ON THE LATE PERMIAN AGE (258.3 ± 2.5 MA) AND TECTONIC SIGNIFICANCE OF THE CATARACTE PEGMATITIC LEUCOGRANITE (VALCEA COUNTY, ROMANIA)

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Abstract. We present new zircon U-Pb age data on a leucogranitic laccolith with pegmatitic textures from Cataracte (Valcea County, Romania). The Cataracte body is an S-type granite which was not deformed by regional metamorphism and intrudes into the Sebes Lotru Terrane (SLT) of the Dacia Super-terrane. SLT was metamorphosed to amphibolite facies during continental collision marking the Variscan orogeny (325–350 Ma) and is cross-cut by numerous pegmatitic dikes and sills of syn to late kinematic origin previously dated by zircon U-Pb at 317–325 Ma. In contrast, zircons from the Cataracte laccolith reveal a much younger, concordant, 258.3 ± 2.5 Ma age. This late Permian age is coincident with the age of tectonic juxtaposition of the SLT against lower grade units along the Sibisel Shear Zone located some 40 km to the north and east in modern coordinates. We conclude that the intrusive rock at Cataracte is a rare magmatic body related to this little acknowledged cryptic collisional event that marks regionally the geologically important closure of Paleo-Tethys.

Keywords: Cataracte, Sebes-Lotru Terrane, leucogranite, Permian, Paleo-Tethys.

Résumé. Nous présentons de nouvelles données géochronologiques (méthode U-Pb sur zircons) de la mise en place d'une intrusion laccolitique de composition leucogranitique dans la région de Cataracte (Comté de Valcea en Roumanie). Le massif de Cataracte est un granite de type S intrusif au sein de la terrane de Sebes Lotru (SLT) et qui n'est pas affecté par la déformation et le métamorphisme régional. Appartenant à la Dacia Super-terrane, la SLT a quant à elle, été métamorphisée dans les conditions du faciès amphibolite au cours de la collision continentale associée à l'orogenèse varisque (325–350 Ma) et est recoupée par de nombreux dykes et sills pegmatitiques syn- à tardi-tectoniques (datés par U-Pb sur zircons à 317–325 Ma). En revanche, les zircons de l'intrusion laccolitique de Cataracte révèlent un âge concordant plus jeune de 258.3 ± 2.5 Ma. Cet âge fini-Permien coïncide avec la phase d'empilement tectonique de la SLT sur les unités de bas grade, le long de la zone de cisaillement de Sibisel située 40 km au NE de la zone étudiée. Par conséquent, nous interprétons le massif intrusif de Cataracte comme un vestige rare de cet événement collisionnel resté cryptique dans la région, marquant la fermeture de la Paléo-Téthys.

Mots-clés: Cataracte, Sebes-Lotru, Terrane, leucogranite, Permien, Paléo-Téthys.

INTRODUCTION

This paper reports some new zircon U-Pb ages on a leucogranite laccolith-like body (hereafter referred to as the Cataracte body) with pegmatitic textures from the Sebes Lotru Terrane (SLT, Balintoni *et al.*, 2014). Previously only a whole rock Pb-Pb isochron age of 333 Ma was reported from this general area in an abstract format (Ledru *et al.*, 1997); the meaning and accuracy of this age or the location could not be evaluated since they were not formally published. Other syn to late kinematic dikes and sills of various pegmatites from the SLT (Hann, 1987 for a detailed early review) were later indeed dated to be of that age (317–325 Ma) by zircon U-Pb (Balintoni *et al.*, 2010a, our own unpublished data). However, this particular igneous body has not been dated, even though it stands out as one of the largest leucogranitic (and pegmatitic) igneous body within the SLT. We show that its age is somewhat surprisingly late Permian and coincident with the development of an important ductile shear zone nearby, one that possibly marks the suture of the Paleo-Tethys regionally. Consequently, we speculate this newly determined age has regional tectonic implications which will be discussed below.

GEOLOGIC BACKGROUND

The basement of Romanian Carpathians (Balintoni, 1997) is made of a various peri-Gondwanan Neo Proterozoic to early Paleozoic arc and back-arc terranes that were accreted to each other and to larger continental masses during the Paleozoic (Balintoni *et al.*, 2014; Ducea *et al.*, 2016). Most likely these terranes formed at the consuming margin of the Rheic ocean (von Raumer *et al.*, 2008, 2013). During accretion they were metamorphosed and in places, were subject to more magmatism. They were further fragmented and shuffled during the Alpine orogeny (e.g. van Hinsbergen *et al.*, 2020; Schmid *et al.*, 2020 and references therein). Unlike in parts of the Alps, no high-grade Alpine metamorphism is superimposed on these Carpathian basement units; Alpine metamorphism is limited to local prehnite-pumpelleyite facies in the South Carpathians (Ciulavu *et al.*, 2008). For more in depth reviews of regional geology, the reader is referred to recent and comprehensive regional review papers by Matenco (2017), Iancu, Seghedi (2017), van Hinsbergen *et al.* (2020), Schmid *et al.* (2008, 2020) and references therein.

In detail, the geologic and especially the petro-tectonic evolution of Carpathian basement terranes continue to be poorly known although much progress has been made recently on deciphering ages of protoliths (Balintoni *et al.*, 2009, 2010a, 2014) and metamorphism (Dragusanu, Tanaka, 1999, Medaris *et al.*, 2003; Ducea *et al.*, 2016). Still, correlations between various units and timing of their assembly are far from being resolved. The SLT (Fig. 1) as the largest single coherent basement unit of the Romanian Carpathians, is located in the South Carpathians and occupies the bulk of the Sebes and Lotru Mountains as well as nearby ranges (Balintoni *et al.*, 2014). It is part of the Getic nappe or thrust sheet (Iancu *et al.*, 2005) which structurally lies on top of a Jurassic oceanic thrust sheet, the Severin (not pictured in Fig. 1 a). The structure was developed in the earliest Cretaceous, although precise ages of thrusting have yet to be determined. Together with the units structurally above it, the SLT forms the Median Dacides of Sandulescu (1984), also known as Dacia Super-terrane (sometimes referred to as Dacia Mega-Unit). The SLT does have a latest Paleozoic unmetamorphosed cover in a few places and is also locally covered by some younger sedimentary rocks of the Alpine cycle (Iancu *et al.*, 2005).

The SLT comprises a latest Precambrian (Ediacaran, 560–580 Ma) thin continental crustal basement exposed in the southern parts of the SLT, and named the *Lotru Metamorphic Unit* (Balintoni *et al.*, 2010a). This thin arc basement unit was invaded by an arc formed at about 440–480 Ma, with a high flux peak in the Mid-Ordovician at 466 Ma (Stoica *et al.*, 2016, Balintoni *et al.*, 2010a, Ducea *et al.*, 2018) (Fig. 1 b). This unit, which is dominated by mafic to intermediate volcanic arc successions (now metamorphosed) is known as the *Cumpana Metamorphic Unit* (Balintoni *et al.*, 2010a). There are inherited zircon indications that this Ordovician-Silurian arc was formed off-shore the main Gondwanan mass but close to the present Arabian-Nubian shield. Consequently, the terrane is characterized by few zircons of ages older than 1 Ga. The latest magmatic manifestations of this peri-Gondwanan arc were in the earliest Silurian (440 Ma, the Cozia gneiss) and together, these two units were metamorphosed during the Carboniferous (Medaris *et al.*, 2003).

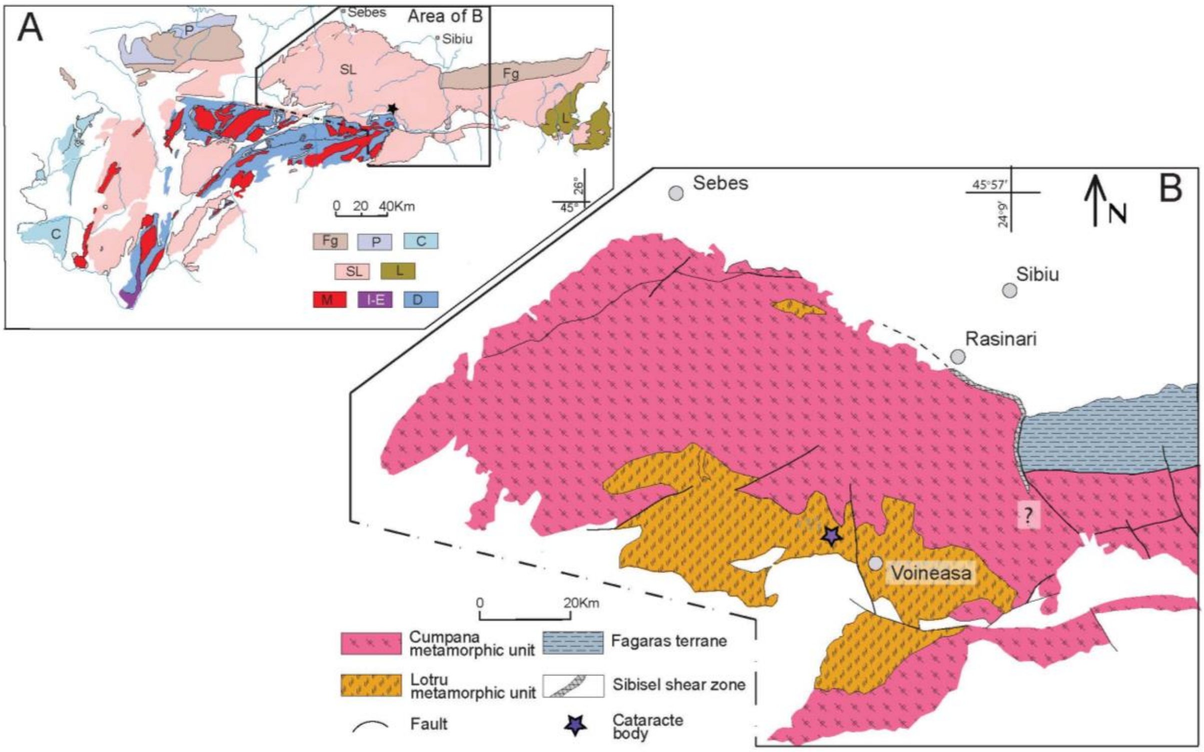

Fig. 1. A. Major elements of the basement units in the South Carpathians (modified after Balintoni *et al*., 2010a). Terranes: SL – Sebes Lotru, L – Leaota, Fg – Fagaras, P – Pades, C – Caras, D – Danubian. Other elements: I – E Iuti Eibental ophiolite, M – various pre-Alpine un-metamorphosed magmatic rocks. Areas in white are younger rocks (Mesozoic and younger). This map contains no structural elements for simplicity. B. A more detailed map of the central part of the South Carpathians showing the location of the Cataracte body and the main geographic locations and geologic elements discussed in text. The outline of the Lotru and Cumpana metamorphic units is from Balintoni *et al.* (2010a). Only some minor later faults are shown in this figure, but no major tectonic elements of the Alpine fold and thrust belt, which is of no significance in this paper.

Regional geology of the SLT in the central south Carpathians is more complex than the representation of the Lotru and Cumpana Metamorphic units depict in our text and Figure 1b. Other regional papers and geologic maps present a more complex division of units (e.g. Sabau, 1994; Stelea, 1994; Hann, 1995), but the simplicity of the Balintoni *et al.* (2010a) unit presentation – a latest Precambrian thin basement unit intruded by a massive transitional arc unit of Ordovician age – captures the bulk of SLT basement geology. One additional important regional unit is the Negovanu Mare formation (not pictured on our simplified map, but seen in the map of Stelea, 1999), a metasedimentary (mica schists, quartzites) unit, which may be lying unconformably over these arc terranes, hence it was probably deposited later. Nevertheless, the Negovanu Mare formation, as well as the rest of the Cumpana and Lotru units were metamorphosed together during the Variscan collisional orogeny.

In the SLT, regional metamorphism primarily of amphibolite facies is documented to be Carboniferous, as best determined by garnet 317–355 Ma Sm-Nd isochron ages (Medaris *et al.*, 2003). Numerous meter- to decameter dikes and sills of S-type pegmatitic leucogranites or simply "pegmatites" (Hann, 1987) intrude and mostly cross-cut the metamorphic fabric. Their age has been determined to be around 317–325 Ma in a few places in the Sebes, Cibin and Lotru Mts (Balintoni *et al.*, 2010a, Ducea, in progress, 2021) indicating that this age range seals the ductile deformation. While not properly interpreted as such in the literature, these leucogranites are syn to late collisional products marking the latest stages of compression that generated regional amphibolite facies metamorphism here. This age is widely recognized regionally to represent a Variscan event. It marks the timing of a Himalayan-style collision (Stern, 1994, von Raumer *et al.*, 2013) that was followed in many places throughout Europe by extensional collapse in the earliest Permian (Menard, Molnar, 1988).

The Cataracte body (Manecan, 1985, Hann, 1987) is a poorly exposed pegmatitic leucrogranite intruded into the Lotru Metamorphic Unit of the SLT in the southern part of the Lotru Mts., some 10 km NW of the town of Voineasa (Valcea County), along the Lotru river (Savu, Schuster, 1975). Its best exposures are found in a region where the Lotru river cuts a short but deep gorge into this granitoid. The name of the body (meaning "waterfalls" in Romanian) comes from the waterfalls formed by the Lotru river in that area. The body has a laccolith like shape that is about 3x2 km in horizontal dimensions and about 0.8 km in vertical dimension. The overall shape of the body is determined by outcrop mapping (Savu, Schuster, 1975) but also from many km of mining adits and boreholes that were dug into the body for geologic prospecting and white mica mining work during the 1970s and 1980s in Communist Romania.

At outcrop levels, the body contains numerous large enclaves of the metamorphic rocks nearby and is not as uniform as it may appear at larger scale; its appearance at small scale is more of a network of hundreds of sills intruded into the metamorphic basement which at the geologic map scale (Savu, Schuster, 1975) takes the shape of a laccolith. Detailed studies indicate some zoning at the scale of the intrusion, with an outer domain richer in mafic minerals (Hann, 1987). It is pegmatitic in most places, with crystal as large as many cm. Petrographically, it is a low temperature, S-type leucogranite dominated by quartz, k-feldspar commonly with myrmekitic textures, two micas, and almandinic garnet in places. Zircon, tourmaline and apatite are common accessory minerals; however, the intrusion is free of rare accessory minerals found commonly in pegmatites worldwide. The S-type character of this leucogranite is evident from whole-rock major, trace elements as well as high radiogenic isotopes (with measured ^{87}/Sr/^{86}Sr ratios as high as 0.9) (Ducea *et al.*, 2021, unpublished). In places, the Cataracte body appears concordant (even at large scale, hence its laccolithic appearance) but it is clearly not internally deformed. The great majority of outcrops display igneous textures that suggest that it clearly postdates the Variscan regional metamorphism.

SAMPLE AND METHODS

Sample V15 (N45.465911/E23.871381) was collected from the core of the Cataracte body in an outcrop along the Lotru river. It is a fresh, coarse grained pegmatitic granitoid with major quartz, k-feldspar, plagioclase, muscovite and biotite visible in hand specimen and apatite, tourmaline and zircon found as accessory minerals and seen only in thin section. The studied sample is an S-type granite, which is significantly more radiogenic than most of the SLT (Ducea, unpublished data), due to the high Rb/Sr ratio, in turn constrained by the abundant micas and alkali-feldspars.

The zircons from the sample were extracted using the traditional method of crushing, sieving, heavy liquid separation, magnetic separation and hand-picking. The ~40 zircon grains were then mounted on epoxy with SL, R33 and FC zircon grains used as primary and secondary standards (see detailed method and analytical procedure in Pullen *et al.*, 2018). Growth features and morphology of each zircon grains were identified using cathodoluminescence (CL) images using the Gatan ChromaCL2 scanning electron microscope in the Arizona LaserChron SEM Lab. Spot locations for analysis were then picked using the CL images to locate core and rim boundaries in complex zircons. In situ isotopic analysis of the zircons was conducted using the Thermo Element2 single-collector inductively coupled plasma mass spectrometry (ICPMS) coupled to a Photon Machines Analyte G2 Excimer Lasers at the Arizona LaserChron Center (ALC) (Gehrels *et al.*, 2006, 2008; Gehrels, Pecha, 2014). The U-Pb age for each analysis was then calculated using the ALC in-house software

E2agecalc, and for concordant subsets, a weighted average age was calculated using Isoplot 4.15 (Ludwig, 2008).

RESULTS

We measured 30 individual crystals from sample V15 (Table 1). Zircons from Cataracte are typically high U with values as high as 12% U, but commonly in the range of 2000–3000 ppm U. These zircons also have high U/Th ratios, typically in excess of 100. Only one measured crystal is inherited and had an age of 540 Ma, which is typical for the Lotru Metamorphic Unit of the SLT. Most crystals are inclusions-free, euhedral or subhedral and about 100–200 microns in their long dimension, suggesting a magmatic origin (despite the large U/Th).

Several of the analyzed grains are metamict, as seen in the secondary electron (SE) or backscattered (BSE) images taken on the SEM. Most of these crystals are not zoned in BSE images or luminescent in CL (Fig. 2). A few non metamict crystals do show some complex crystallization zoning (Fig. 2), however their age is the same as those of the metamict crystals and do not display any discernable age trends from core to rim.

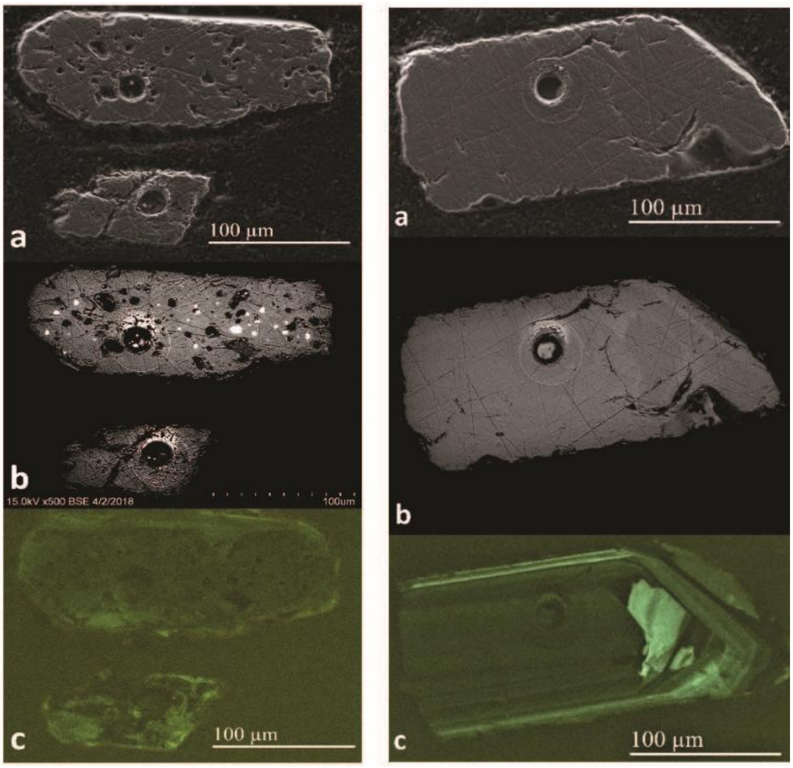

Fig. 2. SEM images of metamict (left panel) and non-metamict (right panel) zircons from the Cataracte pegmatite. In each panel (a) represents a secondary electron (SE) photograph, (b) a backscattered (BS) image, and (c) a cathodoluminescence image. The SE and BS scales are identical.

Excepting the inherited age, the remainder of ages were evaluated on concordance. Those grains that are discordant were not further used in age calculation, whereas the 23 grains that passed the concordance test were pooled into a 258.3 ± 2.5 Ma age with a mean of 258 ± 1.7 Ma at a confidence level of 95% with a MSWD of 2.1 (Figure 3). This is the first late Permian age of a granitoid in the SLT and in the South Carpathians in general. Similar age (250–270 Ma) pegmatites are however described from the western Carpathians and Pannonian regions (Slovakia and Hungary) (Uher, Broska, 1996; Poler *et al.*, 2002). Similar age granites are also found in the foreland east of the modern Carpathians in North Dobrogea (Balintoni *et al.*, 2010b), but they represent a distinct geologic block not relatable to the Dacia Superterrane in particular.

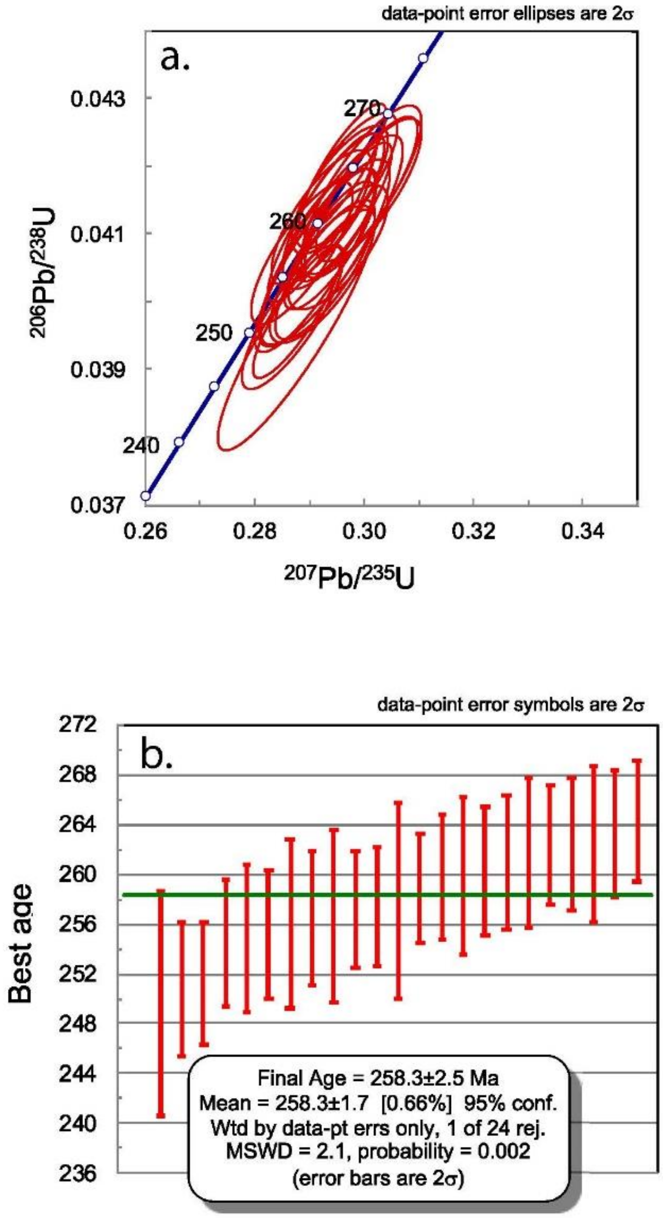

Fig. 3. (a). Concordia diagram for sample V15 with data point ellipses plotted at 2 sigma. (b) Best age for sample V15 based on $^{238}U/^{206}Pb$ ages pooled among concordant grains. Drawn with a modified version of Isoplot 3.7 (Ludwig, 2008).

Table 1

Zircon U-Pb data for sample V15, Cataracte body (provided as separate excel sheet, but also available at *osf.io* as described under the Acknowledgment section)

Table1. U-Pb geochronologic analyses for sample V15

Analysis	U (ppm)	206Pb/204Pb	U/Th	206Pb*/207Pb*	± (%)	Isotope ratios: 207Pb*/235U*	± (%)	206Pb*/238U	± (%)	error corr.	Apparent ages (Ma): 206Pb*/238U*	± (Ma)	207Pb*/235U	± (Ma)	206Pb*/207Pb*	± (Ma)	Best age (Ma)	± (Ma)
-SAMPLE 1 Spot 4	60484	7833	66.0	16.5022	3.6	0.3166	4.1	0.0379	1.8	0.44	239.9	4.2	279.3	9.9	624.0	78.6	239.9	4.2
-SAMPLE 1 Spot 32	4365	27225	534.9	18.2943	1.5	0.2950	1.8	0.0392	1.1	0.59	247.6	2.6	262.5	4.2	397.4	33.0	247.6	2.6
-SAMPLE 1 Spot 21	3003	5405099	542.7	19.0385	0.9	0.2858	2.1	0.0395	1.8	0.90	249.6	4.5	255.3	4.6	307.3	20.6	249.6	4.5
-SAMPLE 1 Spot 17	5274	193845	912.9	19.1606	0.7	0.2853	1.3	0.0397	1.1	0.83	250.8	2.7	254.9	3.0	292.8	16.6	250.8	2.7
-SAMPLE 1 Spot 11	1933	85585	174.1	19.0277	0.6	0.2878	1.2	0.0397	1.0	0.87	251.2	2.5	256.8	2.6	308.7	13.1	251.2	2.5
-SAMPLE 1 Spot 35	3486	201503	425.7	19.0608	0.9	0.2912	1.3	0.0403	1.0	0.76	254.5	2.6	259.5	3.1	304.7	19.8	254.5	2.6
-SAMPLE 1 Spot 24	4427	13535	130.8	17.0674	1.8	0.3257	2.2	0.0403	1.2	0.55	254.9	3.0	286.3	5.4	551.0	39.8	254.9	3.0
-SAMPLE 1 Spot 26	2181	190684	140.9	19.0338	0.8	0.2923	1.3	0.0404	1.0	0.80	255.1	2.6	260.4	3.0	307.9	17.5	255.1	2.6
-SAMPLE 1 Spot 14	2288	199397	203.7	19.2019	0.8	0.2908	1.6	0.0405	1.4	0.87	256.0	3.4	259.2	3.6	287.8	17.9	256.0	3.4
-SAMPLE 1 Spot 34	2054	65404	173.1	19.3707	0.8	0.2888	1.3	0.0406	1.1	0.80	256.5	2.7	257.6	3.0	267.8	18.2	256.5	2.7
-SAMPLE 1 Spot 31	2886	510359	128.3	19.1878	0.9	0.2917	1.6	0.0406	1.4	0.84	256.6	3.5	259.9	3.8	289.5	20.5	256.6	3.5
-SAMPLE 1 Spot 28	3279	84092	134.4	19.0216	0.9	0.2949	1.3	0.0407	0.9	0.73	257.1	2.3	262.4	2.9	309.4	19.5	257.1	2.3
-SAMPLE 1 Spot 18	2161	700599	109.4	19.1638	0.7	0.2929	1.2	0.0407	0.9	0.82	257.4	2.4	260.9	2.7	292.4	15.2	257.4	2.4
-SAMPLE 1 Spot 22	1642	39380	191.0	19.0651	0.9	0.2951	1.8	0.0408	1.6	0.86	257.9	3.9	262.5	4.2	304.1	21.4	257.9	3.9
-SAMPLE 1 Spot 19	2173	94468	153.8	19.2440	0.8	0.2935	1.2	0.0410	0.9	0.75	258.9	2.2	261.3	2.7	282.9	17.8	258.9	2.2
-SAMPLE 1 Spot 10	2056	202394	162.9	19.4331	0.8	0.2917	1.3	0.0411	1.0	0.78	259.9	2.5	259.9	2.9	260.5	18.3	259.9	2.5
-SAMPLE 1 Spot 15	2656	82244	155.7	19.3955	0.6	0.2923	1.4	0.0411	1.2	0.89	259.9	3.1	260.4	3.2	264.9	14.6	259.9	3.1
-SAMPLE 1 Spot 30	1922	613569	150.0	19.2131	0.6	0.2955	1.2	0.0412	1.0	0.85	260.2	2.6	262.9	2.8	286.5	14.2	260.2	2.6
-SAMPLE 1 Spot 25	2182	88934	161.5	19.3355	0.7	0.2944	1.3	0.0413	1.1	0.83	260.9	2.7	262.0	3.0	272.0	16.6	260.9	2.7
-SAMPLE 1 Spot 29	2298	65056	133.3	19.0484	0.8	0.2997	1.4	0.0414	1.2	0.84	261.7	3.0	266.2	3.3	306.2	17.4	261.7	3.0
-SAMPLE 1 Spot 12	1916	61409	164.7	19.3407	0.8	0.2960	1.2	0.0415	0.9	0.77	262.4	2.4	263.3	2.8	271.3	17.7	262.4	2.4
-SAMPLE 1 Spot 20	2118	608450	131.6	19.0811	0.8	0.3001	1.3	0.0415	1.0	0.79	262.4	2.7	266.5	3.1	302.3	18.5	262.4	2.7
-SAMPLE 1 Spot 16	2238	748320	172.5	19.1663	0.9	0.2988	1.5	0.0416	1.2	0.81	262.4	3.1	265.4	3.5	292.1	20.1	262.4	3.1
-SAMPLE 1 Spot 23	2017	3461416	170.6	19.4171	0.8	0.2958	1.3	0.0417	1.0	0.77	263.2	2.5	263.2	2.9	262.3	18.5	263.2	2.5
-SAMPLE 1 Spot 27	2336	238860	114.4	19.5264	0.6	0.2954	1.1	0.0418	0.9	0.86	264.3	2.4	262.8	2.5	249.4	13.0	264.3	2.4
-SAMPLE 1 Spot 3	1807	4252	151.6	12.6748	3.8	0.4794	3.9	0.0441	1.1	0.28	278.1	3.0	397.7	12.9	1168.7	74.5	278.1	3.0
-SAMPLE 1 Spot 7	3502	3931	79.5	12.4236	3.7	0.4895	3.9	0.0441	1.0	0.26	278.3	2.8	404.6	12.9	1208.2	73.2	278.3	2.8
-SAMPLE 1 Spot 5	32481	1579	206.1	9.3869	6.5	0.6549	8.6	0.0446	5.7	0.66	281.3	15.8	511.5	34.7	1740.1	118.6	281.3	15.8
-SAMPLE 1 Spot 9	4586	2427	195.1	9.9431	5.1	0.6333	5.4	0.0457	1.6	0.29	288.0	4.4	498.1	21.1	1633.9	95.5	288.0	4.4
-SAMPLE 1 Spot 8	41306	64330	95.9	20.1557	0.9	0.3280	2.8	0.0480	2.6	0.94	302.0	7.6	288.0	6.9	175.9	22.0	302.0	7.6
-SAMPLE 1 Spot 1	218	77600	2.8	17.2738	1.0	0.7005	1.9	0.0878	1.6	0.84	542.5	8.5	539.1	8.1	524.7	23.0	542.5	8.5

INTERPRETATIONS

High U/Th ratios are rather common in South Carpathian pegmatites (Balintoni *et al.*, 2010a) and probably owe this to sequestration of Th in the source in the form of monazite. However, unlike the smaller pegmatitic dikes and sills previously measured from the SLT, which were all dated at 317–325 Ma, the Cataracte body is much younger. Another significant difference is that the smaller dikes and sills have a large proportion of inherited grains among their zircon population (>50%), whereas in the case of Cataracte body, the great majority of analyzed zircons reveal their crystallization age. Only one out of 30 grains is inherited. Given the U-rich nature of the measured grains, it is not surprising that many of the crystals are metamict. However, given that most ages are concordant, we interpret that the pooled age of 258.3 ± 2.5 Ma is geologically significant and represents the crystallization age of this body.

Is there a tectonic event to which this intrusion is to be connected? Recently, Ducea *et al.* (2016) have shown that the Sibisel Shear zone located some 40 km to the north and east (Fig. 1b) was probably active as a major ductile structure in the latest Permian. This important steep compressional ductile structure (Pana, Erdmer, 1994; Hann, 1995) juxtaposed the SLT against the Rausorul Cisnadioarei Series, a greenschist facies meta andesite dominated unit that, unlike the SLT, was metamorphosed during the Ordovician (Ducea *et al.*, 2016). The ages of mylonitization in the shear zone (near the village of Rasinari) are rather poorly constrained by Rb-Sr isochron ages and span the late Permian and possibly earliest Triassic (270–249 Ma) (Ducea *et al.*, 2016). We speculate that the soft collision or transpressional event interpreted to have generated the Sibisel Shear Zone (Ducea *et al.*, 2016) is responsible for the melting event that produced the Cataracte laccolith, since it is the only regional tectonic event of that age and is a process that commonly produces S-type granites by *self ignition* of high U metasedimentary rocks in thickened crust.

The larger significance of the Sibisel Shear Zone remains somewhat unresolved but it clearly juxtaposes two peri-Gondwanan terranes of similar igneous origin but very different metamorphic histories prior to their assembly in the Permian. This is a likely candidate to represent a - or <u>the</u> suture of the Paleo-Tethys in the Romanian Carpathians.

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