Geophysical Research Abstracts, Vol. 9, 11630, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-11630

Electrical resistivity monitoring of seepage and stability of the Tephra Barrier at Crater Lake, Mt Ruapehu, New Zealand

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Prior to eruptions in 1995 and 1996 the outlet of Crater Lake on Mt Ruapehu in the North Island of New Zealand was via a narrow channel on the south side of the lake. During the eruptions a tephra barrier was formed across the former outlet to a height of some 7-8 m above the original lake level, effectively damming the outlet. By early 2005 the lake had again reached the level of the original outlet, allowing water seepage into the barrier and raising the possibility of an eventual collapse, releasing a catastrophic lahar. The New Zealand Departments of Civil Defence and Conservation have undertaken regular monitoring of the barrier, installed early warning systems and developed an emergency plan in anticipation of such an eventuality.

In order to test whether the extent of the seepage could be measured (and monitored) by geophysical means, direct current (dc) resistivity surveys have been carried out across the barrier. Between the initial measurements, made in January 2005, and February 2006, a gradual decrease in resistivity above the old outlet gave the first indication that lake water was seeping into the barrier. Between October and December 2006 a rapid rise in lake level to only 2 m below the top of the barrier accelerated this process to the stage where 10-20 l/s of water was penetrating through the barrier and starting to cause erosion of the barrier on its downstream side. A further resistivity survey in January 2007 showed a huge decrease in resistivity throughout the entire barrier indicating it to be close to saturated. At this stage it was estimated that collapse of the barrier would occur within 1 to 2 months. At the time of writing the lake level is rising rapidly due to snow melt, and is only 1.5 m below the top of the barrier.