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COMPOSITION OF SOME SODIC PYROXENES FROM THE ECLOGITIC MICASCHISTS OF LOWER VAL D'AOSTA (SESIA-LANZO ZONE, WESTERN ALPS)

RIASSUNTO. — Sono stati determinati la composizione, i parametri reticolari ed il chimismo della roccia incassante, di 7 pirosseni sodici (3 giadeiti, 3 omfaciti e 1 egirin-augite) provenienti dai micascisti eclogitici della bassa Valle d'Aosta fra Quassolo e Quincinetto (Zona Sesia-Lanzo interna).

La composizione dei pirosseni che cristallizzano nelle fasi precoci dell'evento metamorfico eo-Alpino (giadeite ed omfacite) è controllata dal chimismo della roccia incassante; l'osservazione microscopica conferma che essi non sono in equilibrio con l'albite e che quindi le variazioni nel tenore di molecola giadeitica in questi pirosseni non dipendono da gradienti di pressione o temperatura.

L'egirin-augite, e più in generale i pirosseni acmitici che si formano dalla destabilizzazione della giadeite nelle fasi tardive dell'evento eo-Alpino, sono invece in equilibrio con l'albite. I tenori in molecola giadeitica di questi pirosseni indicano che le fasi tardive dell'evento eo-Alpino si sono sviluppate in condizioni bariche sensibilmente inferiori a quelle delle fasi iniziali, ma ancora corrispondenti a gradienti geotermici bassi.

ABSTRACT. — Composition, unit-cell dimensions and bulk chemistry of the host rock have been investigated for 7 sodic pyroxenes (3 jadeites, 3 omphacites and one aegirine-augite) from the eclogitic micaschists of the Quassolo-Quincinetto section in the central Sesia-Lanzo Zone.

The jadeites occur in persilicic rocks poor in Ca, Fe and Mg, the omphacites in eclogitic schists of quartzdiortitic composition and in a siliceous marble. The aegirine-augite occurs as product of the destabilization of jadeite (together with albite, white mica, blue amphibole and epidote).

The close areal association of jadeite with omphacite and the correlation between composition of the investigated pyroxenes and host-rock composition demonstrate that the jadeite content in these pyroxenes cannot be used to infer P-T gradients for the eclogitic metamorphism of the Sesia-Lanzo Zone. As predictable from these results, textural relations show that neither jadeite nor omphacite is in equilibrium with albite; only aegirine-augite appears to be in equilibrium with albite and therefore its jadeite content can be used to infer P-T conditions.

Introduction

In the Sesia-Lanzo Zone of the Western Alps, granites, high-grade schists and metabasites have been subjected during the early-Alpine event to very high pressures

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and comparatively low temperatures, resulting in a variety of eclogitic assemblages (COMPAGNONI *et al.*, this volume). Pyroxenes of the jadeite-omphacite series are essential constituents of all these assemblages. Assuming that the sodic pyroxenes are in equilibrium with albite, variations in the jadeite component have been related to P-T gradients within the Sesia-Lanzo Zone (VELDE and KIENAST, 1973; LIEBEAUX,

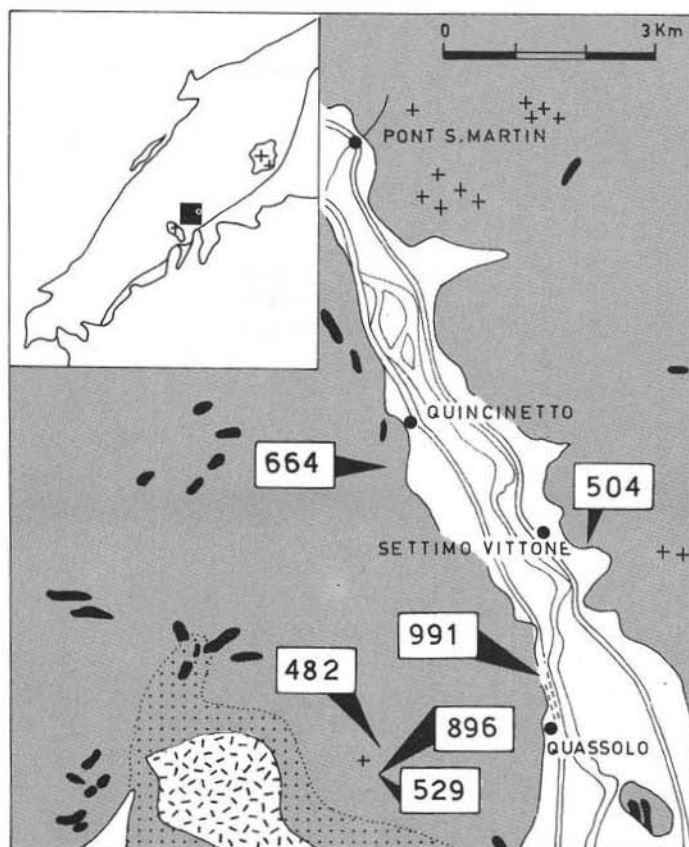


Fig. 1. — Geological sketch map of the lower Val d'Aosta, showing locations of investigated samples. Heavy stipple, eclogitic micaschists; crosses, metagranitic rocks; black, marbles; dotted, contact aureole of the Brozzo stock (cross-hatched). Inset shows the position of the Quassolo-Quincinetto area in the Sesia-Lanzo Zone.

1975). Actually, it is well known that the amount of jadeite molecule in a sodic pyroxene in equilibrium with albite depends only on pressure and temperature (ESSENE and FYFE, 1967).

Petrographical evidence shows on the contrary that in the eclogitic schists of the Sesia-Lanzo Zone neither jadeite nor omphacite is in equilibrium with albite, the latter forming from destabilization of the former minerals (COMPAGNONI and MAFFEO, 1973; COMPAGNONI, this volume). Moreover, in the Sesia-Lanzo Zone jadeite- and

omphacite-bearing rocks are closely associated in the field and jadeite appears to be restricted to rocks of particular composition (whereas omphacite forms in a spectrum of compositions ranging from basic to pelitic). Therefore it was decided to test a possible correlation between pyroxene composition and bulk chemistry of the host rocks.

Materials analysed

The analysed pyroxenes are all from the lower Val d'Aosta between Quassolo and Quincinetto (Fig. 1). The dominant lithology in this area is an eclogitic

TABLE 1

Mineral composition of the eclogitic schists from lower Val d'Aosta

	SL664	SL482	SL504	SL529	SL896	SL991
K-feldspar	x					
Allanite				o		
Quartz	xx	xx	xx	xx	x	xx
Phengite	xx	xx	xx	xx	x	x
Jadeite	xx	xx	xx			
Omphacite				xx	xx	x
Garnet	o	x	o	xx	x	
Glaucofane		x		x	xx	
Rutile			o	x	x	
Carbonates						xx
Tremolite						x
Mg-chlorite						x
Apatite	x		o	x		
Opaque ores					x	x
Albite	x	x	x	x	x	
White micas	x	x	x	x		o
Aegirine-augite	x	x	x			
Blue amphibole		x	x			
Actinolite				x	x	
Epidote	x		x	x		
Chlorite			x	x		
Sphene			x	x		

xx major constituent x minor constituent o accessory

- SL 664 Meta-aplite dyke, Road Quincinetto - S. Maria.
 SL 482 Meta-aplite dyke, Southern slope of Le Colme (Val d'Aosta - Valchiusella divide).
 SL 504 Jadeite micaschist, Settimo Vittone.
 SL 529 Eclogitic metatonalite, Southern slope of Le Colme.
 SL 896 Cognate inclusion in the metatonalite.
 SL 991 Quartz-omphacite marble, Quassolo.

omphacite-garnet micaschist with intercalations of glaucofane eclogites and marbles. Metatonalites occur west of Quassolo in the Val d'Aosta-Valchiusella divide (ANDREOLI et al., 1976) and metamorphosed dykes of aplitic composition are common in the micaschists.

Seven sodic pyroxenes were selected for study:

- 1) Jadeite SL 664, from a metamorphosed dyke of aplitic composition. Jadeite occurs as pale-green crystals, several millimeters long, in an aggregate of quartz, oriented phengites and relics of large magmatic K-feldspars.
- 2) Jadeite SL 482, from a meta-aplite dyke with jadeite megablasts (see ANDREOLI et al., 1976).
- 3) Jadeite SL 504a, from a micaschist consisting of large (4.5 cm), green jadeites in a quartz-phengite matrix.
- 4) Omphacite SL 529, from the eclogitic metatonalites of the Val d'Aosta-Valchiussella divide.
- 5) Omphacite SL 896, from a cognate inclusion in the metatonalites, consisting of grass-green omphacite and minor glaucophane, quartz and phengite.
- 6) Omphacite SL 991, from a quartz-omphacite marble.
- 7) The Ac-rich pyroxene forming with albite, white mica and glaucophane from jadeite SL 504a.

Mineral composition and location of the host rocks are listed in Table 1. *K-feldspar* and *allanite* are the only relics of pre-Alpine assemblages. *Jadeite*, *omphacite*, *phengite*, *garnet* and *glaucophane* appear to have crystallized in a first episode of the early-Alpine event. In contrast to the metagranitoids and paraschists of the Mucrone area described by COMPAGNONI and MAFFEO (1973) no relics of pre-Alpine textures were found in these rocks.

The three jadeites analysed in this study show the characteristic alteration into *albite*, *white mica*, *Ac-rich pyroxene*, *glaucophane* and *epidote*, described as Type 2 by ANDREOLI et al. (1976) in the Colme area. As in these occurrences the Ac-rich pyroxenes may occur as narrow rims around quartz inclusions in the host jadeite. In rocks SL 529 and SL 896 omphacite is partly replaced by *albite* + *actinolite* occurring as brownish symplectites or as coarser-grained intergrowths.

Composition of the pyroxenes

The chemical analyses and the calculated formulae of the investigated pyroxenes are given in Table 2. SL 504a and b were analysed by means of the electron microprobe (COMPAGNONI and GHENT, in prep.); in these analyses total Fe was partitioned between Fe^{2+} and Fe^{3+} assuming $Fe^{2+}/Fe^{3+} = (Ca - Mg)/(Na - Al^{VI})$. The other analyses were performed by standard wet methods and X-ray fluorescence on mineral concentrates obtained by isomagnetic separation and centrifuging with heavy liquids. Purity of the concentrates was in all cases greater than 99%.

The analysed pyroxenes appear optically homogeneous, but splitting of the $\bar{2}21$ reflection in X-ray powder patterns showed that the concentrate of omphacite SL 529 was not homogeneous; variation of composition in this sample, however, is not large and less than 10% in the jadeite component according to the determinative diagram of ESSENE and FYFE (1967).

TABLE 2

Chemical analyses and calculated formulae of the pyroxenes from lower Val d'Aosta*

	SL664	SL482	SL504a	SL529	SL896	SL991	SL504b
SiO ₂	57.61	58.96	59.03	56.32	56.07	57.09	53.87
TiO ₂	0.09	0.03	n.d.	0.20	0.23	0.09	n.d.
Al ₂ O ₃	23.71	23.08	22.01	13.70	13.12	12.33	3.69
Fe ₂ O ₃	1.88	1.61	2.07	2.35	2.48	-	15.43
FeO	0.33	0.56	0.94	2.83	3.34	1.86	4.74
MnO	-	-	n.d.	-	0.04	-	n.d.
MgO	0.20	0.26	0.67	5.89	5.75	8.22	4.52
CaO	0.72	1.32	1.37	10.42	10.67	13.12	10.18
Na ₂ O	15.09	13.98	14.03	8.91	8.34	7.41	8.23
K ₂ O	0.20	0.12	n.d.	0.03	0.04	0.01	n.d.
Total	99.83	99.92	100.12	100.65	100.08	100.13	100.66
Si	1.974	2.004	2.010	1.979	1.986	2.000	2.004
Al	0.026	-	-	0.021	0.014	-	-
ΣT	2.000	2.004	2.010	2.000	2.000	2.000	2.004
Al	0.930	0.925	0.883	0.546	0.533	0.509	0.162
Ti	0.002	0.001	-	0.005	0.006	0.002	-
Fe ³⁺	0.049	0.041	0.053	0.062	0.066	-	0.432
Fe ²⁺	0.009	0.016	0.027	0.083	0.099	0.055	0.147
Mn	-	-	-	-	0.001	-	-
Mg	0.010	0.013	0.034	0.308	0.304	0.429	0.251
ΣM1	1.000	0.996	0.997	1.004	1.009	0.995	0.992
Ca	0.026	0.048	0.050	0.392	0.405	0.493	0.406
Na	1.002	0.921	0.926	0.607	0.573	0.504	0.594
K	0.009	0.005	-	0.001	0.002	-	-
ΣM2	1.037	0.974	0.976	1.000	0.980	0.997	1.000
Total	4.037	3.974	3.983	4.004	3.989	3.992	3.996

* SL 664, 529, 896 and 991: SiO₂, TiO₂, Al₂O₃, Fe₂O₃, CaO and K₂O determined by X-ray fluorescence; FeO, MgO, MnO and Na₂O by standard wet methods. Analyst: L. Fiora. SL 504a and b: microprobe analyses. Analyst: R. Compagnoni. Analysis SL 482 is from ANDREOLI et al. (1976).

The chemical formulae are expressed as (M2)(M1)T₂O₆, where M2 consists of Ca, Na and K; M1 of Al, Fe³⁺, Fe²⁺, Mg, Mn and Ti; T of Si and tetrahedrally coordinated Al as required to make a total of two atoms. As usual in pyroxenes formed under high pressures, the amount of Al in tetrahedral coordination is low (YODER, 1950) and does not exceed 1-2 % of the total tetrahedral content. The sums of the M1 cations are close to the expected value of 1.00, whereas the sums of the M2 cations show somewhat larger variations.

TABLE 3

Compositions of the sodic pyroxenes from lower Val d'Aosta expressed as molecular percentages of the end-members jadeite (Jd), acmite (Ac), tschermakite (Ts) and diopside-hedenbergite (Di+Hd)

	SL664	SL482	SL504a	SL529	SL896	SL991	SL504b
Jd	93.0	95.3	89.9	57.0	55.9	50.7	16.3
Ac	5.3	-	4.4	4.0	2.9	-	43.4
Ts	-	2.0	0.5	1.1	1.1	0.3	-
Di+Hd	1.7	2.7	5.2	37.9	40.1	49.0	40.3

Compositions expressed in terms of the end-member molecules Jd, Ac, Ts and Di+Hd are given in Table 3. In the calculation the method proposed by CAWTHORN and COLLERSON (1974) was used, but En and Fs were combined with Wo as Di + Hd and the tschermakitic molecules (Ca-ferritschermak's, Ca-Ti-tschermak's and Ca-tschermak's) were added together. In the compositional diagram

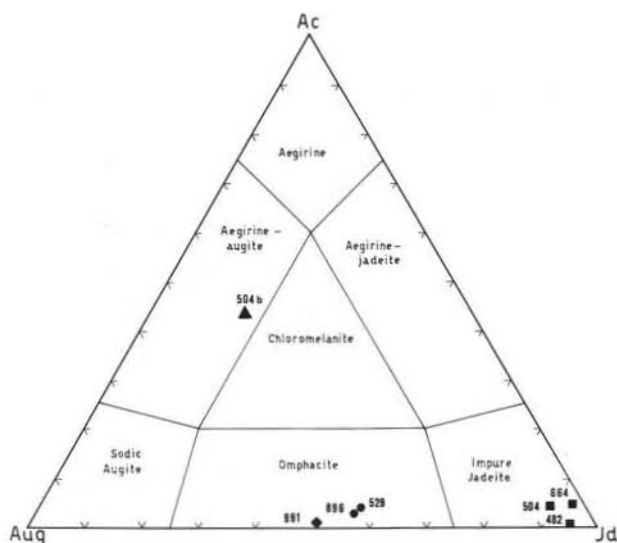


Fig. 2. — Composition of the pyroxenes from Quassolo-Quincinetto in terms of the end-member molecules jadeite (Jd), acmite (Ac), diopside+hedenbergite+tschermakite (Aug). Pyroxenes from meta-aplites and jadeite-micaschist are represented by squares, pyroxenes from the metatonalite and the cognate inclusion by dots, pyroxene from the marble by diamond, and the Ac-rich pyroxene by triangle. Pyroxene composition fields after ESSENE and FYFE (1967).

(Fig. 2) the classification of ESSENE and FYFE (1967) has been followed: pyroxenes SL 664, 482 and 504a plot in the field of impure jadeite, SL 529, 896 and 991 of omphacite. The jadeite molecule is 90-95% in the jadeites, 50-57% in the omphacites; in both the acmite component is very low (3-5%). The Ac-rich pyroxene forming from

the breakdown of jadeite SL 504a has the molecular composition $Jd_{16}Ac_{44}Di_{25}Hd_{15}$ and plots in the middle of the aegirine-augite field, thus differing significantly from previously reported secondary pyroxenes (LIEBEAUX, 1975), which have less Ac (20-25%) and more Jd (30-35%) and plot in the chloromelanite field close to the omphacite-chloromelanite boundary.

Unit-cell parameters

Unit-cell dimensions of the pyroxenes are listed in table 4. Unit-cell parameters were calculated by least-squares refinement of data from X-ray powder patterns (CuK_{α} rad.). 20 to 30 unambiguously indexed reflections were measured; standard deviations average 0.0016 for a, b, c and 0.03' for β .

TABLE 4

Unit-cell parameters of the jadeites and omphacites from lower Val d'Aosta

	SL664	SL482 ^b	SL504	SL529	SL896	SL991
a (Å)	9.431 (2) ^a	9.434 (1)	9.452 (2)	9.556 (2)	9.546 (2)	9.557 (1)
b (Å)	8.579 (2)	8.576 (1)	8.597 (1)	8.761 (2)	8.757 (2)	8.758 (1)
c (Å)	5.227 (1)	5.229 (1)	5.232 (1)	5.257 (1)	5.253 (1)	5.256 (5)
β (°)	107.57(3)	107.61(2)	107.50(2)	106.99(4)	106.96(4)	106.96(2)
V (Å ³)	403.20	403.22	405.43	420.90	420.00	420.82

a) Numbers in parentheses represent standard deviations in final figures.

b) Cell parameters from ANDREOLI et al. (1976).

The unit-cell dimensions of jadeites SL 664 and 482 are comparable to those ($a = 9.439 \pm 1 \text{ \AA}$; $b = 8.5846 \pm 4 \text{ \AA}$; $c = 5.226 \pm 2 \text{ \AA}$; $\beta = 107^{\circ}27.5' \pm 0.9'$; $V = 404.0 \text{ \AA}^3$) of the Manzanal jadeite ($Jd_{94.5}Ac_{0.8}Di_{4.6}Hd_{0.4}$) analysed by McBIRNEY et al. (1967). Omphacites SL 529, 896 and 991 have parameters very close to the Kaminaljuyù (CLARK and PAPIKE, 1968) and Puerto Cabello (CLARK et al., 1969) omphacites. Also two omphacites from the Sesia-LANZO ZONE (EDGAR et al., 1969, Table III, ns. 21 and 22) and the one studied by OGNIBEN (1968) show unit-cell dimensions close to those of SL 529, 896 and 991. These data are in good agreement with compositions obtained from chemical analysis since all these omphacites fall in the narrow compositional range $Jd_{49-57}Ac_{2-6}$.

In Fig. 3 unit-cell parameters of the studied pyroxenes are plotted versus the jadeite content (1). The other data on sodic pyroxenes from the Sesia-Lanzo Zone (OGNIBEN, 1968; EDGAR et al., 1969) are also plotted for comparison. It is worth

(1) The Ac and Hd components were added to Di since the amounts of these molecules are small and the error in their determination large. Furthermore, these components appear to have opposite effects on the parameters of clinopyroxenes in the Jd-Di series.

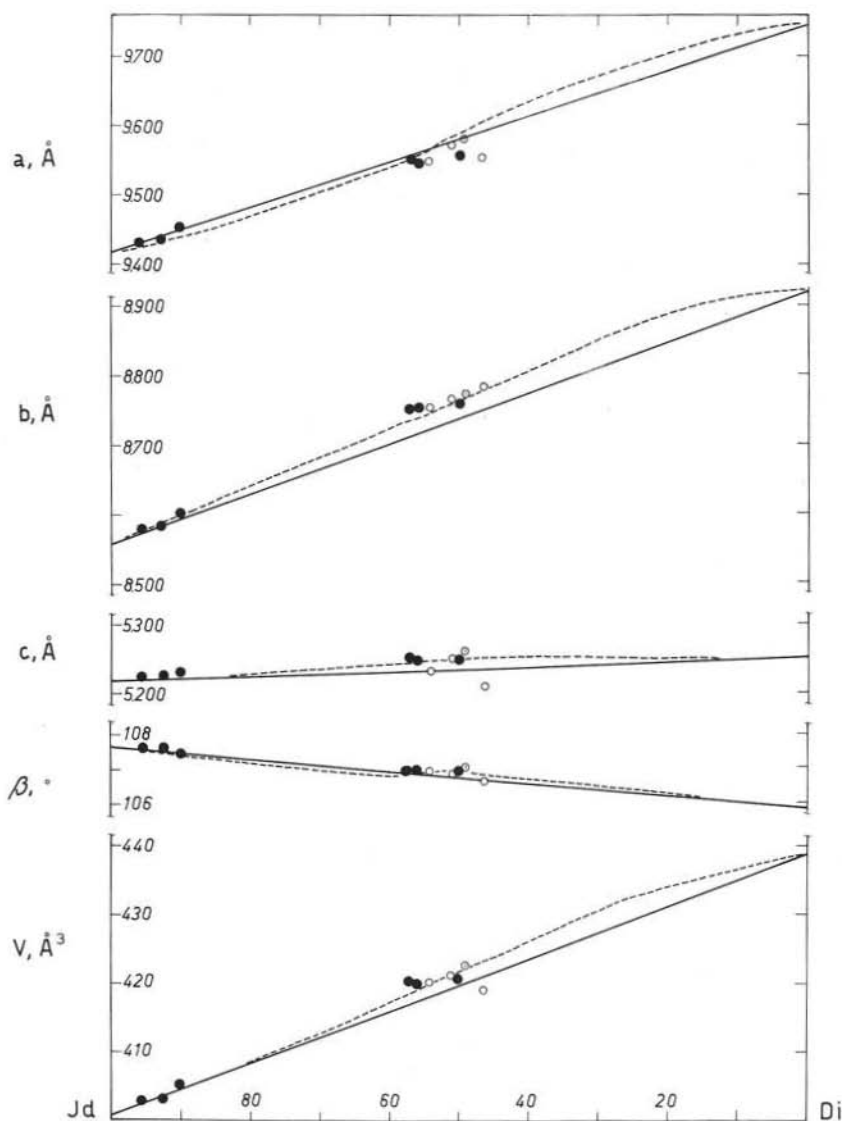


Fig. 3. — Unit-cell parameters of jadeites and omphacites from the Sesia-Lanzo Zone plotted against Jd content. Solid dots are results of this study, open dots from EDGAR et al. (1969), circled points from OGNIBEN (1968). The dotted lines are the variation curves obtained by KUSHIRO (1969) on synthetic sodic pyroxenes. The straight lines connect the parameters of pure jadeite and diopside.

noting that the omphacites fit better the correlation curves obtained by KUSHIRO (1969) on synthetic material than a linear relation as suggested for the b parameter by EDGAR et al. (1969).

Bulk chemistry of the host rocks

Chemical analyses of the eclogitic schists from lower Val d'Aosta are presented in Table 5. The analyses of rocks SL 664 and SL 482 are the first available for the jadeite-bearing meta-aplites of the Sesia-Lanzo Zone; both are low in FeO, MgO, CaO and high in silica and alkalis, but SL 482 is low in potash and has $\text{Na}_2\text{O} > \text{K}_2\text{O}$, whereas the K-feldspar-bearing SL 664 is higher in potash and has

TABLE 5

Chemical composition of the eclogitic schists from lower Val d'Aosta*

	SL664	SL482	SL504	SL529	SL896
SiO ₂	74.43	71.71	72.35	64.78	56.02
TiO ₂	0.13	0.19	0.22	0.73	0.76
Al ₂ O ₃	13.44	15.52	14.35	15.18	14.10
Fe ₂ O ₃	0.18	0.60	0.88	0.51	2.40
FeO	1.36	1.76	1.33	4.70	3.87
MnO	0.01	0.01	0.01	0.08	0.02
MgO	0.93	0.78	0.80	2.48	5.35
CaO	0.56	0.81	0.81	4.22	8.67
Na ₂ O	3.38	5.30	5.47	3.12	5.89
K ₂ O	4.72	1.89	1.91	2.69	1.22
P ₂ O ₅	0.26	0.32	0.24	0.24	0.11
H ₂ O ⁺	0.98	1.14	1.06	1.54	1.00
Total	100.38	100.03	99.43	100.27	99.41

* SiO₂, TiO₂, Al₂O₃, total Fe as Fe₂O₃, CaO and K₂O determined by X-ray fluorescence; FeO, MgO, MnO, Na₂O, P₂O₅ and H₂O⁺ by standard wet methods. Analyst: L. Fiora.

$\text{K}_2\text{O} > \text{Na}_2\text{O}$. The composition of the eclogitic metatonalite SL 529 is very close to that of the Lillianes metatonalite (CALLEGARI et al., 1976), which also shows a similar mineralogy, but is somewhat higher in K₂O than the latter. Bulk chemistry of the cognate inclusion in the metatonalite, on the contrary, is rather different from that of the two inclusions analysed by CALLEGARI et al., which however occur in rocks of different composition (metagranodiorites).

Comparison between the jadeite- and omphacite-bearing rocks shows that the former (SL 664, 482 and 504) are poorer in FeO, MgO, CaO and have more silica than the latter (SL 529 and 896). Al₂O₃, Na₂O and K₂O are not significantly different in the two groups, excepting meta-aplite SL 664. These relations may be illustrated by a FMA triangle (Fig. 4). In this diagram the analysed rocks fall in two groups: the jadeite-bearing rocks plot near the A apex, whereas the rocks with omphacite

plot in the centre of the triangle. The same chemical relations are shown by the jadeite- and omphacite-bearing schists analysed by LIEBEAUX (1975), which, however, are from a much wider area than the one considered here.

In Fig. 4 the compositional field of all the omphacite-bearing rocks from the Sesia-Lanzo Zone (eclogites, glaucophanites, micaschists) has been shown for comparison. It is worth noting that compositions appropriate for omphacite appear to be rather common, occurring in a spectrum of lithologies ranging from micaschists to eclogites, whereas compositions producing jadeite are found only in a narrow range of lithologies.

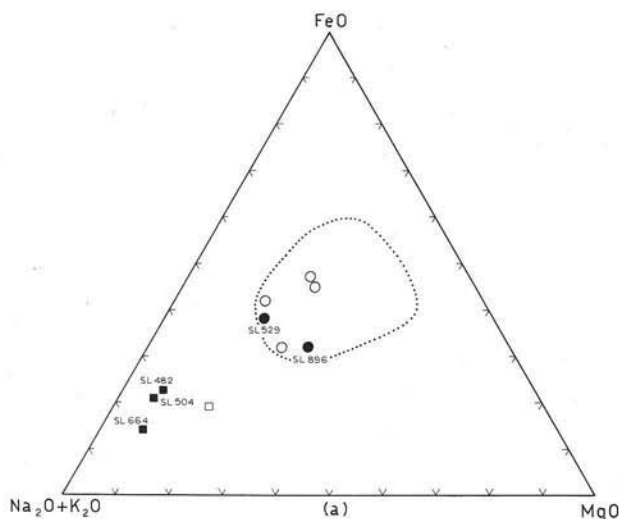


Fig. 4. — FMA diagram of the eclogitic schists from Quassolo-Quincinetto. Total iron expressed as FeO. Squares, jadeite-bearing rocks; dots, omphacite-bearing schists. Solid symbols, analyses from this study; open symbols, data from the whole Sesia-Lanzo Zone (LIEBEAUX, 1975). The dotted line encloses the compositional field of all the omphacite-bearing rocks of the Sesia-Lanzo Zone.

Correlation of pyroxene composition with bulk chemistry of the host rocks

In lower Val d'Aosta jadeite- and omphacite-bearing schists appear to be closely associated in the field; in particular jadeite-bearing meta-aplite SL 482 occurs only 200 meters from omphacite-bearing metatonalite SL 529 (Fig. 1). Occurrences like this are very common throughout the Sesia-Lanzo Zone and show all the indications of having recrystallized under the same physical conditions, so that the very different Jd content of their pyroxenes cannot be explained by variation in pressure or grade of metamorphism. Moreover, petrographical evidence shows that both jadeite and omphacite formed in the same episode of the early-Alpine event, whereas albite formed only later from destabilization of the sodic pyroxenes and is in obvious textural disequilibrium with them. The different bulk chemistry of

the jadeite- and omphacite-bearing schists (Table 5 and fig. 4) suggests on the contrary that compositional variation in these pyroxenes may be related to differences in the bulk chemistry of the host rocks.

Since the analysed pyroxenes are essentially solid solutions of Jd and (Di + Hd) compositional variation in this group may be represented by the ratio $\text{Na}/(\text{Na} + \text{Ca})$, i.e. by the occupancy of the M2 site. In fig. 5 the $\text{Na}/(\text{Na} + \text{Ca})$ ratios of the pyroxenes from lower Val d'Aosta are plotted versus $\text{Na}/(\text{Na} + \text{Ca})$ in the host rocks ⁽²⁾. All the points plot slightly above the line which indicates equal $\text{Na}/(\text{Na} + \text{Ca})$ ratios in the clinopyroxene and in the rock. This relation is obvious

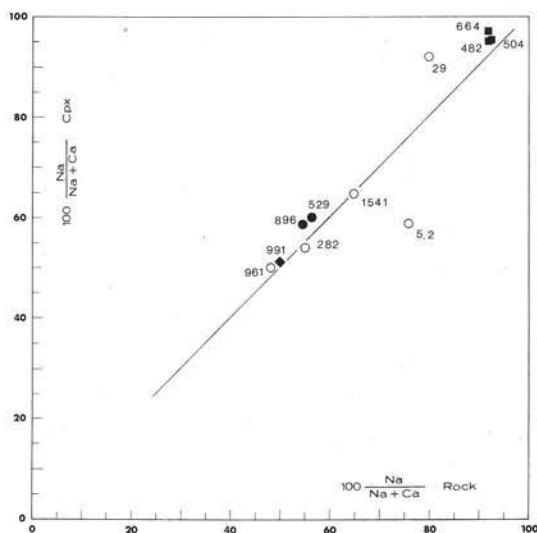


Fig. 5. — $\text{Na}/(\text{Na} + \text{Ca})$ ratios (number of cations) in sodic pyroxenes and in eclogitic schists from lower Val d'Aosta. Symbols as in fig. 2. The data on sodic pyroxenes and eclogitic micaschists from the whole Sesia-Lanzo Zone (LIEBEAUX, 1975) are indicated by open points. The straight line indicates equal $\text{Na}/(\text{Na} + \text{Ca})$ ratios in the pyroxene and in the rock.

for the rocks where clinopyroxene is the only major Ca-Na phase, but appear to be valid also for the rocks where other phases containing Na (glaucophane) and Ca (garnet) occur in addition to clinopyroxene (SL 529, 896), suggesting that partition of Ca and Na among coexisting phases maintains the ratio $(\text{Na}/\text{Na} + \text{Ca})_{\text{cpx}}/(\text{Na}/\text{Na} + \text{Ca})_{\text{rock}}$ close to 1.

$\text{Na}/(\text{Na} + \text{Ca})$ ratios in clinopyroxenes and host rocks analysed by LIEBEAUX were also plotted in fig. 5. Also these eclogitic schists, with one exception possibly due to the large amount of glaucophane (5.2), plot on the line which indicates equal $\text{Na}/(\text{Na} + \text{Ca})$ ratios in the clinopyroxene and in the rock.

⁽²⁾ Only the amounts of CaO (2.92 %) and Na_2O (1.60 %) in the insoluble residue were considered in calculating the $\text{Na}/(\text{Na} + \text{Ca})$ ratio of the marble from Quassolo (SL 991).

Conclusions

The results here reported can be summarized as follows:

- 1) Jadeite content of the analysed jadeites and omphacites is related to the bulk chemistry of the host rocks.
- 2) Textural evidence confirms that these pyroxenes are not in equilibrium with albite.
- 3) A pyroxene of aegirine-augitic composition in equilibrium with albite develops in a later phase from destabilization of jadeite.

These results show that the variations in jadeite content of the jadeites and omphacites do not result from variations in P-T conditions within the eclogitic micaschists but from differences in the bulk chemistry of the host rocks. If the amount of jadeite molecule in the first-phase pyroxenes cannot be used as a geobarometer, the occurrence of nearly pure jadeite in equilibrium with quartz, however, shows that the eclogitic micaschists of the Sesia-Lanzo Zone must have recrystallized under very high lithostatic pressures, in excess of 15-16 Kb according to the experimental data on the equilibrium $Ab \rightleftharpoons Jd + Qz$ (JOHANNES *et al.*, 1971; HAYS and BELL, 1973) and assuming temperatures estimates of 500-600° C based on mineral compatibilities (COMPAGNONI, this volume), O_{18}/O_{16} ratios in coexisting minerals (DESMONS and O'NEIL, 1977), and distribution coefficients between garnet and clinopyroxene (DESMONS and GHENT, 1977).

Unlike the first-phase pyroxenes, the Ac-rich pyroxenes forming from destabilization of jadeite appear to be in equilibrium with albite and their Jd content might give informations about the physical conditions during the last phases of the early-Alpine event. By comparing the composition of these pyroxenes with the experimental and calculated curves on the solubility of jadeite in diopside and aegirine as function of pressure and temperature (ESSENE and FYFE, 1967; WIKSTRÖM, 1970; POPP and GILBERT, 1972) pressures could be estimated if temperatures were known.

Such an estimate, however, would be fraught with uncertainties arising from several sources:

- a) the Ac-rich pyroxenes are not binary but quaternary solutions (Ac + Di + Jd + Hd) and interpolation between the solubility curves Jd-Di and Jd-Ac is necessary; moreover, the influence of the Hd component on the solubility is unknown;
- b) these pyroxenes appear to be strongly zoned;
- c) other sodic phases (glaucophane, paragonite) form from the destabilization of jadeite;
- d) data for a precise estimate of temperatures during the last phases of the early-Alpine event are still lacking.

Anyway, the composition of the sodic pyroxenes coexisting with albite in the eclogitic micaschists suggests that the last phases of the early-Alpine event occurred

under lithostatic pressures significantly lower than those of the earlier phases but still corresponding to low geothermal gradients. This result is consistent with the overall trend of the early-Alpine event inferred from petrological observations.

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