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Melt-present and melt-depleted stages in Grenvillian-age UHT migmatites: implications for the rheology of the lower crust

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Partial melting, identified by the presence of quartzo-feldspathic leucosomes, plays a major role in the rheological behaviour of mid to lower crust.Its understanding is thus critical for the thermo-mechanical modeling of large hot orogens. Although some leucosomes correspond to *in situ* segregations of near eutectic melts, others may be mixtures of peritectic and cumulitic minerals left over after melt extraction. The liquid behaviour of such leucosomes, characterized by the breakdown of the crystal framework, is thus restricted to the melt-present stage. The time scale of this stage may be very short compared to that of orogenic processes. A 4000 km^2 migmatite complex from the Grenvillian basement of the Andes in Southern Peru is comprised of stromatites that consist of quartz-bearing, K-feldspar-rich, plagioclase-poor anhydrous leucosomes, interlayered with Al-rich orthopyroxene-sillimanite or biotite-sillimanite melanosomes. These rocks evolved well above the minimum melting of granite, up to the conditions of UHT metamorphism ($T>900$ºC). The amount of melt produced and extracted from these migmatites cannot be assessed from regional field data that neither permit to observe a potential protolith. However, the abundance of K-feldspar and sillimanite in the migmatite and the presence of orthopyroxene in the melanosome suggest that fluid-absent, incongruent melting of muscovite and biotite are plausible reactions that took place in a mica-rich protolith to produce the migmatite. Given that under fluid-absent conditions the stability of micas does not exceed 900ºC, melting and melt extraction would have predated UHT conditions. Indeed, the absence of back reactions at the leucosome-melanosome interface indicates that H_2O-saturated solidus conditions were not attained during cooling, suggesting that dehydration was

achieved by virtually complete melt extraction. This type of Al and K-rich, dehydrated migmatites thus appear as left-over after extraction of H_2O-undersaturated, Na-enriched melts. By re-introducing about 30% hydrous melt of haplogranitic composition (1/3 Qtz, 1/3 Kfs, 1/3 Pl) into the migmatite and inverting potential muscovite and biotite melting reactions, a fertile muscovite-biotite plagioclase-bearing schist composition is obtained for the protolith (Qtz:32; Pl:18; Ms;30; Bt20). According to this melting-melt extraction sequence, these migmatites probably acted as mixtures of solids and molten layers (melt fraction in leucosomes around 30%) during that part of the prograde P-T-t path comprised between the minimum melting of granite and the exhaustion of micas. They acted as layered solids (with a few % melt fraction in the leucosome) during the UHT and retrograde portions of the P-T path.