Monitoring changes in the active lava lake and Inner Crater at Erebus volcano, Antarctica using terrestrial laser scanning

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Active lava lakes are a rare and poorly understood phenomenon that provide unique opportunities to monitor the volcanic activity of an open magma conduit. We used an Optech ILRIS-3D terrestrial laser scanner (TLS) to monitor surface area and elevation changes of the active lava lake located within the Erebus Inner Crater and to detect deformation of the crater floor over four austral summer field seasons, from 2008 - 2012. TLS systems provide a portable tool for data collection in areas inaccessible due to terrain, heat, or volcanic gas emissions. The Erebus lava lake was scanned from the crater rim, 300 meters above the lava lake. Four to eight hours of continuous data were collected each season, despite sub-optimal conditions including minimally-reflective snow and ice, temperatures below operating specifications, and plume moisture. Raw point clouds were imported into PolyWorks where a matrix transformation and translation were applied. Alignments were further constrained by manually choosing stable reference points above the crater floor. Using the point cloud and GPS data, we saw a yearly 2-3 meter decrease in the average lava lake elevation and a meter-scale deformation of the crater floor. We scanned the lava lake continuously at 30 second intervals to obtain a time-series of elevation changes of the lava lake surface. The average elevation of five, meter-square areas on the lake surface was plotted against time. Elevation changes were cyclical and on the order of 0.5-1 meter, although bigger changes were seen during one eruption from the lake. Time-series plots showed a periodicity of 18 minutes in elevation changes for the lake in 2008 and 2009 and 13-11 minutes for 2010 and 2011. The decrease in the periodicity corresponds to a reduction in the lava lake surface area. Surface area of the lake was 1700 square meters in 2008 and 2009, but reduced to 800 square meters in 2010 and 500 square meters in 2011. These results show TLS to be effective in determining a continued reduction in volcanic activity and provide insight into the dynamics of the conduit system.