

SCAR Prince of Asturias Fellowship 2004 – Report to SCAR

Awarded to:	Dr. Steven Boger
Country of origin;	Australia
Institution;	The University of Melbourne, Australia
Host institution	Universität Bremen, Germany
Tenure of fellowship;	March 2004 – February 2005
Amount of fellowship (\$).	10 000 USD

Mesozoic evolution of the Lambert Graben.

Introduction

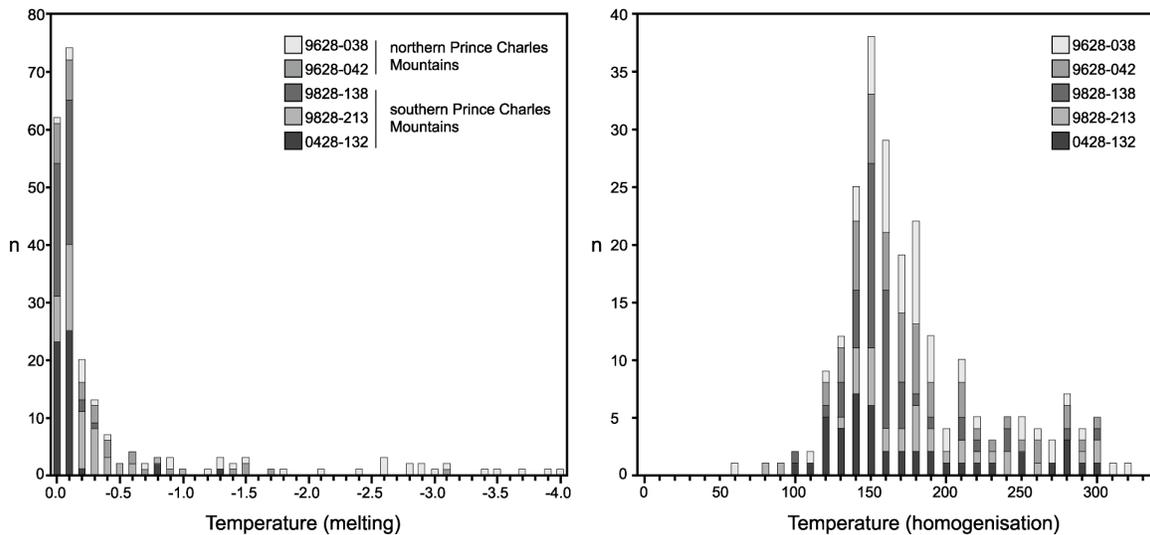
The Lambert Graben of MacRobertson Land, East Antarctica, is one of the most remarkable crustal scale structures observed on the continent. It extends at least 700 km inland from the Antarctic coast at Prydz Bay and is defines a 5-7 km deep fault-bound depression, consisting of thinned continental crust underlying the Lambert Glacier. Although representing Antarctica's most significant Mesozoic structure, very little is actually known of the origin or subsequent evolution of the Lambert Graben.

The aim of the present study was to build on the published structural (Boger & Wilson, -Tectonophysics, 2003) and fission track studies (Arne et al. – Antarctic Science, 1994, Lisker et al. – Tectonics, 2003) that describe alternate scenarios for the evolution of the Lambert Graben. Based on the presence of Permo-Triassic sediments in the current Graben, as well as apatite fission track data that suggest the majority of the surrounding regions were uplifted between 300 Ma and 220 Ma, the first hypotheses argues that the Lambert Graben has its origins in the Late Carboniferous to Early Permian. This hypothesis, then infers that the Lambert Graben was reactivated during the Cretaceous (c. 120 Ma) when India broke away and drifted northward from Antarctica. The alternate hypothesis argues that the Lambert Graben formed simply as a result of the Cretaceous events that led to the break-up of India and Antarctica. This hypothesis is based on a relatively uniform direction of extension preserved on the faults that define the Lambert Graben, together with the parallelism of this extension direction with that inferred for the break-up of India and Antarctica. These two models are based on different datasets. Neither dataset provides direct age constraints on the faults that define the Lambert

Graben. Thus, the aim of this study was characterise the chemistry of the fluids that migrated along these faults, constrain at approximately what temperatures the faults were active, and collect geochronological data directly from these structures.

Results

Fluid inclusion microthermometry was performed on samples, using the fluid inclusion microscope housed at the Uninvestität Bremen. Five samples yielded excellent results. Two of the samples were collected from quartz filled faults from the Radok Lake region of the northern Prince Charles Mountains, while the remaining three samples were from quartz filled faults exposed along the Mawson Escarpment, southern Prince Charles Mountains. A total of 230 individual heating and cooling experiments were carried out on the observed fluid inclusions from these samples. Cooling experiments involved supercooling the sample to -100°C , then heating to the point at which the sample melts (T_m). This gives a proxy for fluid composition. Heating experiments involved heating the inclusions (liquid and gas) to the point of homogenisation (T_h). This measurement gives an estimate of the trapping (or formation) temperature of the fluid inclusion. The data for which is summarised below.



The data illustrate that T_m and T_h for all fault were approximately -0.2°C and $150 \pm 30^{\circ}\text{C}$ respectively. These data indicate that the fluids had very low salinities (close to pure H_2O) and were probably sourced from near surface ground water. Together with

the low homogenisation temperatures, these data indicate the fault system defining the Lambert Glacier was likely to have been epithermal in nature. These data are consistent with the vuggy nature (vug = an unfilled cavity within a rock) of many of the observed faults. Vugs are only present low pressures and, together with the fluid inclusion data, suggest that the faults observed in the Lambert Basin formed within the upper 2-3 km of the crust (at temperatures below the closure temperature of apatite). These data support the inference that the faults formed after the Carboniferous to Permian cooling dated via apatite fission track analyses.

These data represent the completion of the first phase of the proposed work plan. The second phase involved the dating of the fluid inclusions via Ar-Ar or Rb-Sr geochronology. These methodologies are not well established for such low temperature faults and the required trial and error application of these methodologies was, in hindsight, beyond the budgetary constraints provided by the fellowship. Nevertheless, this work remains a high priority and, as planned, will be carried out at the University of Melbourne. The money to complete these experiments has been put aside from an alternate source. However progress has been slow as SDB has become heavily involved in an ongoing project in Madagascar. This project began within three months of returning from Bremen.

Use of fellowship funds

The following table outlines the use of the funds presented to SDB as part of the fellowship. The majority of the money was used to fund accommodation in Bremen and to prepare and analyse the samples. In addition to the analytical work undertaken at Bremen, the Fellowship allowed SDB to deepen his collaborative links with Dr. Frank Lisker at Bremen Universität. Additionally the fellowship allowed SDB to interact with his German and Russian PCMEGA colleagues from the BGR and St Petersburg - an extremely valuable experience. SDB was able to visit Dr's Roland, Damaske and Laufer at the BGR on a number of occasions, and took part in a field trip to the Austrian Alps with Laufer. SDB also visited Dr Mikhalsky (St Petersburg) who was also in Germany (BGR – Hannover) for several months during 2004. From these visits Boger and

Mikhalsky are undertaking a collaborative study on the mafic dykes from the southern Prince Charles Mountains. No publications have as yet arisen from the fellowship. This awaits the completion of the second phase of the project.

Date	Item	Debits	Credits
14/8/03	SCAR Prince of Asturias Fellowship 2004 \$10 000 USD (\$13 864 ASD)		\$13,864.00
3/11/03	Staff training coarse	\$398.00	
3/11/03	Purchase of textbook	\$51.00	
24/3/04	Sample preparation and analyses	\$1,760.00	
21/4/04	Sample preparation and analyses	\$1,130.00	
16/9/04	Accommodation Bremen Mar 2004-Feb 2005 University Guest House - Haschtedt	\$10,082.00	
	Balance of expenses	\$13,421.00	
	Residual balance		\$443.00