Low-Calcium Olivine Crystals in Subduction-Related Magmas: Messengers From the Mantle or the Magma Chamber?

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Subduction-related magma's are complex mixtures of silicate liquid(s) with one or more populations of crystals, which do not need to be related to the liquid in which they are found. Unraveling the origin of different components contributing to arc magmas is a prerequisite to understanding the processes and geochemical components that are involved in their origins.

Our work has focused on olivine- and clinopyroxene-bearing picritic magmas from geographically diverse subduction-related areas (South Sulawesi, Valu Fa Ridge, Solomon Islands, Kamchatka). The magmas' whole rock compositions are high in calcium and magnesium and undersaturated in silica. A significant part of the olivine population has low calcium and high nickel contents, which is at odds with the calcic whole rock composition. The low-Ca olivines contain inclusions of orthopyroxene, which is unstable in Si-undersaturated magma.

Olivine crystals with low Ca and high Ni contents are often interpreted as mantle xenocrysts, but we propose that these crystals have formed in a silica-rich magma with low calcium contents. This interpretation is based on the shape and chemical zoning of the crystals, the composition of included minerals and the presence of melt inclusions. The co-existence within the subduction environment of silica-rich, calcium-poor magmas, documented by these low-Ca olivine crystals, and silica-undersaturated, high-calcium magma's represented by the bulk of the sample, is striking.

It is possible that both magma types represent localised dissolution-precipitation reactions in a shallow magma chamber, as recently proposed for high-calcium magmas by several authors. This, however, does not solve the question as to the origin and fate of the hypothetical, hot (>1250ºC), 'normal' subduction-related magma that caused these localised reactions