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Imaging subsurface density structure in Luynnier volcanic field, Saudi Arabia, using 3D gravity inversion technique

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On 19 May, 2009, an earthquake of magnitude (M=5.4) shocked the most volcanically active recent basaltic fields, Luynnier volcanic field, northwestern Saudi Arabia. This event was the largest recorded one since long time ago. Government evacuated the surrounding residents around the epicenter for over 3 months away from any future volcanic activity. The seismic event caused damages to buildings in the village around the epicenter and resulted in surface fissure trending in NNW-SSE direction with about 8 km length.

Seismologists from Saudi Geological Survey (SGS) worked out on locating the epicenter and the cause of this earthquake. They collected seismic data from Saudi Geological Surveys Station Network as well as installed broadband seismic stations around the region of the earthquake. They finally concluded that the main cause of the M=5.4 event is dike intrusion at depth of about 5 km (not reached to the surface).

In the present work, we carried out detailed ground/airborne gravity survey around the surficial fissure to image the subsurface volcanic structure where about 380 gravity stations were recorded covering the main fissure in an area of 600 km2. Gravity data was analyzed using CET edge detection tools and 3D inversion technique. The results revealed that, there is a magma chamber/body beneath the surface at 5-20 km depth and the main reason for the M=5.4 earthquake is tectonic settings of the Red Sea. Additionally, the area is characterized by set of faults trending in NW direction, parallel to the Red Sea, and most of the volcanic cones were located on faults/contacts implying that, they are structurally controlled. The 8-km surficial crack is extended SE underneath the surface.