

## Carbon isotopes in basaltic magmas, processus or source signature ?

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It is regularly proposed that the  $\delta^{13}\text{C}$  of magmatic carbon can be used to characterize the origin of the carbon present in mantle sources and in particular to decipher between carbonate and organic carbon contributions to the mantle through sediment subduction.

We have analysed more than a hundred basaltic samples (MAR, EPR SWIR and seamounts from South Pacific Society archipelagos) ranging from N-MORB to alkali basalt composition. The gas entrapped in vesicles and the corresponding dissolved carbon and water have been systematically analysed.

A large range of  $\delta^{13}\text{C}$  is obtained, up to  $-2.9\text{‰}$  in vesicles and down to  $-18\text{‰}$  for the dissolved carbon. In the same sample  $\delta^{13}\text{C}$  up to  $-4\text{‰}$  (gas) and down to  $-12$  to  $-18\text{‰}$  (dissolved C) can coexist. The higher values can be compared to "sedimentary carbonate" and the lower values have typical values for "organic carbon" but this has evidently no sense if the two coexist in a single  $\sim 1\text{cm}$  fresh glass sample. All these data are readily explained by outgassing processes, with an initial  $\delta^{13}\text{C}$  at  $-4.5\text{‰}$  and using a  $\Delta_{\text{CO}_2\text{-magma}} = +3.5\text{‰}$  (experimentally measured) applied during a 2-3 step degassing process.

The same is true for subduction zone volcanoes where the  $\delta^{13}\text{C}$  of the  $\text{CO}_2$  reflect the outgassing degree of the magma chamber. Deep chambers have little degassed ( $\delta^{13}\text{C}_{\text{CO}_2} = -4.5 + 3.5 = -1$ ). Shallower magma chambers with  $\text{CO}_2$   $\delta^{13}\text{C}$  ( $-10 + 3.5 = -6.5$ ) correspond to magmas outgassed to  $\sim 50\%$ .

The water content of the submarine glasses vary from 500 to 6000 ppm  $\text{H}_2\text{O}$  with D's varying from  $-85$  to  $-51$ . Water is present in vesicles only when dissolved water content is high (above 5000 ppm for an eruption depth of  $> -3500\text{m}$ ) and its  $\delta\text{D}$  is heavier than that of dissolved water but isotopic equilibrium is rarely reached.

The reconstruction of the carbon and water initial content of the magmas before degassing can be done using the vesicularities and  $\delta^{13}\text{C}$ . The carbon initial concentrations vary largely, from 25 to 8000 ppm, the lower ones reflecting the existence of shallow magma chambers and the largest fast degassing from great depth of volatile-rich magmas. The initial water concentrations vary from 500 to 10 000ppm, with  $\text{C}/\text{H}_2\text{O}$  ratios close to 0.8-1 in the volatile-rich magmas.

On a specific site, the  $\delta\text{D}$  variations observed (from  $-85$  to  $-45$ ) in different lavas having very different alkali characters can be explained only by magma mixing. It corresponds to 2 end-members: depleted N-MORB and E-MORB or an alkali-rich melt (possibly a metasomatic fluid or a true alkali basalt) with identical  $\delta^{13}\text{C}$  and different  $\delta\text{D}$ .

## Oxygen isotopes and granitoid series characterization in the Borborema province, northeastern Brazil

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Neoproterozoic metaluminous to slightly peraluminous calc-alkalic, high-K calc-alkalic, and shoshonitic magmatic epidote-bearing granitoids intrude metasedimentary terranes of the Borborema province, northeastern Brazil. Calc-alkalic plutons (CA) are I-type, medium-grained equigranular hornblende biotite tonalites to granodiorites; high-K calc-alkalic (HKCA) plutons are coarse grained granodiorites to granites, locally showing commingling with diorite, and shoshonitic (SH) plutons consist of equigranular, less commonly porphyritic, medium- to coarse-grained syenogranites, quartz monzonites and quartz monzodiorites, in which clinopyroxene and/amphibole and/or biotite are the main mafic phases. Shoshonitic granitoids have higher Sr, and lower Mg abundances, lower  $\text{Sr}_0$  (0.70526), and  $\epsilon\text{Nd}$  (-11) values than the CA ( $\text{Sr}_0 = 0.70876$ ;  $\epsilon\text{Nd} = -5.3$ ) and HKCA ( $\text{Sr}_0 = 0.70871$ ;  $\epsilon\text{Nd} = -3.8$ ; except for the São Rafael pluton in which  $\epsilon\text{Nd} = -19.6$ ) granitoids. Oxygen isotope ratios of mineral separates from these granitoids are distinct for the three magmatic series. Zircon has an overall  $\delta^{18}\text{O}$  variation of  $\sim 5\text{‰}$ , ranging from 5.72‰ in the São Rafael pluton (HKCA granitoids) to 10.30‰ in the CA granitoids. Values of the SH and the other HKCA granitoids are between these two extremes, and are also distinct one from each other. The highest values of  $\delta^{18}\text{O}$  (zircon) ( $9.88\text{‰} \pm 0.35\text{‰}$ ;  $n = 13$  samples) are for the CA granitoids, which are slightly, but significantly higher than those for HKCA granitoids ( $9.10\text{‰} \pm 0.41\text{‰}$ ;  $n = 19$  samples) with little overlap. Values for these granitoids greatly differ from the average for the SH granitoids ( $7.43\text{‰} \pm 0.19\text{‰}$ ;  $n = 5$  samples), and from that for the São Rafael pluton ( $5.92\text{‰} \pm 0.26\text{‰}$ ;  $n = 9$  samples). These differences repeat for the other analyzed minerals, with little overlap of values. There is a good positive correlation between mineral pairs in the three series, although quartz-epidote and zircon-epidote fractionations are higher than predicted for equilibrium at magmatic temperatures, and yield apparent temperatures around  $500^\circ\text{C}$ . These results suggest distinct  $\delta^{18}\text{O}$  source for the three granitoid series, in spite of their similar geochemical nature and pressure of crystallization (ca. 6 kbar, except for the São Rafael pluton, which is estimated to be ca. 4 kbar). The variable stable and radiogenic isotopic compositions for the three series reflect distinct mantle contributions to the crustal parental magmas.