

# SCAR FELLOWSHIP REPORT 2005-2006

**Name of Candidate: Narelle Paula Marie Baker**

**Country of Origin: New Zealand**

**Institution Visited: Bristol Glaciology Centre (BGC), University of Bristol, UK**

**Start Date: 10 October 2005**

**End Date: 09 April 2006**

**Amount of Fellowship: US\$10,000**

This Scientific Committee on Antarctic Research (SCAR) Fellowship 2005-06 provided me with an excellent foundation in ice sheet modelling and has facilitated my future research on the evolution of the Antarctic Ice Sheet. This report describes activities undertaken during the fellowship period, outlines the exact allocation of monies and indicates how the research fits into my future work plan.

## **Overview of Activities**

The main aim of my PhD research is to use numerical modelling to reconstruct the evolution of the Antarctic Ice Sheet, particularly in the Ross Sea Region of Antarctica. The fellowship period at Bristol Glaciology Centre (BGC) was imperative to this research, as both a practical and theoretical understanding of how ice sheets evolve and can be numerically modelled forms the entire foundation of this research. Profs. Martin Siegert and Tony Payne at BGC are world-renowned researchers in this area, and together with other members of the BGC team provided me with an excellent basis for my future research. Prof. Martin Siegert was in particular an excellent supervisor and mentor and I found meetings with him to discuss my progress extremely beneficial.

The plan for the fellowship period was to develop my skills in ice sheet modelling. I feel that I not only achieved this, but enhanced my knowledge of glaciology as a whole, gained extensive organising/tutoring/demonstrating experience and made important contacts for future collaborations. The activities undertaken at BGC fall broadly into five categories, each of which will be discussed in turn. These are:

1. Theoretical/numerical ice sheet modelling research
2. Practical ice sheet modelling experience
3. General knowledge gain
4. Academic conference/workshop organisation and participation
5. Demonstrating and tutoring experience

### **1. Theoretical/numerical ice sheet modelling research**

In order to understand ice sheets modelling I had to gain an enhanced understanding of ice sheet processes and their numerical representation. This was achieved through my own research and by attending a series of lectures on numerical ice sheet modelling presented by Prof. Tony Payne.

In addition, through Prof. Martin Siegert's research into Antarctic subglacial lakes, I became extremely interested in how subglacial lakes influence ice sheet flow dynamics. Research (Wingham et al., accepted) suggests that these lakes are a source of subglacial water flow, both between lakes and to the coast. This has enormous implications for ice sheet modelling, as water at the bed of a flowing ice mass enhances sliding and accelerates flow (Paterson, 1994).

### **2. Practical ice sheet modelling experience**

The most important component of the fellowship period was definitely the practical ice sheet modelling experience gained at BGC. I began by analysing simple ice sheet models and moved up to working with GLIMMER. The GLIMMER ice sheet model, designed by Prof. Tony Payne, is a three-dimensional thermo-mechanically coupled ice sheet model. It runs on a Linux/UNIX operating system and is mainly coded in Fortran 90/95, with some python script. Initially, I had

very little understanding of UNIX/Linux or of either Fortran and Python programming languages. While I am still learning, the last six months has allowed me to gain a sufficient understanding of these components to undertake all the tasks necessary to run and modify GLIMMER. The initial setup of GLIMMER took some time, in part because the documentation is inadequate for a researcher at my level. I did manage to obtain several successful trial runs before I finished at BGC, although I will need to improve on these in my future work.

### **3. General knowledge gain**

In addition to ice sheet modelling, I also learned a lot about glaciology and geography in general during my time at BGC by attending guest lectures, by reading appropriate journals and through liaising with staff and students in the department. I also sat in on a number of Prof. Martin Siegert's second and third year undergraduate lectures. In New Zealand there are limited opportunities to attend lectures on ice sheet mechanics and ice sheet evolution. I particularly found lectures on the northern hemisphere ice sheets beneficial, from the perspective of the interesting similarities and differences from observations in Antarctica.

### **4. Academic meeting participation**

I was fortunate enough to attend one meeting and one workshop during my fellowship period. These were The Royal Society Discussion Meeting on The Evolution of the Antarctic Ice Sheet: New Understanding and Challenges (17-18 October 2005) in London (UK) and the Global Land Ice Measurement from Space (GLIMS) and Snow and Ice Research Group (SIRG) NZ Workshop (6-10 February 2006) in Twizel (New Zealand). The Royal Society Meeting was extremely relevant to my research, but unfortunately it was too soon after the beginning of my fellowship to allow me to present. The GLIMS/SIRG Workshop was also extremely useful, as I plan to use satellite remote sensing to investigate changes in the Antarctic Ice Sheet at the highly dynamic coastal regions. I presented a poster at this workshop (see details below) that outlined my research with the GLIMMER ice sheet model and outlined why observed flow changes at outlet glaciers such as the Byrd are important. I also co-organised the GLIMS/SIRG Workshop, which provided me with experience in organising and running an international event.

#### **Reports List:**

**Poster:** *Is Byrd Glacier Slowing Down? Modelling the Evolution of the Antarctic Ice Sheet*, presented at Global Land Ice Measurement from Space (GLIMS) and Snow and Ice Research Group (SIRG) NZ Workshop in Twizel, New Zealand (6-10 February 2006).

**Conference Program:** *Global Land Ice Measurement from Space (GLIMS) and Snow and Ice Research Group (SIRG) NZ Workshop*, Twizel, New Zealand (6-10 February 2006).

### **5. Demonstrating and tutoring experience**

I did not expect to have the opportunity to teach whilst at BGC. However, the opportunity presented itself and I found the experience extremely rewarding. I was one of three demonstrators in the first-year undergraduate remote sensing labs and organised and delivered tutorials to three first-year undergraduate physical geography groups, on the subjects of glaciology, hydrology and the atmosphere.

#### **Allocation of funds**

When I applied for the SCAR Fellowship, I was just starting a PhD at Victoria University of Wellington, New Zealand. Subsequently, I was accepted to undertake my PhD at Scott Polar Research Institute (SPRI), University of Cambridge. Taking into consideration advice from all parties, I accepted the offer from Cambridge and deferred until April to allow me to undertake the SCAR Fellowship at BGC prior to starting. For this reason, the allocation of funds (Table 1) differs slightly from the initial budget submitted as part of my application. Full documentation of all entries in Table 1 is available upon request, as are all invoices.

Note that the remainder of these funds have been directed to attending the SCAR Open Science Conference in Hobart, where I have been accepted to present a talk (see details below).

**Table 1 – Allocation of Funds, SCAR Fellowship 2005-06**

	<b>GB£</b>	<b>US\$</b>
<b>SCAR Fellowship</b>	5,593.09	10,000.00
<i>less</i>		
<b>Funds Spent</b>		
Pre-UK costs (including flight)	1,087.27	1,943.95
Accommodation	2,085.00	3,727.81
Bills	391.40	699.79
Food	697.75	1,247.52
Stationary	138.53	247.68
Insurances	350.68	626.99
Transport	160.86	287.60
Spending	525.79	940.07
<b>Total Funds Spent</b>	<b>5,437.28</b>	<b>9,721.43</b>
<b>Remaining Funds</b>	<b>155.81</b>	<b>278.57</b>

Note: Conversion rate: GB£ 1 = US\$ 1.787920452  
from: <http://www.xe.com/ucc/>

### **Future Work Plan**

The PhD research I will undertake at SPRI (beginning April 2006) is not substantially different from the work proposed at Victoria University. I will continue to work with GLIMMER, with the aim of using this ice sheet model to understand the evolution of the Antarctic Ice Sheet. This research is in line with the scientific goals of SCAR's Antarctic Climate Evolution (ACE) Program, to integrate palaeoclimate and ice sheet modelling studies with geological investigations of the proxy record of Antarctic climates and ice sheets. The exact temporal boundaries of the project are still in discussion, but will also meet the ACE Programme criteria.

Due to the time spent at BGC, I will also focus on subglacial hydrology and how this important ice flow mechanism can be incorporated in ice sheet models. At present, subglacial hydrology is often ignored in ice sheet models. This situation must change if numerical modelling is to provide a reasonable caricature of how ice sheets evolve. This research will proceed in line with SCAR's Subglacial Antarctic Lake Environments (SALE) Program.

I will be working under Dr. Neil Arnold at SPRI, with associated supervision from Dr. Andrew Shepherd (Edinburgh University). I also hope to maintain a supervisory relationship with Prof. Martin Siegert (Bristol University), especially in relation to subglacial lakes.

### **Future Reports (confirmed):**

**Oral Presentation:** *Antarctic Ice Sheet Evolution*, SCAR Open Science Conference, Hobart, July 2006.

### **References**

- Paterson, W.S.B., 1994. *The Physics of Glaciers*. Elsevier Science, Oxford.  
Wingham, D.J., Siegert, M.J., Shepherd, A.P. and Muir, A.S. Rapid discharge connects Antarctic subglacial lakes. *Nature*. (accepted).