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Seismic tomography reveals the feeding system of the Toba supervolcano from the slab to the shallow reservoir

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In the Toba Caldera, several large explosive eruptions occurred in the recent geological past, including the world's largest Pleistocene eruption 74,000 years ago. The major cause of this particular behavior might be the subduction of the water rich Investigator Fracture Zone (IFZ) just underneath the continental crust of Sumatra. We present a new model of the P and S seismic velocities beneath the Toba region based of inversion of the P and S arrival times from local seismicity recorded by two networks installed in 1995 and 2008. The derived seismic anomalies clearly reveal a complex multilevel magma system beneath Toba. A large amount of volatile enriched melts is generated in the subducting IFZ at ~150 km depth that is visible as a low velocity anomaly and increased seismicity. The fluids may react with peridotites in the mantle wedge and transform them into phlogopite or amphibole bearing rocks having lower melting temperature. The ascending flow of partially molten magma is expressed as a vertical low-velocity anomaly. At depths of 30-50 km, it forms a large reservoir with strong negative anomaly of shear velocity and much weaker P-wave velocity anomaly that testifies the presence of significant amounts of melt. Following the -7% contour line of the S-wave velocity anomaly, we estimate its volume as 100x25x20=50,000 km3. Differentiated light and volatile enriched fractions from this reservoir are buoyant enough to ascend into the upper crust and to form the shallow silicic magma reservoir, which is directly responsible for supereruptions. The results of our tomographic model suggest that the Toba magma generating engine continues to be active at present and, despite its current period of inactivity, this volcano might generate strong eruptions in the future.