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Full-waveform inversion of the OBS data from the Japan Trench area affected by the petit-spot volcanism

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Petit-spot volcanoes, recently discovered volcanic structures, have significantly enriched our understanding of intraplate volcanism, particularly occuring in response to plate flexure during subduction. Discovery of these volcanoes in the vicinity of the Japan Trench marked a milestone showcasing the profound impact of tectonic processes on the intraplate volcanism and supporting the existence of small-degree melts at the base of the lithosphere.

One of the key question marks surrounding the petit-spot volcanoes is the extraction and ascent of melts to the seabed that would required development of lithospheric-scale fractures. As for now, no physical model has been devised to validate this hypothesis. The complexities involved in understanding the intricate genesis of petit-spot volcanism underline the need for its further investigation with innovative approaches.

In 2017 Japan Agency for Marine-Earth Science and Technology (JAMSTEC) carried out an active seismic survey to investigate the geological setting impacted by petit-spot volcanism in the trench-outer-rise region of the Japan Trench. During the survey 40 ocean-bottom seismometers (OBS) were deployed at 2 km intervals along an 80-km long 2D receiver profile, coupled with the firing of 983 air-gun shots at 100 m intervals along an extensive 100-km shooting profile. The resulting dataset creates an opportunity for in-depth analysis of subsurface and holds the potential for constructing a high-resolution velocity model with full-waveform inversion (FWI).

In this work we use first arrival traveltime tomography and time-domain acoustic FWI to reconstruct P-wave velocity model at the wavelet resolution. We push the inversion up to 8 Hz, which allows us to delineate sharp velocity contrasts within the incoming plate that are likely related to the petit-spot volcanism phenomenon occurring in this region. The resulting velocity model promises to contribute to our comprehension of intraplate volcanism, offering a perspective on the broadening of our understanding the underlying processes causing intraplate volcanism.