Department of Geography

High Performance Computing Centre

# BACK TO THE FUTURE :the potential of InSAR to give new InSights into ancient ice sheets

**Andrew L.J. Ford, Denis Nicole & Antony J. Payne**

University of Southampton

*Andrew.Ford@soton.ac.uk*

EPSRC Engineering & Physical Sciences Research Council

## 1. Introduction

Unravelling complex fluctuations in ancient (Pleistocene) ice sheets is crucial to understanding present day ice sheets and climate and any predictions about their future. The relics of these ice sheets include lineations, some of the strongest clues to their growth, decay and migration.

Much glaciological information may be gleaned from the morphometry of lineations, yet detailed topographic field surveys are impractical, taking approximately one day per 1−2 km$^2$ whilst 30% of the Earth's surface has been glaciated. Where national mapping agencies have produced detailed topographic maps using analogue and analytical photogrammetry (Fig. 1) these, together with Digital Elevation Models (DEMs) derived from the same data (Fig. 2), have been proven to be of little use for the study of lineations. DEMs derived from digital photogrammetry may offer a solution but for data storage problems at sufficient coverage. Aerial photography is also dependant on weather conditions and still requires extensive ground control. DEMs efficiently and accurately derived from Interferometric Synthetic Aperture Radar (InSAR) offer a solution to the present lack of morphometric data, with little ground control and independence from conditions

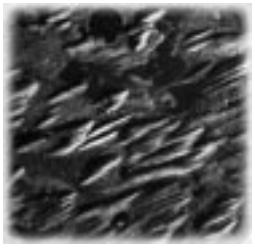


Fig. 1 − Airphoto of glacial lineations as used in analogue and analytical photogrammetry

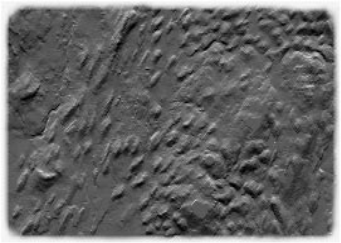


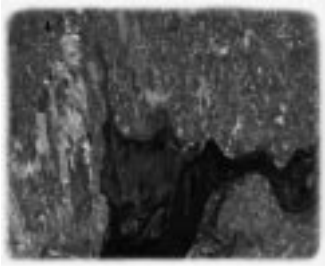
Fig. 2 − Lineations revealed in a commercial DEM of the Lake District produced by the Ordnance Survey from contour data

Fig. 3 − Shuttle Imaging Radar −C (SIR−C) deployed in the open payload bay of STS−68

## 2. Morphometric data derived from InSAR

ERDAS InterferoDEM software will routinely be used for the extraction of DEMs. Being a computationally intense process InSAR is also an ideal application for High Performance Computing. Work involving the optimisation and parallelisation of InSAR will be performed using InSAR code available from the Alaska SAR Facility (ASF), University of Fairbanks.

Field measurements, aerial photography, commercially available DEMs and InSAR generated DEMs using Shuttle Imaging Radar −C (SIR−C, Fig. 3) data covering selected parts of Dumfries & Galloway and Cumbria (Fig. 4) are being acquired. Using established criteria for the quantification of glacial lineaments (Rose & Letzer, 1975) these will be compared in a pilot study to validate the use of InSAR DEMs in glaciology. Once validated SIR−C InSAR data will be acquired for other glaciated regions of the UK and North America and detailed morphometric studies will begin. SIR−C data is freely available for



Dumfries & Galloway

Cumbria

Fig. 4 − SIR−C InSAR data for use in pilot study

## 3. Anticipated work

Using InSAR morphometric data theories of net subglacial sediment flux, crucial to the deformable bed model and outlined by Hart (1995), can be explored. Sediment transfer rates associated with the formation of superimposed drumlins on mega−lineations can be derived for a significant number of features, leading to measures of ice sheet velocity. Conventional extrapolation of sedimentology for ice sheet reconstruction can also be carried out with increased confidence. As an experimental mission SIR−C InSAR produced limited coverage in the form of scattered swaths which lend themselves to transect studies of spatial variation of mega−lineations at continental and ice sheet wide scales.

Commercial applications of extensive morphometric studies of glacial lineations include the prospecting and quantification of sediment volumes for the aggregate industry and efficient mineral prospecting by source location of trace minerals found within such features (Wagner, 1995).

## 4. Results and discussion

With such accurate and extensive coverage provided by InSAR derived DEMs unparalleled quantities of morphometric data will be made available to the glaciologist, allowing the first comprehensive study of a spectrum of morphometric theories. Future work also includes BETA testing of ERDAS InterferoDEM software and co−operation with the Geospatial Information Systems Group (GISG), responsible for photogeology (including SAR), and the Scotland & Northern England Group (SNEG), responsible for Quaternary & Palaeozoic mapping, at the British Geological Survey (BGS).