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Detailed Gravity Analysis of the Erebus Volcano, Antarctica.

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Erebus volcano, Antarctica, is a polygenetic stratovolcano located on Ross Island at the southern end of the Terror Rift within the West Antarctic Rift System. The volcano is constructed of phonolitic lavas overlying older more basic basanite to phonotephrite lavas. The summit region has two distinct caldera rims formed over the last 95 ka. The calderas are filled with minor pyroclastic deposits extensive lava flows and the summit crater and cone which hosts a persistent lava lake. Numerous geothermal features occurring in the summit area are warm ground, fumarolic ice towers and ice caves melted into the snow and ice cover. . Of major importance is the persistent convecting phonolite lava lake. The lake is the exposure top of a multi-branched, magma-filled conduit system. Infrequent Strombolian eruptions from the lake eject phonolite lava bombs up to 1 km distance. A detailed gravity survey was undertaken to investigate the subsurface structure of the conduit system, to compliment a detailed 3D P-wave seismic tomography experiment that imaged the entire caldera region. The seismic data shows that the magma conduits feeding the lava lake are too small (<50 m) to be imaged and that most of the shallow magma resides NW of the lava lake and Inner Crater and at depths greater than 500 meters. The gravity survey had a station spacing between 50-200 meters was conducted within and surrounding the caldera. 190 gravity stations were occupied and with detailed DEM data (< 2m resolution within the caldera and 20m outside) were processed to complete Bouguer gravity anomalies. The Bouguer gravity anomaly map indicates a large amplitude (8 mGal) gravity minimum NW of the Inner Crater at the same location as the seismic velocity low. A variety of map transformation methods (e.g., wavelength filtering, polynomial trend surface, upward continuation, derivatives) were applied to determine the location of the subsurface conduit system. A first-order polynomial trend surface residual and residual gravity map created by upward continuing the data to 200 meters show that a gravity minimum dominates the western section of the caldera with the highest amplitude minima coinciding with the seismic velocity low. A smaller amplitude gravity minimum is located north of the lava lake and corresponds to the location of several large ice cave systems. Three-dimensional gravity inverse modeling of the residual gravity anomalies indicate that the caldera is underlain by low density material up to 3 km below the summit crater. The lowest density region resides approximately 1.5 km below the summit with at least three conduits leading to the near surface.