日本海溝アウターライズ域のさらに海側にあるプチスポットで起こる水循環・熱輸送：フラックス推定と数値モデリング

Heat and fluid transport among the petit-spot volcanoes seaward of the Japan Trench outer rise area: Flux estimation and numerical modeling

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The subducting oceanic plate experiences various deformation processes before subduction. On the seaward area of the Japan Trench, for example, the area within 300 km seaward of the trench axis shows a convex topography and is called the outer rise. Seismic surveys have revealed the occurrence of normal faults and the decrease in the seismic velocity within the upper crust of this area (e.g. Tsuru et al., 2000; Fujie et al., 2013), which were probably formed by extensional deformation of the uppermost oceanic crust. The incorporation (and probably circulating) of fluid within may occur within these faults. However, deformation is also undertaken in the more seaward area. The area ~500 km seaward of the trench axis shows a slight concave topography, on which the petit-spot volcanoes have been found (e.g. Hirano et al, 2006). Hirano et al. (2006) and subsequent studies have attributed the formation of petit-spot volcanoes to extensional deformation near the lowermost part of the oceanic plate. The petit-spot volcanoes behave as a heat source when they are young (Ray et al., 2015); more importantly, they work as a fluid passageway even if they are cooled out. The latter incorporates fluid into the oceanic crust from the ocean. The fluid circulation occurring both in the outer rise normal faults and petit-spot volcanoes alters the oceanic crust and influences the physicochemical properties of the seismogenic zone at depth. This presentation considers the role of the petit-spot volcanoes on the transport of heat and fluid.

We first estimate the heat and mass fluxes from the petit-spot volcanoes based on the heat flow observation. The only data at present is low heat flow observed within a few kilometres around one of the petit-spot volcanoes discovered by Hirano et al. (2006); observation shows less than a half that expected on the oceanic plate of the corresponding plate age (~135 Ma) (Yamano et al., 2018, this meeting). We regard this heat flow deficit as the hydrothermal contribution. We can obtain the hydrothermal heat flux from the targeted petit-spot volcano by multiplying the observed heat deficit by the area involved. In addition, specifying the typical temperature of fluid discharge leads us to obtain the fluid mass flux. The heat and fluid mass fluxes are of the orders of 0.1 MW and 1 kg/s, which are roughly one-tenth of those estimated for the Baby Bare seamount on the young (~3.5 Ma) Juan de Fuca Ridge frank.

We then model the transport of heat and fluid of the petit-spot ‘complex’. At a single site, there are a lot of petit-spot volcanoes, which may result in fluid transport among them. This is an important factor but was not considered in the above estimation. To take this effect into account, we construct the three-dimensional finite element model of heat and fluid transport within the oceanic plate including the presence of multiple seamounts. Various types of fluid circulation form in a single seamount: An axisymmetric fluid flow with discharge at the centre and recharge at the edge of a seamount; an axisymmetric fluid flow with recharge at the centre and discharge at the edge of a seamount; recharge from a half surface area of a seamount and discharge from the other side. The first type agrees with the heat flow observation, resulting low heat flow around it. Fluid flow between two seamounts also occurs, which is so-called the hydrothermal syphon (e.g. Fisher et al. 2000). This fluid flow drastically changes the pattern of fluid transport. The parameter dependence of the results (seamount size, seamount numbers, permeability, etc.) will be discussed in the presentation in more detail.

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