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Anatexis of metasedimentary rocks in the Iberian Variscan Belt: the example of the Mundão migmatites (Northern Central Portugal)

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The oldest rocks exposed in the axial zone of the Iberian massif of Central Northern Portugal (Central Iberian Zone) belong to a thick turbiditic metasedimentary sequence of Neoproterozoic-Lower Cambrian age, consisting of metagreywackes and metapelites with minor calc-silicates and conglomerates. In the Mundão area, this sequence was extensively migmatized during the Variscan orogenic event. Field and structural evidence show that the partial melting conditions were reached in the last stages of crustal thickening (D1), continued during subsequent extensional deformation (D2) and culminated with the emplacement of large volumes of S-type granite magmas in a transcurrent tectonic regime (D3).

The Mundão anatectic complex comprises two main migmatite types: metatexites and diatexites, showing in general transitional contacts. The metatexites are composed of dark fine-grained layered hosts and small volumes of quartz-feldspathic veins (leucosomes), whilst the diatexites have igneous looking appearance, larger amounts of the lighter portions and schollen or nebulitic structures. In the latter, the foliation is defined by the presence of biotite rich schlieren and/or the alignment of feldspar crystals in the leucocratic bands.

Petrographically, the Mundão migmatite types are distinguished by variations of the modal proportions of the same mineral assemblage (quartz + plagioclase + biotite $\pm$ K- feldspar + apatite + zircon + monazite + opaques). Fibrolitic sillimanite occurs either as small clots of fibres or as needles included within the other mineral phases (plagioclase and muscovite). Tourmaline is a common accessory phase. Large flakes of retrograde muscovite overgrowing the syn-migmatization structures are generally present. The lack of garnet and orthopyroxene in these rocks suggests that melting was dominantly controlled by muscovite breakdown.

Whole rock major and trace element geochemistry reveals that the unmigmatized schists and metagreywackes and the darker portions of the metatexites have similar geochemical signatures, characterized by low SiO_2 and CaO contents, K2O > Na2O, high $Al2O_3$, $Fe2O_3T$, TiO_2, poorly fractionated REE patterns (LaN/YbN = 6.55 – 7.05) and negative Eu anomalies (Eu/Eu* = 0.52-0.56). The similarities encountered appear to indicate that the dark metatexite layers represent partially melted metasediments from which little or no melt extraction occurred.

The leucosomes of the metatexites are enriched in SiO_2 (74-75%), CaO (0.62-0.77%) and Na2O (2.11-2.79%), depleted in $Al2O_3$, $Fe2O_3T$, TiO_2 and REE and have positive Eu anomalies (Eu/Eu* = 1.05-1.58). Their compositions are typical of melts produced either by small amounts of partial melting in disequilibrium conditions and/or by early removal of feldspars from the primary melts (cumulates). In contrast, the leucocratic nebulitic diatexites display SiO_2 values varying between 70-72%, K2O enrichment (5.20-6.67%), fractionated REE patterns (LaN/YbN = 11.88 – 22.75) and distinct negative Eu anomalies (Eu/Eu* = 0.34-0.47) and may therefore correspond to more fractionated melts derived from higher melt fractions.

The zircon saturation temperatures for samples from the leucosomes of the metatexites and the leucocratic diatexites range between 740 and 780C, suggesting that migmatization occurred mainly via muscovite dehydration reactions. Apparently, the amount of melt generated was enough to flow, implying melt fractions above the melt escape threshold of 20% vol. melt.

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