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VARISCAN HT METAMORPHISM IN A CONTEXT OF DYNAMIC EVOLUTION: THE EXAMPLE OF MONTE E SENES HERCYNIAN COMPLEX (SARDINIA, ITALY)

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The axial zone of the Sardinia Variscan belt is characterized by medium- to high-grade metamorphic continental crust and is intruded by the Late Variscan composite batholith (Bralia et al., 1981). On the whole, three main "suites" compose the batholith: I) early granitoids (Mg-K suite; 330 – 325 Ma) II) syn-late tectonic granitoids (diorites, granodiorites, monzogranites; 325 –306 Ma) III) post-tectonic granites (leucogranites; up to 275 Ma).

The late Variscan extensional tectonic event (Elter et al., 1999, Corsi and Elter, 2005) associated with the Permo-Carboniferous gravitational collapse affected the whole belt with a composite shear network (Elter et al., 1999, 2004; Corsi b. et Elter F.M., 2005): the shear network could be subdivided in two events: Early Shear Event (ESE) and the Late Shear Event (LSE).

The widespread ESE penetrative schistosity is evidenced by a sin-kynematic HT-LP metamorphism (K-feldspar+sillimanite zone, T=600° – 450° C, P= 6-4 Kbar, Ricci, 1992). On the XZ plane preserved kinematic indicators as σ and δ porphyroclasts, domino like porphyroclasts, asymmetric boudins, shear folds, sheath folds and S-C planes give a shear component Top to NE/SE. The LSE event is related with a composite network of strike slip shear zone (the main component is dextral while the secondary is sinistral): the metamorphic evolution comprises I) the LSE showing high-temperature textures ($T\leq 500°$ C, Elter et al., 1999) and associated with syn-kinematic intrusions of foliated Mg-K granitoids, and II) the LSE marked by retrograde metamorphism (T= 400˚– 300˚ C, P=2- 3 kbar, Elter et al., 1999). The LSE can be further subdivided in LSE, with a syn-kinematic greenschist metamorphism and the LSE with retrograde metamorphism in the muscovite+K-feldspar zone (Muzio, 2003, Elter et al., 1990, 1999, 2004, Elter and Ghezzo, 1995, Elter and Corsi, 1995).

The extensional shear frame ESE took place in a time span between 350 - 344 Ma (Ferrara et al. 1978, Beccaluva et al., 1985, Del Moro et al. 1991, Elter & Corsi, 1995, Elter et al., 1990, 1999, 2004), while the LSE develops between 325–290 Ma, (Muzio, 2003, Elter et al., 1990, 1999, 2004; Corsi B. et Elter F.M., 2005).

In the Mt. E'Senes area well preserved relationships between emplacement of syn-tectonic granitoids and the shear network are recognizable. The M. E'Senes's complex is characterized by the presence of three major plutons: two of them include the syn- late tectonic granitoids: the Cuile is Furros Granodiorite and the two-micas granite of Punta su Grabellu. On the whole the granitoids have N40 orientation. The latest intrusion is characterised by a post-tectonic leucocratic complex (Mt. E'Senes Leucogranite).

The syn-tectonic Cuile is Furros granodiorite is a 6 km^2body dated at 320$\pm$5 Ma (Muzio, 2003) outcropping to the SE end of the Posada – Asinara lineament. It intrudes the polymetamorphic basement including metapsamites (al + ol + bt zone, Elter et al., 1986), metaarenites and minor metacarbonate boudins. The granite body exhibits a magmatic planar anisotropy deriving from the preferred mineral alignment (Magmatic Foliation; MF - Muzio, 2003)

The granodiorite intrusion is surrounded by a thermal aureole hundreds meters thick mostly in metapelites and marbles. The development of the thermal aureole (M3) overprints M1 and M2 schistogenous events and in turn results a polyphase event:

1. A static M3a phase characterised by porphyroclasts development of andalusite with Mn-rich (Kanonaite) core, plagioclase, muscovite 1, biotite 1

2. A dynamic M3b phase characterised by a schistosity syn-tectonic to S_3, related to a non-coaxial deformation with a top to SE shear component (σ porphyroclasts, s-c planes, and folds at different scales), characterised by the stability of prismatic sillimanite, biotite 2, muscovite 2

3. A static M3c phase characterised by minerals re-crystallization with mimetic growths of fibrolite and biotite 3 on pristine minerals.

The Ms + Bt + And assemblage, in the lack of K-feldspar suggests T $\approx$ 600˚C for pressures $\leq$ 0.3 GPa. The transition to the Sill + Ms + Bt + Kf (+ Crd?) assemblage could point to a moderate T and P increase ($\approx$ 650˚C; 0.3-0.4 GPa).

In the carbonatic boudins aligned SW – NE perpendicular to the granodiorite contact surface over 60 meters, the following assemblages developed: A) Calcite + Diopside + Grossular; B) Calcite + Albite + Clinochlore; C) Calcite + Clinochlore + Quartz; D) Calcite + Quartz.

The stability of diopside in carbonatic rocks, in equilibrium with sillimanite corresponds to 600˚C (Bucher and Frey, 1994). In the field, the gradual transition to assemblages B), C) and D) point to T about 450˚ - 440˚C, and assemblage D) corresponds to an almost pure marble.

Quartz grains affected by grain boundary migration, bulging and tear drops indicate T exceeding 400˚C for M3b, consistent with thrust microfaults mica fish in biotites and deformation twins in albite. Fractured quartz grains, with undulose extinction, deformed lamellae and subgrain formation support temperature about 300˚-400˚C for M3c.

In carbonates, the smooth temperature decrease from assemblage A) to C) and the abrupt change to assemblage D) is consistent with the occurrence of a dm–thick shear zone in the host rock of carbonatic boundins, that likely resulted in the sinistral thrust of the lower grade assemblages. This phase is also recorded in the marble boudins as σ-porphyroclasts and tear drops in quartz.

This structural evolution is recognizable also in the granodiorite. The static M3b phase is related to the presence of the Magmatic Foliation, that is recorded as Tuillage (Blumenfeld, 1983), indicating a dextral non-coaxial deformation Top to SE like a metamorphic structure. Also in the field a continuity arises between the S_3schistosity and the MF.

As a conclusion, I) the depth of emplacement is constrained between 9-12 km based on the indication of 0.3-0.4 GPa derived from assemblage II) in metapelites; II) the structural pattern in the host complex indicates an early thermal overprint under static regime, whereas the following dynamic event could represent a local effect associated with the granodiorite emplacement III) The late sinistral shearing accounts for the elision of the formerly complete, diffusion-controlled, thermal aureole.

The CFG is therefore a rare case where the thermometamorphic event is controlled by shear dynamics in the area. On the whole, petrological and structural investigations of the thermal metamorphism within the M. Senes complex provide a support to the modelling of the late Variscan phases in NE Sardinia.