$^{87}Sr/^{86}Sr$ ratio in the marbles from the Rhodopes in the context of their age and correlation

$^{87}Sr/^{86}Sr$ отношение в мрамори от Родопите в контекста на тяхната възраст и корелация

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Introduction

The geological correlation of high grade metamorphic rocks across the Rhodope massif in Southern Bulgaria and Northern Greece has been controversial for decades. Recently, 2 different models with contrasting approaches to correlation are employed. According to the 1st model, the Rhodope massif is regarded as a stable crustal fragment of Precambrian age. Proponents of this model use a litostratigraphic approach for subdividing and correlation of the metamorphic rocks across the massif. The 2nd model considers the Rhodope massif as a stack of tectonic plates consisted of two major tectonic units (a.k.a. the Upper and Lower terrains) separated by several mylonitic zones and “intermediate” tectonic units (Burg et al., 1996; Ivanov, 1998). Supporters of the latter model employ litothectonic principles to subdivide and correlate metamorphic rocks across the massif (Sarov, 2012).

In all correlation schemes the P-T conditions of metamorphism, style and type of deformation are obtained by investigating dominantly metapelites, metabasites or metagranites. By reason of this, the metacarbonate rocks remain outside the attention. Machev et al. (2009) made the first attempt to use the mineralogy and stable isotope (i.e., $\delta^{18}O$ and $\delta^{13}C$) compositions of marble samples collected from 3 different localities across the Bulgarian part of the Rhodopes for correction of these rocks.

This study focuses on the $^{87}Sr/^{86}Sr$ ratio in the marbles from 4 localities: 1. Asenitsa Lithotectonic Unit – 4 samples were collected along the Asenovgrad-Chepelare road; 2. Lower terrain – 4 samples were collected from an abandoned quarry near the village of Petrovo; 3. Asenitsa Lithotectonic Unit – 4 samples were collected along the road to Yagodina cave. 4. Asenitsa Lithotectonic Unit – 4 samples were collected in the vicinity of Smolyan. The aim of the study is to compare the rocks from these localities postulating that: (1) they were in isotopic equilibrium with the sea water during the deposition; (2) the carbonate sediments record the $^{87}Sr/^{86}Sr$ of the sea water and (3) the $^{87}Sr/^{86}Sr$ of the sea water changes in geological time (Faure, Powell, 1972; Fig. 1).

Petrology

Only “snow white” marbles, without macroscopically visible non-carbonate minerals were collected. Additionally, the sampling was conducted away from tectonic zones and from areas of hydrothermal alteration, respectively.

Locality 1 (L1) – Asenitsa Lithotectonic Unit. The rocks are massive, pure calcite marbles with a medium grained equigranular texture. Rare xenoblastic quartz and white mica (colorless phlogopite?) grains are observed, too. The calcite grains contain numerous lamellar or intersecting deformation type III twins (after Burkhard, 1993). $^{87}Sr/^{86}Sr$ ratio in the marbles is ranging from 0.707337 to 0.707402 (av. 0.707371).

Locality 2 (L2) – Lower terrain. The samples represent massive, pure calcite marbles. In contrast to the samples from L1, L2 samples have unequigranular texture. Relatively large calcite grains occur “floating” in fine-grained recrystallized matrix. These crystals have lobate outlines and core-mantle texture is a specific feature of these rocks. Wide lamellar and intersecting deformation twins are typical for the large calcite grains. $^{87}Sr/^{86}Sr$ ratio in these marbles varies from 0.707958 to 0.708037 (av. 0.708000).

Locality 3 (L3) – Asenitsa Lithotectonic Unit. The marbles occur with massive structure and, in contrast to the L1 and L2 samples, contain dolomite. Texturally L3 samples are similar to L2, however, matrix calcite in L3 samples is slightly coarser. $^{87}Sr/^{86}Sr$

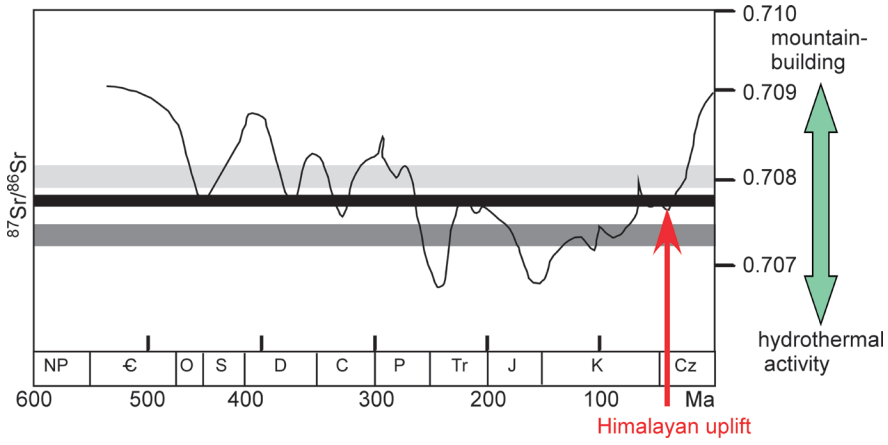

Fig. 1. Variations of $^{87}Sr/^{86}Sr$ of sea water during the Phanerozoic (Faure, Powell, 1972): *light gray field*, $^{87}Sr/^{86}Sr$ in marbles from Lower terrain; *dark gray field*, $^{87}Sr/^{86}Sr$ in marbles from Asenitsa Lithotectonic Unit; *black field*, $^{87}Sr/^{86}Sr$ in marbles from the vicinity of Sinanitsa and Vihren summits

ratio in the marbles is in the range 0.707295–0.707366 (av. 0.707342).

Locality 4 (L4) – Asenitsa Lithotectonic Unit (Chokmanovo klippe). The marbles have medium grained equigranular texture with $^{87}Sr/^{86}Sr$ ratio ranging from 0.707209 to 0.707445 (av. 0.707330).

Georgiev et al. (2012) report data about the $^{87}Sr/^{86}Sr$ ratio in the marbles from the vicinity of Sinanitsa and Vihren summits (Northern Pirin) which are in the area 0.70766–0.70776 (black field on Fig. 1).

The comparison of the $^{87}Sr/^{86}Sr$ values shows that the marbles from localities L1, L3 and L4 have very close ratio (dark gray field on Fig.1). Only the marbles from L2 differ being with higher $^{87}Sr/^{86}Sr$ ratio (light gray field).

Conclusion

The obtained results show the possibility for using the $^{87}Sr/^{86}Sr$ ratio in metacarbonate rocks for correlation and age determination. All $^{87}Sr/^{86}Sr$ values are in the range 0.707295–0.708037, i.e. they are Phanerozoic (Fig. 1). They confirm the Jurassic age of the marbles from the North Rhodopes, which is close to the age of the associated metagranites and metavolcanites (Bachkovo lepthithic gneisses and Dobralak metagranites). On the other hand, they do not support the idea of Machev et al. (2009) that the marbles from the area of Yagodina cave are part from the Lower terrane i.e. they present a tectonic window. This circumstance favors $^{87}Sr/^{86}Sr$ ratio as a reliable tool for correlations rather than stable isotopes ($\delta^{18}O$ and $\delta^{13}C$). In this sense the marbles from the Northern Pirin (in the area of the Vihren and Sinanitsa summits) have intermediate $^{87}Sr/^{86}Sr$ ratio between these from the Lower terrain and Asenitsa Lithotectonic Unit (Fig. 1). If we assume that they are part of the Lower terrain it means that these rocks have relatively higher variations of the $^{87}Sr/^{86}Sr$ ratio. These data are in a good agreement with the Carboniferous–Permian ages of associated metagranites i.e. they are Late Hercinian, too. Finally, summarizing the data about the $^{87}Sr/^{86}Sr$ ratio in the marbles from the Rhodopes made uncertain the reported presence of Precambrian fossils in these rocks (Kozoukharov, Timofeev, 1979; Tchoumachenko, Sapunov, 1988).

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