Calc-alkalic vs. tholeiitic revisited: A radical view of andesite genesis

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Two distinctive differentiation trends, tholeiitic (TH) and calc-alkalic (CA), are recognized in subduction zone magmas. TH and CA andesites to dacites often coexist in close temporal and spatial proximity. The genetic relation between these two types of andesitic magmas should be solved for better understanding the andesite genesis.

Sr-isotope micro-analyses, using a combined micromilling/TIMS and an *in situ* LA-MC-ICPMS, were conducted on plagioclase phenocrysts from CA and tholeiitic TH andesites from the Quaternary Zao Volcano in the NE Japan arc. ^{87}Sr/^{86}Sr of plagioclase occurring in TH rocks is constant at 0.70428±0.00005 and show little correlation with the An-content, whereas that for CA rocks varies from 0.70337 to 0.70418 and shows more complex characteristics. The observation that high-An plagioclase embedded in the most mafic CA basaltic andesites exhibits the lowest ^{87}Sr/^{86}Sr should be stressed. These results may not be consistent with a general consensus that the major mechanisms of TH and CA andesite production are fractional crystallization of a mantle-derived TH basaltic magma and mixing between TH basaltic and crust-derived felsic magmas, respectively. Instead, two isotopically distinct basaltic magmas could form beneath the volcano, one for the TH series produced by anatexis of the pre-existing, hence more radiogenic mafic lower crust, and other for the CA series by partial melting of less radiogenic mantle wedge peridotite. A mantle-derived CA basaltic magma will mix with crust-derived TH melts to form CA andesites.

C-isotope exchange experiments between DIC and TCE

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Introduction

Isotope fractionation of organic carbon during degradation of contaminants is an important tool to quantify natural attenuation [1], but the role of coexisting inorganic carbon (DIC) in this process has been regarded to be neglegible. Recent studies [2], however, did not corroborate this theory and made it evident that the behaviour of C isotopes between TCE and DIC should further be studied. We report new data from triplicate sets of exchange experiments in sealed vessels, using conventional TCE, Na_2CO_3 and $NaHCO_3$ as well as ^{13}C labelled Na_2CO_3 and $NaHCO_3$ in solution with concentrations ranging from 0.1 to 10 mmol/l, temperatures from 20 to 60°C and experiment time from 10 – 100 days. Blank sample sets were performed accordingly.

Results

Experiments performed at 20°C showed no enrichment of ^{13}C in TCE, even for highest DIC/TCE ratios, and 100 days experiment time. A decrease in TCE concentration over experiment time could be observed, but due to experimental setup not be quantified. GC-IRMS measurements could not identify any degradation product of TCE and $\delta^{13}C_{PDB}$ values for residual TCE ranged, within analytical uncertainty, between -23±2‰. At 60°C similar results were obtained, with two exceptions: both data sets using Na_2CO_3 and concentrations of 10mmol/l showed significant C-isotopic enrichment of TCE after 30 days with final δ-values of -7‰ after 100 days. The amount of enrichment correlates with the DIC/TCE ratio and surprisingly this effect can be observed for ^{13}C-enriched but also for natural Na_2CO_3 solutions.

Discussion

The data suggest that at normal groundwater temperatures there is no C-isotope exchange between DIC and TCE. We attribute the observed shift of $\delta^{13}C$ values in natural and enriched Na_2CO_3 solutions to hydrolysis of TCE, triggered by high pH values of 11,4 in the10mmol/l Na_2CO_3 solutions and by elevated temperatures of 60°C.

[1] Prommer *et al.* (2007) doi,10.1016/j.jconhyd.2007.11.003.
[2] Taubald & Schüth (2004) *GCA*, **68**, 11S, A459.