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An integrated Distinct Element Modeling and Remote Sensing Study of the Barrier, British Columbia, Canada

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The Barrier is a steep, 250 m-high escarpment of dacite erupted from Clinker Peak in Garibaldi Provincial Park, British Columbia. The flow comprises four lobes, two of which (Lobes 3 and 4) came into contact with ice of the decaying Cordilleran ice sheet near the end of the Pleistocene. Lobe 3 was the source of a large (25 x 106 m^3) in 1855-1856 and a smaller event in 1977. The objective of this study was to determine the potential mechanisms responsible for the 1855-1856 landslide and the reasons why Lobe 4, which is similar geologically and geomorphically to Lobe 3, has not failed. This objective will be met using the numerical modeling code UDEC (Universal Distinct Element Code) by Itasca Consulting Group Inc. Primary UDEC model input parameters are slope dimensions, rock properties, and discontinuity parameters. The main challenges in modelling The Barrier are constraining the dimensions and rock material units of Lobes 3 and 4 and to obtain representative structural data. The depth of the lava flow and the morphology of the terrain beneath The Barrier are largely unknown, and previous studies provided few data on the geological structure of the lava flow. To this end, we undertook magnetic surveys to determine the three-dimensional form of Lobes 3 and 4. The surveys results were used to estimate the thickness of the lava flows and the inclination of the surface on which they rest. Long-range photogrammetry was used to build a high-resolution digital terrain model and to map discontinuities. Additional stability considerations are ice-contact structures within the volcanic rocks, particularly pseudo-pillow, column-on-column and sheet-like fractures. Survey results show that The Barrier is a complex rock slope, with many irregular discontinuities of different persistence and direction and with gradational transitions between structurally different rock units. Cohesion of rock bridges contributes to rock mass strength, and instabilities probably form through progressive failure, where non-continuous joints propagate and coalesce to form new fracture surfaces. This interpretation led us to use Voronoi tessellation in our model, allowing simulation of fracture propagation through intact rock. Column-forming large-scale fractures attributed to ice-contact cooling of the lavas were included in the model. Furthermore, some models include vertical discontinuities representing flow- or stress-related lineaments. These fractures were represented by distinct discontinuities because of their very high persistence and potential contribution to slope instability. Potential failure mechanisms for The Barrier failure indicated by the DEM Voronoi modelling results are presented.