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The Ioko-Dovyren layered massif (Southern Siberia, Russia): 2. Melt vs sulphide percolation process and modeling sulphide saturation in the parental magmas and original cumulates

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An important feature of the Dovyren intrusive complex [1] is its fertility due to the presence of massive sulphide ores near the bottom of the Ioko-Dovyren massif (YDM, SW and NE margins), as well as PGE-reefs in anorthosites from the Ol-gabbronorite zone in the centre [2]. These observations argue for the importance of downward percolation of sulphides through the porous space of cumulates and probable link of this process with upward migration of intercumulus melts at a post-cumulus stage. Indirectly, this is supported by the basic conclusion on the open-system behavior of the magma chamber [1]. A key aspect of these speculations is the onset of sulphide immiscibility in YDM parental magmas and the original cumulates. To reconstruct the sulphide saturation history, we applied a newly developed sulphide version of COMAGMAT (ver. 5.2 [3]) to the rocks from the chilled zone of YDM and underlying ultramafic sills, by simulating the course of their crystallization coupled with the SCSS calculations. Modeled crystallization trajectories evidence for under-saturated nature of the most primitive parental magmas (1310oC, Fo88) from which the chilled rocks were crystallized, whereas more evolved rocks from the sills demonstrate sulphide saturation starting from their initial temperature (1190oC, Fo85), see [1]. This correlates with the absence of sulphide ores in the central parts of the pluton and their occurrence in underlying ultramafics and YDM border series containing olivine Fo$\sim$85. Another set of calculations was carried out to demonstrate the effect of bulk Ni contents in Ol cumulate piles on the evolution of SCSS during their post-cumulus crystallization [3]. To achieve the goal, two calculations by the COMAGMAT-5.2 model were carried out. The first one involved modelling equilibrium crystallization for an initial mixture of Ol (Fo88) and intercumulus melt ($\sim$1320oC), with the starting composition corresponding to that of a bottom Pl-dunite (2315 ppm NiO, 0.030 wt% S). The second modelling was performed for the initial trapped melt only (517 ppm NiO, 0.067 wt% S), estimated for the primitive Ol orthocumulate. The major difference between these calculations is the onset of modelled sulphide saturation. In the case of “Ol cumulus pile”, the sulphide liquid appears at 1209oC, slightly earlier than plagioclase and pyroxenes start to crystallize. For the “Ol-free magma”, sulphides appear at much lower temperature ($\sim$1173oC) where the Ol-Pl-Opx-Cpx assemblage is stable. This indicates that the presence of a large amount of Ni-enriched Ol crystals should be considered as a “Ni-buffer” which does not allow for Ni content in the trapped melt to decrease significantly, giving rise to earlier precipitation of sulphides as it follows from the pronounced effect of Ni on sulphide solubility discussed in [3].
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[1] Ariskin et al. (2013) This volume [2] Kislov E.V. (1998) The Yoko-Dovyren Layered Massif, Ulan-Ude, 264 p. (in Russian) [3] Ariskin et al. (2012). Abs. 12th Intern. Ni-Cu-(PGE) symp. (China)