Sensitivity of global carbon cycling models to changing subduction fluxes

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Global C cycle models often inadequately represent subduction zone processes and consider C cycling as a process confined to Earth's atmosphere, oceans, land-sur-face, and crust. Here, we demonstrate the impact that consi-deration of changing subduction zone fluxes can have on predictions by carbonate-silicate global C cycle models.

Based on study of subduction-related metamorphism (Franciscan-type, Alpine), greater subduction efficiency for volatiles is thought to correlate with cooler margins where older oceanic lithosphere is rapidly subducted. Higher efficiency should lead to greater fractional return of C to the mantle (i.e., less efficient return to the surface via volcanism or forearc venting). Thus, arc volcanic C fluxes may differ from that estimated by direct proportionality to spreading rates or the size of the atmosphere-crust-oceans C reservoir. Depending on subduction rates, warmer early-Earth subduction likely resulted in less efficient C return to the mantle. Study of HP/UHP rocks indicates deep retention of much of the initially subducted reduced C (organic) and oxidized C (sediment, oceanic crust), perhaps to >100 km in cool margins. Carbon retained in accetionary prisms or in exhuming more deeply subducted rocks could be released during heating related to the subduction cessation.

Imbalance between subducted C input flux and C return by magmatism (on global basis, ~40±20% of subducted C return via arcs, and ~70±20% by all magmatism) indicates net C return to the mantle today, perhaps a reversal of earlier Archean net outgassing (despite more rapid subduction), and with long-term implications for surface C availability. Modern sedimentary C subduction flux is dominated by Central America and Makran (~50% of sedimentary C subducted at these margins, with ~70% of total subducting C in oceanic crust), thus future C cycling will be affected by the duration of C subduction pulses in these regions and any new subduction in carbonate-rich ocean basins such as the Atlantic. BLAG and WHAK models predict that ~20% change in subduction/volcanic C return to the atmosphere, feasibly produced by changing C subduction flux, could significantly modify atmospheric CO_2 levels and thus global climate.

Petrology of metasomatized mantle xenoliths from Shiveluch Volcano, Kamchatka

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Mantle xenoliths of predominantly spinel harzburgite, with minor occurrences of spinel lherzolite and pyroxenite, were collected from the debris of the explosive 1964 eruption of Shiveluch Volcano, Kamchatka. The xenoliths have been metasomatized to various degrees in the form of mm-scale veins of orthopyroxene, ± phlogopite, ± amphibole that cross-cut the unaltered mineralogy, or as zones of orthopyroxene, ±clinopyroxene, ± phlogopite, ± amphibole that replace the primary mineralogy in irregular patches. The primary (unmetasomatized) mineralogy of the samples is most commonly that of a harzburgite with coarse (protogranular), porphyroclastic, and granuloblastic textures, consistent with plastic deformation under conditions of mantle flow. Primary mineral compositions are refractory, with olivine from Fo_{89-94} and Cr# (Cr/Al+Cr*100) in spinel from 40-80. These compositions for olivine and spinel fall within the mantle array of spinel peridotites as defined by Arai (1994; Chem. Geol. v. 113). Metasomatic mineral compositions are also Mg-rich. Orthopyroxene and clinopyroxene compositions in veins and metasomatic patches fall within a narrow range of high Mg# (Mg/Mg+Fe*100) from 89-94, similar to those in the unmetasomatized parts of the samples. The xenoliths have therefore undergone a two-step evolution involving melt extraction resulting in a depleted mantle residue, followed by infiltration of potassic and silica-rich fluids or hydrous melts, possibly within the modern Kamchatka subduction zone. Further work applying appropriate geothermobarometers will constrain the physical conditions under-which the xenoliths have formed and evolved beneath Kamchatka.