Geophysical Research Abstracts
Vol. 20, EGU2018-912, 2018
EGU General Assembly 2018

Hazards posed by large mass movements at Mount Meager volcano, Canada

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Large mass movements at volcanoes are major hazards. A volcanic collapse can transform into a highly mobile debris avalanche and travel long distances with devastating effects far from the volcanic edifice. Removal of large volumes of rock from a volcano by landsliding can decompress the magmatic system and trigger an eruption. Mount Meager is an unstable complex of young volcanoes in southwestern British Columbia, Canada. It is considered to be one of the most geologically active areas in Canada, with a long record of historic and pre-historic landslides and a large eruption about 2430 years ago. During the summer of 2010, the south flank of Mount Meager collapsed, generating a 53 million m3 debris avalanche, the largest historical landslide in Canada. From air photo analysis and field mapping, we documented 60 years of deformation prior to the event, characterized by a transition from slow gravitational slope deformation to catastrophic collapse and transformation of the failed rock mass into a multi-rheology debris avalanche. Following this event, we carried out a geomorphic study of the volcano to identify other unstable slopes and to characterize their motion. Using LiDAR, InSAR, and aerial imagery, we identified over 20 large instabilities with volumes up to several hundred million cubic metres. Some instabilities had lateral displacement rates exceeding 4 cm/month during the summers of 2015 and 2016. If these slopes fail catastrophically, the large landslides could impact populated areas downvalley. Decompression after such a collapse could affect the volcanic system. Preliminary numerical models of stress changes following a major collapse show decompression up to 4 MPa at 5 km depth, which might be enough to destabilize the system and trigger an eruption. The risk posed by large mass movements at Mount Meager has been deemed to be unacceptable. We recommend implementation of a permanent monitoring system at the volcanic complex.