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Do we really need mantle reservoirs to define mantle processes?

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The isotopic heterogeneity of oceanic basalts has long been related to the interaction of a few mantle reservoirs, e.g. Mid-Ocean Ridge Basalts (MORB) and Ocean Island Basalts (OIB), thought as distinct and physically accessible mantle portions. However, the growing evidence that oceanic basalts are heterogeneous and do not represent a specific mixture of well identified mantle end-members has led to consider the correspondence between geochemical components and specific mantle reservoirs to be highly speculative. We discuss the concept of geochemical reservoir starting from a petrological and geochemical approach, but adopting a new method of plotting that allows to display the compositional variability of a magmatic association in a multi-dimensional space, thus simultaneously accounting for a great number of compositional variables. This allows to switch from a perspective based on physically distinct mantle reservoirs to a model based on processes related to the recycling of oceanic lithosphere. We bring arguments that support OIB derivation from a marble-cake mantle, due to their variability in geochemical and isotopic signatures that may be observed on the scale of a single ocean island as well as on that of an ocean, mostly varying between two extreme, “depleted-enriched”, compositions. The two OIB main components are not strictly related to the so-called mantle reservoirs (DMM, EMI, EMII, HIMU), are peculiar of the source sampled on each ocean island or archipelago and are strongly dependent on Pb isotope systematic. They are respectively represented by OIB tholeiites, picrites and alkali basalts (“depleted”), and basanites, nephelinites and alkali basalts (“enriched”). They likely represent the final result of different extents of partial melting of a peridotitic/pyroxenitic mantle source, in which a major role is played by recycling of subducted younger oceanic lithosphere vs an older eclogitic sources with a strong negative buoyancy (plume heads?). We consider that different kinds of partial melts can derive by different mantle mineralogic assemblages, each

one with its melting relations. In this way, partial melting within the same mantle volume can sample very diverse sources which differ for mineralogic, geochemical and isotopic compositions in a relatively small mantle volume.