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Chemistry of mesozoic metabasites in the middle and eastern part of the Hohe Tauern

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With 7 Figures

Zusammenfassung

Haupt- und Spurenelementgehalte von Metabasiten (Eklogite, Metabasalte, Metagabbros) verschiedener Vorkommen der Mittleren und Östlichen Hohen Tauern charakterisieren zwei große Metabasit-Gesteinszüge (I und II in Fig. 1) als Ozeanboden-Basalte. Ein dritter Gesteinszug (III) weist teilweise tholeiitischen, teilweise alkalibasaltischen Charakter auf. Kleinere Vorkommen von Metabasiten in der Fuscher Fazies zeigen Merkmale von „within plate"-Basalten.

Summary

Major and trace element analyses of metabasites (eclogites, metabasalts, metagabbros) from different parts of the middle and eastern section of the Hohe Tauern indicate strong oceanic affinities for two large metabasic bodies (I and II in fig. 1). Ambiguous results, tholeiitic as well as alkalibasaltic affinities, characterize a third body (III) while small occurrences of metabasites in the Fusch facies resemble within-plate-basalts.

Introduction

The mesozoic sedimentary sequence of the Hohe Tauern is closely associated with ultrabasic and basic rocks (Bündnerschieferserie by FRASL, 1958, and FRASL & FRANK, 1966). Simplified, three large elongated bodies accompanied by smaller layers may be distinguished (fig. 1).

The first one (I) is situated in the southern part of the Tauern window approximately between Umbal-valley (Osttirol) in the west and Heiligenblut (Möll-valley, Carinthia) in the east. It is associated with eclogitic rocks (cf. MILLER, this volume) and may be genetically and structurally related with the second body (II) in the northern escarpment extending from the Stubach-valley in the west across the Kitzsteinhorn area to the Seidlwinkl-valley east of the Fuschertörl.

Ranging from Fuscher-valley a third (III) layer can be recognized.

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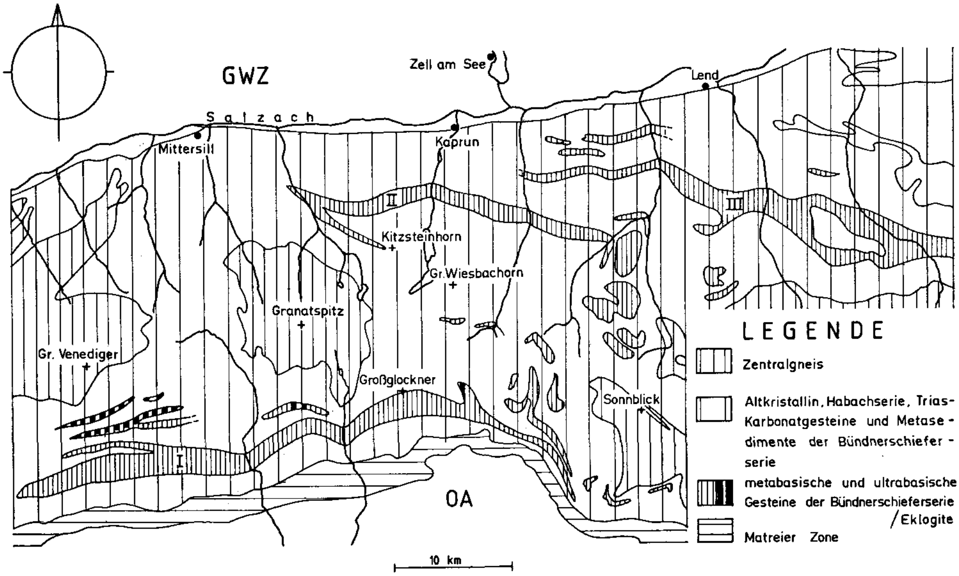


Fig. 1: Simplified geological sketch map of the middle part of the Hohe Tauern, Nr. I, II, III refer to large metabasic and ultrabasic bodies.

Whereas these large basic masses are mainly associated with pelitic and carbonaceous sediments (Glockner facies) the more clastic series (Fusch facies, Brennkogel facies) contain only relativly small occurrences of metabasic rocks.

Except for the eclogitic rocks (eg. MILLER, 1977, RAITH et. al., 1977) and their associated metavolcanics (prasinites) only few chemical data have been reported so far from the middle part of the Hohe Tauern (BICKLE and PEARCE, 1975). Here the results of 51 analyses of major elements carried out by atomic absorption spectrophotometry and solution photometry, as well as 20 XRF analyses of the trace elements (Y, Zr, Nb, Cr) of prasinites and metagabbros from all three metabasic bodies are presented.

Primary, magmatic textures and/or minerals are only occasionally preserved, for example some pillow or gabbroic textures (cf. MILLER, this volume) in eclogites and prasinites or sometimes brown amphiboles or diopsidic clinopyroxenes in coarse grained metavolcanics in the Fusch facies. Generally all rocks are completely altered to eclogites (eg. MILLER, 1977) or prasinites (CORNELIUS and CLAR, 1939). Nevertheless a few coarse prasinites might be assigned to gabbros and ferrogabbros ("Gabbroamphibolit" and "Epidotamphibolit" by CORNELIUS and CLAR, 1939). In any case the gabbros are closely connected with serpentinites and metavolcanics.

Metagabbros

Compared with the metabasalts all gabbro-types are low in P_2O_5 (0.01–0.1%), Al_2O_3 (8.5–15%) and Na_2O (0.5–2.5%). The metaferrogabbros are rich in iron (12–16.5% Fe_2O_3 as total Fe) and TiO_2 (2–7.2%) (cf. MOTTANA and

BOCCHIO, 1975). The leucocratic metagabbros are low in TiO_2 (< 1.5%) and high in MgO (7.5–18.5%).

Metabasalts

The chemistry of prasinites resembles basaltic compositions with a variation of SiO_2 between 45 and 52 weight%. Total iron (Fe_2O_3) and CaO range from 6 to 12%, while Na_2O rarely exeeds 4%. K_2O is generally below 0.5%, P_2O_5 varies from 0.1 to 0.3% and TiO_2 ranges from 1.5 to 2%. There is no obvious change in composition with increasing grade of metamorphism and thus probably no substantial change of bulk chemistry due to the Alpine regional metamorphism.

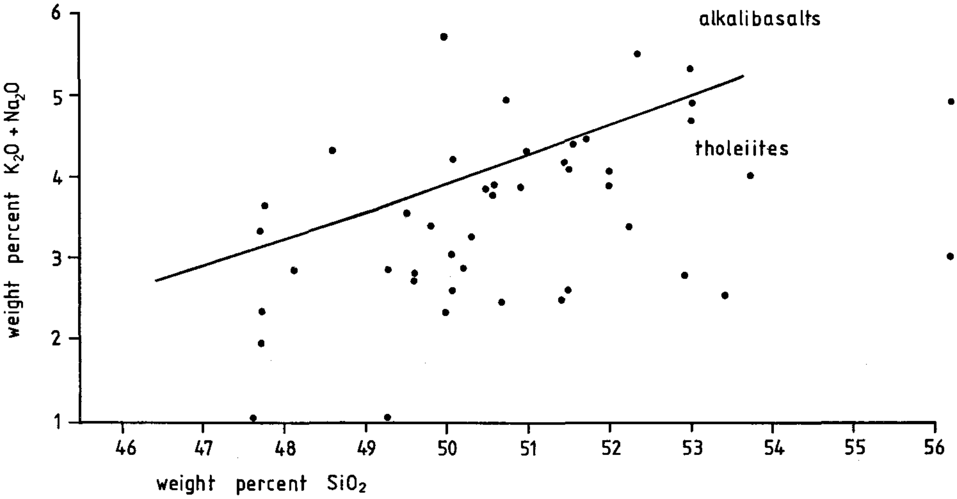


Fig. 2: Alkali vs silica diagram (McDONALD and KATSURA, 1964). Only analyses of prasinites are considered; they are plotted on an anhydrous basis.

A first inspection of the alkali vs silica diagram (McDONALD and KATSURA, 1964) in fig. 2 shows, that most of the analyses (constituents normalized to 100%, COLEMAN, 1977) fall well within the tholeiitic field. Calculation of the CIPW norm on the basis: $Fe_2O_3 = 1.5$ weight% (KAY et. al. 1970) shows, that most of the prasinites are hypersthene or even quartz normative tholeiites while only few yield nepheline in the norm and should therefore be regarded as alkalibasalts.

It is well known, that basalts might be subject to subsea weathering (REED and MORGAN, 1971, WOOD et. al. 1976) and/or ocean floor metamorphism (MIYASHIRO, 1972) which causes extended alteration in major element chemistry. However, some minor elements, Ti, P and trace elements like Nb, Y, Zr, Cr are believed to be immobile during alteration processes and therefore possibly potential tools for magma discrimination (PEARCE and CANN, 1973, PEARCE, 1975, FLOYD and WINCHESTER, 1975, WINCHESTER and FLOYD, 1976).

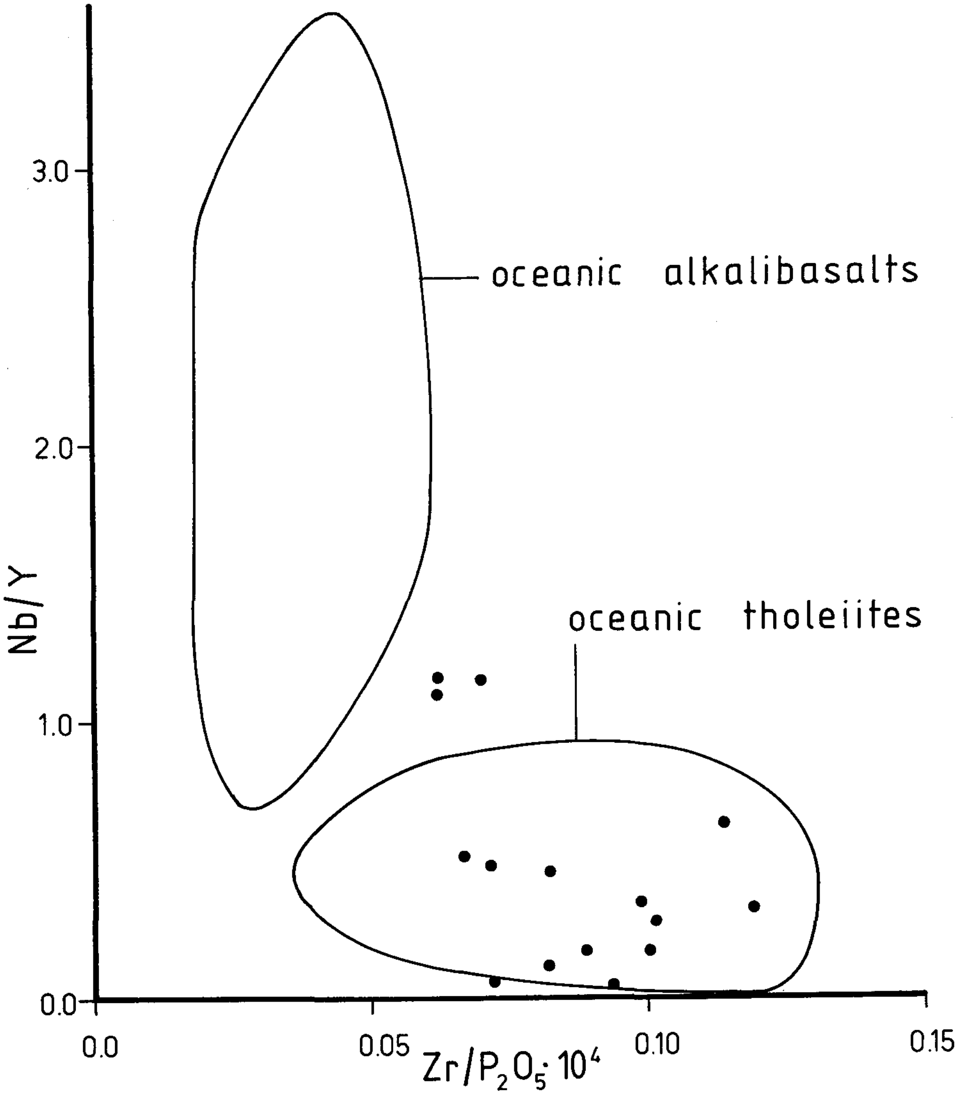


Fig. 3: Nb/Y vs Zr/P_2O_5 diagram (FLOYD and WINCHESTER). The prasinites of layer I and II and partly III fall well within the field of oceanic tholeiites. Analyses of prasinites from the Fusch facies and partly layer III plot between the oceanic alkalibasalt- and oceanic tholeiite field.

Zr/Tix 100^{-2}/Yx 3, Ti vs Zr and Ti vs Cr diagrams (PEARCE and CANN, 1973, PEARCE, 1975) and Nb/Y vs Zr/P_2O_5 diagram (FLOYD and WINCHESTER, 1975, WINCHESTER and FLOYD, 1976) have been used to discriminate between different types of prasinites. Samples from the first (I) and second (II) prasinite body show clearly tholeiitic affinities not only with major elements but also using the FLOYD & WINCHESTER diagram (fig. 3) and

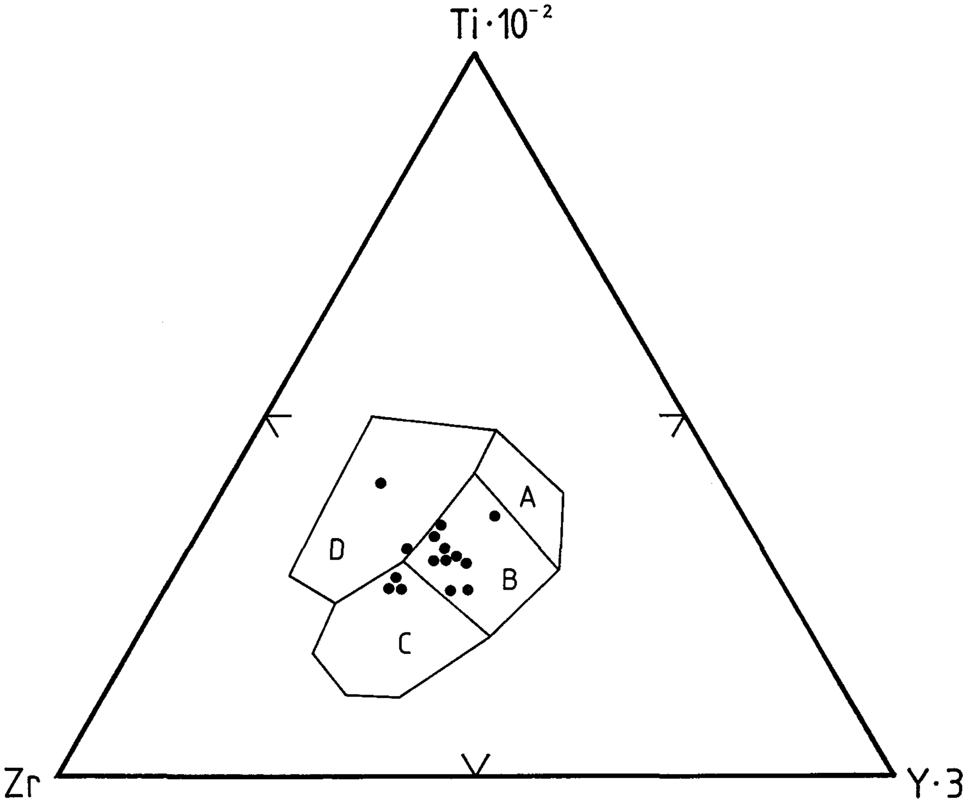


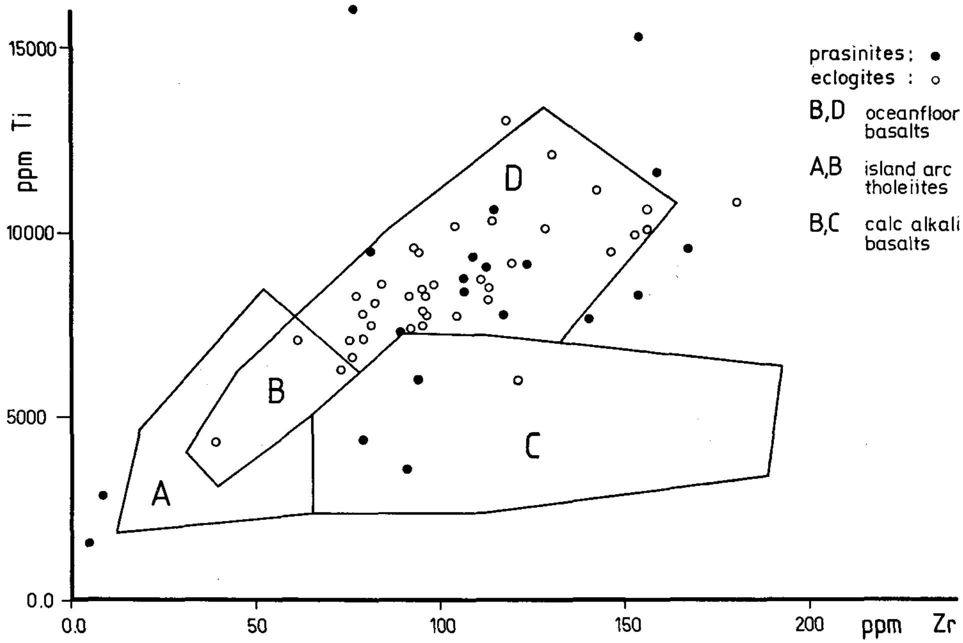
Fig. 4: The Ti-Zr-Y diagram distinguishes between low K-tholeiites (A), ocean floor basalts (B), calc alkalic tholeiites (C) and within-plate-basalts (D). Analyses from the Fusch facies and some from layer III plot in field D and C, all analysed metabasalts from body I and II and few of III plot in the ocean floor field.

fall well within field B (ocean-floor basalt field) of the Ti-Zr-Y diagram of PEARCE & CANN (fig. 4). The same holds for the Ti vs Zr and Ti vs Cr diagram (fig. 5, 6).

More alkalic character is assigned to prasinites from the Fusch facies by Nb/Y vs Zr/P_2O_5 diagram (fig. 3). They plot in field D and C in the Ti-Zr-Y-diagram (fig. 4) i. e. in the field of within plate basalts (ocean-island basalts?) and island-arc tholeiites which is at least partly in agreement with the results of BICKLE and PEARCE (1973). Systematic sampling would be necessary to elucidate the genetic relationships in the third metabasic body (III) from Fusch-Rauris-Gastein-Hüttschlag, which consists of several units and shows ambiguous trends comprising tholeiitic basalts as well as alkalibasalts.

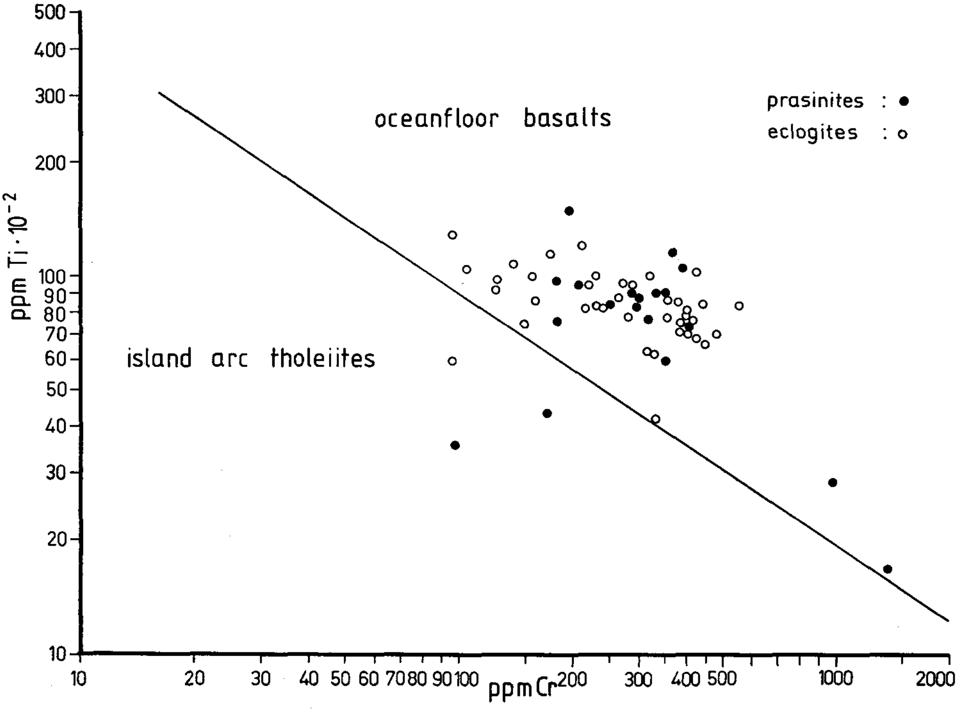
Eclogites

The following discussion is based on major element fluorescence analyses of 62 eclogites and related rocks, 53 of which have been published elsewhere



15000
10000
5000
0.0
ppm Ti
0.0
50
100
150
200
ppm Zr
A
B
C
D
prasinites: ●
eclogites : ○
B,D oceanfloor basalts
A,B island arc tholeiites
B,C calc alkali basalts

Fig. 5



500
400
300
200
100
90
80
70
60
50
40
30
20
10
ppm Ti · 10⁻²
10
20
30
40
50
60
70
80
90
100
200
300
400
500
1000
2000
ppm Cr
oceanfloor basalts
island arc tholeiites
prasinites : ●
eclogites : ○

Fig. 6

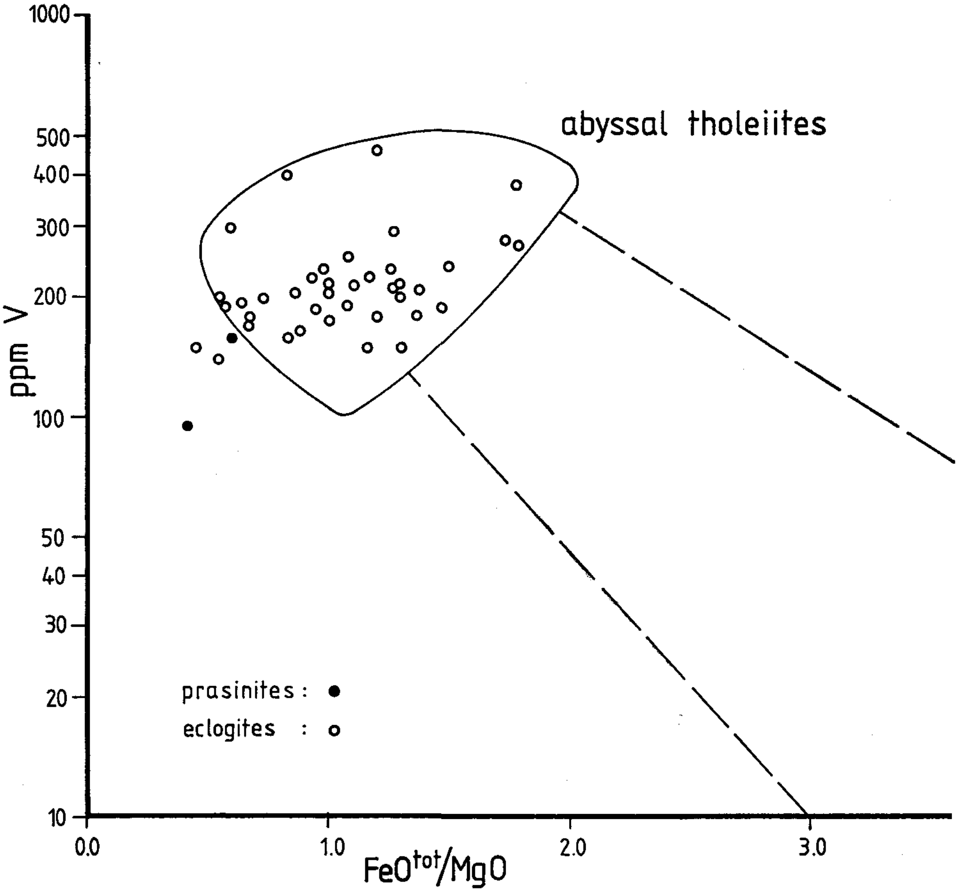


Fig. 7: Variation of vanadium content with increasing FeO/MgO in Tauern eclogitic rocks. The abyssal tholeiite field is taken from MIYASHIRO and SHIDO (1975).

(MILLER, 1977; cf also RAITH et al., 1977) and on a new set of trace element data. As discussed previously, oceanfloor metamorphism, sub-sea weathering, admixture of sedimentary material and metamorphic processes (COLEMAN et. al., 1965) often tend to obscure the nature of the original magma. Bearing this in mind, the major element affinities of the Tauern eclogites with alkali and high-alumina basalts are probably apparent rather than real, because an evaluation of the relatively immobile trace element concentrations (FLOYD and WINCHESTER, 1975, WINCHESTER and FLOYD, 1976) clearly shows their tholeiitic

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Fig. 5: Ti-Zr diagram; most analyses of prasinites and eclogites plot within the field of ocean floor basalts, analyses plotting outside field B and D belong to all three metabasic layers.

Fig. 6: Ti-Cr diagram showing discrimination between ocean floor basalts and island-arc tholeiites (PEARCE, 1975). Almost all analyses of eclogitic and prasinitic rocks plot within the ocean floor field.

character (MILLER, 1974, 1977). Moreover, as evident from the use of PEARCE and CANN's (1973) Ti-Zr-, of PEARCE's (1975) Ti-Cr and of MIYASHIRO and SHIDO's (1975) discrimination diagrams (fig. 5, 6, 7) these eclogitic rocks seem to represent oceanfloor basalts.

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