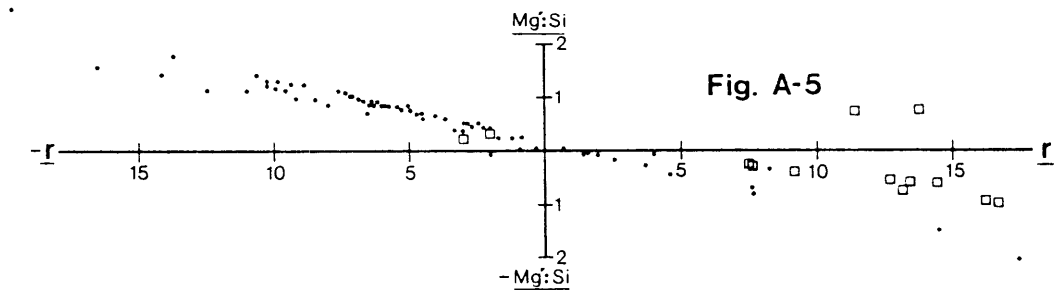
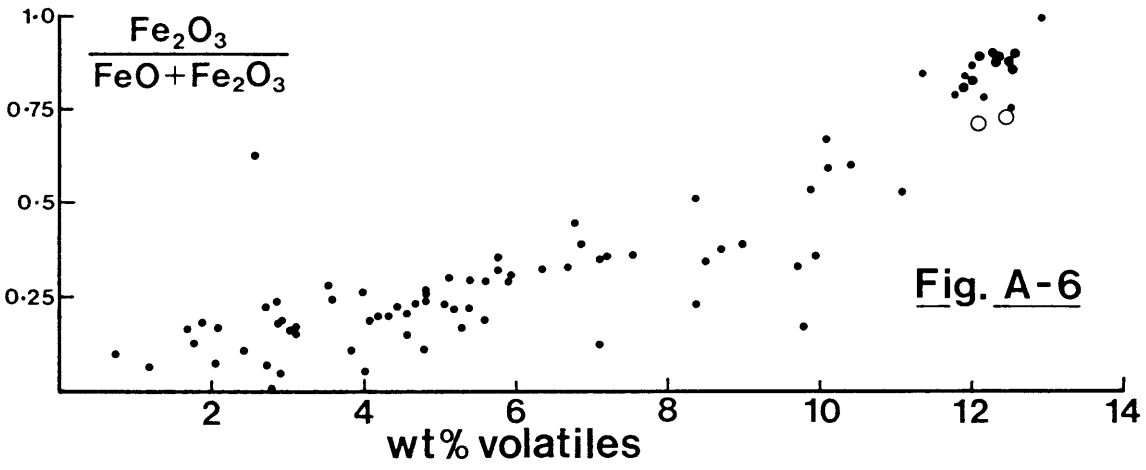


Fig. A-5: Variation of Mg':Si as a function of r in some PBOC mafic and ultramafic rocks. See text of Appendix A for a description of this figure. Symbols as in Fig. A-4.



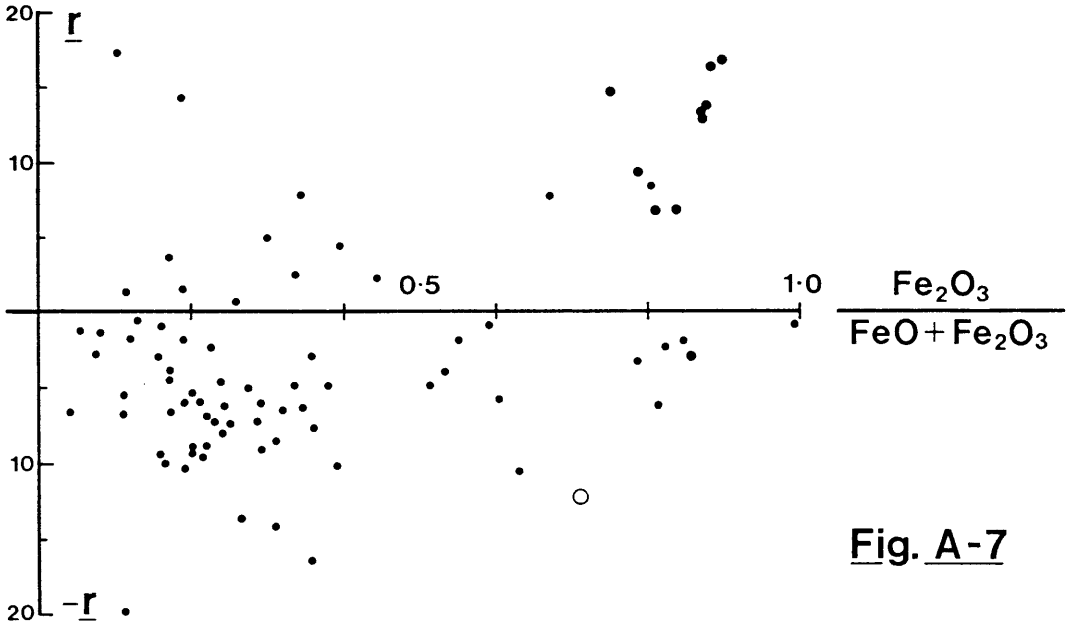


Fig. A-6: Variation of $Fe_2O_3/(FeO+Fe_2O_3)$ with increasing volatile content in PBOC mafic and ultramafic cumulates (•), sedimentary serpentinites (O) and tectonized harzburgites (•).

Fig. A-7: Variation in r as a function of $Fe_2O_3/(FeO+Fe_2O_3)$ in PBOC mafic and ultramafic cumulates (•), sedimentary serpentinite (O) and tectonized harzburgites (•).

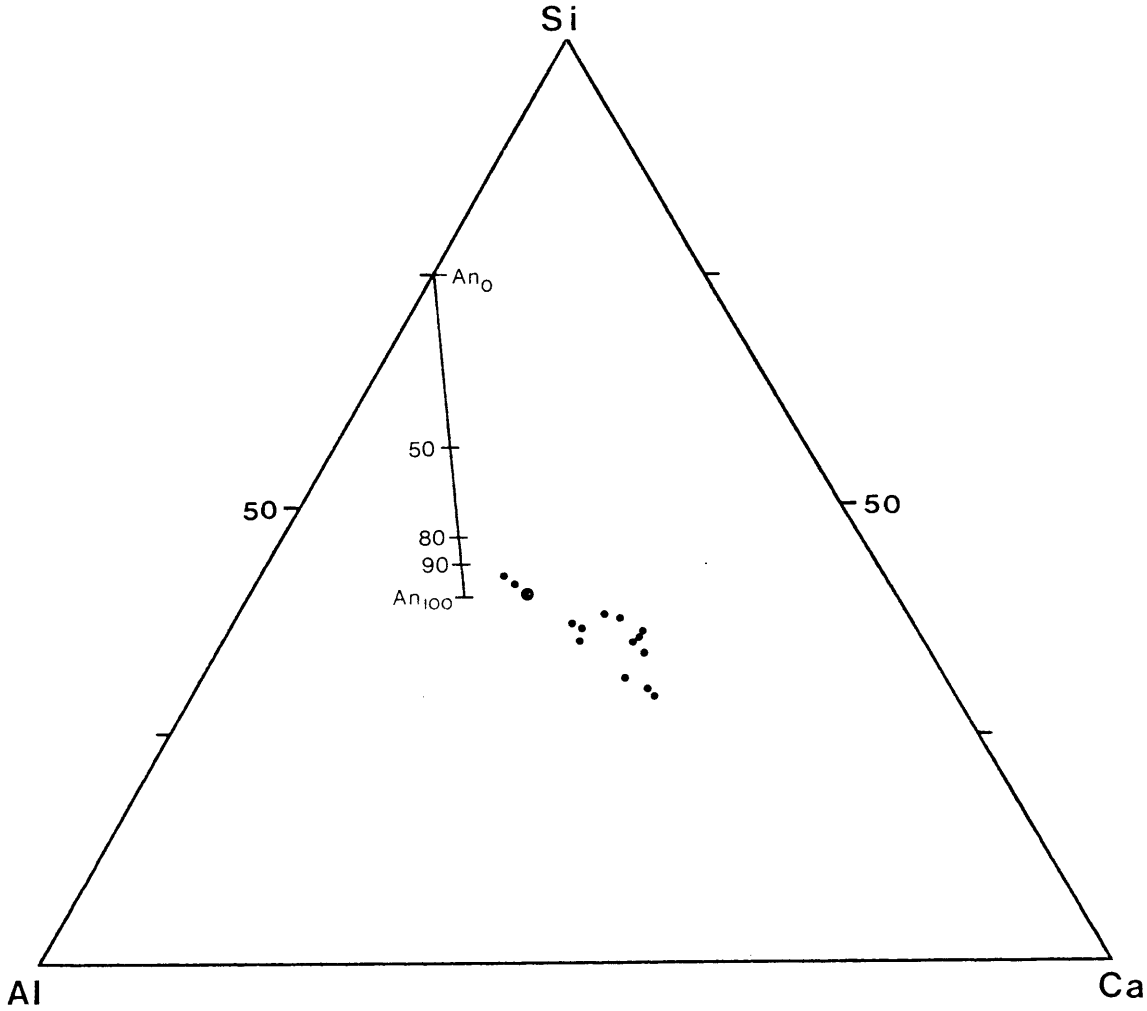


Fig. A-8: Si:Al:Ca relations in hydrogarnets from PBOC plagioclase-bearing peridotites and olivine norites (small dots) and from an olivine gabbro in the Curricabark Fault Zone, Glenrock Station (large dot). Line An_0 - An_{100} = locus of Si:Al:Ca relations in 'ideal' plagioclase feldspars.