NERC GEOPHYSICAL EQUIPMENT FACILITY SCIENTIFIC REPORT

Loan 887: Hydraulics and sediment deformation beneath an ice stream: A multi-component geophysical AVO investigation

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Abstract
A set of geophysical experiments on Rutford Ice Stream in the 2009-10 austral summer produced new data addressing the physical conditions and flow controls at the ice stream bed. NERC GEF seismic and GPS equipment were used to support active seismic and ice-penetrating radar surveys. Data analyses are at an early stage. So far, GPS monitoring of ice flow confirms a known periodic variability and surface elevation grids have been used to process seismic and radar data. Future work will analyse the seismic data (reflection and AVO) to determine the physical nature of the bed material, allowing modelling of groundwater flow beneath the ice stream. An inability to recover the majority of the passive seismic data means they are of little value to the project.

1. Background
Three Leica 1230 GPS receivers and six Reftek high frequency seismic stations from the NERC Geophysical Equipment Facility (GEF) were used as part of a combined set of geophysical experiments on Rutford Ice Stream, West Antarctica (Fig. 1) during the 2009-2010 austral summer. The GEF equipment complemented ice-drilling, active seismic recording and ice-penetrating radar equipment provided by BAS.

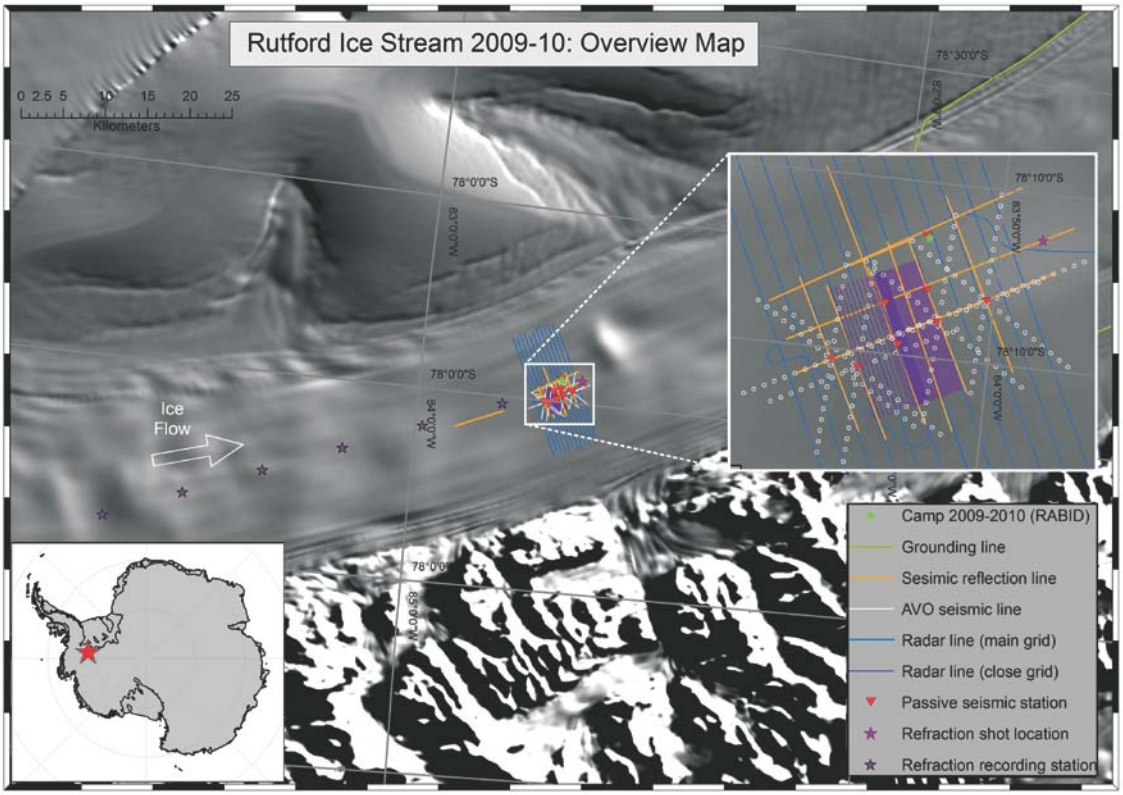

Figure 1. Location map. Inset (white box) shows acquisition details in the core project area.

The dynamics of modern ice streams are profoundly influenced by fast flowing ice streams. Modelling efforts are directed at understanding their operation and at forecasting their future behaviour, but currently the lack a physically-based basal boundary condition is a major limitation. The project's aim is to test the theory that sediment deformation is linked to drainage and

recovered data, intermittent interim periods at different stations, is of interest but of little rigorous scientific value.

Table 1. Summary of passive seismic stations and data recovery

DAS	Field site name	Lat (S)	Long (W)	Star	Deployment period	Data recovery	Reason for position
All	Huddle	78 09.1	083 53.0	N/A	30/11/2009-16/12/2009	Included below	Huddle test at camp
A484	Reftek 1	78 08.2	084 00.6	STAR 1	16/12/2009 – 2/2/2010	97%	Directly above subglacial drumlin
	+30 km	77 55.5	084 21.0	N/A	7/2/2010 – 8/2/2010		Refraction line
A514	Reftek 2	78 09.4	083 57.9	STAR 2	17/12/2009 – 20/1/2010	20%	Downstream of subglacial drumlin
	Reftek 7	78 09.9	083 56.4	STAR 5	20/1/2010 – 2/2/2010		Downstream of subglacial drumlin
	+40 km	77 50.5	084 30.2	N/A	7/2/2010 - 8/2/2010		Refraction line
A670	Reftek 3	78 08.5	084 00.9	STAR 3	16/12/2009 – 2/2/2010	5%	Adjacent to subglacial drumlin
	+60 km	77 40.4	084 48.2	N/A	7/2/2010		Refraction line
AA1A	Reftek 4	78 08.7	083 57.2	STAR 4	16/12/2009 - 20/1/2010	60%	Directly above subglacial MSGL
	Reftek 8	78 09.2	083 56.0	STAR 6	20/1/2010 – 2/2/2010		Directly above subglacial MSGL
	+10 km	78 05.5	084 02.2	N/A	7/2/2010 – 8/2/2010		Refraction line
AAE9	Reftek 5	78 08.9	083 59.4	N/A	16/12/2009 – 2/2/2010	7%	Mid-survey area to improve source locations
	+50 km	77 45.5	084 39.2	N/A	7/2/2010		Refraction line
A644	Reftek 6	78 09.1	083 53.0	N/A	17/12/2009 – 2/2/2010	10%	Camp
	+20 km	78 00.5	084 11.7	N/A	7/2/2010 – 8/2/2010		Refraction line

Loss of all the data from the refraction experiment was particularly cruel, for two reasons. Firstly, data from all six stations were recoverable for the period leading up to just before the source explosion; just a few more hours could have turned failure into success. Secondly, this was a unique opportunity to achieve this experiment and determine whether the subglacial ridge comprises bedrock or moraine. This opportunity resulted from diligent preparation over a number of years to achieve what is probably a once-only availability of both sufficient explosives on site and appropriate recording capability; it is unlikely that this situation will be attainable again.

5. Conclusions and recommendations

Scientific conclusions are still at an early stage. Except for the passive seismic stations, the data acquisition stage of this project was very successful and a considerable, comprehensive active seismic, radar and GPS dataset was achieved. The only major recommendation to make at this stage would be for complete system testing of Reftek data cards before providing them to any future projects. Loss of another critical cryosphere seismology data set through equipment failure of the high-frequency stations has been hard to bear.

6. Publications

Publications are planned on the seismic reflection data (including comparisons with earlier surveys), radar reflectivity of the bed and its relation to basal water, sediment properties from the STAR data and a synthesis of all these data contributing to groundwater flow modelling. None is expected from the passive seismic.

References

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