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# Use of Structure-from-Motion Photogrammetry Technique to model Danxia red bed landform slope stability by discrete element modeling — case study at Mt. Langshan, Hunan Province, China

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Important to the evolution of Danxia landforms is how the rock cliffs are in large part shaped by rock collapse events, ranging from small break offs to large collapses. Quantitative research of Danxia landform evolution is still relatively young. In 2013-2014, Chinese and Slovak researchers conducted joint research to measure deformation of two large rock walls. In situ measurements of one rock wall found it to be stable, and Ps-InSAR measurements of the other were too few to be validated. Research conducted this year by Chinese researchers modeled the stress states of a stone pillar at Mt. Langshan, in Hunan Province, that toppled over in 2009. The model was able to demonstrate how stress states within the pillar changed as the soft basal layer retreated, but was not able to show the stress states at the point of complete collapse. According to field observations, the back side of the pillar fell away from the entire cliff mass before the complete collapse, and no models have been able to demonstrate the mechanisms behind this behavior. A further understanding of the mechanisms controlling rockfall events in Danxia landforms is extremely important because these stunning sceneries draw millions of tourists each year. Protecting the tourists and the infrastructure constructed to accommodate tourism is of utmost concern.

This research will employ a UAV to as universally as possible photograph a stone pillar at Mt. Langshan that stands next to where the stone pillar collapsed in 2009. Using the recently developed structure-from-motion technique, a 3D model of the pillar will be constructed in order to extract geometrical data of the entire slope and its structural fabric. Also in situ measurements will be taken of the slope's toe during the field work exercises. These data are essential to constructing a realistic discrete element model using the 3DEC code and perform a kinematic analysis of the rock mass. Intact rock behavior will be based on the Mohr Coulomb Plasticity Model. Physical and mechanical parameters of the continuum and discontinuum elements will be gathered from laboratory experiments and used as constitutive criteria parameters within the 3DEC model. This research hopes to show how easily and relatively cheaply previously unaccessible Danxia landform geometrical data can be obtained using readily available photographic and software technologies. Also, obtaining a clearer quantitative understanding of the mechanisms controlling slope failure in Danxia landscapes will help future land planners appropriately take advantage of these outstanding scenic sites.