ISOMORPHISM TENDENCIES IN ZONAL AMPHIBOLES FROM SVIDNYA K-ALKALINE MAGMATITES

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Richterite to magnesio-arfvedsonite tendency has been described in amphiboles from Svidnya magmatites (Grozdanov, 1969, 1982; Dyulgerov, 2003). Until now, however, detailed data on the variations in the chemical composition of zonal amphiboles from aegirine-amphibole quartz-syenites (phase III) and amphibole-aegirine syenite porphyries (phase IV) (Dimitrov, 1934; Grozdanov, 1965; Vladykin et al., 2001) have not been published.

The present paper reports results from the studies of amphiboles from three samples: sample No 2 (phase III) – collected from the eastern body; sample No 44 (phase IV) – from the western bank of Svidnya River; and sample No 36b – pegmatoid mineralization (postdating the magmatic crystallization) from the same outcrop. Sample locations are shown in Fig. 1 of Grozdanov (1969). The chemical composition of the studied rocks is given in Table 1.

Results from microprobe analyses and computed structural formulae (Table 2) reveal the following specific features. According to Leake et al. (1997), the chemical compositions of amphiboles from phase III refer to the mineral species richterite and those from phase IV and the pegmatoid mineralization – to magnesio-arfvedesonite. As a whole this confirms the tendency that is already known from the literature.

Table 1. Chemical composition (wt. %) of the studied rocks.

Sam. No	2	44	36[b]
SiO_2	58.55	59.68	73.26
TiO_2	1.50	1.27	2.16
Al_2O_3	9.73	10.08	8.69
Fe_2O_3	4.76	6.70	3.53
FeO	5.72	2.52	1.08
MnO	0.25	0.23	0.34
MgO	4.03	3.75	1.35
CaO	3.28	3.12	1.19
Na_2O	3.42	3.80	1.90
K_2O	6.46	6.98	5.22
P_2O_5	0.88	0.79	0.17
CO_2	<0.03	0.13	<0.03
H_2O^-	0.20	0.16	0.19
H_2O^+	1.10	0.57	0.49
Σ	99.91	99.78	99.60
Ka	1.30	1.34	1.01
Mg#	41.80	43.88	36.10

Table 2. Structural formulae of the studied amphiboles.

Sam. No	2 core	2 med.	2 rime	2 gr. m.	44 core	44 med.	44 rime	44 gr. m.	36[b] core	36[b] med.	36[b] rime
K	0.53	0.35	0.37	0.30	0.52	0.52	0.40	0.43	0.40	0.30	0.36
Na	0.18	0.24	0.34	0.32	0.25	0.37	0.48	0.58	0.57	0.68	0.56
A	0.71	0.59	0.71	0.62	0.77	0.89	0.88	1.01	0.97	0.98	0.92
Na	1.06	1.40	1.38	1.38	1.07	1.17	1.86	1.83	1.88	1.88	1.91
Ca	0.94	0.60	0.62	0.62	0.93	0.81	0.14	0.17	0.12	0.12	0.09
Mn	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
B	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Mg	3.22	2.14	2.10	2.07	3.83	3.53	3.05	3.02	3.50	3.34	3.28
Mn	0.03	0.09	0.09	0.10	0.04	0.03	0.18	0.18	0.16	0.20	0.12
Fe^{2+}	1.28	1.85	2.12	2.01	0.77	1.15	1.16	1.26	0.47	0.70	0.78
Fe^{3+}	0.16	0.63	0.38	0.57	0.22	0.07	0.24	0.25	0.82	0.62	0.65
Al	0.09	0.05	0.03	0.02	0.00	0.00	0.10	0.03	0.00	0.00	0.00
Ti	0.22	0.23	0.28	0.26	0.13	0.22	0.27	0.26	0.05	0.08	0.08
C	5.00	5.00	5.00	5.00	4.99	5.00	5.00	5.00	5.00	4.94	4.91
Si	7.65	7.66	7.70	7.65	7.70	7.76	8.00	8.00	7.96	8.00	8.00
Al	0.35	0.34	0.30	0.35	0.20	0.17	0.00	0.00	0.00	0.00	0.00
Ti	0.00	0.00	0.00	0.00	0.10	0.07	0.00	0.00	0.04	0.00	0.00
T	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
mg	0.72	0.54	0.50	0.51	0.83	0.75	0.72	0.71	0.88	0.83	0.81
Na	1.24	1.64	1.72	1.70	1.32	1.54	2.35	2.41	2.45	2.56	2.48
Al	0.44	0.40	0.33	0.37	0.20	0.17	0.10	0.03	0.00	0.00	0.00
Fe	1.44	2.18	2.50	2.58	1.00	1.22	1.40	1.51	1.29	1.32	1.43

mg = $Mg/(Mg+Fe^{2+})$

The following more distinctly expresses tendencies can be deduced with respect to the process of magmatic crystallization (phase III and IV) from porphyry individuals towards those in the groundmass: increase of Fe, Fe^{2+}, Na and decrease of K, Ca and Mg. Indicative is the earlier involvement of the stronger magnesium cation, which is compensated later mainly by the weaker ferro-cation. Similar but weakly expressed is the relationship between Ca and Na cations. During the process of formation of the pegmatite mineralization, there is a relatively weak tendency for replacement of Mg^{2+} by Fe^{2+}. Indicative is the total lack of Al and the maximum content of Si.

The computed summary energy characteristics (Table 3), based on the derived by Ivanov (1987) energy coefficients (for K 4.34, Na 5.14, Al 7.61, Ca 5.99, Mn 6.26, Fe^{2+} 7.23, Fe^{3+} 7.47, Ti 7.05, Si 7.93) indicate very close values. Most probably this is due to crystallization at almost equal T in conditions of partially higher oversaturation in the mineral crystallization environment.

Table 3. Energy characteristics of the studied amphiboles.

2 med.	2 rime	2 gr. m.	44 core	44 med.	44 rime	44 gr. m.	36[b] core	36[b] med.	36[b] rime
1.52	1.60	1.30	2.26	2.26	1.74	1.87	1.74	1.30	1.56
8.43	8.84	8.74	6.78	7.92	12.08	12.39	12.59	13.16	12.75
3.04	2.51	2.82	1.52	1.29	0.76	0.29	0.00	0.00	0.00
3.59	3.71	3.71	5.57	5.45	0.84	1.02	0.72	0.72	0.54
0.56	0.56	0.63	0.75	0.19	1.13	1.13	1.00	1.25	0.75
6.18	15.88	15.65	28.96	26.69	23.06	22.83	26.46	25.25	24.72
3.38	15.33	14.53	5.57	8.31	8.39	9.11	3.40	5.06	5.64
4.71	2.84	4.26	1.64	0.52	1.79	1.87	6.13	4.63	4.86
1.62	1.97	1.83	1.62	2.04	1.90	1.83	0.63	0.56	0.56
0.74	61.06	60.66	60.06	61.54	63.44	63.44	63.12	63.44	63.44
3.77	114.30	114.13	114.73	116.21	115.13	115.78	115.79	115.37	114.82

References

Dimitrov, S. 1937. A contribution to the study of our K-alkaline rocks. The eruptive rocks at Svidnya Village. – *Ann. Univ. Sofia, Fac. Phys.-Math*., 33**,** 3, *Sci Natural*., 291-343 (in Bulgarian).

Dyulgerov, M. 2003. Comparative mineralogical study on pyroxenes and amphiboles from Variscan potassic-alkaline magmatism in Stara Planina Mts., Bulgaria. *Bulg. Geol. Soc., Annual Sci. Conf. "Geology 2003"*, *Sofia, December 11-12, Abstracts*, 27-29.

Grozdanov, L. 1965. Sequence of formation and crystallization of Svidnya K-alkaline rocks. – *Bull. NIGI*, **2**, 383-398 (in Bulgarian).

Grozdanov, L. 1969. Crystallo-chemical and X-ray studies of some amphiboles of Svidnya K-alkaline rocks. – *Bull. Geol. Inst., Ser. Geochim. Mineral. Petrol*., 18, 123-143 (in Bulgarian).

Grozdanov, L. 1982. Crystallochemistry of amphiboles from the potassium-alkaline igneous rocks from the village of Svidnya, Western Stara Planina Mountain. *Papers 13th General IMA, Meet. Varna,* 119-120.

Ivanov, I. M. 1987. On a method of determinig the dynamics of distribution of rare elements in the process of granitre pegmatite formation. - *Geochem. Mineral. Petrol*., 23, 18-31. (in Rossian).

Leake, B. E. et al. 1997. Nomenclature of amphiboles: Report of the Subcommittee on Amphiboles of the International Mineralogical Assotiation, Commission on New Minerals and Mineral Names. *Canad. Mineral.,* 35, 219-246.

Vladykin, N. V., L. A. Grozdanov, I. K. Bonev. 2001. Chemical composition and geochemical characteristic of the Svidnya magmatic potassic-alkaline association, Western Stara Planina Mountain. *Geochem. Mineral. Petrol*., 38, 3-22.