Montserrat Island (Lesser Antilles Arc) is composed of three andesitic volcanoes: Silver Hills (2600-1200 ka), Centre Hills (950-550 ka), and currently active Soufrière Hills (SHV; 170 ka-present). Our 3D seismic velocity model of Montserrat shows the presence of a low velocity volume beneath SHV, which contrasts with the high velocities found beneath Silver Hills and Centre Hills. The temperatures required to explain the low seismic velocities beneath Soufrière Hills exceed the andesite solidus, indicating that melt is present.

We integrated the tomographic results with numerical simulations of magma chamber growth by accretion of sills. The temperatures and melt fractions predicted by the simulations were used to produce synthetic velocity anomalies, which were compared with the tomographic anomaly. The results are consistent with a magma chamber 2-4 km in diameter with a top at 5.5 km depth (consistent with petrology) and extending to at least 7.5 km depth, i.e. a deeper and larger chamber than assumed in some previous studies. A second deeper chamber, beyond reach of current tomography, has been proposed in some studies. Our models cannot distinguish between chambers slowly and steadily growing over a few thousand years and chambers rapidly growing during shorter episodes interrupted by long reposes. However, a slow rate growth over more than a few tens of thousand years produces temperatures inconsistent with observations.