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Seismic velocity and attenuation tomography models beneath the Lunayyir basaltic field (Saudi Arabia) reveal the activation of magma sources

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We present the tomography models of P- and S-velocities and S-wave attenuation in the crust beneath the Cenozoic basaltic field of Lunayyir (western Saudi Arabia), where a strong seismic swarm occurred in 2009. The velocity models (P- and S-velocity and Vp/Vs ratio) were computed based on travel times from 1879 local events (8904 P- and 10579 S-picks). The calculations were performed using the LOTOS code. The resulting model shows that the seismicity swarm area coincides with a contact zone between high and low velocities. At the same time, the swarm area is characterized by high values of Vp/Vs ratio which indicates to the presence of fluids and melts in the fracture zone. The attenuation tomography inversion uses coda information from the S-wave arrivals of over 300 strong events (M>3.5) with the clearest signal. The obtained 3D attenuation model distinguishes the low-attenuation zones corresponding to the rigid basaltic cover at shallow depths. At greater depths, we detect a high-attenuation anomaly coinciding with the main seismicity cluster. We propose that this zone corresponds to the upper part of the conduit area ascending from deeper magma sources. Fluids and melts from this conduit appear to reach a depth of $\sim$2 km. We cannot exclude this scenario from being repeated during the next activation phase in another place where the crust is weaker, which makes a new eruption at Harrat Lunayyir plausible.