Press Releases

December 16, 2016
JAMSTEC

Ascending Mantle Plume in the Society Hotspot
- A step to elucidate mantle dynamics -

Overview

A research team led by Dr. Noriko Tada at Department of Deep Earth Structure and Dynamic Research, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) conducted a seafloor magnetotelluric[*1] survey in the Society hotspot in the South Pacific. It successfully obtained the first image of three-dimensional high electrical conductivity anomaly in the upper mantle beneath the Society hotspot. The scientists have interpreted the high-conductivity anomaly as evidence of the high melt fraction, which is robust regardless of assumed temperature, and existence of carbonated silicate melt beneath the hotspot. This anomaly seems to be continuous from the lowest part of the upper mantle to a depth of approximately 50 km below sea level. The features of the anomaly strongly indicate the upwelling of volatile-rich, partially molten material in the upper mantle beneath the hotspot. These results suggest that the Society hotspot is a pathway for ascending volatiles from the deeper part of the upper mantle to the surface. This work was carried out in collaboration with Institut Universitaire Européen de la Mer and Earthquake Research Institute, the University of Tokyo.

To understand the mantle convection and its mechanism, it is indispensable to understand the properties of ascending plum as well as the subducting plate. By focusing on electrical conductivity of the earth's interior, it has become clear that mantle plume contains more abundant H_2O and CO_2 than the surrounding mantle, which indicates that ascending of mantle plume is affected by buoyancy depending on different properties.

These results are very significant in elucidating the composition of H_2O and CO_2 in the Earth's mantle for further understanding of mantle dynamics.

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The above results were published in the *Geophysical Research Letters* online first on December 13, and the volume 43 Issue 12 on December 16, 2016 (JST).

Title: Electromagnetic evidence for volatile-rich upwelling beneath the Society hotspot, French Polynesia

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*1 Magnetotelluric (MT) is a geophysical exploration method for measuring the physical properties of the subsurface using the earth's magnetic and electric fields based on subsurface and submarine observations.

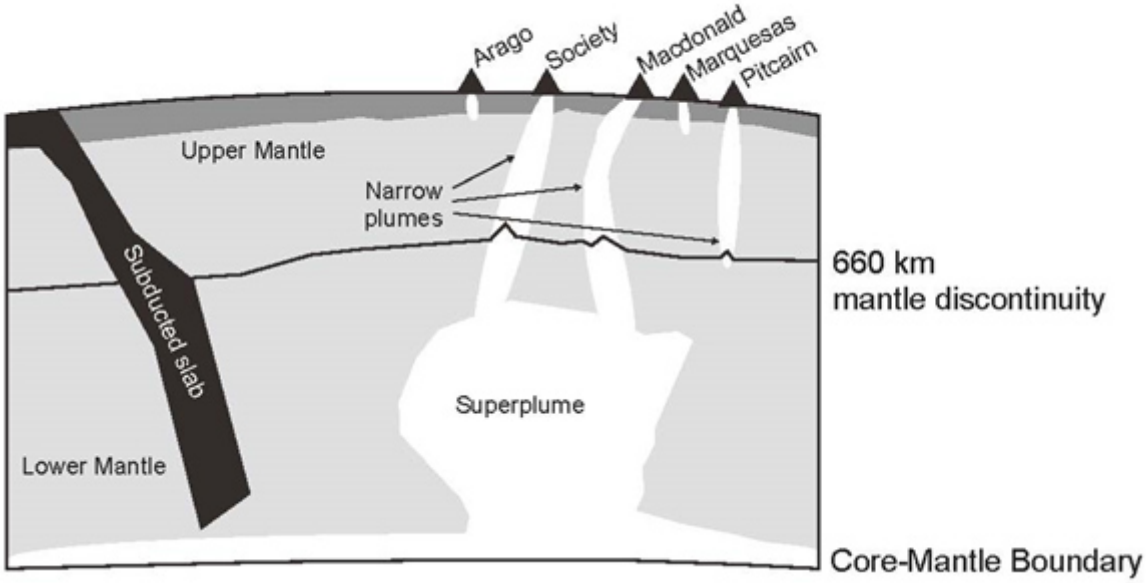

Figure 1. (Revised from Figure 14, Suetsugu and Hanyu in 2013)
The study has revealed that the mantle plume forming the Society Islands is ascending from superplume in the lower part of the mantle.

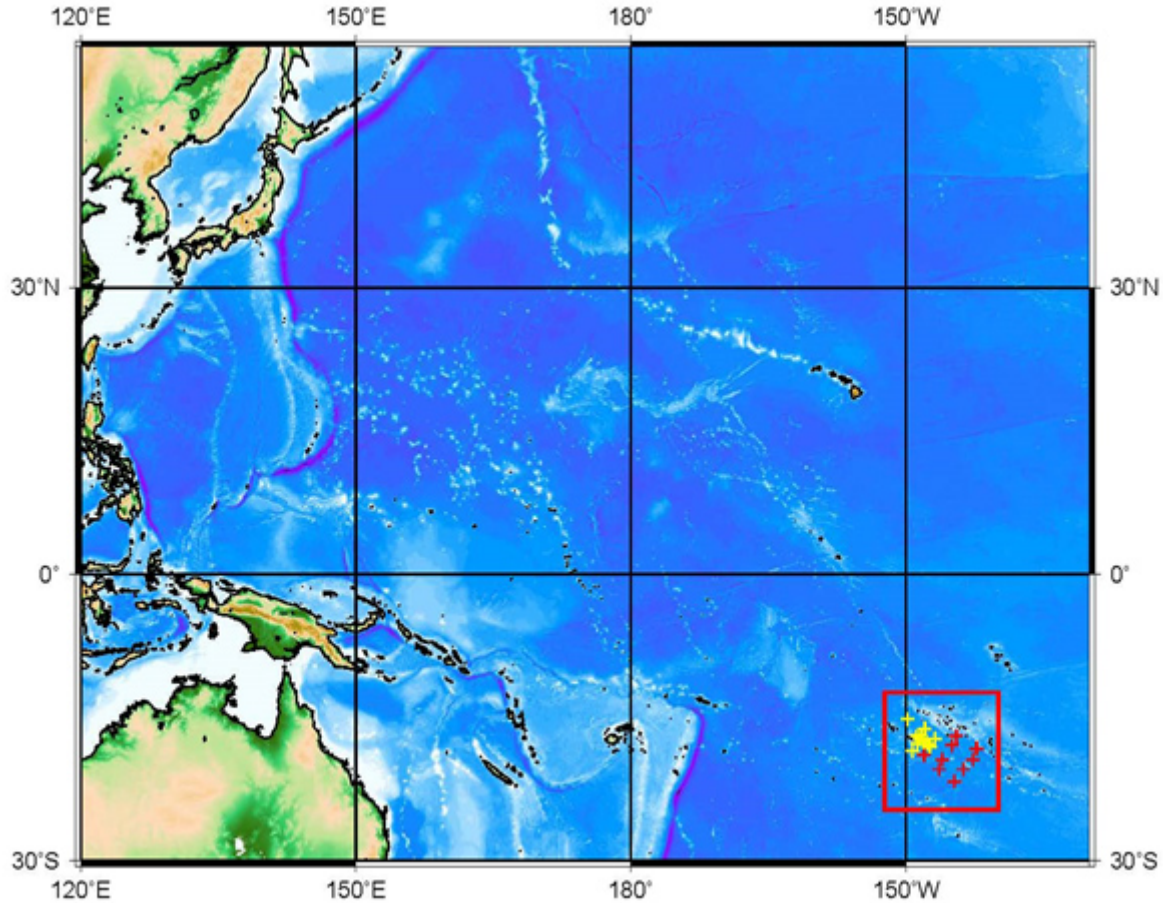

Figure 2. Location of observatory points. The red plus signs indicate locations where the researchers obtained data between 2009 and 2010, while the yellow in 1990s. The red box indicates the area shown in the figure 3.

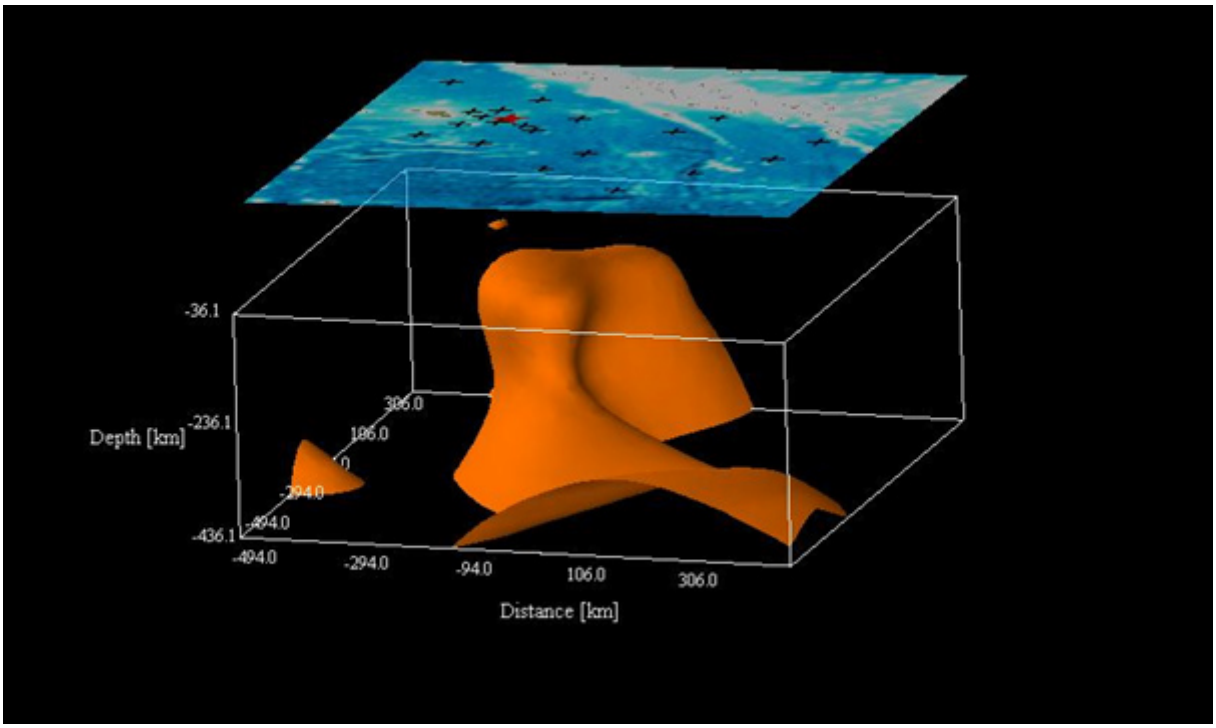

Figure 3. Three-dimensional electrical conductivity model obtained by a three-dimensional inversion analysis of the MT data. The high-conductivity anomaly beneath the Society hotspot is depicted as the iso-surfaces of 0.3 S/m (orange). The origin of the horizontal directions is defined at the location of the Society hotspot.

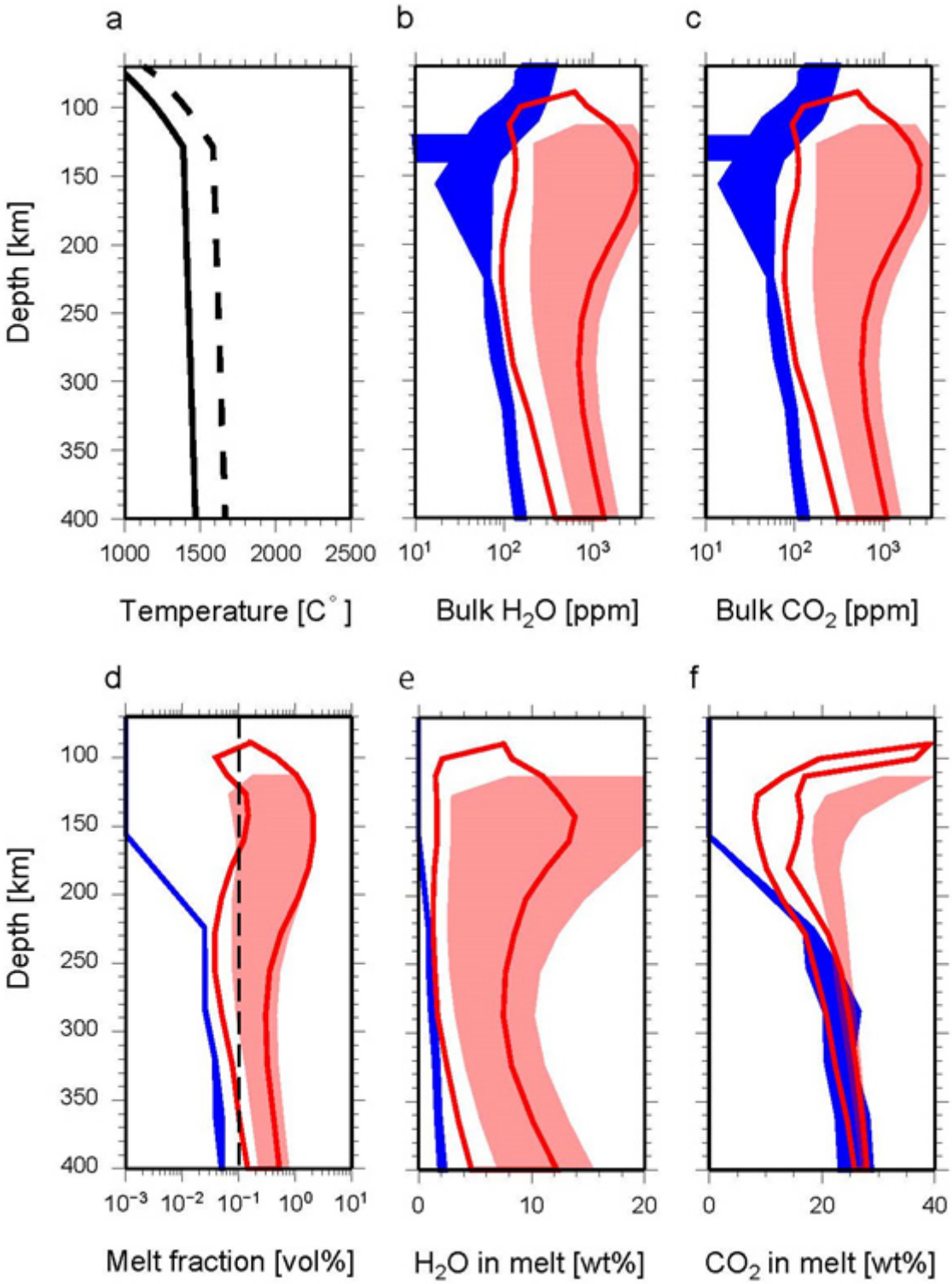

Figure 4. Melt fraction and H_2O and CO_2 contents estimated in this study. (a) The solid line shows the temperature profile assumed in this study, while the dashed one shows the temperature profile assuming that the temperature of the mantle plume is 200°C higher than that in the surrounding mantle. (b)-(f) The red and blue regions indicate the ranges of each parameter for the mantle plume and the surrounding mantle, respectively, assuming the temperature profile of the solid line. The red solid lines mark the ranges of the estimated values for the mantle plume when the temperature profile is that shown in the dashed line.

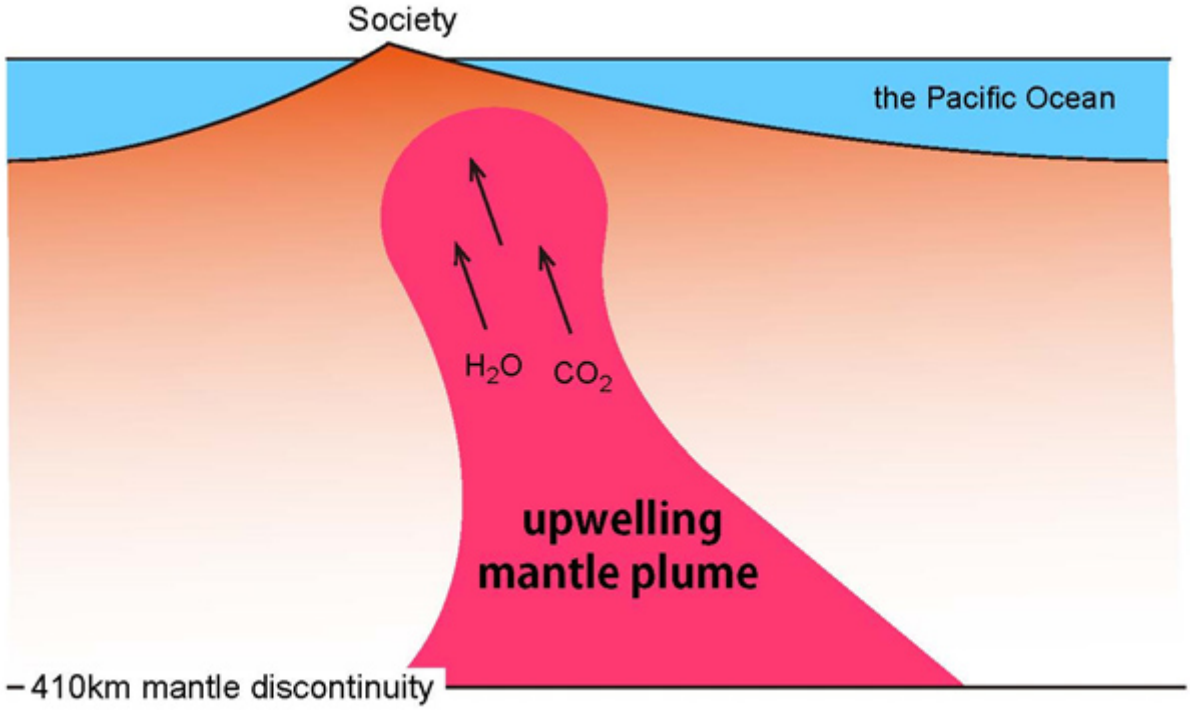

Figure 5. Model proposed by this study.

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