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Insights into magma storage and requilibration from hornblende thermobarometry

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Understanding the mechanisms that control the storage and assembly of subvolcanic and plutonic magma reserviors in the crust is key to understanding processes ranging from volcanic hazards to the formation and evolution of the continental crust on our unique planet. However, conventional case studies hardly allow us to see the full picture of this problem. Here, we apply statistical geochemistry, compiling and analyzing a dataset of hornblende-bulk rock pairs from global arc-derived igneous rocks. In conjunction with pressures inferred from geochemical thermobarometry, we integrate information on the pressure, temperature, and chemical composition of magma reservoirs. We find that the calculated melt from plutonic rocks in equilibrium with hornblende is more evolved than the bulk composition relative to volcanic rocks, and that volcanic rocks have higher average crystallization temperatures than plutonic rocks at a given depth. We argue that what causes these observations is the continual re-equilibration of hornblende in plutonic rocks with residual melt during incremental emplacement and storage, rather than melt extraction. Our results support a view of crustal magma systems as sites of long-term geochemical reequilibration, and further contextualize the process of magmatic differentiation at crustal scale.