Press Releases

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JAMSTEC
Tokyo Institute of Technology

Subducted Seamounts Could Trigger Volcanic Activities

In the forearc area of the northeastern part of the Kamchatka Peninsula, monogenetic volcanic cones dated at <1 Ma were found with remarkable variations, including primitive basalt and high-Mg andesite containing high-Ni (up to 6,300 ppm) olivine. It is considered to be a consequence of the subduction of the Emperor Seamount Chain, which triggered the ascent of Si-rich fluids and formed a peridotite-pyroxenite source, causing the temporal evolution of local magmatism with wide composition range. This research project was led by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) and Tokyo Institute of Technology (Yoshinao Mishima, President) in collaboration with Russian Academy of Sciences, National Institute of Advanced Industrial Science and Technology, Chiba Institute of Technology, and The University of Tokyo.

The Kamchatka Peninsula is one of the largest volcanic arc in the world. It corresponds to the subduction of the northernmost part of the Pacific Plate. In the middle part of the peninsula, there is the subduction of the Emperor Seamount chain, which has known to be warmer than surrounding plates around the Seamount chain, though the volcano itself became inactive a long time ago. It has not been clear, however, how these subducted seamounts would affect volcanic activities on the Kamchatka Peninsula.

The research team's analysis suggests that it is likely that Si-rich fluid from subducted seamounts was temporarily supplied to an overlying mantle wedge near the trench, where no magmatism is usually observed, because of its warm nature to produce the fluid and cracks formed by the collapse of the subducted seamount. This Si-rich fluid also caused melting of mantle rocks of locally different compositions, which resulted in local and temporal magmatism of remarkable variations.

It indicates that subducted seamounts could trigger volcanic activities and lead to volcano formation even in an area where no volcanism usually occurs.

Around Japan, there are subducting seamounts. It has been pointed out that these seamounts may be related to occurrence of earthquakes, and this study newly suggests the possible relation of subducted seamounts to volcanism. To better understand the dynamic processes beneath the Japanese Islands, these findings are expected to make significant contributions.

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Title: Genesis of ultra-high-Ni olivine in high-Mg andesite lave triggered by seamount subduction

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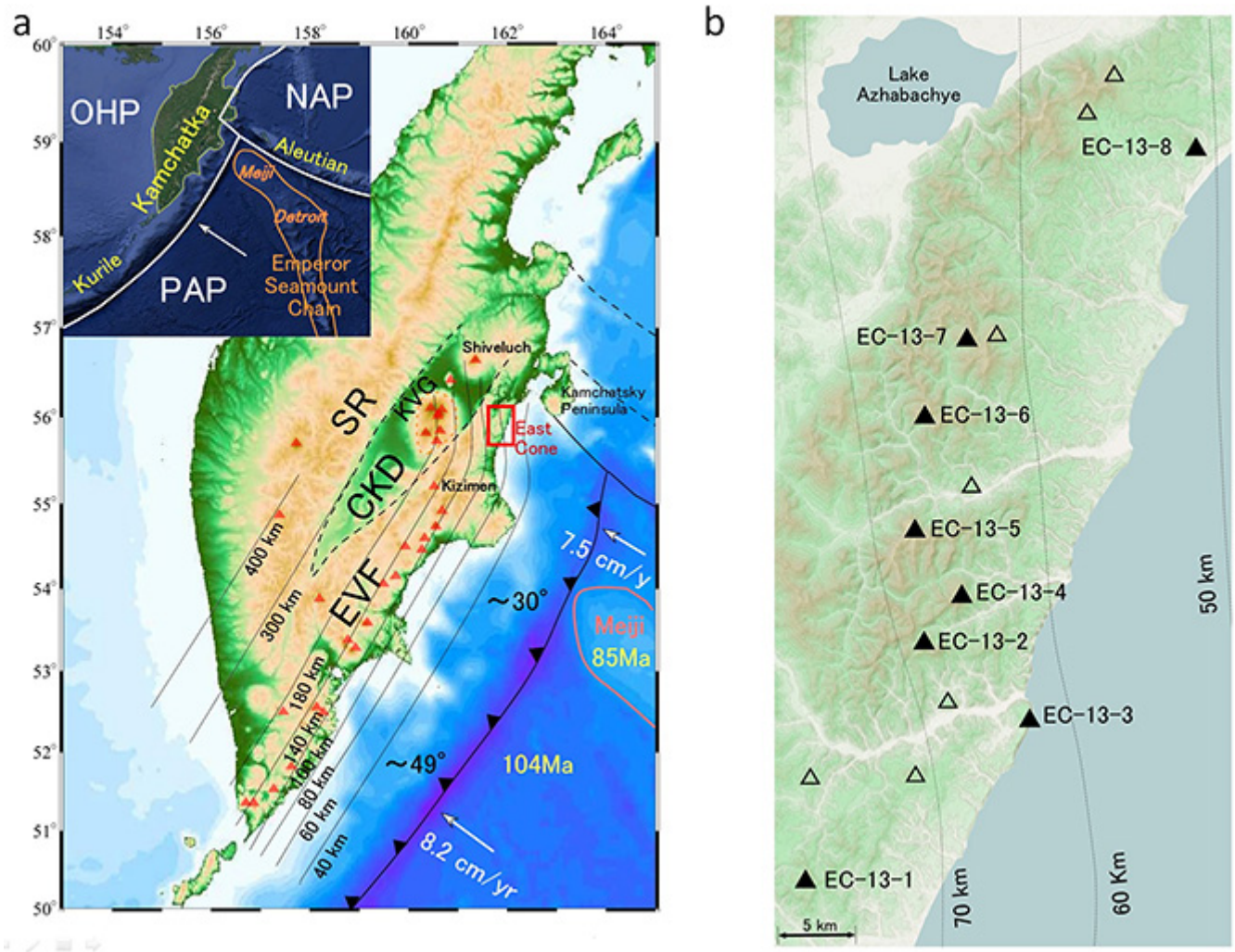

Figure 1. Plate tectonic setting and major geological structures of the Kamchatka Peninsula and detailed map of the studied area (East Cone Volcanic group: EC) (a) The inset shows the plate tectonic setting and location of the Emperor Seamount Chain that connects to the Hawaiian hotspot. The North American Plate (NAP),

Pacific Plate (PAP), and Okhotsk Plate (OHP) form a triple junction in this region. Plate configuration is after Seno, T., Sakurai, T. & Stein, J. Geophys. Res. 101, 11305–11315 (1996). White arrows indicate the motion vector of the Pacific Plate. Red triangles indicate locations of active volcanoes. Thin lines with numbers show depth of subducted Pacific Plate. Black dashed lines are from Erlich, E.N. & Gorshkov, G.S., Bull. Volcanol. 42, 1–298 (1979).
(b) Topographic map of studied area (EC). Black triangles indicate monogenetic cones of the EC, the true heights of which are 200–600 m and the relative elevation is ~200 m. The slab depth is 50–80 km (dotted lines) and the thickness of the crust is 25–30 km. Sampling was performed at the top and/or hillside on cones (filled black triangles) from which fresh lavas were obtained for use in this study.

Note: Fig. 1a was created by using Generic Mapping Tools. The inset was captured from Google Earth™ with the map data provided by NOAA, U.S. Navy, NGA, GEBCO. Fig. 1b was captured from OpenStreetMap with the map data provided by 、© OpenStreetMap contributors, CC-BY-SA. All figures were overlaid by using Canvas 11.

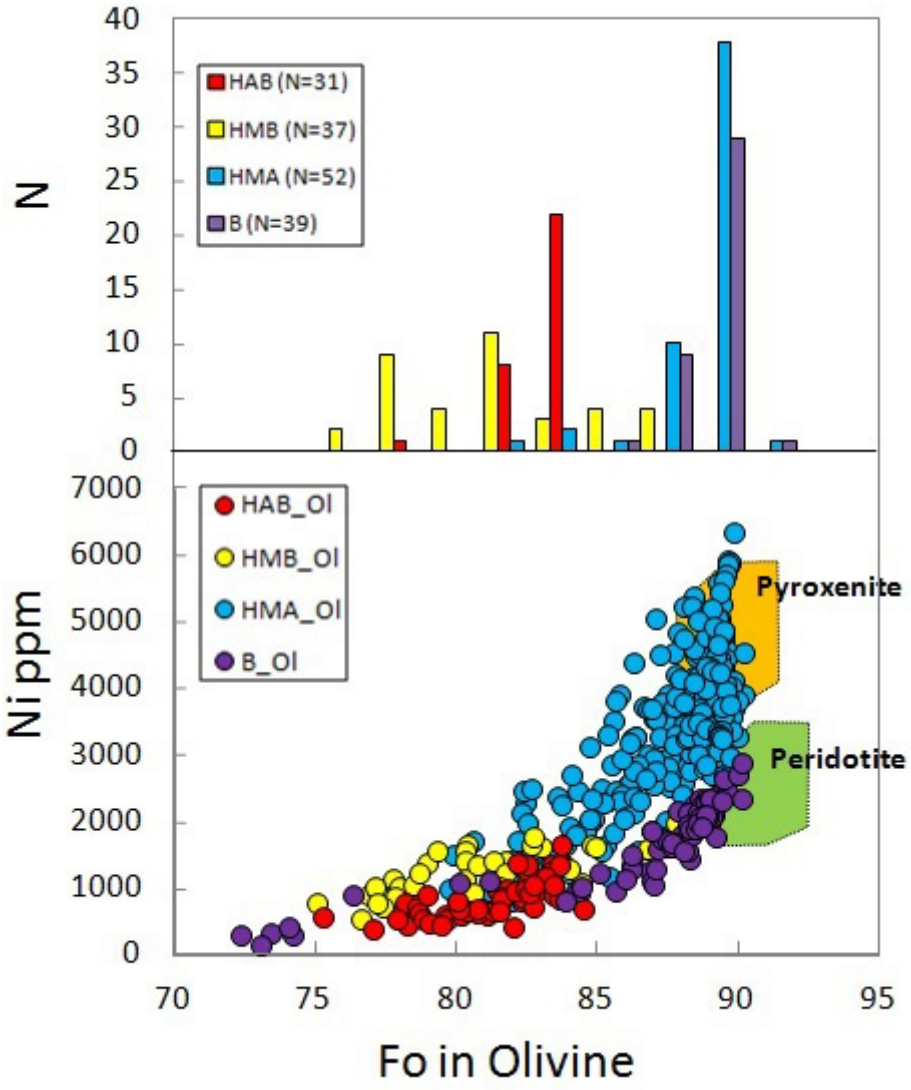

Figure 2. Ni abundance of olivine in the EC lavas. Olivine (Ol) of HAB, HMB, HMA, and B. The upper histogram shows the Fo composition of these cores. Green field and ochre field indicate compositional fields of Ol that crystallizes from melts in equilibrium with mantle peridotite and pyroxenites, respectively.

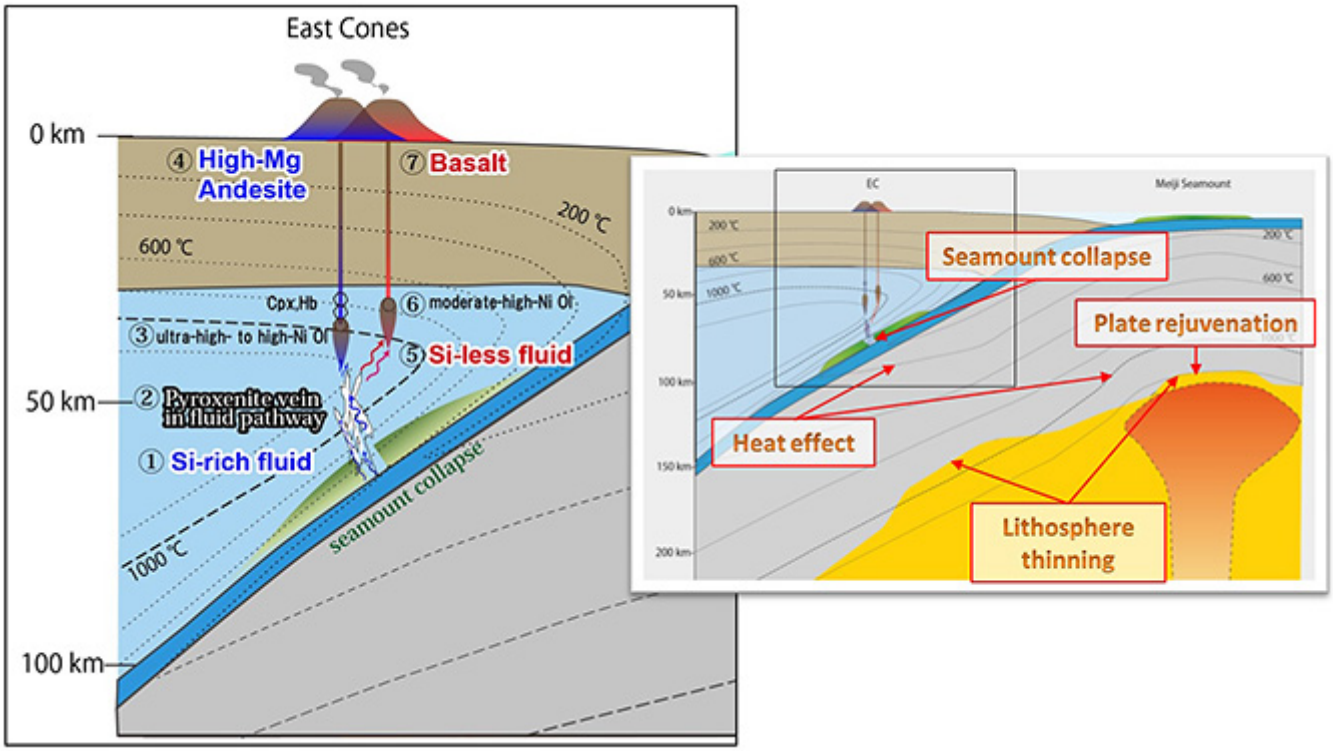

Figure 3. Cross section of northern subduction zone of the Kamchatka Peninsula and schematic model of EC magma generation.
Right figure shows overall cross-sectional view of the subduction zone and it represents why the subducted seamount is the cause of efficient slab dehydration just beneath the EC area (<80 km), via the following effects: thinning of the lithosphere, plate rejuvenation from a mantle plume, and formation of fluid pathway along cracks formed by the collapse of the subducted seamount.
Left figure (black frame part in right figure) focuses on the mantle wedge beneath the EC and it represents the genesis of EC lavas. Based on these effects, ① silica-enriched slab fluids are dehydrated from the subducted seamount and ② form pyroxenite veins in the mantle wedge, which are formed locally along fluid pathways. Its melting would ③ generate ultra-high-Ni melt and ④ crystallize ultra-high-Ni olivine (~6,300 ppm Ni) at the initial stage of crystallization in the mantle. Cpx also starts to crystallize from the initial stage and pargasitic hornblende breakdown by subsequent decompression. For subsequent stages, ⑤ the residual Si-less fluid would cause flux melting of peridotite to produce basalt with moderate–high-Ni olivine (~2,900 ppm Ni) ⑥ and ⑦. The black dashed lines indicate temperature contours from 200 to 1,200 °C with a contour of 200 °C intervals. The seamounts and EC are not drawn to scale.

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