# The role of oceanic arcs and arc collisions in the evolution of continental crust

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Formation and evolution of continental crust is a fundamental problem in Earth science that remains incompletely understood. Although new melts form at oceanic island arcs, and although arc magmatism shares some geochemical characteristics with continental crust, it is unclear exactly how the commonly mafic composition of arc magmatism acquires the intermediate silica content and light-rare-earth-element enrichment of bulk continental crust. Scientists' understanding of intra-oceanic arc composition is far from complete, owing to the difficulty of accessing and sampling modern oceanic arcs at depth. Though incomplete knowledge of oceanic arc crust may partly explain the apparent disparity between arc and continental composition, it has also been proposed that the process of arc-continent collision, whereby oceanic arc terranes accrete onto continents to become incorporated into continental crust, alters the arc magmatic composition and produces more continental-type melts.

Geologic and geochemical effects of arc-continent collision vary according to the geometry of collision, with substantial differences resulting from forward-facing collision (in which the arc, on the upper plate, meets a passive continental margin) vs. backward-facing collision (in which the arc, on the lower plate in one of two subduction zones, backs into an active continental margin). Modern examples of forward-facing collision occur at Taiwan and the eastern Banda Arc. Ancient examples exist in the geologic record of the Urals (Devonian), Appalachians-Caledonides (Ordovician), and New Caledonia (Tertiary). Examples of backward-facing collision include the Jurassic Talkeetna Arc of Alaska and the Cretaceous Kohistan Arc. In forward-facing collision, it has been demonstrated (using the Ordovician Lough Nafooey - South Mayo - Tyrone arc terrane in Ireland) that magmatism during collision can be highly enriched, more enriched even than the continental composition with which arc melts mixed. Collisional magmas there underwent enough crystal fractionation to generate highly enriched melts over a wide spatial scale, which could drive the bulk composition of accreted crust toward continental values. In contrast, arc terranes such as Talkeetna and Kohistan that accreted by backward-facing collision with an active margin did not produce such enriched syn-collisional magmatism. The composition of accreted materials in ancient arc terranes also will depend on the prevalence of tectonic erosion vs. accretion in the oceanic arc, and can be temporally biased toward the latest stages of arc activity.

The proposed deep drilling into the Izu-Bonin-Mariana (IBM) arc will provide an unprecedented opportunity to sample unaltered middle-crustal material thought to be an important building block of continental crust. Because site IBM-4 will sample a region of intermediate mid-crustal plutons, this will improve understanding of oceanic arc crustal composition prior to interaction with continent-derived melts. It is likely that the origin of continental crust involves some combination of evolved oceanic arc magmatism prior to collision and also the generation of enriched melts (and loss of lower-crustal cumulates) during arc-continent collision.