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Low-temperature thermochronological constraints on the Alpine evolution of the central parts of Sredna Gora Zone, Bulgaria

Нискотемпературни термохронологички данни за алпийската еволюция на Централно Средногорие, България

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Abstract. We present the first apatite and zircon fission-track results coupled with new muscovite and biotite ⁴⁰Ar/³⁹Ar analysis on samples from the pre-Mesozoic granitic basement and the Upper Cretaceous to Danian volcano-sedimentary cover, which allowed us to reveal the Alpine thermal and tectonic evolution of the central parts of Sredna Gora Zone. Our new results disclosed the existence of several heating and cooling episodes related to distinct tectonic and magmatic events in the studied area.

Keywords: Sredna Gora Zone, LA-ICP-MS fission-track dating, ⁴⁰Ar/³⁹Ar multiple single-grain fusion dating, thermal evolution.

Introduction

The central parts of the Sredna Gora Zone in Bulgaria have experienced a complex Alpine tectonic evolution. The main tectonic and thermal events since the end of the Triassic are the Late Jurassic–Early Cretaceous (early Alpine) and Late Cretaceous–Paleogene (late Alpine) compression separated by Late Cretaceous extension and formation of magmatic-arc and intra/back-arc basin system (e.g. Ivanov, 2017). During most of the Cenozoic, the area was mainly under post-orogenic extension (e.g. Gautier et al., 1999), whereas some compressional events were also reported (e.g. Burchfiel et al., 2008). However, the Alpine evolution of the

Sredna Gora zone rests still poorly constrained and the existing thermochronological studies are limited (Handler et al., 2004; Velichkova et al., 2004; Rieser et al., 2008).

In order to unravel the thermal and tectonic evolution of the area during Alpine time we performed low-temperature thermochronological analysis, combining ⁴⁰Ar/³⁹Ar dating with apatite and zircon fission-track analysis. Our target region was the central part of Sredna Gora Zone, where the Upper Cretaceous sediments of the Panagyurishte basin are cropping out together with their Variscan crystalline basement. The obtained results represent the first quantitative estimates of the time and amount of the tectonic burial during the early and late Alpine

Fig. 1. Schematic evolutionary model of the central parts of Sredna Gora Zone during Alpine time

compressional events as well as the exhumation rate during the Eocene–Oligocene extension in the area.

Samples and methods

Nine rock samples were collected for $^{40}\text{Ar}/^{39}\text{Ar}$ and apatite and zircon fission-track dating along two traverses in the central parts of Sredna Gora Zone. From the first traverse, five granitic samples were collected from the crystalline basement at different altitudes along the slope of the highest parts of the Sredna Gora Mountain, in order to constrain the cooling history of the Variscan basement and estimate its exhumation rate. Along the second traverse, four samples were collected from the Upper Cretaceous volcanic and subvolcanic rocks and the upper Maastrichtian–Danian sediments of the Panagyurishte basin, in order to constrain the thermal and tectonic evolution of the inverted basin. The LA-ICP-MS fission-track analyses were carried out in the newly established Low-Temperature Thermochronology Laboratory in Bulgaria by a consortium of Sofia University, Department of Geology, Paleontology and Fossil Fuels and the Geological Institute, BAS, whereas the biotite and muscovite multiple single-grain fusion $^{40}\text{Ar}/^{39}\text{Ar}$ dating was performed at the Vrije Universiteit of Amsterdam.

Results

The new apatite and zircon fission-track dating combined with $^{40}\text{Ar}/^{39}\text{Ar}$ analysis revealed four distinct Alpine (post-Triassic) heating and cooling events related to tectonic and magmatic processes in the central parts of Sredna Gora Zone in Bulgaria (Fig. 1).

The $^{40}\text{Ar}/^{39}\text{Ar}$ single-grain fusion ages of two granitic samples (SG1, SG9) from the pre-Mesozoic basement indicate that the thermal peak of the early Alpine compressional event was attained at about 140–138 Ma at temperatures between ~300 and 400 °C probably during active thrusting (Fig. 1A).

The zircon fission-track data suggest that the Late Cretaceous (90–86 Ma) arc-related magmatic and volcanic activities in the central parts of the Sredna Gora Zone induced an elevated thermal gradient and reheating which attained temperatures above 300 °C in the basement rocks along the shoulders of the Panagyurishte basin (Fig. 1B). Upper Cretaceous volcanic and subvolcanic rocks (samples SG5, SG7 and SG8) were rapidly cooled to surface temperatures soon after their emplacement or eruption (Fig. 1B).

The modelling of the apatite fission-track data revealed middle to late Paleocene thermal event between 65 and 55 Ma related to the late Alpine thrusting and closure of the Panagyurishte back-/intra arc basin (Fig. 1C). During this stage, the Upper Cretaceous volcanic and subvolcanic rocks (samples SG5 and SG7) and the upper Maastrichtian–Danian sediments (sample SG6) were tectonically buried and attained temperatures within the apatite partial annealing zone between 60 and 120 °C (Fig. 1C). This event was followed by rapid to moderate cooling of the sedimentary and volcanic rocks at 55–50 Ma probably during syn-tectonic erosion and denudation of the thrust sheets.

The exhumation of the central parts of the Sredna Gora Zone crystalline basement (samples SG1, SG2, SG3, SG4) has taken place during one or two stages of post-orogenic middle Eocene to Oligocene extension (Fig. 1D) most probably associated with the opening of the Thrace basin south of the studied area.

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