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Toba and Yellowstone: similar different supervolcanoes

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Toba and Yellowstone are the supervolcanoes, where several world's largest caldera-forming volcanic eruptions occurred within the last several million years. These two volcanic systems appear to be of fundamentally different origin: Yellowstone is associated with the mantle plume, whereas Toba is the subduction-related volcano. Normally, the plume and subduction related volcanoes have different structures of magma conduits and erupt with completely different scenarios, but this is not a case of Toba and Yellowstone, which look very similar in many aspects. In this talk, we present recent results of seismic tomography studies for both supervolcanoes using different data types: P and S body waves from local earthquakes and teleseismic events, as well as surface waves derived from correlation of seismic noise. In the case of ambient noise tomography, we have estimated the radial anisotropy and found that beneath both Toba and Yellowstone calderas, there are strongly anisotropic bodies at depths below 5-7 km, which are interpreted as sill complexes containing a large amount of volatile contaminated silicic magmas. According to the travel time tomography studies using deep seismicity in the Toba case and teleseismic rays in the Yellowstone case, we found another reservoir located in the lower crust and in the uppermost mantle. In both cases, they seem to be separated from the upper crust's reservoirs. Based on comparison of these tomography results together with other geophysical and geological data, we have revealed several similar features and proposed a common scenario of the volcano feeding systems. The anomaly located just below the crust, beneath each of these volcanic complexes is interpreted as a large body of hot partially molten mantle basalts, containing basaltic melts, that which cannot ascend through the continental crust due to negative buoyancy. This body serves as a large heater and a source of volatiles that can easily propagate through the crust. These volatiles reach the upper crust and contaminate the partially molten silicic crustal rocks, containing silicic melts. When a critical amount of hot fluid-rich melts is accumulated in the upper crust, an avalanche-type process may lead to a catastrophic explosive eruption. This mechanism appears to be similar for both cases, except for the origin of the initial mantle heater.
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