

White's clinopyroxene diagram applied to the differentiation of the eclogite and granulite facies

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К проблематике применения диаграмма Уайте (White) клинопироксенов для отличия эклогитовой и гранулитовой фации.

При сравнении химизмов клинопироксенов (омфацитовых салитов) из омфацитовых гранулитов в Чешском массиве была применена диаграмма Уайте с целью выяснения метаморфной фации. Было утверждено мнение, что диаграмм клинопироксенов Уайте (Уайте, 1964) для отличия их возникновения в гранулитовой или эклогитовой фации имеет ограниченное употребление. Омфацитовые гранулиты содержат большое количество ядеитовой молекулы, что не отвечает результатам диаграммы Уайте. Для отличия гранулитовой фации от фации эклогитовой является выгоднейшим установление соотношения $\text{FeO} : \text{MgO} : 2 \text{Na}_2\text{O}$ или $\text{Mg} : \text{FeO} : \text{CaO}$ пироксенов.

White's clinopyroxene diagram applied to the differentiation of the eclogite and granulite facies

White's clinopyroxene diagram has been tested for differentiating the granulite and eclogite metamorphic facies in the Bohemian Massif. It has been stated, however, that the omphacite granulites have clinopyroxenes with a large content of jadeite molecule, which does not agree with White's diagram. The validity of White's diagram is obviously limited. More suitable for differentiating the granulite and eclogite facies using the chemistry of pyroxenes is the $\text{FeO} : \text{MgO} : 2 \text{Na}_2\text{O}$ or $\text{FeO} : \text{MgO} : \text{CaO}$ diagram.

A. J. R. White (1964) proposed the possibility of distinguishing between the eclogite and the granulite facies on the basis of the content of jadeite and Tschermak molecules in clinopyroxenes. From the

presented diagram it follows that omphacites do not exist in granulites. In examining an orthopyroxene-bearing granulite from the borehole near Tirschheim in the Saxonian Granulitgebirge (Mathé, 1969)

noted the presence of omphacite and questioned the validity of White's diagram. He emphasized that to differentiate eclogites and granulites according to the composition of clinopyroxenes, the Fe/Mg ratio is much more important than the Na content. J. Fiala et al., (in print) found omphacites in dark granulites near Nové Vilémovice in the Rychlebské hory Mts. These omphacite-bearing granulites accompanied by predominating light-coloured "acid" granulites extend from Czechoslovakia to the Gieraltów area in Poland, where they were described in detail by (Kozłowski, 1965), (Smulikowski and Bakun-Czubarowa, 1973). They were assigned by these authors to a transitional facies between granulites and eclogites, and in 1980 Smulikowski used the term omphacite granulite for them, but only in parentheses. The third occurrence of omphacite granulite in the Bohemian Massif was assessed by Paděra in the Čáslav crystalline complex near Běstvina in the Železné hory Mts. (Dudek — Fediuková, 1974) considered the Běstvina omphacite granulite to be an eclogite. All these omphacite granulites are accompanied by predominant light-coloured "acid" granulites (see Mathé, 1969, Matějovská, 1970, Zoubek et al., 1977, etc.).

The omphacite granulites contain major amounts (15–30 %) of primary plagioclase (oligoclase — andesine) and quartz (15–20 %). Potassium feldspar is absent or present in a small amount. Other essential components are metacrystals (poikiloblasts) of garnet (20–35 %) and omphacite (20–50 %). It is the presence of a major amount of primary plagioclase that distinguishes the pyroxene and omphacite granulites from eclogites in which a considerable content of primary plagioclase is exceptional.

Chemical analyses of omphacites from the omphacite granulites of the Bohemian

Massif are given in Table 1. They are taken from the papers of (Kozłowski, 1965), (Mathé, 1969), (Smulikowski and Bakun-Czubarowa, 1973), (Dudek — Fediuková, 1974), (Fiala — Paděra, 1981). The clinopyroxenes analyzed contain 2.8 to 5.1 Na₂O and White's diagram projects them to the field of eclogites (Fig. 1). The question arises whether this diagram is only of partial validity, or whether the rocks are eclogites or, possibly, rocks formed in the transitional granulite-eclogite facies. The presence of accompanying light-coloured granulites, which have been formed in conditions of the granulite-facies or transitional between the amphibolite and the granulite facies, provides evidence

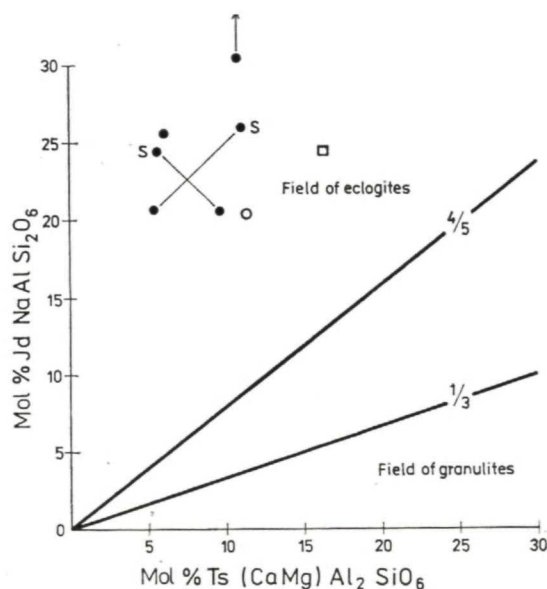


Fig. 1. White's diagram of clinopyroxenes for the distinction of eclogite and granulite metamorphic facies. Projections of clinopyroxenes from omphacite granulites of the Rychlebské hory Mts. are marked by small full circles. Straight lines connect centres of the analyzed omphacite grains (marked S) with grain margins. The open circle corresponds to omphacite from Tirschheim and open square to omphacite from Spačice

Chemical analyses of clinopyroxenes (omphacites) from omphacite granulites of the Bohemian Massif

Tab. 1

Analyst	Tirschheim	Spačice	Kozłowski	Rossol	Rychlebské hory Mts.			
	Posner	Fediuková*			Fiala*	centre	margin	centre
						margin		margin
SiO ₂	50.0	50.41	52.76	51.49	51.91	53.40	53.35	52.39
TiO ₂	1.9	3.09 ?	0.23	0.48	0.66	0.46	0.56	0.52
Al ₂ O ₃	8.8	11.64	8.11	11.80	11.13	6.33	8.49	8.30
Fe ₂ O ₃	0.4	—	1.88	1.36	—	—	—	—
FeO	9.4	9.03	6.50	7.02	7.32	3.01	7.01	7.27
MnO	0.2	—	0.02	0.06	0.06	0.05	0.08	0.06
MgO	9.0	8.10	8.81	8.45	8.77	10.44	10.18	10.56
CaO	15.6	14.58	17.90	13.26	16.41	18.40	16.97	18.06
Na ₂ O	2.8	3.34	3.58	5.11	3.82	2.93	3.41	3.00
K ₂ O	0.3	—	0.37	0.12	0.01	0.01	0.00	0.01
	98.4	100.19	100.16	99.15	100.09	100.58	100.05	100.17
Si	1.89	1.84	1.94	1.89	1.89	1.95	1.95	1.91
Al (IV)	0.11	0.16	0.06	0.11	0.11	0.05	0.05	0.09
Al (VI)	0.28	0.34	0.29	0.41	0.37	0.25	0.32	0.27
Ti	0.05	0.09	0.01	0.01	0.02	0.01	0.02	0.01
Fe ³⁺	0.01	—	0.05	0.04	—	—	—	—
Fe ²⁺	0.30	0.28	0.20	0.22	0.22	0.25	0.21	0.22
Mn	0.01	—	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.51	0.44	0.48	0.46	0.48	0.57	0.55	0.57
Ca	0.63	0.57	0.70	0.52	0.64	0.72	0.66	0.71
Na	0.20	0.24	0.26	0.36	0.27	0.21	0.24	0.21
K	0.01	—	0.02	0.01	0.00	0.00	0.00	0.00

* determined by electron microprobe
all Fe determined as Fe²⁺

that the omphacite granulites themselves also originated in granulite facies conditions. The solution to the problem of whether or not the rocks in question should be assigned to the granulite facies is facilitated by using the triangular diagram of Mg, Fe and Na oxides in clinopyroxenes from the omphacite granulites described from the Bohemian Massif. The comparison of the composition of clinopyroxenes from the eclogites of adjacent areas, i. e. the Góry Snieżnickie Mts. in Poland, and in the Moravian and Bohemian parts of the Moldanubicum (Fig. 2) is also useful. The twofold exaggeration of the sodium content was chosen so as to enhance the differences between the

clinopyroxenes. Partial chemical analyses of clinopyroxenes from the eclogites of the Góry Snieżnickie were taken from the paper of (Smulikowski, 1967) and chiefly from that of (Bakun-Czubarowa, 1968), where 36 partial analyses of clinopyroxenes from the eclogites at the Nowa Wies locality are given. Chemical analyses of clinopyroxenes from the eclogitic rocks (griquaite and garnet pyroxenites) of the Bohemian and Moravian parts of the Moldanubicum were taken mainly from the publication of (Dudek — Fediuková, 1974) and completed by data (Paděra, 1971) and many other as yet unpublished chemical analyses. The diagram permits the distinction of clinopyroxenes in omphacite granu-

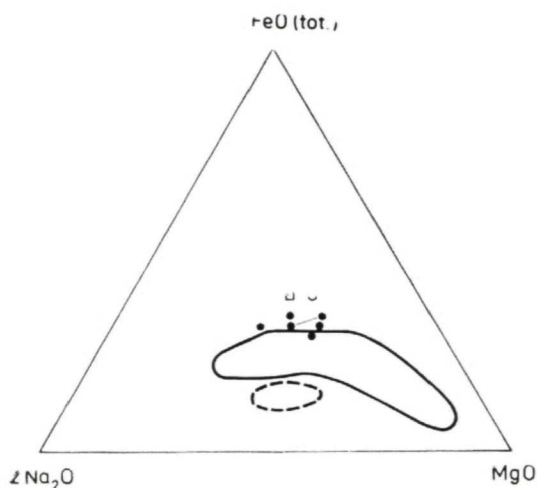


Fig. 2. Comparison of partial analyses of clinopyroxenes from omphacite granulites of the Bohemian Massif with clinopyroxenes from eclogitic rocks (griquailes, garnet pyroxenites) of the Bohemian and Moravian parts of the Moldanubicum (solid line) and with omphacites from eclogites of the Góry Snieżnickie Mts. (dashed line). Full circles represent partial analyses of omphacites from the Rychlebské hory Mts., the small open circle corresponds to omphacite from Tirschheim and the open square to omphacite from Spačice

lites of the Bohemian Massif from those of the eclogitic rocks in the Moldanubicum, and indicates a striking difference between the latter and the eclogites of the Góry Snieżnickie. It also shows that the sodium content in clinopyroxenes is not as important in distinguishing the eclogite facies from the granulites as previously thought. Of primary importance for genetic conclusion is the Fe/Mg ratio in clinopyroxenes, which was also stressed by (Mathé, 1969). White's diagram of clinopyroxenes is obviously only of partial validity for distinguishing the eclogite and the granulite facies.

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