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Characteristics and Tectonic Significance of Subduction Initiation Ophiolites

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Since the 1984 publication on 'the characteristics and tectonic significance of supra subduction zone (SSZ) ophiolites', it has become even more apparent that subduction initiation ophiolites are much the most significant sub-group of the SSZ category. In 1984, an absence of in situ analogues restricted our understanding of this ophiolite type. However, thanks, in particular, to several ocean drilling expeditions in the subduction initiation type localities of the Western Pacific and to better plate tectonic reconstructions, there is now a much-improved knowledge of the process of sea-floor spreading associated with post-subduction slab rollback and of the geochemical characteristics of the resulting oceanic crust and mantle lithosphere. Here, I review, and present new information on, methodologies for the recognition and detailed interpretation of subduction initiation ophiolites in the geologic record based on mineral and whole rock compositions from top to bottom of the ophiolite structure. Optimum characterization needs to be based not just on single-setting compositions but also on the MORB-through-boninite evolution that characterizes lava chemostratigraphies, cross-cutting dyke geochemistry, cumulate petrochemistry and residual mantle spinel compositions. In terms of Earth evolution, subduction initiation ophiolites assist plate reconstructions by, for example, providing ages for ocean closure and for the regional and global tectonic drivers that elicit subduction initiation responses – such as continent collisions and continent breakup events. There are good examples within all major Phanerozoic and Neo-Proterozoic orogenic belts, but these become sparse by the start of Rodinia breakup, with perhaps only two good >800 Ma examples: the 1.02Ga East Sayan Belt in Southern Russia marking the start of CAOB evolution and some 1.9 Ga Northern Manitoba lavas, which mark the start of closure of the Manikewan Ocean. Whether the paucity of subduction initiation ophiolites in the Meso-Proterozoic and prior to 2 Ga is due to a lack of plate tectonics in these periods, a lack of discovery or preservation, or a lack of sufficient slab rollback in a hotter Earth is unresolved at present, as is the question of whether the small, highly deformed and metamorphosed Early Earth outcrops in Isua and Nuvvuagittuq do have a subduction initiation, ophiolitic character.