What can basalts tell us about the evolution of a rifted continental arc?

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The Taupo Volcanic Zone (TVZ) is a rifted volcanic arc, and one of the most productive silicic magmatic systems in the world. Basalts in the TVZ contain unique mineral assemblages, indicative of separate storage, and comprise <0.1% of the total erupted volume. Despite their scarcity at the surface, basalts provide valuable snapshots into portions of the deeper magma plumbing system, and hence give insights into the drivers of silicic magma genesis.

Crystal specific oxygen isotopes combined with textural analysis reveal the nature of the mafic plumbing system. By assessing crystal-crystal and crystal-melt oxygen isotope equilibria, we are able to establish the relative timing and amount of crustal assimilation in mafic magmas. We find that eruptions from the south are dominated by mafic cumulates of olivine ± orthopyroxene mantles, oscillatory zoned clinopyroxene crystal clots and are generally plagioclase poor. Eruptions further north are overprinted by shallow crustal mineral assemblages and by interaction with rhyolite crystal mushes. Oxygen isotopes of mafic phases from the north overlap entirely with those from the south. We infer the crystal cargoes from the south hold clues to the early conditioning of the crust beneath the TVZ, prior to the dominance of rhyolitic volcanism that is synonymous with the maturation of the arc. We suggest that mafic underplating dominates the lower crust and recharge of primary mantle melts remobilises crystal cumulates. Eruptions that are plagioclase dominant have stalled in the mid-upper crust, before subsequent fault-controlled ascent, whereas eruptions that are plagioclase poor are sourced directly from the area of underplating.