

Genesis of Pegmatite-Type High-Purity Quartz Deposits in Tysfjord, N Norway

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High-purity quartz (total trace elements < 50 µg/g) is a raw material for the high-tech and low-carbon industries. So far, high-purity quartz is mainly sourced from granites and granitic pegmatites. While granitic pegmatites are common in the crust, those becoming high-purity quartz deposits are very rare. Thus, the genesis of pegmatite-type high-purity quartz deposits remains poorly understood. Tysfjord in N Norway is a tectonic window in Caledonides, exposing granitic gneiss that belong to the Baltica basement. There are more than 30 pegmatites with a Nb-Y-F (NYF) affinity in Tysfjord, which are the globally largest known intra-plutonic NYF pegmatites and produce the world's second-best high-purity quartz. This work summarizes the geology and quartz chemistry of the Tysfjord pegmatites, aiming at improving our understanding on the genesis of pegmatite-type high-purity quartz deposits. The pegmatites formed during two events: Paleoproterozoic (1772–1755 Ma) granitic magmatism and Caledonian orogenic metamorphism (400–379 Ma). The Paleoproterozoic pegmatites, which show strong shearing of the pegmatite bodies and breakdown of pegmatite minerals, formed from highly fractionated melts of the ~1.8 Ga granitic magmatism and were deformed at 410–400 Ma under peak conditions of up to ~12 kbar and ~730 °C during the Caledonian orogeny. In contrast, the well-zoned Caledonian pegmatites are not deformed and formed from anatectic melts during post-collisional extension of the Caledonian belt. We determined the trace element contents of quartz from both groups of pegmatites. Both pegmatite groups have high-purity quartz. The chemistry of quartz from the Paleoproterozoic pegmatites has been modified by the Caledonian metamorphism and became homogeneous via dynamic recrystallization, whereas the chemistry of quartz from the Caledonian pegmatites shows typical primary magmatic signatures and is largely heterogeneous. Our work reveals that both Paleoproterozoic magmatism and Caledonian metamorphism are important for the formation of high-purity quartz deposits within the Tysfjord pegmatites.