Stable isotope study of marbles from Rhodopes metamorphic terrain – an useful contrivance for tectonic correlations

Изследване на стабилни изотопи в мрамори от Родопския метаморфен терен – надежден инструмент за тектонски корелации

Philip Machev[1], Serguey Arkadakskiy[2], Lutz Hecht[3], Laslo Klain[1]
Филип Мачев[1], Сергей Аркадакски[2], Луц Хехт[3], Ласло Клайн[1]

[1] Faculty of Geology and Geography, Sofia University "St. Kliment Ohridski"; E-mail: machev@gea.uni-sofia.bg
[2] Isobrine Solutions, #4-341, 10230 Jasper Ave. Edmonton, Canada; E-mail: serguey@isobrine.com
[3] Museum für Naturkunde, Humboldt University, Berlin; E-mail: lutz.hecht@mfn-berlin.de

Key words: marble, Rhodope metamorphic terrain, stable isotope.

Introduction

The geological correlation of high grade metamorphic rocks across the Rhodopes massif in Southern Bulgaria and Northern Greece has been controversial for decades. Two different models with contrasting approaches to correlation are employed today. According to the first model, the Rhodopes massif is viewed as a stable crustal fragment of Precambrian age. Proponents of that model use a litostratigraphic approach to sub-divide and correlate metamorphic rocks across the massif. The second model considers the Rhodopes massif a stack of tectonic plates that consists 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.

Both models, however, correlate massive marbles that crops out near the villages of Trigrad and Yagodina, i.e., in the south-western section of the massif to marbles cropping out to the north near the town of Assenovgrad. According to the different classification schemes applied by the two models, marbles are either a part of the Dobrostan Formation (Kozhoukharov, 1984, model 1) or the Asenitza lithotectonic unit (Sarov et al., 2009, model 2).

This study focuses on the mineralogy and stable isotope (i.e., $\delta^{18}O$ and $\delta^{13}C$) compositions of marble samples collected from three different localities across the Bulgarian part of the Rhodopes massif including the Trigrad and Yagodina area as well as.

Petrology

Only "snow white" marbles, without macroscopically visible non-carbonate minerals were collected. Sampling was conducted away from tectonic zones and areas of hydrothermal alteration. Calcite-dolomite proportions were determined from Alizarin red-S colored thin sections. Stable isotope compositions were determined on powdered whole rock samples. Approximately 20 mg of sample was reacted with 100% phosphoric acid following the modified procedure of McCrea (1950). Extracted CO_2 was analyzed for $\delta^{13}C$ and $\delta^{18}O$ on a Finnigan Mat 252 Isotope Ratio Mass Spectrometer in a dual inlet mode.

Locality 1 (L1) – Asenitza lithotectonic unit. Four samples were collected along the Asenovgrad-Chepelare road. These consist of massive, poor 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). Calcite MgO contents vary in a narrow range (0.68–0.8%), hence, the minerals can be classified as low-Mg calcites. Samples from this location have nearly identical $\delta^{13}C$ compositions, i.e., from +0.14 to +1.57‰ (average +0.66, n=4). The $\delta^{18}O_{marble}$ values range from −5.50 to −6.40‰ (average −5.88, n=4; Fig. 1), respectively.

Locality 2 (L2) – Lower terrain. Four samples were collected from an abandoned carrier near the village of Petrovo. The samples comprise massive, poor calcite marbles. In contrast to the samples from L1, L2 samples have unequigranular texture. Relatively big calcite grains "float" in fine-grained recrystallized matrix. The large crystals have lobate outlines and core-mantle texture is a specific feature of these rocks. Wide lamellar and intersecting deformation twins are characteristic features of the big calcite grains. The MgO content of matrix calcite is 0.75–0.86%. L2 samples exhibit significant isotope varia-