



## Constraints on the creation of a HIMU-Like isotopic reservoir beneath New Zealand

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## Triple oxygen isotope composition of photosynthetic oxygen and dissolved oxygen at saturation

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The measurement of biological production rates is essential for our understanding how marine ecosystems are sustained and how much CO<sub>2</sub> is taken up through aquatic photosynthesis. Traditional techniques to measure marine production are laborious and subject to systematic errors. A new biogeochemical approach based on triple oxygen isotope measurements in dissolved oxygen (O<sub>2</sub>) has been developed over the last few years, which allows the derivation of gross productivity integrated over the depth of the mixed layer and the time-scale of O<sub>2</sub> gas exchange [1]. This approach exploits the relative <sup>17</sup>O/<sup>16</sup>O and <sup>18</sup>O/<sup>16</sup>O isotope ratio differences of dissolved O<sub>2</sub> compared to atmospheric O<sub>2</sub> to work out the rate of biological production. Two parameters are key for this calculation: the isotopic composition of dissolved O<sub>2</sub> in equilibrium with air and the isotopic composition of photosynthetic oxygen. Recently, a controversy has emerged in the literature over these parameters [2] and one of the goals of this research is to provide additional data to resolve this controversy. In order to obtain more information on the isotopic signature of biological oxygen, laboratory experiments will be conducted to determine the isotopic composition of oxygen produced by different phytoplankton species. In addition, the isotopic composition of dissolved oxygen at saturation will be measured under different temperature and salinity conditions.

[1] Luz & Barkan (2000) *Science* **288**, 2028–2031. [2] Kaiser (2011) *Biogeosciences* **8**, 1793–1811.

## Constraints on the creation of a HIMU-like isotopic reservoir beneath New Zealand

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The New Zealand microcontinent (Zealandia) formed as the active eastern margin of Gondwana. Upon cessation of subduction at ~110 Ma, extension led to opening of the Tasman Sea at 82 Ma, preceded by the formation of metamorphic core complexes, the opening and filling of half-graben structures and the intrusion of mafic dikes (~88 to 68 Ma). Subsequently, Zealandia has been punctuated by volumetrically minor, intermittent yet widespread intraplate magmatism from ~100 Ma through to recent times. This magmatism has typical OIB-like trace element abundances and radiogenic isotope compositions that trend towards a HIMU (high time integrated U/Pb) end member mantle composition. Recent publications have argued that the intraplate OIB-like magmatism is not related to a mantle plume but is rather formed by delamination of mantle lithosphere, replacement by asthenosphere and associated partial melting. The variably diluted HIMU signature is interpreted to be the result of mixing between depleted mantle bearing a HIMU component with an Enriched Mantle or continental crust component.

New geochemical and isotopic analyses suggest the dike swarms also have an OIB-like chemistry. Initial Pb isotopic compositions of the dikes however are more similar to Pacific MORB. It is possible that the HIMU-like component in Zealandia is a result of trace element enrichment (with high U/Pb and Th/Pb) of a depleted mantle melt region in the Cretaceous. This source has remained stable beneath Zealandia while Pb ingrowth proceeded rapidly in U-Th rich domains. Repeated melt extraction from this source resulted in the intraplate magmatism with HIMU-like Pb isotopes. Isotopic data from peridotite xenoliths in the Cenozoic intraplate volcanoes reveal that the spinel facies lithospheric mantle beneath Zealandia also has high <sup>206</sup>Pb/<sup>204</sup>Pb ratios. Lithospheric peridotite mantle is a potential source component for the intraplate basalts, which require an additional garnet rich source component.