A few single crystal zircon ages from the Padeş suite orthogneisses (Southern Carpathians, Romania)

Ioan BALINTONI^{1*}, Constantin BALICA¹, Monica CLIVETI¹, Li-Qiu LI²,
Horst Peter HANN³, Fukun CHEN²

¹ Department of Geology, "Babeş-Bolyai" University, 1 Kogălniceanu, 400084 Cluj Napoca, Romania

² Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing, 100029, China

³ Institut für Geowissenschaften, Universität Tübingen, 72076 Tübingen, Germany

Received July 2005; accepted March 2006

ABSTRACT. The Padeş suite from the Poiana Ruscă Mountains is a component of the Padeş Paleozoic terrane. The Padeş terrane evolved as an island arc between the Cadomian Sebeş-Lotru and Făgăraş terranes, the main parts of the Getic crystalline in the Southern Carpathians. Evaporated single zircon grains offered 394 ± 20 Ma, 546 ± 20 Ma, 655 ± 19 Ma, 1305 ± 17 Ma, and 1538 ± 17 Ma ages. The 394 Ma age has been interpreted as an early Variscan collision age, 546 Ma as the protolith age and the other ages as signifying Cadomian and Saharan detrital zircons. Similar to the terranes in the Apuseni Mountains, the Padeş terrane has a North African-Gondwanan provenance.

Key words: Southern Carpathians, Padeş terrane, zircon ages

INTRODUCTION

Due to very divergent models proposed during the last decade, regarding the Poiana Ruscă Mountains crystalline (e.g. Kräutner, 1996; Balintoni, 1997; Mureşan, 2003) we will join in the present paper with the ideas presented by Balintoni (1997), based on the paper of Balintoni and Iancu (1996). According to these authors, the Padeş suite represents the uppermost lithotectonic unit of the Getic crystalline (from an Alpine point of view), although the pre-Alpine tectonic relationship with the Făgăraş suite, also present in the Poiana Ruscă Mountains, is obvious (Fig. 1). As a possible continuation of the Tulgheş suite from the Eastern Carpathians, the Padeş suite is a part of a Variscan suture between the Sebeş-Lotru terrane and Făgăraş terrane. In a Variscan model of the Southern Carpathians Getic crystalline, the following Paleozoic terranes can be separated: Sebeş-Lotru, Leaota, Făgăraş, Bocşiţa-Drinova and Padeş (Fig. 1). The Getic crystalline has an Alpine tectonic relationship with the Danubian crystalline. Thus, the Padeş suite is regarded as an island arc terrane characterized by intense acidic volcanism. Thick bodies of meta-rhyolites are known in the northern part of Poiana Ruscă Mountains, near Deva town and north of Mureş River, in the Rapolt Massif (Bordea et al., 1978; Lupu et al., 1982). In this paper we present single zircon evaporation ages performed on meta-rhyolites of Padeş suite.

SAMPLE DESCRIPTION

The sample #182 was collected from Rapolt massif, north of Mureş valley, near the Rapolt village. The sample #183 was picked up west of Deva town, near Veşel village.

Both samples contain the same minerals: quartz, plagioclase, K-feldspar, muscovite, epidote, opaque minerals, apatite, zircon and small amounts of stilpnomelane. The sample #183 is richer in muscovite and epidote than the sample #182. The rocks are foliated with quartz and feldspar porphyroblasts. According to the mineralogy and structure presented here, the samples represent metarhyolites.

ANALYTICAL METHODS

Measurement on isotopic ratios were performed in the Laboratory of Radiogenic Isotope Geochemistry, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, using an IsoProbe-T thermal ionization mass spectrometer manufactured by the GV company. The IsoProbe-T is equipped with 9 Faraday cups, 1 Daly receiver and 7 ion-counters. The technique used for zircon evaporation is similar to that developed by Kober (1986). Pb isotopes (^{204}Pb , ^{206}Pb , ^{207}Pb , and ^{208}Pb) were statically measured using four ion-counters with an 8-second-intergration.

Calculation of $^{207}\text{Pb}/^{206}\text{Pb}$ ages is based on mean values of all measurements and uncertainties are given at 2σ standard deviation. Age for several zircons from the same sample is given as weighted average and its 2σ error propagated from the assigned errors (2σ internal error; Ludwig, 2001).

Pb-Pb analytical data were evaluated with 2σ standard error using the PbDAT program (Ludwig, 1988). Probability/density plots in diagrams were done using the Isoplot program (Ludwig, 2001). More details on analytical techniques are given in Chen et al. (2000).

*Correspondence: I. Balintoni (ibalinto@bioge.ubbcluj.ro)

Fig. 1. Sketch of the Southern Carpathians showing the main pre-Alpine and Alpine tectonic units and sampling locations. Compilation based on Balintoni et al. (1989), Balintoni (1997), Berza et al. (1994), and Berza and Iancu (1994).

ANALYTICAL RESULTS

Two crystals evaporated from samples 182 (Rapolțel) and 183 (Vețel), gave a cluster of 394 ± 17 Ma (Fig. 2, Table 1). One zircon crystal evaporated out of sample 183 (Vețel) furnished an age around 546 ± 20 Ma (Fig. 3).

Another crystal of sample 183 (Vețel) offered a cluster at 655 ± 19 Ma (Fig. 4). Finally, one evaporated zircon crystal from sample 182 (Rapolțel) yielded two clusters at 1305 ± 17 Ma and 1538 ± 17 Ma, respectively (Fig. 5). All these ages have geological significance.

Table 1. Zircon evaporation data for samples of the Pădure sequence. Calculation of $^{207}\text{Pb}/^{206}\text{Pb}$ ages is based on mean values of all or selected measurements and uncertainties are given at 2σ standard deviation

Sample	No of grains	No. of ratios	Mean value of $^{207}\text{Pb}/^{206}\text{Pb}$ ratios	$^{207}\text{Pb}/^{206}\text{Pb}$ age (Ma)
182-I & 183-III	2	39	0.054556	394 ± 17
183-I	1	32	0.058435	546 ± 20
183-II	1	26	0.061449	655 ± 19
182-II	1	9	0.084524	1305 ± 17
		9	0.095518	1538 ± 17

DISCUSSION

Ages provided by the Pădure meta-rhyolites strike similar with the ages provided by the Baia de Arieș, Someș and Păiușeni sequences rocks from the Apuseni Mountains (Balintoni et al., 2007 a, b, c).

The 394 Ma age can be viewed as a recrystallization related to early Variscan collision. This age coincides with that one of the Arieș migmatites leucosome.

The 546 Ma is the protolith age of Baia de Arieș orthogneisses. This is also the possible protolith age of Pădure meta-rhyolites.

Again the 655 Ma age is identical with the detrital zircon age (656 Ma) in the Păiușeni metapelite. A metasandstone from the Someș sequence contains detrital zircons of 722 Ma. Consequently the 655 Ma age can be admitted as a detrital zircon age. The 546 Ma and 655 Ma ages point to the Cadomian orogeny as the genetic environment of the Pădure sequence. Ages around 1305 Ma and 1538 Ma are also known from the Baia de Arieș sequence rocks. They have been interpreted as signaling Saharan detrital zircon ages. Therefore we suppose a Saharan zircon presence in the Pădure sequence meta-rhyolites, too.

Fig. 2. Frequency diagram of two evaporated zircon grains out of sample 182-I (Rapolțel) and 183-III (Vețel) which gave a mean $^{207}\text{Pb}/^{206}\text{Pb}$ age of 394 ± 17 Ma.

Fig. 4. Frequency diagram of one evaporated zircon grain out of sample 183-II (Vețel) which gave a mean $^{207}\text{Pb}/^{206}\text{Pb}$ age of 655 ± 19 Ma.

Fig. 3. Frequency diagram of one evaporated zircon grain out of sample 183-I (Vețel) which gave a mean $^{207}\text{Pb}/^{206}\text{Pb}$ age of 546 ± 20 Ma.

Fig. 5. Frequency diagram of one evaporated zircon grain out of sample 182-II (Rapolțel) which gave a mean $^{207}\text{Pb}/^{206}\text{Pb}$ age of 1305 ± 17 Ma and 1538 ± 17 Ma.

CONCLUSIONS

The data presented here are insufficient in order to present a strong conclusive model regarding the Padeș sequence evolution. However, we can say that the Padeș sequence, as the constitutive material of the Padeș terrane, suggests a Cadomian, peri-Gondwanan origin. It probably collided with other Carpathian terranes around 400 Ma. If the Padeș sequence represents a prolongation of the Tulgheș sequence from the Eastern Carpathians, then the Padeș terrane has been situated between the Sebeș-Lotru and Făgăraș terranes as the main constituents of the Southern Carpathians Getic crystalline.

We mention that Pană et al. (2002) communicated lowermost Ordovician-Cambrian U/Pb ages from the Tulgheș sequence meta-acidic rocks.

Acknowledgements. This paper was possible through financial support from grants 1/226 2005 CNCSIS and 37-01/2004-2006 MEC. We also are indebted to Mrs. Cristina Mariș of COMINEX S.A. Cluj, and geologist Adrian Minuț from Roșia Montană Gold Corporation for help with the milling facilities.

REFERENCES

- Balintoni, I., 1997, *Geotectonica terenurilor metamorfice din România*, Ed. Carpatica, Cluj Napoca, 176 pp.
- Balintoni, I., Balica, C., Cliveți, M., Li-Qiu L., Hann, H.P. & Chen, F. 2007 a, Paleogeographic and plate tectonic significance of single crystal zircon ages in a few orthogneisses and Vința granite from the Baia de Arieș sequence (Apuseni Mountains, Romania). *Submitted to International Journal of Geological Science (Geol. Rund.)*.
- Balintoni, I., Balica, C., Cliveți, M., Li-Qiu L., Hann, H.P., Chen, F. & Ghergari, L. 2007 b, Somes terrane, a new Cadomian entity in the Apuseni Mountains, Romania (Apuseni Mountains, Romania). *Studia Universitatis Babeș-Bolyai, Geologia, in review*.
- Balintoni, I., Balica, C., Cliveți, M., Li-Qiu Li, Hann, H.P. & Chen, F. 2007 c, How can be interpreted the single zircon ages from Muncel granite and Henț metapelite, Paiușeni sequence, Apuseni Mountains. *Studia Universitatis Babeș-Bolyai, Geologia, in review*.
- Balintoni, I., Berza, T., Hann, H.P., Iancu, V., Kräutner, H.G. & Udubașă, G. 1989, *Precambrian metamorphics*

- in the South Carpathians. Guide to excursions. Institutul Geologic și Geofizic, București, 83 pp.
- Berza, T., Iancu, V. 1994, Variscan events in the basement of the Danubian nappes (South Carpathians). *Romanian Journal of Tectonics and Regional Geology*, 75 (Suppl. 2): 93-103.
- Bordea, J., Berbeleac, I., Borcoș, M., Mantea, G., Stancu, J. & Rogge-Ţăranu, E. 1978, *Harta Geologică a României, sc. 1:50.000*, Geoagiu Sheet.
- Chen, F., Hegner, E., Todt, W. 2000, Zircon ages, Nd isotopic and chemical compositions of orthogneisses from the Black Forest, Germany - evidence for a Cambrian magmatic arc. *International Journal of Earth Science*, 88: 791-802.
- Iancu, V., Balintoni, I. 1986, The mineral assemblages and parageneses in the Metamorphics of the Baia de Arieș Group - Apuseni Mountains. In *Mineral Parageneses*, Teophrastus Publications, Athens, pp. 473 - 493.
- Kober, B. 1986, Whole-grain evaporation for $^{207}\text{Pb}/^{206}\text{Pb}$ age investigations on single zircons using a double-filament thermal ion source. *Contribution to Mineralogy and Petrology*, 93: 481-490.
- Kräutner, H.G. 1996, Alpine and pre-Alpine tarranes in the Romanian South Carpathians and equivalents south of the Danube. In *Terranes of Serbia* (Knezevic, V., Krstic, B., Eds.), Belgrade, pp. 563-58.
- Ludwig, K.R. 1988, *Pbdat for MS-Dos - a computer program for IBM-PC compatibles for processing raw Pb-U-Th isotope data*. U.S. Geological Survey, Open-file Report, 88-542, 1-37.
- Ludwig K.R. 2001, *Isoplot/Ex, rev. 2.49: A Geochronological Toolkit for Microsoft Excel*. Berkeley Geochronological Center, Special Publication 1a, 58 pp.
- Lupu, M., Kräutner, H.G., Ţicleanu, N., Boştinescu, S., Bandrabur, T., Kräutner, F., Horvath, A.R. & Nicolae, I. 1982, *Harta Geologică a României, sc. 1:50.000*, Deva Sheet.
- Mureșan, M. 2003, Unitatea epimetamorfică de Poiana Ruscă (redefinire; metamorfite Caledoniene și Varistice; linii tectonice direcționale) – Carpații Meridionali. *Studii și. Cercetări de Geologie*, 48: 21-47.
- Pană, D., Balintoni, I., Heaman, L. & Creaser, R. 2002, The U-Pb and Sm-Nd dating of the main lithotectonic assemblages of the Eastern Carpathians, Romania. *Geologica Carpatica*, 53: 177-180.