

Earthquake-volcano interactions in the 2016 Kumamoto earthquake area

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The 16 April 2016 Kumamoto earthquake (M 7.3) took place in north-central Kyushu where several active arc volcanoes exist (e.g., Aso, Kuju, Tsurumidake, and Unzen) due to the active subduction of the Philippine Sea (PHS) plate beneath the Eurasian plate. On 8 October 2016 the Aso volcano erupted, which may be related to the occurrence of the Kumamoto earthquake. Many previous studies have suggested that earthquakes and volcanoes can interact with each other in subduction-zone regions. To investigate the possible earthquake-volcano interaction in Kyushu, in this work we study the three-dimensional seismic velocity (V_p , V_s) and attenuation (Q_p and Q_s) structures in the source area of the 2016 Kumamoto earthquake (M 7.3) using ~62,000 P and S wave arrival times and 48,000 t^* data measured from digital seismograms of 742 local shallow and intermediate-depth earthquakes recorded by the Hi-net stations in Kyushu Island. Our results show that significant low-velocity (low-V) and low-Q (high attenuation) anomalies exist in the crust and mantle wedge beneath the volcanic front and back-arc area, which reflect hot and wet anomalies caused by convective circulation in the mantle wedge and fluids from the PHS slab dehydration. The PHS slab is imaged clearly as a high-velocity (high-V) and high-Q (low attenuation) dipping zone in the upper mantle. The 2016 Kumamoto earthquake occurred in a high-V and high-Q zone in the upper crust, which is surrounded and underlain by low-V and low-Q anomalies in the lower crust and upper mantle. These results suggest that the 2016 Kumamoto earthquake took place in a brittle seismogenic layer in the upper crust, but its rupture nucleation was affected by fluids and arc magma ascending from the mantle wedge. In addition, a prominent low-V and low-Q zone is revealed in the forearc mantle wedge beneath Kyushu, which reflects serpentinization of the forearc mantle due to abundant fluids from the PHS slab dehydration. These results suggest that arc magma and fluids play an important role in the generation and nucleation processes of large crustal earthquakes which can in turn rupture the active faults and produce new cracks in the crust, facilitating the volcanic eruption. As a result, earthquake-volcano interactions take place in north-central Kyushu.

Keywords: Kumamoto earthquake, volcanoes, Kyushu, subduction zone, Philippine Sea plate