3D rendering and numerical modelling of the dynamics of Martian valley glaciers
Advisors: Bryn Hubbard (byh@aber.ac.uk); Alun Hubbard (abh@aber.ac.uk); Jeffrey Kargel (kargel@hwr.arizona.edu)

Background
Recent research has revealed the widespread presence of so-called ‘glacier-like forms’ (GLFs) on the surface of Mars. These are visually similar to valley glaciers on Earth, showing evidence of flow from a relatively broad upper basin to a confined tongue that is commonly bounded by raised moraine ridges (Fig. 1). Although numbering greater than 1300, these features appear to be restricted to fairly steep terrain in the planet’s mid-latitudes where, in contrast to Earth, their presence correlates only weakly with elevation. Very little is known about these GLFs; for example, we have little or no knowledge of the processes of accumulation and ablation that these GLFs are subject to and consequently know nothing about the spatial arrangement of their mass balance. Indeed, it is not known whether these forms are currently active or whether they are essentially relics of an earlier, warmer Mars. Much of this basic information can potentially be addressed by combining satellite observations with numerical modelling of glacier flow. Indeed, flow-line modelling was carried out by Milliken et al. (2003 [JGR 108/E6, 5057]), indicating that such features flow only very slowly (mms per year). However, the study was subject to large errors because, at that time, GLF geometry was poorly constrained (only low-resolution satellite imagery were available) and the flow-line model used excluded the influence of non-local (transferred) stresses. Further, close inspection of recently-available high-resolution HiRISE satellite imagery reveals the presence of several indicators of flow that were not available for model calibration and validation in the past. These include surface ridges, bed forms, surface crevasses, and proglacial moraine suites marking palaeo-ice limits. Perhaps most importantly though, recent HiRISE image pairs are now available to allow surface digital elevation models to be generated of selected GLFs and their surrounding topography – allowing subglacial topography to be approximated by interpolation and higher order computer models of ice flow to be run on Martian GLFs for the first time.

There is therefore a need to (i) obtain and collate newly-available HiRISE-based glaciological and geometrical information relating to Martian GLFs, and (ii) use that information to guide higher-order models of the flow of GLFs on Mars.

Aim and objectives
The aim of this PhD is to combine satellite-based information with computer modelling to investigate the mass balance and dynamics of glacier-like forms on Mars.

Addressing this aim will involve the following objectives:
- To identify candidate GLFs on low resolution (CTX) satellite images.
- To generate digital elevation models of selected GLFs from overlapping HiRISE images.
- To inspect HiRISE images for surface indicators of patterns and rates of GLF mass balance and flow.
- To apply a spatially-distributed model to specific selected GLFs in the light of the geometries and glaciological information generated from the HiRISE images.

Person specification

Essential
- A good undergraduate degree (2(i) or higher) in a relevant earth science or space science subject.
- Strong quantitative/analytical skills.
- Some glaciological training.

Desirable
Experience in image processing.
Experience in numerical modelling.

Further information
For further information please email any of the advisors named at the top of this leaflet. For application forms and procedures, please go to the Institute’s relevant web page (http://www.aber.ac.uk/en/iges/prospective/postgraduate/) and the University’s relevant web page (http://www.aber.ac.uk/en/postgrad/howtoapply/). Your application form needs to be accompanied by two references (although these can be sent separately following the form if time is tight) and a research proposal, typically of a few sides of A4. Please feel free to work away from the outline provided above to construct your specific proposal.