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Ophiolite Generation and Emplacement in Subduction Rollback Systems

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Suprasubduction zone (SSZ) ophiolites in orogenic belts represent oceanic crust generation in subduction rollback cycles during the closing stages of basins prior to terminal continental collisions. Oceanic lithosphere created at mid-ocean ridges is generally recycled back into the mantle via subduction, and only rarely do fragments of this MOR lithosphere become accreted into continental margins (ridge-trench collision, accretion margin tectonics). Mantle flow and slab rollback may result in one or more episodes of arc splitting and basin opening, producing a collage of 'proto-arc and forearc oceanic lithosphere' in suprasubduction zone settings. SSZ Tethyan ophiolites generally have Penrose-type oceanic crust and contain well-developed sheeted dike complexes indicative of magmatic extension beneath narrow rift zones during their seafloor spreading evolution. Igneous accretion of these SSZ Tethyan ophiolites involved upper plate extension and advanced melting of previously depleted asthenosphere in host basins, showing a progressive evolution from MORB-like to IAT (island arc tholeiite) to boninitic (extremely refractory) proto-arc assemblages. The IAT and boninitic magmas were derived from depleted peridotites that had already experienced previous MORB-type melt extraction during the early stages of ophiolite formation in the Tethyan subduction rollback systems. Rapid slab rollback and associated extension in the arc-forearc region caused increasing asthenospheric diapirism and corner flow toward the forearc mantle, resulting in shallow partial melting of the highly refractory harzburgites producing boninitic magmas. Differences in the geochemical evolution of Tethyan ophiolites resulted from variations in their subduction zone geodynamics. The production of increasingly more calc-alkaline rocks in the later stages of the generation of some Tethyan ophiolites suggests higher sediment input into the melting regimes via subduction and hence a longer period of subduction and arc maturity during their SSZ evolution. Emplacement of SSZ ophiolites onto rifted continental margins, particularly in the Tethyan realm, was a result of trench–continent collisions, followed by continental underplating, blueschist metamorphism, and slab breakoff in the downgoing plate.