Late-tectonic evolution of the Sveconorwegian (Grenvillian) orogen in Southern Norway: what do granites tell us?

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Granites *s.l.* (granitoids) occupy an important volume of the continental crust, especially in orogenic belts, and they represent key markers of the Earth's crust evolution. In particular, it is now well established that despite their massive aspect, granitoids commonly display homogeneous fabrics that mimic the tectonic pattern of their country rocks. This means that granitic bodies are capable of recording tectonic strain in the course of their crystallization and may be used as markers of crustal deformation.

In the Precambrian basement of Southern Norway and Southwest Sweden, abundant granitic plutons were emplaced at 0.99-0.92 Ga (Bingen et al., 2008b; Vander Auwera et al., 2011; and references therein), during the last stage of evolution of the Sveconorwegian (Grenvillian) orogen. These plutons are classically regarded as post-tectonic bodies, emplaced in an extensional context related either to gravitational collapse of the orogenic belt, considering the conventional, collisional model admitted for the Sveconorwegian orogen (Bingen et al., 2008b) or to steepening of the subducting slab, considering a challenging, accretionary model proposed recently (Slagstad et al., 2013). An alternative tectonic context to extension is discussed here, based on published structural maps, using the anisotropy of magnetic susceptibility (AMS) technique, of three late-Sveconorwegian plutons of Southern Norway (Bolle et al., 2003, 2018): the Holum granite, and the Kleivan and Sjelset granitic complexes. The Holum granite is a homogeneous, biotite+hornblende granite dated at 957 ± 7 Ma (zircon U-Pb age; Bingen et al., 2006). The Kleivan and Sjelset granitic complexes are two composite plutons, containing both biotite (±hornblende) and orthopyroxene granitic facies that are almost coeval in the Kleivan complex (U-Pb ages of single zircons from 936.94 ± 0.42 Ma to 935.62 ± 0.67 Ma; Bolle et al., 2018), but correspond to magmatic pulses with a significant age difference in the Sjelset complex (935.67 ± 0.37 Ma and 932.43 ± 0.75 Ma; Bolle et al., 2018).

The three plutons are elongated parallel to the regional tectonic framework defined by several generations of superimposed folds developed along *ca.* N-S-trending axes. The Holum granite and the Kleivan complex crop out, respectively, along strike and in the core of a large-scale fold. Their magnetic lineations are parallel to the axis of these folds, as well as to lineations measured in the country rocks. Magnetic lineations in the Sjelset complex are also parallel to fold axes and lineations in the country rocks. These results demonstrate that regional-scale folding was still active in the area at the time of emplacement of the three plutons (957-932.5 Ma) and probably shortly after, *i.e.* up to *ca.* 40 Ma after the peak of regional metamorphism dated at 1.035-0.97 Ga (Bingen et al., 2008a; Drüppel et al., 2013; and references therein).

The mean magnetic lineation calculated for the Holum granite, and the Kleivan and Sjelset granitic complexes points to a *ca.* N-S and low-angle (<45°) regional axis of stretching (*X* axis). Folding around this axis implies a *ca.* E-W and low-angle direction of shortening (*Z* axis). Such regional *X* and Z axes approximate the pattern of finite strain that would be produced either by a strike-slip deformation or by a strike-slip-dominated, homogeneous (i.e. not or weakly partitioned) transpression or transtension at low to moderate magnitude of strain. The strike-slip explanation being probably irrelevant in the late-Sveconorwegian

context, we propose that transpression is a viable alternative to extension or transtension since this regime can also promote the emplacement of granitoids, as well as the exhumation of deep crustal rocks causing extensional movements.

References

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