https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Solid Earth Discussions
Open Access

Tectonostratigraphy of the Mérida Massif reveals a new suture zone exposure in SW Iberia

Rubén Díez Fernández[1*], Ricardo Arenas[2], Esther Rojo-Pérez[2], Sonia Sánchez Martínez[2], José Manuel Fuenlabrada[3]

[1]*Departamento de Geodinámica, Estratigrafía y Paleontología, Universidad Complutense de Madrid, 28040 Madrid, Spain*

[2]*Departamento de Mineralogía y Petrología, Universidad Complutense de Madrid, 28040 Madrid, Spain*

[3]*Unidad de Geocronología (CAI de Ciencias de la Tierra y Arqueometría), Universidad Complutense de Madrid, 28040 Madrid, Spain*

*Corresponding author: rudiez@ucm.es

ABSTRACT

Dividing a crystalline basement into tectonostratigraphic units, along with the recognition of the nature of their boundaries (primary vs. tectonic), are essential steps to identify major tectonic slices involved in orogeny. The Neoproterozoic and Paleozoic rocks of the Mérida Massif (SW Iberia) have been grouped into five tectonostratigraphic units according to their structural position, continental or oceanic crust affinity, and equivalent tectonometamorphic evolution. Each unit is separated from the rest ones by either crustal-scale thrusts and/or extensional detachments. The lowermost unit (Magdalena Gneisses; lower plate) has continental crust affinity, and rest below a variably strained and

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

metamorphosed mafic-ultramafic ensemble, referred to as the Mérida Ophiolite (suture zone). The Neoproterozoic Montemolín Formation of the Serie Negra Group constitutes a unit with continental crust affinity (Upper Schist-Metagranitoid Unit; upper plate) located on top of the Mérida Ophiolite. A carbonate-rich succession (Carija Unit) occupies the uppermost structural position. Structural and isotopic data suggest that the suture zone depicted by the Mérida Ophiolite and the tectonic piling and main foliation of the Neoproterozoic and Cambrian units were formed during the Cadomian Orogeny. Superimposed shortening during the late Paleozoic formed a train of upright to NE-verging folds and thrusts that affected the Cadomian suture zone and juxtaposed it onto Ordovician strata (fifth tectonostratigraphic unit) during the Variscan Orogeny. Cenozoic contraction during the Alpine Orogeny formed SW-directed thrusts in an intraplate setting. The Mérida Ophiolite represents a new Cadomian suture zone exposure of the Iberian Massif, but its root zone is yet to be identified. This suture zone exposure seems to share a far-travelled nature with other Cadomian and Variscan suture zone exposures in Iberia, making the latter a piece of continental lithosphere built at the expense of allochthonous terranes transferred inland from peri-Gondwana onto mainland Gondwana, both during the Neoproterozoic-Cambrian and the Devonian-Carboniferous.

Keywords: Cadomian tectonics; Cadomian allochthons; Cadomian suture; Ophiolite; Variscan tectonics; SW Iberian Massif

1. INTRODUCTION

Bedrock mapping of regions featured by a rich variety of rocks may result in contrasting outcomes depending on lithological grouping criteria. Establishing coherent lithological groups to be mapped is essential. Classical criteria to divide crystalline

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

basement bedrock include: (i) structural position at regional scale, (ii) continental, oceanic or transitional crust affinity, and (iii) equivalent tectonometamorphic evolution. Such approach leads to the establishment of what is usually referred to as the tectonostratigraphy of a region, a practical concept that gathers compositionally complex rock sequences layered after penetrative deformation affecting one or more sections of the lithosphere, each of which would represent an independent tectonostratigraphic unit. This workflow has advantages and drawbacks of its own, but allows identifying major geological features and helps set the base for future, more oriented, research. Grouping of contrasting lithologies makes detailed time-resolved geodynamic reconstructions based on petrological aspects more difficult, but on the other hand it favors recognition of terranes (e.g., major tectonic blocks) by acknowledging their internal complexity. This purpose-oriented method is particularly useful to identify continental blocks intervening in a suture zone, and is actually the basis for widely accepted ideas in tectonic reconstructions, such as the ophiolite concept.

Here we present a new simplified geological map and cross-section of the Mérida Massif aimed to distinguish its main tectonostratigraphic units and their relationships. Lithological ensembles for each unit have been grouped according to criteria cited above. The resulting tectonostratigraphy provides light into a nappe structure that had remained unnoticed for the region, despite large scale thrusting events in SW Iberia have been claimed for Variscan models (Azor et al., 1994; Díez Fernández and Arenas, 2015; Ribeiro et al., 2010) and Cadomian tectonics (Díez Fernández et al., 2019; Abalos et al., 1991). It also adds another ophiolite and suture zone exposure to the set that features the Iberian Massif, thus strengthening the notion of the Iberian domain as a region built after numerous suturing processes throughout geological history.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

2. GEOLOGICAL SETTING

The Iberian Massif constitutes the southernmost exposure of the Variscan Orogen in Europe (Fig. 1), which resulted from the progressive collision of Gondwana, Laurussia and their respective pericontinental terranes during the Devonian and Carboniferous (Simancas et al., 2013; Martínez Catalán et al., 2009; Ribeiro et al., 2007; Díez Fernández et al., 2016). Yet, the current structure of the Iberian Massif is the result of three orogenic cycles. Gondwana was affected by long-lived subduction under its periphery during the Neoproterozoic and Lower Paleozoic (Linnemann et al., 2007; Quesada, 1990; Pereira et al., 2007; Eguíluz et al., 2000; D'Lemos et al., 1990; Nance et al., 1991; Chantraine et al., 2001), its northern paleomargin bearing abundant evidence of arc-related magmatism (Bandrés et al., 2004; Henriques et al., 2015; Dorr et al., 2002; Drost et al., 2004; Rubio-Ordóñez et al., 2015), basin development in active settings (Rojo-Pérez et al., 2019; Fuenlabrada et al., 2012; Fuenlabrada et al., 2016; Linnemann et al., 2000; Linnemann et al., 2007; Fernández-Suárez et al., 2013; Pereira, 2015), and contractional and extensional deformation (Díez Fernández et al., 2019; Expósito et al., 2003; Simancas et al., 2004; Eguíluz et al., 2000; Bandres et al., 2002; Kröner et al., 2000; Strachan and Taylor, 1990; Díaz García, 2006; Balé and Brun, 1989), all of which are collectively referred to as Cadomian Orogeny (cycle). It is well-established that the external section of Gondwana facing such subduction was involved in the Variscan cycle, whose onset and culmination may correspond to an extensional event that led to the opening of oceanic basins (e.g., Rheic Ocean; Nance et al., 2010; Linnemann et al., 2007), and the raise of the Variscan Orogen after their suturing (Matte, 1991; Martínez Catalán et al., 2009; Ballèvre et al., 2009; Franke, 2000), respectively. The Iberian Massif contains Cenozoic mountain ranges formed during the Alpine cycle (e.g., de Vicente and Vegas, 2009). Some of them occur at the boundaries of the Iberian micro-plate (e.g., Pyrenees, Betics), while others

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

occupy intra-plate positions. Both are the result of plate tectonics in the Mediterranean domain as well as of distributed strain upon Africa-Europe convergence (Dewey et al., 1989; Jolivet et al., 2008; de Vicente et al., 2018).

The Mérida Massif is located in the SW part of the Iberian Massif (Fig. 2). Previous studies have suggested that its composition and current structure is the result of Cadomian, Variscan, and Alpine tectonics (Bandrés, 2001; Gonzalo, 1987, 1989; Insúa Márquez et al., 2003). This massif includes an extensive exposure of Neoproterozoic and Lower Paleozoic rocks (Fig. 3), and represents a good opportunity to study Cadomian tectonics and the interference of subsequent orogenic cycles over Cadomian imprint. Mapping of its bedrock geology has provided rather different outcomes over the years (Insúa Márquez et al., 2003; Bandrés, 2001; Gonzalo, 1987; Roso de Luna and Hernández Pacheco, 1950). Although poorness of exposure may explain some variation, most of it seems to derive from contrasting criteria followed during mapping. The Mérida Massif, although relatively small in size, is characterized by a significantly rich variety of rocks, making it difficult to establish coherent lithological groups to be mapped if not oriented to a purpose. Deformation in this area includes the development of foliations, folds, faults, and shear zones, some of which are coeval to pervasive metamorphism (Gonzalo, 1987, 1989; Bandrés, 2001; Bandrés et al., 2000).

3. TECTONOSTRATIGRAPHY

In this section, we will provide a brief description of the main lithological associations we have established in the Mérida Massif. Grouping is aimed to the recognition of major tectonic blocks intervening in Cadomian and Variscan tectonics. Rocks included into each tectonostratigraphic unit meet the following grouping criteria, and they are different from those gathered into other units for the same reasons: (i) similar

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

structural position at regional scale, (ii) the ensemble shows either continental or oceanic crust affinity, (iii) equivalent tectonometamorphic evolution, and (iv) they are separated from other units by either a major mechanical boundary (i.e., fault or ductile shear zone) or a major stratigraphic discontinuity (e.g., discordance). Age of protoliths alone was not taken as a grouping criteria, because the amalgamation of two tectonic blocks may juxtapose rocks of similar age located at each block. Descriptions are given following reverse chronological order according to their (meta-) sedimentary strata. In case bedding and age constrains are lacking, overlying units (as indicated by their main foliation) will be described first.

3.1. Cenozoic cover

The crystalline basement of the Mérida Massif is discordantly covered by a wide variety of Cenozoic sedimentary rocks. Since Cenozoic processes are not the focus of this contribution, no distinction has been made in the geological map between sequences of different age and composition. Previous works have divided this Cenozoic cover into informal units according to their age (Miocene through to Holocene), location, and sedimentary environment (Insúa Márquez et al., 2003).

The oldest Cenozoic deposit is represented by Miocene conglomerates and arkosic sandstones, followed by sandstones and conglomerates, and then red silt and clay and minor sandstones. This continental series is succeeded by Miocene arkosic sandstones, which are then covered by a Pliocene-Pleistocene succession of conglomerates, sandstones and silt. Other Pleistocene and Holocene deposits include carbonated deposits (caliche), carbonated crusts, glacis deposits (irregular pebbles, gravel, and minor silt), fluvial terraces (rounded conglomerates, sandstones, and silt), alluvial fans, and aeolian sands.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

3.2. Ordovician strata

The youngest sedimentary series that is now exposed as metamorphic rocks in the study area corresponds to a succession of meta-sandstones, meta-conglomerates, quartzites, and slates that occurs to the north of the Mérida Massif (Fig. 3). The series is cut by a major fault, so its basal section is not exposed in the study area. The lower part exposed consists of coarse-grained meta-sandstones (quartz-rich micro-conglomerates), which are covered by quartzites and orthoquartzites that alternate with slates. Quartzite beds are thinner upwards while slates become more abundant. This part of the series has been ascribed to the Early Ordovician (Tremadocian-Floian), and is considered a SW Iberian correlative to the (Arenig) Armorican quartzite (Insúa Márquez et al., 2003; Gutiérrez-Marco et al., 2002). The series culminates with black slates and minor layers of black quartzites exposed within, whose age has been considered to be Middle Ordovician (Llanvirn-Llandeil) (Insúa Márquez et al., 2003).

3.3. Cambrian carbonate-rich series: Carija Unit

This unit gathers a carbonate-rich, meta-sedimentary succession of variably strained rocks that is exposed northwest of Merida town (Fig. 3), around the Carija hill. Strain is particularly concentrated along its basal boundary and decreases progressively upwards. The lower part consists of black calc-schists that rest below a series in which fine-grained, banded grey-white marbles alternate with fine-grained dark grey-light grey dolomitic marbles and yellow-brown marbles. This series has been ascribed to the Early Cambrian (Insúa Márquez et al., 2003), and considered correlative to other carbonate-rich Early Cambrian successions of SW Iberia (e.g., Sánchez-García et al., 2010).

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

3.4. Upper Schist-Metagranitoid Unit: Serie Negra Group (Montemolín Formation)

This unit comprises metasedimentary and metaigneous rocks, in which mafic, intermediate, and felsic terms can be recognized. The metasedimentary series includes schists, grey metagreywackes, black quartzites, and black schists. Black schists and quartzites occur as decimeter- to meter-scale lenses within the other schists and metagreywackes, while the latter are featured by cm- to mm-scale compositional layering that alternates finer and coarser grained rocks (relict of sedimentary bedding). Metabasites can be found as fine-grained, lens-shaped (meter-scale) bodies dispersed over the metasedimentary series. Former regional studies identified this series as a correlative to a section of the Serie Negra Group (Bandrés, 2001). Its primary immature nature (as inferred from greywackic composition), along with its content in mafic rocks, suggest it could be equivalent to the lower (and older) member of such group, regionally referred to as Montemolín Formation (Eguíluz, 1987).

The sedimentary series was the host to a compositionally complex variety of intrusive igneous rocks. The (finer-grained) metabasites cited above can be distinguished from metagrabbros that occur as coarser-grained rocks in larger patches and usually next to metatonalites. Some metagabbros preserve a primary (equigranular) igneous texture. Differences in grain size between the latter and fine-grained metabasites are not observed in zones accumulating larger strain. Therefore, current differences in grain size may be related to its primary texture (basalts/microgabbros vs. gabbros). Metatonalites, metagranodiorites, and metagranites occur as variably strained, kilometer-scale bodies within the metasedimentary rock series. Sections of these bodies accumulating more strain can be observed as mafic, intermediate, or felsic orthogneisses, respectively, whereas poorly strained sections show good exposures to analyze the primary texture of their protoliths. Introducing details on the range of primary textures exceeds the purpose

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

of this contribution, but as a preliminary approach, all metagranitoids presented phaneritic texture, ranging between fine- and coarse-grained, and showed either equigranular or porphyritic terms (more common in felsic granitoids). Varied combinations of these primary end-members plus heterogeneous strain explain the whole microstructural variety observed in the metagranitoids of this unit, in which it can be recognized felsic through to mafic metagranitoids with vaguely-defined planar fabric up to gneisses with well-developed compositional banding or even augen (K-Feldspar) structure.

Being the most heterogeneous in lithological composition, this unit gathers variably strained lithologies that resulted from metamorphic transformation of a rock ensemble that included sedimentary and intrusive igneous rocks. None of the lithologies listed above is separated from the rest ones within this unit by mechanical contacts with crustal bearing, since no juxtaposition of lithologies with contrasting tectonothermal evolution (see below) is observed. Therefore the whole ensemble represents a coherent tectonic slice with continental affinity.

3.5. Mafic-ultramafic Unit: Mérida Ophiolite

The Mérida Massif contains an exposure of mafic and ultramafic rocks that have been grouped into a single tectonostratigraphic unit due to its contrasting composition and consistent structural position (see below) relative to surrounding lithologies. This unit contains coarse-grained gabbros, pegmatitic gabbros, coarse-grained metagabbros, amphibolites, garnet-bearing amphibolites, hornblendites, and serpentinites. It lacks of felsic and intermediate igneous rocks, and of paraderived lithologies. No cross-cutting relationships have been observed between pristine igneous rocks and the rest of metamorphic rocks of this unit. In fact, some of the latter have been directly observed as the result of variably strained sections of the first along discrete shear zones (e.g.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

amphibolites after gabbros). Therefore the whole ensemble is considered as a heterogeneously strained and variably recrystallized mafic-ultramafic complex.

Ultramafic rocks, such as strongly foliated serpentinites, occur at different levels across structure within this unit. Poorly-strained gabbros allow inferring primary igneous textures (will not be described here), none of which dominates over a particular structural position across this unit. This mafic-ultramafic Unit shows outstanding ocean crust affinity, and probably represents tectonic slices of lower oceanic crust and upper mantle that will be collectively referred to as the Mérida Ophiolite.

3.6. Lower Gneiss Unit: Magdalena Gneisses

This unit consists of penetratively deformed and strongly recrystallized metamorphic rocks. A preliminary study does not allow us to recognize between ortho- and paraderived terms in it, being felsic rocks in all cases. They contain abundant quartz and feldspar, although abundance in mica varies from one field exposure to the other. Grain size is usually small (larger crystals in the matrix are 1-2 mm in size). Some gneisses show lenticular grains that are slightly larger (2-3 mm) than the minerals in the quarzt-feldspathic matrix, whereas others contain mineral aggregates (mostly made of quartz and feldspar) that show similar structure. The augen appearance for single-mineral lenses could derive from a micro-porphyritic texture in the protolith, which could tentatively be identified as igneous (granitoid?) in nature. Some of these gneisses include green amphibole and biotite. Mica-rich and augen-free varieties in these gneisses are less abundant and could represent paraderived rocks.

No mafic rocks were observed within these gneisses, as opposed to the rest of units around. The absence of mafic rocks makes it difficult to interpret this ensemble as a piece of either oceanic or transitional crust. Potential protoliths for the lithologies grouped into this unit (sedimentary and felsic igneous rocks) represent typical counterparts of continental crust *sensu lato*, although alternative options cannot be ruled out due to the limited exposure of this unit.

4. REGIONAL STRUCTURE AND METAMORPHISM

The youngest regional structure of the Mérida Massif is a set of NE-dipping, high-angle faults that cuts across the contacts of the Miocene sedimentary rocks (RP-1; Fig. 3) and juxtaposes the crystalline basement onto some sections of the Cenozoic cover. Tectonic transport is consistently to the SW. Displacement for all these thrusts, as deduced from offsets in pre-fault lithological contacts, is quite limited, probably in the range of tens of meters at most. Some of the sinuous trace of the basal contact of the Cenozoic cover near these thrusts could be explained by very open folds, e.g. fault-propagation folds, although no systematic measurement of bedding is available to prove it. Besides such direct evidence of Alpine tectonics, it should be noted that most of the exposure of the Mérida Massif occurs in a small peneplain that stands about 30-60 meters above the areas located to the SW, S, and SE of the Guadiana river, whose trace in the surroundings of Mérida town could be controlled by some other Alpine thrusts with similar displacement (vertical offset at 30-60 meters) and kinematics (RP-2; Fig. 3) (Vegas et al., 2012). The carbonated crusts, proposed to be Pleistocene-Holocene in age (Insúa Márquez et al., 2003), affects both the Miocene deposits and the overriding crystalline basement, thus suggesting a post-Miocene and pre-Pleistocene age (probably Pliocene) for some Alpine thrusts in the region.

The Ordovician and pre-Ordovician rocks of the study area are separated by a SW-dipping fault, the San Pedro thrust (RP-3; Fig. 3). Kinematics of this fault is top-to-the-NE, and includes a left-lateral component that makes it an oblique-slip thrust (Gonzalo,

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

1987, 1989; Bandrés, 2001). Each block of this fault shows slightly different structural record. The internal structure of the footwall is dominated by Ordovician strata affected by NW-SE trending, upright to NE-verging overturned folds (Cornalvo synform), to which local, and single, main foliation is axial planar (Fig. 4a). There, strata is duplicated and folds are cut by SW-dipping thrusts with moderate offset, which probably represent minor fault imbricates of the San Pedro thrust. The internal structure of the hanging wall to the San Pedro thrust is defined by rocks showing a main foliation affected by NW-SE trending, upright to either NE- or SW-verging overturned folds (Figs. 3 and 4a). SW-verging folds are scarcer and tend to occur around a NE-dipping thrust that cuts across the internally folded structure of the upper block to the San Pedro fault, which will be referred to as the Barranca back-thrust (RP-4; Fig. 3). The main foliation usually runs parallel to the boundaries of the bodies of metagranitoids that can be observed in the Upper Schist-Metagranitoid Unit. The Lower Gneiss Unit crops out in the core of a dome-like fold, the Magdalena antiform or dome (RP-5; Fig. 3), while the Cambrian marbles occupy the core of a synform paired with the Magdalena antiform, here referred to as the Carija synform (RP-6; Fig. 3). Using the main foliation as reference, the structure of the pre-Ordovician units would consist of a tectonic pile with the Lower Gneiss Unit resting below the Mérida Ophiolite, which would be covered by the Schist-Metagranitoid Unit (Ediacaran Serie Negra Group) and then the Carija Unit (Cambrian marbles) (cross-section in Fig. 4b).

The traces of the contacts between tectonostratigraphic units in the hanging wall to the San Pedro thrust are featured by mylonites. As a preliminary description, the contact between the Upper Schist-Metagranitoid Unit and the Mérida Ophiolite is defined by a ductile shear zone that includes a shear band with mylonites (after mafic and ultramafic rocks, metasedimentary rocks and metagranites) located at the boundary

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

between tectonostratigraphic units (core of a major shear zone), and a set of variably strained rocks towards more distal sections (Trujillanos detachment). Kinematic criteria indicate consistent top-to-the-SSE shear sense. The contact between the Mérida Ophiolite and the Lower Gneiss Unit is also featured by mylonites (Magdalena thrust). A preliminary kinematic analysis of this contact provided no consistent results, probably due to a more complex nature compared to that of other major boundaries in the region (see discussion section). The contact between the Upper Schist-Metagranitoid Unit and the Carija Unit is marked by mylonites after limestones and siliciclastic rocks (black calc-schists) (Carija detachment). Kinematic criteria indicate a consistent top-to-the-NNW sense of shear. The trace of all of these contacts shows sinuous pattern and run roughly parallel to the main foliation observed in the hanging wall to the San Pedro thrust, both (foliation and mechanical contacts) defining the same NE-SW trending folds (Fig. 4a).

Strain and metamorphic recrystallization is heterogeneous, but the metamorphic grade varies vertically across structure. The mineral assemblages of the main foliation in the hanging wall to the San Pedro thrust defines an overall normal metamorphic gradient. As a reference, the main foliation in the metasedimentary rocks of the Upper Schist-Metagranitoid Unit may include quartz, plagioclase, white mica, biotite, and minor (secondary?) chlorite, which make a typical greenschist facies fabric (probably in the biotite zone). The main foliation in the mafic rocks of that unit includes plagioclase, fine-grained green amphibole, zoisite, epidote, titanite and chlorite, an assemblage also compatible with greenschist facies conditions. The main foliation in the mafic rocks of the Mérida Ophiolite is defined by plagioclase, brown-green amphibole (hornblende), titanite, opaques, and minor rutile. Some exposures include large garnet porphyroblasts, and altogether define a typical assemblage for amphibolite facies conditions (grain-size for the meta-mafic rocks in this unit is significantly larger than in the Upper Schist-

Metagranitoid Unit). PT conditions for this assemblage were estimated at 1.2 GPa and 750 ºC (Bandrés et al., 2000). The main foliation in the Lower Gneiss Unit includes recrystallized plagioclase, K-feldspar, green amphibole, biotite and quartz ribbons with granoblastic polygonal texture. This fabric is occasionally accompanied by patches of melt crystallized along bands parallel to the main foliation. The regional normal gradient in the hanging wall to the San Pedro thrust is juxtaposed onto Ordovician strata, which show a penetrative slaty cleavage formed by quartz, white mica, chlorite, sericite and opaques (chlorite zone).

5. DISCUSSION AND PRELIMINARY CONCLUSIONS

Alpine deformation in the Mérida Massif is limited and mostly restricted to high-angle thrusts that reworked its crystalline basement and faulted its Cenozoic cover (at least during the Pliocene). Main shortening direction is NE-SW and dominant tectonic transport for thrusts is to the SW. Given the distal position to Cenozoic plate boundaries, this deformation can be framed into an intra-plate setting for the Iberian micro-plate (e.g., de Vicente and Vegas, 2009).

The NW-SE trending folds that affect the basement of the Mérida Massif represent the first deformation for the Ordovician strata, but are at least the second pulse of deformation taken by the entire set of pre-Ordovician rocks (note their main foliation and ductile shear zones are affected by these folds). This indicates that these folds, and the faults they are cut by (San Pedro and Barranca thrusts) are Variscan in age, and that the main foliation and ductile shear zones in the pre-Ordovician rocks are probably pre-Variscan and responsible for the layered structure of most of the tectonostratigraphic units. This pre-Variscan age of deformation is also supported by Sm-Nd dating of metamorphic garnet growth in the metabasites of the Mérida Ophiolite (555 Ma; Bandrés

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

et al., 2004). As a consequence, the current contacts between tectonostratigraphic units in the hanging wall to the San Pedro thrust could be framed in a Cadomian setting. Normal metamorphic gradient within and around their juxtaposed tectonic blocks, together with their crustal-scale bearing (they juxtaposed sections with different metamorphic imprint), suggest they represent large-scale extensional shear zones. The current folded structure of these shear zones favors a primary flat-lying geometry for all of them, so they should be referred to as extensional detachments. The Carija detachment affects Cambrian strata, so the functioning of some of them may be restricted to the Cambrian and perhaps Ordovician.

The current regional boundaries between all of the pre-Ordovician lithostratigraphic units are mechanical in nature, so there is no reason to consider the entire set of basement rocks as a single tectonic block prior to Ordovician times. Some of these contacts reflected the functioning of rather different faults through time, what may explain part of their kinematic complexity observed in a preliminary analysis. The Mafic-Ultramafic Unit of the Mérida Massif separates two lithological ensembles that show continental crust affinity, the Mérida Ophiolite being an exposure of a suture zone. Should the current upper boundary of the Mérida Ophiolite be a pre-Ordovician extensional fault (Trujillanos detachment), the suture zone this mafic-ultramafic unit represents must be Cadomian in age. The current juxtaposition of tectonostratigraphic units in the Mérida Massif suggests a large-scale nappe structure for this suture, where the Lower Gneiss Unit would represent the lower plate, and the Mérida Ophiolite would account for oceanic lithosphere located at the base of the upper plate, here represented by the Upper Schist-Metagranitoid Unit. This way, the primary upper and lower boundaries of the Mérida Ophiolite could be Cadomian accretionary thrusts, the current nappe structure being the result of a late Cadomian extensional event that operated over previously thickened crust

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

built at the expense of basal tectonic accretion (peak metamorphic conditions for the Mérida Ophiolite suggest lower crust depth). The root of the suture zone represented by the Mérida Ophiolite is not exposed in the study area, as its lower plate (Lower Gneiss Unit) occurs in a tectonic window. This supports a pre-Variscan low-dipping geometry for the thrust sheets involved in the suture zone (e.g. Magdalena thrust; Fig. 4b), some of the tectonostratigraphic units being actual allochthonous terranes.

The sequence and broad timing of tectonic events recognized for the building of Mérida Massif fit well into the regional geology of SW Iberia. The Cadomian suture zone and nappe structure identified in the Mérida Massif add to the evidence of Cadomian tectonics in southern Europe (Eguíluz et al., 2001; Díez Fernández et al., 2019; Quesada, 1990; Simancas et al., 2004; Pereira et al., 2012; Díaz García, 2006; Pieren et al., 1987; Bandres et al., 2002), which is tightly connected to subduction-accretion processes in the periphery of the African margin of Gondwana (Orejana et al., 2015; Fuenlabrada et al., 2012; Rojo-Pérez et al., 2019; Arenas et al., 2018; Sánchez Lorda et al., 2014; Linnemann et al., 2008; Bandrés et al., 2004). Variscan deformation in the Mérida Massif reworked but did not reactivate major Cadomian structures such as accretionary faults and extensional detachments, which are now observed as folded planes cut at high-angle by Variscan major faults. In this regard, late Cadomian extension can be observed as a transitional stage to the Variscan cycle, but most importantly, as a contributor to the stabilization (cratonization) of orogenic crust before subsequent deformation.

The gathering of contrasting individual lithologies into tectonostratigraphic units is proven here as a powerful tool to identify major tectonic blocks in orogeny, even at the lithosphere scale. Equivalent approaches performed in other areas of the Iberian Massif before focused mostly on the identification of major Variscan thrust sheets (Ribeiro et al., 2010; Ries and Shackleton, 1971; Díez Fernández and Arenas, 2015; Arenas et al., 1986).

Our work presents a case example that proves this method right for Cadomian tectonics, and adds evidence to the notion that the lithosphere of the Iberian micro-plate was constructed not only by the functioning of large-scale accretionary faults and tectonic transport of allochthonous terranes during the Variscan Orogeny (e.g., Martínez Catalán et al., 2009; Díez Fernández et al., 2016; Ribeiro et al., 2007), but also during the Cadomian Orogeny (e.g., Díez Fernández et al., 2019; Abalos et al., 1991).

6. DATA AVAILABILITY

The data is directly accessible through the published text and figures.

7. AUTHOR CONTRIBUTION

RDF, RA and ERP designed the mapping campaign and carried it out. RDF delineated the maps (Figures 2 and 3) and draw the cross-sections (Figure 4). All authors discussed and interpreted the data and prepared the manuscript.

8. COMPETING INTERESTS

The authors declare that they have no conflict of interest.

9. ACKNOWLEDGMENTS

Research funded by Spanish project CGL2016-76438-P (Ministerio de Economía, Industria y Competitividad).

10. REFERENCES CITED

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Abalos, B., Gil Ibarguchi, J. I., and Eguiluz, L.: Cadomian subduction, collision and Variscan transpression in the Badajoz-Cordoba Shear Belt, Southwest Spain, Tectonophysics, 199, 51-72, 1991.

Arenas, R., Gil Ibarguchi, J. I., González Lodeiro, F., Klein, E., Martínez Catalán, J. R., Ortega Gironés, E., Pablo Maciá, J. G. d., and Peinado, M.: Tectonostratigraphic units in the complexes with mafic and related rocks of the NW of the Iberian Massif, Hercynica, 2, 87-110, 1986.

Arenas, R., Fernández-Suárez, J., Montero, P., Díez Fernández, R., Andonaegui, P., Sánchez Martínez, S., Albert, R., Fuenlabrada, J. M., Matas, J., Martín Parra, L. M., Rubio Pascual, F. J., Jiménez-Díaz, A., and Pereira, M. F.: The Calzadilla Ophiolite (SW Iberia) and the Ediacaran fore-arc evolution of the African margin of Gondwana, Gondwana Research, 58, 71-86, 10.1016/j.gr.2018.01.015, 2018.

Azor, A., Lodeiro, F. G., and Simancas, J. F.: Tectonic evolution of the boundary between the Central Iberian and Ossa-Morena zones (Variscan belt, southwest Spain), Tectonics, 13, 45-61, 10.1029/93tc02724, 1994.

Balé, P., and Brun, J. P.: Late Precambrian thrust and wrench zones innorthern Brittany (France), Journal of Structural Geology, 11, 391-405, 1989.

Ballèvre, M., Bosse, V., Ducassou, C., and Pitra, P.: Palaeozoic history of the Armorican Massif: Models for the tectonic evolution of the suture zones, Comptes Rendus Geoscience, 341, 174-201, 10.1016/j.crte.2008.11.009, 2009.

Bandres, A., Eguíluz, L., Ibarguchi, J. I. G., and Palacios, T.: Geodynamic evolution of a Cadomian arc region: the northern Ossa-Morena zone, Iberian massif, Tectonophysics, 352, 105-120, 10.1016/S0040-1951(02)00191-9, 2002.

Bandrés, A., Eguiluz, L., Menéndez, M., Ortega, L. A., and Gil Ibarguchi, J. I.: El macizo precámbrico de Mérida (suroeste de España): petrografía, geoquímica,

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

geocronología y significado geodinámico, Cadernos del Laboratorio Xeolóxico de Laxe, 25, 159-163, 2000.

Bandrés, A.: Evolución geodinámica poliorogénica de los Dominios septentrionales de la Zona Ossa-Morena, Universidad del País Vasco, 377 pp., 2001.

Bandrés, A., Eguíluz, L., Pin, C., Paquette, J. L., Ordóñez, B., Le Fèvre, B., Ortega, L. A., and Gil Ibarguchi, J. I.: The northern Ossa-Morena Cadomian batholith (Iberian Massif): magmatic arc origin and early evolution, International Journal of Earth Sciences, 93, 860-885, 10.1007/s00531-004-0423-6, 2004.

Chantraine, J., Egal, E., Thiéblemont, D., Le Goff, E., Guerrot, C., Ballèvre, M., and Guennoc, P.: The Cadomian active margin (North Armorican Massif, France): a segment of the North Atlantic Panafrican belt, Tectonophysics, 331, 1-18, 10.1016/s0040-1951(00)00233-x, 2001.

D'Lemos, R. S., Strachan, R. A., and Topley, C. G.: The Cadomian Orogeny, Geological Society of London, Special Publications, 423 pp., 1990.

de Vicente, G., and Vegas, R.: Large-scale distributed deformation controlled topography along the western Africa–Eurasia limit: Tectonic constraints, Tectonophysics, 474, 124-143, 10.1016/j.tecto.2008.11.026, 2009.

de Vicente, G., Cunha, P. P., Muñoz-Martín, A., Cloetingh, S. A. P. L., Olaiz, A., and Vegas, R.: The Spanish-Portuguese Central System: An Example of Intense Intraplate Deformation and Strain Partitioning, Tectonics, 37, 4444-4469, 10.1029/2018tc005204, 2018.

Dewey, J. F., Helman, M. L., Turco, E., Hutton, D. H. W., and Knot, S. D.: Kinematics of the western Mediterranean, Geological Society of London Special Publication, 45, 265-283, 1989.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Díaz García, F.: Geometry and regional significance of Neoproterozoic (Cadomian) structures of the Narcea Antiform, NW Spain, Journal of the Geological Society, 163, 499-508, 10.1144/0016-764905-090, 2006.

Díez Fernández, R., and Arenas, R.: The Late Devonian Variscan suture of the Iberian Massif: A correlation of high-pressure belts in NW and SW Iberia, Tectonophysics, 654, 96-100, 10.1016/j.tecto.2015.05.001, 2015.

Díez Fernández, R., Arenas, R., Pereira, M. F., Sánchez Martínez, S., Albert, R., Martín Parra, L. M., Rubio Pascual, F. J., and Matas, J.: Tectonic evolution of Variscan Iberia: Gondwana - Laurussia collision revisited, Earth-Science Reviews, 162, 269-292, 10.1016/j.earscirev.2016.08.002, 2016.

Díez Fernández, R., Jiménez-Díaz, A., Arenas, R., Pereira, M. F., and Fernández-Suárez, J.: Ediacaran Obduction of a Fore-arc Ophiolite in SW Iberia: A Turning Point in the Evolving Geodynamic Setting of Peri-Gondwana, Tectonics, 38, 95-119, 10.1029/2018TC005224, 2019.

Díez Fernández, R., Matas, J., Arenas, R., Martín-Parra, L. M., Sánchez Martínez, S., Novo-Fernández, I., and Rojo-Pérez, E.: Two-step obduction of the Porvenir Serpentinite: a cryptic Devonian suture in SW Iberian Massif (Ossa-Morena Complex), in: Special Paper in honor of Eldridge M. Moores, edited by: Wakabayashi, J., Dilek, Y., and Ogawa, Y., GSA Books, in press.

Dorr, W., Zulauf, G., Fiala, J., Franke, W., and Vejnar, Z.: Neoproterozoic to Early Cambrian history of an active plate margin in the Tepla-Barrandian unit - a correlation of U-Pb isotopic-dilution-TIMS ages (Bohemia, Czech Republic), Tectonophysics, 352, 65-85, 2002.

Drost, K., Linnemann, U., McNaughton, N., Fatka, O., Kraft, P., Gehmlich, M., Tonk, C., and Marek, J.: New data on the Neoproterozoic - Cambrian geotectonic setting of the Tepla-Barrandian volcano-sedimentary successions: geochemistry, U-Pb zircon ages, and provenance (Bohemian Massif, Czech Republic), International Journal of Earth Sciences, 93, 742-757, 10.1007/s00531-004-0416-5, 2004.

Eguíluz, L.: Petrogénesis de rocas ígneas y metamórficas en el Antiforme Burguillos-Monesterio, Macizo Ibérico Meridional, Universidad del País Vasco, 694 pp., 1987.

Eguíluz, L., Gil Ibarguchi, J. I., Abalos, B., and Apraiz, A.: Superposed Hercynian and Cadomian orogenic cycles in the Ossa-Morena zone and related areas of the Iberian Massif, Geological Society of America Bulletin, 112, 1398-1413, 10.1130/0016-7606(2000)112<1398:SHACOC>2.0.CO;2, 2000.

Eguíluz, L., Bandrés, A., Ortega, J. L., Gil Ibarguchi, J. I., Garcés, M., Paquette, J. L., and Pin, C.: New evidence on the Cadomian evolution of northern Ossa-Morena zone (SW Spain), Collisional Orogens, Annual Meeting of the IGCP 453, 2001, 67-68,

Expósito, I., Simancas, J. F., González Lodeiro, F., Bea, F., Montero, P., and Salman, K.: Metamorphic and deformational imprint of Cambrian-Lower Ordovician rifting in the Ossa-Morena Zone (Iberian Massif, Spain), Journal of Structural Geology, 25, 2077-2087, 10.1016/s0191-8141(03)00075-0, 2003.

Fernández-Suárez, J., Gutiérrez-Alonso, G., Pastor-Galán, D., Hofmann, M., Murphy, J. B., and Linnemann, U.: The Ediacaran–Early Cambrian detrital zircon record of NW Iberia: possible sources and paleogeographic constraints, International Journal of Earth Sciences, 1-23, 10.1007/s00531-013-0923-3, 2013.

Franke, W.: The mid-European segment of the Variscides: Tectonostratigraphic units, terrane boundaries and plate tectonic evolution, in: Orogenic Processes: Quantification and Modelling in the Variscan Belt, edited by: Franke, W., Haak,

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

V., Oncken, O., and Tanner, D., Geological Society, London, Special Publications, 35-61, doi: 10.1144/GSL.SP.2000.1179.1101.1105, 2000.

Fuenlabrada, J. M., Arenas, R., Díez Fernández, R., Sánchez Martínez, S., Abati, J., and López Carmona, A.: Sm–Nd isotope geochemistry and tectonic setting of the metasedimentary rocks from the basal allochthonous units of NW Iberia (Variscan suture, Galicia), Lithos, 148, 196-208, 10.1016/j.lithos.2012.06.002, 2012.

Fuenlabrada, J. M., Pieren, A. P., Díez Fernández, R., Sánchez Martínez, S., and Arenas, R.: Geochemistry of the Ediacaran-Early Cambrian transition in Central Iberia: Tectonic setting and isotopic sources, Tectonophysics, 681, 15-30, 10.1016/j.tecto.2015.11.013, 2016.

Gonzalo, J. C.: Petrología y estructura del Basamento en el área de Mérida (Extremadura Central), PhD, Universidad de Salamanca, 327 pp., 1987.

Gonzalo, J. C.: Litoestratigrafía y tectónica del basamento en el área de Mérida (Extremadura Central), Boletín Geológico y Minero, 100-1, 48-72, 1989.

Gutiérrez-Marco, J. C., Robardet, M., Rábano, I., Sarmiento, G. N., San José Lancha, M. A., Herranz Araujo, P., and Pieren Pidal, A. P.: Ordovician, in: The Geology of Spain, edited by: Gibbons, W., and Moreno, T., Geological Society of London, London, 31-49, 2002.

Henriques, S. B. A., Neiva, A. M. R., Ribeiro, M. L., Dunning, G. R., and Tajčmanová, L.: Evolution of a Neoproterozoic suture in the Iberian Massif, Central Portugal: New U-Pb ages of igneous and metamorphic events at the contact between the Ossa Morena Zone and Central Iberian Zone, Lithos, 220–223, 43-59, 10.1016/j.lithos.2015.02.001, 2015.

Insúa Márquez, M., López Sopeña, F., Hernández Samaniego, A., Matia Villarino, G., Ortega Ruiz, I., Pascual Martínez, E., Agudo Fernández, L., de la Fuente Krauss,

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

J. V., Martín Duque, J. F., Moreno, F., Carvajal, A., Cantos Robles, R., Liñán Guijarro, E., Fernández-Gianotti, J., Gabaldón, V., Rubio, J. C., and Baeza, L. J.: Mapa Geológico y Memoria explicativa, Hoja 777 (Mérida), Serie MAGNA, 1/50.000, Instituto Geológico y Minero de España, 2003.

Jolivet, L., Augier, R., Faccenna, C., Negro, F., Rimmele, G., Agard, P., Robin, C., Rossetti, F., and Crespo-Blanc, A.: Subduction, convergence and the mode of backarc extension in the Mediterranean region, Bulletin de la Societe Geologique de France, 179, 525-550, 10.2113/gssgfbull.179.6.525, 2008.

Kröner, A., Štípská, P., Schulmann, K., and Jaeckel, P.: Chronological constraints on the pre-Variscan evolution of the northeastern margin of the Bohemian Massif, Czech Republic, Geological Society, London, Special Publications, 179, 175-197, 10.1144/GSL.SP.2000.179.01.12, 2000.

Linnemann, U., Gehmlich, M., Tichomirowa, M., Buschmann, B., Nasdala, L., Jonas, P., Lützner, H., and Bombach, K.: From Cadomian subduction to Early Paleozoic rifting: The evolution of Saxo-Thuringia at the margin of Gondwana in the light of single zircon geochronology and basin development (central European Variscides, Germany), Geological Society, London, Special Publications, 179, 131-153, 2000.

Linnemann, U., Gerdes, A., Drost, K., and Buschmann, B.: The continuum between Cadomian orogenesis and opening of the Rheic Ocean: Constraints from LA-ICP-MS U–Pb zircon dating and analysis of plate-tectonic setting (Saxo-Thuringian zone, northeastern Bohemian Massif, Germany), in: The evolution of the Rheic Ocean: From Avalonian-Cadomian active margin to Alleghenian-Variscan collision, edited by: Linnemann, U., Nance, R. D., Kraft, P., and Zulauf, G.,

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Geological Society of America Special Paper, 61-96, doi: 10.1130/2007.2423(1103), 2007.

Linnemann, U., Pereira, F., Jeffries, T. E., Drost, K., and Gerdes, A.: The Cadomian Orogeny and the opening of the Rheic Ocean: The diacrony of geotectonic processes constrained by LA-ICP-MS U–Pb zircon dating (Ossa-Morena and Saxo-Thuringian Zones, Iberian and Bohemian Massifs), Tectonophysics, 461, 21-43, 10.1016/j.tecto.2008.05.002, 2008.

Martínez Catalán, J. R., Arenas, R., Abati, J., Sánchez Martínez, S., Díaz García, F., Fernández-Suárez, J., González Cuadra, P., Castiñeiras, P., Gómez Barreiro, J., Díez Montes, A., González Clavijo, E., Rubio Pascual, F. J., Andonaegui, P., Jeffries, T. E., Alcock, J. E., Díez Fernández, R., and López Carmona, A.: A rootless suture and the loss of the roots of a mountain chain: The Variscan belt of NW Iberia, Comptes Rendus Geoscience, 341, 114-126, 10.1016/j.crte.2008.11.004, 2009.

Matte, P.: Accretionary history and crustal evolution of the Variscan belt in Western Europe, Tectonophysics, 196, 309-337, 1991.

Nance, R. D., Murphy, J. B., Strachan, R. A., D'Lemos, R. S., and Taylor, G. K.: Late Proterozoic tectonostratigraphic evolution of the Avalonian and Cadomian terranes, Precambrian Research, 53, 41-78, 1991.

Nance, R. D., Gutiérrez-Alonso, G., Keppie, J. D., Linnemann, U., Murphy, J. B., Quesada, C., Strachan, R. A., and Woodcock, N. H.: Evolution of the Rheic Ocean, Gondwana Research, 17, 194-222, 10.1016/j.gr.2009.08.001, 2010.

Orejana, D., Martínez, E. M., Villaseca, C., and Andersen, T.: Ediacaran–Cambrian paleogeography and geodynamic setting of the Central Iberian Zone: Constraints

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

from coupled U–Pb–Hf isotopes of detrital zircons, Precambrian Research, 261, 234-251, 10.1016/j.precamres.2015.02.009, 2015.

Pereira, M. F., Silva, J. B., Chichorro, M., Moita, P., Santos, J. F., Apraiz, A., and Ribeiro, C.: Crustal growth and deformational processes in the northern Gondwana margin: Constraints from the Évora Massif (Ossa-Morena Zone, southwest Iberia, Portugal), in: The evolution of the Rheic Ocean: From Avalonian-Cadomian active margin to Alleghenian-Variscan collision, edited by: Linnemann, U., Nance, R. D., Kraft, P., and Zulauf, G., Geological Society of America Special Paper, 333-358, doi: 310.1130/2007.2423(1116), 2007.

Pereira, M. F., Solá, A. R., Chichorro, M., Lopes, L., Gerdes, A., and Silva, J. B.: North-Gondwana assembly, break-up and paleogeography: U–Pb isotope evidence from detrital and igneous zircons of Ediacaran and Cambrian rocks of SW Iberia, Gondwana Research, 22, 866 - 881, 10.1016/j.gr.2012.02.010, 2012.

Pereira, M. F.: Potential sources of Ediacaran strata of Iberia: a review, Geodinamica Acta, 27, 1-14, 10.1080/09853111.2014.957505, 2015.

Pieren, A. P., Pineda, A., and Herranz, P.: Discordancia intraprecámbrica en el anticlinal de Agudo (Ciudad Real-Badajoz), Geogaceta, 2, 26-29, 1987.

Quesada, C.: Precambrian successions in SW Iberia: their relationship to 'Cadomian' orogenic events, in: The Cadomian Orogeny, edited by: Lemos, D. R., Strachan, R. A., and Topley, C. G., Geological Society, London, Special Publication, Geological Society, London, Special Publication, 353-362, 1990.

Ribeiro, A., Munhá, J., Dias, R., Mateus, A., Pereira, E., Ribeiro, L., Fonseca, P., Araújo, A., Oliveira, T., Romão, J., Chaminé, H., Coke, C., and Pedro, J.: Geodynamic evolution of the SW Europe Variscides, Tectonics, 26, TC6009, 10.1029/2006tc002058, 2007.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Ribeiro, A., Munhá, J., Fonseca, P. E., Araújo, A., Pedro, J. C., Mateus, A., Tassinari, C., Machado, G., and Jesus, A.: Variscan ophiolite belts in the Ossa-Morena Zone (Southwest Iberia): Geological characterization and geodynamic significance, Gondwana Research, 17, 408-421, 10.1016/j.gr.2009.09.005, 2010.

Ries, A. C., and Shackleton, R. M.: Catazonal Complexes of North-West Spain and North Portugal, Remnants of a Hercynian Thrust Plate, Nature Physical Science, 234, 65-79, 10.1038/physci234065a0, 1971.

Rojo-Pérez, E., Arenas, R., Fuenlabrada, J. M., Sánchez Martínez, S., Martín Parra, L. M., Matas, J., Pieren, A. P., and Díez Fernández, R.: Contrasting isotopic sources (Sm-Nd) of Late Ediacaran series in the Iberian Massif: Implications for the Central Iberian-Ossa Morena boundary, Precambrian Research, 324, 194-207, 10.1016/j.precamres.2019.01.021, 2019.

Roso de Luna, I., and Hernández Pacheco, F.: Mapa y memoria explicativa de la Hoja 1:50.000 nº 777 (Mérida) del Mapa Geológico de España (IGME), Instituto Geológico y Minero de España, 1950.

Rubio-Ordóñez, A., Gutiérrez-Alonso, G., Valverde-Vaquero, P., Cuesta, A., Gallastegui, G., Gerdes, A., and Cárdenes, V.: Arc-related Ediacaran magmatism along the northern margin of Gondwana: Geochronology and isotopic geochemistry from northern Iberia, Gondwana Research, 27, 216-227, 10.1016/j.gr.2013.09.016, 2015.

Sánchez-García, T., Bellido, F., Pereira, M. F., Chichorro, M., Quesada, C., Pin, C., and Silva, J. B.: Rift-related volcanism predating the birth of the Rheic Ocean (Ossa-Morena zone, SW Iberia), Gondwana Research, 17, 392-407, 10.1016/j.gr.2009.10.005, 2010.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Sánchez Lorda, M. E., Sarrionandia, F., Ábalos, B., Carrracedo, M., Eguíluz, L., and Gil Ibarguchi, J. I.: Geochemistry and paleotectonic setting of Ediacaran metabasites from the Ossa-Morena Zone (SW Iberia), International Journal of Earth Sciences, 103, 1263-1286, 10.1007/s00531-013-0937-x, 2014.

Simancas, F., Expósito, I., Azor, A., Martínez Poyatos, D., and González Lodeiro, F.: From the Cadomian orogenesis to the Early Palaeozoic Variscan rifting in Southwest Iberia, Journal of Iberian Geology, 30, 53-71, 2004.

Simancas, J. F., Ayarza, P., Azor, A., Carbonell, R., Martínez Poyatos, D., Pérez-Estaún, A., and González Lodeiro, F.: A seismic geotraverse across the Iberian Variscides: Orogenic shortening, collisional magmatism, and orocline development, Tectonics, 32, 417-432, 10.1002/tect.20035, 2013.

Strachan, R. A., and Taylor, G. K.: Avalonian and Cadomian Geology of the North Atlantic, edited by: Blackie, London, 252 pp., 1990.

Vegas, R., Antón, L., Gomes, A., and Medialdea, T.: Lineaments in the West-Central Hesperic Massif (Portugal and Spain) and their geomorphic and tectonic significance, Geo-Temas, 13, 1674-1677, 2012.

FIGURE CAPTION

Figure 1: Zonation of the Variscan Orogen after Díez Fernández and Arenas (2015). Location of the study area is indicated. Location of map in Figure 2 is indicated.

Figure 2: Regional geological map of the Obejo-Valsequillo Domain (Díez Fernández et al., in press) showing the location of the Mérida Massif. Location of map in Figure 3 is indicated.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Figure 3: Geological map showing the distribution of tectonostratigraphic units of the Mérida Massif.

Figure 4: Cross sections showing the current structure of the tectonostratigraphic units of the Mérida Massif. (a) Cross section normal to the trace of Variscan folds and faults. (b) Cross section subparallel to shear direction of Cadomian shear zones and showing the Cadomian nappe pile of the Mérida Massif. Cenozoic cover is not represented.

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Solid Earth
Discussions
Open Access

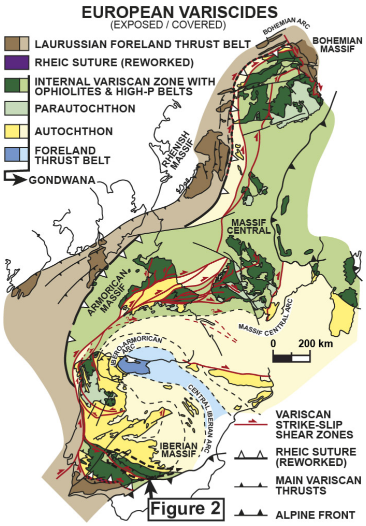
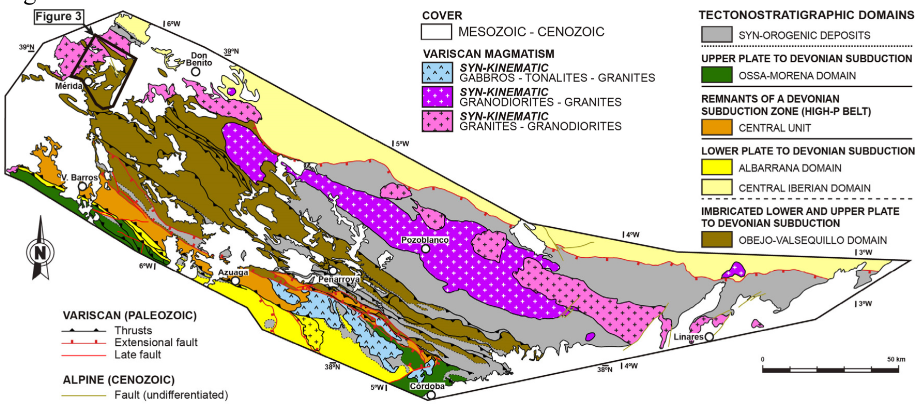


Figure 1

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Figure 2



https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Solid Earth
Discussions
Open Access

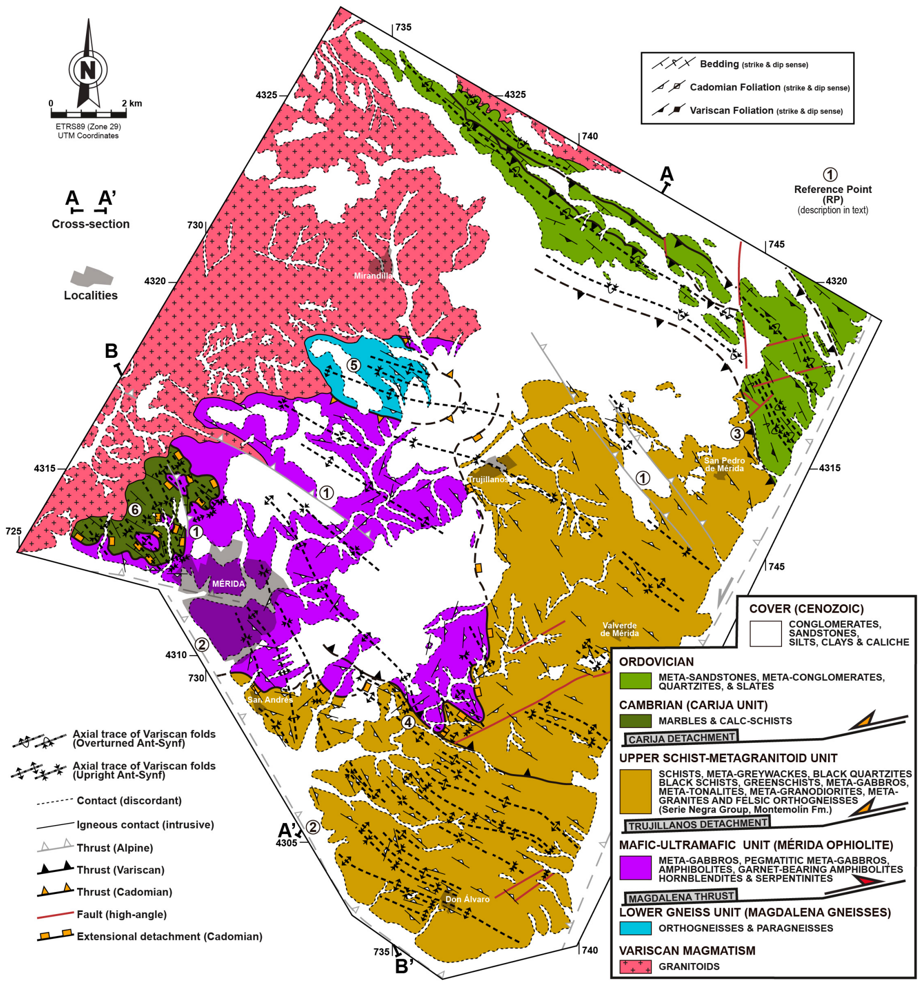


Figure 3

https://doi.org/10.5194/se-2019-189
Preprint. Discussion started: 3 January 2020

Figure 4