New data about stratigraphy and structure of the Vila Velha de Ródão complex syncline (SW sector of the Central-Iberian Zone, Portugal)

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Abstract: New data about the lithostratigraphy and the progressive Variscan structure of the Vila Velha de Ródão complex syncline is presented. During the geological mapping revision was established an Ordovician-Silurian succession, very similar to the Amêndoa-Carvoeiro synform D_3 (Romão, 2000). The Variscan deformation includes: early overthrusts subsequently transformed in forethrusts with *duplex* geometry facing to NE, folds, cleavage and linear structures (D_{1a} and D_{1b}) and latter crenulation, backthrusts and backfolds with an opposite facing (D_{1c}). Their compatible progressive deformation with NE-SW maximum compression induces *décollement* in depth of *thin-skinned* type and creates triangular structures. This macrostructure is affected by late-Variscan faults, probably associated with a *domino* structures, of which the most important is the Ponsul reverse fault.

INTRODUCTION

The Vila Velha de Ródão complex syncline is located in the Central-Iberian Zone (CIZ), SW sector, NE of the Amêndoa-Carvoeiro synform (Romão, 2000) and NW of the Serra de São Mamede syncline. This study refers the Lower to Middle Paleozoic succession, situated above the unconformity that separates the Beiras Group (BG), shale and greywacke complex, of the Armorican Quartzitic Formation (AQF). Our main objective is to present the Ordovician-Silurian lithostratigraphic succession and the Variscan structure of the Vila Velha do Ródão syncline, based on new data that the review of geological mapping on the 1/25000 scale, allowed to establish. It also correlates the lithostratigraphic succession established in the syncline of Vila Velha de Ródão with the D_3 Amêndoa-Carvoeiro synform succession and characterizes the Variscan deformation events and their associated kinematics.

LITHOSTRATIGRAPHY

The revision of Vila Velha de Ródão geologic mapping emphasizes the presence of a lithostratigraphic succession with Lower to Middle Paleozoic age, already recognized in the Amêndoa-Carvoeiro synform (Romão, 2000; 2001; 2006). Above the older unit, BG, still not differentiated in the studied area, overlaps with a high angle unconformity the Ordovician-Silurian sequence.

This sequence initiates with the AQF (±80m) which is composed mostly by massive beds of coarse-grained quartzites. Near the base sometimes quartzitic conglomerates occur (Vilas Ruivas and Sobral Fernando) and to the top fine quartzites appear often laminated and with trace-fossils marks. Inside these fine quartzites were recognized *Skolithus* and *Cruziana* (NE of Foz do Cobrão). Above this unit occur fine pelites and siltstones, occasionally with *Didymograptus* and trilobites (Ribeiro *et al*., 1965; 1967; Teixeira, 1981) which were included in the Brejo Fundeiro Formation (BFF, ±120m). They follow arenites and impure quartzites with storm characteristics that were integrated in the Monte de Sombadeira Formation (MSF, ±15m). On top of the MSF we identified the Fonte da Horta (FHF) and Ribeira do Casalinho (RCF) Formations with thicknesses of few meters. They are characterized respectively, by pelites and quartzo-arenites, intercalated with dark pelites. The Upper Ordovician (Caradocian) is initiated by a regressive sequence of bioturbated pelites and massive arenites which form the Cabeço do Peão Formation (CPF, ±25m). The previous units are overlaid by regressive layers of micaceous impure quartzites of the Ribeira de Laje Formation (RLF, ±5m) and, afterwards, by massive packets of pelite-siltitic sediments, inside which elongated fragments of quartzo-arenitic and quartzitic composition occur. This last unit, with glaciogenic sedimentary structure, was recognized as the Casal Carvalhal Formation (CCF, ±50m).

This Paleozoic succession finishes with one packet of gray quartzites layers, sometimes with aggregates of pyrite and syn-sedimentary structures, typical characteristics of the Vale da Ursa Formation (VUF, ±20m). On top of this last unit were observed some meters of dark laminated graphitic pelites with fossils (brachiopods and *Monograptus*), which should correspond to the Aboboreira Formation (AF). The two last units can already be considered Lower Silurian (Romão, 2000; 2001; 2006).

VARISCAN STRUCTURE

The geological mapping of Vila Velha de Ródão complex syncline permitted evidence that its geometry and limits show strong tectonic control. It is the result of a progressive superposition of deformation events related with the Variscan orogeny.

The main synclinoric structure ends in SSE with a monocline (Campos & Pereira, 1991) in the Serra de São Miguel. In the SW limb of this monocline there is an overthrust with a NE facing. The NNW final part of this macrostructure culminates in a triangular zone (Foz do Cobrão), limited to SW by a forethrust and to NE by a backthrust (Fig.1), with opposite facings. Their SW limb is imbricated by the Vinagra-Foz do Cobrão forethrust, which is characterized by a duplex geometry (Ramsay & Huber, 1987) and it is caused the displacement of the BG metasediments above the AQF quartzites. The forethrust and backthrust terms are related with the dominant regional facing of the thrust-fold system; where their interference originates a triangular zone (Butler, 1982).

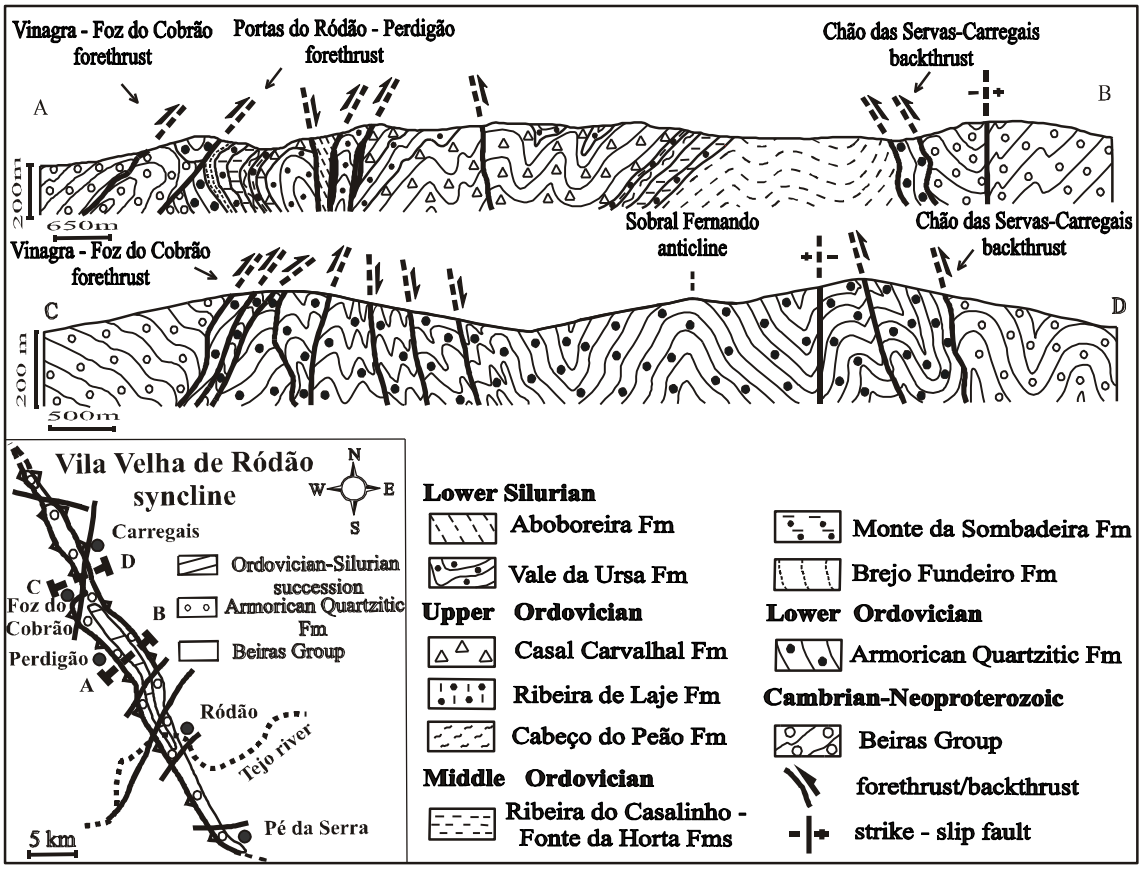

Fig.1 - Schematic framework and geological cross sections of the Vila Velha de Ródão complex syncline

The D_{1a} Variscan deformation induced folds with primary penetrative foliation (S_1) and early overthrusts with a NE facing. The coeval folds, often asynchronous, present geometry and different styles with metric to centimetric amplitudes and, more rarely, decametrics. The axial planes of the folds shows a dominant facing to NE and a NW-SE to NNW-SSE general trend. Their axis are sub-horizontals (values less than 20º-25º) or mostly plunges to SE (Serra de Perdigão and Serra de Foz do

Cobrão) and, more rarely, to NW (Serra de São Miguel). The axial plane S_1 foliation has a NW-SE to NNW-SSE trend. Their axis are sub-horizontals and present a general SW dip (≈70º). The L_1 intersection lineation shows a N35º-40ºW orientation and a sub-horizontal to relatively low dip, mainly to SE and, locally, to NW. Stretching lineation was not observed in the Ordovician-Silurian formations, but only at a lower structural level in the BG metasediments where it presents a sub-horizontal geometry; an extension sub-parallel to the ***a*** kinematic axis could than be emphasized (Ribeiro *et al*., 1990; Romão, 2000).

The D_{1b}Variscan deformation, in continuity with the D_{1a} one, will retakes the early overthrusts, generating larger forethrusts with duplex geometries and with orientation NNW-SSE. They are including in this event the Vinagra-Foz do Cobrão, Portas do Ródão-Perdigão and Vale do Cobrão forethrusts. The Vinagra-Foz do Cobrão forethrust (NNW-SSE, 45º-80ºSW) was due to overlap of the BG shale and greywacke above the AQF quartzites. The kinematic markers on the plane of the forethrust indicate thrusting movement with a slight dextral component.

The Portas do Ródão-Perdigão forethrust (N15º-20ºW, 70ºSW) must correspond to an imbrication of the previously described forethrust. It presents a pure thrust movement, inferred from the striations, and caused the displacement of the AQF beds above the metapelites of the FBF, inducing an inversion of the polarity in the layers of the FBF-MSF-FHF-RCF-CPF succession. In the core of the Vila Velha de Ródão syncline was identified the Vale do Cobrão forethrust (N25ºW, 70ºSW), with a similar facing and sub-parallel to the previous forethrusts. This overthrust was responsible for the superposition of the inverted succession of Middle to Upper Ordovician from the SW limb of the Vila Velha de Ródão syncline above the metapelitic FBF, from the opposite limb of the same syncline.

In continuity the D_{1c} event generates backfolds (N10ºW, 0º-20ºSE) and backthrusts with a SW facing. Among the backthrusts stands out the Chão das Servas-Carregais backthrust, which is induced by the superposition of the BG lithologies above the AQF quartzites on the NE limb of the main structure. On the opposite limb of this structure develops the Vinagra-Foz do Cobrão forethrust, already described. These two overthrusts with opposite facings define one triangular structure, in the core of which was formed the Sobral Fernando anticline, with a NE facing. It is the result of a progressive compression with a NE-SW orientation. Locally, the D_{1c} event also produced a crenulation cleavage with N10º-30ºW trend and a SW dip.

A late-Variscan brittle deformation affects the Vila Velha de Ródão complex syncline. Sinistral strike-slip faults dominate with a NE-SW to NNE-SSW orientation. Among them stands out the Ponsul fault (Ribeiro, 1943; Dias & Cabral, 1989), which was reactivated as a reverse fault during the Alpine movements and is responsible for the overlapping of the Variscan substrate upon the continental Tertiary deposits. The NE-SW to NNE-SSW strike-slips could be interpreted as domino structures, related with the E-W dextral strike-slips, which were cutting the entire Variscan orogeny. This brittle deformation of the Lower Permian, observed at orogenic scale, resulted from an E-W maximum shortening that is locally accompanied by a N-S smaller shortening, which generated in the same time constriction (Ribeiro *et al.*, 2007).

CONCLUSIONS

In the Vila Velha de Ródão complex syncline was recognized and mapped an Ordovician-Silurian succession very similar to the sequence established by Romão (2000; 2001; 2006) in the Amêndoa-Carvoerio synform. The comparative analyse between the two successions indicates that the units are generally thinner and have less fossils than in the Amêndoa-Carvoeiro series. This sedimentary succession was deposited during the development of a larger sedimentar cycle with duration within of 50Ma. The transgressive phase occurred from Arenigian to Dobrotivian and is characterized by the transition from coastal to external platform environments. In the Caradocian the regressive phase is characterized by a coastal deposition environment, where the presence of glacio-marine sedimentation stands out, which originated from sub-glacial waters, close to the continent during Hirnantian (Romão & Oliveira, 1997; Romão, 2000; 2006).

The studied region, in scale of the Variscan orogeny, is located between two transpressive zones with a WNW-ESE to NW-SE trend and opposite movements: the Tomar-Badajoz-Córdoba Shear Zone and the outermost Arc of NW Iberia. The first is characterized by a left transpressive regime and

the second by a right movement. The fold's geometry and attitude, as well as their dominating NE facing and the primary S_1 foliation, which corresponds to the flattening surface of the pre-existing objects, are compatible with a maximum NE-SW compression during the early events of the Variscan deformation phases. Still in these events the sub-vertical stretching in **"a"** indicates a vertical escape of material, thus we can deduce one stress field which is characterized by horizontal shortening and vertical stretching.

The presence of highly inclined NE facing forethrusts, backthrusts and backfolds with NNW-SSE trend and SW facing, as well as secondary S_2 foliation with NE facing, indicates that deformation gradually continued during the rest of the D_1 orogenic phase with a similar stress field, eventually with one slight rotation of the major compression towards ENE-WSW due to the progressive deformation of the Iberian-Armorican Arc (Ribeiro *et al*., 2007). The identification of triangular structure in metric and decametric scale, suggests that there may exist a *décollement* in depth of thin-skinned type (Butler, 1982).

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