PROCEEDINGS
XX CONGRESS OF THE
CARPATHIAN-BALKAN
GEOLOGICAL ASSOCIATION

SEPTEMBER 24-26, 2014
TIRANA, ALBANIA

Editors

Beqiraj A.
Ionescu C.
Christofides G.
Uta A.
Beqiraj Goga E.
Marku S.

Special Issue
Vol 1/2014
Special Sessions

TIRANA 2014
MONAZITE U-Th-Pb, METAMORPHIC AGES SURVEY IN THE SOUTH CARPATHIAN BASEMENT UNITS: DELVING INTO TECTONIC STACKING AND DIFFERENTIAL EXHUMATION

Săbău G and Negulescu E

Geological Institute of Romania, I. Caraman St., Bucharest, Romania, g_sabau@yahoo.co.uk

Abstract

Chemical U-Th-Pb monazite ages provide details of the syn-metamorphic tectonothermal history of the basement units of the South Carpathians, assisting their distinction, correlation, and the understanding of their formation and evolution. Monazite ages in connexion with the metamorphic assemblages indicate complex Variscan tectonic stacking of juvenile and reworked units, and post-Variscan, Permain to Mesozoic, differential exhumation ensuing extensional collapse.

Keywords: Monazite U-Th-Pb geochronology, metamorphic ages, basement complexes, South Carpathians.

Introduction

A tradition, longer than centennial, has been established up to now in the study of the basement complexes in the Carpatho-Balkan area. Yet, the advantages of such an extended accumulation of knowledge are at some extent counteracted by the fact that the definition, subdivision and correlation of "grandfathered" metamorphic basement units preceded several major steps taken meanwhile in understanding the evolution and dynamics of the lithosphere, as also principles and terminology pertaining to continuously developing formal lithostratigraphy. Quantitative metamorphic and geochronological data represent powerful criteria in testing the coherence of traditionally defined basement complexes, besides progressively providing rationale for separation and correlation of their subunits. The age of tectonometamorphic consolidation of basement fragments is potentially the most appropriate criterion in outlining units, and geochronology of a metamorphic mineral like monazite is highly suitable for determining it.

Analytical Approach

Metamorphic ages were determined on selected samples from the basement units of the South Carpathians using U-Th-Pb microprobe geochronology. Both major and minor elements were determined in the same session on a Cameca SX100 microprobe located at the Institut für Mineralogie und Kristallchemie in Stuttgart, using an accelerating potential of 20 kV and a probe current of 200 nA in order to maximize peak/background ratios. Full chemical analyses were recorded and processed to obtain structural formulae, normalized chemical plots and model U-Th-Pb ages. Analytical data were corrected for peak overlaps; individual ages and associated errors were calculated using the approximation and corrections given by Săbău (2012). The age spectra obtained from each sample were handled according to the procedure outlined in Săbău and Negulescu (2013): plotting the general probability distribution function, selection of age domains approaching Gaussian distribution, calculation of a pooled average of the point data in each domain, and deconvolution of the global probability function anchored on the mean values of the pooled domains. The deconvolved age spectra were interpreted in connection with the metamorphic or magmatic history of the sample and the chemical shifts identified in the monazite populations on account of grain zonality and normalized elemental ratios.

Results and Discussion

The investigated basement units were the Danubian domain, the Lotru Metamorphic Suite in the Getic Nappe, the Făgăraș and Leaota Massifs. The Danubian Nappe system represents the deepest tectonic level cropping out in the South Carpathians, consisting of several Alpine thrust sheets grouped in the lower and upper Danubian units (Berza et al. 1994, and refs. therein). In the lower Danubian Units a sequence of two Variscan thrust sheets was identified, the Parâng-Retezat Nappe straddling the Vilcan-Pilugu Unit. This relationship was extended to other Alpine units in the thrust sequence, by implying a duplex structure of the Danubian and ascribing all lithologies to two basic types, the Drăgușan basement of the Parâng-Retezat unit and the Lainici-Păius basement of...
the Vllcan-Pilugu unit (Seghedi and Berza 1994), in which also the basement units in the south Banat (Almâj Mts.) were included in virtue of general lithologic similarities. A widely accepted Cadomian age of the metamorphism and granitic plutonism is supported by isotopic data in the Lainici-Paiu~ basement, and to a lesser extent in the other basement units. Monazite data obtained are in excellent agreement with the Proterozoic to Cambrian ages of the Lainici-Paiu~ basement, but all other units consistently yielded Variscan or slightly younger age spectra. The Lainici Păiuş data were collected from three typical lithologies, namely calcsilicate rock, K-feldspar diatexite determined were $629.5 \pm 3.5$ for uranorthorite and $633.9 \pm 3.2$ for thorianite. The other two samples contain abundant monazite displaying age spectra consistent with a Proterozoic to Cambrian tectonothermal evolution (Fig. 1A,B) and bracket the granite age of 592 Ma (Balintoni et al. 2011).

At variance with the Lainici-Păiuş basement, micaschists from the Drăgan basement show dominant Permian metamorphic ages (Fig. 1C). Similarly, monazite from all other units of the Danubian nappe system recorded Variscan ages down to Permian, starting from $369 \pm 3$ Ma (Fig. 2A) in the Ielova complex. Carboniferous ages of $338 \pm 2 - 317 \pm 2$ in the Poiana Mraconia complex

Figure 1. Monazite age patterns from the Lower Danubian units; Lainici-Păiuş basement (A,B) and Drăgan basement (C).

Figure 2. Additional age patterns from other Danubian basement complexes: Ielova (A), Neamţu (B), Corbu/Vodna (C).

Figure 3. Age patterns from the Lotru Metamorphic Suite, Getic Nappe: pre-Variscan Valea Căpârârea Complex (A, B) and the overlying Semenic synmetamorphic nappe (C).

(11Rc1) and high-grade gneiss associated to gneissic granitoids (Suşita type) - 11LP408. In the calcsilicate rock no monazite was found, but uranorthorite and thorianite appear in a diverse accessory assemblage alongside common sulfides, molybdenite, altaite and sperrylite; chemical ages (see also Negulescu et al. 2014), and dominantly Permian ages in the easternmost units (Fig. 2B,C).

The Lotru Metamorphic Suite of the Getic Nappe is composed of concordant synmetamorphic thrust
sheets with contrasting metamorphic history. The uppermost Semenic Unit contains apparently monometamorphic garnet- and kyanite micaschists typically containing rutile. Lower units contain polymetamorphic sillimanite-grade, lower pressure schists and gneisses, with the exception of a high-grade greiss-granite complex (Valea Caprăreasa) recording a strong high pressure overprint (kyanite + K feldspar), and only minor and local sillimanite-muscovite retrogression. The age spectrum preserved in this complex is clearly pre-Variscan, recording granitic plutonism at 474 ± 3 to 460 ± 3 Ma in metagranitites (Fig. 3A) followed by the 442 ± 2 Ma pervasive high-pressure overprint well-expressed in both metagranitites and host gneisses - 448 ± 9 Ma (Fig. 3B). In contrast, the overlying Semenic Unit displays an age spectrum typical of juvenile Variscan rocks, recording the age of the single metamorphic overprint and syn/late-metamorphic stacking in the interval 282-345 Ma (Fig. 3C).

The units containing lower-pressure sillimanite bearing assemblages typically contain higher-pressure relics and a complex distribution of monazite ages, descending from late-Variscan to Triassic. As a rule, higher grades and lower pressures of the most pervasive sillimanite-grade overprint correspond to younger ages, documenting differential uplift following the Variscan tectonic stacking (Fig. 4). The end-member of this evolution is represented by the Ursu dome, consisting of cordierite-sillimanite-K feldspar gneisses and anatectic peraluminous granites. The age spectrum of the granitoid rocks is remarkable as it extends an extended age spectrum (Fig. 4C), witnessing remobilization of Variscan and older basement, anatexis and emplacement of the biphasic dome structure as late as the Middle Jurassic (166 ± 2 Ma).

Monazite geochronology in the Făgăraş and Leaota Massifs also revealed tectonic imbrication of Variscan and pre-Variscan units. In both cases the lowermost term of the basement sequence displays a monometamorphic Variscan history in micaceous schists and gneisses. Structurally upwards, pre-Variscan crustal fragments containing metagranitites typically displaying Lower Palaeozoic intrusion ages. In the Făgăraş Massif the 479 ± 2 Ma Valea Bolovanului granite intrudes a mafic complex strongly overprinted during the Variscan metamorphism, but bearing no evidence of previous metamorphic alterations. The Variscan overprint is strong and general at the scale of the massif; younger ages reaching the Permian-Triassic boundary appear in the structurally deepest level accessible, in dome-shaped structures on the northern slope of the Făgăraş Mts. Unlike in the Lotru basement, these dome structures do not display conspicuous metamorphic contrasts or lower-pressure overprints. In the Leaota Massif, the remobilized pre-Variscan tectonic slice bears evidence of a complex pre-Variscan evolution, with Ordovician intrusion of the Albeşti Granite (462 ± 5 Ma) in an already consolidated metamorphic basement with a poorly constrained metamorphic age, followed by a Late Devonian (371 ± 7 Ma, Săbău and Negulescu 2013) tectonic stacking and higher-pressure overprint. The Variscan evolution is continued by emplacement of younger and less overprinted tectonic slices towards the top of the basement sequence.

Conclusions

Chemical U-Th-Pb monazite ages may provide detailed information regarding the tectono-thermal history of the individual basement units of the South Carpathians, as also their coherence, the tectonic framework of their build-up and mechanisms governing their further evolution. For the Danubian units a more complex Variscan evolution and overprint is revealed than previously recognized, as also suggested by abundant Variscan plutonism dated by Balica (2007). Moreover, no pre-Variscan metamorphic ages were identified in
any of the Danubian units but the Lainici Pâniș basement of the Vlcan-Pilugu Variscan unit. An imbrication of reworked and juvenile metamorphic units is revealed by monazite geochronology, but also metamorphic assemblages, in various basement units, as exemplified by the Getic Nappe basement and the Leaota and Pârgăraș Massifs, in otherwise broadly homogeneous and coherently-looking sequences. Differential uplift of various terms of the sequence is apparent in the Lotru Metamorphic Suite, where higher-grade and lower pressure conditions, together with contrasting unit boundaries, correlate with younger ages, eventually going down to Jurassic in gneissic-anatectic dome structures.

Acknowledgements: Contribution supported by the Romanian Executive Unit for Financing Higher Education, Research, Development and Innovation, Grant PN-II-ID-PCE-2011-3-0030 to GS and EN. H.-J. Massonne kindly granted access to the analytical facilities of Institut für Mineralogie und Kristallchemie, and T. Theye provided invaluable help with the microprobe analyses.

References


