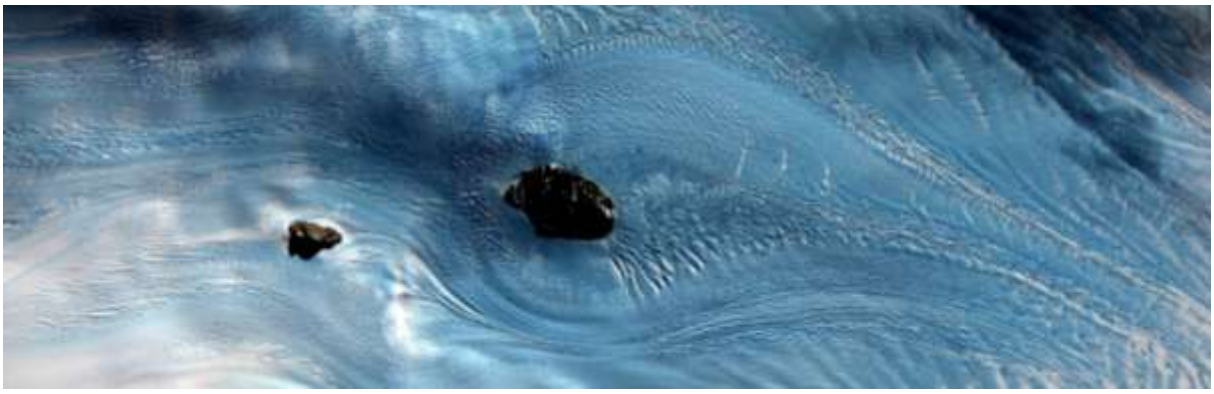
'MicroDice Short and Exchange Visits' Scheme – March 2012

Grounding-line localization by GIS structural mapping: A case study from a small Antarctic ice shelf

Research report



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I. Short summary

Understanding ice shelves dynamics and stability has recently been recognized as a major task in order to improve predictions of future Antarctic ice sheet changes. The grounding line, where ice sheets get detached from the bedrock and get afloat, plays a decisive role in this matter, and small perturbations at this transition zone can have dramatic consequences on the global ice shelf and related ice sheet flow. We applied GIS structural mapping methods on a small Antarctic ice shelf (Nansen Ice Shelf, Terra Nova Bay) in collaboration with Prof. N. F. Glasser at Aberystwyth University, Wales (UK). This research visit allowed us to reconstruct the formation history of important flow features such as rifts or shearing zones from Nansen Ice Shelf, and to determine their influence on the global ice shelf dynamics. We now plan to couple this analysis with ice flow modelling in order to investigate potential factors that influence the physics and mechanics of the grounding line zone, such as rheology and the impact of crevasses and marine ice formation in rifts.

II. Grounding-line localization by GIS structural mapping: a case study from a small Antarctic ice shelf

During this research visit (March 2012; ~2 weeks), Glasser's method (*Glasser and Scambos, 2008*) was applied to Nansen Ice Shelf (NIS), a small ice shelf in Terra Nova Bay, Antarctica (**Fig. 1**), where Italo-Belgian teams have collaborated in recent years. That research visit consisted of (1) compiling satellite images of the geographical zones of interest, (2) determining, from the observation of satellite images, which types of glaciological and geomorphological features should be taken into account for structural analysis, (3) tracking the evolution of these features over time. More than 10,000 glaciological features were traced and tracked, allowing us, on the one hand, to define the distinct flow zones across the ice shelf and, on the other hand, to localize its grounding line precisely. A digital elevation model (DEM), over which mapped features were pasted, was also built across the ice shelf domain (**Fig. 2**). A paper is underway to describe the methodology and report on obtained results.

Grounding line dynamics have recently been recognized as a key element in assessing the reactivity of ice shelves and ice sheets to climate change. Model results show that stress propagation across the grounding line plays a decisive role in global ice shelf and related ice sheet flow. It is therefore important to investigate the factors that influence the physics and mechanics of the grounding line, such as rheology and the impact of marine ice formation in rifts. Crystallographic and rheological data have previously been obtained by the applicant from experimental analysis of ice cores retrieved in the vicinity of NIS grounding line (e.g. Samyn et al., 2007a; Samyn et al., 2007b). These data are currently used to appraise the microstructural flow pattern, the final goal being to

parameterize and integrate our GIS and laboratory data into a high-resolution ice-flow model. These integration steps are underway in collaboration with former colleague Prof. F. Pattyn from the *Glaciology Lab* of Brussels, whose '3D Full-Stokes' model is considered as state of the art today (Pattyn, 2008).

III. References:

- Glasser, N.F. and Scambos, T.A. 2008. A structural glaciological analysis of the 2002 Larsen B ice shelf collapse, J. Glac., 54(184), 3-16.
- Pattyn, F. 2008. Investigating the stability of subglacial lakes with a full Stokes model. J. Glac., 54(185), 353-361.
- Samyn, D., Remy J.-P., Duval P., Montagnat M. and Tison J.-L. 2007a. Compression experiments on marine ice from Nansen Ice Shelf, Antarctica: implications for ice-shelf/continent interactions. Geophys. Res. Abstr. 9: EGU2007-A-00803.
- Samyn, D., Remy J.-P., Duval P., Montagnat M. and Tison J.-L. 2007b. Flow pattern and rheology of marine ice from Nansen Ice Shelf, Antarctica: constraints for modelling. EOS Transactions AGU 88(52): C51B-0396.

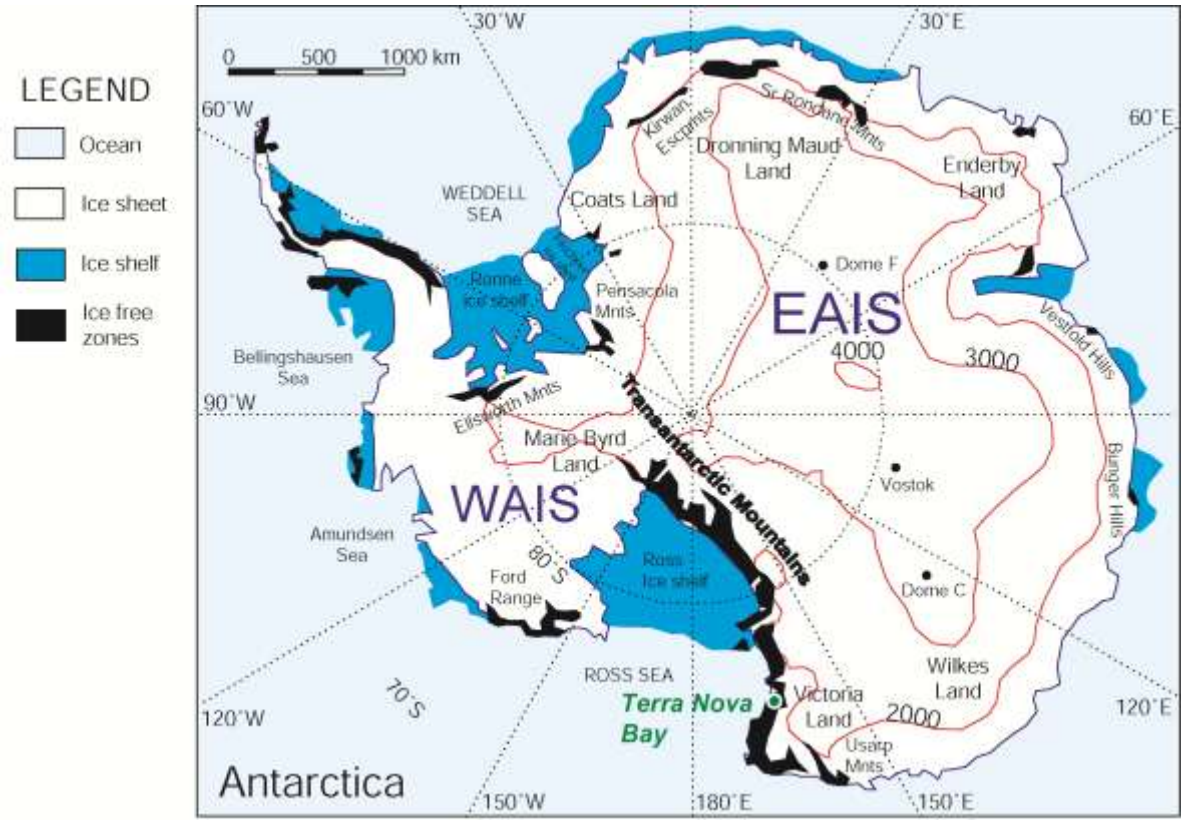

Fig. 1: Map of Antarctica (with Terra Nova Bay area, Victoria Land, in green).

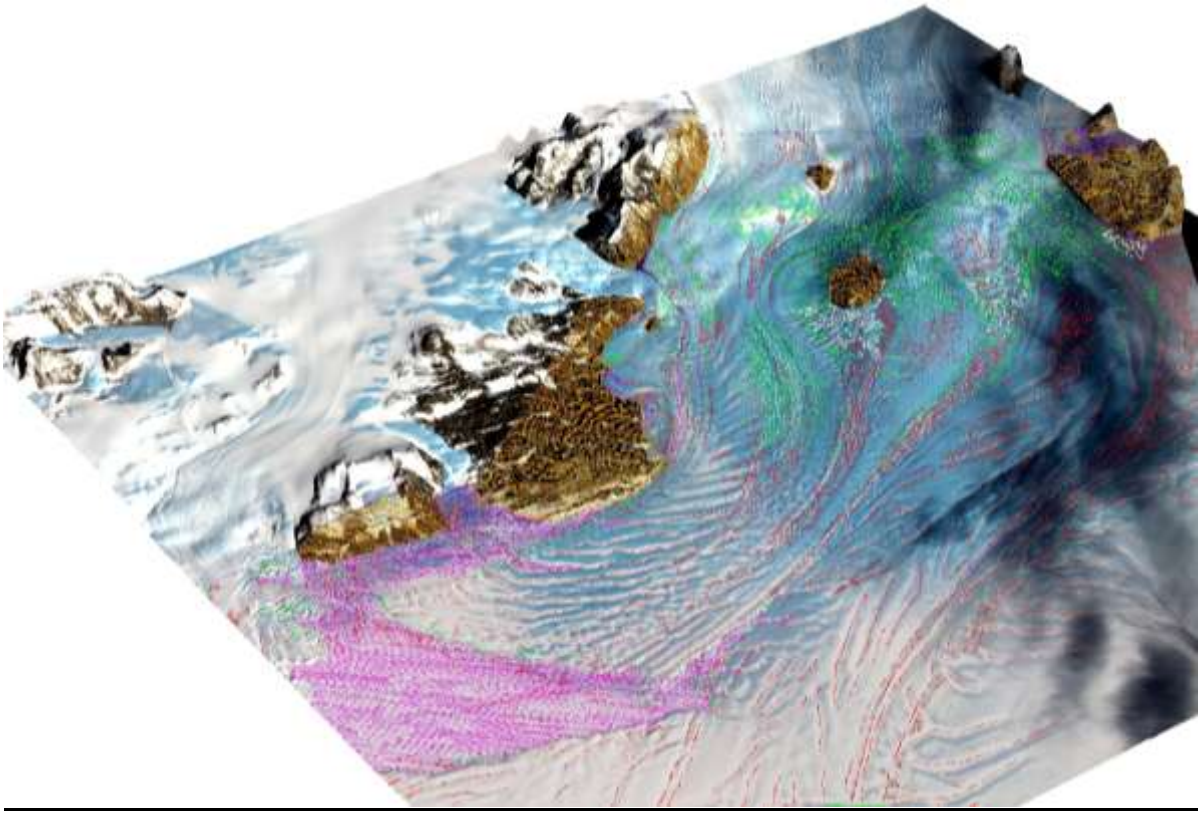

Fig. 2: Digital Elevation Model built by D.S. in collaboration with the Aberystwyth group from Landsat data of Nansen Ice Shelf area, Antarctica. Horizontal map extent: ~50 kms; mapped features were pasted to better visualize flow patterns around the grounding line.