Construction and differentiation of the ferroan (A-type) Sveconorwegian (=Grenvillian) Kleivan intrusion

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It was recognized that two important boundaries, the Farsund-RAP shear zone and the Sveconorwegian (=Grenvillian) opx-in isograd, controlled the composition of the post-collisional magmatism of southern Norway (0.97 to 0.92 Ga) (Vander Auwera et al., 2011). The Farsund-RAP shear zone (Bolle et al., 2010), a boundary between two contrasted lithothectonic units, separates magmatic bodies with different isotopic compositions mainly due to different contaminants. During the regional metamorphism (1.035 to 0.97 Ga: i.e. Bingen et al., 2005), southern Norway lower crustal segments were variably modified, with granulite facies conditions prevailing in the westernmost part of the orogen and producing dehydrated lower crustal sources west of the opx-in isograd, and more hydrated sources east of this isograd. The small Kleivan intrusion (∼20 km², 930 ± 7 Ma, Rb-Sr; Pedersen & Falkum, 1975), located in the eastern hydrated part of the orogen, confirms these interpretations. This pluton contains two different trends. The main trend displays, from North to South and with increasing SiO₂, a gradual variation from opx-bearing charnockites to amphibole-bearing and finally biotite-bearing granites (Petersen, 1980), in which titanite is absent. In the subsidiary Hbl+Tit trend, titanite is present, opx is absent and amphibole is the dominant ferromagnesian. The main trend has a significantly higher Fe# than the Hbl+Tit trend, echoed by higher Fe# in amphiboles and accompanied by a larger range in SiO₂ (63.9 to 77% in the main trend; 63.5 to 68.9% in the Hbl+Tit trend). Both trends are ferroan and have overlapping compositions for trace and other major elements. The bulk magnetic susceptibility (K_m) is higher in the Hbl+Tit trend, reflecting its higher magnetite/ilmenite ratio. The two trends have similar initial Sr, Nd and Pb isotopic compositions indicating contamination by the eastern crustal contaminant only, in agreement with the emplacement of the Kleivan intrusion east of the Farsund-RAP shear zone. Experimental data (Bogaerts et al., 2006) indicate a lower H₂O content (<4.5 wt%) in the parent magma of the main trend than in that of the Hbl+Tit trend (>5.5 wt% H₂O). In addition, higher magnetite/ilmenite ratio and titanite occurrence within the Hbl+Tit trend agree with a higher fO₂. The presence of two trends differing by their H₂O content and fO₂ is here related to straddling of the opx-in isograd (Sveconorwegian metamorphism) by the Kleivan intrusion (Vander Auwera et al., 2011).

It is also worth noting that, despite similar rheologies (similar major elements composition and temperature), the two trends did not mix, preserving their characteristics towards their level of emplacement (3.5 to 5 kbar) through differentiation and upward migration from the lower crust.