Geochemical variation and residence time of groundwater in Mt. Fuji area, central Japan

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Many groundwater samples were collected from Mt.Fuji area, central Japan which is totally composed of basaltic materials. The samples were analyzed for Na^+, K^+, Ca^{2+}, Mg^{2+}, Si, Al^{3+}, Fe^{2+}, Fe^{3+}, TC(total dissolved carbon), Cl^-, NO_3^-, SO_4^{2-} and TP(total phosphorus). Analytical data plotted against altitude indicate that alkali and alkali earth element (Na^+, K^+, Ca^{2+}, Mg^{2+}, Ca^{2+}) and Si concentrations increase with decreasing altitude, indicating that the dissolution of silicates in basaltic materials control the trends. Ca and Mg concentrations positively correlate with each other and the correlation coefficient is 1.64. This is consistent with CaO/MgO molal ratio of basalt which is 1.47. Therefore, it is inferred that Ca and Mg in groundwater were derived mainly from the congruent dissolution of basalt. Ca/Si concentration ratio determined by the dissolution reactions of basalt accompanied by the precipitation of allophane is 0.29 which is lower than 0.48 estimated from the analytical data on groundwater. This lower value could be due to the precipitation of silica mineral (SiO_2). The agreement between theoretical and analytical results indicate that Ca, Mg and Si concentrations of groundwater are governed by dissolution and precipitation reactions. In order to interpret groundwater chemistry and estimate residence time of groundwater the simplified coupled dissolution kinetics-fluid flow model was used. Assuming reasonable values of parameters (reactive surface area, mass of groundwater, temperature etc) and using rate constant experimentally determined, residence time of groundwater in southeastern part of Mt.Fuji area(Kakitagawa site) was estimated to be several years to 30years). This estimated residence time is consistent with isotope data (herium isotope and tritium concentration).

CO_2-water-basalt interactions: Experimental and mineralogical study

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Introduction

Development of a better understanding of fluid-rock interaction is important in many areas of applied science and basic research. Investigation of reaction of basalt with H_2O and CO_2 at different P-T-fO_2 conditions is important both for planetary processes including processes in subduction zones of the Earth and mineral storage of CO_2 including the problem of reducing the anthropogenic CO_2 emission into the atmosphere. We have carried out experimental, mineralogical and carbon stable isotope study of this reaction.

Experimental Method

Carbonation experiments were run by exposing natural basalt powders (100-200µm grain size) to CO_2 and H_2O under various conditions in a hydraulic press (total pressure 1kbar and 400-500°C). Oxalic acid ($H_2C_2O_4$) was used as a source of CO_2 and H_2O. Additional amounts of H_2O were added in the platinum capsules. The thus produced CO_2 and H_2O were then reacted with the basalt powder at high pressure and temperature. Gas phase and solid products of experiments were analyzed by manometry, step heating and mass-spectrometry techniques. Mineralogical study of the products of experiments by Scanning Electron Microscopy allowed the identification and observation of carbonates and water-bearing minerals.

Discussion and Conclusions

Our experimental results document the effect of the H_2O-CO_2 medium on basalts under these P,T conditions and that calcite forms during the carbonation of plagioclase. We observed that carbonation reaction in basic rocks is different from that in ultrabasic rocks. Pressure, temperature and molar fractions of H_2O and CO_2 are important parameters whose influences were quantified. Measured δ^{13} C of gas and solid phase allowed to discuss kinetic and thermodynamic factors of carbon isotope fractionation in such reactions and are discussed in terms of mass balance.