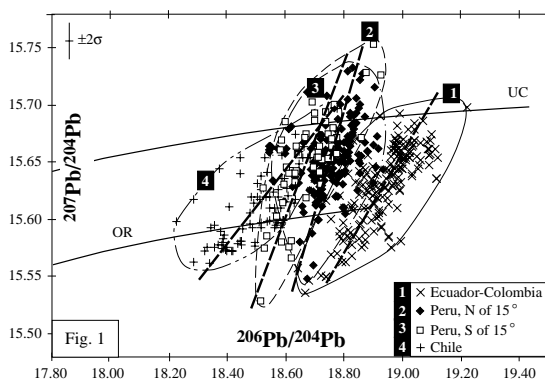


Lead isotope evidence for latitudinal mantle heterogeneity beneath the Andes

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Lead isotope variability of magmatic arc rocks and associated mineralization of the Central Andes is usually considered the result of mixing between a homogeneous mantle and heterogeneous continental crust. About 230 new lead isotope data on the Northern and Central Andes allowed us to compare for the first time lead isotope systematics of the Late Cretaceous-Tertiary arc magmatism and associated mineralization along the Andean chain between 8°N and 40°S. Lead isotope compositions indicate mixing between mantle and upper crustal rocks along the whole Andean chain. Additionally, we have found that mantle end-members of the Late Cretaceous-Tertiary magmatism are heterogeneous and systematically shifted towards less radiogenic $^{206}\text{Pb}/^{204}\text{Pb}$ compositions from north to south along the Andes (Fig. 1). This heterogeneity most likely results from mixing between a low radiogenic mantle, possibly carrying a DMM or EM I component, and a more radiogenic mantle, possibly carrying an HIMU component (Chiaradia and Fontboté, 2002). Subduction (and/or underplating) beneath northern South America of ^{206}Pb -rich mid-Cretaceous oceanic plateaus or, less likely, diffusion of a Mesozoic plume head in northern South America are speculative processes proposed to explain the enrichment of the northern sub-Andean mantle. Our results imply that lead isotope variability of Andean arc magmas at the continental scale is caused not only by crustal but also by mantle heterogeneity.



References

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The influence of ionic strength and magnesium ions on calcite crystal growth morphology

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The influence of ionic strength (I) and magnesium ions on calcite crystal morphology and surface microtopography were investigated by transmission electron microscopy (TEM) and atomic force microscopy (AFM). Calcite overgrowths were precipitated from aqueous $\text{NaCl}-\text{NaHCO}_3-\text{CaCl}_2-\text{MgCl}_2$ solutions on reagent grade calcite seed powders and millimeter-size cleavage fragments in a chemo-stat system at 25°C for up to 6 days. Aliquots of reacting solutions were sampled regularly for analysis and the suspended seeds were separated for the preparation of Pt-C replicas and TEM imaging. Most cleavage fragments were recovered at the end of the experiments for AFM imaging.

In all experiments, the euhedral $\{10\bar{1}4\}$ rhombohedron of calcite seeds is modified at the same corners and edges within 24 hours of growth. In magnesium-free and low saturation state ($\Omega=1.2-1.6$) solutions, the new crystal morphology comprise the same combinations of the $\{10\bar{1}4\}$, $\{02\bar{2}5\}$, and $\{10\bar{1}1\}$ rhombohedra at different ionic strengths (0.13 and 0.69 m) but the steep $\{02\bar{2}5\}$ rhombohedron gains in importance in I=0.69 solutions. Each form develops a distinct microtopography: $\{10\bar{1}4\}$ faces develop growth spiral in most solutions, but step bunching and curving is more pronounced at I=0.69 m. $\{02\bar{2}5\}$ faces display meandering steps, small growth mounds and domains of straighter $\langle 2\bar{2}1 \rangle$ steps. $\{10\bar{1}1\}$ surfaces feature straight $\langle 010 \rangle$ steps and step separation narrows at I=0.69m.

At I=0.69 m, $[\text{Mg}^{2+}]/[\text{Ca}^{2+}]=1$, the corners of $\{10\bar{1}4\}$ seed rhombohedra soon develop curved and complex faces approximately indexed as $\{01\bar{1}5\}$, which give way to $\{02\bar{2}5\}$ faces that dominate after growth for 72 hours. $\{10\bar{1}4\}$ faces persist but become the least important in relative area. Noticeably, stepped $\{11\bar{2}0\}$ prismatic faces develop exclusively in Mg-bearing solutions and disappear after 72 hours of growth. As the $[\text{Mg}^{2+}]/[\text{Ca}^{2+}]$ ratio increases from 1 to 5, so does the saturation state (from $\Omega=2.75$ to 6.4) to maintain a fixed precipitation rate. Seed crystals do not develop new faces. Mosaics of rounded islands cover the $\{10\bar{1}4\}$ surfaces of calcite seeds and cleavage fragments, suggesting growth by the birth and spread mechanism.

The present study shows that an increase in ionic strength to seawater-like value, and $[\text{Mg}^{2+}]/[\text{Ca}^{2+}]=1$, enhances the morphological importance of $\{02\bar{2}5\}$ relative to other forms. At a seawater-like $[\text{Mg}^{2+}]/[\text{Ca}^{2+}]$ ratio, magnesium ions inhibit growth on $\{10\bar{1}4\}$ more strongly and modify the growth mechanism.