Global modeling of mercury with Br as atmospheric oxidant

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Global models have generally assumed that OH and ozone are the main atmospheric oxidants of Hg (0), but recent studies suggest that these reactions are too slow to be of atmospheric relevance. Rapid loss of Hg (0) observed in the polar boundary layer in spring is known to be due to oxidation by halogen radicals, with Br atoms likely the most important oxidant. The observed diurnal cycle of reactive gaseous mercury (RGM) in the marine boundary layer also suggests a dominant role of Br atoms for Hg (0) oxidation, and this would then represent a major mechanism for Hg uptake by the ocean. In the free troposphere and stratosphere, Br atoms produced by the degradation of natural and anthropogenic bromocarbons could drive the oxidation of Hg (0).. Simulations using the GEOS-Chem coupled atmosphere-ocean-land model indicate that oxidation of Hg (0) by Br atoms can fit the observational constraints on the global atmospheric lifetime of Hg, the spatial and seasonal variability of Hg (0), and other features. Observations of elevated Hg (0) over the northern hemisphere oceans remain a challenge to explain but could be due to elevated Hg in the deep ocean representing a legacy of past human activity. Application of GEOS-Chem to derive source-receptor relationships for different continental regions shows large variability in the relative contributions of domestic vs. foreign emissions, and a simulation with projected 2050 emissions indicates major regional trends in the future.

Arc peridotite, eclogite and tonalite: A trio of ingredients for craton assembly

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Amongst the current models for the formation of cratonic lithosphere, the evidence for an arc-related origin has hardened over the last few years. The trio of fundamental rock types in cratons – extremely depleted peridotite, eclogite originating from ocean crust [1], and abundant tonalitic melts that must be derived by melting of basaltic material – all point to accretion of multiple arcs as the cause. Trace element studies of depleted mantle peridotite xenoliths show that most cpx and garnet was introduced later [2], and now even opx has been shown to inherit trace element patterns from former olivine [3], meaning that the lithosphere at the time of craton formation was more strongly depleted than previously recognized. The same multiple overprinting events also affected eclogite xenoliths [4]. The eclogites differ in mineral chemistry and oxygen isotopes signatures from garnet pyroxenites that would result from crystallization of high-pressure melts [5], thus clearly favouring an origin as subducted ocean crust, whereby trace elements implicate arc-related picrite protoliths [6].

Cratonic peridotites are reminiscent of modern accretion of sub-arc lithosphere, where olivines and spinels with Mg# and Cr# both up to 0.95 witness the extreme degree of depletion [7]. These come from areas of accretion of multiple arcs, such as the closure of Tethys or modern Indonesia. Differences are in the style of enrichment: the involvement of subducted crust of continental origin in the Mediterranean finds no parallel in the tonalitic gneisses of the late Archaean, possibly indicating that most crust formed for the first time during the period 3.0-2.5Ga, and that continental crust production was largely prevented at earlier times by a lack of modern-style subduction processes.

[1] Jacob (2004) *Lithos* **77**, 295–316. [2] Rehfeldt *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, 5722–5756. [3] Rehfeldt *et al.* (2010) *Geochim. Cosmochim. Acta* **74**, this volume. [4] Jacob *et al.* (2009) *Lithos* **112S**, 1002–1013. [5] Gonzaga *et al.* (2010) *J. Volc. Geotherm. Res*, **190**, 235–247. [6] Jacob & Foley (1999) *Lithos* **48**, 317–336. [7] Prelevic & Foley (2007) *Earth Planet. Sci. Lett.* **256**, 120–135.