Arc fluxes and the composition of the recycled ocean crust reservoir

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Recycled ocean crust is often proposed as an enriched reservoir in the mantle. Here we propose that it is instead the fertile, depleted reservoir that is commonly sampled at ocean ridges, not as "enriched pyroxenite veins" but as a major depleted component. Recent experimental data for fluxes from subducting ocean crust [1,2], as well as models of global arc volcanism [3], require that contributions from slab melts are ubiquitous at convergent margins. Slabs always melt. Since this is true in the present Earth, it would also have been true in the past when Earth's thermal environment was hotter. The extent of melting and mass of melt can be estimated by what is required to account for the chemical compositions of arc volcanics. Sr is particularly valuable in this regard because it is not particularly enriched in sediments, but nonetheless strongly enriched in convergent margin magmas, requiring a large flux from the subducting ocean crust. Using experimental data it is then possible to make estimates of the amounts of more incompatible elements that are being released from the ocean crust portion of the slab. The quantities are substantial, leading to a recycled ocean crust reservoir that is even more depleted than the average MORB entering subduction zones. This recycled reservoir is then entirely inappropriate as an enriched reservoir, because it is strongly depleted in highly incompatible elements. It nonetheless remains fertile in mineralogy and major elements. These are the essential requirements for the depleted MORB mantle. Enriched reservoirs then can never be the direct result of recycled ocean crust. Only small degree melts from such recycled crust, or other forms of near surface metasomatism by low degree melts, are the exclusive source apart from recycled sediments of enriched reservoirs.

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