Zircon production and modification in the skarns of Skallevikshalsen, East Antarctica, and the role of fluids in Zr mobilisation

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At Skallevikshalsen, an outcrop on the coast of Lutzow-Holm Bay, east Antarctica, distinctive skarns are produced through the interaction of impure dolomitic marbles, pods and adjacent layers of felsic and pelitic gneiss, and fluids or volatile-rich melts associated with granulite-grade metamorphism. Zircon growth is rare in the skarns, but where present has clear associations with metasomatic reaction textures. Euhedral zircon and rutile crystals up to 1mm across are abundantly present in a rare locality, where veins of felsic melt intrude between pelitic gneiss and dolomitic marble. Similar zircon crystals are found in scapolite-chlorapatite-dolomite-zincian spinel pods that, like the veins, are separated from the marble by thick phlogopitic rinds. Oscillatory zoning is characteristic in these zircon crystals, and is modified by low-U growth along fractures, embayments and rims. Subsequent alteration of oscillatory-zoned zircon has produced domains of porous, Ca + Cl enriched zircon. Oscillatory zircon growth is attributed to growth in felsic melt, which synchronously and subsequently reacted with dolomitic marble to produce scapolite-diopside-chlorapatite bearing skarns with cm-thick phlogopitic rinds. The latter contain neoblastic zircon interstitial to blades of phlogopite. These textures were produced by metasomatic reactions involved fluids with high Cl and CO2 activities. Modification and overgrowth of oscillatory-zoned zircon, and deposition of neoblastic zircon in phlogopite zones, can be attributed to the enhanced solubility of Zr in calcic, carbonated brines of high pH, through the formation of ternary Ca-Zr-OH complexes.

Dating of these generations of zircon growth constrain the timing of both melt generation and fluid-controlled metasomatism to the Early Cambrian, consistent with the timing of granulite metamorphism in the Lutzow-Holm Complex. The alteration of oscillatory-zoned zircon to Ca + Cl enriched domains is a much later hydrous event, as it is preceded by metamictisation of U-rich zones through prolonged radiation damage at low temperatures.