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# Origin of crystals in mafic to intermediate magmas from circum-Pacific continental arcs: transcrustal magmatic systems versus transcrustal plutonic systems

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Complex zoning in crystals is characteristic for arc magmas and occurs in response to closed-system changes in magmatic P-T-$fO_2$ conditions and open system processes such as magma mixing and degassing or regassing. However, over which time frame do such changes occur? Do zoning patterns record changes occurring during the polybaric ascent of magmas that carry the crystals, or alternatively indicate the uptake of antecrysts that experienced long periods of cold storage in plutonic precursors? A priori, these scenarios are endmember models, with the former transcrustal magmatic systems, where the crystals record the changing conditions during magma ascent, traditionally preferred over the latter, which we here term transcrustal plutonic systems, where aphyric parental melts acquire their entirely antecrystic crystal cargo during ascent from plutonic protoliths, and where only crystal rims may be related to the host magma. We discuss the evidence for dominantly plutonic antecrystic cargo in some continental arc magmas, identified by considering mineral phase proportions and evidence for hydrothermally altered cargo picked up by fresh melts. We then turn to two-pyroxene thermobarometry and review the evidence for plutonic antecryst dominance revealed by this method in SW Japan and the southern Taupo Volcanic Zone. We provide additional data from the Andes, the Cascades, and northern Taiwan, corroborating that the uptake of crystals by aphyric to scarcely phyric melts is prevalent in continental arc magmatic systems. Thus, in many cases transcrustal plutonic systems seem to dominate, implying that a significant proportion of parental melts of continental arc magmas are felsic, too hot to carry crystals, and typically too hot and not hydrous enough to be generated by differentiation in frequently postulated lower crustal hot zones, as we will demonstrate. Our data indicate that in continental subduction zones, the mantle wedge is the source of a diversity of melt compositions, irrespective of the age and temperature of the subducting slab. We discuss the implications of the prevalence of non-canonical transcrustal plutonic systems for the thermal structure of the crust, magma ascent processes, volcano monitoring, economic geology, as well as the evolution of continental crustal growth and recycling through time.