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Magmatic Imprint of Subduction Initiation in the Phanerozoic Ophiolite Record

Yildirim Dilek (1) and Harald Furnes (2)

(1) Miami University, Geology, Oxford, United States (dileky@muohio.edu, 1-513 529-1542), (2) Department of Earth Science & Centre for Geobiology, University of Bergen, 5007 Bergen, Norway

Most of the suprasubduction zone (SSZ) ophiolites in Phanerozoic orogenic belts display geochemical signatures and a structural architecture, indicating a seafloor spreading origin in forearc-incipient arc settings during the early stages of subduction. The magmatic stratigraphy in the extrusive sequences of these ophiolites generally shows a progression from older MORB-like lavas at the bottom towards younger island arc tholeiite (IAT) and boninitic lavas in the upper parts. A similar progression of the lava chemistry also occurs in crosscutting dike swarms and sheeted dikes, indicating increased subduction influence in the evolution of ophiolitic magmas through time. In the subduction initiation stage, magma is first produced by decompressional melting of deep and fertile lherzolitic mantle and produces the earliest crustal units with MORB-like compositions. Fluids derived from the subducted slab have little influence on melt evolution at this early stage. Lherzolitic peridotites in structurally lower parts of the upper mantle sequences of these ophiolites represent the residue after MORB melt extraction. The subsequent phases of melting are strongly influenced by slab dehydration and related mantle metasomatism, melting of subducting sediments, repeated episodes of partial melting of metasomatized peridotites and mixing of highly enriched liquids from the lower fertile source with refractory melts in the melt column beneath the extending protoarc-forearc region. Harzburgite and harzburgite-dunite associations higher up in the mantle sequences and below the mafic-ultramafic cumulates (transitional Moho) are crosscut by networks of orthopyroxenite (opxt) veins, which include hydrous minerals (amphibole). These orthopyroxenite veins represent a reaction product between the host harzburgite (depleted, residual peridotite) and the migrating Si-rich (boninitic) melt. The harzburgite-dunite-opxt suites characterize melt-residue relationships and melt migration patterns in the mantle wedge during the initial stages of subduction and incipient arc construction. The lateral and vertical progression of melt evolution in the crustal and upper mantle components of SSZ ophiolites traces different stages of subduction initiation-related magmatism, reminiscent of the forearc magmatism in some of the modern arc-trench rollback systems as in the Izu-Bonin-Mariana and Tonga-Kermadec subduction factories. The along-strike continuity for more than 1500 km of this well-documented chemostratigraphy and geochemical progression in different ophiolite belts is strong evidence for subduction initiation followed by rapid slab rollback in ancient ocean basins.