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Siderite and zirconian pyroxene in the Mt Gibraltar microsyenite, New South Wales, Australia: Late magmatic mineralogy reflecting uncommon crystallization conditions and magma composition.

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The Mt Gibraltar intrusion near Mittagong and Bowral in New South Wales, Australia (lat. 34º37'42"S, long. 150º24'12") is a small intrusive body of hypersolvus alkaline microsyenite emplaced into the Triassic Hawkesbury Sandstone of the Sydney Basin in Jurassic time, possibly related to extensional faulting. The rock itself consists of intermediate alkali feldspar with minor titanomagnetite and interstitial pyroxene ranging from nearly pure hedenbergite to $\approx Hd_{50}Aeg_{50}$ in composition. It is crosscut by an irregular system of veins consisting of homogeneous alkali feldspar ($\approx Ab_{50}Or_{50}$), clinopyroxene evolving from sodic hedenbergite to zirconium-rich aegirine, arfvedsonite and siderite, reflecting highly peralkaline residual liquid compositions formed during in-situ crystallization of the magma. During the final, post-magmatic stage of evolution of the veins, microcrystalline or amorphous silica precipitated together with calcite as fillings in miarolitic cavities. The microsyenite contains up to 3500 ppm Zr, but lacks primary zircon, baddeleyite and alkaline zirconium silicate minerals; zirconium is hosted by pyroxene and to a lesser extent, amphibole.

The late magmatic mineralogy of the rock is a consequence of anomalous physicochemical conditions of crystallization. At a pressure of 700 bars (estimated from geological constraints), a phase assemblage with $Ab_{50}Or_{50}$ + aegirine + arfvedsonite + siderite + hydrous silicate melt would be stable at T=650-670 ºC and log f_{O2}= -22, which is very close to the magnetite-wustite buffer curve. High-Zr pyroxene has a restricted stability field in the system SiO_2-ZrO_2-FeO-$FeO_{1.5}$-$NaO_{0.5}$-$HO_{0.5}$, combining moderately elevated peralkalinity, intermediate silica activity and low oxygen fugacity. Under such conditions, Zr will be incorporated in pyroxene and amphibole, whereas zircon or more exotic Zr silicates will not crystallize.

The Mt Gibraltar microsyenite provides an example of a separate family of alkaline igneous rocks, which are neither "miaskitic" with zircon nor "agpaitic" (s.l.) with alkaline zirconium silicate minerals. The reason for this is the uncommon combination of crystallization conditions and magma composition. Also because of the highly reducing conditions of late magmatic crystallization, the Mt Gibraltar microsyenite provides a rare, possibly unique example of siderite occurring as a member of a magmatic mineral assemblage.

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