Slab dehydration and melting of the Philippine Sea Plate by progressive subduction beneath the SW Japan arc over the past 15 million years

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Geochemical data including 389 XRF analyses, 203 ICP-MS trace element analyses, 188 Sr-Nd, 120 Pb, and 83 Hf isotope compositions were examined to reveal the origin of the late Cenozoic magmatic activity (~15 mys) in the SW Japan arc. This activity includes OIB-type alkali basalts, IAB-type sub-alkali basalts, HMA, and adakites (ADK). Activity in the SW Japan volcanic arc commenced at ~15 Ma when the back arc basin (BAB) of the Japan Sea opened. Initiation of subduction of the young Shikoku Basin Philippine Sea plate (PHS) occurred at the same time. At ~15 Ma, OIB activity occurred in the rear arc due to upwelling of the asthenosphere by BAB opening, whereas IAB and Setouchi HMA were produced in the forearc due to dehydration and melting of the young slab. ADK and IAB activity between these two areas began at about 8-9 Ma. This ADK-IAB zone migrated to the rear arc by 2 Ma, and has remained active to the present. At the same time, OIB activity ceased in the area where ADK-IAB activity began. OIB activity does not require slab inputs and thus originates from asthenospheric mantle. In contrast, IAB, HMA, and ADK obviously require slab fluids and melts. The temporal rear arc-ward migration of the slab-related magmas indicates progressive penetration of the PHS into the anomalously hot mantle asthenosphere that was emplaced during BAB opening. Interaction of BAB opening tectonics and initiation of young PHS slab subduction combined to form the complex volcanism present in the SW Japan arc.

Oxygen isotope analysis of silicates using continuous flow isotope ratio mass spectrometry

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Oxygen is the most abundant element in the Earth's crust and therefore δ^{18}O analysis of silicates is a routine procedure used in many geochemical applications (e.g. mineral exploration, paleoclimatology, etc.). Continuous flow isotope ratio mass spectrometry (CF-IRMS) offers an attractive alternative to the usage of hazardous fluorine or interhalogen fluoride gas vacuum lines for oxygen isotope analysis of silicates. The development of peripherals and additives for online sample processing prior to introduction in the mass spectrometer has greatly expanded the capabilities of CF-IRMS. In this study we use a modified method similar to Werner [1] to test the ability of thermal conversion elemental analysis (TC/EA) coupled with CF-IRMS to accurately analyze the oxygen-isotope composition of silicates.

Online fluorination was attempted via the use of solid fluorinated compounds which are much less hazardous to handle than fluorinated gases. At high temperatures the fluorinated additives enable the breaking of Si-O bonds in silicates liberating oxygen which is then reacted with carbon to produce CO and waste gases. Waste gases are subsequently removed before CO is analyzed using standard CF-IRMS techniques.

These results represent preliminary research into the suitability of various fluorination compounds for the accurate analysis of several internal and external silicate standards. Crushed silicate samples (e.g. NBS-28, NBS-30, and internal standards) are added to silver cups and mixed with fluorinated graphite powder, Teflon tubing, Teflon powder, potassium fluoride, or a combination of two or more additives. Cups are sealed and then heated instantaneously to 1460°C in the TC/EA. The oxygen then reacts with carbon in the furnace creating CO which is carried in a stream of helium to a chemical and cold trap. The chemical trap contains magnesium perchlorate and Ascarite II® to remove water and fluorinated compounds respectively before the gas is transported to a GC column. After gas separation in the GC column the CO is transported to the open split and then to the mass spectrometer.

With the increasing number of laboratories with CF-IRMS and TC/EA apparatus the development of this method will hopefully help to diversify their analytical capabilities.

[1] Werner (2003) *Isotopes Environ. Health Stud.* **39**, 85-104.