Imaging the fossils of magma supplying system: Electrical resistivity structure of the Mt. Okue batholith

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The shape of magma supplying system in the crust has been imagined by many studies. The classic image is that a single or multiple spheroids magma chambers are connected by dikes or narrow magma pathways. On the other hand, recent studies have suggested the magma system extends vertical column-shape in the crust (Cashman et al., 2017). The proposed system is that the majority of magma reservoirs were assumed to be mush state with the crystals content over 40-50 %. Several lenticular magma regions with low crystal content < 40-50 % are connected each other, and are totally surrounded by mush magma region. The mush magma is relatively immobile, while the low crystal content magma is considered to be highly mobile and eruptible. Although the column-like shape electrical conductors are frequently imaged beneath active volcanoes (e.g., Bertrand et al., 2012, 2013; Comeau et al., 2015; Aizawa et al., 2014), it is difficult to judge whether they correspond to the transcrustal ascending magma system or zone of other electrical conductive material, such as volatiles (e.g., Aizawa et al., 2014) and graphite (Bedrosian et al., 2018).
When magma reservoirs are completely solidified, they are imaged as electrical high-resistivity bodies (e.g., Aizawa et al., 2014, Bedrosian et al., 2018). In the area around Mt. Okue, Japan, a granitic batholith and surrounding ring dikes, which intruded 14 Ma and later, are exposed on the surface (Takahashi, 1984). The granitic batholith (33 x 23 km), which is a fossil of a magma reservoir, have little pore space and fracture, and is expected to show electrical high resistivity. The purpose of this study is to image the shape of fossils of the magma supplying system beneath Mt. Okue by estimating the subsurface resistivity structure.
We conducted 84 broadband MT observations around Mt.Okue in 2015, 2017 and 2020. As a preliminary analysis, we estimated the 1-D resistivity structure by using the MT response function (0.003125 s - 3276.8 s) obtained from 84 observations sites. The obtained response function suggest the validity of 1-D assumption up to the period of 1s, which correspond to the surface to the depth of about 5 - 15 km with 10^3 - 10^4 Ωm uniform resistivity. The 1-D structures of 84 sites show that the high-resistivity zone approximately correspond to the area inside of the ring dykes. In particular, the extremely high resistivity zone is located on the western region inside of the ring dykes. These extremely high resistivity zone have the thickness over 15 km, and may be interpreted as the root of the batholith. The zone of seismic swarm is located at the western rim of the high-resistivity zone, while little earthquakes occur inside of the high-resistivity zone. This is consistent with the idea that the high-resistivity batholith is hard to fail, and earthquakes occur around the batholith (Bedrosian et al., 2018). In the presentation, we will show the 3-D resistivity structure.

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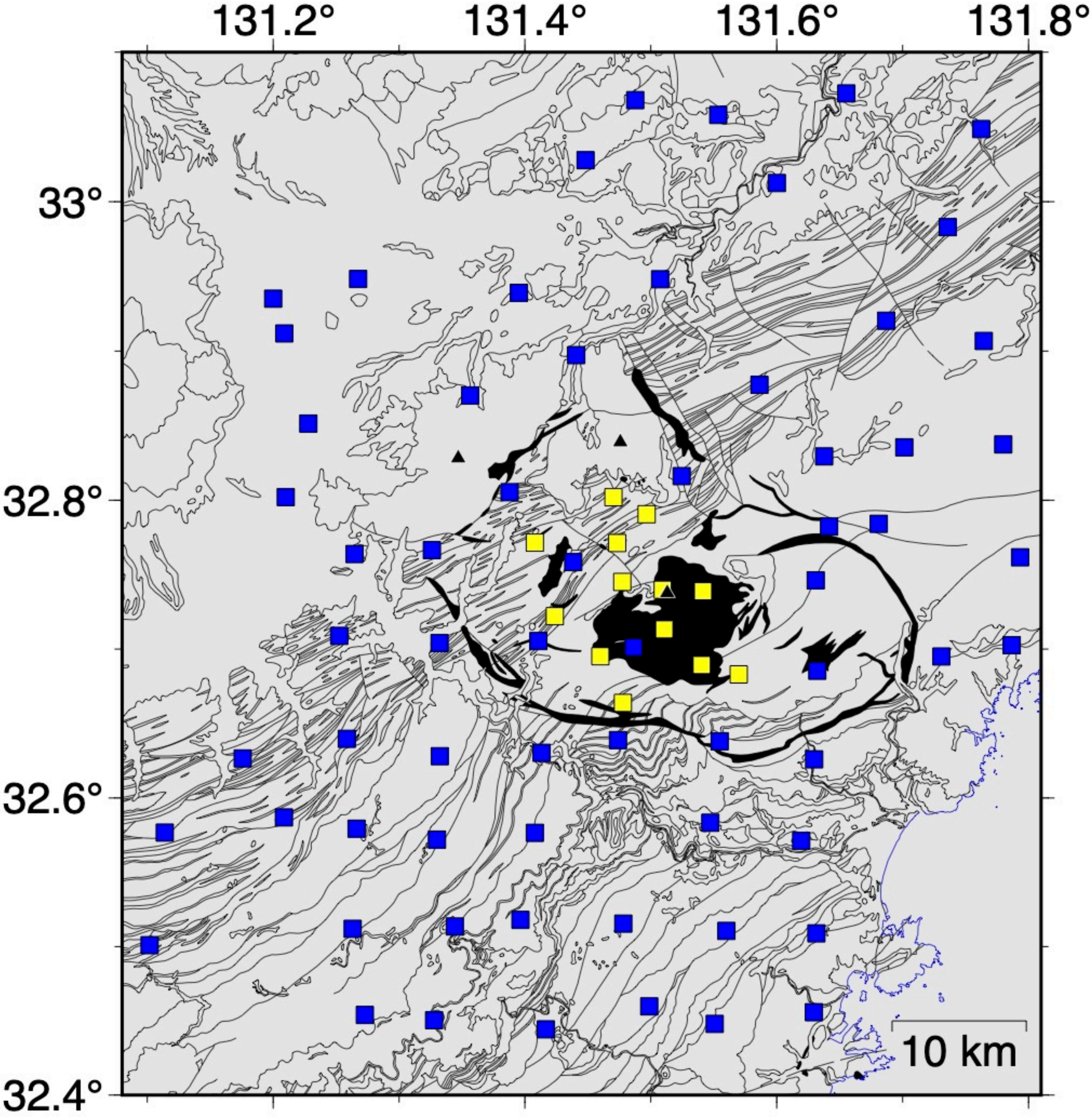

The black colored areas show the distribution of the batholith and ring dike around Mt.Okue;
Blue (in 2015 and 2017) and yellow (in 2020) squares show MT observation sites.

