Internal Structure of the Évora Massif: The Évora High-grade Terrains and the Montemor-o-Novo Shear Zone (Ossa-Morena Zone, Portugal).

Estructura interna del Macizo de Évora: Los Terrenos Metamórficos de Alto-grado y la zona de Cisalla de Montemor-o-Novo (Zona de Ossa-Morena, Portugal).

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ABSTRACT

The Évora Massif is divided into two major tectonic units, in order to improve the general understanding of their internal complex structure: (1) the Évora High-grade Metamorphic Terrains and (2) the Montemor-o-Novo Shear Zone. Geological mapping based on stratigraphic, structural and metamorphism data of Neoproterozoic-Paleozoic rocks has shown great variations in style and intensity of deformation and metamorphic processes on both tectonic units.
A progressive deformation regime associated with sinistral transcurrent movements parallel to the orogen-strike is proposed to explain the overall structural pattern.

Key words: *Ossa-Morena Zone, Évora Massif, Évora High-grade Metamorphic Terrains, Montemor-o-Novo Shear Zone, Transcurrent movements*

RESUMEN

El Macizo de Évora es subdividido en dos unidades tectónicas, con el objetivo de mejorar la interpretación general de la su compleja estructura interna: (1) los Terrenos Metamórficos de Alto-grado de Évora y (2) la Zona de Cisalla de Montemor-o-Novo. Cartografía geológica basada en datos estratigráficos, estructurales y de metamorfismo en rocas del Neoproterozoico-Paleozóico han mostrado grandes variaciones en el estilo y intensidad de los procesos de deformación y metamorfismo en ambas unidades tectónicas. Es propuesto un regímen de deformación progressiva con movimientos transcurrientes izquierdos en paralelismo con la dirección del orógeno, para explicar la estructura general observada.

Palabras clave: *Zona de Ossa-Morena, Macizo de Évora, Terrenos Metamórficos de Alto-grado de Évora, Zona de Cisalla de Montemor-o-Novo, Movimientos transcurrientes*

Geogaceta, 33 (2003), 71-74
ISSN:0213683X

Introduction

The Évora Massif (EM - Carvalhosa, 1983; Quesada and Munhá, 1990) located in the western Ossa-Morena Zone (OMZ) and included in the northwestern part of the Beja-Aracena domain (Apalategui *et al.*, 1990) or the Montemor-Ficalho sector (Oliveira *et al.*, 1991), exhibits a complicated internal structure. The EM is a 25-45 km wide and 75 km long tectonostratigraphic, metamorphic and magmatic complex domain (Figure 1). It runs according to a NW-SE strike from Montemor-o-Novo (NW) towards Évora, at SE. Steeply NW-SE foliation and transcurrent fault zones separating tectonic units of various rock-types mainly characterize this NW-SE trending band. The EM rocks have been considered to be of mainly Neoproterozoic age (Serie Negra Succession named Escoural Formation by Carvalhosa and Zbyszweski, 1994; Gonçalves and Carvalhosa, 1993-1994) and Lower Paleozoic age (Cambrian known as the Monfurado Formation and Ordovician? -Silurian? named Carvalhal Formation by Carvalhosa and Zbyszweski, 1994). This domain also includes a small Upper Paleozoic basin, the Cabrela Formation of Devonian-Carboniferous age (Carvalhosa and Zbyszweski, 1994). Minor occurrences of eclogites (Pedro and Munhá, 1997) seem to high pressure metamorphisme affecting be related to the Neoproterozoic and/or Lower Paleozoic sequences. The deformation and metamorphism responsible for the complex structural pattern within the EM shows great variations in style and intensity. For this reason, it was decided to devide the EM in two major tectonic units (Figure 1) significantly differents: (1) the Évora high-grade Metamorphic Terrains (EHMT) and (2) the Montemor-o-Novo Shear Zone (MNSZ). In the first place, it

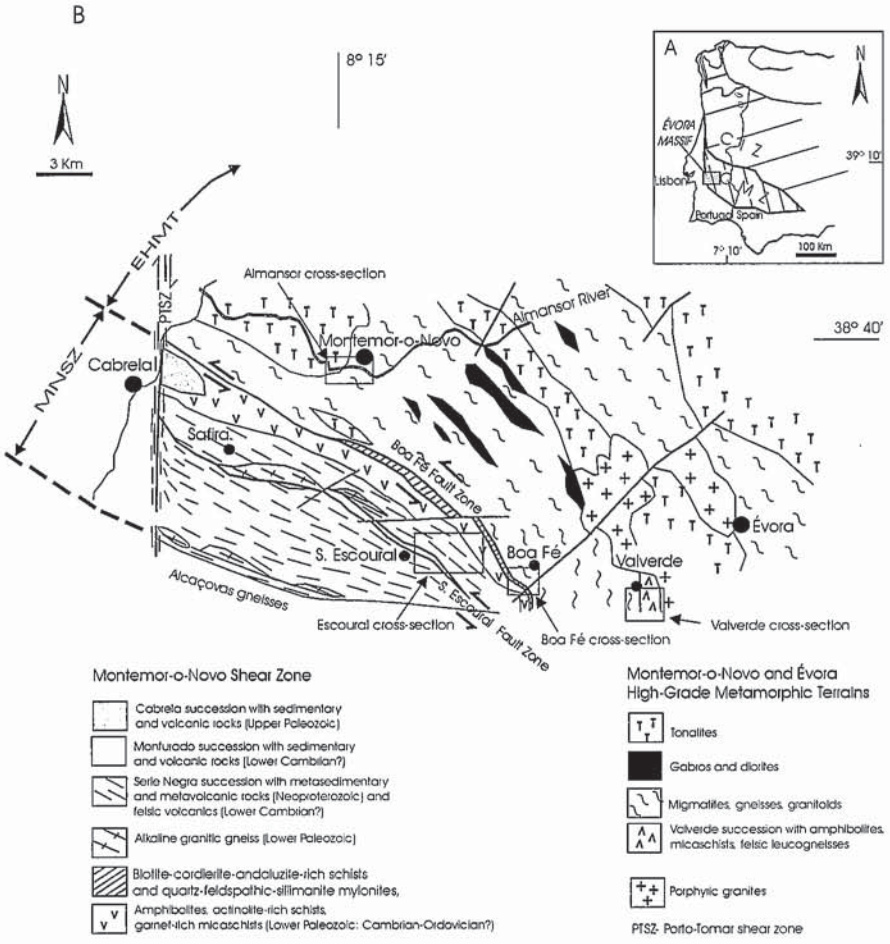

Fig. 1.– A) Esbozo geológico con la localización del Macizo de Évora en los domínios occidentales de la Zona de Ossa-Morena (OMZ). B) Mapa geológico simplificado de lo Macizo de Évora con la subdivisión en los Terrenos Metamórficos de Alto-grado de Évora (EHMT) y la Zona de Cisalla de Montemor-o-Novo (MNSZ), con la localización de los cortes de Santiago do Escoural- N.S. Boa Fé y de Valverde. Modificado de Barros *et al.*, 1969; Carvalhosa y Zbyszweski, 1994; Oliveira *et al.*, 1992; Pereira y Silva, 2001?.

Fig. 1.- A) Geological sketch map of the Évora Massif located at the westernmost domains of the Ossa-Morena Zone (OMZ). B) Simplified geological map of the Évora Massif with the subdivision in two major tectonic units: the Évora high-grade Metamorphic Terrains (EHMT) and the Montemor-o-Novo Shear Zone (MNSZ), with trace of the Santiago do Escoural- N.S. Boa Fé and Valverde cross-sections. Modified from Barros et al.,1969; Carvalhosa and Zbyszweski, 1994; Oliveira et al., 1992; Pereira and Silva, 2001.

should be pointed that these two major tectonc units of the EM are difficult to separate from each other by a single discrete fault. Contrarywise a 0.1 – 1 km wide steep zone of faulted and strongly sheared contacts is observed along this band of weakness between different crustal blocks. West of Montemor-o-Novo, the Porto-Tomar dextral shear zone, which defines the contact with the South-Portuguese Zone (SPZ), offsets the EM that is probably covered by the Tejo basin Tertiary sediments.

With this division of the EM into two tectonic units, it is our aim to improve the general understanding of their internal structure, related to the evolution of the deformation and metamorphic processes on a Neoproterozoic-Paleozoic stratigraphic sequence. These units are briefly described based on detailed studies along two transverses (Valverde and Santiago do Escoural - N.S. Boa Fé), supported by mapping projects, stratigraphy, petrographic and structural analysis, which allowed a preliminary characterization of the structure on these EM key-areas. Their cartographic meaning is discussed at the end of this work.

The Évora High-grade Metamorphic Terrains (EHMT)

This tectonic unit extends, with a NW-SE trend, along c. 75 km from Montemor-o-Novo into Évora with an average width of 15-20 km. It is formed by a structurally complex assemblage of migmatites and gneisses associated to variably strained NW-SE trending granodiorites, tonalites and minor gabrodiorites (mainly nearby Montemor-o-Novo), intruded by an undeformed suite of porphyritic granitoids (near Évora) (Figure 1).

These undated high-grade metamorphic rocks mainly composed of biotitic paragneisses, stromatic migmatites and banded leucogneisses include enclaves of previously deformed and metamorphosed black metachertes and metapelites, and minor amphibolites from the Neoproterozoic Serie Negra Succession. Migmatization also affects Lower Paleozoic sequences as can be proved by the occurrence of enclaves of amphibolites, pelitic and calc-silicate rocks (at N.S. Boa Fé) and by local anatexis of felsic protoliths with Lower Cambrian affinities (at Valverde).

Earlier D1 structures are preserved as foliations in enclaves of black metachertes and pelitic paragneisses indicating that migmatization affected the early deformed and metamorphosed Neoproterozoic Serie Negra succession. D2 structures are related with a sinistral ductile shearing. This regime of progressive deformation developed composite fabrics with an earlier S2a steep NW-SE-trending foliation and a gently dipping mineral lineation defined by biotite on gneisses and migmatites. This fabric was folded and overprinted by foliation S2b parallel to the subvertical NNW-SSE-trending axial-planes (Pereira and Silva, 2001). It has also been observed that D2 structures present N-S trending, subvertical foliation with unusual subvertical stretching lineation (at Valverde).

The northeastern boundary of this unit is poorly known but towards the southwest migmatites contact a complex fault zone (Boa Fé fault zone, BFFZ) with a continuous history of ductile to brittle evolution.

The Montemor-o-Novo Shear Zone (MNSZ)

The MNSZ which extends along c. 30 km from Cabrela Basin to N.S. Boa Fé and is 2-10 km wide is limited to the northeast by an intensely deformed fault zone (Boa Fé Fault Zone), and to the south by the strong mylonitized Alcaçovas felsic gneisses (Figure 1). This important ductile shear zone includes: (1) the OMZ Cadomian basement represented by black metacherts,

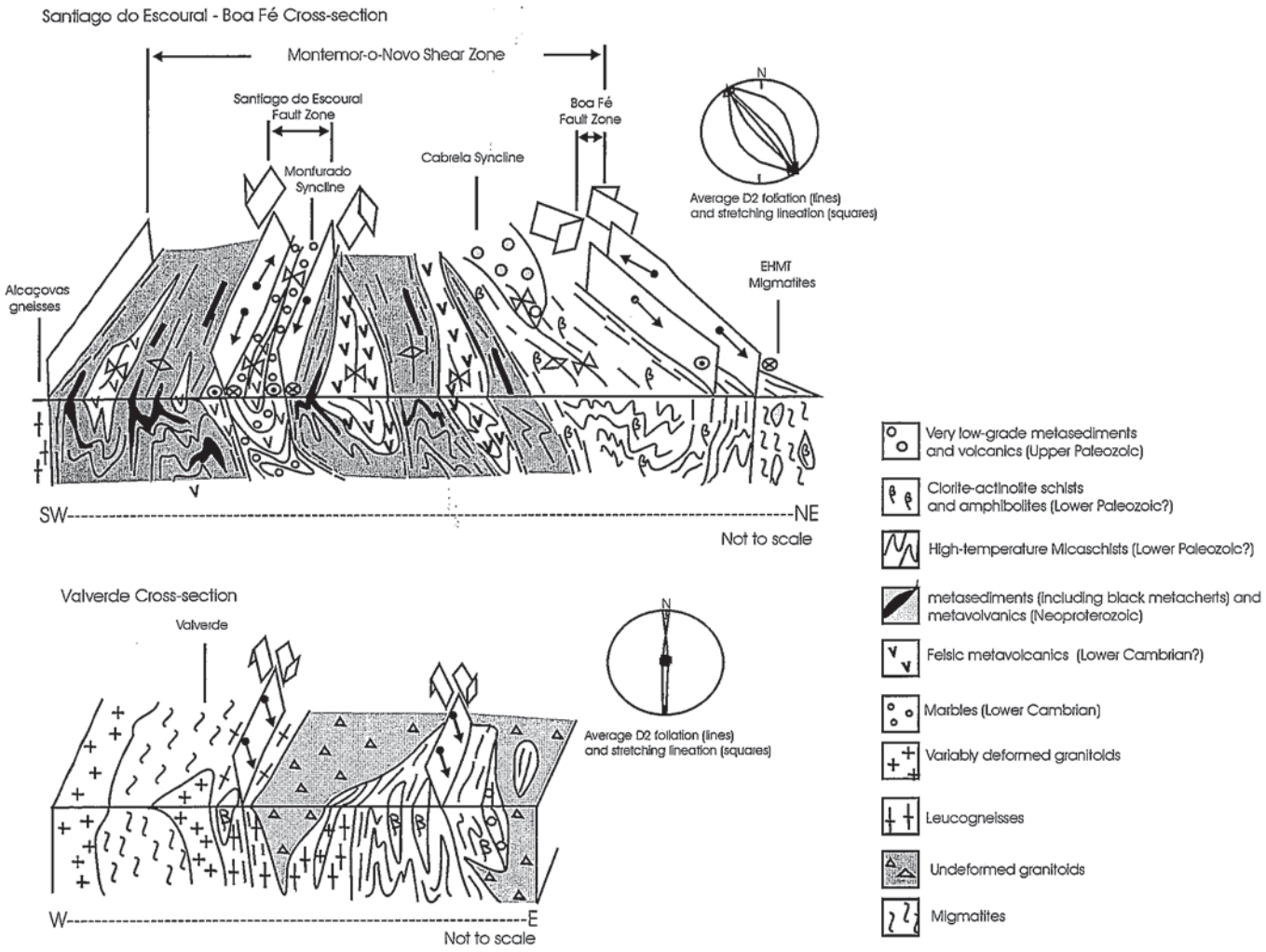

Fig. 2.– Cortes geológicos esquemáticos de Santiago do Escoural - N.S. Boa Fé y de Valverde (Localización en la Figura 1).

Fig. 2.– Schematic geological cross-sections of Santiago do Escoural- N.S. Boa Fé and of Valverde (see Figure 1 for location).

metapelites, metapsammites, micaschists and amphibolites (Neoproterozoic Serie Negra Succession) and felsic metavolcanics (probably the lowermost Cambrian?) characterized by low- to high-grade metamorphism; (2) low- to high-grade metamorphic Lower Paleozoic cover with marbles, metatuffs, metabasites (Cambrian) and amphibolitic schists, amphibolites and minor micaschists and calc-silicate rocks (Ordovician?-Silurian?); (3) very-low grade metamorphic Devonian-Carboniferous sedimentary (pelites, limestones, conglomerates) and volcanic rocks (felsic tuffs); (4) variably deformed granitoids; (5) unknown age lenses of eclogites within the Cadomian basement rocks.

The Neoproterozoic Serie Negra rocks preserved diagnostic signs of complex polyphasic deformation processes (such as oriented inclusions within feldspar porphyroblasts of micaschists and complex patterns of folds interference on black metacherts). Earlier D1 structural pattern cannot be accurately defined so far, since major D2 transcurrent movements caused widespread mylonitization within large areas, which also difficult the characterization of the earlier M1 metamorphism conditions. D2 structures are recognized by the existence of a NW-SE trending and strongly dipping (mainly to NE) S2a mylonitic fabric associated to a gently dipping (both to NW or SE) stretching lineation. This planar-linear fabric is folded by isoclinal or open folding responsible for the generation of macroscale anticlinal (mainly in Neoproterozoic Serie Negra rocks) and synclinal (Monfurado and Cabrela Paleozoic rocks) structures with strongly sheared limbs, gently dipping axes and axial-plane S2b foliation trending NW-SE or NNW-SSE.

The MNSZ includes two major fault zones:

(1) The Boa Fé Fault Zone (BFFZ) at the MNSZ / EHMT tectonic limit or the northern limb of the Cabrela Syncline, which is characterised by great changes on metamorphic conditions of the rocks that contact with the EHTM migmatites: at southwest of Montemor-o-Novo, the migmatites contact with very-low grade metamorphic rocks from the Cabrela Formation and towards the southeast, nearby N.S. Boa Fé, they contact with high-grade metamorphic sequences of probably Lower Paleozoic age;

(2) The Santiago do Escoural Fault Zone (SEFZ) that includes the strongly stretched Monfurado Syncline and its extent to the Safira felsic gneiss.

Concluding remarks

The main concluding remarks that arise from this work are as follows:

(1) The majoritary the rocks in the EHMT and the MNSZ suffered more or

less intense shearing consistent with a sinistral sense of movement under a regime of progressive deformation. Intense shearing is particularly clear in the EHMT migmatites located along the contact with the MNSZ, within the BFFZ, along the limbs of the Monfurado (SEFZ) and Cabrela synclines, and in the felsic gneisses that outcrop within the Serie Negra, at North and at South of the SEFZ.

(2) Migmatization affects the Neoproterozoic, Lower Cambrian and probably Ordovician rocks but the lack of radiometric data difficult further interpretations.

(3) The existence of significant change in the metamorphic grade across the EHMT / MNSZ boundary suggests that there was a great displacement along the BFFZ (parallel to the orogen-strike), a very important zone of weakness between different crustal blocks.

(4) The complicated internal structure of the EM is the result of polyphase deformation and metamorphism. D1 deformation relics of the Cadomian cycle are preserved in Neoproterozoic Serie Negra rocks, overprinted by Early-Variscan (?) episodes (D1a structures). This sequence is unconformably overlain by Devonian-Carboniferous sediments of the Cabrela Formation, which are affected by Variscan D2b structures.

Aknowledgements

Finantial support was given by the Grupo de Tectónica – Centro de geofísica da Universidade de Évora budget for 2001-2002 and Acção Integrada Luso-Espanhola-2001/2002 (Acção Nº E-59/01-CRUP);

Martim Chichorro benefits of a Fundação para a Ciência e Tecnologia (FCT) PhD scholarship: Praxxis XXI/SFRH/BD/2947/2000

Discussion with L. Eguiluz, T. Palácios and A. Apraiz was of great help.

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