P, Cr, and Al zonation in komatiitic olivine

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The nearly ubiquitous presence in magmatic olivines of P zoning, often correlated with Cr and Al [1], suggests that these elements may help to clarify early stages of crystal growth that are otherwise inaccessible due to diffusive reequilibration of the dominant, divalent cations. Here, we describe zoning in olivine from unusually fresh, ~ 90 Ma komatiites of La Isla de Gorgona, Colombia [2, 3]. Komatiites are extreme among magmatic rocks in their ultramafic compositions; they are commonly thought to have high emplacement temperatures and a deep origin.

We mapped Ti, Fe, Cr, Al, and P in 40 olivines from five Gorgona thin sections taken from a jointed flow top, two randomly oriented spinifex zones, and two oriented spinifex zones. Olivines from the jointed flow top are skeletal-to-polyhedral microphenocrysts. The random spinifex zones include chain, branching, and hopper forms; plate olivine dominates the oriented spinifex zone.

Most olivine is normally zoned in Fe; Cr, Al, and P distributions are spatially correlated with each other, but not with Fe; and Cr zoning is preserved even in altered regions where P and Al zoning is absent or obscured. Unlike most igneous olivine [1], Cr zoning in Gorgona olivine is more pronounced than for either Al or P, with P zoning frequently being the weakest, consistent with high whole-rock Cr and low P [3]. Al/Cr slopes from analyses of two olivines are very similar to Hawaiian microphenocrysts (1.7-1.8) but that from a random spinifex zone olivine is lower (0.3), implying a different substitution mechanism; positive Cr intercepts suggest that all Al is associated with Cr but not the reverse.

Microphenocrysts from the jointed flow top are oscillatory and sector zoned in Cr, Al, and P, most containing a single, sub-central, high-P core similar to Hawaiian phenocrysts [1]. Olivine in the random and oriented spinifex zones have a single Cr-rich band or oscillatory zoning parallel to the long axis. The oscillations vary in width (e.g., ~10 to 50 μm) and, occasionally, thin bands diverge at an angle from wider bands, suggesting merged crystals. The Cr-Al-P zoning in and skeletal nature of komatiitic olivine point to rapid crystal growth but this need not mean fast cooling rates.

[1] Milman-Barris, M.M. *et al.* (2008, in press) *CMP*. [2] Kerr, A.C., *et al.* (1996) *Lithos* **37**, 245-260. [3] Kerr, A.C. (2005) *Lithos* **84**, 77-101.

Hydrothermal activity and stromatolite formation in the pre-2.95 Ga record of South Africa

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Stromatolites are a common feature in the late Archaean shallow-marine record and form an integral part of carbonate platform and ramp deposits that are preserved in intracratonic basins and greenstone belts. Stromatolites older than 2.9 Ga are rare, and the same holds true for sedimentary carbonates, suggesting secular changes in ocean chemistry, depositional setting and/or microbial activity. In the Archaean of southern Africa there exist only three occurrences of stromatolites older than 2.9 Ga. These include stromatolite-like structures in 3.3 – 3.4 Ga cherts of the Barberton and Nondweni greenstone belts and c. 2.97 Ga stromatolitic carbonates of the Pongola Supergroup.

Cherts in the Barberton and Nondweni belts represent silicified sedimentary horizon overlying hydrothermally altered volcano-sedimentary successions, with the latter commonly transected by hydrothermal chert veins at the top. Carbonaceous matter is abundant in the cherts, and remains of microfossil-like structures have been described in many studies. In contrast, small, domical and pseudocolumnar structures resembling stromatolites have only been described from a few localities, and their origin is controversial. The precursor rock for stromatolitic chert is unknown, but most silica is replacive and precipitated from syn-depositional emanations of hydrothermally modified seawater, as exemplified, for example, by elevated base metal contents and large positive Eu anomalies in Nondweni stromatolitic cherts. As stromatolites are rare, but seafloor hydrothermal activity was widespread, a direct genetic link between hydrothermal activity and abiogenic/biogenic growth of stromatolite-like structures is uncertain and other, possibly environmental factors may have played a role for stromatolite formation.

Stromatolites of the c. 3.0–2.9 Ga old Pongola Supergroup formed in a large, predominantly shallow-marine basin, but despite the favourable environment, both carbonates and stromatolites are surprisingly rare; only very few, metre-scale stromatolitic dolomite horizons have been described from the volcano-sedimentary Nsuze Group. The thickest unit directly rests on mafic volcaniclastic rocks that are strongly affected by carbonate alteration. This relationship may suggest a strong control of syndepositional alteration of the volcanic substrate to allow for the precipitation of carbonates and the growth of stromatolites in the overlying water column.