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Detrital and newly formed metamorphic monazite in amphibolite-facies metapelites from the Motajica Massif, Bosnia

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ABSTRACT

The Motajica Massif in Bosnia, situated in the Sava Zone between the Tisza Unit and the Dinarides, hosts a Late Cretaceous flysch series, which is partly preserved in an anchimetamorphic state, partly affected by amphibolite-facies overprint. Samples from both parts contain abundant accessory monazite, which was investigated by means of the electron microprobe with reference to age and composition. In the amphibolite-facies samples new metamorphic monazite has formed. Chemical Th–U–Pb monazite ages indicate that the regional metamorphic event happened in the Late Cretaceous or the Early Palaeogene. In addition, inherited detrital monazite of Permian age has been identified. Based on various observations it is argued that the detrital monazite was not the direct precursor to the metamorphic monazite. The latter may rather have grown from other, more reactive REE carrier minerals, either detrital ones (e.g. detrital allanite) or such that formed during diagenesis and low-grade metamorphism. A later greenschist-facies event that occurred in connection with a ca. 27 Ma old granodiorite intrusion led in some samples to the formation of late fluorapatite–allanite coronas around both detrital and newly formed monazites.
The anchimetamorphic samples contain exclusively detrital monazite. These are partly of Permian as well as Jurassic to Early Cretaceous age. Based on their compositional and textural features, the Jurassic to Early Cretaceous monazite relics are considered to be mainly derived from metamorphic rocks. The Permian monazite displays high yttrium content up to ca. 3.5 wt.% Y_2O_3, indicating a high formation temperature (>650 °C) and therefore probably a magmatic origin. Apart from almost ubiquitous Permian high-Y monazite, the Motajica flysch also contains large Permian xenotime with magmatic zoning patterns, fluorapatite with parasitic monazite inclusions (formerly REE-rich fluorapatite), and zircon with A-type granite morphology. This accessory mineral spectrum implies that, among others, rift-related REE-rich Permian A-type granites or rhyolites should be considered as a source for the Sava Zone flysch.

1. Introduction

This study was initially started with the aim to provide first age constraints on the Alpine metamorphic evolution of the Motajica Massif in Bosnia by applying the method of chemical dating of monazite with the electron microprobe. It is a geochronological contribution to international geological research currently being carried out in the Sava Zone between Tisza Unit an the southerly adjacent Dinarides (Schmid et al., 2008; Ustaszewski et al., in press). During the course of the work, genetic aspects regarding monazite growth and stability during diagenesis, low-grade and higher-grade regional metamorphism have also been uncovered and are addressed in this paper.

The amphibolite-facies metapelitic samples used for dating contained metamorphic monazite, abundant detrital monazite relics, as well as allanite+fluorapatite coronas, which formed around both types of monazite. These samples provided the possibility to examine the inherited monazites, the growth behaviour of new metamorphic monazite, the genetic relations between both monazite groups, and the effect of a later greenschist-facies overprint on newly grown and detrital monazite. We have also studied low-grade metamorphic equivalents of the metapelites, which are exposed in the southern part of the Motajica Massif.

2. Geological background

The samples from the Motajica Massif in Bosnia represent flyschoid, mostly siliciclastic rocks of the Sava Zone, which is located at the southwestern margin of the Pannonian basin (Fig. 1A). This zone follows the contact between the tectonic units of Tisza to the north and the Dinarides to the south. The flysch series is interpreted to have

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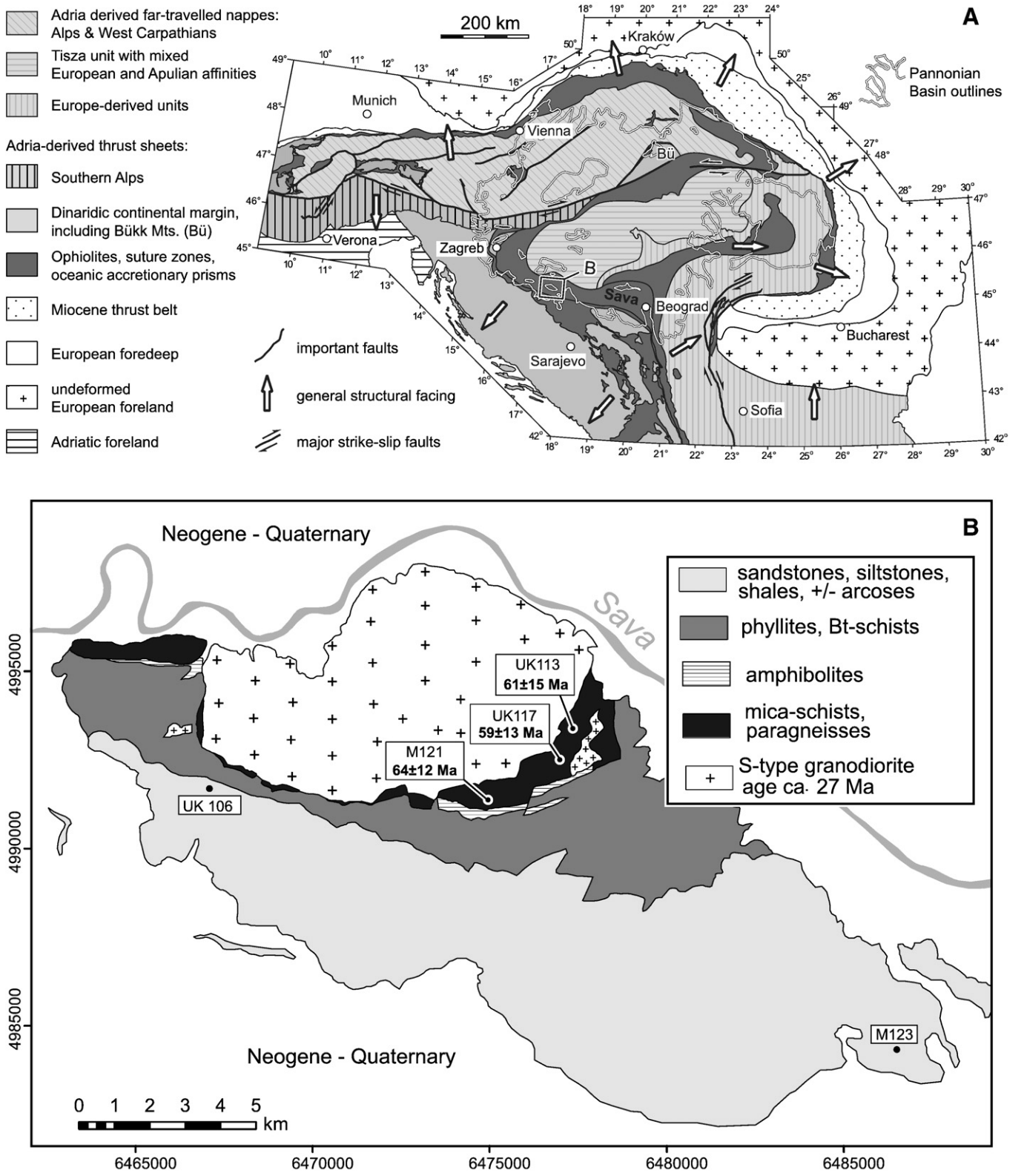

Fig. 1. Geology of the Motajica Massif and its position within the tectonic framework of the Alps, Dinarides and Carpathians (slightly modified after Schmid et al., 2008). Shown are the sample locations of this study and the average monazite ages obtained from newly formed monazite in the amphibolite-facies samples. Numbers at map edge (in b) are MGI Balkan 6 coordinates.

been deposited in a forearc, during the Late Cretaceous to Early Palaeogene closure of an oceanic basin that originally separated Tisza from the Dinaride margin of the Adriatic plate (Pamić 1993; Pamić et al., 2002). The subsequent collision between the internal Dinarides and the Tisza Unit saw the latter in an upper plate position and gave rise to Alpine regional metamorphism and deformation of the