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Assimilation-fractional crystallization calculation using thermodynamic phase diagram and element partitioning model: Evaluation of isotopic and bulk rock compositions of the Hida Jurassic plutons in Japan

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Input of mantle-derived magma in active continental margins is considered as an important factor controlling geochemical evolution of continental crust. Quantitative geochemical modeling can give insight into key parameters and components involved in such deep crustal processes. A geochemical variety of the Jurassic plutons in the Hida belt provides a test for interactions between intrusive mafic magma and crustal metamorphic rocks at the active continental margin. Previous studies revealed several types of variations in initial Sr isotope ratio (SrI) vs Rb/Sr suggesting there could be variable extents of interaction with various components of crustal rocks. Recent progress in thermodynamic calculation enables us to model assimilation-fractional crystallization (AFC) for evolving melt-solid system. In order to examine the geochemical variations in the Hida plutonic rocks, we use MAGEMin program [1] which gives major element compositions and proportions of liquid and solid phases in each step of AFC. Trace element and isotopic variations are separately calculated using the up-to-date partition coefficients between liquid and minerals (considering compositional dependence). Two input components are considered: average of modern arc basalt and fractionated andesite. Wallrock compositions are represented by the four typical values of metamorphic rocks in the Hida belt: low SrI hornblendite, moderate SrI Hbl gneiss and two groups of high SrI felsic gneiss (low Rb and high Rb). Results of calculations are evaluated based on major elements, Sr and Rb contents and SrI in calculated melt. The results show that primary magma with a high H_2O content crystallizes Amph ealier and Pl later than low H_2O magma does and well reproduces the TiO_2 and Al_2O_3 contents of the Hida plutonic rocks. Difference in input magma (basalt or andesite) is not distinctive for geochemical variation of felsic magma. Overall, our AFC calculations suggest that the difference in the geochemical signature of the Hida plutons can be attributed to the surrounding lithology at the loci of intrusions, depicting that mafic lower crust had been folded up at the East Asian continent margin before the beginning of oceanic subduction in the early Jurassic age.

[1] Riel et al. (2022), *G-cubed 23*.