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Coeval interaction between magmas of contrasting composition (Late Carboniferous-Early Permian Santa Eulália-Monforte massif, Ossa-Morena Zone): field relationships and geochronological constraints

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ABSTRACT

The Santa Eulália-Monforte massif is a post-kinematic Late Carboniferous-Early Permian calc-alkaline composite massif (LC-EP) located in the Ossa-Morena Zone (OMZ, Portugal). This paper examines the field relationships between pinkish granites and mafic-intermediate rocks from the external ring of this massif and presents new U-Pb zircon age determinations. The estimated ²⁰⁶Pb/²³⁸U ages, 297±4Ma for the pinkish granite and 303±3Ma for a gabbro-diorite point to a short time interval between the crystallization of both magmas. At outcrop scale, contacts of the mafic-intermediate rocks with the host pinkish granite are sharp and corroborate this age relationship, but do not justify why the host-enclave contacts often has curved and irregular shapes, indicating liquid-liquid interaction. A full analysis of the distribution of U-Pb zircon ages and respective Th/U ratios suggests that the compositionally distinct magmas were roughly contemporaneous. The obtained ages also fit the LC-EP Iberian calc-alkaline suite that was formed contemporaneously to the development of the Iberian-Armorican Arc and when the Paleotethyan oceanic Plate subducted under the Eurasian active margin. Taking this geodynamic setting as a reference, the LC-EP Iberian calc-alkaline magmatism can be interpreted as most probably related to the Cimmerian cycle instead of the traditionally accepted model that ascribe a closer connection of this magmatism with the Variscan cycle.

KEYWORDS Iberian Massif. Late Carboniferous-Early Permian. Calc-alkaline bimodal plutonism. Zircon dating. Variscan and Cimmerian cycles.

INTRODUCTION

The Iberian Massif experienced a polymetamorphic evolution during the Carboniferous as a result of the collision between Laurussia and Gondwana (*e.g.* Variscan Orogeny; Martínez Catalán *et al.*, 2009; Díez Fernández

et al., 2016). The Laurussia-Gondwana convergence caused crustal thickening by the stacking of tectonic nappes and the rejuvenation of reliefs. The regional switch from contractional to extensional deformation was followed by an orogenic collapse and the generation of abundant crustal-derived magmatism (Escuder Viruete

et al., 1994; Pereira *et al.*, 2009; 2017a; Martínez Catalán *et al.*, 2014; Alcock *et al.*, 2015; Cambeses *et al.*, 2015; Díez Fernández and Pereira, 2016). Mantle contributions were more abundant towards the SW Iberian Massif, as syn-kinematic magmatism related to intra-orogenic extension was slightly older in the Ossa-Morena and South Portuguese zones (Simancas *et al.*, 2005; Pereira *et al.*, 2009; 2015a) than in the Central Iberian Zone.

The age and compositional ranges of syn-kinematic (Carboniferous) and post-kinematic (Late Carboniferous–Early Permian, LC-EP) intrusions are wide in the NW (*e.g.* Central Iberian Zone; Castro *et al.*, 2002 and references therein) and SW (Ossa-Morena Zone; Pereira *et al.*, 2015a and references therein) Iberian Massif. Most syn- and post-kinematic granitic rocks are S-type peraluminous, but there are also granitic rocks with transitional features between S- and I-type, I-type granites and hybrid granites, including metaluminous varieties (Dias *et al.*, 1998, 2002; Castro *et al.*, 1999, 2002; Bea *et al.*, 1999, 2003; Fernández-Suárez *et al.*, 2000, 2011; Neiva and Gomes 2001; González Menéndez *et al.*, 2006; Moita *et al.*, 2009; Neiva *et al.*, 2009; Solá *et al.*, 2009; Lima *et al.*, 2011, 2012; Teixeira *et al.*, 2011; Villaseca *et al.*, 2012; Merino Martínez *et al.*, 2014; Pereira *et al.*, 2015a, 2017a; LópezMoro *et al.*, 2017). These Carboniferous and Permian calc-alkaline granitic rocks are often closely and spatially associated with calc-alkaline mafic-intermediate rocks (*e.g.* Castro *et al.*, 2003; Bea, 2004; Larrea *et al.*, 2004; González Menéndez *et al.*, 2006; Jesus *et al.*, 2007; Pin *et al.*, 2008; Solá *et al.*, 2009; Moita *et al.*, 2015) and are characterized by many structures and textures formed through the complex interplay of distinct petrogenetic processes. Such composite plutons typically preserve an integrated record of prolonged magmatic evolution, including pluton accumulation, crystallization and emplacement within the crust that evidence the coeval interaction between two or more magmas of contrasting composition and physical properties (Turnbull *et al.*, 2010). Mixing of magmas within a magma chamber to produce a homogeneous hybrid, followed by mingling and partial mixing of the hybrid magma with one of the remaining end-members is commonly identified in the successive stages of the magmatic history of composite plutons (Barbarin, 2005 and references therein). By studying the temporal and spatial interaction of magmas of contrasting compositions that remained in the contact in liquid state, insights can be gained into the duration of physical and thermal processes responsible for the formation of plutons.

Our study presents original field data and SHRIMP zircon U-Pb dating for a post-kinematic intrusion in the Ossa-Morena Zone with the aim of studying the temporal and spatial interaction of a felsic and a mafic-intermediate magma forming the external ring of the Santa Eulália-Monforte massif. The obtained results will shed light on

the timing of crystallization and emplacement of the Santa Eulália-Monforte intrusion, and on the global geodynamic context of the post-kinematic Iberian calc-alkaline magmatism. The results achieved broaden the knowledge on the spatial and temporal relationships between distinct LC-EP post-kinematic intrusions of the Iberian Massif. Our data also show that the crystallization ages of the Santa Eulália-Monforte I-type granite and associated mafic rocks are younger than the Nisa-Albuquerque batholith. Both intrusions cut across the Variscan structures, establishing a maximum range of about 13Ma, from the Late Moscovian to Asselian, for the LC-EP post-kinematic magmatism in the SW Iberian Massif. The subject of this study was chosen because L.G. Corretgé, who receives an honorable mention in this volume, was one of the petrologists who mostly contributed to gather data on the magmatism of the Iberian Massif, thus, fostering scientific cooperation between Portuguese and Spanish geologists.

LP-EC POST-KINEMATIC INTRUSIONS OF THE IBERIAN MASSIF

The LC-EP granitic rocks of the Iberian Massif have been traditionally classified as Late-Variscan because they crosscut the main Variscan structures and syn-kinematic intrusive rocks (*ca.* 306–287Ma; Ferreira *et al.*, 1987; Dias *et al.*, 1998; Fernández-Suárez *et al.*, 2011; Neiva *et al.*, 2012; Orejana *et al.*, 2012; Villaseca *et al.*, 2012). However, these post-kinematic intrusions are also recently considered as unrelated to the Gondwana-Laurussia collision *sensu stricto* (*e.g.* Gutiérrez-Alonso *et al.*, 2011; Pereira *et al.*, 2015b).

The LC-EP post-kinematic intrusions are abundant in the Central Iberian Zone, but are relatively less represented in the Ossa-Morena Zone. The Nisa-Albuquerque massif is a composite elongated body oriented parallel to, and crossing, the boundary between the Central Iberian and Ossa-Morena zones (González Menéndez, 2002) (Fig. 1). This post-kinematic intrusion consists of a dominant S-type monzogranite-syenogranite (*ca.* 309–307Ma) that surrounds a discontinuous core of I-type tonalite-granodiorite (*ca.* 306Ma) (SHRIMP zircon U-Pb dating; Solá *et al.*, 2009). The Santa Eulália-Monforte massif, located in the northern domains of the Ossa-Morena Zone, is a composite intrusion (Gonçalves and Coelho, 1969–1970; Gonçalves, 1971; Gonçalves *et al.*, 1972, 1975; Carrilho Lopes *et al.*, 1998; Sant’Ovaia *et al.*, 2015) consisting of S- and I-type granites and mafic-intermediate bodies (González Menéndez *et al.*, 2006). Rb-Sr whole-rock ages of *ca.* 281Ma (Mendes, 1967–1968) and of *ca.* 290Ma (Pinto *et al.*, 1987) have been, for decades, the only available isotopic ages performed on granites from the Santa Eulália-Monforte massif.

THE SANTA EULÁLIA-MONFORTE MASSIF

Host rocks of the Santa Eulália-Monforte massif

The Santa Eulália-Monforte massif intrudes two important domains of the Ossa-Morena Zone (Figs. 1 and 2): i) the strongly deformed and variable metamorphosed Ediacaran to Ordovician sedimentary and igneous rocks of the Coimbra-Córdoba shear zone (Burg *et al.*, 1981; Pereira *et al.*, 2008, 2010); and ii) the Cambrian-Ordovician sedimentary and igneous rocks of the Alter do Chão-Elvas sector (Apalategui *et al.*, 1990; Oliveira *et al.*, 1991).

The original contacts and textures of the Ediacaran-Cambrian sedimentary and volcanic rocks (Pereira *et al.*, 2006; Linnemann *et al.*, 2008) and Cambrian-Ordovician plutonic rocks (Pereira *et al.*, 2011; Sánchez-García *et al.*, 2013; Díez Fernández *et al.*, 2015) are best exposed in the

northern and southern margins (Fig. 2). In the northern and southern margins of the Coimbra-Córdoba shear zone, as well as in the Alter do Chão-Elvas sector, despite the Variscan ductile deformation and greenschist facies metamorphism, the Ediacaran succession-consisting of metapelite, metagreywacke, black metachert, metamafic rocks, and rare carbonate rocks is unconformably overlain by a Cambrian sequence (Gonçalves, 1971; Gonçalves *et al.*, 1975; Oliveira *et al.*, 1991; Pereira *et al.*, 2006). From the base to the top, the Cambrian sequence consists of: i) felsic metavolcanic rocks, quartzite and marble, and ii) schists, metagreywackes, quartzites, metaconglomerates and metamafic rocks. Cambrian magmatism includes calc-alkaline and MORB compositions (Pereira and Quesada, 2006; Sánchez-García *et al.*, 2010). The Ediacaran-Cambrian succession is intruded by Cambrian-Ordovician peralkaline and alkaline igneous rocks (Gonçalves and Assunção, 1970; Gonçalves *et al.*, 1975; Díez Fernández *et al.*, 2015).

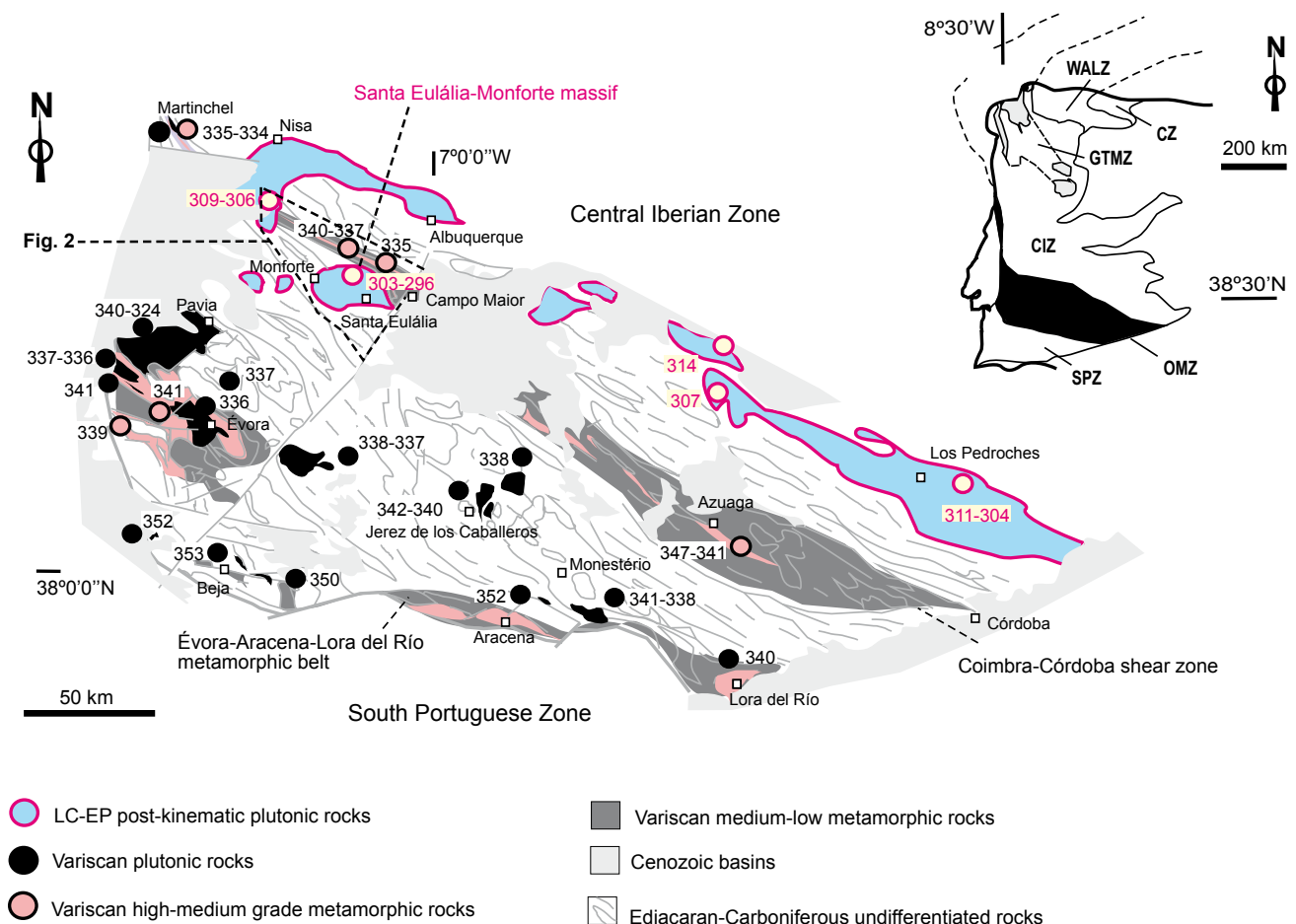


FIGURE 1. Schematic geological map of the Ossa-Morena Zone, showing the location of the Variscan plutonic and metamorphic rocks (adapted from Pereira *et al.*, 2015a and references therein), and the Late Carboniferous-Early Permian (LC-EP) post-kinematic plutonic rocks, including the Santa Eulália-Monforte Massif. Inset of the main subdivision of the Évora Massif: CIZ: Central Iberian Zone; CZ: Cantabrian Zone; GTMZ: Galicia-Trás-os-Montes Zone; OMZ: Ossa-Morena Zone; SPZ: South Portuguese Zone; WALZ: West Asturian-Leonese Zone.

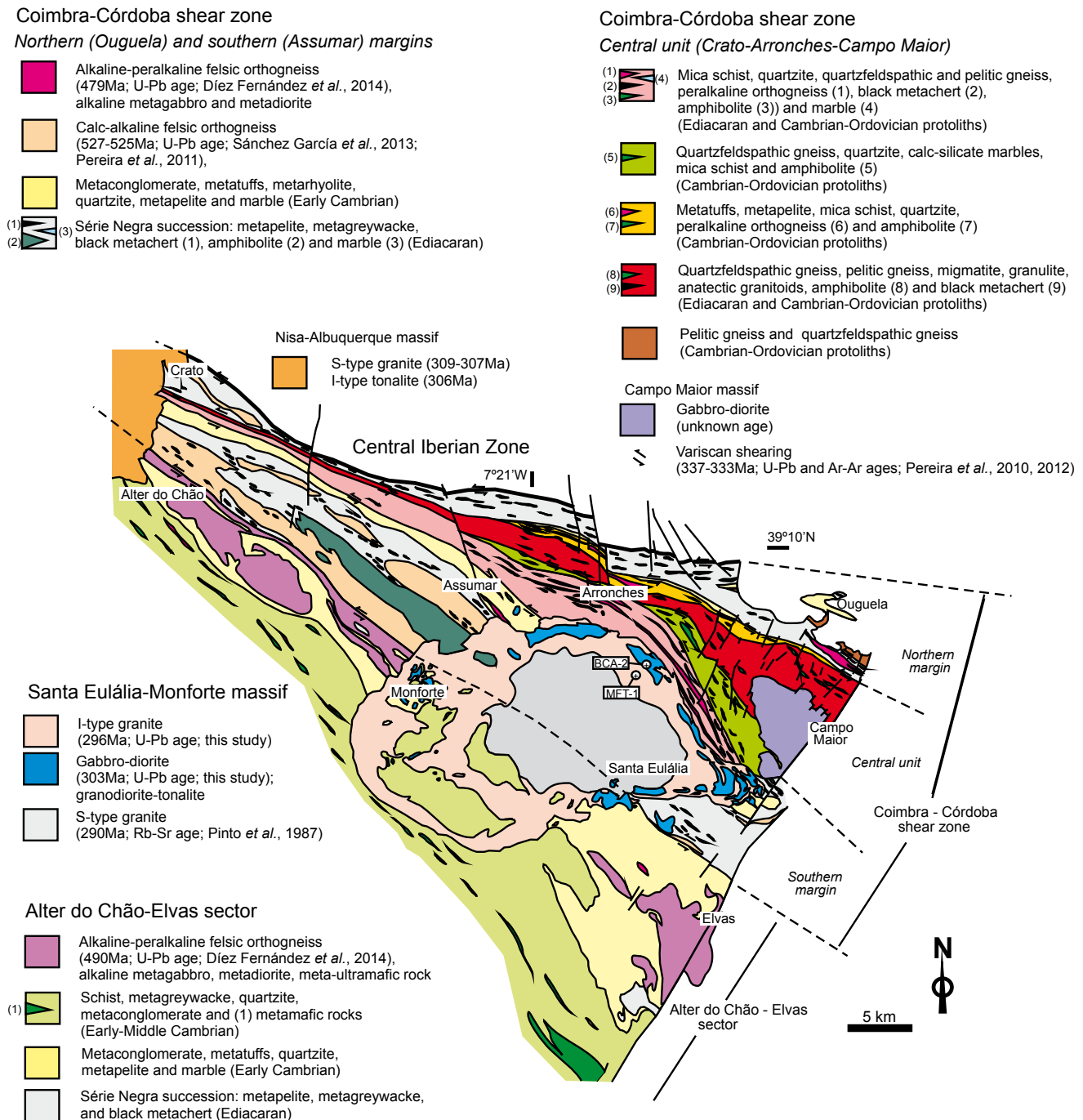


FIGURE 2. Geologic map of the northern domains of the Ossa-Morena Zone (Portugal) (adapted from Gonçalves and Assunção, 1970; Gonçalves, 1971; Gonçalves *et al.*, 1972, 1975; Gonçalves and Fernandes, 1973; Pereira, 1999; Pereira *et al.*, 2008, 2010), including the Santa Eulália-Monforte massif intrusive in the Coimbra-Córdoba shear zone and in the Alter do Chão-Elvas sector. Sample locations (BCA-2 and MFT-1) are shown.

In the Central Unit of the Coimbra-Córdoba shear zone, the Carboniferous (*ca.* 340-333Ma) ductile deformation and associated metamorphism, reaching amphibolite to granulite and eclogite facies conditions, transformed the original contact and textures of the Ediacaran-Ordovician rocks (Pereira *et al.*, 2008, 2010, 2012) (Fig. 2). Cambrian-

Ordovician plutons occur as elongated bodies of weakly- to moderately-foliated rocks, or as narrow bands of orthogneiss alternating with schists and paragneisses affected by strong Variscan deformation and metamorphism (Gonçalves *et al.*, 1972; Pereira *et al.*, 2008, 2010; Díez Fernández *et al.*, 2015) (Fig. 1).

Field relationships, petrography and geochemistry

The Santa Eulália-Monforte massif (Fig. 2) is a ring-shaped composite intrusion 18km wide and 32km long elongated body in E-W direction (Gonçalves and Coelho, 1969-1970; Gonçalves, 1971; Gonçalves *et al.*, 1972, 1975; Oliveira, 1975; Carrilho Lopes *et al.*, 1998; González Menéndez *et al.*, 2002, 2006). It includes a 10km wide and 16km long core of greyish fine- to medium-grained biotite granite (Fig. 3A) surrounded by a ring consisting of a complex association between pinkish coarse-grained biotite granite and mafic-intermediate rocks (Figs. 3, 4, 5 and 6).

The core of this ring-shaped intrusion consists of S-(prevailing) and I-type high-K calc-alkaline peraluminous granite ranging in composition from monzogranite to granite (Fig. 7A; B). Quartz, plagioclase, microcline, biotite and muscovite are the main minerals, being also present cordierite (Fig. 3A). The geochemistry of the greyish granite suggests the derivation from a mixed source of metasedimentary (dominant) with intermediate to acid igneous rocks extracted from the mid-lower crust (González Menéndez *et al.*, 2006). The external pinkish granite is composed of quartz, biotite, and K-feldspar prevails in respect to plagioclase. It also contains chlorite, amphibole, allanite and zircon. The available geochemical data (Carrilho Lopes *et al.*, 1998; González Menéndez *et al.*, 2006) indicate that it is an I-type high-K calc-alkaline peraluminous granite (Fig. 7A; C). The pinkish granite is interpreted to derive from partial melting of intermediate composition gneissic rocks from the mid-lower crust (González Menéndez *et al.*, 2006).

The pinkish granite of the external ring (Fig. 6A) includes variable size and irregular, 0.5-1.5km wide and 0.8-6km long gabbro-diorite to granodiorite-quartzdiorite-tonalite enclaves, and kilometer-scale xenoliths consisting of Ediacaran and Cambrian host rocks (Fig. 6B). Mafic-intermediate rocks range compositionally (Fig. 7) from gabbro-diorite, which are mainly composed by plagioclase, amphibole, pyroxene, biotite, apatite and zircon, to granodiorite-quartzdiorite-tonalite consisting of plagioclase, K-feldspar, quartz, biotite, amphibole, apatite and zircon. The mafic-intermediate associations have been interpreted to derive from distinct sources (González Menéndez *et al.*, 2006): an enriched mantle (gabbro-diorite) and from partial melting of a lower mafic crust (granodiorite-quartzdiorite-tonalite).

Field relationships show that the greyish granite from the core (Fig. 3A) intrudes both the pinkish granite (Fig. 6A) and the associated mafic-intermediate rocks (Fig. 4A). Mafic-intermediate bodies at the eastern margin of the Santa Eulália-Monforte massif are intruded by the pinkish granite

(Figs. 3B and 6C, D, E). Angular mafic enclaves (Fig. 5B) seem to represent early cooled pieces of gabbro caught up in the granodiorite-quartzdiorite-tonalite magma, but the variation from sharp though irregular contacts to more diffuse contacts suggests that they are contemporaneous (Fig. 4E). It is notable the presence of composite enclaves (Fig. 3E) and irregular patches of granodiorite-quartzdiorite-tonalite (Fig. 3D) hosted by gabbro-diorite, together with a channel-like enclave swarm of mafic-intermediate rocks (Fig. 4C; D) suggest intermingling of two magmas. Gabbro-dioritic rocks include leucocratic veins and lenses of quartzdiorite and/or tonalite (Fig. 3C; D). The occurrence of K-feldspar within the gabbro-dioritic enclaves, which may be the same as that of the host granitic rock (Fig. 5), suggests that granitic magma could have interacted with the mafic-intermediate magmas, probably at a time when both were not completely crystallized. The existence of mafic-intermediate enclaves with irregular, rounded and elliptical shapes, suggests mingling with the host granitic magma (Fig. 5).

U-PB GEOCHRONOLOGY

Sample preparation and analytical methods

Zircon separation from a sample of granite (MFT-1) and a sample of gabbro-diorite (BCA-2) of the external ring of the Santa Eulália-Monforte massif (sampling sites on Fig. 2) was performed by means of traditional techniques using dense liquids and magnetic separation at the University of Évora (Portugal). Selected crystals were hand-picked using a binocular lens. Zircon concentrates were cast on a 3.5cm diameter epoxy mount, together with zircon standards (TEMORA zircon, SL13 zircon and GAL zircon), then polished and documented using SEM-CL (Fig. 8), at the IBERSIMS (University of Granada, Spain). Mounts were coated with gold (80-microns thick) and inserted into the SHRIMP for analysis.

Each selected spot was rastered with the primary beam during 120s prior to analysis, and then analyzed over 6 scans following the isotope peak sequence $^{196}\text{Zr}_2\text{O}$, ^{204}Pb , 204.1 background, ^{206}Pb , ^{207}Pb , ^{208}Pb , ^{238}U , ^{248}ThO , ^{254}UO . Every peak of each scan was measured sequentially 10 times with the following total counts per scan: 2s for mass 196; 5s for masses 238, 248, and 254; 15s for masses 204, 206, and 208; and 20s for mass 207. The primary beam, composed of $^{16}\text{O}^{16}\text{O}^{2+}$, was set to an intensity of 4 to 5nA, using a 120-micron Kohler aperture, which generates 17 x 20micron elliptical spots on the target. The secondary beam exit slit was set at 80microns, achieving a resolution of about 5,000 at 1% peak height. All calibration procedures were performed

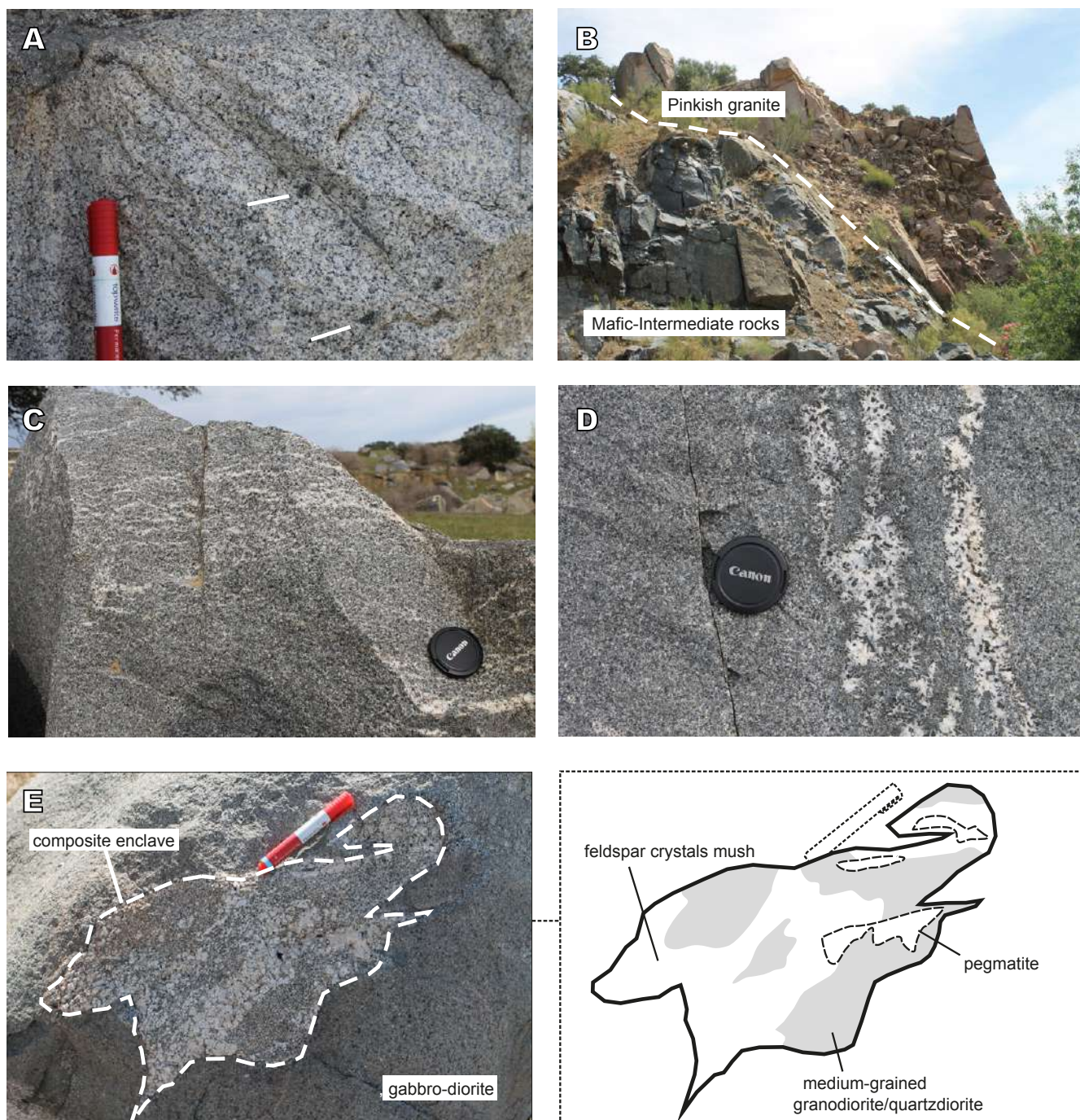


FIGURE 3. Representative field relationships of the main rock types of the Santa Eulália-Monforte massif: A) greyish granite from the core, containing megacrysts of cordierite; B) sharp contact between the coarse-grained pinkish granite and the mafic-intermediate rocks from the external ring, C) intermediate (dioritic) and D) mafic (gabbroic) bodies from the external ring, with leucocratic veins; E) composite enclave with irregular shape consisting of medium-grained quartzdiorite/granodiorite, coarse-grained K-feldspar mush and pegmatite, surrounded by gabbro-dioritic rocks.

on the standards included on the same mount. Mass calibration was performed on the GAL zircon (*ca.* 480Ma, very high U, Th and common lead content; Montero *et al.*, 2008). Analytical sessions initially involved the measurement of SL13 zircon (Claoué-Long *et al.*, 1995), which was used as a concentration

standard (238ppm U). TEMORA zircon (*ca.* 417Ma, Black *et al.*, 2003), used as isotope ratios standard, was then measured every four unknowns.

Data reduction was performed using the SHRIMPTOOLS software specifically developed

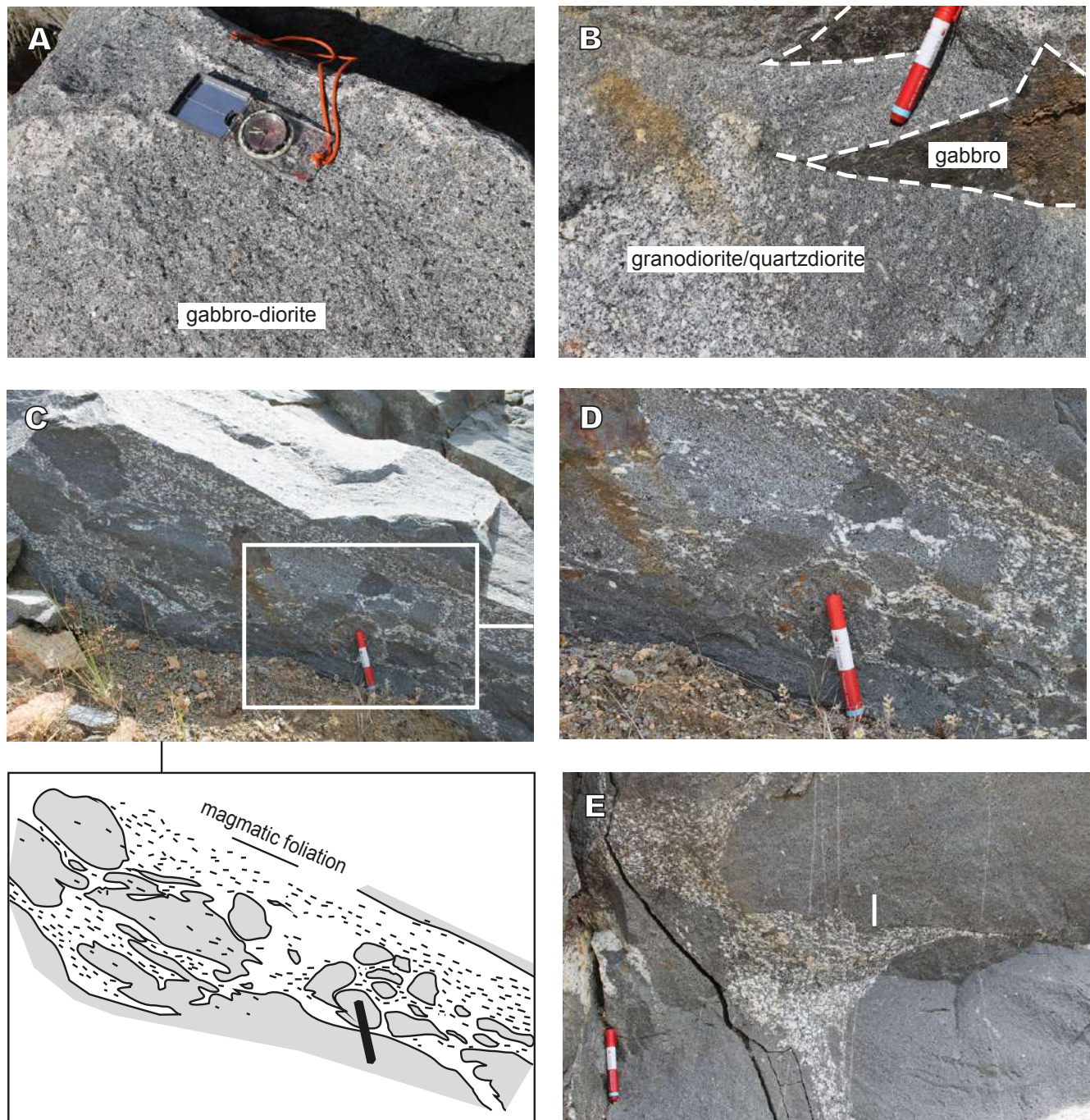


FIGURE 4. Representative field relationships of the mafic-intermediate rocks of the Santa Eulália-Monforte massif: A) gabbro-diorite; B) cusped-shape contact between the quartzdiorite-granodiorite and the surrounded gabbro-diorite containing K-feldspar crystals, apparently similar to those of the quartzdiorite-granodiorite; C) channel-like enclave swarm of mafic-intermediate rocks with magmatic foliation defined by the preferred orientation of K-feldspar crystals; D) detail of C) showing various enclave rock types (gabbro, gabbro-diorite and quartzdiorite/granodiorite) and sizes enclosed in quartzdiorite/granodiorite and felsic aggregates, mainly formed of large K-feldspar crystals; E) flame structures filled by quartzdiorite/granodiorite with large K-feldspar crystals.

for IBERSIMS (available at www.ugr.es/~fba). The intensity of each measured isotope was calculated in two steps using the software: first, the STATA letter-value display algorithm was used to find outliers in the

ten replicates measured at each peak during each scan, discarding them and averaging the rest once they had been normalized to SBM measurements; then, for each isotope, a robust regression of each scan average *versus*

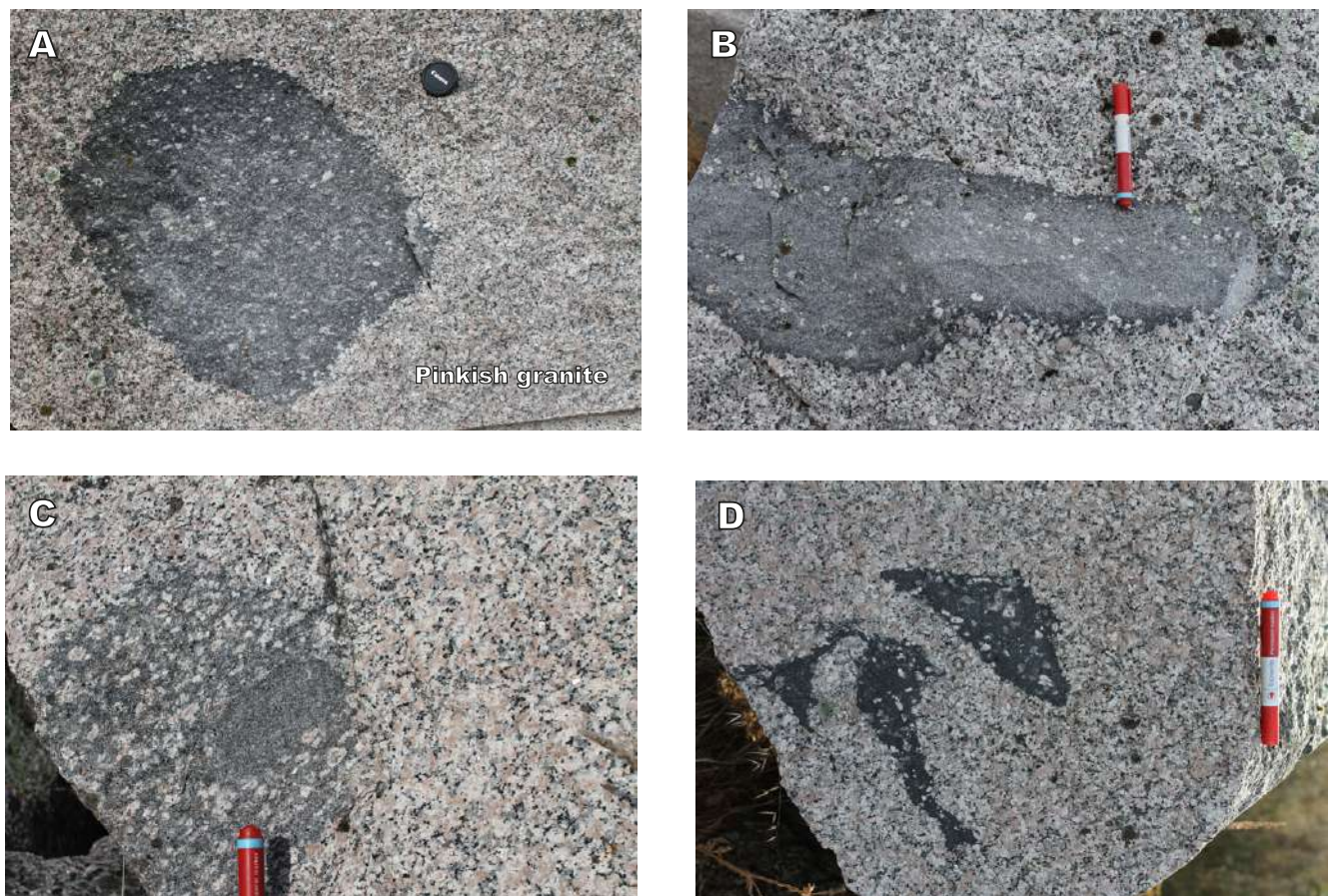


FIGURE 5. Mesoscale details of host-enclave relationships in the coarse-grained pinkish granite from the external ring of the Santa Eulália-Monforte massif: A) rounded enclave of mafic-intermediate rock with crenulated contact; B) elongated enclave of intermediate rock with a biotite-rich rim, derived from the enclave-host reaction, along the irregular contact, and K-feldspar phenocrysts aligned to the major axis of the enclave; C) composite intermediate enclave; D) curved and irregular shape mafic enclaves. All mafic and intermediate enclaves of this figure contain K-feldspar phenocrysts similar to those of the host granite.

time, if measured, was performed. The final result for each isotope was calculated as the value at the mid-time of the analysis resulting from a robust regression line. Errors (95% confidence level) were calculated as the standard error of the linear prediction at the midpoint of the analysis. $^{206}\text{Pb}/^{238}\text{U}$ was calculated from the measured $^{206}\text{Pb}^+ / ^{238}\text{U}^+$ and UO^+ / U^+ following the method described by Williams (1998). For high-U zircons ($\text{U} > 2,500\text{ppm}$) $^{206}\text{Pb}/^{238}\text{U}$ was further corrected using the algorithm of Williams and Hergt (2000). Plotted and tabulated analytical uncertainties are 1σ precision estimates. Uncertainties in calculated mean ages are 95% confidence limits ($t\sigma$, where t is the Student's t multiplier) and, for mean $^{206}\text{Pb}/^{238}\text{U}$ ages, include the uncertainty in Pb/U calibration (0.3–0.5%). Common Pb corrections assumed a model common Pb composition appropriate to the age of each spot (Cumming and Richards, 1975). U-Th-Pb data are presented in Table 1 (electronic appendix, available at www.geologica-acta.com) and plotted in Figure 9, using Isoplot 4 (Ludwig, 2009).

RESULTS

Sample MFT-1 (granite)

Most zircons are stubby and elongated euhedral prisms (150–300 μm diameter in the long-axis) (Fig. 8). Morphologically complex zircons analyzed show cores of variable size (dark-cathodoluminescence (CL) subeuhedral cores with concentric zoning and wavy extinction, subeuhedral cores of a patchy to irregular texture with linear or wavy dark and bright-CL bands, sub-rounded dark-CL and unzoned cores). Cores are surrounded by concentric zoned to unzoned rims (Fig. 8). Few grains are simple, showing banded or concentric zoning and some show discordant zircon overgrowths or recrystallization textures. Twenty-nine U-Th-Pb isotopic analyses of 25 representative zircon grains are listed in Table 1. Twenty-five $^{206}\text{Pb}/^{238}\text{U}$ ages in the range *ca.* 536 to 273 Ma, were obtained using 204-lead correction and show a discordance $\leq 5\%$. The oldest age of *ca.* 537 Ma (Cambrian), obtained in analysis

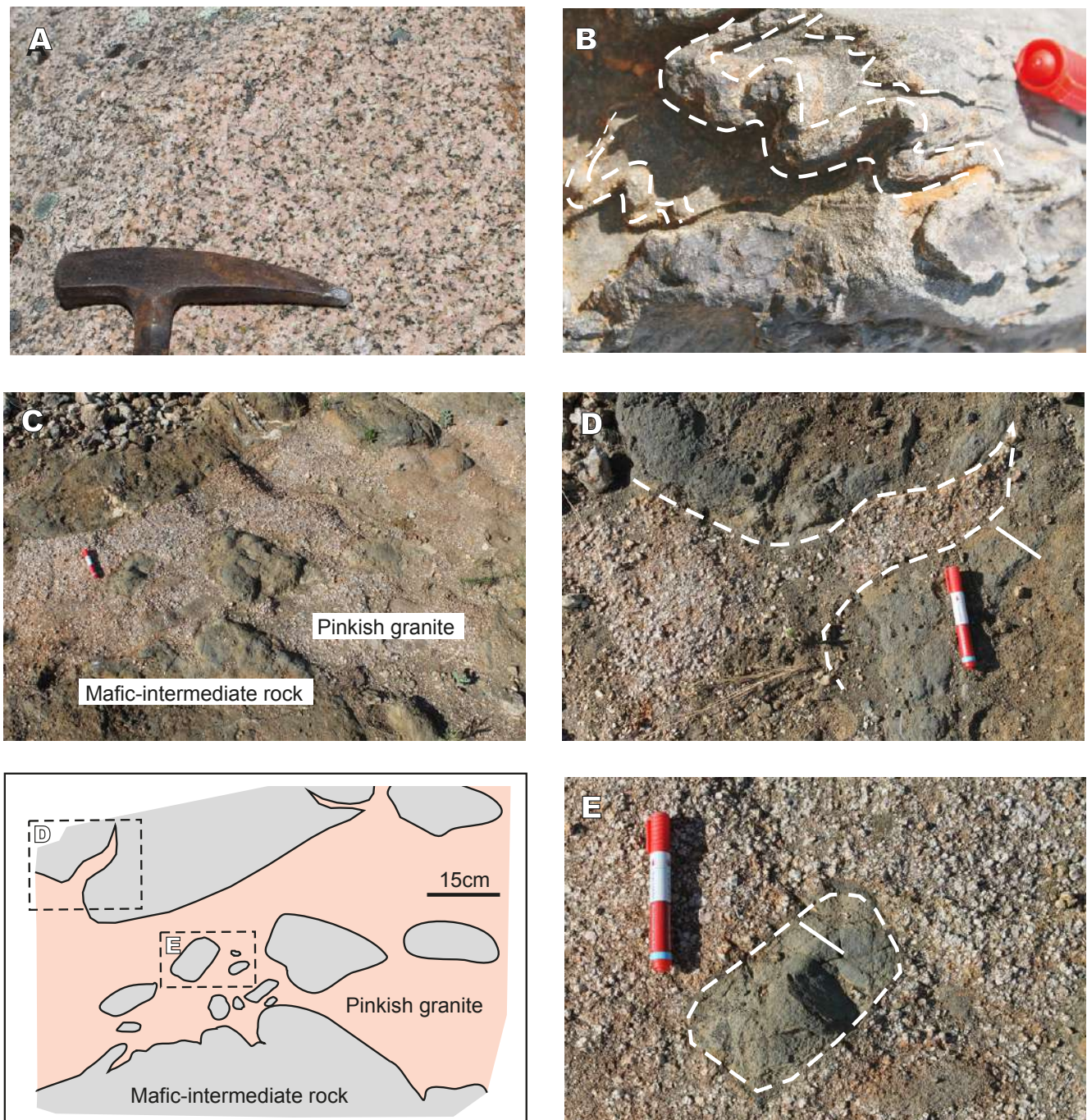


FIGURE 6. Representative field relationships between the pinkish granite and the mafic-intermediate rocks of the Santa Eulália-Monforte massif and surrounding country rocks: A) coarse-grained pinkish granite from a dyke cutting across mafic-intermediate rocks; B) xenolith of a previously folded and metamorphosed carbonate rock from the Coimbra-Córdoba shear zone; C) mafic-intermediate rocks intruded by the pinkish granite; D) apophysis of granite; E) mafic enclave with a fine-grained and biotite-rich reaction rim.

8.2, is interpreted as an inherited old core and, indeed, close inspection showed that it is surrounded by a young overgrowth (8.1). The remaining 19 $^{206}\text{Pb}/^{238}\text{U}$ ages were obtained in zircons with a wide range of U (295-2,277ppm) and Th (118-1,763ppm) contents, and an average Th/U ratio of 0.37 (error standard deviation=0.03; Fig. 9A). These 19

U-Th-Pb isotopic compositions yielded a weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of $296 \pm 4\text{Ma}$ (MSWD=0.62). However, the omission of three analyses with high-U (10.1, 14.1 and 16.1) gave a weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of $297 \pm 4\text{Ma}$ (MSWD=0.43; Fig. 9B), which is probably the best estimate of the crystallization age of the granite.

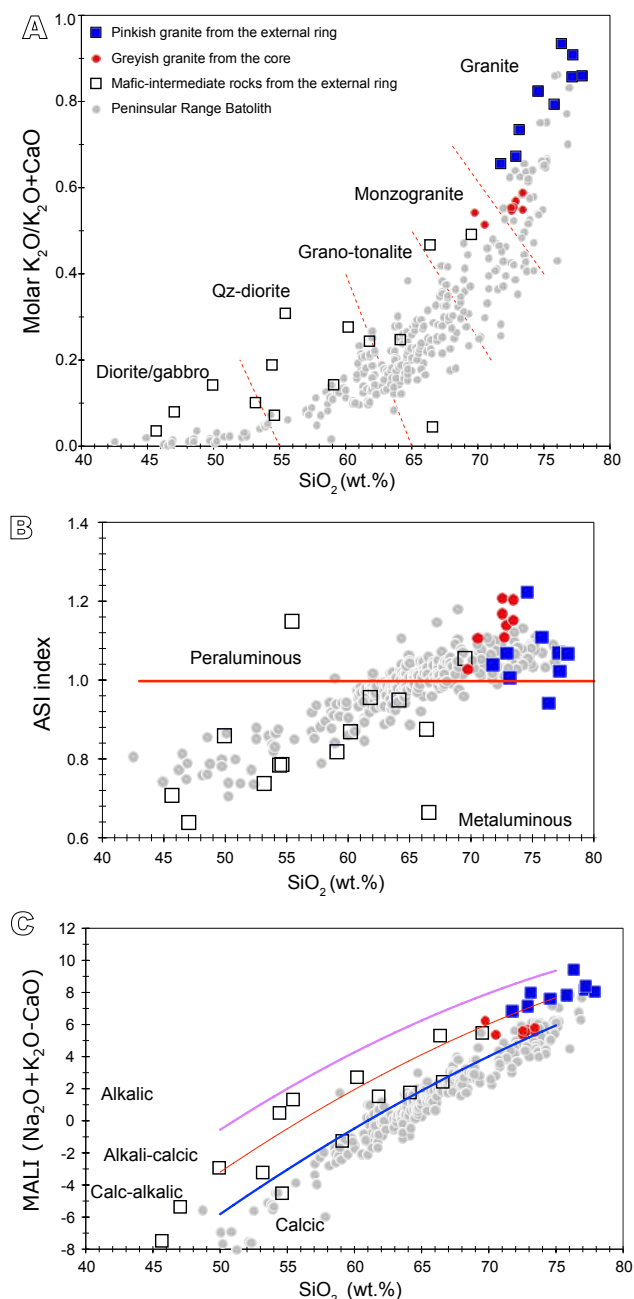


FIGURE 7. Geochemical diagrams showing essential variations of representative plutonic rocks of the Santa Eulália-Monforte massif. The geochemical data of the Santa Eulália-Monforte massif presented in these diagrams were compiled from Carrilho Lopes *et al.* (1998) and González Menéndez *et al.* (2006). The Peninsular Range batholith, representing Mesozoic continental arcs formed on the edge of the Precambrian North American craton by subduction of the Farallon oceanic Plate beneath North America, is used as comparative data (Lee *et al.*, 2007). A) SiO_2 vs. $K_2O/(K_2O+CaO)$ diagram shows the compositional range of the mafic-intermediate plutonic rocks and the position of the greyish granite from the core between the pinkish granite and the mafic-intermediate rocks forming the external ring. B) SiO_2 vs. ASI index diagram indicating the peraluminous character of almost all granites of the Santa Eulália-Monforte massif. C) The relation between the SiO_2 content and the MALI index (Frost *et al.*, 2001) delimits the trend of Santa Eulália-Monforte massif as calc-alkalic and alkali-calcic, above the typical calc-alkaline trend.

Sample BCA-2 (gabbro-diorite)

Zircons of this sample present morphological differences with respect to those of the granite described above. CL images of stubby and elongated euhedral prisms (150-350 μm diameter in long-axis) show simpler internal textures. Most zircon grains have banded zoning (Fig. 8), but a few show oscillatory concentric zoning or are unzoned.

Twenty-four U-Th-Pb isotopic analyses of representative zircon grains are listed in Table 1. Common lead 204-lead corrected isotope ratios gave $^{206}Pb/^{238}U$ ages of *ca.* 319-248Ma, having a cluster between *ca.* 310Ma and 290Ma. Sixteen U-Th-Pb analyses with discordance of $\leq 5\%$ were performed on zircons characterized by a wide range of U (89-629ppm) and Th (54-343ppm) content and average Th/U ratio of 0.64 (error standard deviation=0.02; Fig. 9A). This group of analyses yielded a concordia age of 303 ± 3 Ma (MSWD=0.079; Fig. 9D) overlapping the weighted mean $^{206}Pb/^{238}U$ age of 303 ± 4 Ma (MSWD=1.01; Fig. 9E), which is probably the best estimate for the crystallization age of the gabbro-diorite.

DISCUSSION

Significance of the obtained U-Th-Pb data

The new obtained U-Pb ages of the Santa Eulália-Monforte massif suggest that the gabbro-diorite (*ca.* 303Ma) crystallized somewhat 6Ma earlier than the external granite (*ca.* 297Ma) (Figs. 9 and 10). However, the overlapping ages of zircons shown in Figure 10 suggest that the mafic-intermediate rocks and the pinkish granite can also be roughly contemporaneous, as documented by field data. In some cases, it has been demonstrated that zircon populations in a magma chamber are a mix of autocrysts, antecrysts, and xenocrysts, and that the resultant plutonic rocks are, thus, a mechanical mixture of crystals (*e.g.* Charlier *et al.*, 2005; Miller *et al.*, 2007) that may have different individual ages. The obtained data suggest that the external ring of the Santa Eulália-Monforte massif formed by the crystallization of injections of compositionally distinct magmas. These magmas were close enough in time so that the earlier gabbro-dioritic magma had not cooled yet and had differentiated significantly before the addition of the later granitic magma.

The Th/U ratios obtained from analyzed zircons of both samples (Fig. 10) prove the coexistence of two compositionally distinct magmas from which zircon crystallized during the evolutionary history of the bimodal magmatic chamber. The average Th/U ratio of the granite (0.40) is significantly lower than that of the gabbro-diorite (0.64), indicating felsic-intermediate

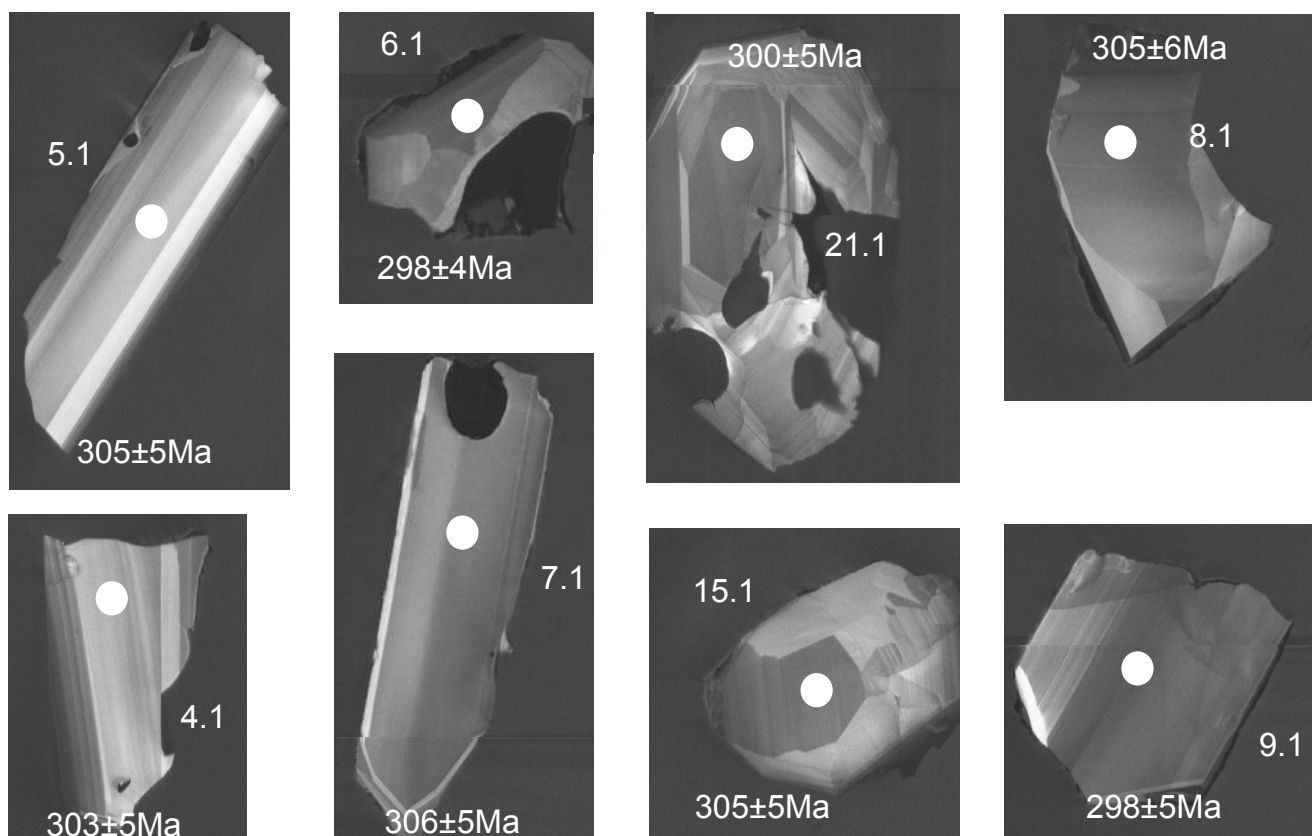
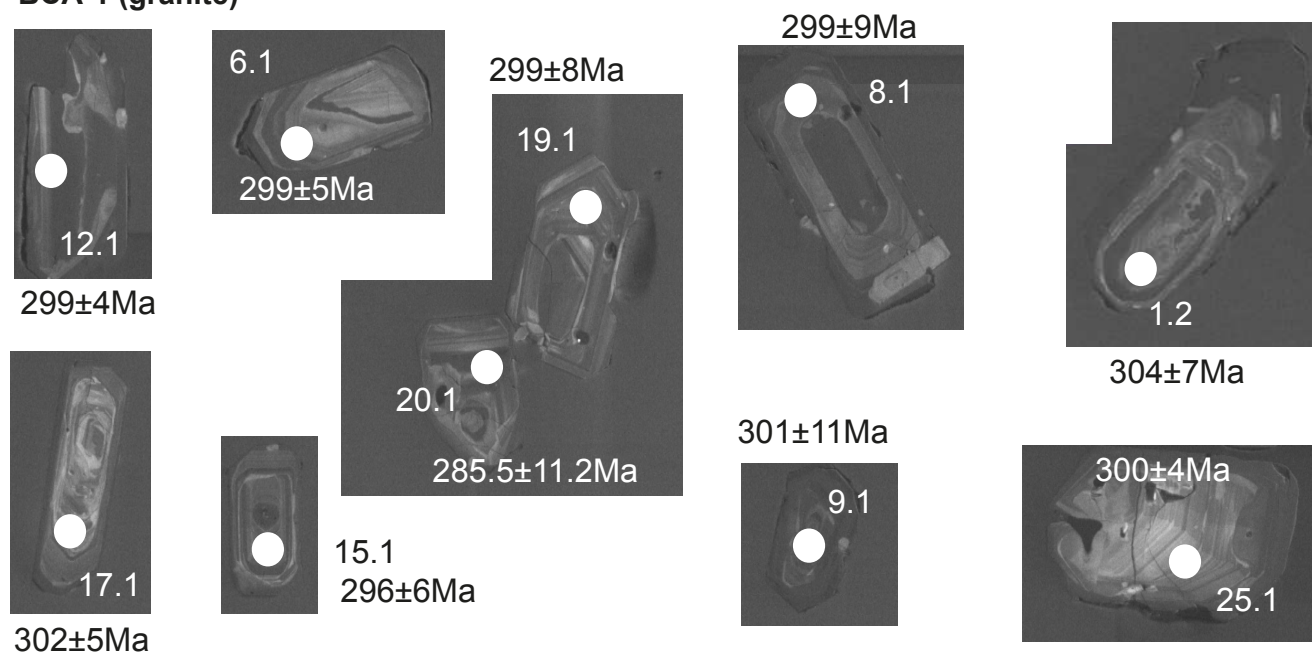
BCA-2 (gabbro-dioritic rock)**BCA-1 (granite)**

FIGURE 8. Cathodoluminescence (CL) imaging of representative zircons of the samples BCA-2- gabbro-dioritic rock and MFT-1- pinkish granite, with analytical sites and their resulting $^{206}\text{Pb}/^{238}\text{U}$ ages indicated. Analysis spots and ages are listed in Table I.

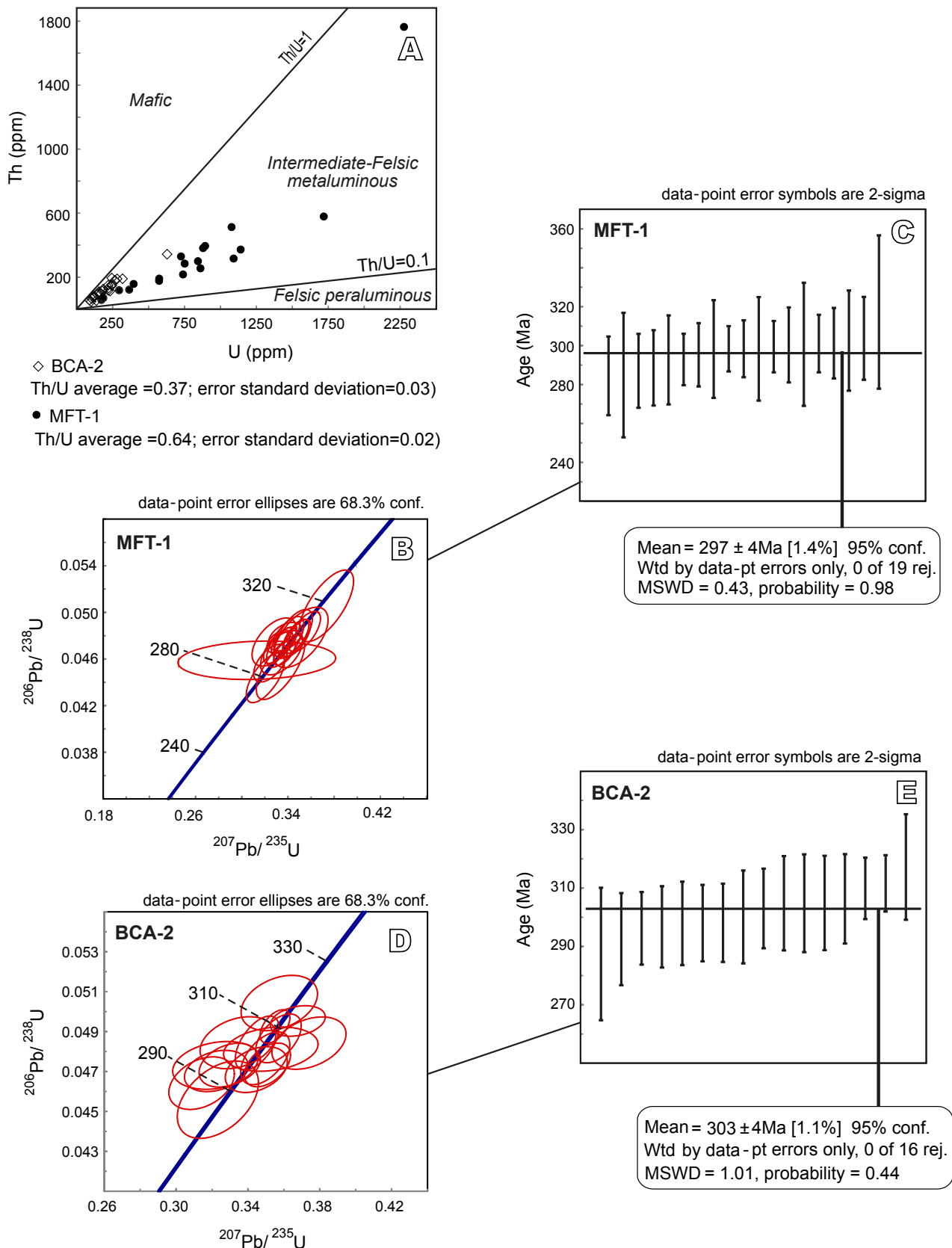


FIGURE 9. U-Th-Pb data: A) Th vs. U diagram with the fields that reflect different sources composition of melt from which zircon crystallized; B) and C) weighted mean and Concordia diagram of $^{206}\text{Pb}/^{238}\text{U}$ ages for sample MFT-1, respectively; D) and E) Concordia diagram and weighted mean of $^{206}\text{Pb}/^{238}\text{U}$ ages for sample BCA-2, respectively.

metaluminous sources for the two magmas (Heaman *et al.*, 1990; Hanchar and Miller, 1993; Hoskin and Schaltegger, 2003). In Figure 6, most zircon analyses of granite (sample MFT-1) are plotted in the range of $0.3 < \text{Th}/\text{U} < 0.5$, closer to the field of felsic peraluminous sources, in which probably there is abundant monazite ($\text{Th} > \text{U}$), and lower than those from the gabbro-diorite (sample BCA-2), in the range of $0.5 < \text{Th}/\text{U} < 0.7$, in which there is no other U-Th accessory.

Age relationship of the Santa Eulália-Monforte massif with other LC-EP Iberian calc-alkaline plutonic rocks

The reported weighted mean $^{206}\text{Pb}/^{238}\text{U}$ ages (this study) for the plutonic rocks of the external ring of the Santa Eulália-Monforte massif is of $303 \pm 3 \text{ Ma}$ (Late Carboniferous) for the gabbro-diorite and of $297 \pm 4 \text{ Ma}$ (Early Permian) for the granite. T-test indicates that the difference between these two zircon age populations is statistically significant (p -value is 0.02, *i.e.* lower than 0.05). Field observations of the consistent intrusive relationships between the greyish granite and the external ring (Gonçalves and Coelho, 1969-1970; Gonçalves, 1971; Oliveira, 1975; Gonçalves *et al.*, 1972, 1975; Carrillho Lopes *et al.*, 1998; González Ménendez *et al.*, 2006; Sant'Ovaia *et al.*, 2015) also suggest that these intrusions are coeval. Crystallization ages of the calc-alkaline magmatic rocks of the Santa Eulália-Monforte massif are within the wider range of ages obtained for other post-kinematic magmatic rocks of the Iberian Massif: i) the neighboring calc-alkaline Nisa-Alpalhão and Los Pedroches batholiths (U-Pb zircon ages of *ca.* 314-304Ma; Carracedo *et al.*, 2008; Solá *et al.*, 2009) (Fig. 1); ii) the calc-alkaline plutonic rocks of the Central Iberian and West-Asturian Leonese zones (U-Pb zircon ages of *ca.* 312-286Ma; Valverde-Vaquero, 1997; Dias *et al.*, 1998; Montero *et al.*, 2004; Valle Aguado *et al.*, 2005; Bea *et al.*, 2006; Neiva *et al.*, 2009; Fernández-Suárez *et al.*, 2011; Gutiérrez-Alonso *et al.*, 2011; Valverde-Vaquero *et al.*, 2011; Díaz Alvarado *et al.*, 2013; Díez Fernández and Pereira, 2017); and iii) the volcanic and plutonic rocks of the Central-eastern Pyrenees (U-Pb zircon ages of *ca.* 314-283Ma; Roberts *et al.* 2000; Aguilar *et al.*, 2014; Druguet *et al.*, 2014; Pereira *et al.*, 2014; and $^{40}\text{Ar}/^{39}\text{Ar}$ ages in the range of *ca.* 291-285Ma; Solá *et al.*, 2002). Our new U-Pb ages are *ca.* 20Ma younger with regard to the published age estimates for the Variscan plutonism and high-medium grade metamorphism recorded in the Ossa-Morena Zone (*ca.* 353-324Ma; Fig. 1). This age relationship indicates that the undeformed calc-alkaline magmatic rocks of the Santa Eulália-Monforte massif are consistent with a post-Variscan intrusion (*i.e.* post-kinematic), representing so far the youngest LC-EP

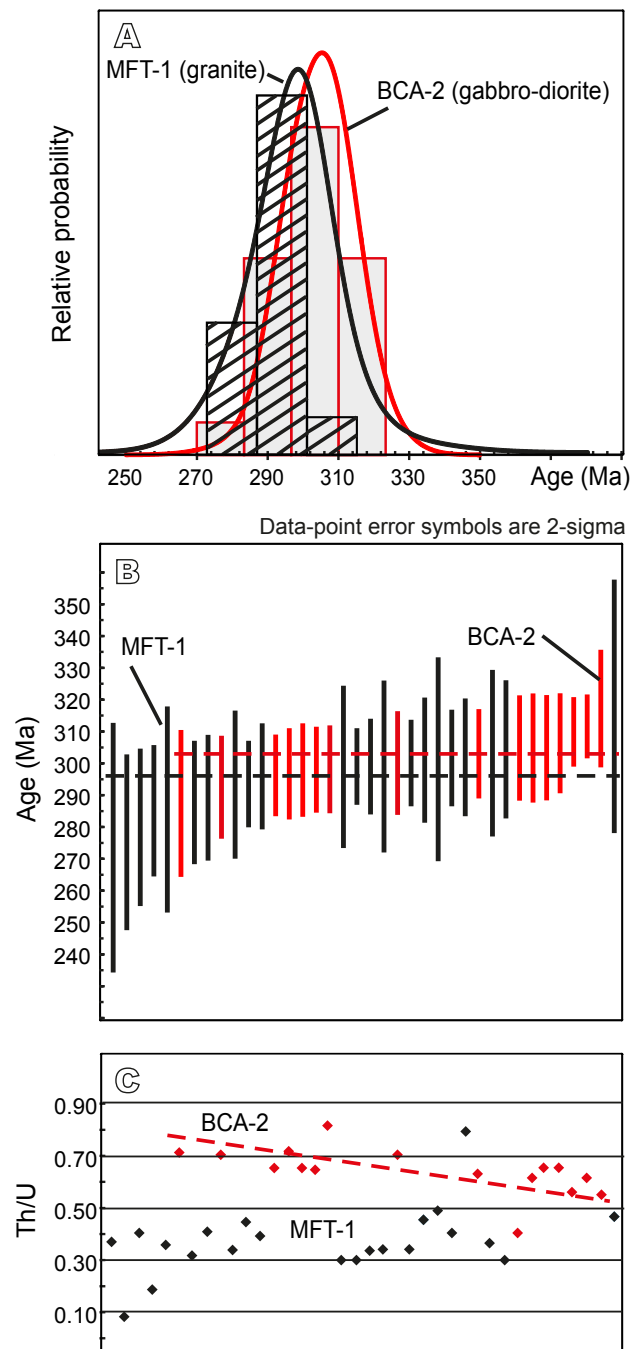


FIGURE 10. Joint projection of samples BCA-2 and MFT-1 U-Pb results: A) Age and probability density diagrams, B) weighted mean of $^{206}\text{Pb}/^{238}\text{U}$ ages, and C) Th/U ratio vs. age diagram.

calc-alkaline magmatic event of the Ossa-Morena Zone. The emplacement of the Santa Eulália-Monforte massif immediately followed the neighboring calc-alkaline granite intrusion of the Nisa-Albuquerque massif (*ca.* 309-306Ma; Solá *et al.*, 2009) and, in part, was almost synchronous to the latest magmatic pulses of the Los Pedroches massif (*ca.* 309-304Ma; Carracedo *et al.*, 2008) (Fig. 1).

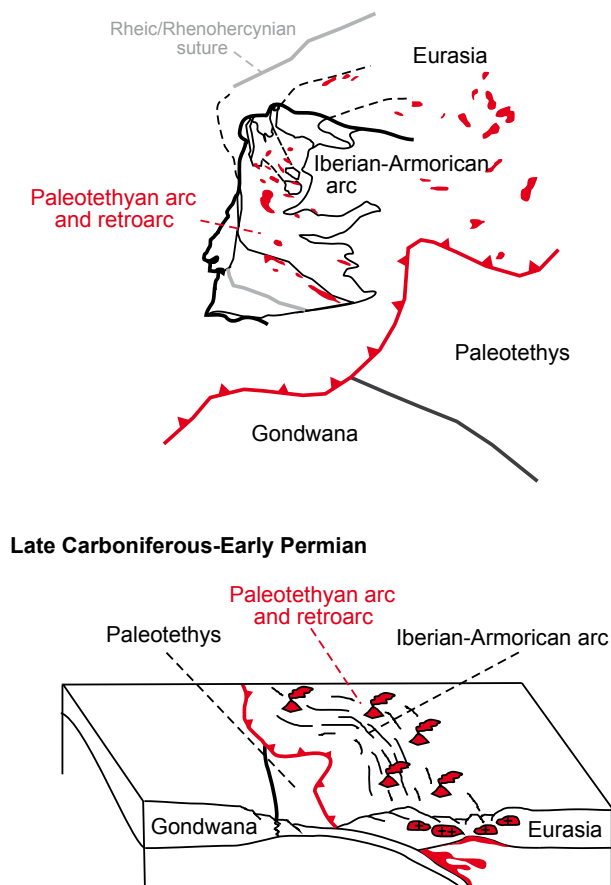


FIGURE 11. Schematic diagrams with the reconstruction of: A) the Iberian-Armorican arc and Paleotethyan arc and forearc at Early Carboniferous, after the closing of the Rheic (or Rheno-Hercynian) Ocean, and before the end of the subduction at the western corner of the Paleotethys Ocean; B) the oceanic-continent subduction zone and the formation of plumes resulting from the dehydration of the subducted crust, aqueous fluid transport, partial melting, melt extraction, and melt emplacement in the form of volcanism and intrusive plutons likewise, at the Santa Eulália-Monforte massif (modified from Pereira *et al.*, 2015b and references therein).

Geodynamic model

There is a general acceptance of a single, consensual interpretation that supports the growth of the Iberian LC-EP batholiths within the framework of the Variscan orogenic cycle (“late-Variscan batholiths”). This interpretation is considered valid even if the origin of these calc-alkaline magmas is about 60–80 Ma younger than the development of the Rheic Ocean active margin (Martínez Catalán *et al.*, 2009; Díez Fernández *et al.*, 2016; Pereira *et al.*, 2017b). This paradigm disregards the wider context of the amalgamation of the Pangaea and the spatial proximity of Iberia relative to the Eurasian active margin during the LC-EP closing of the Paleotethys Ocean (Pereira *et al.*, 2015b).

The generation of LC-EP post-kinematic I-type calc-alkaline Iberian batholiths in a tectonic setting other than

subduction conflicts with essential thermal requirements and phase equilibria constraints on metaluminous magma generation and fractionation (Pereira *et al.*, 2015b). The emplacement and thermal effects of the LC-EP calc-alkaline batholiths into a fertile middle crustal level, dominated by several kilometer-thick fertile Ediacaran-Cambrian metasedimentary successions, explains the late generation of S-type peraluminous granitic rocks and local hybridization of the intrusive magma, which became more peraluminous and potassic (Díaz Alvarado *et al.*, 2011; 2013). The lower crust is usually mentioned as the source of the Iberian calc-alkaline batholiths based on the assumptions that they are intrusive into the middle crust and that melts produced from the mantle underlying the continental crust must be basaltic (Dias *et al.*, 1998; Neiva *et al.*, 2009, 2012; Villaseca *et al.*, 2009, 2012). The new conception of subduction-related magmatism owing to plume-assisted relamination (Gerya *et al.*, 2004; Castro *et al.*, 2010; Gerya and Meilick, 2011; Vogt *et al.*, 2012) assumes that the generation of magmas of intermediate composition (andesite-diorite) occurs by means of the melting of subducted materials in silicic composite plumes, *i.e.* composed of oceanic crust and sediments. These materials are later relaminated to a level below the lower crust, where they split by melt segregation into liquids that are emplaced in the middle and upper crust (batholiths) and residues that remain in the lower crust as mafic granulites (Castro, 2013, 2014). In the case of the LC-EP calc-alkaline Iberian magmatism, several factors indicate an extra-crustal origin (Castro *et al.*, 2010, 2013; Castro, 2013, 2014; Pereira *et al.*, 2015b). The LC-EP Iberian batholiths have close compositional similarities with the calc-alkaline silicic magmatism of active continental margins as the Andes (Patagonian batholith) and the North American Cordillera (Sierra Nevada batholith). They also include arc-related appinitic rocks, suggesting a link to a subduction setting (Murphy, 2013) similar to that of the post-Paleozoic Cordilleran batholiths formed at the Pacific active margin of the Americas (Castro *et al.*, 2011). The period during which LC-EP calc-alkaline magmatism was generated (*ca.* 315–280 Ma) coincides with the development of the Iberian-Armorican Arc (Fig. 11) (*i.e.* Cantabrian orocline; Gutiérrez-Alonso *et al.*, 2008, 2011; Fernández-Suárez *et al.*, 2011; Weil *et al.*, 2012; Johnston *et al.*, 2013), which was probably related to the Pangaea self-subduction (Gutiérrez-Alonso *et al.*, 2008, 2011). In a global context, during the Late Carboniferous the western zones of the Iberian Massif were affected by the late stages of the Laurussia-Gondwana convergence, whereas the subduction of the Paleotethyan Ocean prevailed during and after LC-EP times (Cimmerian cycle) along the Eurasian eastern domains (Stampfli and Borel, 2002; Stampfli *et al.*, 2013) (Fig. 11). The progression of the Paleotethys subduction led to the collision between Cimmerian terranes (detached from the non-collisional northern margin of

Gondwana) and the Eurasian active margin (Cocks and Torsvik, 2006; Stampfli and Kozur, 2006), which can explain the inception of a LC-EP Paleotethyan magmatic arc in Iberia (Fig. 11; Pereira *et al.*, 2015b).

CONCLUSIONS

This paper presents the first SHRIMP U-Pb zircon dating of the Santa Eulália-Monforte massif. Concordia and weighted average zircon ages from granite and gabbro-diorite samples indicate magmatic crystallization at *ca.* 297Ma and 303Ma, respectively. However, field evidence and full analysis of zircon ages do not definitively rule out that they may have been contemporaneous during a certain stage of magma emplacement.

The Santa Eulália-Monforte massif represents so far the youngest LC-EP calc-alkaline magmatic event of the Ossa-Morena Zone (*ca.* 303-297Ma), which immediately followed the neighboring calc-alkaline granite production of the Nisa-Albuquerque massif (*ca.* 309-306Ma) and in part, was almost synchronous to the latest magmatic pulses of the Los Pedroches massif (*ca.* 309-304Ma). The LC-EP Iberian magmatism was coeval with the formation of the Iberian-Armorican arc (Cantabrian orocline). The LC-EP Iberian magmatism can be framed into a plausible model of a transient continental magmatic arc developed in the Eurasian convergent Plate margin above the subducted Paleotethys oceanic Plate.

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ELECTRONIC APPENDIX I

TABLE 1. Zircon U-Pb geochronological data (samples from the external ring of the Santa Eulália-Monforte massif)

id	U (ppm)	Th (ppm)	²⁰⁶ Pb (ppm)	% f206_4 f206_8		Th/U	common lead uncorrected isotope ratios										
				%			²⁰⁴ Pb/ ²⁰⁶ Pb				²⁰⁶ Pb/ ²³⁸ U				²⁰⁷ Pb/ ²³⁵ U		rho
				f206_4	f206_8		±err	±err	±err	±err	±err	±err	±err	±err			
BCA2-1.1	124.8	78.5	5.5	1.2	0.1	0.65	0.00071	0.00017	0.05316	0.00062	0.05075	0.00088	0.37199	0.00779	0.599		
BCA2-10.1	144.7	92.4	5.9	0.2	0.0	0.65	0.00014	0.00010	0.05177	0.00049	0.04715	0.00068	0.33651	0.00580	0.601		
BCA2-11.1	629.4	343.1	26.8	0.0	-0.1	0.56	0.00000	0.00003	0.05226	0.00026	0.04925	0.00055	0.35487	0.00434	0.659		
BCA2-12.1	184.6	125.1	7.4	0.2	-0.5	0.70	0.00009	0.00009	0.05041	0.00082	0.04649	0.00087	0.32313	0.00798	0.544		
BCA2-13.1	244.4	147.1	10.5	1.1	-0.5	0.62	0.00065	0.00060	0.05123	0.00098	0.04972	0.00076	0.35121	0.00858	0.451		
BCA2-14.1	115.9	80.5	4.6	0.2	0.3	0.71	0.00012	0.00012	0.05318	0.00031	0.04569	0.00128	0.33498	0.00956	0.705		
BCA2-15.1	137.2	53.7	5.7	-0.2	0.0	0.40	-0.00010	0.00010	0.05453	0.00076	0.04833	0.00086	0.36338	0.00821	0.566		
BCA2-16.1	232.2	113.0	9.6	0.5	-0.1	0.50	0.00027	0.00009	0.05168	0.00071	0.04769	0.00081	0.33980	0.00743	0.558		
BCA2-17.1	281.4	189.4	9.6	0.3	-1.7	0.69	0.00018	0.00014	0.05402	0.00042	0.03937	0.00070	0.29325	0.00572	0.660		
BCA2-18.1	218.9	148.6	9.3	3.0	-0.1	0.70	0.00180	0.00167	0.05484	0.00106	0.04886	0.00067	0.36949	0.00877	0.417		
BCA2-19.1	156.1	109.2	6.4	-0.1	0.2	0.72	-0.00008	0.00008	0.05188	0.00081	0.04702	0.00075	0.33637	0.00752	0.516		
BCA2-2.1	112.8	73.4	4.8	0.4	-0.2	0.67	0.00024	0.00010	0.05174	0.00052	0.04934	0.00078	0.35196	0.00660	0.608		
BCA2-20.1	167.4	96.2	7.0	0.5	0.0	0.59	0.00031	0.00010	0.05326	0.00151	0.04854	0.00051	0.35649	0.01076	0.249		
BCA2-21.1	265.9	180.1	11.0	0.1	-0.2	0.69	0.00007	0.00005	0.05429	0.00058	0.04772	0.00087	0.35727	0.00756	0.622		
BCA2-22.1	319.0	190.0	13.6	-0.2	-0.2	0.61	-0.00011	0.00007	0.05226	0.00070	0.04943	0.00050	0.35617	0.00599	0.433		
BCA2-23.1	179.1	113.0	7.4	0.3	0.1	0.65	0.00019	0.00012	0.05222	0.00131	0.04747	0.00079	0.34178	0.01029	0.396		
BCA2-24.1	100.5	47.7	4.4	1.3	0.1	0.49	0.00079	0.00016	0.05464	0.00010	0.05034	0.00054	0.37929	0.00414	0.709		
BCA2-3.1	220.1	117.3	9.6	0.1	0.0	0.55	0.00007	0.00011	0.05242	0.00019	0.05049	0.00091	0.36497	0.00671	0.705		
BCA2-4.1	105.8	65.2	4.4	-0.1	-0.2	0.63	-0.00005	0.00015	0.05245	0.00098	0.04808	0.00072	0.34768	0.00833	0.450		
BCA2-5.1	89.1	56.8	3.7	0.3	0.1	0.65	0.00017	0.00011	0.05253	0.00067	0.04859	0.00086	0.35193	0.00765	0.584		
BCA2-6.1	244.3	153.5	10.0	0.2	0.3	0.64	0.00014	0.00006	0.05247	0.00113	0.04743	0.00073	0.34318	0.00905	0.417		
BCA2-7.1	154.0	99.5	6.5	-0.1	-0.2	0.66	-0.00005	0.00003	0.05245	0.00069	0.04861	0.00080	0.35155	0.00745	0.563		
BCA2-8.1	222.0	132.5	9.3	0.1	-0.3	0.61	0.00004	0.00004	0.05226	0.00036	0.04845	0.00089	0.34914	0.00687	0.675		
BCA2-9.1	243.9	194.2	10.0	-0.2	-0.2	0.82	-0.00012	0.00005	0.05202	0.00052	0.04722	0.00072	0.33874	0.00616	0.603		
MFT1-1.1	574.1	176.5	22.7	0.3	0.2	0.32	0.00016	0.00005	0.05389	0.00044	0.04578	0.00107	0.34014	0.00842	0.679		
MFT1-1.2	740.6	216.2	31.0	0.1	0.0	0.30	0.00004	0.00002	0.05374	0.00049	0.04839	0.00114	0.35857	0.00906	0.672		

BCA-2- gabbro-diorite (39°4'5.9"N; 7°12'51"W); MFT-1- pinkish granite (39°04'4.5"N; 7°13'53"W)
SHRIMPTOOLS data processing; IBERSIMS laboratory, University of Granada, Spain
Errors are at one sigma level. The error in 206/238 averaging the standard has been already propagated. Th/U ratios are atomic (232/238), not in weight
Point-to point errors, calculated on replicates of the TEMORA standard, are: 0.36% for ²⁰⁶Pb/²³⁸U, and 0.32% for ²⁰⁷Pb/²⁰⁶Pb

TABLE 1. (Cont.)

id	U (ppm)	Th (ppm)	²⁰⁶ Pb (ppm)	% ε206_4 ε206_8		Th/U	common lead uncorrected isotope ratios				±err	²⁰⁷ Pb/ ²³⁵ U	±err	rho
							²⁰⁴ Pb/ ²⁰⁶ Pb	±err	²⁰⁷ Pb/ ²⁰⁶ Pb	±err	²⁰⁶ Pb/ ²³⁸ U	±err		
MFT1-10.1	3246.3	582.4	129.3	0.2	0.1	0.18	0.00014	0.00001	0.05417	0.00013	0.04533	0.00115	0.34364	0.00861
MFT1-11.1	2277.6	1763.1	94.6	0.0	-0.1	0.79	0.00003	0.00002	0.05286	0.00011	0.04796	0.00097	0.34957	0.00710
MFT1-12.1	861.8	254.6	35.7	0.7	0.8	0.30	0.00042	0.00005	0.05708	0.00035	0.04785	0.00065	0.37655	0.00561
MFT1-13.1	879.6	381.2	35.5	0.1	0.0	0.44	0.00007	0.00003	0.05343	0.00018	0.04664	0.00074	0.34364	0.00560
MFT1-14.1	4891.5	1761.5	194.0	0.6	-2.1	0.37	0.00035	0.00006	0.05720	0.00027	0.04362	0.00231	0.36132	0.01831
MFT1-15.1	751.7	284.3	30.6	0.1	-0.1	0.39	0.00004	0.00003	0.05155	0.00037	0.04700	0.00089	0.33409	0.00678
MFT1-16.1	8522.3	657.5	366.2	0.1	0.5	0.08	0.00007	0.00001	0.05374	0.00013	0.04366	0.00160	0.36784	0.01190
MFT1-17.1	396.7	156.9	16.5	0.1	0.1	0.41	0.00003	0.00007	0.05160	0.00031	0.04795	0.00080	0.34115	0.00604
MFT1-18.1	913.7	359.4	35.1	0.1	0.1	0.40	0.00008	0.00004	0.05349	0.00016	0.04443	0.00140	0.32773	0.01035
MFT1-18.2	7013.1	5433.9	219.4	7.2	2.1	0.79	0.00425	0.00015	0.11705	0.00212	0.03288	0.00146	0.58321	0.02589
MFT1-19.1	1092.1	315.4	45.2	0.6	0.5	0.30	0.00037	0.00008	0.05556	0.00029	0.04778	0.00137	0.36599	0.01064
MFT1-19.2	911.8	406.1	34.5	8.8	10.9	0.46	0.00518	0.00024	0.13192	0.00209	0.04373	0.00112	0.79539	0.02394
MFT1-20.1	634.7	218.4	24.9	0.0	0.2	0.35	-0.00002	0.00003	0.05317	0.00024	0.04527	0.00182	0.33190	0.01342
MFT1-21.1	172.1	57.1	6.9	0.6	-0.2	0.34	0.00035	0.00006	0.05155	0.00026	0.04627	0.00115	0.32881	0.00835
MFT1-22.1	844.4	299.3	35.2	0.1	0.1	0.36	0.00006	0.00004	0.05278	0.00022	0.04821	0.00138	0.35083	0.01015
MFT1-23.1	186.1	69.5	8.9	13.7	15.5	0.38	0.00811	0.00215	0.16428	0.02318	0.05523	0.00129	1.25107	0.17891
MFT1-24.1	893.8	394.4	37.0	0.0	-0.1	0.45	0.00001	0.00001	0.05296	0.00016	0.04781	0.00105	0.34913	0.00774
MFT1-24.2	295.8	117.5	13.3	11.0	11.7	0.41	0.00647	0.00033	0.14489	0.00332	0.05207	0.00118	1.04012	0.03351
MFT1-25.1	365.8	121.2	15.1	0.1	0.1	0.34	0.00005	0.00003	0.05212	0.00032	0.04769	0.00072	0.34273	0.00556
MFT1-3.1	6604.7	822.0	232.9	1.7	1.8	0.13	0.00099	0.00019	0.06876	0.00296	0.03740	0.00164	0.38627	0.02278
MFT1-4.1	6165.8	1616.6	206.5	2.8	3.9	0.27	0.00166	0.00016	0.08012	0.00308	0.03585	0.00179	0.42740	0.02572
MFT1-5.1	726.5	328.9	31.8	0.0	-0.1	0.46	-0.00002	0.00003	0.05332	0.00040	0.05054	0.00203	0.37160	0.01516
MFT1-6.1	574.4	190.3	23.7	0.3	0.1	0.34	0.00017	0.00002	0.05384	0.00049	0.04763	0.00081	0.35354	0.00683
MFT1-7.1	1141.6	372.1	46.5	1.0	1.2	0.33	0.00058	0.00008	0.06071	0.00024	0.04705	0.00127	0.39383	0.01071
MFT1-8.1	1719.5	578.6	71.1	0.6	0.3	0.35	0.00035	0.00003	0.05666	0.00018	0.04777	0.00145	0.37322	0.01135
MFT1-8.2	2885.0	893.3	218.6	0.1	-0.2	0.32	0.00005	0.00001	0.05916	0.00024	0.08687	0.00862	0.71414	0.07041
MFT1-9.1	1078.1	512.2	45.1	1.0	0.7	0.49	0.00058	0.00008	0.06180	0.00064	0.04837	0.00172	0.41219	0.01530

BCA-2- gabbro-diorite (39°45.9'N; 7°12'51"W); MFT-1- pinkish granite (39°04.4.5'N; 7°13'53"W)

SHRIMPTOOLS data processing: IBERSIMS laboratory, University of Granada, Spain

Errors are at one sigma level. The error in 206/238 averaging the standard has been already propagated. Th/U ratios are atomic (232/238), not in weight

Point-to point errors, calculated on replicates of the TEMORA standard, are: 0.36% for ²⁰⁶Pb/²³⁸U, and 0.32% for ²⁰⁷Pb/²⁰⁶Pb

TABLE 1. (Cont.)

id	$^{208}\text{Pb}/^{232}\text{Th}$	common lead uncorrected ages (Ma)					$^{207}\text{Pb}/^{235}\text{U}$	$\pm\text{err}$	% discord.
		$\pm\text{err}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm\text{err}$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm\text{err}$			
BCA2-1.1	0.01607	0.00036	335.5	26.2	319.1	5.4	321.1	5.8	0.6
BCA2-10.1	0.01474	0.00023	275.1	21.6	297.0	4.2	294.5	4.4	-0.8
BCA2-11.1	0.01535	0.00018	296.7	11.2	309.9	3.4	308.4	3.3	-0.4
BCA2-12.1	0.01403	0.00032	213.9	37.0	292.9	5.3	284.3	6.1	-3.0
BCA2-13.1	0.01481	0.00041	251.1	43.2	312.8	4.6	305.6	6.4	-2.4
BCA2-14.1	0.01469	0.00076	336.5	12.8	288.0	7.9	293.4	7.3	1.8
BCA2-15.1	0.01516	0.00031	392.9	31.0	304.3	5.3	314.7	6.1	3.4
BCA2-16.1	0.01483	0.00030	271.1	31.4	300.3	4.9	297.0	5.6	-1.2
BCA2-17.1	0.01061	0.00022	371.7	17.6	249.0	4.4	261.1	4.5	4.6
BCA2-18.1	0.01523	0.00024	405.9	42.8	307.5	4.1	319.3	6.6	3.6
BCA2-19.1	0.01504	0.00026	280.1	35.4	296.2	4.6	294.4	5.7	-0.6
BCA2-2.1	0.01527	0.00030	273.9	22.8	310.5	4.8	306.2	5.0	-1.4
BCA2-20.1	0.01530	0.00024	340.1	62.8	305.6	3.1	309.6	8.1	1.2
BCA2-21.1	0.01475	0.00029	383.3	23.8	300.5	5.3	310.2	5.7	3.2
BCA2-22.1	0.01522	0.00018	296.7	30.4	311.0	3.0	309.3	4.4	-0.6
BCA2-23.1	0.01507	0.00032	295.1	56.4	299.0	4.9	298.5	7.8	-0.2
BCA2-24.1	0.01601	0.00028	397.7	4.2	316.6	3.3	326.5	3.0	3.0
BCA2-3.1	0.01586	0.00032	303.9	8.4	317.5	5.5	315.9	5.0	-0.6
BCA2-4.1	0.01484	0.00036	305.1	42.0	302.7	4.4	303.0	6.3	0.0
BCA2-5.1	0.01533	0.00038	308.5	28.8	305.9	5.3	306.2	5.8	0.0
BCA2-6.1	0.01527	0.00026	306.1	48.2	298.8	4.5	299.6	6.9	0.2
BCA2-7.1	0.01494	0.00033	304.9	30.0	306.0	4.9	305.9	5.6	0.0
BCA2-8.1	0.01479	0.00032	296.9	15.4	305.0	5.5	304.1	5.2	-0.2
BCA2-9.1	0.01467	0.00024	286.5	22.6	297.5	4.5	296.2	4.7	-0.4
MFT1-1.1	0.01508	0.00038	366.5	18.4	288.5	6.6	297.3	6.4	3.0
MFT1-1.2	0.01526	0.00060	360.3	20.4	304.6	7.0	311.1	6.7	2.0
MFT1-10.1	0.01516	0.00046	377.9	5.6	285.8	7.1	299.9	6.5	4.8

BCA-2- gabbro-diorite (39°4'5.9"N; 7°12'51"W); MFT-1- pinkish granite (39°04'4.5"N; 7°13'53"W)
 SHRIMPTOOLS data processing; IBERSIMS laboratory, University of Granada, Spain
 Errors are at one sigma level. The error in 206/238 averaging the standard has been already propagated. Th/U ratios are atomic (232/238), not in weight
 Point-to point errors, calculated on replicates of the TEMORA standard, are: 0.36% for $^{206}\text{Pb}/^{238}\text{U}$, and 0.32% for $^{207}\text{Pb}/^{206}\text{Pb}$

TABLE 1. (Cont.)

id	common lead uncorrected ages (Ma)									
	$^{208}\text{Pb}/^{232}\text{Th}$	$\pm\text{err}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm\text{err}$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm\text{err}$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm\text{err}$	% discord.	
MFT1-11.1	0.01492	0.00033	322.9	4.4	302.0	6.0	304.4	5.4	0.8	
MFT1-12.1	0.01764	0.00026	494.5	13.4	301.3	4.0	324.5	4.1	7.2	
MFT1-13.1	0.01459	0.00027	347.3	7.6	293.9	4.6	299.9	4.2	2.0	
MFT1-14.1	0.00921	0.00071	499.3	10.4	275.2	14.3	313.2	13.7	12.2	
MFT1-15.1	0.01458	0.00031	265.5	16.4	296.1	5.5	292.7	5.2	-1.2	
MFT1-16.1	0.02197	0.00185	360.3	5.4	275.5	9.9	318.1	8.9	13.4	
MFT1-17.1	0.01526	0.00027	267.9	13.8	301.9	4.9	298.0	4.5	-1.4	
MFT1-18.1	0.01423	0.00046	349.7	6.6	280.3	8.7	287.8	7.9	2.6	
MFT1-18.2	0.01316	0.00068	1911.7	32.2	208.5	9.1	466.5	16.7	55.4	
MFT1-19.1	0.01676	0.00049	434.9	11.4	300.9	8.5	316.7	8.0	5.0	
MFT1-19.2	0.03406	0.00105	2123.7	27.4	275.9	6.9	594.2	13.6	53.6	
MFT1-20.1	0.01468	0.00073	336.3	10.4	285.4	11.2	291.0	10.3	2.0	
MFT1-21.1	0.01408	0.00039	265.3	11.8	291.6	7.1	288.7	6.4	-1.0	
MFT1-22.1	0.01543	0.00044	319.5	9.6	303.5	8.5	305.3	7.6	0.6	
MFT1-23.1	0.06126	0.00763	2500.3	219.8	346.6	7.9	823.9	84.1	58.0	
MFT1-24.1	0.01486	0.00034	326.9	6.8	301.1	6.5	304.1	5.9	1.0	
MFT1-24.2	0.04562	0.00147	2286.5	38.8	327.2	7.2	724.0	16.8	54.8	
MFT1-25.1	0.01538	0.00032	290.7	13.8	300.3	4.4	299.2	4.2	-0.4	
MFT1-3.1	0.02475	0.00301	891.7	86.4	236.7	10.2	331.6	16.8	28.6	
MFT1-4.1	0.02358	0.00231	1200.1	74.0	227.1	11.2	361.3	18.4	37.2	
MFT1-5.1	0.01569	0.00070	342.5	17.0	317.8	12.4	320.8	11.2	1.0	
MFT1-6.1	0.01532	0.00028	364.3	20.2	299.9	5.0	307.4	5.2	2.4	
MFT1-7.1	0.01818	0.00050	629.1	8.6	296.4	7.8	337.2	7.9	12.0	
MFT1-8.1	0.01572	0.00050	478.3	7.0	300.8	8.9	322.0	8.4	6.6	
MFT1-8.2	0.02607	0.00353	573.1	8.8	537.0	51.4	547.2	42.6	1.8	
MFT1-9.1	0.01645	0.00070	667.3	22.0	304.5	10.6	350.4	11.0	13.0	

BCA-2- gabbro-diorite (39°45.9'N; 7°12'51"W); MFT1-1- pinkish granite (39°04'4.5"N; 7°13'53"W)

SHRIMPTOOLS data processing; IBERSIMS laboratory, University of Granada, Spain

Errors are at one sigma level. The error in 206/238 averaging the standard has been already propagated. Th/U ratios are atomic (232/238), not in weight

Point-to point errors, calculated on replicates of the TEMORA standard, are: 0.36% for $^{206}\text{Pb}/^{238}\text{U}$, and 0.32% for $^{207}\text{Pb}/^{206}\text{Pb}$

TABLE 1. (Cont.)

id	$^{208}\text{Pb}/^{232}\text{Th}$	$\pm\text{err}$	204-corrected isotope ratios				$^{207}\text{Pb}/^{235}\text{U}$	$\pm\text{err}$	$^{207}\text{Pb}/^{238}\text{U}$	$\pm\text{err}$	rho_4cor
			$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm\text{err}$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm\text{err}$					
BCA2-1.1	322.1	7.2	0.04254	0.00284	0.05009	0.00089	0.29377	0.02035	0.29377	0.02035	0.184
BCA2-10.1	295.8	4.6	0.04971	0.00163	0.04703	0.00068	0.32231	0.01164	0.32231	0.01164	0.289
BCA2-11.1	308.0	3.6	0.05229	0.00052	0.04925	0.00055	0.35509	0.00548	0.35509	0.00548	0.523
BCA2-12.1	281.6	6.4	0.04910	0.00163	0.04641	0.00087	0.31422	0.01203	0.31422	0.01203	0.352
BCA2-13.1	297.1	8.2	0.04162	0.00960	0.04914	0.00093	0.28201	0.06527	0.28201	0.06527	0.059
BCA2-14.1	294.7	15.1	0.05143	0.00187	0.04559	0.00128	0.32328	0.01491	0.32328	0.01491	0.438
BCA2-15.1	304.1	6.1	0.05602	0.00177	0.04842	0.00087	0.37401	0.01362	0.37401	0.01362	0.353
BCA2-16.1	297.5	6.1	0.04772	0.00154	0.04746	0.00081	0.31227	0.01148	0.31227	0.01148	0.334
BCA2-17.1	213.4	4.5	0.05142	0.00223	0.03925	0.00071	0.27825	0.01309	0.27825	0.01309	0.276
BCA2-18.1	305.4	4.7	0.02760	0.02707	0.04725	0.00163	0.17978	0.17649	0.17978	0.17649	0.025
BCA2-19.1	301.6	5.2	0.05308	0.00153	0.04709	0.00076	0.34470	0.01142	0.34470	0.01142	0.349
BCA2-2.1	306.3	6.0	0.04823	0.00172	0.04912	0.00078	0.32667	0.01284	0.32667	0.01284	0.292
BCA2-20.1	306.8	4.7	0.04866	0.00220	0.04826	0.00051	0.32380	0.01509	0.32380	0.01509	0.164
BCA2-21.1	296.0	5.7	0.05321	0.00095	0.04766	0.00087	0.34967	0.00902	0.34967	0.00902	0.511
BCA2-22.1	305.4	3.7	0.05385	0.00136	0.04953	0.00050	0.36779	0.01010	0.36779	0.01010	0.267
BCA2-23.1	302.3	6.4	0.04945	0.00232	0.04730	0.00079	0.32253	0.01612	0.32253	0.01612	0.241
BCA2-24.1	320.9	5.6	0.04293	0.00255	0.04962	0.00055	0.29369	0.01780	0.29369	0.01780	0.132
BCA2-3.1	318.0	6.4	0.05141	0.00178	0.05043	0.00091	0.35747	0.01405	0.35747	0.01405	0.332
BCA2-4.1	297.7	7.2	0.05317	0.00248	0.04812	0.00073	0.35276	0.01737	0.35276	0.01737	0.222
BCA2-5.1	307.4	7.5	0.05007	0.00187	0.04844	0.00086	0.33444	0.01390	0.33444	0.01390	0.308
BCA2-6.1	306.2	5.3	0.05046	0.00146	0.04732	0.00073	0.32923	0.01084	0.32923	0.01084	0.335
BCA2-7.1	299.7	6.5	0.05321	0.00087	0.04866	0.00081	0.35700	0.00839	0.35700	0.00839	0.508
BCA2-8.1	296.6	6.4	0.05170	0.00071	0.04842	0.00089	0.34516	0.00802	0.34516	0.00802	0.572
BCA2-9.1	294.2	4.8	0.05378	0.00098	0.04733	0.00072	0.35092	0.00845	0.35092	0.00845	0.456
MFT1-1.1	302.5	7.7	0.05161	0.00092	0.04564	0.00107	0.32480	0.00960	0.32480	0.00960	0.569
MFT1-1.2	306.0	11.8	0.05312	0.00057	0.04835	0.00114	0.35417	0.00926	0.35417	0.00926	0.650
MFT1-10.1	304.2	9.2	0.05217	0.00021	0.04521	0.00114	0.32522	0.00842	0.32522	0.00842	0.704
MFT1-11.1	299.4	6.7	0.05247	0.00036	0.04794	0.00097	0.34684	0.00750	0.34684	0.00750	0.673

BCA-2- gabbro-diorite (39°45'9"N; 7°12'51"W); MFT-1- pinkish granite (39°04'4.5"N; 7°13'53"W)

SHRIMPTOOLS data processing; IBERSIMS laboratory, University of Granada, Spain

Errors are at one sigma level. The error in 206/238 averaging the standard has been already propagated. Th/U ratios are atomic (232/238), not in weight Point-to-point errors, calculated on replicates of the TEMORA standard, are: 0.36% for $^{206}\text{Pb}/^{238}\text{U}$, and 0.32% for $^{207}\text{Pb}/^{235}\text{U}$

TABLE 1. (Cont.)

204-corrected isotope ratios									
id	$^{208}\text{Pb}/^{232}\text{Th}$	$\pm\text{err}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm\text{err}$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm\text{err}$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm\text{err}$	rho_4cor
MFT1-12.1	353.5	5.1	0.05088	0.00088	0.04748	0.00065	0.33312	0.00745	0.438
MFT1-13.1	292.7	5.4	0.05247	0.00046	0.04659	0.00074	0.33708	0.00626	0.619
MFT1-14.1	185.2	14.2	0.05203	0.00091	0.04334	0.00230	0.31090	0.01739	0.682
MFT1-15.1	292.5	6.2	0.05095	0.00055	0.04697	0.00089	0.32999	0.00730	0.618
MFT1-16.1	439.2	36.7	0.05279	0.00022	0.04361	0.00160	0.31740	0.01178	0.712
MFT1-17.1	306.0	5.2	0.05113	0.00117	0.04792	0.00080	0.33785	0.00966	0.420
MFT1-18.1	285.6	9.2	0.05238	0.00064	0.04437	0.00140	0.32045	0.01089	0.667
MFT1-18.2	264.2	13.6	0.05488	0.00348	0.03029	0.00135	0.22921	0.01778	0.414
MFT1-19.1	335.8	9.7	0.05016	0.00129	0.04746	0.00136	0.32819	0.01271	0.533
MFT1-19.2	676.9	20.4	0.05629	0.00475	0.03956	0.00103	0.30706	0.02715	0.212
MFT1-20.1	294.6	14.5	0.05343	0.00050	0.04528	0.00182	0.33362	0.01381	0.699
MFT1-21.1	282.6	7.8	0.04636	0.00103	0.04597	0.00114	0.29384	0.00987	0.534
MFT1-22.1	309.5	8.8	0.05192	0.00067	0.04815	0.00138	0.34471	0.01090	0.652
MFT1-23.1	1201.7	145.9	0.04393	0.04807	0.04702	0.00244	0.28483	0.31201	0.034
MFT1-24.1	298.2	6.8	0.05274	0.00028	0.04780	0.00105	0.34761	0.00795	0.692
MFT1-24.2	901.5	28.4	0.04949	0.00702	0.04589	0.00109	0.31310	0.04507	0.119
MFT1-25.1	308.5	6.3	0.05141	0.00059	0.04765	0.00072	0.33773	0.00651	0.562
MFT1-3.1	494.1	59.5	0.05420	0.00429	0.03671	0.00162	0.27435	0.02487	0.350
MFT1-4.1	471.1	45.6	0.05581	0.00409	0.03475	0.00174	0.26742	0.02377	0.405
MFT1-5.1	314.6	13.8	0.05354	0.00059	0.05056	0.00203	0.37325	0.01557	0.692
MFT1-6.1	307.2	5.5	0.05140	0.00063	0.04748	0.00081	0.33650	0.00716	0.577
MFT1-7.1	364.1	10.0	0.05213	0.00122	0.04654	0.00125	0.33452	0.01202	0.540
MFT1-8.1	315.1	9.9	0.05158	0.00044	0.04747	0.00144	0.33762	0.01068	0.689
MFT1-8.2	520.2	69.7	0.05850	0.00030	0.08680	0.00862	0.70014	0.06965	0.719
MFT1-9.1	329.8	13.8	0.05323	0.00138	0.04785	0.00171	0.35119	0.01554	0.580

BCA-2- gabbro-diorite (39°45.9'N; 7°12'51"W); MFT-1- pinkish granite (39°04'4.5"N; 7°13'53"W)

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Point-to point errors, calculated on replicates of the TEMORA standard, are: 0.36% for $^{206}\text{Pb}/^{238}\text{U}$, and 0.32% for $^{207}\text{Pb}/^{206}\text{Pb}$

TABLE 1. (Cont.)

204-corrected ages (Ma)												
id	$^{208}\text{Pb}/^{232}\text{Th}$	$\pm\text{err}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm\text{err}$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm\text{err}$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm\text{err}$	% discord.	$^{208}\text{Pb}/^{232}\text{Th}$	$\pm\text{err}$	$\pm\text{err}$
BCA2-1.1	0.01392	0.00057	0.0	0.0	315.1	5.5	261.5	16.1	-20.4	279.3	11.3	11.3
BCA2-10.1	0.01436	0.00029	181.5	74.8	296.2	4.2	283.7	9.0	-4.4	288.1	5.7	5.7
BCA2-11.1	0.01536	0.00011	298.1	22.6	309.9	3.4	308.5	4.1	-0.4	308.1	2.2	2.2
BCA2-12.1	0.01381	0.00030	152.7	75.8	292.5	5.4	277.4	9.3	-5.4	277.1	5.9	5.9
BCA2-13.1	0.01282	0.00189	0.0	250.9	309.2	5.7	252.2	53.0	-22.6	257.5	37.8	37.8
BCA2-14.1	0.01440	0.00035	260.3	81.6	287.4	7.9	284.4	11.5	-1.0	288.9	7.0	7.0
BCA2-15.1	0.01563	0.00049	453.1	68.6	304.8	5.3	322.6	10.1	5.6	313.4	9.8	9.8
BCA2-16.1	0.01385	0.00036	0.0	160.5	298.9	5.0	275.9	8.9	-8.4	278.0	7.2	7.2
BCA2-17.1	0.01023	0.00032	259.7	96.4	248.2	4.4	249.3	10.5	0.4	205.7	6.5	6.5
BCA2-18.1	0.01039	0.00450	0.0	398.7	297.6	10.0	167.9	164.6	-77.2	208.9	90.3	90.3
BCA2-19.1	0.01524	0.00023	332.5	63.8	296.7	4.7	300.7	8.6	1.4	305.7	4.5	4.5
BCA2-2.1	0.01460	0.00034	110.5	82.4	309.1	4.8	287.0	9.9	-7.8	292.9	6.7	6.7
BCA2-20.1	0.01431	0.00036	131.3	103.2	303.9	3.2	284.8	11.6	-6.8	287.2	7.1	7.1
BCA2-21.1	0.01456	0.00015	337.9	39.8	300.1	5.3	304.5	6.8	1.4	292.1	3.1	3.1
BCA2-22.1	0.01556	0.00025	364.9	56.0	311.6	3.1	318.0	7.5	2.0	312.1	5.0	5.0
BCA2-23.1	0.01454	0.00039	169.3	106.0	297.9	4.8	283.8	12.4	-5.0	291.7	7.8	7.8
BCA2-24.1	0.01289	0.00067	0.0	0.0	312.2	3.4	261.5	14.1	-19.4	258.8	13.5	13.5
BCA2-3.1	0.01561	0.00042	259.3	77.8	317.2	5.7	310.3	10.5	-2.2	313.1	8.4	8.4
BCA2-4.1	0.01498	0.00050	335.9	102.6	303.0	4.5	306.8	13.1	1.2	300.5	10.0	10.0
BCA2-5.1	0.01485	0.00039	198.5	84.6	304.9	5.3	292.9	10.6	-4.0	297.9	7.8	7.8
BCA2-6.1	0.01488	0.00021	216.5	65.6	298.0	4.4	289.0	8.3	-3.2	298.5	4.1	4.1
BCA2-7.1	0.01509	0.00022	337.7	36.6	306.3	5.0	310.0	6.3	1.2	302.6	4.4	4.4
BCA2-8.1	0.01467	0.00018	272.3	30.8	304.8	5.5	301.1	6.1	-1.2	294.3	3.5	3.5
BCA2-9.1	0.01493	0.00015	361.7	40.8	298.1	4.5	305.4	6.4	2.4	299.5	2.9	2.9
MFT1-1.1	0.01422	0.00030	268.1	40.2	287.7	6.6	285.6	7.4	-0.8	285.3	6.0	6.0
MFT1-1.2	0.01500	0.00047	334.1	24.0	304.4	7.0	307.9	7.0	1.2	300.9	9.4	9.4
MFT1-10.1	0.01366	0.00014	292.9	9.0	285.1	7.1	285.9	6.5	0.2	274.1	2.9	2.9
MFT1-11.1	0.01486	0.00014	306.1	15.4	301.9	6.0	302.3	5.6	0.2	298.1	2.8	2.8

BCA-2- gabbro-diorite (39°45.9'N; 7°12'51"W); MFT-1- pinkish granite (39°04.5'N; 7°13'53"W)

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TABLE 1. (Continued)

204-corrected ages (Ma)											
id	$^{208}\text{Pb}/^{232}\text{Th}$	$\pm\text{err}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm\text{err}$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm\text{err}$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm\text{err}$	% discord.	$^{208}\text{Pb}/^{232}\text{Th}$	$\pm\text{err}$
MFT1-12.1	0.01510	0.00032	235.7	39.6	299.0	3.9	291.9	5.6	-2.4	302.9	6.5
MFT1-13.1	0.01433	0.00017	306.1	20.0	293.5	4.5	295.0	4.8	0.6	287.5	3.4
MFT1-14.1	0.00717	0.00050	286.7	39.6	273.5	14.2	274.9	13.6	0.6	144.4	10.1
MFT1-15.1	0.01439	0.00017	238.7	24.6	295.9	5.5	289.6	5.6	-2.2	288.7	3.4
MFT1-16.1	0.01794	0.00080	319.7	9.4	275.2	9.9	279.9	9.1	1.6	359.4	15.9
MFT1-17.1	0.01511	0.00033	246.9	52.0	301.7	4.9	295.5	7.3	-2.0	303.2	6.6
MFT1-18.1	0.01391	0.00020	301.9	27.8	279.9	8.7	282.2	8.4	0.8	279.2	4.0
MFT1-18.2	0.00521	0.00041	407.3	135.8	192.4	8.5	209.5	14.7	8.2	105.0	8.3
MFT1-19.1	0.01449	0.00050	202.3	58.8	298.9	8.4	288.2	9.8	-3.8	290.8	10.1
MFT1-19.2	0.01505	0.00105	463.7	177.0	250.1	6.4	271.9	21.3	8.0	301.9	21.0
MFT1-20.1	0.01477	0.00034	347.3	20.8	285.5	11.2	292.3	10.5	2.4	296.3	6.7
MFT1-21.1	0.01226	0.00036	0.0	0.0	289.7	7.0	261.6	7.8	-10.8	246.2	7.2
MFT1-22.1	0.01513	0.00021	281.9	29.2	303.2	8.5	300.7	8.2	-0.8	303.6	4.2
MFT1-23.1	0.01650	0.01405	0.0	1467.3	296.2	15.0	254.5	282.5	-16.4	330.8	281.3
MFT1-24.1	0.01480	0.00010	317.7	11.8	301.0	6.4	302.9	6.0	0.6	297.0	2.1
MFT1-24.2	0.01393	0.00190	170.9	301.6	289.2	6.7	276.6	35.5	-4.6	279.6	38.0
MFT1-25.1	0.01512	0.00027	259.1	26.2	300.1	4.4	295.4	4.9	-1.6	303.3	5.5
MFT1-3.1	0.01153	0.00333	379.3	168.8	232.4	10.1	246.2	20.0	5.6	231.7	66.7
MFT1-4.1	0.01333	0.00197	444.9	155.2	220.2	10.8	240.6	19.2	8.4	267.7	39.3
MFT1-5.1	0.01575	0.00019	351.9	24.6	317.9	12.4	322.1	11.6	1.4	315.9	3.7
MFT1-6.1	0.01443	0.00015	258.7	27.8	299.0	4.9	294.5	5.4	-1.6	289.5	3.1
MFT1-7.1	0.01503	0.00042	291.1	52.8	293.3	7.8	293.0	9.2	-0.2	301.5	8.4
MFT1-8.1	0.01388	0.00020	266.9	19.2	299.0	8.9	295.4	8.2	-1.2	278.7	4.0
MFT1-8.2	0.02540	0.00037	548.7	11.0	536.6	51.3	538.9	42.5	0.4	506.9	7.2
MFT1-9.1	0.01423	0.00032	338.5	57.8	301.3	10.5	305.6	11.7	1.4	285.6	6.3

BCA-2- gabbro-diorite (39°4'5.9"N; 7°12'51"W); MFT-1- pinkish granite (39°04'4.5"N; 7°13'53"W)

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