Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33362

A gradual Proterozoic transition from an Unstable Stagnant Lid to the modern Plate Tectonic system, and the destruction of fossil Archean oceanic lithosphere to form Proterozoic anorthosite massifs

JEAN H.J. BÉDARD[1] AND FÉLIX GERVAIS[2]

[1]Geological Survey of Canada
[2]Polytechnique Montreal

An Unstable Stagnant Lid model for the Archean Earth is proposed. Mantle overturns rework the lithosphere and generate large-scale currents that caused continental drift and Kenoran-style accretionary orogenesis despite the absence of subduction. The Abitibi Greenstone Belt is interpreted as a narrow oceanic tract developed behind a detached ribbon-continent during partial breakup of the Southern Superior craton in response to Neoarchean mantle overturn. The Abitibi has ~50 km of apparent stratigraphic thickness with 2-10 My mafic-felsic bimodal volcanic cycles. Archean Style Oceanic Lithosphere (ASOL) would be difficult to subduct because of its weakness and buoyancy. The Archaean/Proterozoic boundary reflects near-global emergence from the water of stiffening granitic continents. Albeit associated with continent-derived siliciclastic debris, Paleo-Proterozoic igneous rocks resemble Archaean ones geochemically. The Siderian-Rhyacian *Quiet Period* could be a Stagnant Lid phase that followed the 2.5 Ga mantle overturn. When the next mantle overturns ruptured the lid at ~2.2-2.0 Ga (and again at ~1.9-1.8 Ga), continents were set into motion, forming the oldest documented arcs and ridges. However, most of Earth at 2.0 Ga was probably still largely covered by ASOL. Where did it all go? Voluminous anorthosite-mangerite-charnockite-granite/gabbro suite rocks (AMCG) are mostly of Proterozoic age, requiring either an ephemeral source, or a unique process. Partial melting of mafic rocks was simulated by phase equilibria modeling for pressure-temperature conditions slightly deeper (~1.7 GPa at 850-1000 ^{o}C) and hotter than that recorded in Grenvillian lower crust during the main anorthosite emplacement phase (1.18-1.14 Ga). Results show that representative Archean basalts could have melted to high degree (20-32%) with abundant residual garnet (30-40%) and no residual plagioclase. Calculated model melts from ASOL sources yield trace element signatures that closely match those of model melts calculated from anorthosite massifs. In contrast, basalts from modern environments stabilize residual plagioclase to higher pressures, with less garnet in the residue, and do not generate as much melt. The Proterozoic would thus have combined the conditions required for the emplacement and destruction of hot ASOL slabs or masses underthrust below the base of the crust, where the temperature was high enough to generate the melts parental to anorthosites.