On the origin of OIB: Processes, sources and mantle convection

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Consideration of global OIB datasets [1, 2] suggests that oceanic lithosphere thickness variations (or the *lid effect*) exert the primary control on OIB chemistry on a global scale. The effect of the 'lid' is to cap the final depth (pressure) of melting or melt equilibration, but this does not unequivocally record the initial depth/temperature of melting, suggesting that caution is necessary when extracting initial mantle melting conditions from oceanic basalts. The high quality data on olivine phenocrysts from MORB and global OIB suites [3] are fully consistent with the *lid effect*. Subducted ocean crust (SOC) is too depleted (i.e. $[La/Sm]_N$ <1) to be a source material for highly enriched (e.g. $[La/Sm]_N$ >>1) OIB. Signals of continental sediments are reported for some OIB, but there is no convincing evidence for their significance on a global scale. OIB sources are more enriched than the primitive mantle, and enriched in the progressively more incompatible elements, requiring that OIB sources be pre-enriched by low-*F* melt metasomatism. The lithosphere-LVZ interface represents a natural solidus and is the ideal site for such metasomatism. The ~ 70 Myr history of oceanic lithosphere growth to its full thickness is the history of mantle metasomatism, signifying the deep portion of the oceanic lithosphere as an important enriched geochemical reservoir. The metasomatic agent is H_2O-CO_2-rich silicate melt of LVZ origin. The 'coincidence' between the lithosphere base as an isotherm (geophysical) and the solidus (petrological) indicates that this is a wet (H_2O-CO_2-rich) solidus with a slope of $dT/dP \approx 0$ at depths < 90 km. A solidus topology change at ~ 90 km, with a local slope of $dP/dT \approx 0$, if verified, explains why the old (> 70 Ma) oceanic lithosphere cannot be thicker than ~ 90 km. SOC is > 3.0% denser than PREM, and the two LLSVPs at the base of the mantle beneath the Pacific and Africa are probably piles of SOC accumulated since plate tectonics began on Earth. Subducted mantle lithosphere (SML, ~ 15 times the mass of SOC) is buoyant relative to PREM and may overlie the LLSVPs, explaining the surface topographic highs of the Pacific superswell and African continent. SML is also the best fertile source material candidate for OIB.

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Continental crust growth as a result of continental collision: Ocean crust melting and melt preservation

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The significance of the continental crust (*CC*) on which we live is self-evident. However, our knowledge remains limited on its origin, its way and rate of growth, and how it has acquired the 'andesitic' composition from mantle derived magmas. Compared to rocks formed from mantle derived magmas in all geological environments, volcanic arc rocks associated with oceanic lithosphere subduction share some common features with the *CC*; both are relatively depleted in 'fluid-insoluble' elements (e.g. Nb, Ta and Ti), but enriched in 'fluid-soluble' elements (e.g. U, K and Pb). These chemical characteristics are referred to as the 'arc-like signature', and point to a genetic link between subduction-zone magmatism and *CC* formation, thus leading to the 'island arc' model widely accepted for the origin of *CC* over the past 40 years. However, this 'Island-arc' model has many difficulties. These include (1) bulk arc crust (*AC*) is basaltic whereas the bulk *CC* is andesitic [1]; (2) *AC* has variably large Sr excess whereas the *CC* is Sr deficient [2]; and (3) *AC* production is mass-balanced by subduction-erosion and sediment recycling, thus contributing no new mass to *CC* growth, at least in the Phanerozoic [3, 4]. Our data on magmatic rocks (both volcanic and intrusive) formed during the India-Asia continental collision (~55±10Ma) show remarkable compositional similarity to the bulk *CC* with the typical 'arc-like signature' [5]. Also, these syncollisional felsic rocks exhibit strong mantle isotopic signatures, meaning that they were recently derived from a mantle source. The geochemistry of these syncollisional felsic rocks is most consistent with an origin via partial melting of upper oceanic crust (i.e. last fragments of underthrusting oceanic crust) under amphibolite facies conditions, adding net mantle-derived materials to form juvenile *CC* mass. This leads to the logical and testable hypothesis that continental collision *produces* and *preserves* the juvenile crust, and hence maintains net continental growth.

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