Application for Project 1112 for season 2001/02

Title - Crustal rebound in the Lambert Glacier area

Chief	DR Paul TREGONING	Australian National University	+61 2 6249 5510
	PROF Kurt LAMBECK	Australian National University	+61 2 6249 5445
	DR Herb MCQUEEN	Australian National University	+61 2 6249 5515
	DR John STONE	University of Washington	+ 1 206 685-9514

Question 1. Years and Area of Operations

Project status sorted by season

- 1999/00 - Approved - In year 1 of multiyear.
- 2000/01 - Approved - In year 2 of multiyear.
- 2001/02 - Approved - In year 3 of multiyear.
- 2002/03 - Approved - In year 4 of multiyear.
- 2003/04 - Approved - In year 5 of multiyear.

Areas sorted by season

- 1999/00 - Davis , Prince Charles Mountains ,
- 2000/01 - Prince Charles Mountains ,
- 2001/02 - Beaver Lake , Komsomolkiy Peak , Prince Charles Mountains ,
- 2002/03 - Prince Charles Mountains ,
- 2003/04 - Prince Charles Mountains ,

Question 2. Program Areas

Program - Geosciences

Government goal - 4. to undertake scientific work of practical, economic and national significance

Key Science Output	Milestones
KSO 2 Measurement of vertical and lateral movements of the Antarctic continent.	GPS and VLBI and geophysical data at the ANARE stations and at selected points on the Antarctic continent are collected (2000-2005) Geophysical monitoring is carried out successfully (2000-2005)

Question 3. Program Information

3.1.1 Objectives

The objectives of the project are:

- to measure present-day vertical movements and isostatic rebound in the Lambert Glacier region
- to improve the ice-sheet models of deglaciation since the Last Glacial Maximum
- to maintain and expand a very high accuracy geodetic network

This project will maintain and expand a very high accuracy geodetic network using GPS to monitor differential vertical and horizontal movements of rock surfaces associated with changes in ice volumes in eastern Antarctica since the time of the Last Glacial Maximum (LGM). The positions of two sites in the southern and northern Prince Charles Mountains will be measured continuously with GPS with another two sites observed during the summer seasons. The surveys commenced in 1998 and will be continued in 2000. The estimated uplift velocities will provide direct measurement of the present-day isostatic rebound which is occurring and will allow us to discriminate between different icesheet models for the Antarctic continent. This has major ramifications for the understanding of sea level change due to deglaciation since the LGM, which in turn affects the understanding of current sea level rise due to global warming.

This reseach contributes to achieving the milestones of collecting GPS data at selected points on the Antarctic continent by observing at 4 key sites in the Prince Charles Mountains. It also contributes to the successful geophysical monitoring of post-glacial rebound in the Lambert Glacier region.

3.1.2 Public Summary

The present-day observed change in sea level is the sum of several factors, including the continuing readjustment of the crust to the past redistribution of the surface ice-water load and any present-day melting of the Antarctic ice sheet. Constraints can be provided on both

of these contributions by measuring the magnitude of the crustal rebound using the Global Positioning System. By combining the measurements with other estimates of sea-level change, it becomes possible to separate the two contributions. This will lead to both improved mass balance models for the ice-ocean system and improved understanding of present sea-level change.

3.1.3 i. Data Collection

Data will be collected at sites located in the northern and southern Prince Charles Mountains. We propose to install equipment which will be left unattended throughout the year. The equipment will be powered from a combination of solar power and power generated from a hydrogen Proton-Exchange-Membrane (PEM) fuel cell. The equipment consists of the GPS receiver and antenna, solar panels, PEM fuel cells, a supply of hydrogen for the fuel cells, satellite communications links and a small housing to protect the equipment. We will also collect and date samples of glacial moraine from near the GPS sites.

Previous Fieldwork

A solar-powered GPS system was installed near Beaver Lake on 12/1/98 to demonstrate the feasibility of this project. The equipment was revisited on 19/1/99 and found to have survived the winter season. It had operated until 26 March 1998 before running out of power due to insufficient levels of sunlight (*Tregoning et al.,* 1999, 2000). The system was replaced in January 1999, left operating for the remainder of the 1999 summer season and, when revisited in February 2000, was found to have collected data until 27/2/99 when the receiver memory filled. We have clearly shown the viability of operating GPS equipment unattended during the summer season using solar power.

In 2000 we installed new sites at Dalton Corner and Landing Bluff as well as recommencing the operation of the Beaver Lake equipment.

- At Dalton Corner we installed a GPS receiver with 3 solar panels (although most of the solar panel frame was left behind at Davis). Operation of the system was commenced and the data will be retrieved in the 2000/01 season.
- At Landing Bluff we operated at GPS receiver between 3-13 February. The equipment was removed at the end of the summer season, although the antenna mount remains so that the antenna can be replaced in the 2000/01 season.
- We enhanced the equipment at Beaver Lake to include a fuel cell to provide power during winter and a satellite phone to allow transmission of data back to Canberra. Data was successfully transmitted for a few days before a software problem prevented further communications with the equipment. As a result, we do not know how the fuel cell is performing at the site.
- We installed a fuel cell, solar panels and an electronics system at Davis in order to monitor the performance of the fuel cell. Unfortunately, the fuel cell suffered an internal failure in February and was returned to the manufacturers. The electronics equipment continues to operate and the diagnostic data collected has shown that we can successfully hibernate our equipment throughout the winter and then recommence GPS observations when solar power returns. Firmware modifications are underway to allow this capability in systems to be installed in the 2000/01 season.

Fieldwork for the 2000/2001 summer season

- At Landing Bluff we will install a solar-powered system (GPS receiver, satellite phone, 6 solar panels and electronics).
- The equipment currently at Davis will be transferred to Dalton Corner (with the exception of the hydrogen cylinders) and we will commence operation of a solar-powered system (GPS receiver, 6 solar panels, electronics).
- We will replace the fuel cell at Beaver Lake with a new model. We will also return the satellite phone, re-establish communications with the site and recommence operation of the GPS receiver (if it has failed). If it is found that the hydrogen cylinders are empty, we will transfer half of the hydrogen currently at Davis to the Beaver Lake site.
- We will install a new fuel cell at Davis in order to monitor its performance throughout 2001 (as we had planned to do during 2000). We will have limited equipment at Davis - fuel cell, cylinders, computer, batteries and a resistor load.

Proposed fieldwork for the 2001/2002 summer season

Assuming that the 2000/2001 fieldwork is conducted as planned and that the equipment operates as expected, we propose the following for the 2001/02 season:

- Landing Bluff: visually inspect the equipment and make any modifications required;
- Beaver Lake: Remove and replace the supply of hydrogen. Inspect the equipment and make modifications as required;
- remove all equipment from Davis;
- Dalton Corner: Transport the fuel cell and hydrogen supply from Davis to Dalton Corner. Recover the data recorded in 2000. Inspect the equipment and make modifications as required. Commence operation of an all-year operating system. Collect samples for cosmogenic isotope exposure dating at a range of altitudes, from the Lambert Glacier margin (ca. 930 m) to the highest exposed rock on the main bluff at Dalton Corner (ca. 1230 m).
- Collect samples for cosmogenic isotope exposure dating at Mt Borland and, if time and weather permit, Wilson Bluff. This fieldwork was originally approved under ASAC project 2189 (*Mabin and Stone*, 1998) but could not be carried out in the 1997/98 season due to limited helicopter time and the lack of a fuel cache in the southern Prince Charles Mtns. **John, This is probably better placed in the "rationale section"** What appear to be erratic boulders and discontinuous lateral moraine ridges are visible along the west flank of Mt Borland in 1973 air photos. The same set of air photos shows a well defined lateral moraine on the lower west side of Wilson Bluff. The appearance of the moraine in air photos and its elevation suggest that it correlates with similar deposits on Mts Menzies, Mather, Bayliss and Scherger on the Fisher Glacier to the west. Exposure dates have established an LGM age for the moraine at Mt Menzies. This is the likely age for the prominent moraine at Wilson Bluff.
- **NEW** Komsomolkiy Peak: Install a new site at Komsomolkiy Peak. Owing to the difficulties in accessing the site, we will install a solar-powered site only with a reduced amount of equipment (that is, no fuel cell, no satellite phone). This is an important extension to our current GPS network and forms a critical part of the overall project. We will also take advantage of the visit to Komsomolkiy Peak to collect rock samples for cosmogenic isotope exposure dating.

We will provide one field person trained in the installation and operation of the equipment and one geologist experienced in collecting samples for cosmogenic isotope exposure dating. The primary responsibility of the second field person is to assist with installing the GPS equipment. However, given the importance of establishing the glacial history of the region, it is essential that one member of the team is able to interpret the glacial geomorphology and collect samples for dating from these remote sites.

We propose to send the field party consisting of two people to the PCMs in early December 2001/January 2002. It is difficult to estimate how much time will be required at each GPS site because, at this stage, the equipment hasnt been installed in the 2000/01 season. Based on past experience (and on the assumption that all the work is conducted in 2000/01 as planned), the field party will require about 2-3 days at each site.

We assume that it will be necessary to stockpile aviation fuel at Dalton Corner in order to access Komsomolkiy Peak. Furthermore, 18 hydrogen cylinders will need to be transported to Dalton Corner to operate the fuel cell there. We would like our field party to spend 1 week in the vicinity of Dalton Corner. Approximately 2 days will be required for setting up the fuel suppy and operation of the fuel cell. The remaining time allows for sample collection at Dalton Corner and 1 day reconnaissance trips to each of Mt Borland and Wilson Bluff. These sites are ~30 minutes flying time from Dalton Corner.

Once the existing sites have been visited the field party would be moved further south to Komsomolkiy Peak. Since the site has not been visited, they will have to make a reconnaissance to select the site for the survey mark, install the mark then set up the solar-powered system. The mark installation takes less than 2 hours, the system setup can be done in less than 8 hours. It is not known how long it would take to find a suitable location. We request that the field party be allowed 2 days at the site, although we will accept less time if an overnight stay is not possible for logistical reasons. While at the site, the geologist would use whatever time is available to find suitable rock samples for exposure dating.

We request that Komsomolkiy Peak be revisited at the end of the summer season. Whilst this is not essential, it is highly desirable since it will allow us to retrieve the observed data and to assess the performance of the equipment. There will be a need for someone familiar with the equipment to be present on the second visit to the sites, although this could be the assistant provided by the Antarctic Division rather than our own specialist. The downloading of the equipment could be performed in a couple of minutes while the helicopter waits at the site without shutting down.

3.1.3 ii. Data Analysis

The GPS data will be analysed at the Research School of Earth Sciences, The Australian National University. The data will be processed simultaneously with the available global tracking data using the GAMIT software. Accurate orbits will be estimated along with station coordinates and velocities.

Sample preparation and analysis for cosmogenic isotope exposure dating will be carried out at the Australian National University, and the University of Washington and Lawrence Livermore National Laboratory in the USA. These institutions provide the facilities

necessary for analysis of cosmogenic Be-10, Al-26 and Cl-36. The choice of isotopes for exposure dating will depend on what rock types occur as erratics at each site. All three isotopes have been used so far in dating limestone, marble, gneiss and quartzite erratics from Dalton Corner and other sites in the Prince Charles Mtns (*Stone et al.,* 1998).

3.1.3 iii. Rationale

GPSWith recent advances in GPS technology and analysis techniques, it has become possible to measure very accurate site velocities within a time frame of a few years. However, it has been shown (e.g. *Elosegui et al.,* 1995) that changing and/or replacing the GPS antennae at permanently tracking sites can introduce height biases of several millimetres. It has also been shown (e.g. *Scherneck et al.,* 1998) that campaign-style GPS observations are not sufficient for estimating accurate uplift rates using GPS. For these reasons, we are installing the GPS equipment (in particular the antennae) for the duration of the project and to operate the equipment on a continual basis.

The most comprehensive GPS network designed to measure postglacial rebound, the BIFROST project, is in Fennoscandia (*Scherneck et al.,* 1998). Preliminary results of this ongoing project have shown that precisions of uplift rates of ~1 mm/yr can be measured and that the estimated uplift rates reflect the expected pattern due to postglacial rebound. Thus, GPS can be used to measure postglacial rebound.

Tregoning et al. (1999) showed that it is feasible to operate an unattended, solar-powered GPS system in the Lambert region. However, a solar-powered system will probably only operate between October and March due to limited sunlight in the winter period. With recent modifications to our electonics systems, we now believe that we may be able to preserve sufficient power throughout the winter to enable the system to recommence observations when solar power returns. We will be installing such a system at Landing Bluff in 2000/01. Long, continuous time series of GPS heights are required in order to differentiate uplift signal from noise inherent in GPS analyses (*Tregoning et al.,* 2000). Therefore, observations spanning the whole year are required at the more southerly sites where solar power is not sufficiently strong for a considerable proportion of the year. For this reason, we propose to operate fuel cells at Beaver Lake and Dalton Corner. Logistics will prevent us from operating a fuel cell at Komsomolkiy Peak.

The additional site at Komsomolkiy Peak will extend the length of our transect of GPS sites further south. If we estimate uplift rates at these four sites, we will be able to differentiate more carefully between different models of ice history for the Lambert Glacier. The further inland one is able to install a site and measure a rate of uplift, the greater the sensitivity of the GPS uplift rates to detect subtle changes in ice models.

Cosmogenic isotope exposure dating

The uplift rate estimated from repeat GPS observations represents the sum of responses to historical changes in the ice sheet as well as present-day changes. In order to discriminate between these two components we must consider other sources of information, for example information about changes in the ice sheet since the LGM. This can only be obtained from geological field observations combined with cosmogenic isotope exposure dating. Mabin

and Stone commenced work of this nature, mapping and sampling moraine deposits at Mt Menzies, on the Fisher Glacier, in 1998 (*Mabin and Stone*,1998). They also collected samples from an un-named ice-free valley north of the Turk Glacier in the Mawson Escarpment, and obtained reconnaissance samples from geologists Chris Wilson and Steve Boger, who worked at Dalton Corner during the 1997-98 field season. Exposure dates on these samples show that: (i) The Fisher Glacier, which drains the western Lambert Basin, stood 200-250 m higher adjacent to Mt Menzies during the LGM, and began to retreat from its maximum moraine limit some time after 14.0 kyr BP. (ii) The main Lambert Glacier thickened by ca. 600 m along the Mawson Escarpment near the Turk Glacier, and retreated from its highest moraine limit some time after 16.9 kyr BP. (iii) The Lambert Glacier had thinned to less than 200 m above its present height at the Turk Glacier site and at Dalton Corner by 11.0-10.8 kyr BP. These observations show that the maximum thickening of the Lambert Glacier during the LGM occurred in the vicinity of its present grounding limit, south of Mt Stinear (*Zwartz et al.*, 1999; *Stone et al.*, 2000).

It is important to extend these data defining the LGM ice load further south to compliment the GPS data from Dalton Corner and Komsomolkiy Peak. Reconnaissance observations at Dalton Corner (S. Boger, pers. comm.) indicate that glacial erratics occur on the main bluff, but we do not yet know if there is an upper moraine limit marking the highest level reached during the LGM. We propose to search for evidence of the level reached by LGM ice, and collect erratic samples from a range of altitudes to define the ice retreat history at Dalton Corner. The combination of all the pieces of information will lead to greater understanding of the past history and present-day changes in the Lambert Glacier.

3.1.3 iv. Work plan

Field Person 1 (TBA): Will be responsible for installing and resupplying the GPS, power supply and communications equipment at Beaver Lake, Landing Bluff and Dalton Corner and for installing the solar-powered system at Komsomolkiy Peak (a proposed site).

Field Person 2 (TBA): Will be resonsible for rock sampling at Mt Wilson, Mt Borland and Komsomolkiy Peak.

3.1.3 v. Details of shared resources

The GPS data collected as part of this project may be useful to other research projects using GPS in the Lambert Glacier/Amery Iceshelf region. We will make our data available to other groups who may require data from a static GPS site in the region. We are currently cooperating closely with AUSLIG, the surveying group at the University of Tasmania (Prof. Richard Coleman - ASAC project 1120) and the AMISOR group(Ian Allison - ASAC project 1164) in regard to sharing of our GPS data. We will provide data from our stand-alone GPS equipment at Beaver Lake, Dalton Corner and Landing Bluff to support other GPS programs in the area.

3.1.3 vi. Participating Institutions

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We are cooperating with Hydrogenics Corporation, Canada, to demonstrate that

low-powered fuel cells are suitable for operation in the Antarctic environment. In addition, there are several other international groups who are commencing similar projects to estimate postglacial rebound from GPS measurements. We will be cooperating with these groups to ensure that we are using the most appropriate technology suitable to our application.

There is considerable interest in the geodetic community about the feasibility of using fuel cells to power GPS equipment in Antarctica and in the Arctic regions. We are the first group to attempt to operate the equipment through the Antarctic winter using a fuel cell and have had several requests already for progress reports from international groups. If we can show that this works successfully, it will create possibilities for other areas of research in Antarctica where remote equipment requires power through the winter months.

The analysis of the GPS data will be conducted at ANU. We have many ongoing links to other national and international groups in the GPS field (e.g. Department of Earth, Atmospheric and Planetary Science, MIT). These links will be important to ensure that the analysis of the data computed at ANU is of the highest quality.

The link with Hydrogenics Corporation is a bilateral link. All other links mentioned above are informal agreements with other researchers.

3.1.4 References cited and any additional information on 3.1.1 and 3.1.3

Elosegui, P., J.L. Davis, R.T.K. Jaldehag, J.M. Johansson, A.E. Niell and I.I. Shapiro, Geodesy using the Global Positioning System: The effects of signal scattering on estimates of site position, *J. Geophys. Res.*, 100, 9921-9934, 1995.

Mabin, M. and J. Stone, Quaternary glaciation of the Southern Prince Charles Mountains, ASAC Project # 2189, 1998.

Scherneck, H.G., J.M. Johansson, J.X. Mitrovica and J.L. Davis, The BIFROST project: GPS determined 3-D displacement rates in Fennoscandia from 800 days of continuous observations in the SWEPOS network, *Tectonophysics*, 294, 305-321, 1998.

Stone, J.O., D. Zwartz, M.C.G. Mabin, K. Lambeck, D. Fabel and L.K. Fifeld, Exposure dating constraints on ice volume and retreat history in East Antarctica, and prospects in West Antarctica, *in preparation*, 2000.

Tregoning, P., B. Twilley, M. Hendy, and D. Zwartz, Monitoring of isostatic rebound in Antarctica with the use of continuous remote GPS observations, *GPS Solutions*, 2, 70-75, 1999.

Tregoning, P. A. Welsh, H. McQueen and K. Lambeck, The search for postglacial rebound near the Lambert Glacier, Antarctica, *Earth, Planets and Space, in press*, 2000.

Zwartz, D., K. Lambeck, M. Bird and J. Stone, Constraints on the former Antarctic ice sheet from sea-level observations and geodynamic modelling, in *The Antarctic Region: Geological Evolution and Processes*, 821-828, 1997.

Zwartz, D., P. Tregoning, K. Lambeck, P. Johnston, and J. Stone, GPS measurement of postglacial rebound in MacRobertson Land, Antarctica, *Geophys. Res. Lett.*, 26, 1461-1464, 1999.

3.2.1 Computer Systems Compatibility

No issues have been entered.

3.2.2 Commercial Implications

n/a

3.2.3 Assessments - comments on process

This proposal has been discussed with Dr Peter Harris (Geoscience Program Leader) and Dr Ian Allison (Glaciology Program Leader) who are aware of the project and the logistical requirements of the project. Geoff Dannock is also aware of the logistical requirements of providing aircraft support for our program in past years.

Question 4. Legal Requirements

Question 4.1 Special Protected Areas

No SPA entered.

Question 4.2 Sites of Special Scientific Interest

No SSSI entered.

4.3 Usage of Animals

4.3.1 Lay Summary

(a) Purpose. Why does this research need to be done?

(b) Alternatives. What alternatives are there to the use of the proposed invasive and/or non-invasive procedure(s)?

(c) Potential Developments. What will this research lead to in the future?

(d) Practicality and Efficacy. How practical is/are the procedure(s) in sub-Antarctic or polar conditions, with respect to both the subject and the investigator?

(e) Use Outside Antarctica/sub-Antarctica. For each procedure, is the procedure currently in use in temperate lattitudes and what was the basis for ethics approval?

(f) Use by Other Antarctic Nations. For each procedure, is the procedure used by other national Antarctic programs and what infomation can be aquired from those studies?

(g) Skill Level of Field Assistants. How experienced do field assistants need to be in order to carry out the procedure(s) without harming the animal subject?

(h) Publication. When does the Chief Investigator intend to publish a paper based on the use of the procedure(s) in peer-reviewed literature?

(i) Impact on other Animals. What effect(s) will the application of the proposed procedure(s) have on animals in the vicinity of the [target] individual animal subject?

No Animal Usage Information entered for this season.

4.4 Sampling and Collection

4.4.1 a) Location - **Lambert Glacier Mt Wilson, Mt Borland**
4.4.1 b) Specimens

Rocks 20.00 kilograms

4.4.1 c) Sampling Techniques and Justification -
John Stone to provide details .....

4.5 Useage of Radioactive and Stable Isotopes

No Isotope Information entered for this season.

4.6 Environmental Assessment

Reasons for no assessment

Approval has been granted for previous seasons. The type of fieldwork to be conducted in 2001/02 is exactly the same as that which has been done previously.

4.7 Occupational Health and Safety

4.7.1 Training.

n/a

4.7.2 Details of any OH&S precautions to be implemented beyond basic 'supervision'.

yes - basic supervision will be sufficient.

NOTE The fuel cells to be used are of a different design to those used in 2000. They are sealed to prevent hydrogen from mixing with the other electrical components.

There is a hydrogen sensor installed in the insulation box which will stop the operation of the fuel cell if a buildup of hydrogen is detected. Furthermore, all relays etc used in our electronics are sealed, making the system intrinsically safe.

4.7.3 Details of any special emergency requirements or arrangements necessary for the project

n/a

4.7.4 This is the list of currently entered Risk-related Issues.

- **Risk No** - 122
  Location - Davis - fuel cell installation
  Task - operating fuel cell
  Equipment - fuel cell
  Hazard/ potential injury - fire/explosion
  Risk Level - Low
  Control Action required - care when connecting hydrogen gas lines

- **Risk No** - 123
  Location - Davis - Beaver Lake
  Task - fuel cell operation
  Equipment - fuel cell
  Hazard/ potential injury - fire/explosion
  Risk Level - Low
  Control Action required - care when connecting hydrogen gas lines

4.8 Human Ethics

No Human Ethics have been entered.

4.9 Use of Firearms & Weapons

No Weapons have been entered.

Question 5. Supporting Information

5.1 ANARE Publications

Use the links on the reference number if you wish to correct details about the publication.

Published papers that have not been vetted by the Publications Section of the Antarctic Division will appear in this list but not on any public lists. This will include 'in press' papers. If un-vetted papers have been published, please update volume and page numbers, and send a copy of the paper to the Publications Section.

Serial - Refereed

Tregoning, P., Twilley, B., Hendy, M. and Zwartz, D. (1999) Monitoring isostatic rebound in Antarctica with the use of continuous remote GPS observations *GPS Solutions* 2 . 70-75 ; [Ref: 8408]

Zwartz, D., Bird, M., Stone, J. and Lambeck, K. (1998) Holocene sea-level change and ice-sheet history in the Vestfold Hills, East Antarctica. *Earth and Planetary Science Letters* 155 . 131-145 ; [Ref: 8457]

Zwartz, D., Lambeck, K., Bird, M. and Stone, J. (1997) Constraints on the former Antarctic ice sheet from sea-level observations and geodynamic modelling *The Antarctic Region: Geological Evolution and Processes* . 821-828 ; [Ref: 8479] Not vetted

Zwartz, D., Tregoning, P., Lambeck, K., Johnston, P. and Stone, J. (1999) Estimates of present-day glacial rebound in the Lambert Glacier region, Antarctica *Geophysical Research Letters* 26 (10) . 1461-1464 ; [Ref: 8746]

5.2 Investigator 5 Year Publication History

Publications by Tregoning

Tregoning, P., A. Welsh, H. McQueen and K. Lambeck, The search for postglacial rebound near the Lambert Glacier, *Earth, Planets and Space, in press*,2000

Tregoning, H. McQueen, K. Lambeck, R. Jackson, R. Little, S. Saunders and R. Rosa, Present-day crustal motion in Papua New Guinea, *Earth, Planets and Space, in press*, 2000.

Tregoning, P. and R. Jackson, The Need for Dynamic Datums, *Geomatic Research Australasia* , 71,87-102, 1999.

Tregoning, P. R. Jackson, H. McQueen, K. Lambeck, C. Stevens, R. Little, R. Curley and R. Rosa, Motion of the South Bismarck Plate, Papua New Guinea, *Geophys. Res. Lett* , 26, 3517-3520, 1999.

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OBrien, D. and P. Tregoning, Geographical distributions of GPS satellites viewed from a low-earth orbiting satellite, *Report EOC-1998-01* , CSIRO Earth Observation Centre, Canberra, 1998.

Tregoning P., K. Lambeck, A. Stolz, P. Morgan, S.C. McClusky, P. van der Beek, H. McQueen, R.J. Jackson, R.P. Little, A. Laing, and B. Murphy, Estimation of current plate motions in Papua New Guinea from Global Positioning System observations, *J. Geophys. Res.*, 103, 12,181-12,203, 1998.

Tregoning, P. F. Tan, J. Gilliland, H. McQueen, and K. Lambeck, Present-day crustal motion in the Solomon Islands from GPS observations, *Geophys. Res. Lett.*, 25, 3627-3630, 1998.

Tregoning, P., R. Boers, D.M. OBrien, and M. Hendy, Accuracy of absolute precipitable water vapour measurements from GPS observations, *J. Geophys. Res.*, 103, 28,701,28,710, 1998.

Tregoning, P., GPS measurements in the Australian and Indonesian regions (1989-1993), *Unisurv Report S-44*, 134pp, University of N.S.W., Kensington, N.S.W., Australia, 1996.

Tregoning, P., F.K. Brunner, Y. Bock, S.S.O. Puntodewo, R. McCaffrey, J.F.Genrich, E. Calais, J. Rais, and C. Subarya, First geodetic measurement of convergence across the Java Trench, *Geophys. Res. Lett.*, 21, 2135-2138, 1994.

Publications by McQueen

Nawa, K., Suda, N., Fukao, Y., Sato, T., Tamura, Y., Shibuya, K., McQueen, H., Virtanen, H. and Kaariainen, J., Incessant excitation of the Earths free oscillations: global comparison of superconducting gravimeter records, *Phys. Earth Planet. Inter.*, 120, 289-297, 2000.

Sato, T., H. McQueen, B. Murphy, K. Lambeck, Y. Hamano, K. Asari, Y. Tamura and M. Ooe, On the observations of gravity tides and Earths free oscillations with a superconducting gravimeter CT#031 at Mt Stromlo, Australia, in *Proc 13th Int. Symposium on Earth Tides*, Brussels, Observatoire Royal de Belgique, 583-589, 1997.

McQueen, H.W.S. and K. Lambeck, Determination of crustal structure in central Australia by inversion of travel-time residuals, *Geophys. J. Int.*, 126, 645-662, 1996.

Sambridge, M., J. Braun and H.W.S. McQueen, Geophysical parameterization and interpolation of irregular data using natural neighbours, *Geophys. J. Int.*, 122, 837-857, 1995.

Sambridge, M., J. Braun and H.W.S. McQueen, Computational methods for natural neighbours interpolation in two and three dimensions, in *Computational Techniques and Applications: CTAC95*, R.L. May and A.K. Easton (Eds), World Scientific, 1995.

Publications by Lambeck: K. Lambeck has over 30 reviewed publications in journals in the past 5 years. We include here a selection of the relevant publications for 1998 and 1999 only.

Shennan, I., K. Lambeck et al., Modelling western North sea palaeogeographics and tidal changes during the Holocene, *Geol. Soc. Lond. Spec. Publ.*, 166, Dec 1999.

Shennan, I. K. Lambeck et al., Holocene isostasy and relative sea-level changes on the east coast of England, *Geol. Soc. Lond. Spec. Publ.*, 166, Dec 1999.

Kooi, H., P. Johnston, K. Lambeck, C. Smither and K. Molendijk, Geological causes of recent (~100yr) vertical land movements in the Netherlands, *Tectonophysics*, 299, 297-316, 1999.

Johnston, P.J. and Lambeck, K. 1999. Postglacial rebound and sea level contributions to changes in the geoid and the Earths rotation axis, *Geophys. J. Int.*, 136, 537-558, 1999.

van der Beek, P., Braun, J., and Lambeck, K., the post-Palaeozoic uplift history of south-eastern Australia revisited: Results from a process-based model of landsvape evolution, *Aust. J. Earth Sci.*, 46, 157-172, 1999.

Lambeck, K., Shoreline displacement in southern-central Sweden and the evolution of the Baltic Sea, *Geol. Soc. Lond.*, 156, 465-486, 1999.

Fleming, K., P. Johnston, D. Zwartz, Y. Yokoyama, K. Lambeck and J. Chappell, Refining the eustatic sea-level curve since the Last Glacial Maximum using far- and intermediate-field sites, *Earth Plan. Sci. Lett.*, 163, 327-342, 1998.

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5.3 Keywords

GPS
Ice-Sheet History
Lambert Glacier
Postglacial Rebound

5.4 Digital Spatial Data

No mapping requirements found.

5.5 Data and Samples

Use the link on the Metadata record to see full details of the dataset that this project created. The 'Delete' link will remove the link from this project to that metadata record.

- GEMIR_GPS_ANU Geodetic monitoring of isostatic rebound near the Lambert Glacier

Question 6. Project Personnel

New People entered for 2001/02

DR PAUL TREGONING - Chief Investigator

Geodesist , Australian National University

Personal Details	Work address	Home address
[Person Id - **20778**] Date of birth - 8-Feb-1969 Sex M Full given names - PAUL Preferred Mail Address is Work	Research School of Earth Science Australian National University Canberra ACT Australia 0200 Phone +61 2 6249 5510 Fax +61 2 6249 5443 Email pault@rses.anu.edu.au	

TBA - Field Person

Personal Details	Work address	Home address
[Person Id - **0**] Date of birth - Sex Full given names - Preferred Mail Address is Unknown		

- Trip type - Summerer | Departing voyage - V 3 Disembark at D | Return voyage - V 5 in Embark at D

  Contact information - Person to be identified. May be someone from the University of Washington.

TBA - Field Person

Personal Details	Work address	Home address
[Person Id - **0**] Date of birth - Sex Full given names - Preferred Mail Address is Work	Research School of Earth Science Australian National University Canberra ACT Australia 0200	

- Trip type - Summerer | Departing voyage - V 3 Disembark at D | Return voyage - V 5 in Embark at D

  Contact information - Expeditioner has not yet been identified.

DR JOHN STONE - Investigator

Geochemist , University of Washington

Qualifications - PhD (1986)

Personal Details	Work address	Home address
[Person Id - **0**] Date of birth - 10-Feb-1961 Sex M Full given names - JOHN OWEN Preferred Mail Address is Work	Department of Geological Science Box 351310 University of Washington Seattle WA USA 98195-1310 Phone + 1 206 685-9514 Fax + 1 206 543-3836 Email stone@geology.washington.edu	

DR KURT LAMBECK - Investigator

Geophysicist , Australian National University

Personal Details	Work address	Home address
[Person Id - **32299**] Date of birth - 20-Sep-1941 Sex M Full given names - KURT Preferred Mail Address is Work	Research School of Earth Science Australian National University Canberra ACT Australia 0200 Phone +61 2 6249 5445 Fax +61 2 6249 5443 Email kurt.lambeck@anu.edu.au	

DR HERBERT MCQUEEN - Investigator

Geophysicist , Australian National University

Personal Details	Work address	Home address
[Person Id - **38691**] Date of birth - 14-Apr-1954 Sex M Full given names - HERBERT Preferred Mail Address is Work	Research School of Earth Science Australian National University Canberra ACT Australia 0200 Phone +61 2 6249 5515 Fax +61 2 6249 5443 Email herb@rses.anu.edu.au	

Berth Requests as processed by the Australian Antarctic Division

No berths leaving in 2001/02.

Question 7. Land based Requests

Requirement No 11502 -- Communications at Lambert Glacier

7.4.3 PC details.

- 4 x PC104 card 486 computers operating DR-DOS at each GPS site
- Laptop computer (Gateway notebook operating Windows98) as portable field computer.

7.4.4 Special.

Communications from Landing Bluff and Beaver Lake possible via installed satellite phone. Communications at Dalton Corner and Komsomolkiy Peak will need to be arranged.

The applicant will supply:-

- relevant operational and technical maintenance handbooks
- spare parts
- copies of software installation disks

Antarctic Division Comments - none entered

Status - New

Requirement No 11501 -- Field locations at Davis

Number of personel is 2 at Beaver Lake from V3 to V5.

Number of personel is 2 at Landing Bluff from V3 to V5.

Number of personel is 2 at Dalton Corner from V3 to V5.

Number of personel is 2 at Komsomolkiy Peak from V3 to V5.

Antarctic Division Comments - none entered

Status - New

Requirement No 11569 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 50 kg. Expected cargo dimensions is .5 m^3.

Locations to be visited - Dalton Corner-Mt Wilson-Mt Borland-Dalton Corner (1 hour)

Field party moved to Mt Borland for further rock sampling.

Antarctic Division Comments - none entered

Hours required - 1.00

Status - New

Requirement No 11570 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 50 kg. Expected cargo dimensions is .5 m^3.

Locations to be visited - Dalton Corner-Mt Borland-Dalton Corner-Beaver Lake (3 hours)

Field party picked up from Mt Borland, stop briefly at Dalton Corner to download system data (helicopter to wait on ground for 5 minutes) then transfer to Beaver Lake. .

Antarctic Division Comments - none entered

Hours required - 3.00

Status - New

Requirement No 11573 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 100 kg. Expected cargo dimensions is .5 m^3.

Locations to be visited - Landing Bluff-Davis (1 hour)

Field party returned to Davis at the end of the fieldwork. .

Antarctic Division Comments - none entered

Hours required - 2.00

Status - New

Requirement No 11571 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 100 kg. Expected cargo dimensions is .5 m^3.

Locations to be visited - Beaver Lake-Landing Bluff (1 hour)

Field party moved to Landing Bluff.

Antarctic Division Comments - none entered

Hours required - 2.00

Status - New

Requirement No 11568 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 50 kg. Expected cargo dimensions is .2 m^3.

Locations to be visited - Dalton Corner-Komsomolkiy Peak-Mt Wilson-Dalton Corner (4 hours)

Field party moved from Komsomolkiy Peak to Mt Wilson for rock sampling..

Antarctic Division Comments - none entered

Hours required - 4.00

Status - New

Requirement No 11566 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 1500 kg. Expected cargo dimensions is 3 m^3.

Locations to be visited - Davis to Dalton Corner (3 hours flying time)

Field party to be left at the site for two days to install the hydrogen fuel cell and fuel supply..

Special requirements and Modifications - Sling loading of cylinders? Use of fixed wing aircraft to Dalton Corner?.

Hazardous Goods - 18 cylinders of compressed hydrogen.

Antarctic Division Comments - none entered

Hours required - 12.00

Status - New

Requirement No 11567 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 200 kg. Expected cargo dimensions is 1 m^3.

Locations to be visited - Dalton Corner to Komsomolkiy Peak (2 hours each way)

Field party moved from Dalton Corner and dropped off at Komsomolkiy Peak for 2 days.

Antarctic Division Comments - none entered

Hours required - 4.00

Status - New

Requirement No 11574 -- Helicopters at Davis

Number of S76 required is 2. Number of people required is 2. Expected cargo weight is 10 kg. Expected cargo dimensions is .1 m^3.

Locations to be visited - Davis-Beaver Lake-Dalton Corner-Komsomolkiy Peak-Dalton Corner-Beaver Lake-Davis(8 hour return)

Revisit equipment at Komsomolkiy Peak to download GPS data (helicopter to wait 5

minutes on the ground). Stop off at Dalton Corner on the return to retrieve GPS data (helicopter to wait 5 minutes on the ground)..

Antarctic Division Comments - none entered

Hours required - 16.00

Status - New

Requirement No 11576 -- Vehicles at Princs Charles Mts - North

Light oversnow vehicle (eg. Skidoo, 4 wheel all terrain vehicle). Number required is 1 from V3 to V5

Details of the use of each vehicle (eg. weekly sampling at Lake) is quads required to access GPS site from Beaver Lake huts. Will be used for 2-3 days only.

Antarctic Division Comments - none entered

Status - New

Question 8. Marine Science or Voyage Support Requests

8.1 Cargo Shipments

No cargo Information entered.

8.2-8.6 Other Voyage Requirements

No ship-based requirements found.

Question 9. ASAC Grant Requests

Grants requested for Season 2001/02

- 9.1.1 Applicant -
- 9.1.2 Affiliate institution/organisation which will receieve and administer the ASAC grant: -
- 9.1.3 Australian Business Number -
- 9.1.4 Deductible Gift Recipient - No
- 9.2.1 - Travel and Support Costs

- Airfare Seattle-Hobart - Priority 1 - Requested $3,000.00
- medicals - Priority 1 - Requested $1,000.00
- 2 x return airfares CBR-HOB - Priority 1 - Requested $1,440.00
- 2 x 4 nights accommodation in Hobart - Priority 2 - Requested $440.00

- 9.2.2 - Personnel (Research and technical assistance)

  - Salary for Field Person 1: 4 months @ $1,500/month - Priority 2 - Requested $6,000.00

- 9.2.4 - Other (Consumables, hire of equipment and maintenance)

  - Hydrogen fuel supply and cylinder rental. - Priority 1 - Requested $10,000.00

Total amount requested - $21,880.00

9.3 - Justification

- The hydrogen fuel is an essential item, required to run the fuel cells which provide power to the remote installations during winter when solar power is not available. Without the fuel, the systems will not function throughout the winter and will require operator intervention early in the Spring to recommence the operation of the equipment.
- We request an international airfare for the field person who will be coming from the University of Washington. It is important that the field geologist is familiar with sampling methods for cosmogenic isotope exposure dating; the chosen geologist will be someone trained by John Stone (one of the co-investigators).
- We request funding for domestic airfares between Canberra and Hobart as well as accommodation in Hobart to cover the period immediately before the voyage departure.
- We request funds to cover the costs of medical expenses associated with sending expeditioners to Antarctica.
- We request 4 months salary for the GPS Field Person. This will cover the time spent in Antarctica as well as preparation/training time spent at RSES to learn how to install/operate the GPS and associated electronic equipment.

9.4 - Other funding

1998

- $5,000 provided by Research School of Earth Sciences (RSES) to cover costs of equipment purchases.

1999

- $142,000 ANU Major Equipment grant awarded ($40,000 from RSES funds, $102,000 from ANU funds)
- $5,000 provided by RSES to cover the salary of the field expeditioner

2000

- $42,000 provided by RSES to cover equipment costs

- $6,000 provided by RSES to cover the salary of the field expeditioner.

Question 10. Certifications

Certifications have not been received.

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My Application Is Finished

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