# Expansion of the northeast Pacific oxygen-minimum zone since 1995? Sediment N-isotope evidence from Soledad Basin, Baja California

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Pronounced gradients in the N-isotopic composition of nitrate along the west coast of North American reflect the combined effects of denitrification within a strong oxygen-minimum zone (OMZ) and advection. Since the N-isotopic composition of organic matter preserved in the sediment is related to the isotopic composition of nitrate, sediment cores can be used to reconstruct past variations in the intensity of the oxygen-minimum zone. A particularly promising location is Soledad Basin, a suboxic basin located 20 nm west of southern Baja California, where sediment has been accumulating without bioturbation at a rate of ~1 m/kyr for the past 10 kyr. A new record from from Soledad Basin indicates a general decline in $\delta^{15}N$ from 12.0 to 9.5 ‰ during the Holocene with centennial-scale variability of roughly ±1 ‰ superimposed. Similar trends have been reported for several locations in the region and can be attributed to a broad decline in the intensity of denitrification that is probably linked to a weakening of the OMZ. An increase in $\delta^{15}N$ from 8.7 to 10.3 ‰ in the upper portion of a recently collected box-core from Soledad Basin suggests that this trend may have reversed over the past 15 years. The age-model for this core is constrained by $^{210}Pb$ dating, the bomb-$^{14}C$ content of planktonic foraminiferal tests, and a comparison of Uk37-derived variations in sea-surface temperature with instrumental records. Even though the underlying mechanisms need to be better understood, N-isotope records provide a valuable long-term perspective for the interpretation of more recent hydrographic observations of variations in OMZ intensity.

# The effect of toroidal flow on mantle mixing efficiency in numerical simulations of 3D spherical convection

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The stirring of heterogeneities by mantle convection is a key process in explaining geochemical observations, but to date most studies have been performed in only two-dimensional geometry. If 3-D convection has only poloidal motion, then its stirring efficiency is similar to that of 2-D convection (Coltice and Schmalzl, 2006 [1]), but the presence of toroidal motion could make a major difference because it can lead to chaotic stirring paths even in a steady-state flow (Ferrachat and Ricard, 1998 [2]). Toroidal flow is mainly associated with plate motions. Two previous studies have assessed the influence of steady state present-day plate motions on mantle stirring (van Keken and Zhong, 1999 [3]; Stegman *et al*., 2002 [4]). Here we instead study flows in which time-dependent plate tectonics is self-consistently generated by the rheology in a spherical shell, similar to (van Heck and Tackley, 2008 [5]), and in which the surface toroidal:poloidal ratio is in the range observed for the Earth.

The stirring efficiency is evaluated using passive tracers. The velocity field is decomposed into poloidal and toroidal components, and by removing all or part of the toroidal component of the velocity field used to advect the tracers we control the amount of toroidal flow the tracers experience. In this way the effect of toroidal flow on the stirring paths is isolated, for flows that are otherwise identical.

Several diagnostics are used to measure the efficiency of dispersion and stretching and their spatial variation as function of toroidal:poloidal ratio of the fluid flow.

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