The "Andesite Model" of Continental Crust origins

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In the latter part of the 1960s, Ross Taylor [1, 2] proposed the "andesite model" for the origins of continental crust on the basis of similarities between "calc-alkaline" [3] or orogenic andesite and the bulk composition (~60 wt% SiO_2) of this crustal type. Subsequent studies [4] have substantiated Taylor's estimate of continental crust bulk composition, and have noted distinctive trace element fractionations (high U/Nb, low Ce/Pb) only found in supra-subduction zone magma types [5]. During the 1970s, despite the wave of petrologic enthusiasm inspired by the plate tectonic paradigm, it became apparent that andesite is generally not a primary subducted slab- or mantle wedge-derived magma in island arcs, but overwhelmingly a derivative rock type from parental basaltic magmas [6]. The mass balance of andesite + ultramafic-mafic cumulate (UMC) = basalt necessitates disposal of the complementary UMC, and is an acute problem for Phanerozoic arc systems. However, the possibility remains of primary (high-Mg) andesite magmas in the Archean, generated from hot and young subducted lithosphere. Modern seismically-determined arc crustal profiles while confirming bulk andesite intra-oceanic arc compositions for the Izu-Bonin-Mariana system [7], also indicate a solution to the UMC disposal problem: the critical characteristic of cumulates from relatively wet (~2 wt% H_2O) arc magmas is the delayed crystallisation of plagioclase and the likely sub-Moho predominance of dunites and wehrlites [8]. These cumulates are likely protoliths for ankaramitic magmas in arcs and generally become entrained in asthenospheric wedge recycling [9]. The low La/Yb of high mass flux intra-oceanic arc magmas is a Phanerozoic dilutant of preexisting high La/Yb continental crust in crustal evolution. Overall, a modified andesite model is still consistent with observed features of the continental crust.

References

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