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U/Pb ZIRCON GEOCHRONOLOGY ON TTG ROCKS FROM SOUTH CARPATHIANS (ROMANIA): INSIGHTS INTO THE GEOLOGIC HISTORY OF THE GETIC CRYSTALLINE BASEMENT

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Abstract: In situ U/Pb zircon geochronology was carried out on some minor granitoids intrusions from the western Getic domain (Buchin and Slatina-Timis intrusions) and on the swarm of trondhjemitic dikes, sills and small granodiorite bodies from the northern Getic domain - South Carpathians. According to previous petrological studies these intrusions are related to partial melting of a thickened continental crust (Dobrescu 2001, 2004; Dobrescu et al. 2008). Most of the dated zircon crystals are composite, with xenocrystic cores surrounded by multiple overgrowths. Age results on inherited cores of the Buchin and Slatina-Timis intrusions reveal ages from Neoarchean to Late Proterozoic-Cambrian that represent inheritance from old crust. As revealed by ages from zircon overgrowths characterised by oscillatory zoning, the intrusion occurred in the Upper Cambrian-early Silurian. The outer rims of the Buchin zircons record the Variscan metamorphic peak conditions suffered by the Getic basement. The U-Pb ages on inner cores from rocks of the northern Getic domain reveal Paleoproterozoic to Neoproterozoic inheritance. Prevalent ages in zircon cores and rims are in the range 539-428 Ma and seem to date a major component forming the Caledonian crustal basement of the South Carpathians. Scarce but ubiquitous ages of 320-214 Ma on rims overlap the $^{40}Ar/^{39}Ar$ ages (Dallmeyer et al. 1994) on mylonites from the shear-zone and indicate imprints of the late Variscan dynamic retromorphism. The magmatic intrusion occurred between 110 Ma and 105 Ma in agreement with previous Ar/Ar ages (109-108 Ma; Dobrescu and Smith 2000).

Keywords: South Carpathians, Getic crystalline basement, granitoids, U/Pb zircon age.

1. Introduction

Various types of granitoids of different outcropping dimensions randomly intrude the Romanian South Carpathians. Most of them are restricted to the basement of the southern Danubian domain that was mainly emplaced during the Pan-African post-collision period (Berza et al., 2000). Two Variscan calc-alkaline granitoid plutons (Sichevita and Poniasca) outcrop in the crystalline basement of the northern Getic domain. Several alkaline to calcalkaline large granitoid plutons known as “Banatites” intruded the Getic domain during the mid-Alpine (Laramian) orogeny. They belong to “the Banatite magmatic and Metalogenetic Belt” (Berza et al., 1998) that is a 1000 km long belt going from northern Apuseni Mountains through South Apuseni- Banat-Timok-Srednegorie to the Black Sea.

Some of the major granitoid intrusions have been already dated. SHRIMP age data indicate an intrusion age of 311±2 Ma for the Poniasca biotite diorite (Duschesne et al., 2008). U/Pb zircon ages, Re/Os ages and molibdenite ages on the plutonic Banatites range between 75.5 and 79.6 Ma (Nicolescu et al., 1999; Ciobanu et al., 2002). Geochronological data on the smaller intrusions that occasionally show a peculiar geochemical affinity (Savu, 1997; Dobrescu, 2001; 2004) are scarce. This hampers large-scale correlations and do not allow to have a time-dependent view of the magmatic evolution in the Getic domain. In this work, in situ U/Pb zircon geochronology was carried out on some minor intrusions: i) the intrusions of Buchin (BG) and Slatina-Timis (STG) in the western Getic domain and ii) the swarm of trondhjemite dikes, sills and small granodiorite bodies (TGSCF) from the northern Getic domain.

2. Geology of BG-STG and TGSCF

The BG and STG granitoid intrusions (the biggest - of 12/1.6 km^2 and 2/0.6 km^2 outcropping area) and other smaller ones are exposed in the western part of the Getic domain (NE Semenic Mountains) and intrude the medium-high grade Precambrian crystalline basement (Fig. 1). According to Dobrescu (2004) BG and STG are trondhjemite-tonalite-granodiorite rocks forming co-genetic intrusions with adakitic geochemical affinity, similar to that described as K-adakites by Xiao and Clemens (2007). Dehydration partial melting of a heterogeneous material at the base of a thickened continental crust has been inferred as a possible genetic process. No geochronological data are available for these intrusions but some authors presumed Precambrian or Lower Paleozoic (Savu and Micu, 1964) or Variscan ages (Barlea, 1975; Iancu, 1996 in Savu, 1997) on structural data basis.

Trondhjemites, tonalites and granodiorites characterised by gneissic structure and a medium to fine granulation are the major lithologies of the BG and STG intrusions (described by Savu and Micu, 1964; Savu, 1979). Trondhjemites consists of quartz, zoned plagioclase (An_{28-30}), biotite and scarce microcline; the granodioritic parts have more microcline, K-feldspars usually interstitial and occasionally substituting plagioclase. Sphene, allanite, apatite, zircon and magnetite are accessory phases. Tonalites consist of plagioclase (An_{25-28}), deformed quartz, green hornblende, biotite and accessory sphene, allanite, apatite, zircon and opaque.

The TGSCF magmatic system (around 300 occurrences) outcrops on an area of about 1200 km^2 along the Rasinari shearing zone (RSZ) in the north Getic Domain (Sebes-Cibin-NW Fagaras mountains) (Fig. 1). The TGSCF rocks have been described as trondhjemites and granodiorites (Dobrescu, 2001). Porphyritic trondhjemites occur as sills and dikes whereas granodiorites as small intrusive bodies. In the porphyritic trondhjemites phenocrysts of zoned plagioclase ($An_{6.8-29}$), quartz, biotite and rare hornblende are dispersed in a microcrystalline groundmass. The accessories are zircon, apatite, ilmenite, epidote, sphene, rutile, pirite and magnetite. The granodiorites are medium to coarse-grained rocks consisting of plagioclase, quartz, K-feldspar, biotite with accessory zircon, apatite, and sphene. According to Dobrescu et al. (2008) TGSCF rocks have a high-SiO_2 adakitic geochemical affinity and their petrogenesis is likely related to melting of an underplated enriched lower crust.

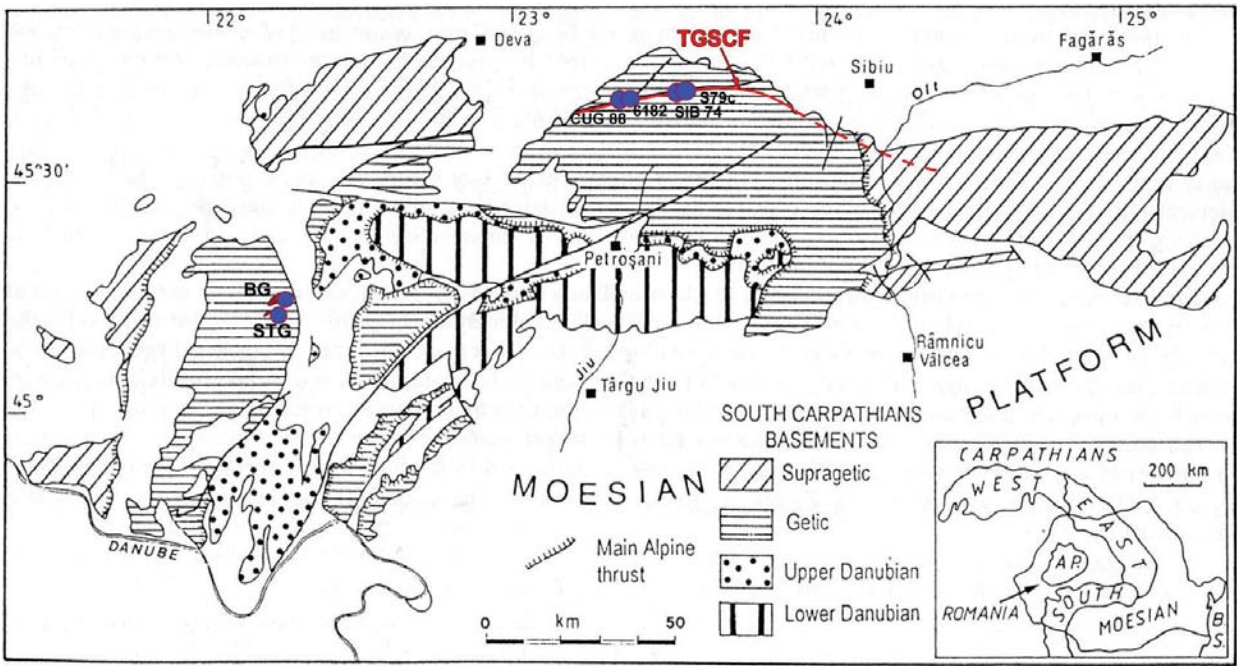

Fig. 1. Geological skech-map of the South Carpathians (modified from Kraütner et al., 1988 in Liegeois et al. 1996) with the emplacement of the Buchin and Slatina-Timis granitoids (BG-STG – red spots) and the swarm of trondhjemite dikes, sills and granodiorite bodies from N Getic domain (Sebes-Cibin-NW Fagaras mountains) (TGSCF alignment - red line); blue dots proximate location of samples collection.

Tab. 1. Location of the dated samples.

Granitoid	Sample	Rock type	Location	GPS coordinates
BG - pluton	BUCH	granodiorite	Semenic Mts.-S Buchin body	N49^0 49' 18" E28^0 52' 30"
STG - phacolith	Sl-T	trondhjemite	Semenic Mts.-Slatina-Timis	N49^0 42' 53" E28^0 57' 15"
TGSCF- sill	S79c	porphyritic trondhjemite	Sebes-Cibin Mts.-Cetatelei Brook	N50^0 12' 34" E30^0 28' 2"
TGSCF- dyke	6182	porphyritic trondhjemite	Sebes-Cibin Mts.-Romosel valley	N50^0 8' 53" E30^0 10' 22"
TGSCF- body	CUG88	granodiorite	Sebes-Cibin Mts.-Cugiru Mare valley	N50^0 10' 51" E30^0 19' 42"
TGSCF- body	SIB74	granodiorite	Sebes-Cibin Mts.- Sibisel valley	N50^0 8' 14" E30^0 7' 21"

3. Geochronology

Six samples of granitoids were considered in this study: a granodiorite from BG (sample BUCH), a trondhjemite from STG (sample Sl-T), two porphyritic trondhjemites (samples S79c and 6182) and two granodiorites (samples CUG88 and SIB74) from TGSCF (Tab. 1). Zircon crystals form each rock were sieved as fraction of less than 0.2 mm and between 0.2-0.4 mm, then separated by panning, heavy liquids, and hand picking. Grains were mounted in epoxy resin and polished down to 0.25 microns with diamond paste. Pb geochronology was carried out at the CNR - Istituto di Geoscienze e Georisorse - U.O. Pavia (Italy) using an ArF excimer laser ablation microprobe operating at 193 nm (Geolas200Q-Microlas) coupled with a HR-ICP-MS (Element-ThermoFinnigan). Prior to U-Pb dating, internal structure of zircon grains was characterised by cathode luminescence (CL) at the University of Milan (Italy). Instrumental and laser-induced U/Pb fractionations were corrected using the 1065 Ma 91500 zircon (Widenbeck et al., 1995) as an external standard. The same integration intervals and spot size were used on both the external standard and unknowns. During each analytical run, the reference zircon 02123 was analysed together with unknowns for quality control: the mean Concordia age resulted 297±10 Ma in agreement with the reference value of 295 Ma (Ketchum et al., 2001). The spot size was set to 20 or 10 μm and laser fluency at 12J/cm^2. Analytical details and method are fully described in Tiepolo (2003). Data reduction was carried out using the "Glitter" software package (van Achtenberg et al., 2001). During each analytical run the reproductibility on the standards was propagated to all determinations according to the equation reported in Horstwood et al. (2003). After this operation, analyses are considered accurate within quoted errors. Concordia ages were determined and plotted using the Isoplot/EX 3.0 software (Ludwig, 2000).

3.1. Age results on BG and STG intrusions

Thirteen zircon crystals were separated from the BG granodiorite. Only one zircon was found in the STG trondhjemite sample. The majority of zircon crystals are prismatic, but also stubby crystals are present and CL analyses (Fig. 2) reveal a composite structure with inherited xenocrystic cores surrounded by multiple overgrowths. Xenocrystic cores are either homogeneous with high CL emission or characterised by oscillatory zoning. At least two events of overgrowth on the xenocrystic core can be distinguished: i) an inner overgrowth usually showing oscillatory zoning typical of growth under magmatic conditions; ii) an outer overgrowth characterised by a low CL emission and homogeneous structure. In the single zircon from the STG sample the homogeneous low CL overgrowth is missing.

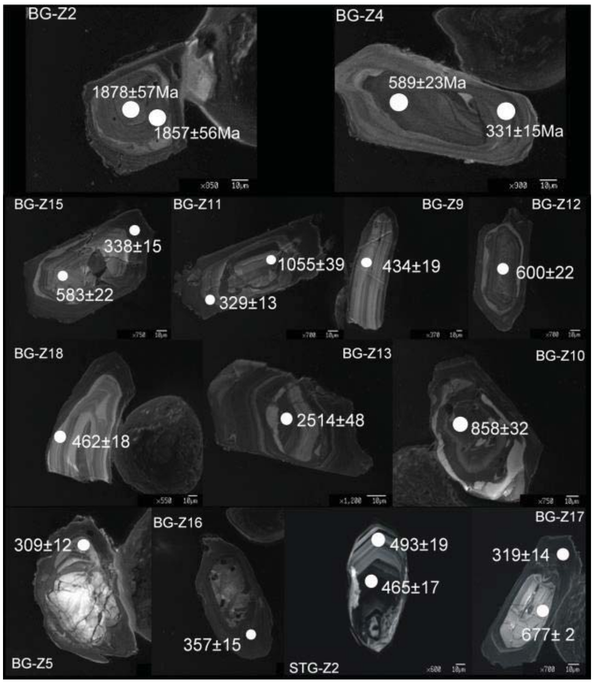

Fig. 2. CL images of the BG-STG zircon crystals and the analysed spots.

Seventeen analyses were performed on the different zircon domains from the BG sample and two analyses on the STG zircon (Tab. 2a). The following discussion is based only on U-Pb concordant data; the few discordant results were neglected because apparent geological meaningless. The xenocrystic cores yielded ages from Neoarchean to

Tab. 2a. LA-ICP-MS age results for BG and STG samples.

Sample	Zircon	Run#	Spot size (μm)	Isotopic ratios						Apparent ages							
				$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ	Concordia Age	2σ
BG	2-core	Se21b043	20	0,121	0,003	0,332	0,007	5,458	0,187	1971	45,4	1846	39	1894	65	1878	57
BG	2-mid rim	Se21b044	20	0,115	0,003	0,334	0,007	5,221	0,180	1880	43,9	1858	40	1856	64	1857	56
BG	4-core	Se21b045	20	0,059	0,002	0,096	0,002	0,779	0,028	558	14,4	590	12	585	21	589	23
BG	4-rim	Se21b046	20	0,054	0,002	0,053	0,001	0,395	0,018	373	13,9	331	7	338	15	331	15
BG	5-rim	Se24a005	20	0,053	0,002	0,049	0,001	0,355	0,010	331	11,4	309	6	309	9	309	12
BG	5-core	Se24a006	20	0,112	0,004	0,251	0,005	3,824	0,114	1838	65,9	1444	29	1598	48	---	---
BG	8-mid rim(core?)	Se24a007	20	0,165	0,005	0,081	0,002	1,846	0,049	2505	81,5	503	10	1062	28	---	---
BG	9-outer rim	Se24a008	20	0,065	0,002	0,048	0,001	0,415	0,013	761	27,8	301	6	353	11	---	---
BG	9-inner rim(core?)	Se24a009	20	0,058	0,003	0,070	0,002	0,541	0,027	523	27,7	434	10	439	22	434	19
BG	10-outer rim	Se24a010	20	0,531	0,017	0,043	0,001	3,150	0,084	4329	140	273	6	1445	39	---	---
BG	10-core	Se24a012	20	0,068	0,003	0,143	0,003	1,309	0,047	862	35,5	861	18	850	31	858	32
BG	11-outer rim	Se24a013	20	0,162	0,005	0,055	0,001	1,232	0,033	2480	81	345	7	815	22	---	---
BG	11-core	Se24a014	20	0,075	0,003	0,178	0,004	1,826	0,059	1060	39	1055	23	1055	34	1055	39
BG	11-outer rim	Se24a015	20	0,055	0,002	0,052	0,001	0,391	0,010	410	13,4	328	7	335	9	329	13
BG	12-core	Se24a016	20	0,059	0,002	0,098	0,002	0,792	0,023	573	20	603	12	592	17	600	22
BG	12-rim	Se24a017	20	0,210	0,007	0,067	0,001	1,942	0,055	2904	96	418	9	1096	31	---	---
BG	13-outer rim	Se24a018	20	0,522	0,017	0,041	0,001	2,892	0,076	4305	140	257	5	1380	36	---	---
BG	13-core	Se24a019	20	0,169	0,005	0,471	0,009	10,85	0,283	2543	82,9	2486	47	2510	65	2514	48
BG	15-inner rim	Se24a020	20	0,059	0,002	0,095	0,002	0,768	0,024	563	20,5	584	12	579	18	583	22
BG	15-outer rim	Se24a021	20	0,053	0,002	0,054	0,001	0,385	0,013	332	12,2	339	8	331	11	338	15
BG	16-mid rim	Se24a022	20	0,049	0,002	0,057	0,001	0,411	0,016	156	6,65	358	8	350	14	357	15
BG	16-core	Se24a023	20	0,344	0,014	0,033	0,001	1,645	0,059	3681	146	207	5	988	35	---	---
BG	17-outer rim	Se24a024	20	0,053	0,002	0,051	0,001	0,353	0,015	332	15	320	7	307	13	319	14
BG	17-core	Se24a025	20	0,062	0,003	0,111	0,003	0,951	0,048	678	36,7	677	15	679	34	677	29
BG	18-outer rim	Se24a026	20	0,105	0,004	0,055	0,001	0,792	0,025	1717	62,2	343	7	592	19	---	---
BG	18-inner rim	Se24a027	20	0,055	0,002	0,074	0,002	0,568	0,020	425	17,3	463	9	457	16	462	18
STG	2-rim	Se24a028	20	0,056	0,002	0,080	0,002	0,616	0,021	458	17,7	494	10	487	16	493	19
STG	2-core	Se24a029	20	0,056	0,002	0,075	0,001	0,582	0,016	470	15,9	464	9	466	13	465	17

Cambrian. The Neoarchean age at 2514±48 Ma is in agreement with the ages obtained on orthogneisses and metagranites from the Sebes-Lotru terrane (2.4–2.6 Ga; Balica, 2007) and with the ages in the upper part of the low-grade Caras unit of the South Carpathians, interpreted as of Saharian provenance (2.5-2.7 Ga; Balintoni et al., 2009). The Early Paleoproterozoic (1878±57 and

Tab. 2b. LA-ICP-MS age results for S79c and 6182 porphyritic trondhjemites samples from TGSCF.

Sample	Zircon	Run#	Spot size (μm)	Isotopic ratios						Apparent ages							
				$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ	Concordia Age	2σ
S79C	z1-rim	Se21a005	20	0,0479	0,003	0,0166	0,0003	0,1105	0,0066	91	5	106	2	106	6	106	4
S79C	z2-iner core	Se21a008	20	0,0694	0,008	0,0163	0,0005	0,1586	0,0189	910	111	104	3	150	18	---	---
S79C	z3-core	Se21a010	20	0,0580	0,001	0,0852	0,0011	0,6820	0,0144	530	11	527	7	528	11	527	13
S79C	z3-rim	Se21a011	20	0,0481	0,002	0,0169	0,0002	0,1117	0,0041	104	4	108	1	108	4	108	3
S79C	z4-outer rim	Se21a012	20	0,0516	0,002	0,0424	0,0005	0,3033	0,0107	266	10	268	3	269	10	268	7
S79C	z4-iner rim	Se21a013	20	0,0600	0,001	0,0869	0,0011	0,7185	0,0143	602	12	537	7	550	11	539	12
S79C	z5-outer rim	Se21a014	20	0,0502	0,002	0,0165	0,0002	0,1139	0,0037	206	7	105	1	110	4	105	3
S79C	z5-mid rim	Se21a015	20	0,0587	0,001	0,0851	0,0010	0,6883	0,0120	555	10	527	6	532	9	528	12
S79C	z5-core	Se21a016	20	0,0569	0,001	0,0863	0,0009	0,6770	0,0105	486	9	534	6	525	8	531	11
S79C	z6-outer rim	Se21a017	20	0,0562	0,008	0,0160	0,0005	0,1145	0,0161	461	66	102	3	110	16	102	6
S79C	z6-core	Se21a018	20	0,0623	0,004	0,1068	0,0020	0,9166	0,0591	684	45	654	12	661	43	654	24
S79C	z7-outer rim	Se21a019	20	0,0468	0,003	0,0161	0,0003	0,1031	0,0056	39	2	103	2	100	5	103	4
S79C	z7-mid rim	Se21a020	20	0,0564	0,007	0,0687	0,0019	0,5267	0,0646	468	58	428	12	430	53	428	22
S79C	z7-core	Se21a021	20	0,0563	0,002	0,0760	0,0010	0,5894	0,0170	462	13	472	6	471	14	472	12
S79C	z8-(outer)rim	Se21a022	20	0,0579	0,002	0,0783	0,0012	0,6231	0,0258	526	22	486	7	492	20	486	14
S79C	z8-core (mid)	Se21a023	20	0,0575	0,002	0,0782	0,0010	0,6199	0,0194	510	16	485	6	490	15	485	12
S79C	z9-iner rim	Se21a025	20	0,0568	0,008	0,0860	0,0014	0,6706	0,0287	483	69	532	9	521	22	531	17
6182	z1-outer rim	Se21a029	20	0,0482	0,003	0,0166	0,0003	0,1097	0,0076	108	8	106	2	106	7	106	4
6182	z1-core	Se21a030	20	0,1425	0,003	0,4006	0,0047	7,7810	0,1318	2258	40	2172	26	2206	37	---	---
6182	z2-rim	Se21a031	20	0,0491	0,003	0,0163	0,0003	0,1104	0,0066	154	9	104	2	106	6	104	3
6182	z2-core	Se21a032	20	0,0555	0,001	0,0707	0,0008	0,5396	0,0135	430	11	441	5	438	11	440	10
6182	z3-core	Se21a033	20	0,0604	0,001	0,1047	0,0012	0,8707	0,0204	618	15	642	8	636	15	641	14
6182	z4-outer rim	Se21a034	20	0,0484	0,003	0,0168	0,0003	0,1110	0,0061	117	7	107	2	107	6	107	4
6182	z4-iner rim	Se21a035	20	0,0729	0,001	0,1656	0,0018	1,6616	0,0308	1011	20	988	11	994	18	990	19
6182	z5-outer rim	Se21a036	20	0,0466	0,002	0,0167	0,0002	0,1071	0,0037	26	1	107	1	103	4	107	3
6182	z5-core	Se21a037	20	0,0553	0,003	0,0744	0,0012	0,5659	0,0294	424	22	462	8	455	24	462	15
6182	z6-rim	Se21a038	20	0,0563	0,002	0,0724	0,0010	0,5606	0,0212	465	18	450	6	452	17	450	12
6182	z7-mid rim	Se21a039	20	0,0555	0,001	0,0619	0,0007	0,4741	0,0087	432	8	387	4	394	7	388	8
6182	z7-core	Se21a040	20	0,0548	0,001	0,0597	0,0007	0,4510	0,0098	403	9	374	4	378	8	374	8
6182	z8-rim	Se21a041	20	0,0488	0,003	0,0162	0,0003	0,1087	0,0065	138	9	104	2	105	6	104	3
6182	z8-rim	Se21a042	20	0,0467	0,004	0,0165	0,0003	0,1063	0,0093	31	3	106	2	103	9	106	4
6182	z9-rim	Se21a043	20	0,0452	0,006	0,0163	0,0004	0,1025	0,0134	0	0	104	3	99	13	104	5
6182	z9-rim	Se21a044	20	0,0486	0,003	0,0157	0,0003	0,1055	0,0061	130	8	101	2	102	6	101	3
6182	z10-outer rim	Se21a045	20	0,0510	0,002	0,0416	0,0006	0,2917	0,0097	239	8	263	4	260	9	263	7
6182	z10-core	Se21a046	20	0,0565	0,001	0,0766	0,0010	0,5959	0,0151	472	12	476	6	475	12	476	12

1857±56 Ma), Mesoproterozoic (1055±39 Ma) and Neoproterozoic (858±32 Ma) ages represent possible inheritance from the Eburnean, Kibaran and Arabian-Nubian orogens (correlation according to Balintoni et al., 2009). The Neoproterozoic-Cambrian ages of 677±29, 600±22, 589±23 and 583±22 Ma were obtained on the xenocrystic cores with oscillatory zoning. Although they could represent inheritance from the country rocks, an origin from the crustal material source of the parental liquids cannot be excluded.

The inner overgrowth with oscillatory zoning is most likely related to the igneous event at the origin of the two intrusions. Ages range from upper Cambrian-Ordovician to early Silurian (493±19 Ma and 465±17 Ma for STG; 462±18 Ma and 434±19 Ma for BG) and confirm the supposed Lower Paleozoic ages inferred from structural information (Savu and Micu, 1964). Data are relatively scattered and do not allow to unequivocally define an intrusion age. After emplacement, the studied rocks underwent a complex metamorphic history (e.g. outer overgrowth; see below) and a partial perturbation of the U-Pb system in the inner sector of the zircon is likely. The magmatic event is thus best represented by the older ages (493-462 Ma; Fig. 3b belonging to the concordia diagram - Fig. 3a).

The outer structureless low CL rims of the BG zircon crystals yield ages at 357±15, 338±15, 331±15, 329±13, 319±15 and 309±12 Ma and are most likely related to the Variscan metamorphic peak suffered by the Getic basement. Data are in agreement with those reported in the literature (e.g., Dallmeyer et al., 1998; Dragusanu and Tanaka, 1999; Ducea et al., 2001; Medaris et al., 2003).

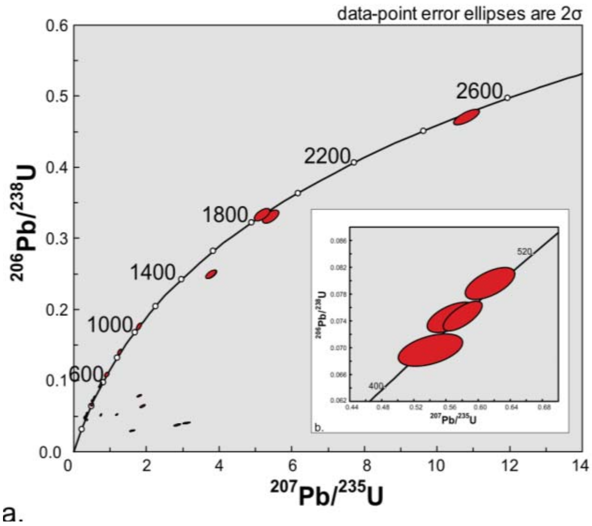

Fig. 3. U-Pb concordia diagram for the BG-STG analysed zircons (a); detail between 490– 470 Ma (b).

3.2. Age results on TGSCF rocks

A total of 85 age data (Tab. 2b, c, d) were obtained

Tab. 2c. LA-ICP-MS age results for SIB74 granodiorite sample from TGSCF.

Sample	Zircon	Run#	Spot size (μm)	Isotopic ratios						Apparent ages							
				$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ	Concordia Age	2σ
SIB74	zr2 core	Se21b006	20	0,0656	0,0017	0,1244	0,0026	1,1226	0,0399	793	20	756	16	764	27	757	29
SIB74	z1-rim	Se21b007	20	0,0710	0,0020	0,1414	0,0028	1,3829	0,0519	956	28	853	17	882	33	857	31
SIB74	1-core	Se21b008	20	0,0738	0,0021	0,1719	0,0036	1,7426	0,0663	1036	30	1023	21	1024	39	1023	38
SIB74	3-rim	Se21b009	20	0,0488	0,0025	0,0164	0,0004	0,1098	0,0061	137	7	105	2	106	6	105	5
SIB74	3-mid rim	Se21b010	20	0,0513	0,0022	0,0163	0,0003	0,1155	0,0056	253	11	104	2	111	5	104	4
SIB74	4-core	Se21b011	20	0,0607	0,0015	0,1012	0,0022	0,8465	0,0303	629	16	622	13	623	22	622	25
SIB74	5-rim	Se21b012	20	0,0581	0,0038	0,0163	0,0004	0,1290	0,0088	533	35	104	3	123	8	---	---
SIB74	5-core	Se21b013	20	0,1780	0,0040	0,3778	0,0075	9,2699	0,3093	2634	59	2066	41	2365	79	---	---
SIB74	6-outer ri	Se21b014	20	0,0470	0,0030	0,0170	0,0004	0,1099	0,0073	48	3	108	3	106	7	108	5
SIB74	6-mid rim	Se21b015	20	0,0467	0,0017	0,0171	0,0004	0,1096	0,0048	31	1	109	2	106	5	109	5
SIB74	6-core	Se21b016	20	0,0586	0,0024	0,0811	0,0017	0,6541	0,0311	553	23	503	11	511	24	503	20
SIB74	8-outer ri	Se21b018	20	0,0476	0,0037	0,0162	0,0004	0,1041	0,0084	76	6	103	3	101	8	103	6
SIB74	8-mid rim	Se21b019	20	0,0566	0,0020	0,0782	0,0017	0,6077	0,0267	476	17	486	11	482	21	485	21
SIB74	8-core	Se21b020	20	0,0561	0,0025	0,0815	0,0019	0,6302	0,0320	455	20	505	12	496	25	504	22
SIB74	9- int.rim	Se21b021	20	0,0537	0,0013	0,0509	0,0011	0,3768	0,0133	360	9	320	7	325	11	320	13
SIB74	9-ext core	Se21b022	20	0,0565	0,0013	0,0746	0,0015	0,5805	0,0198	470	11	464	10	465	16	464	18
SIB74	10-rim	Se21b023	20	0,0499	0,0027	0,0161	0,0004	0,1106	0,0066	190	10	103	2	107	6	103	5
SIB74	10-core	Se21b024	20	0,1282	0,0034	0,3562	0,0073	6,3194	0,2277	2073	55	1964	40	2021	73	1997	59
SIB74	11-outer ri	Se21b025	20	0,0502	0,0021	0,0339	0,0008	0,2328	0,0112	202	8	215	5	213	10	215	10
SIB74	11-mid rim	Se21b026	20	0,0629	0,0017	0,1103	0,0024	0,9574	0,0357	704	19	675	15	682	25	676	27
SIB74	11-core	Se21b027	20	0,0697	0,0022	0,1075	0,0023	1,0307	0,0416	918	29	658	14	719	29	---	---
SIB74	12-outer ri	Se21b031	20	0,0482	0,0015	0,0158	0,0003	0,1048	0,0041	111	3	101	2	101	4	101	4
SIB74	12-core	Se21b032	20	0,0595	0,0017	0,0933	0,0019	0,7648	0,0289	587	17	575	12	577	22	575	23
SIB74	12-iner rim	Se21b033	20	0,0527	0,0013	0,0474	0,0010	0,3444	0,0122	316	8	299	6	301	11	299	12
SIB74	13-core	Se21b034	20	0,0598	0,0022	0,0881	0,0019	0,7274	0,0322	596	22	545	12	555	25	545	23
SIB74	15-core	Se21b037	20	0,0583	0,0023	0,0898	0,0020	0,7254	0,0334	541	21	554	12	554	26	554	23
SIB74	16-rim	Se21b038	20	0,0487	0,0021	0,0159	0,0003	0,1071	0,0052	135	6	102	2	103	5	102	4
SIB74	16-core da	Se21b039	20	0,0483	0,0024	0,0166	0,0004	0,1110	0,0062	112	6	106	3	107	6	106	5
SIB74	16-core lig	Se21b040	20	0,0559	0,0014	0,0713	0,0015	0,5497	0,0195	447	11	444	9	445	16	444	18
SIB74	17-rim	Se21b041	20	0,0490	0,0022	0,0169	0,0004	0,1143	0,0059	149	7	108	2	110	6	108	5

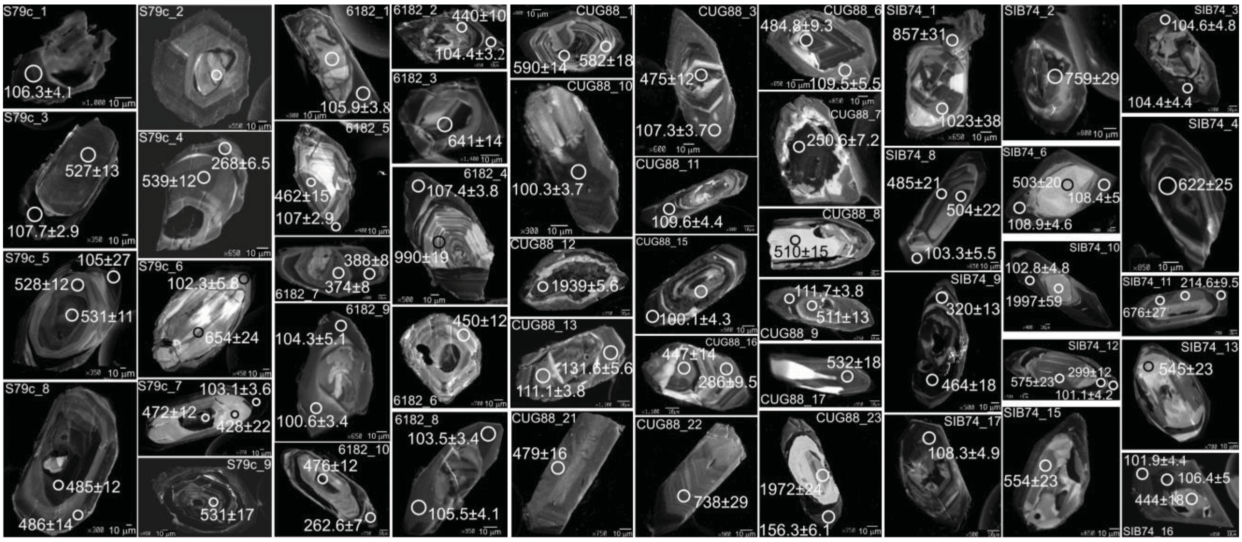

Fig. 4. CL images of the TGSCF zircon crystals and the location of the analysed spots.

on 49 analyzed zircon crystals: 16 data on 9 zircons from the trondhjemite dyke (S79C), 17 data on 10 zircons from the trondhjemite sill (6182), 25 data on 16 zircons (CUG88) and 27 data on 14 zircons (SIB74) from granodiorites. Zircons from the dikes and sills (Fig. 4) are either stubby or prismatic with CL images revealing the presence of xenocrystic cores. Zircons from the granodiorite have more complex textures. The xenocrystic cores show multiple overgrowths with igneous and "ghost" textures, such as bulbous replacement fading the original growth, convoluted, blurred, thickened or transgressive patches probably related to metamorphic events. Some xenocrystic cores show Paleoproterozoic (1.99; 1.97; 1.93 Ga) and Mesoproterozoic (1.02 Ga) ages, most likely related to the Getic basement, with possible link to the west-African craton (Balintoni et al., 2008). Five Neoproterozoic ages (from 990 to 738 Ma) on zircon cores overlap the Sm-Nd TDM ages of 980-730 Ma on bulk rock (Dobrescu, 2001; Dobrescu and Liegeois, 2001). Seven data on zircon cores gave Cadomian ages (757- 575 Ma) and 27 core ages between 539 and 428 Ma. The latter time span overlaps the Caledonian crustal building in the South Carpathians (Dallmeyer et al., 1994).

Ages between 388 and 214 Ma were obtained on the metamorphic overgrowths and partly overlap

Tab. 2d. LA-ICP-MS age results for CUG88 granodiorite sample from TGSCF.

Sample	Zircon	Run#	Spot size (μm)	Isotopic ratios						Apparent ages							
										$^{207}Pb/^{206}Pb$		$^{206}Pb/^{238}U$		$^{207}Pb/^{235}U$		Concordia Age	
				$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ		1σ		1σ		1σ		2σ
CUG88	z1-outer rim	Se24b005	20	0,0442	0,0013	0,0172	0,0003	0,1047	0,0030	---	---	110	2	101	3	---	---
CUG88	1-core	Se24b006	20	0,0594	0,0011	0,0955	0,0016	0,7861	0,0138	580	10	588	10	589	10	590	14
CUG88	1-mid rim	Se24b007	20	0,0580	0,0013	0,0952	0,0016	0,7614	0,0169	531	12	586	10	575	13	582	18
CUG88	2-outer rim	Se24b009	20	0,0514	0,0017	0,0161	0,0003	0,1140	0,0037	259	9	103	2	110	4	---	---
CUG88	3-outer rim	Se24b010	20	~~0,04704~~	0,001	0,0168	0,000291	0,10884	0,003341	51	1,6069	107,4	1,8573	104,9	3,2202	107,3	3,7
CUG88	3-core	Se24b011	20	0,05657	0,001	0,07615	0,001299	0,59643	0,009799	474,2	7,886	473,1	8,0689	475	7,8039	475	12
CUG88	4-core	Se24b012	20	0,05856	0,001	0,07956	0,001385	0,64552	0,013824	550,8	11,905	493,5	8,5894	505,7	10,83	---	---
CUG88	6-rim	Se24b013	20	0,04978	0,004	0,01714	0,000437	0,10858	0,009196	184,7	16,004	109,6	2,7918	104,7	8,8675	109,5	5,5
CUG88	6-core	Se24b014	20	0,05647	0,001	0,07883	0,001259	0,61456	0,008197	470,2	6,7487	489,1	7,8141	486,4	6,4872	484,8	9,3
CUG88	7-core	Se24b015	20	0,05179	0,001	0,03916	0,000708	0,27914	0,004567	276	4,3107	247,6	4,4771	250	4,0905	250,6	7,2
CUG88	13-outer rim	Se24b017	20	0,04876	0,002963	0,02063	0,000443	0,13869	0,008276	136,3	8,2823	131,6	2,8282	131,9	7,8704	131,6	5,6
CUG88	13-mid rim	Se24b018	20	0,04856	0,001325	0,01738	0,000303	0,11638	0,003115	126,7	3,4563	111,1	1,935	111,8	2,9921	111,1	3,8
CUG88	12-core	Se24b019	20	0,11615	0,001624	0,3491	0,006662	5,72758	0,091151	1897,8	26,536	1930,3	36,834	1935,5	30,802	1939	5,6
CUG88	11-mid rim	Se24b020	20	0,04661	0,00298	0,01715	0,000345	0,10977	0,006869	29	1,854	109,6	2,2062	105,8	6,621	109,6	4,4
CUG88	10-core	Se24b021	20	0,04933	0,001346	0,01568	0,000295	0,10655	0,002892	163,7	4,4662	100,3	1,8877	102,8	2,7906	100,3	3,7
CUG88	9-core	Se24b022	20	0,05737	0,000945	0,08264	0,00142	0,65413	0,01077	505,2	8,3191	511,9	8,7939	511	8,4138	511	13
CUG88	9-rim	Se24b023	20	0,04706	0,001114	0,01752	0,000304	0,1137	0,002632	52,1	1,2335	111,9	1,9414	109,3	2,5299	111,7	3,8
CUG88	8-core	Se24b024	20	0,05713	0,001081	0,08296	0,001429	0,6538	0,012207	495,8	9,3817	513,8	8,853	510,8	9,5368	510	15
CUG88	20-rim	Se24b028	20	0,04982	0,001106	0,03628	0,000669	0,24778	0,00554	186,7	4,1434	229,7	4,2339	224,8	5,0266	228,3	8,2
CUG88	20-core	Se24b029	20	0,05617	0,000889	0,07601	0,001304	0,5893	0,009287	458,6	7,2575	472,3	8,1043	470,4	7,4135	470	12
CUG88	15-rim	Se24b030	20	0,05643	0,002846	0,01565	0,000342	0,1112	0,005513	468,7	23,638	100,1	2,1872	107,1	5,3101	100,1	4,3
CUG88	15-core	Se24b031	20	0,06317	0,000911	0,10918	0,001782	0,95117	0,013007	714	10,294	668	10,902	678,7	9,2813	---	---
CUG88	16-core	Se24b032	20	0,0518	0,001005	0,04548	0,000799	0,32481	0,006272	276,6	5,3688	286,7	5,0394	285,6	5,5146	286	9,5
CUG88	16-rim	Se24b033	20	0,05602	0,001121	0,0716	0,001209	0,55311	0,010742	452,9	9,0601	445,8	7,5302	447	8,6813	447	14
CUG88	17-core	Se24b034	20	0,05808	0,001523	0,0861	0,001578	0,68892	0,01793	532,5	13,965	532,4	9,7553	532,2	13,851	532	18
CUG88	23-outer rim	Se24b035	20	0,04802	0,002429	0,02454	0,000481	0,16631	0,007988	99,1	5,0128	156,3	3,0655	156,2	7,5023	156,3	6,1
CUG88	23-core	Se24b036	20	0,12007	0,002033	0,35835	0,00641	5,97824	0,100473	1957,3	33,144	1974,4	35,318	1972,7	33,154	1972	24
CUG88	22-core-rim?	Se24b037	20	0,06254	0,002954	0,12141	0,002554	1,05342	0,048379	692,6	32,719	738,7	15,538	730,6	33,553	738	29
		Se24b038	20	0,04649	0,001112	0,01735	0,000296	0,11148	0,002598	23,2	0,5551	110,9	1,8893	107,3	2,5006	---	---
CUG88	21-rim	Se24b039	20	0,05768	0,001864	0,07708	0,001335	0,6127	0,019052	517,3	16,719	478,6	8,2868	485,3	15,09	479	16

the Variscan HP event (358–316 Ma) in the Sebes-Lotru series (Dragusanu and Tanaka, 1999; Medaris et al., 2003; Balintoni, 2009). The younger ages coincide with the $^{40}Ar/^{39}Ar$ ages at 299-286 Ma on mylonites in shear zones (Dallmeyer et al., 1994, 1998) reactivated at the end of the Variscan orogeny (Pfalzic phase). The Mid-Cretaceous ages on 30 zircon rims yielding concordia ages at between 110 and 105 Ma (Fig. 5b, d, f) confirm the $^{40}Ar/^{39}Ar$ cooling ages of 109-108 Ma of Dobrescu and Smith (2000) and most likely define the intrusion ages. Despite the fact that the RSZ have been considered for long time the overthrust line between Getic and Supra getic Domains (Balintoni et al., 1989; Iancu and Maruntiu, 1994), the mid-Cretaceous ages of the TGSCF intrusion preclude the idea of superposition of the two domains, at least in the outcropping area of the igneous system.

4. Concluding remarks

In situ U/Pb geochronology of zircons in some minor intrusions from western and northern Getic domain allowed us to define several common features of the two magmatic systems:

- The presence of xenocrystic cores of Proterozoic and even older ages (up to Neoarchean), is consistent with the occurrence in western and northern Getic domain of a basement with Pre-Gondwanan inheritance (in agreement with age results from Balintoni et al., 2009). Noticeably, both Grenvillian and Cadomian ages are present, disturbing for good the so-called "Grenvillian silence" (e.g. Balintoni, 2005, Săbău and Massonne, 2008). The newly obtained Neoproterozoic ages illustrate the magmatic episode (evidenced also by Balintoni et al., 2009) which supplied the lower part of the Getic basement;

- The Variscan HP metamorphic event affecting the Getic basement imprinted Mid-Upper Paleozoic ages on both granitoid systems.

The U/Pb data for STG and BG approximate an intrusion age within late Cambrian–early Silurian time span. The age data for TGSCF indicate an intrusion time between 110 and 105 Ma.

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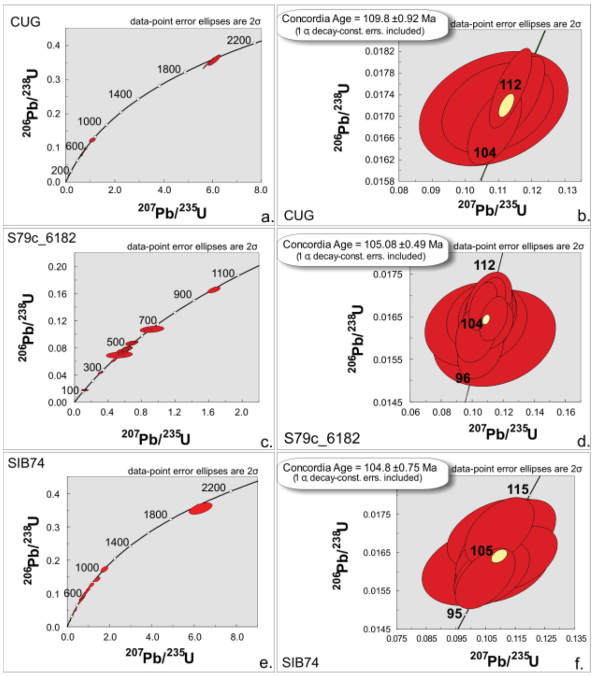

Fig. 5. U-Pb concordia diagram for the TGSCF analysed zircons of CUG granodiorite (a) and detail at 109.8±0.92 Ma concordia age (b); concordia diagram for the analysed zircons of 79c_6182 trondhjemite sill and dike samples (c) and detail at 105.08±0.49 Ma concordia age (d); concordia diagram for the analysed zircons of SIB74 granodiorite (e) and detail at 104.8±0.75 Ma concordia age (f).

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