Fully funded STFC studentship @ University College London

Supervisor: Tom Mitchell, University College London, (tom.mitchell@ucl.ac.uk)

Co-Supervisors: Peter Grindrod (Birkbeck, University of London), Harrison Schmitt, Liran Goren, Ben-Gurion (University of the Negev) and Gerald Roberts (Birkbeck, University of London)

Application deadline: Friday 14th October 2016:

Project Title: The formation mechanism of long run-out landslides on planetary bodies

Project Summary:

Landslides are not only an important landscape-forming process on solid bodies throughout the Solar System, but on Earth also represent a natural hazard to life and infrastructure. The mechanisms responsible for the onset and flow of long run-out (typically tens of km) landslides are particularly poorly understood. Numerous methods have been proposed to explain long run-out landslide formation (Legros, 2002; Pudasaini and Miller, 2013) , including, but not limited to: basal fine powders, interstitial fluids, pore fluid pressure, air pockets, steam generation and thermal pressurisation, frictional melts, lubrication, fluidization and dynamic fragmentation.

On Earth, fieldwork allows the in situ investigation of long run-out landslide deposits, which can reveal important insights into the formation mechanism. The slipping zone, or basal plane, of large landslides that accommodates much of the slip displacement is, in many cases, saturated with fluid. The amount of pore fluid pressure can lower the apparent friction of the sliding mass by carrying some of the overburden and reducing the effective stress. Frictional heating and chemical reactions of materials in the landslide slip zone can also lead to pressurization of the pore fluid along the shear zone and reduce the frictional resistance to sliding, by decomposing or dehydrating slip zone material and produce overpressured fluids. This chemical-thermal-poro-mechanical process can lead to extremely high sliding velocity (10-100 m/sec) and can explain the anomalously large runouts. For example, recent studies (Goren et al., 2010; Mitchell et al., 2015) showed that at the Heart Mountain landslide, the largest sub-aerial landslide on Earth, shear heating at high slip velocities could have caused thermal decomposition and the release of CO_2, which allowed catastrophic slip even on a low angle detachment surface. However, investigating these deposits in the rock record on Earth can be hampered by active geological processes driven by plate tectonics. Therefore it is useful to use other planetary bodies, where deposits have been better preserved due to lower rates of geological activity.

On Mars, there are a large number of long run-out landslides (Quantin et al., 2004; Soukhovitskaya and Manga, 2006) that suffer from a similar uncertainty in formation mechanism , but which are also important in dating key geological processes (Grindrod and Warner, 2014). Some studies have proposed dehydration controls on the initiation and mechanics of enormous Martian landslides (Montgomery and Gillespie, 2005). The scale of such landslides can be seen in Valles Marineris, Mars in the following NASA movie- https://www.youtube.com/watch?v=crsqzZNUXsY . On the Moon, a long run-out landslide, thought to be triggered by nearby thrust faulting or ejecta from the distant Tycho impact event, has been used as a key calibration point in age dating recent thrust faults or formation of planetary surfaces through crater size-frequency analysis. Understanding these landslides on other planetary bodies not only expands the number of features for study, but also provides environmental constraints not necessarily known for Earth.

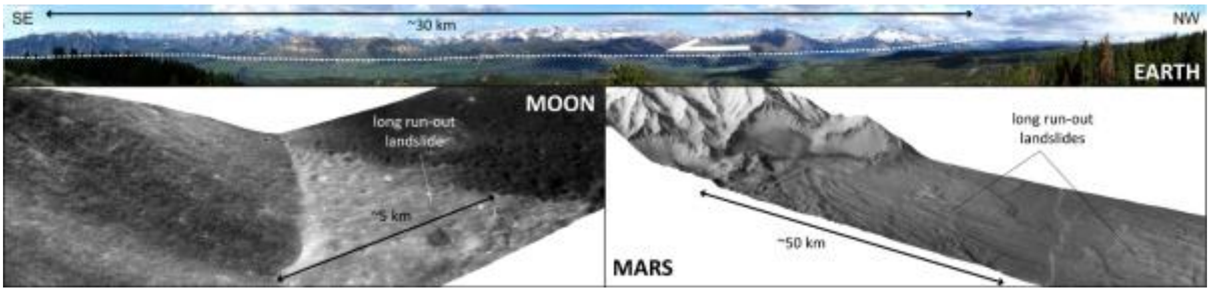

Figure 1. *Examples of the long run-out landslides to be studied. Heart Mountain, Earth (Credit: Tom Mitchell); Taurus Littrow Valley, Moon (Credit: NASA/GSFC/ASU), Valle Marineris, Mars (Credit: NASA/JPL/MSSS/Peter Grindrod).*

This project will address the question of how long run-out landslides initiate and propagate on Earth, the Moon and Mars. This will involve a combination of in situ analysis for terrestrial deposits, and the latest high-resolution remote sensing data (e.g. LROC, HiRISE) for the Moon and Mars. Co-supervisor Schmitt also carried out fieldwork at one of the study landslides in the Taurus-Littrow valley on the Moon during the Apollo 17 mission (Schmitt et al., in press). The student will gain experience in structural geology, remote sensing, mechanics of granular matter and rock physics experiments. We are looking for a dynamic, hardworking and highly motivated candidate with a good background in physical science with a strong component of mathematics, to work on an exciting multi-disciplinary project.

Reading:

Goren, L., Aharonov, E., and Anders, M. H., 2010, The long runout of the Heart Mountain landslide: Heating, pressurization, and carbonate decomposition: Journal of Geophysical Research: Solid Earth, v. 115, no. B10, p. B10210.

Grindrod, P. M., and Warner, N. H., 2014, Erosion rate and previous extent of interior layered deposits on Mars revealed by obstructed landslides: Geology, v. 42, no. 9, p. 795-798.

Legros, F., 2002, The mobility of long-runout landslides: Engineering Geology, v. 63, no. 3-4, p. 301-331.

Mitchell, T. M., Smith, S. A. F., Anders, M. H., Di Toro, G., Nielsen, S., Cavallo, A., and Beard, A. D., 2015, Catastrophic emplacement of giant landslides aided by thermal decomposition: Heart Mountain, Wyoming: Earth and Planetary Science Letters, v. 411, no. 0, p. 199-207.

Montgomery, D. R., and Gillespie, A., 2005, Formation of Martian outflow channels by catastrophic dewatering of evaporite deposits: Geology, v. 33, no. 8, p. 625-628.

Pudasaini, S. P., and Miller, S. A., 2013, The hypermobility of huge landslides and avalanches: Engineering Geology, v. 157, p. 124-132.

Quantin, C., Allemand, P., Mangold, N., and Delacourt, C., 2004, Ages of Valles Marineris (Mars) landslides and implications for canyon history: Icarus, v. 172, no. 2, p. 555-572.

Schmitt, H. H., Petro, N. E., Wells, R. A., Robinson, M. S., Weiss, B. P., and Merce, C. M., in press, Revisiting the Field Geology of Taurus-Littrow: Icarus.

Soukhovitskaya, V., and Manga, M., 2006, Martian landslides in Valles Marineris: Wet or dry?: Icarus, v. 180, no. 2, p. 348-352.

Application Procedure

- You must send the below documents to both g.shields@ucl.ac.uk and tom.mitchell@ucl.ac.uk . In the email, you should include the following attachments
  - **Curriculum vitae (CV)/resumé** (3 page max). Please include the contact details of at least two referees.
  - **Cover Letter** (2 pages max) Please identify your research interests and explain why you are interested in this PhD, and explain how your current qualifications and skills map onto the requirements for this project.
  - **English Language Certification** Generally, if you are from an EU country other than the UK, and wish to be considered you do need to meet UCL's English Language requirements (http://www.ucl.ac.uk/prospective-students/undergraduate/application/requirements/english-requirements). Please read the Eligibility section for more information.
  - Before we can give full consideration to your application, we will need to receive two academic references. These will be sent to your referees upon submission of your application.