Manufacturing and recycling crust in oceanic subduction systems of the southwest Pacific: processes and timescales

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Formation of the Earth's earliest evolved crust is interpreted to have involved processes similar to those taking place at today's active convergent margins. The closest approximation to the simple plate tectonics of the early Earth is found at the margins of ocean basins where thin plates of oceanic lithosphere are converging. Although average continental crust is broadly andesitic in composition, current models predict that in intra-oceanic arcs the magmatic material added to the crust should be dominantly basaltic. However, as oceanic arcs are more extensively explored, it is becoming obvious that silicic rocks such as dacite and rhyolite are much more common in these systems than previously supposed.

In the Tonga-Kermadec arc magmatism is driven by the subduction of the Pacific plate beneath the Australasian plate; no continental crust is involved. Although the volcanoes of the arc are fundamentally basalt to basaltic andesite, magmatic activity during the past ~10ka has been dominated by eruption of silicic magmas. Thermal modelling of the evolution of the arc suggests that with time, progressive geochemical maturation and thickening of the crust together with transfer of heat from the mantle by underplating and multiple intrusion of mafic magmas will inevitably lead to dehydration melting of the lower crust and the production of silicic magmas. Timescales involved in these processes are of the order of 1 ma. Similar models probably also apply in continental arcs.