Press Releases

February 26, 2018
JAMSTEC
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First Evidence Suggesting Asthenospheric Injection into Mantle Wedge of the Izu Arc

Overview
Scientists have identified two types of basalts with different zirconium contents collected from active backarc rift zone of the Izu arc in the northwest Pacific Ocean. Basalts collected at the Sumisu Rift show higher zirconium contents than those from the entire area of the active rift zone. In addition, it has become clear that the distribution of these basalts with higher zirconium contents corresponds with the anomalous zone of low seismic velocity of the underlying mantle wedge.

The backarc rifting of the Izu arc began at about 3 million years ago just behind the volcanic front and has made the Aogashima, Myojin and Sumisu Rifts from north to south (Fig. 1). High zirconium contents in basalts from the Sumisu Rift indicate the subducting slab surface beneath the Sumisu Rift is extremely hot because the high zirconium contents result from the melting of zircon of the slab surface. This high temperature and the low seismic velocity of the mantle wedge suggest that hot asthenospheric materials have been injected into the mantle wedge.

A typical example of back-arc basins is the Sea of Japan, which spread about 20 million years ago. The underwater "lost continent" of Zealandia in the South Pacific is believed to have separated from Australia due to the formation of backarc basins between the two continents. It has been pointed out that the opening of backarc basin may be related to the injection of deep asthenospheric materials. In this study, scientists have presented the first evidence supporting this hypothesis. Their findings indicate that asthenospheric injection could be a possible driving force of backarc basin opening.

This study project was carried out by a research student, Yasuhiro Hirai and Dr. Yoshihiko Tamura from the Japan Agency for Marine Earth Science and Technology (JAMSTEC: President; Asahiko Taira) in collaboration with Profs. Satoshi Okamura from Hokkaido Education University and Ryuichi Shinjo from University of the Ryukyus.

This work was supported by JSPS KAKENHI Grant Number JP17H02987.

The above study was published in *Geology* on February 24, 2018 (JST).
Title: Breakdown of residual zircon in the Izu arc subducting slab during backarc

rifting
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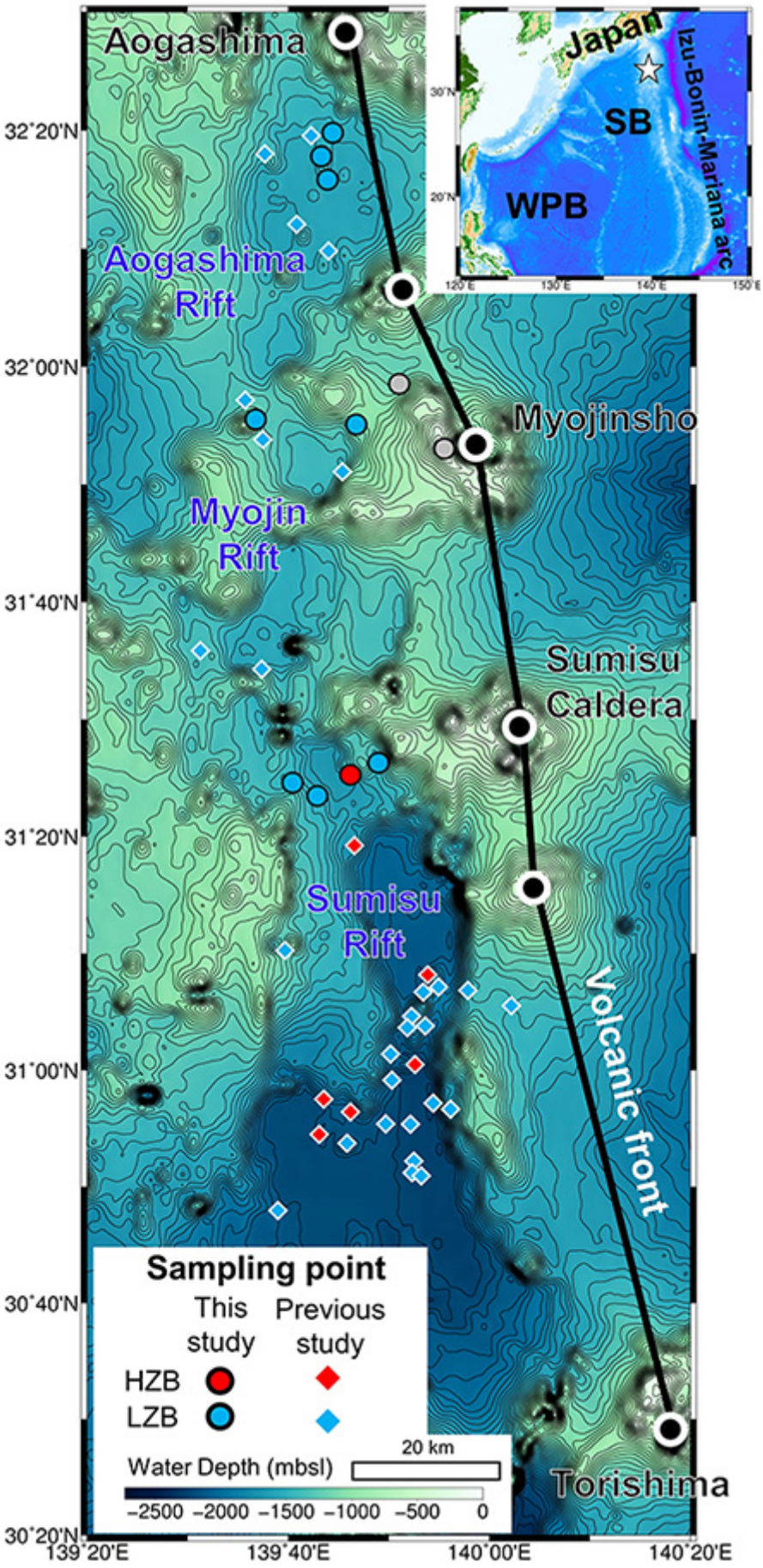

Fig. 1. Study area and sampleing points

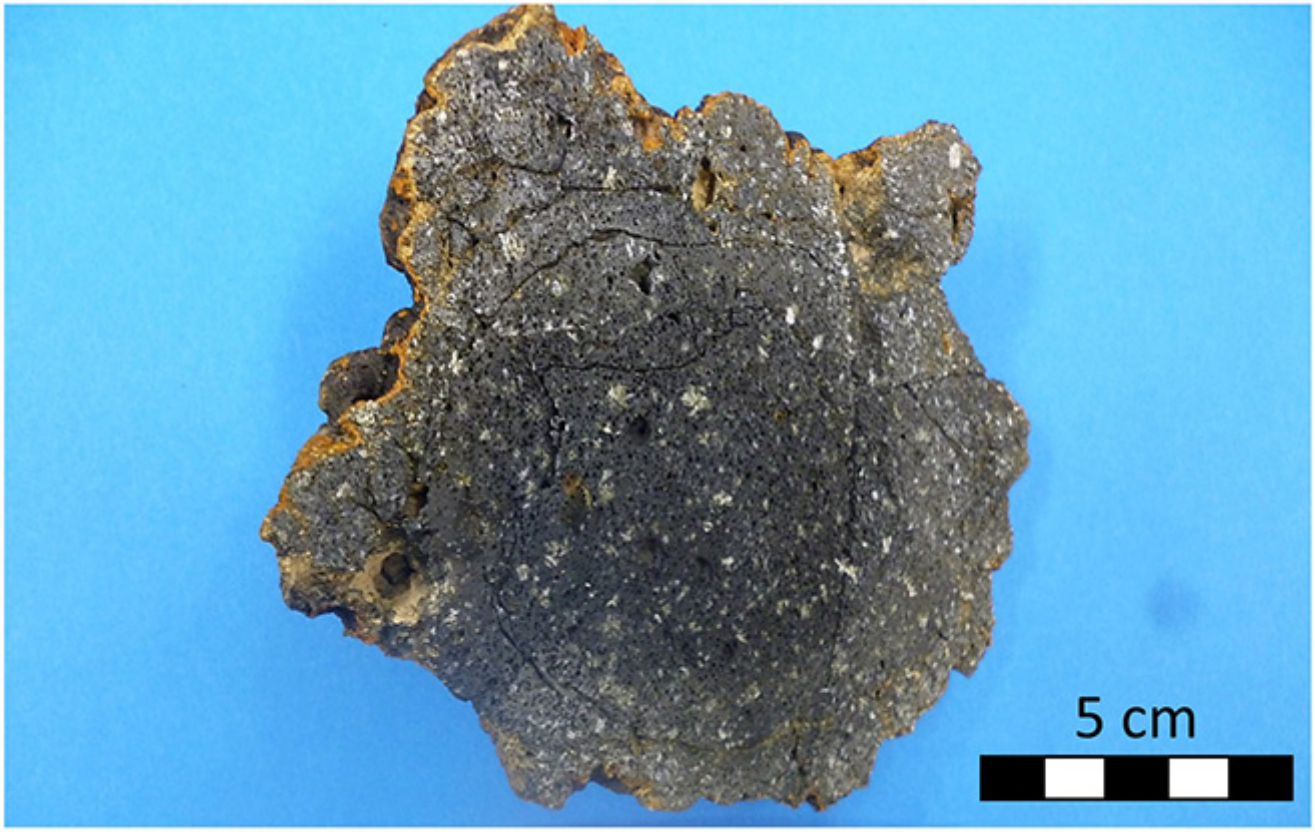

Fig. 2. A piece of lavas collected from the north of active Smisu Rift. High zirconium contents have been found in it.

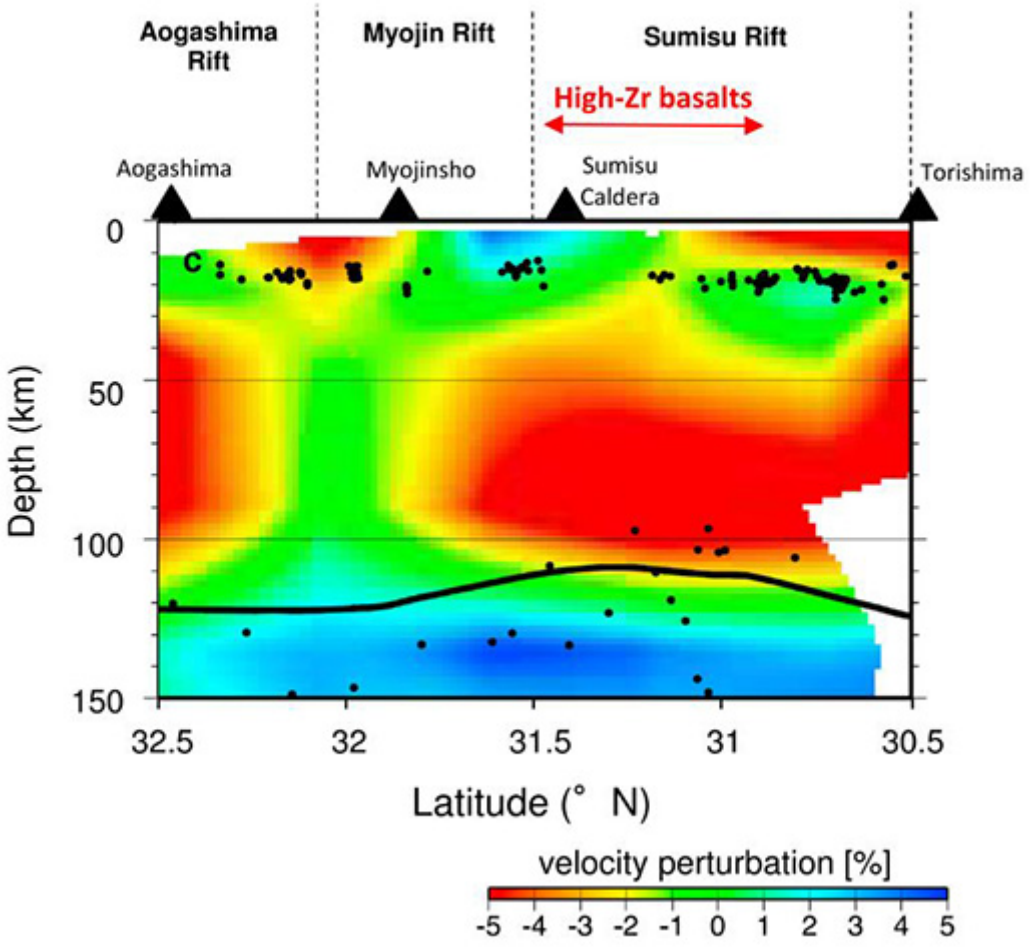

Fig. 3. Seismic wave (shear wave: S-wave) velocity perturbations beneath the volcanic front of the Izu-Bonin-Mariana arc.
Dashed lines represent the inferred boundary of each rift where the S-wave velocity structure is applied to the active rift zone. Black triangles are Quaternary volcanoes. The thick solid line and dots are the top of the subducting Pacific Plate and earthquakes within 20 km of the cross section, respectively.

By applying the S-wave velocity structure to the active rift zone, it is estimated that S-wave is remarkably slow beneath the Sumisu Rift. Basalts collected from these zones show high zirconium contents. S-waves travel slow through liquids or under high temperatures. If low-velocity anomalies are due to hot asthenosphere, heat from the asthenospheric materials may be causing the breakdown of residual zircon in the slab, which produces basalts with high zirconium contents.

* The figure of S-wave velocity structure has been modified from a figure quoted from Obana et al. (2010): Along-arc variation in seismic velocity structure related to variable growth of arc crust in northern Izu-Bonin intraoceanic arc: Geochemistry Geophysics Geosystems, v. 11,
Q08012, http://onlinelibrary.wiley.com/doi/10.1029/2010GC003146/full

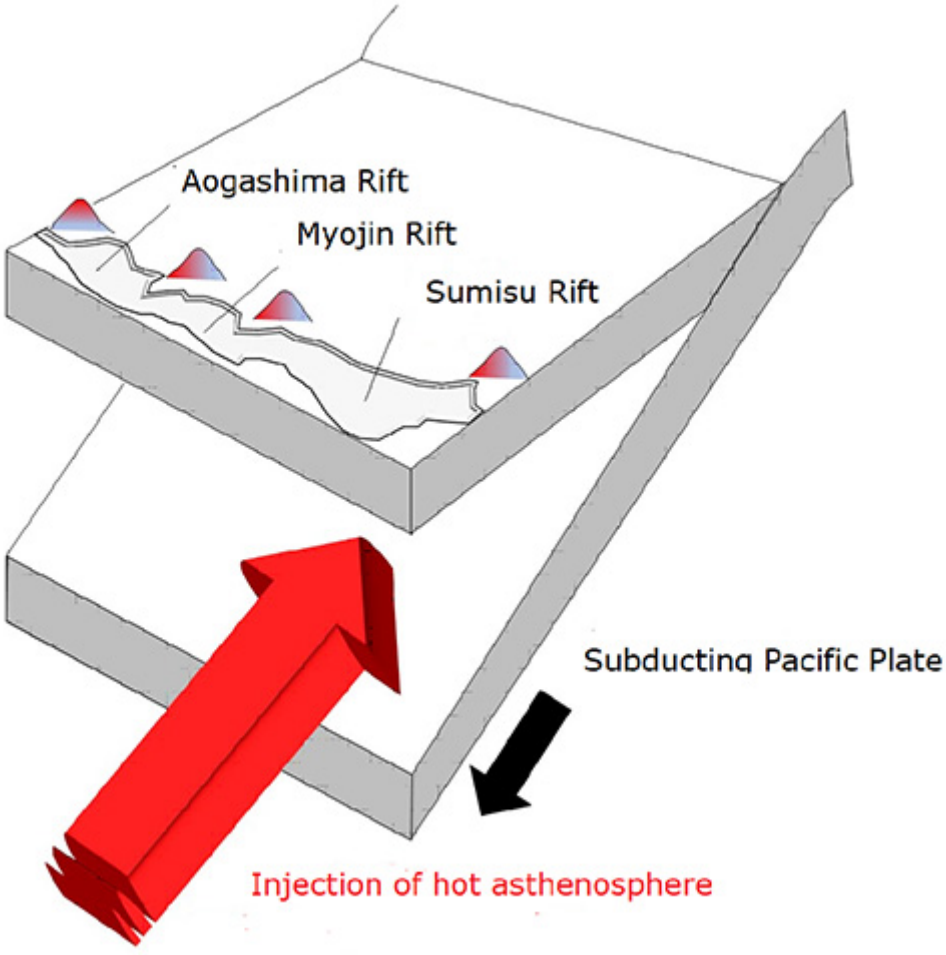

Fig.4. Conceptual diagram of this study
Basalts with high zirconium contents were found only at Sumisu Rift. It indicates that the temperature of the subducting Pacific Plate is becoming very high. In addition, existence of seismic low-velocity zones under the Sumisu Rift suggest increasing temperature of the subducting Pacific Plate due to injection of asthenospheric materials into the Plate.

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