論文 / 著書情報
Article / Book Information

題目(和文)	カムチャツカ半島北部の火成活動とテクトニクス
Title(English)	Magmatism and tectonics in the northern Kamchatka Peninsula
著者(和文)	西澤達治
Author(English)	Tatsuji Nishizawa
出典(和文)	学位:博士(理学), 学位授与機関:東京工業大学, 報告番号:甲第10731号, 授与年月日:2018年3月26日, 学位の種別:課程博士, 審査員:岩森 光,横山 哲也,中島 淳一,上野 雄一郎,太田 健二
Citation(English)	Degree:Doctor (Science), Conferring organization: Tokyo Institute of Technology, Report number:甲第10731号, Conferred date:2018/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

Summary of Ph.D. thesis

Magmatism and tectonics in the northern Kamchatka Peninsula

Tatsuji Nishizawa

Department of Earth and Planetary Sciences,
Graduate School of Science and Engineering,
Tokyo Institute of Technology

At the convergent boundary, especially at subduction zones, many geological phenomena such as seismic activities and volcanic activities, as well as long-term growth-extinction of the continental crust, occur and have attracted the attention of scientists. Of these phenomena, the mechanism and processes that drive the volcanic activities are enigmatic: Although magmatism in subduction zones is thought to be caused by interactions between a subducting slab, wedge mantle and the upper plate, the mechanism and processes for the arc magmatism are still poorly constrained in several essential geophysical and geochemical aspects.

The Kamchatka Peninsula located on the north side of the Kuril arc is one of the largest volcanic arcs in the world. It corresponds to the subduction of the northernmost part of the Pacific Plate. Associated with transition from the Kamchatka arc to the Aleutian arc, a trench-transform-transform type triple junction consisting of the Pacific Plate, the North American Plate and the Okhotsk Plate is formed. At the slab edge of the Pacific Plate, the mantle wedge opens to the north. Furthermore, the Emperor Seamount Chain is subducting beneath the northern Kamchatka from near the triple junction, which influences the deformation of the subducting Pacific Plate; slab dip is believed to shallow from 55° in the South to 35° in the North. This arc is characterized by the wide volcanic zone in the across-arc direction, which consists of three volcanic chains, and numerous extremely active and large volcanoes such as those in the Klyuchevskoy Volcanic Group (KVG), which potentially provides abundant information on the problems described above for the origin of arc magmatism.

Considering these points mentioned above, the northern part of Kamchatka is an important and the best area for revealing the mechanism and processes associated with seamount subduction and the dynamics along the plate edge. In this thesis, the effects and contributions of seamount subduction to arc magmatism and the thermal structure and the fluid distribution at the slab edge are discussed. Combining these results, as well as the new age and isotope data with the published data from literature, the mechanism of magmatism and the mantle dynamics beneath whole Kamchatka are also discussed.

The East Cone volcanic group (hereafter, EC) in a forearc area of the northeastern part of the Kamchatka peninsula is located ~60 km above the subducting slab. The EC lavas exhibit primitive characteristics and show variability in rock-type including high-Mg andesite (HMA) and relatively primitive basalts in spite of the relatively small range in time (0.73–0.12 Ma) and space (30 km × 60 km area). Olivine phenocrysts in the EC lavas also show different characteristics in each rock-type. Ultra-high-Ni olivine was observed in HMA, which contains ~6300 ppm Ni, the highest value recorded in arc lavas to date. The melting and crystallization conditions of these lavas indicate a locally warm slab, facilitating dehydration beneath the forearc region, and a relatively cold overlying mantle wedge fluxed heterogeneously by slab-derived fluids. It is suggested that the collapse of a subducted seamount triggered the ascent of Si-rich fluids to vein the wedge peridotite and formed a peridotite-pyroxenite source, causing the temporal evolution of local magmatism with the wide compositional range.

The north Sredinny Range (N-SR) (around 58°N) corresponding to the northern part of the third volcanic line and/or backarc area (SR) in the Kamchatka is located 100 km north beyond the north edge of the subducting Pacific Plate (slab edge). The magmatism started after the Lower Pliocene and continues to the Holocene. Lava plateaus were dominant during the Neogene, while monogenetic cones and/or stratovolcanoes are dominant during the Quaternary, with different volumes, rock textures, modal mineral compositions and bulk rock major and trace element compositions between the two stages. The N-SR lavas were estimated to have derived from flux melting of water-saturated mantle under a similar genetic pressure-temperature condition. The fluids contributed to the arc magmatism were derived from the subducting Pacific Plate or derived from the subducted Bering Plate, and/or the forearc slivers beneath the northern Kamchatka. The arc lavas exhibit high HFSE concentrations (~18 ppm Nb and ~1.2 ppm Ta) compared to the lavas from KVG, most of which were likely caused by the deep dehydration. These results suggest that the slab-derived fluids play an important role in the arc magmatism even in N-SR which is located north beyond the slab edge.

On the basis of geochemical, geological and geophysical observations (e.g., paleomagnetic estimates, seismological estimates and gravity data), the models of geotectonic history and tectonic evolution of Kamchatka have been suggested, which are roughly identical. However, there are differences in the models.

Utilizing the new geological and geochemical data in this thesis as well as data from literature concerning the age, composition and tectonic-geophysical setting over the Kamchatka Peninsula lead, the following are suggested. The geochemical data show a systematic change in the time and space. In the western side of Kamchatka, the magmatism started at least from the Miocene and the activity formed lava plateaus over the entire SR. Subsequently in the Lower Pleistocene, the magmatism expanded and shifted to the eastern side of Kamchatka, which corresponds to the present magmatism that forms monogenetic cone and/or stratovolcano along the volcanic front consisting the Eastern Volcanic Front and KVG. The systematic spatiotemporal change of magmatism in Kamchatka seems to be consistent with the tectonic evolution model that accompanied with the eastward smooth trench retreat and slab rollback in the Lower Pleistocene.

The new geochemical data of the N-SR lavas indicate that the arc magmatism have been occurred in the north beyond the slab edge where the subducting Pacific slab would not exist. Combining these characteristics, we proposed two scenarios for the origin of the Quaternary N-SR lavas; 1. Contributions of metasomatized mantle and/or fluids from the south of the slab edge, 2. Supplying slab-derived fluid from the subducted Bering Sea Plate and/or forearc slivers located in the north of the Pacific Plate. In order to further discuss the origin of the N-SR volcanism, better constraints on the seismic structure, as well as flow and thermal modeling, beneath the N-SR region would be required in future.