Core-Mantle Interaction

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Chemical reactions between the core and mantle have been suggested to explain a variety of phenomena including the D" layer (*e.g.*, ref .1) and Os isotopic signatures observed in some plume derived magmas (*e.g*., ref. 2). However, little is known about potential interactions between the core and mantle. Important factors for determining the chemical nature of a core-mantle interaction are how close the core and mantle are to chemical equilibrium, the composition of the core (*i.e*., the identity of the light element(s)), and partitioning of elements between the inner and outer core. The state of equilibrium between the core and mantle is dependant on the mode of core formation: Did the core continually re-equilibrate with the mantle as it formed and the Earth grew, or did core metal equilibrate with mantle silicates at pressures significantly lower than those of the present day core-mantle boundary and then rapidly descend to the core (for example as in the model of ref. 3). All that is known about the composition of the core is that it is Fe alloyed with some lighter element. The identity of the light element is unknown and the amount of that element is dependent upon its identity (4,5). The identity of the light element is also critical for determining how elements might partition between the inner and outer core. Recent experimental and theoretical work on core-mantle interaction, light element in the core, and partitioning at very high pressures will be reviewed.

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Volatile Mass Balance and Recycling at Subduction Zones

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Ascertaining the state of volatile mass balance (input via the trench versus output via the arc and back-arc) for subduction zones impacts our understanding of all aspects of the subduction process from controls on the stability of the down-going slab and the production of fluids (and melts) to the chemistry of arc-related magmas and their eruption characteristics. It is also key to describing the volatile systematics of the mantle as species transferred beyond the zone of arc magma generation have the potential to influence the characteristics of both the shallow (MORB-source) mantle and that of deep-seated plumes.

We assess the extent of mass balance for a range of major (H_2O, CO_2, N_2, SO_2) and trace (He, Ar) volatile species – for both individual subduction zones as well as for subduction zones globally. Our approach is to define the volatile input flux via specific trenches by combining estimates of the volatile characteristics of localized sediments (Plank and Langmuir, 1998) and oceanic basement (assuming 7 km depth) with extrinsic properties such as subduction rate, arc length and sediment thickness and porosity. The output flux at the corresponding arc are derived using a new approach to defining SO_2 fluxes for a particular arc and combining these values with knowledge of the gas chemistry of localized fumarolic gas discharges (e.g. SO_2/CO_2, SO_2/He ratios). In this way, it is possible to obtain output flux estimates for a variety of volatile species at different arcs. Quantification of the contribution of the slab-derived component (as opposed to volatiles from the mantle wedge) can be obtained using noble gases (Sano and Marty, 1995). Therefore, it is possible to compare volatile input via the trench with volatile output via the arc system for a range of species at individual subduction zones. Output fluxes at individual arcs can be summed to produce estimates of the global output of individual species via arcs systems, and this figure forms the basis for comparison with a global integration of input parameters.

We show results of our mass balance analysis for a number of specific arcs. For example, the Central American margin recycles organic-derived CO_2 very efficiently between trench and arc (F_{out}/F_{in} ~1). However, only a minor proportion (<20%) of subducted limestone-derived CO_2 emerges via the arc system implying that production of arc magmas and fluids does not act as a ‘subduction barrier’ to inorganic CO_2. We extend this approach to arcs globally and discuss criteria that can be used to recognise volatile species (nominally of mantle derivation) which are predominantly primordial in origin and unlikely to have been recycled versus other species which are largely present in the mantle through subduction zone recycling through geological time.