Geochemistry of sills from the early stage of the Oslo Rift

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The Oslo Rift is a mildly alkaline, highly magmatic rift formed in the latest Carboniferous to Permian times, as a branch of the Skagerrak Centered Large Igneous Province (Kirstein et al. 2006, Torsvik et al. 2008). Sill intrusions radiometrically dated with large uncertainty to 305–300 Ma (whole rock Rb-Sr) are considered the first magmas emplaced during the prolonged rift activity (up to 50 Myr; Sundvoll & Larsen 1994). Their relation with the first effusive basaltic phase and a line of gabbroic plugs is still unresolved. The sills have been investigated from the 19th century, but they are still poorly studied with modern techniques. We aim at characterizing the sills geochemically, and document their interaction with the host rocks. Due to recent infrastructure developments, spectacular new sections and boreholes have become available. We sampled sills emplaced in Cambrian and Ordovician black shales from new road sections (Jevnaker, Kistefoss), one borehole core (Brevik; Schovsbo et al. 2018), and classic localities (Gran, Slemmestad, downtown Oslo; Scott & Middleton, 1983) covering a 150 km long transect along the Oslo Rift. The sills vary in thickness from decimeters to tens of meters, and in some sections they cumulatively make up over 90% of the stratigraphic thickness. In one quarry section in proximity of a gabbroic plug (Buhammeren), the subvolcanic bodies cross the stratigraphy and form a variety of dykes. The sills range in composition all across the TAS diagram, between lamprophyric (camptonite) and rhyolitic end members. The majority of the sills are alkaline, but the Slemmestad section is entirely tholeiitic. We observe strong local chemical variability in relatively immobile elements such as Ti or REE in the investigated rocks, both within the same locality and among different sampling sites. Tightly defined major and trace element correlations reflect a strong role of fractional crystallization coupled with some crustal assimilation. For example, sills from outcrops sampled downtown Oslo show exclusively evolved compositions, along with evidence of strong crustal assimilation. Local tapping of specific mantle sources is needed to explain some of the observed variation. Future work will focus on clarifying the relationship with the basalt phase through geochemistry and geochronology, and the interaction of the sills with the organic- and sulfide-rich host shales through isotope geochemistry (e.g. $^{187}Os/^{188}Os$), disclosing mechanisms of organic matter maturation and potential hydrocarbon generation. Clarifying the origin and timing of emplacement of these sills will help understanding the magmatic evolution of the Oslo Rift.

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