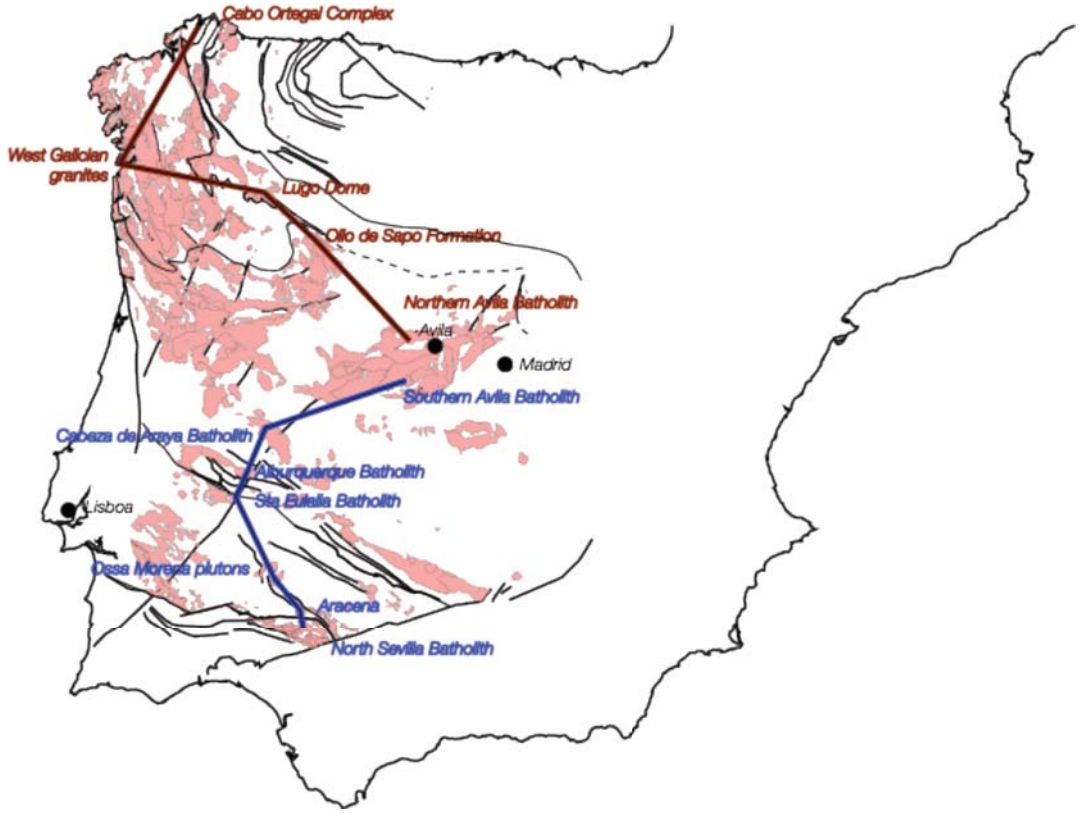
VII Hutton Symposium on Granites and Related Rocks
Avila, Spain, July 4-9 2011

Pre-meeting field trip
Southern Iberia Traverse
(29th June to 4th July 2011)



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The Southern Traverse includes visits to the I-type granitoids of the North Sevilla Batolith, the complex Variscan gabbro-granite plutons and the alkaline pre-Variscan granitoids of the Ossa Morena Zone, and the strongly peraluminous granitoids of the Central Iberian Zone. Since most of this section is parallel to recently made deep seismic profiles, the field trip will permit us to correlate the features of the Variscan granites with the crustal structure of south Iberia. The field trip will also give the participants the opportunity to know Sevilla, Zafra and Mérida which are among the most charming Spanish cities.

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Overview

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The European Variscan belt resulted from the late Paleozoic plate collision of Laurentia-Baltica and Gondwana (e.g., Matte, 2001).The Iberian Variscan Massif is one of the largest exposures of the Variscan belt and has been divided into a number of zones with distinctive Proterozoic/Paleozoic geological histories. In southwest Iberia three zones have been distinguished, from south to north: the South-Portuguese zone (ZSP), the Ossa-Morena zone (OMZ) and the Central-Iberian zone (CIZ) (Fig. O.1).

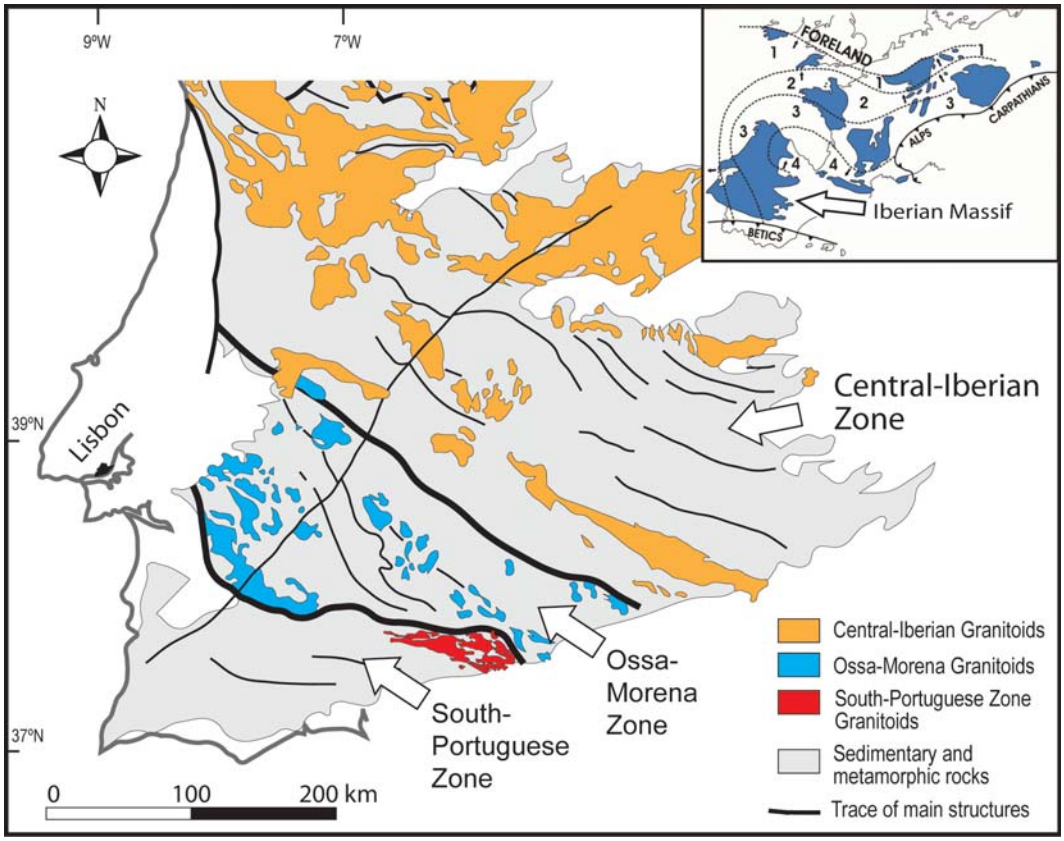

Fig. O.1 Simplified map of the southern Iberian Massif showing granitoids and main structures. Inset: 1 Rhenohercynian Zone (SPZ) 2. Saxothuringian Zone (OMZ) 3. Moldanubian Zone (CIZ). 4. South European Zone (Cantabrian Zone) (Bromley and Holl 1986). Thin northwest-southeast trending lines in the main figure are the principal structures: faults, thrusts and/or traces of folds.

Volcanic and volcanoclastic rocks are very abundant in southwest Iberia whereas plutonic rocks, mainly granites, are especially abundant in the centre and northwest.

The South-Portuguese zone (day 1)

This zone constitutes an external orogenic domain unrelated to the other zones of the Iberian Variscan Massif (Simancas, 2004 and references therein). Its northern contact with the Ossa-Morena zone has several oceanic-related features: possible ophiolitic rocks, Beja-Acebuches amphibolites, and accretionary prism sediments, Pulo do Lobo Unit. These elements indicate that this contact might be an important orogenic suture.

The magmatism in the SPZ defines two events:

i. a volcano-sedimentary complex, ca. 350-370 Ma, that consists of continental extension related bimodal volcanism represented by dacites + rhyolites, tholeiitic ± alkali basalts and minor andesites (Pascual et al., 2004 and references therein).

ii. The Sierra Norte batholith, 336 ± 98 Ma, that includes a high proportion of basic rocks, tholeiitic/calc-alkaline gabbro-diorites, and intermediate rocks, calc-alkaline tonalites-granodiorites, together with calc-alkaline granitoids and subvolcanic Grt-monzogranites (De la Rosa and Castro, 2004 and references therein).

The Ossa-Morena (days 2 and 3) and Central-Iberian zones (days 4 and 5)

These zones have distinctive Neoproterozoic stratigraphies (Vidal et al., 1994) and show Early Paleozoic stratigraphic differences (Robardet, 2002; González Lodeiro, 2004; Azor, 2004 and references therein). These two zones constitute once different continental blocks, presently placed side by side by the Coimbra-Córdoba Shear zone (Burg et al., 1981) also known as the Badajoz-Córdoba Shear Zone (Ábalos et al., 1991), or, more specifically, the Central Unit (Azor, 2004), where lower Paleozoic amphibolites suggest preservation of an ocean basin/rift environment (Gómez-Pugnaire et al., 2003). However, there is still some controversy about the nature of this shear zone. For some authors it is a Cadomian suture (Ábalos et al., 1991), for others it represents a Variscan suture resulting from closure of an early Paleozoic ocean (Azor, 2004), whereas for others it is a Variscan suture but representing a major intracontinental shear zone (Pereira et al., 2010).

Magmatism in the OMZ spans from the Neoproterozoic to the Carboniferous through three main events (Galindo and Casquet, 2004 and references therein):

i. Neoproterozoic-Cambrian, Cadomian collision related

ii. Cambrian to Ordovician, rift related

iii. Carboniferous, Variscan collision related

This protracted and complex volcanic and plutonic magmatic history is represented by abundant metaluminous I-type and A-type granitoids with mafic intrusives and by peraluminous granitoids.

The magmatism in the CIZ is predominantly restricted to the Carboniferous Variscan, 330 to 290 Ma, and mostly consists of voluminous peraluminous S-type granitoids. Mafic rocks crop out as small stocks or enclaves. Many of the granitoids have crustal isotopic signatures, high A/CNK values and high K contents (Bea, 2004 and references therein).

South Portuguese Zone Summary

The South-Portuguese Zone (SPZ) is located in the south westernmost position of the Iberian Variscan Massif. It has usually been correlated with the Rhenohercynian zone of Central Europe and represents an external orogenic zone with a southwest vergence of the main structures (Simancas 2004 and references there in). The northern limit of the SPZ is a tectonic contact where rocks of oceanic provenance crop out, thus indicating its nature as a Variscan orogenic suture: accretionary prism sediments/mélanges (phyllites + quartzites ± volcanic of the Pulo do Lobo Unit), and ophiolitic derived rocks (amphibolites of the Beja-Acebuches belt).

Even though the SPZ is defined as an external orogenic domain, it has some contradictory features such as the ubiquitous presence of foliations, quite abundant magmatism and a high Variscan thermal gradient, regional sub-greenschist/greenschist metamorphism and contact metamorphism that occasionally reached high grade conditions. The stratigraphy is composed of mid-Devonian to Permian sediments. During the upper Devonian and the lower Carboniferous, an extensional regime caused the abundant magmatism and high thermal gradient of this zone. In this geological context very important massive sulphide deposits formed: the Iberian Pyrite Belt, dated around 350 Ma, Devonian-Carboniferous transition, related to a volcanic-sedimentary complex of the same age. After the lower Carboniferous period, the Variscan compressive deformation affected the whole SPZ.

The magmatism in the SPZ defines two events:

i. A volcanic-sedimentary complex, 350-370 Ma, that consists of continental extension related bimodal volcanism represented by dacites + rhyolites, tholeiitic ± alkali basalts and minor andesites (Pascual et al., 2004 and references therein).

ii. The Sierra Norte batholith, 336 ± 98 Ma, that includes a high proportion of basic rocks, tholeiitic/calc-alkaline gabbro-diorites, and intermediate rocks, calc-alkaline tonalites-granodiorites together with calc-alkaline volcanic granitoids and subvolcanic Grt-monzogranites (de la Rosa and Castro, 2004 and references therein).

Ossa Morena Zone Summary

The Ossa-Morena zone (OMZ) represents, from a palaeogeographical point of view, either the most external margin of Gondwana (Robardet, 2003) or a separate microplate, namely Armorica (Matte, 2001). This zone constitutes a continental block formed by Neoproterozoic to Carboniferous rocks that was sutured to the South-Portuguese zone and to the Central-Iberian zone during the Variscan orogeny. Both suture zones are delineated by oceanic affinity rocks. Two regional late Neoproterozoic formations, Serie Negra and Malcocinado, and a complete Palaeozoic series, Lower Cambrian to Devonian, have been described.

The tectono-metamorphic evolution of this zone was complex due to the superposition of Cadomian (Late Neoproterozoic) and Variscan events. The main Variscan structures are syn-metamorphic km-scale southwest-vergent recumbent folds (Expósito 2000). The regional metamorphism is low grade, except in four broad northwest-southeast elongated bands where medium to high grade metamorphic rocks crop out. Two of these bands, Sierra Albarrana and Aracena, are linked to the northern and southern suture zones of the OMZ. The other two high grade metamorphic bands, Monesterio and Lora del Río, are located in the central OMZ and probably represents extensional migmatitic domes developed during the Cambrian rifting (Expósito 2000, Salman 2002, Expósito et al., 2003).

The magmatism in the OMZ took place in three different stages (Galindo and Casquet, 2004 and references therein; Salman 2004):

i. Neoproterozoic – Cambrian - Cadomian stage: metaluminous calc-alkaline, I-type, and alkaline, A-type, magmatism
ii. Cambrian to Ordovician - rift related stage: peraluminous, S-type, and alkaline, A-type, magmatism
iii. Carboniferous Variscan - late Variscan stage: metaluminous, I-type, and peraluminous, S-type, crustal magmatism

This protracted and complex magmatism (volcanic and plutonic) is thus represented by abundant metaluminous granitoids with mafic intrusives and peraluminous, S-type, granitoids.

Central Iberian Zone Summary

This broad zone represents, from a palaeogeographical point of view, the northwest margin of Gondwana during the Variscan cycle (e.g., Matte, 2001). The southern part of the Central-Iberian zone (CIZ) is bounded to the south by the Central unit or Badajoz-Córdoba shear zone (Burg et al., 1981; Azor et al. 1994), which constitutes a suture unit with the Ossa-Morena zone (OMZ).

The CIZ can be divided into two domains based mainly on stratigraphic and structural features (Díez Balda et al., 1990):

i. The southern domain is characterized by the presence of a thick siliciclastic series of pre-Ordovician age, Neoproterozoic-Cambrian, the schist-greywacke complex (SGC), in which the main Variscan structures are km-scale upright folds. However, in the southernmost CIZ, the pre-Ordovician rocks are similar to those in the OMZ, and north east-vergent km-scale recumbent folds have been described (Martínez Poyatos 1997).
ii. The northern domain is characterized by the presence of a Lower Ordovician volcano-sedimentary succession, namely the Ollo de Sapo Formation, in which the dominant structures are east-vergent km-scale recumbent folds.

The regional Variscan metamorphism in the southern CIZ is usually low grade, Chl – Bt zone. Close to the granitic plutons and batholiths, metamorphic aureoles developed and the grade increases, Crd – And and Sill zones. Metamorphic conditions in some zones reached high grade, migmatites, with partial melting of SGC ± orthogneissic rocks (Bea et al. 2003). In some of the southernmost sectors of the CIZ, the metamorphic grade reached the Sill zone.

One of the most distinctive features or the CIZ is the great abundance of Variscan granitoids. Scarce mafic intrusives are commonly related to the granitoid magmatism but with a different petrogenesis (Bea et al. 1999, Molina et al., 2009; Scarrow et al., 2009). The granitoids do not show any composition or age gradient across the CIZ, they have ages between 325-300 Ma, indicating that their generation took place some 30-50 Ma after the main Variscan collision. The granitoid are commonly peraluminous, S-type and K rich, their source is thought to be a fertile and high heat production layer within the SGC (Bea et al. 2003).