The role of mesoscale ocean eddies in the glacial cycle of atmospheric pCO_2

DAVID R. MUNDAY*[1], HELEN L. JOHNSON[2] AND DAVID P. MARSHALL[1]

[1]Department of Physics, University of Oxford, Oxford, UK (*correspondence: munday@atm.ox.ac.uk)
[2]Department of Earth Sciences, University of Oxford, Oxford, UK

The close relationship between Antarctic temperature and atmopsheric pCO_2 suggests an important role for the Southern Ocean in glacial cycles. Recent high-resolution model results indicate that the sensitivity of Southern Ocean upwelling and global stratification to changes in Southern Ocean wind stress may be low [1]. This may limit the sensitivity of the climate system as a whole to changes in Southern Ocean wind stress, by limiting the change in ventilation of abyssal carbon reseroirs.

We use MITgcm in an idealised configuration to investigate the changes in circulation that occur at both coarse (climate model) resolutions and higher, eddy-permitting, resolutions as the applied wind stress is changed. At coarse resolutions, the mesoscale eddy field is represented by the Gent & McWilliams parameterisation. However, at eddy-permitting resolutions, large geostrophic eddies are well represented by the model. By coupling these physical circulations to MITgcm's simple biogeochemistry package, we are able to elucidate the effect that changes in the mesoscale eddy field, and/or its representation, have on atmospheric pCO_2.

We find that the use of an eddy-permitting ocean model reduces the sensitivity of atmospheric pCO_2 to both increasing and decreasing wind stress. A carbon pump decomposition indicates that the 4 main reservoirs of carbon in the ocean (saturation state, disequilibrim, soft tissue carbon, and hard tissue carbon) vary quite differently when the model is eddying, as opposed to the eddy field being parameterised.

[1] Munday, D. R., H. L. Johnson, and D. P. Marshall, 2013: Eddy saturation of equilibrated circumpolar currents. *J. Phys. Oceanogr.*, **43**, 507–532.

Lithospheric mantle heterogeneities beneath Southern Patagonia

A. MUNDL[1]*, T. NTAFLOS[1], E.A. BJERG[2], L. ACKERMAN[3] AND C.A. HAUZENBERGER[4]

[1]Department of Lithospheric Sciences, University of Vienna, Austria (*correspondence: andrea.mundl@univie.ac.at)
[2]CONICET-Universidad Nacional del Sur, Departamento de Geologia, Bahia Blanca, Argentina
[3]Institute of Geology v.v.i., Academy of Sciences of the Czech Republic, 165 00 Praha 6, Czech Republic
[4]Institute for Earth Sciences, University of Graz, Austria

Thirty samples from Pali Aike Volcanic Field (PAVF) and Tres Lagos in Southern Patagonia comprise Sp-lherzolites, Sp-harzburgites, Sp-Gt-lherzolites and Sp-Gt-harzburgites.

According to Cpx REE and other trace element patterns, the samples can be divided in 3 Groups within Sp-peridotites and 3 within Sp-Gt-peridotites. Group I Sp-peridotites show a depletion in LREE reflecting different degrees of partial melting. Group II shows flat REE patterns from HREE to MREE with an enrichment in LREE indicating metasomatic overprint. Group III samples show an enrichment in MREE over LREE and HREE suggesting basaltic melt percolation. While Group I Sp-Gt-peridotites represents slightly depleted samples with typical REE patterns of Cpx in equilibrium with Gt, Group II Cpx REE patterns show LREE enrichments reflecting metasomatic event(s). The garnets in this group exhibit wide kelyphitic rims that have been formed according to the reaction of Gt+Ol to Sp+Cpx+Opx. Primary Sp inclusions in Gts of Group I and II indicate transitions from spinel to garnet stability field. Group III of Sp-Gt-peridotites is represented by highly depleted samples showing REE patterns otherwise typical for Cpx coexisting with Gt. However, an entire abscense of Gt suggests that all Gt has been consumed during partial melting event(s).

Re-Os analyses of unmetasomatized Sp-peridotites reveal highly variable T_{RD}. While T_{RD} at Tres Lagos range from 1 to 1.6 Ga, samples from PAVF yield ages from 0.3 to 2.3 Ga. A depletion in Pt, Pd and Re reflects different degrees of partial melting. Depleted Os compared to other IPGEs (Ir, Ru) can be connected to sulfide breakdown upon eruption, while a general depletion in IPGEs in comparison to PM is suggested to be due to melt percolation processes.

Trace element patterns, samples showing highly different degrees of partial melting, as well as transition reactions from spinel to garnet stability field reflecing a multi-stage thermal history, suggest a very heterogeneous SCLM beneath S-Patagonia.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.13