K- and Si-metasomatism created K-feldspar megacrystic granite in the outer shell of the Vrådal pluton, Telemark, southern Norway

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Abstract Text

Vrådal pluton (967 ± 4 ma) is one of several undeformed Sveconorwegian granitic plutons that intruded the South Telemark Gneiss (ca. 1210 ma) in southern Norway (Sylvester, 1964; 1998; Andersen et al., 2001; 2007). It is a nearly circular pluton, 6 km in diameter, with a central core, about 4 km in diameter, of white and pink granodiorite surrounded originally by a 750-1000 m-wide shell of mafic granodiorite. K-feldspar megacrysts, 2-5 cm long and strongly oriented concentric to the pluton margin, grew metasomatically in the mafic granodiorite, converting it into megacrystic granite. Irregular masses of hybridized diabase comprise 25% of the pluton. Contacts among the rock facies are gradational over meters to tens of meters. Modes of the granitic rocks are as follows: core granodiorite has 40% plagioclase, 35% microcline, 20% quartz, and 5% biotite; outer shell megacrystic granite has 30% plagioclase, 35% microcline, 25% quartz, and 5% biotite; and mafic granodiorite has 45% plagioclase, 10% microcline, 15% quartz, 10% hornblende, and 20% biotite and chlorite. Anhedral titanite and magnetite are so abundant that the pluton constitutes a significant regional magnetic anomaly (Sylvester, 1998). Thin section petrography reveals that K-feldspar slightly to completely replaced plagioclase in the outer shell mafic granodiorite, commonly outward from the plagioclase cores. Myrmekite is locally present. Hornblende and biotite were replaced by quartz, so that the quartz mode increased from 15 to 25%, but some biotite (5%) remains in the megacrystic granite. Ghost plagioclase zoning is preserved in K-feldspar of partly replaced plagioclase crystals. One plane of the microcline grid twinning typically parallels the Carlsbad/albite twinning of the plagioclase. Some megacrysts have secondary oligoclase mantles. Relic plagioclase in the megacrystic granite is partly to intensely micro-fractured, caused, we infer, by synplutonic cataclastic deformation when the pluton's core continued to rise diapirically relative to its almost solidified outer shell. The microfractures were loci of, and pathways for, pervasive fluids containing Si that wholly replaced hornblende as quartz and K that partially and wholly replaced plagioclase to form K-feldspar. Because the K-feldspar megacrysts are 2-4 times larger than the replaced plagioclase, they subsequently grew beyond the boundaries of the original plagioclase and enclosed groundmass minerals. They inherited their concentric preferred orientation from the magmatic flow fabric of primary plagioclase in the mafic granodiorite. Some K for K-feldspar megacrysts came from the breakdown of biotite in the mafic granodiorite, but much K must have come from breakdown of older, felsic, metaigneous rocks in the pluton's source region. Ca released from replaced plagioclase went into titanite. Excess Fe was precipitated in magnetite. Excess Ca and Mg were subtracted from the system.