Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38078

Birth and death of an ocean: close spatial association of records of rifting and convergence along the Laurentian margin of the Iapetus Ocean

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The cyclic opening and closing of ocean basins described by the Wilson Cycle is an enduring paradigm within plate tectonics. However, the processes responsible for the transition of continental margins from passive to active remain cryptic; of particular note, the passive margin collapse stage of the Wilson Cycle has proven difficult to reproduce in numerical models. Subduction initiation in the Iapetus Ocean is recorded in a belt of Cambro-Ordovician supra-subduction zone ophiolites (SSZs) that decorate the Laurentian margin along the Appalachian–Caledonian mountain belt. Three of these ophiolites – the Karmøy and Leka Ophiolites of Norway and the Unst Ophiolite of the Shetland Archipelago, UK – are spatially associated with the enigmatic mafic–ultramafic complexes (MUMCs) of the Vikingstad, Storøya, and Dunrossness Formations, respectively. Metabasalts from these complexes are geochemically distinct from those found in the ophiolites, with uniform enrichment in high-field-strength elements and a pronounced, negative slope across the light rare-earth elements (LREEs) relative to N-MORB. Faceted, wafer-like detrital zircons from metasediments within the Dunrossness Formation yield U-Pb ages of c. 580 Ma that we interpret to date syn-sedimentary volcanism. The geochemical and geochronological evidence suggests the MUMCs were emplaced during Ediacaran rifting of Rodinia to form the Iapetus Ocean and were later structurally juxtaposed with the Caledonian SSZ ophiolites. The repeated structural association among igneous complexes recording rifting and subduction initiation may suggest that Cambro–Ordovician convergence within the Iapetus Ocean was seeded close to or within the passive margin. The SSZ ophiolite–MUMC association along the Laurentian margin of the Caledonian Orogen may be evidence of the passive margin collapse hypothesis of the Wilson Cycle.