

Metasomatic snowball quartz in the Baerzhe REE-Nb-Zr-Be deposit, NE China

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Snowball texture is a term used to describe mainly quartz crystals in highly-evolved rare-metal granites that have a characteristic poikilitic texture, where they enclose albite or, occasionally, aegirine, mica, or cryolite inclusions with a concentric arrangement. The Baerzhe deposit is one of the largest REE deposits in Asia, containing approximately 1.0 Mt of total REE (lanthanides + Y) oxides (TREO), 2.8 Mt of ZrO₂, 300 Kt of Nb₂O₅, and 48,470 t of BeO. The rare-metal minerals occur disseminated throughout an alkaline transsolvolus amphibole granite. Secondary zircon crystals occur individually, or with hematite and ilmenite, and in some cases, astrophyllite, annite, and pyrite, in aggregates that have completely or partially pseudomorphed amphibole crystals. These pseudomorphs occur both inside and outside snowball quartz crystals, whereas REE, Nb, and Be minerals only occur outside snowball quartz. Specifically, REE, Nb, and Be ore minerals occur either in association with hematite and ilmenite, all of which are hosted in large quartz crystals, or have replaced the secondary zircon. In addition, snowball quartz crystals at Baerzhe contain abundant aegirine and albite inclusions and some amphibole relics. In several snowball quartz crystals, some acicular aegirine inclusions have equilibrium boundaries with zircon crystals. These zircon and aegirine crystals are interpreted to have precipitated directly from a fluid during the formation of snowball quartz, rather than through the replacement of amphibole, as occurred in the pseudomorphs.

Zircon in pseudomorphs outside snowball quartz contain less than 1.0 wt. % TREO and lack zoning in BSE images. Zircon in pseudomorphs inside snowball quartz comprise homogeneous, porous crystals, which in some cases have a non-porous zircon overgrowth. The TREO concentrations in the porous crystals are comparable to those in zircon in pseudomorphs outside snowball quartz. The overgrowths on the porous zircon inside snowball quartz, however, contain 3 – 10 wt. % TREO, as do the directly precipitated crystals inside the snowball quartz that is in equilibrium with aegirine. Our data suggest that the snowball quartz at Baerzhe precipitated from a late-stage fluid that contained appreciable amounts of REE and Zr, but lacked Be and Nb, which were added to the system at a later stage.