Table 1. Trace elements in the Arda unit marbles

Rocks	Pure marbles				Impure marbles			
Sample	Whole rock				Whole rock		Insoluble residue	
ppm	min	max	avrg	stdev	min	max	min	max
Cr	<1	9	2.2	1.9	10	66	38	86
Ni	<1	118	14	26.7	0.5	44	22	84
Co	<2	<2	<2		<2	5	3	11
Cu	<2	15	4.2	2.9	<2	21	3	45
Zn	11	52	20.2	12.2	33	74	58	253
Cd	5	6	5.4	0.5	4	5	1	4
Pb	3	12	7.2	2.4	2	46	<2	37
Li	2	5	3.7	0.7	2	6	3	7
Rb	<2	3	<2		<2	43	5	129
Sr	107	228	137.8	31.8	88	1721	18	1678

marbles contain considerable amount (14–58%) of the latter. The most widespread pure marbles are calcite dominated. Among them white coloured varieties differ with lower MgO contents and higher CaO/MgO ratio values when compared with grey coloured ones, respectively: 0.27–1.93%, 30–210 for white marbles; and 1.25–3.21%, 17–44 for grey marbles. The carbonate component of impure marbles is calcite dominated as well, with CaO/MgO ratio values in the range of 18 to 44 similarly to the grey calcite marbles (Fig. 1a).

The insoluble residue of impure marbles display strongly variable major elements proportions, namely: SiO_2 49–79, Al_2O_3 1–15, FeO* 0.2–5.6, MgO 1–9.2, CaO 2–16, Na_2O 4–9, K_2O 1–6 (all in %). Their contents and distribution correspond to dominant silicate minerals proportions. Mass-balance calculations help for understanding the distribution of Ca and Mg between carbonate and silicate fractions of impure marbles. Carbonate phases hold more than 80% of the Ca-amount, and from 25 to 90% of the Mg available. The strong preference of Ca to carbonate phases and incorporation of Mg both in silicate and carbonate minerals are illustrated by lower CaO/MgO ratio in the silicate fractions (Fig. 1b).

The pure marbles are poor in trace elements. Their contents are often lower than the detection limits (Rb and Co < 2 ppm, Table 1). Sr-contents are relatively constant in the range 100–200 ppm. The trace elements studied in pure marbles do not show correlations with major elements (Ca and Mg). The impure marbles are richer in trace elements than pure ones, as noted previously (Cherneva et al., 2003). The majority of the trace elements studied (Cr, Ni, Cu, Zn and Rb) correlate positively with the insoluble residue contents in the impure marbles, indicating the controlling role of silicate minerals on trace elements distribution. Prominent among them are Rb-Pb-K_2O and Sr-Na_2O links that refer to incorporation of trace elements in K-feldspar and plagioclase available. Large Sr variation (Tabl. 1) in whole rocks (88–1721 ppm) and silicate portions (18–1678 ppm) of the impure marbles suggest a complex distribution of the elements between the two compounds. Mass-balance calculations indicate that Cr, Ni, Cu, Zn and Rb tend to concentrate in the silicate fractions, whereas Sr, Pb and Cd are enriched in the carbonate fractions that bear from 50% to 100% of the above elements available.

Our preliminary results on the Arda unit metacarbonate rocks consider pure marbles the more reliable source of data on protoliths compositions. Among them dominate pure calcite marbles, which trace elements geochemical characteristics are promising for comparative geochemical studies. We suggest non-isochemical processes of metamorphism in the silicate-bearing metacarbonate rocks, controlled by fluid driven metamorphic reactions. Impure marbles geochemistry contributes to complete consideration of major and trace elements mass transfer during regional metamorphism.

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