

# DYNAMICAL MODELS FOR SUBDUCTION ZONE PROCESSES IN NE JAPAN INCORPORATING FLUID-ROCK INTERACTIONS

Iwamori, H.<sup>1,2,3</sup>, Nakamura, H.<sup>2,3,4,5</sup>, Horiuchi, S.<sup>2</sup>, Nishizawa, T.<sup>3</sup>, Sasajima, R.<sup>6</sup>, Shibazaki, B.<sup>6</sup>

<sup>1</sup>Univ. of Tokyo, Tokyo, Japan; <sup>2</sup>Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan;

<sup>3</sup>Tokyo Institute of Technology, Tokyo, Japan; <sup>4</sup>Geological Survey of Japan AIST, Tsukuba, Japan; <sup>5</sup>Chiba Institute of Technology, Chiba, Japan; <sup>6</sup>Building Research Institute, Tsukuba, Japan

Subduction zone is a place where near-surface cold materials, including hydrous sediments and rocks, are brought down into the hotter and drier mantle. As a result, steep gradients in terms of chemical, mechanical and thermal aspects occur along the down-going slab, which induces various geological processes in the slab-wedge-crust system. Of these, dehydration of sediments and rocks consisting of the subducting slab, which is caused by temperature and pressure elevation, delivers fluids to the overlying mantle wedge and crust. The ascending fluid significantly modifies the rock properties such as water content, hydrophile element concentrations, density and viscosity, which affects subduction zone dynamics including mantle flow and magmatism (e.g., Iwamori, 1998; Arcay et al., 2005; Cagnioncle et al., 2007; Hebert et al., 2009; Ikemoto and Iwamori, 2014; Wilson et al., 2014).

These geochemical, mechanical and thermal aspects are tightly coupled, which constitutes a feedback system. The thermal-flow structure controls the spatial distribution of dehydration along the slab (e.g., deeper and wider for a cold subduction zone, Iwamori, 2004), which affects the subsequent fluid-rock reactions and modifies the viscosity structure. Then, the thermal-flow structure changes and affects the fluid distribution and the viscosity structure again. In order to understand such a dynamical system, the three aspects need to be consistently and simultaneously considered (Horiuchi and Iwamori, 2016; Nakao et al., 2016).

In this study, we developed a numerical model incorporating the three aspects described above, which allows us to predict chemistry of rock-fluid-melt based on elemental partitioning and transport, as well as thermal and flow field of mantle-crust system based on the density and viscosity distribution. Then we applied the model to the NE Japan arc, where M9 Tohoku Earthquake occurred in 2011 associated with subduction of old and cold Pacific Plate. The model results may explain the observations; the width and location of volcanic belt, seismic velocity structure, and surface heat flow (Horiuchi and Iwamori, 2016). The predicted viscosity structure was used to explain the rapid crustal deformation before and after the M9 Tohoku Earthquake (Sasajima et al., submitted). The trace element compositions of arc magmas are broadly explained by the model, although not perfectly reproduced, which is then used to estimate the subduction flux into the deep mantle for global circulation (Iwamori et al., submitted). These results suggest that combining geophysical and geochemical observations based on the models presented in this study would be a useful approach to decipher the complex subduction zone process as a consequence of chemical, mechanical and thermal interactions of fluid and rock in subduction zones.

## References

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