Geophysical Research Abstracts
Vol. 17, EGU2015-2040, 2015
EGU General Assembly 2015

Origin of ophiolite complexes related to intra-oceanic subduction initiation: implications of IODP Expedition 352 (Izu-Bonin fore arc)

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Ophiolites, representing oceanic crust exposed on land (by whatever means), are central to the interpretation of many orogenic belts (e.g. E Mediterranean). Based mostly on geochemical evidence, ophiolites are widely interpreted, in many but by no means all cases, as having formed within intra-oceanic settings above subduction zones (e.g. Troodos ophiolite, Cyprus). Following land geological, dredging and submersible studies, fore arcs of the SW Pacific region became recognised as likely settings of supra-subduction zone ophiolite genesis. This hypothesis was tested by recent drilling of the Izu-Bonin fore arc. Four sites were drilled, two on the outer fore arc and two on the upper trench slope. Site survey seismic data, combined with borehole data, indicate that three of the sites are located in fault-controlled sediment ponds that formed in response to dominantly down-to the-west extensional faulting (with hints of preceding top-to-the-east compressional thrusting). The sediments overlying the igneous basement, of maximum Late Eocene to Recent age, document ash and aeolian input, together with mass wasting of the fault-bounded sediment ponds. At the two more trenchward sites (U1440 and U1441), mostly tholeiitic basalts were drilled, including massive and pillowed lavas and hyaloclastite. Geochemically, these extrusives are of near mid-oceanic ridge basalt composition (fore arc basalts). Subtle chemical deviation from normal MORB can be explained by weakly fluid-influenced melting during decompression melting in the earliest stages of supra-subduction zone spreading (not as 'trapped' older MORB). The remaining two sites, c. 6 km to the west (U1439 and U1442), penetrated dominantly high-magnesian andesites, known as boninites, largely as fragmental material. Their formation implies the extraction of highly depleted magmas from previously depleted, refractory upper mantle in a supra-subduction zone setting. Following supra-subduction zone spreading, the active modern arc formed c. 200 km westwards of the trench. The new drilling evidence proves that both fore arc-type basalt and boninite formed in a fore arc setting soon after subduction initiation (c.52 Ma). Comparisons with ophiolites reveal many similarities, especially the presence of fore arc-type basalts and low calcium boninites. The relative positions of the fore arc basalts, boninites and arc basalts in the Izu Bonin and Mariana forearc (based on previous studies) can be compared with the positions of comparable units in a range of ophiolite complexes in orogenic belts including the Troodos, Oman, Greek (e.g. Vourinos), Albanian (Mirdita), Coast Range (California) and Bay of Islands (Newfoundland) ophiolites. The comparisons support the interpretation that all of the ophiolites formed during intra-oceanic subduction initiation. There are also some specific differences between the individual ophiolites suggesting that ophiolites should be interpreted individually in their regional tectonic settings.