

Signs of magma ascent in LP and VLP seismic events and link to degassing: an example from the 2010 explosive eruption at Merapi volcano, Indonesia

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The link between seismicity and degassing is investigated during the VEI 4 eruptions of Merapi volcano (Indonesia) in October and early November 2010. Seismicity comprised a large number and variety of earthquakes including Volcano-Tectonic events, a sustained Long Period Seismicity (LPS), i.e., Long-Period events (LP), Very Long Period events (VLP) and tremor. LP seismicity is ascribed to the excitation of fluid-filled cavity resonance and inertial displacement of fluids and magma. During the eruption, Merapi released more than 0.4 Tg of SO₂. We investigate here LPS that occurred between 17 October and 4 November 2010 to get insights into the volcano eruption processes which preceded the paroxysmal phase of the eruption on 4-5 November. We proceed to the moment tensor inversion of a well recorded large VLP event during the intrusion phase on 17 October 2010, i.e., before the first explosion on 26 October. By using two simplified models (crack and pipe), we find a shallow source for this VLP event at about 1 km to the South of the summit and less than 1 km below the surface. We also analyse more than 100 LP events that occurred during the multi-phase eruption (29 October - 4 November). We show that most of them have a dominant frequency in the range 0.2-4 Hz. Within the 31 clearest LP events, at least 3 clusters occurred successively. We interpret them as generated by different fluid-containers in the summit area, possibly excited by the magma rise. We observe significant variations of the complex frequency during the course of the eruption. We discuss these changes in terms of a variable ratio of fluid to solid densities and/or by possible conduit geometry change and/or permeability of the conduit or the edifice, in relation with the release of magma/gas during main eruptive phases. Finally, we also discuss how the major explosions of the eruption were potentially triggered by passing waves, resulting from regional tectonic earthquakes on 3 and 4 November.