Magmatic fractionation and episodic fluid exsolution of the Kymi topaz granite stock, SE Finland: Insights from biotite major and trace element chemistry

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The Kymi monzogranite stock features the chemically most evolved rocks of the 1.65 Ga Wiborg rapakivi batholith. The stock has a well-developed zonation from center to rim, which correlates with the degree of magmatic fractionation. The key rock types are (1) least evolved porphyritic granite (porphyroblasts up to 5 cm and fine-grained matrix), (2) more evolved porphyritic granite (2-3 cm sized prophyroblasts and coarse-grained matrix), (3) equigranular topaz granite, and (4) the marginal stockscheider pegmatite. The well-developed zonation and the presence of abundant miarolitic cavities makes the Kymi stock a perfect target for quantitative studies of magmatic fractionation and fluid exsolution in highly evolved granitic systems. The mineral chemistry of biotites was investigated by EPMA and LA-ICPMS analysis and the data demonstrate clear fractionation trends, which can be explained by progressive magmatic fractionation coupled with episodic fluid exsolution. Biotites are siderophyllite for the porphyry granites and lithian-siderophyllite for the equigranular granite, stockscheider pegmatite and some miarolitic cavities. Fractionation trends within the biotites show increase in Si, Li and Mn content, and decrease in Fe and Mg on M sites. The Na, Rb and Cs concentrations increase towards the most evolved rocks, coupled with decrease of K, Ba and Sr on the I sites. Concentrations of Be, Tl and Zn decrease and those of Mo, Nb, and Ge increase systematically towards the most evolved rocks. The biotites are the main host of indium, and the highest concentrations are present in biotites from more evolved miarolitic cavities. The In concentrations correlate positively with Sn. The Cl/F ratios in biotite decrease systematically along the time sequence. In addition, there are distinct compositional gaps (showing approximately 10 times decrease in Cl/F) between each granite type. The biotites of the miarolitic cavities have Cl/F ratios which plot in between the compositional gaps observed between the three granite types. The more evolved topaz-bearing cavities have compositions similar to the equigranular granite and the stockscheider pegmatite. This suggests that at least three events of fluid exsolution occurred during the magmatic-hydrothermal evolution of the system, which are likely related to the formation of (1) the topaz-bearing cavities, (2) the barren hydrothermal veins and (3) the polymetallic hydrothermal veins.