



WP 7

EXCOM/COs Meeting 2011
Edinburgh, 16,18,19th July 2011

Agenda Item: 2.3.1
Person Responsible: A Capra

Report of SSG Geosciences

Executive Summary

Title: SCAR Standing Scientific Group on Geosciences (SSG GS) Report

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Relevant URLs or references to other reports: WP6,WP11,WP 18

Important Issues or Factors:

Discussions on new proposals that should arise from ISAES 2011.

Development of SERCE PPG.

SCAR endorsement to transform the GWSWF Action Group into an Expert Group with revised Terms of Reference (ToRs). However, discussion arose that the new ToRs overlapped with those of the ICESTAR Expert Group and that the two groups should discuss the best way forward. One idea is to merge both the group into a single Expert Group.'

Recommendations/Actions and Justification:

That SERCE PPG should become SRP

That GWSWF become EG

SSG-GS Report

SSG-GS continues to communicate with its community through the GeoReach Newsletter. A website dealing with a general explanation of the geology of Antarctica (for educational purposes) is under review.

During the last SCAR Meeting in Buenos Aires, 2010 some news occurred relating to Action and Expert Groups. One Action Group (Sub-Ice Geological Exploration) was ended, and a new one, on Acquisition of Multibeam Bathymetric Data, was created. The Cold Seeps and Hydrothermal Vents in the Antarctic (SAVANT) Action Group was shared with SSG-Life Sciences. The workshop requested the preparation of a field guide for seep and vent organisms. Activity will increase from February 2011.

Steady progress has been made by most of the other Action and Expert Groups. These include the Action Group on GPS for Weather and Space Weather Forecasting, which is joint with the SSG-Physical Sciences, and the following Expert Groups: GIANT (Geodetic Infrastructure of Antarctica); EGPPE (EG on Permafrost and Periglacial Environments); IBCSO (International Bathymetric Chart of the Southern Ocean); and ADMAP (Antarctic Digital Magnetic Anomaly Project). A potential problem was noted with the IBCSO, where funding for the scientific coordinator had ceased.

During the II GWSWF in Modena, April 2011, the meeting was dedicated to discussions concerning the formulation of a proposal seeking SCAR endorsement to transform the Action Group into an Expert Group with revised Terms of Reference (ToRs). However, discussion arose during the Cross Linkages Workshop that the new ToRs overlapped with those of the ICESTAR Expert Group and that the two groups should discuss the best way forward. One idea is to merge both the group into a single Expert Group.

SSG-GS is proposing an extension to the Programme Planning Group on Solid Earth Responses and Influences on Cryospheric Evolution (SERCE), to enable an SRP proposal to be submitted to the SCAR meeting in 2012. SERCE will synthesize and interpret the extensive new data-sets obtained during IPY by the geophysical sensor deployments of the international Polar Earth Observing Network (POLENET). SERCE plans to promote communication and coordination with other international groups investigating polar ice mass change, glacial isostatic adjustment, and ice sheet contributions to global sea level rise (see at WP18).

A major future commitment is the 11th SCAR International Symposium on Antarctic Earth Sciences (ISAES) in Edinburgh (July 10-16, 2011) where there will be sessions on all aspects of geosciences research in Antarctica, with special meetings and workshops covering several research fields.

In addition to the ISAES meeting in 2011, the SSG intends to contribute to the International Geological Congress, planned for Brisbane, Australia, in 2012.

Geosciences Action and Expert Group Reports

Expert Group on Geodetic Infrastructure of Antarctica (GIANT)

The objectives of GIANT are to:

- Provide a common geographic reference system for all Antarctic scientists and operators.
- Contribute to global geodesy for the study of the physical processes of the earth and the maintenance of the precise terrestrial reference frame.
- Provide information for monitoring the horizontal and vertical motion of the Antarctic.

The group is currently being revitalised as it has not been active recently.

Expert Group on Permafrost and Periglacial Environments (EGPPE)

The main aim of EGPPE is to promote international collaboration towards the development of Antarctic permafrost research. The IPY core project ANTPAS has been the main driver of its activities and allowed for the implementation of several nationally funded projects, many of them with long-term monitoring and research goals. Current activities benefit from ANTPAS dynamics are framed within the project objectives. EGPPE's activities in 2010 included:

- Two coordination meetings in Longyearbyen, Svalbard (EUCOPIII) and in Buenos Aires (SCAR OSC) that resulted in a revised Steering Committee, with M. Guglielmin (Italy) and G. Vieira (Portugal) as Co-chairs, M. Balks (New Zealand) as Secretary and J. Putkonen (USA) and C. Schaeffer (Brazil) as Communication Officers. A newsletter in order to facilitate communications will be implemented.
- A session at SCAR OSC in Buenos Aires on Antarctic Permafrost and Periglacial Environments, which will result in a special issue of *Geomorphology* edited by M. Guglielmin.
- A session was proposed for ISAES 2011.

For further details see: <http://erth.waikato.ac.nz/antpas/>.

International Bathymetric Chart of the Southern Ocean (IBCSO)

The objective of the IOC regional ocean mapping programme and SCAR Geosciences Expert Group on IBCSO is to gain better knowledge of the sea floor topography in the Southern Ocean. There has been some interruption with progress over the last year due to staffing problems, but it is expected that this will be resolved soon. For further details see: <http://www.ibcso.org/>.

The Antarctic Digital Magnetic Anomaly Project (ADMAP)

ADMAP aims to map Antarctica's magnetic anomaly field to aid in understanding geological processes. It is managed jointly with IAGA (International Association of Geomagnetism and Aeronomy). ADMAP contributes data to the World Magnetic Anomaly Map (for details see: <http://www.geology.ohio-state.edu/geophys/admap>). During 2008, the release of a CD to the World Data Centres with the latest completed ADMAP compilation was approved. This compilation is ADMAP-1999 to indicate the latest year of survey data that the compilation holds. A successful special session on Antarctic geomagnetism was held during the 2010 SCAR meeting. The papers submitted there are being prepared to be published in a special issue of *Tectonophysics*. More than 2.5 million line-kilometres of new aeromagnetic and ship survey data since 2000 are becoming available for inclusion in the database. In addition, a number of new surveys will be completed. Furthermore, CHAMP satellite magnetic observations, collected at altitudes of about 300-325 km, provide important new constraints on Antarctic crustal anomalies. In view of these data developments, a new-generation ADMAP compilation will be made available soon. The new compilation, tentatively entitled ADMAP-2012, will be a significant ADMAP contribution to the legacy of the IPY. ADMAP is cooperating with the Antarctic Geoid Project (<http://tpg.geo.tudresden.de/antgp/antgp.htm>), which aims to support gravity measurements in Antarctica, in order to close the gaps in terrestrial gravity data coverage.

Advancing Technological and Environmental stewardship for subglacial exploration in Antarctica (ATHENA) (joint with LS)

This new expert group emerges in the wake of the recently disbanded Scientific Research Programme, SALE. It is not a new version of SALE, but will take subglacial aquatic research in Antarctica in a new and important direction, by coordinating and facilitating collaboration in Antarctic subglacial aquatic science and specifically technologies and environmental stewardship, both of which are required to underpin current and future subglacial aquatic environment exploration.

ATHENA Terms of reference

- To establish the critical environmental and technological infrastructure for the future access, sampling and monitoring of Antarctic subglacial aquatic environments (SAE)

- To work with SCAR action groups, expert groups and research programmes to promote interdisciplinary science on Antarctic SAE, and specifically by developing linkages with research on Antarctic climate (via ACE), Biodiversity (via EBA) and sub-ice geological exploration (via SieGE).
- To provide an independent and international forum for the sharing of information and data during the run up to and execution of funded lake access drilling campaigns (e.g. US-WISSARD, UK-Lake Ellsworth and Russia-Lake Vostok).

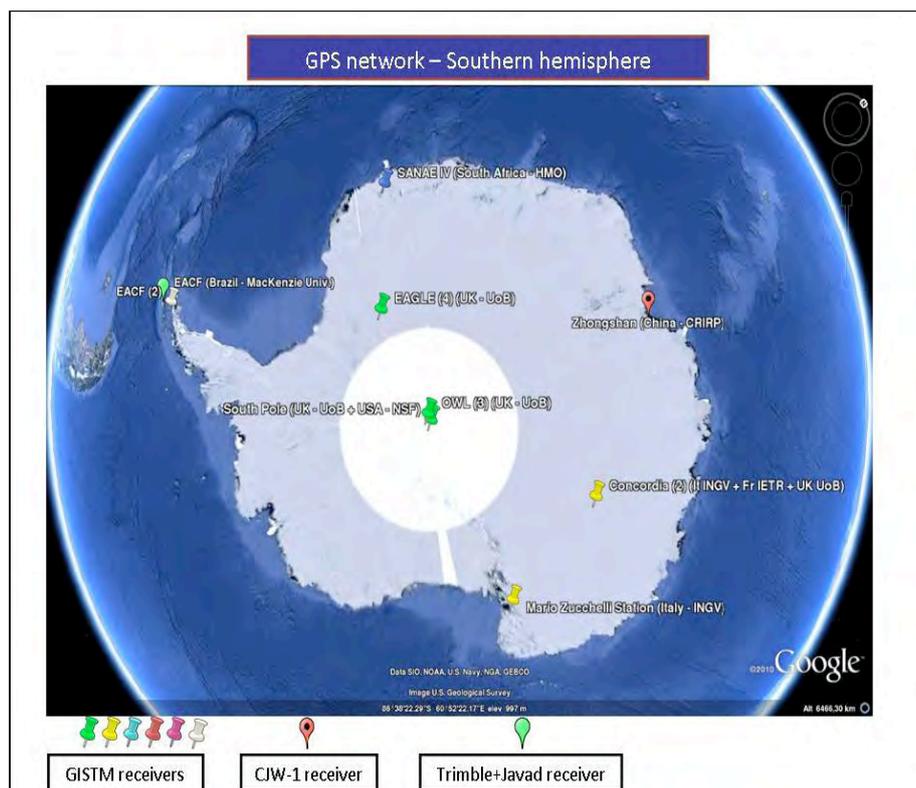
Seeps and Vents in Antarctic (SAVAnt) (joint with LS)

To assist CCAMLR, the SCAR Geoscience and Life Science SSGs have started an Action Group that aims to identify areas within the CCAMLR region likely to contain Vulnerable Marine Ecosystems around cold seeps and hydrothermal vents.

The SAVANT Project will be handed over to Dr Jodie Smith. The need for field guide to seep communities has been met by the organisation that prepared the original CCAMLR guide to Vulnerable Marine Ecosystems so SAVANT will concentrate on compiling the location of known seep and vent occurrences. For further details see: <http://www.scar.org/researchgroups/savant.html>

Action Group on GPS for Weather and Space Weather Forecasting (joint with PS)

The GPS for Weather and Space Weather Forecast (GWSWF), a joint Geoscience and Physical Sciences Action Group, aims to establish a suitable GNSS receivers network over the Arctic and Antarctica with the scope to develop a 3D image of the upper atmosphere as well as to develop algorithms for water vapor retrieval over Antarctica. Such a network is intended to use the existing GNSS standard receivers managed by the POLENET community, and GNSS receivers appropriately configured to observe the ionosphere under quiet and stormy conditions. During 2010 several goals have been successfully reached: an enlargement of the GPS bi-polar network for investigating the ionospheric irregularities and scintillations (Fig.1), publications co-authored by different institutions, presentations on multi-instrument inter-hemispheric scintillation studies, on the mitigation of ionospheric effects on GPS positioning over Antarctica and on the water vapour retrieval using GPS over Antarctica. The GWSWF web has been developed and is now accessible at <http://www.gswf.scar.org> with the scope of results dissemination, data and software facilities sharing, attraction of new collaborations with other groups and institutions. Moreover closer interaction with SCADM will be sought regarding metadata standards, quality control standards & data formats for ionospheric scintillation. A GWSWF business meeting has been held during the SCAR OSC 2010 in Buenos Aires attended by 16 people from 7 Countries. The II GWSWF meeting has been held in Modena (Italy) 11-12 April 2011 to discuss the objectives in the perspective of the next SCAR OSC and Business Meetings in Portland (USA), 2012.



Coordination of Scientific Activities on King George Island Group (joint with PS and LS)

Progress has not been as fast as had been hoped with this group. It was recognized that one of the problems for this group to accomplish its terms of reference is the fact that individual scientists may not have access to all the required information about programmes and scientific equipment and facilities actually present on the island. Such information is often with national Antarctic programme managers or science program directors. The leadership of the group and terms of reference (<http://www.scar.org/researchgroups/lifescience/>) remained unchanged. A discussion on the future of this group will be held at the SCAR Executive Committee Meeting in July 2011.

Action Group on Multibeam Data Acquisition

The SSG on Geosciences recommended the establishment of an Action Group to identify data needs and best practice protocols for mapping of Last Glacial cycle grounding zones using multibeam bathymetry. Mapping the position of past grounding zones of the Antarctic Ice Sheet is important in providing boundary conditions for understanding ice volume history during the last glacial cycle, in understanding regional differences in ice behaviour and in mapping the availability of refugia for marine benthic biota.

The Action Group will:

- Identify the highest priority areas where multibeam bathymetry will provide important insights into the position and retreat history of the Ice sheet grounding zone and where such data do not exist.
- Set out survey design guidelines to maximise the value of multibeam surveys in interpreting grounding zone position, behaviour and history of the Antarctic shelf.

Reports on Meetings

GPS for Weather and Space Weather Forecasting

The II GWSWF meeting has been held in MODENA on April 11-12, 2011.

Detailed minutes, Agenda, list of attendees and presentations can be found at: www.gwswf.scar.org. The first day of the meeting was devoted to recall the main

achievements of the GWSWF Action Group in the period 2008-2010 and to update the principal activities and collaborations of the Group participants. During the second day the meeting was dedicated to the discussions addressed to the formulation of a proposal seeking the SCAR endorsement to transform the Group into an Expert Group (a 4 years duration project).

Although some of the GWSWF participants were in favour of proposing to transform the current Action Group into a Scientific Research, the majority was in favour of an Expert Group, claiming that the GWSWF has surely demonstrated its potentialities through collaborations and joint activities, but that it does not yet reach the needed critical mass and the scientific extent to support the proposal of a Scientific Research Project. After a brief discussion on this everybody agreed to proceed to an Expert Group proposal. A drafted implementation plan was the core of the debate to get ready to submit a first intention to the next SCAR Cross-Linkages meeting (5-6 May 2011, Ottawa, Canada).

The GWSWF agreed to propose an EG with the following **main objectives**:

- Create and maintain distributed networks of specialized GPS/GNSS Ionospheric Scintillation and TEC Monitors particularly at high latitudes.
- Identify and quantify mechanisms that cause scintillation and control interhemispheric differences, asymmetries and commonalities in scintillation occurrence and intensity as a result of the geospace environment conditions.
- Develop ionospheric scintillation climatology, tracking and mitigation models to improve prediction capabilities of space weather.
- Retrieve tropospheric PWV for input to weather forecast models and to develop regional PWV climatology for atmospheric sensing in remote areas.

The objectives will be achieved according to the following method:

- Create a data portal to facilitate sharing and utilization of the GNSS/GPS and geophysical databases.
- Pursue joint studies on relevant scientific topics, development of models and mitigation techniques will be planned and coordinated. Annual meetings/workshops will provide forum for discussions and focus the community efforts towards the GWSWF project goals.
- Form working groups to focus on areas such as data formats and archiving, common software development and data handling, quantifying the causes of scintillation and the role of solar wind interaction with the Earth's magnetosphere-ionosphere system, development of scintillation and tropospheric PWV climatology, scintillation forecasting, and tracking and mitigation models.

The proposed EG will be structured according to the following WGs:

- WG1- Solar-Terrestrial interactions and ionospheric effects in the current solar-cycle.
1. Multi-instruments investigation of the upper atmosphere plasma dynamics and scintillation generation (SuperDARN, GNSS, ionosondes, VLF, etc..)

ANTscape Workshop, 27th Aug-1st Oct 2010, Royal Holloway, University of London

This report summarises the main activities and outcomes of the ANTscape workshop at Royal Holloway. Details of each aim, along with the subsequent results are detailed below.

Reconstruction of 34 Myr timeslice

The aim was to carry out balancing of model outputs so that they were correctly constrained by the available geological evidence. The base for the reconstruction was BEDMAP, rebounded for present-day ice-load, with some increased resolution topography in the Ross Sea. Extension and thermal subsidence in the Ross Sea were accounted for in the same way as by Wilson and Luyendyk (2009), and bodies of Neogene volcanic rock were removed. Erosion volumes were estimated using a combination of surface fitting (Wilson & Luyendyk, 2009) and glacial erosion models (Jamieson et al., 2010), and these were balanced against measured sediment volumes from offshore. The balanced sediment volumes for each individual drainage system were merged

to produce a continent-wide erosion volume map. This was then restored onto the initial topography and a flexural isostatic rebound calculation made to produce the final palaeotopographies (maximum and minimum).

Table 1 shows the sediment volumes provided by CASP members and the associated calculation of their onshore volumes, given adjustments for density change between erosion and deposition and for removal of the biogenic fraction. These form the central constraint on the reconstruction. Other constraints were more qualitative in nature, and included ensuring that coastal trough systems were not over-filled on the assumption that most of these systems started life as pre-Oligocene fluvial valleys or tectonic features. Also detailed in Table 1 are the resulting volumes calculated in the merged sediment restoration models of Wilson and Jamieson that are used for reconstructing the final maximum and minimum palaeo-surfaces. There are a number of mismatches between the measured/estimated offshore sediment volumes and the reconstructed onshore volumes. However, the models over-predict volume by only $0.3 \times 10^6 \text{ km}^3$ for the minimum reconstruction and under-predict by $4.27 \times 10^6 \text{ km}^3$ for the maximum. This latter mismatch is explained by the difficulty in restoring sediment over the Antarctic Peninsula and in the Amundsen Sea, and by the difficulty in restoring enough sediment in Dronning Maud Land and Enderby Land without over-filling troughs. Overall, our reconstructions fall within the upper and lower bounds provided by the CASP sediment estimates. To reduce the error further, a slight re-balancing will be made by adjusting a drainage divide between the Amundsen and Ross Seas. Further adjustment will bring the shelf-edge closer to the coast in the Weddell Sea by removing sediment from the shelf.

Drainage Area	Location	Total Offshore Vol (min)	Total Offshore Vol (max)	Onshore Vol (min)	Onshore Vol (max)	Total Vol Restored (min)	Total Vol Restored (max)	Absolute model accuracy (min)	Absolute model accuracy (max)
DML	0-30E	0.60	0.60	0.34	0.54	0.31	0.31	-0.03	-0.23
EL	30E-60E	0.72	0.72	0.41	0.65	0.38	0.38	-0.03	-0.27
MRL-PEL	60E-94E	1.30	1.30	0.75	1.17	0.83	1.18	0.08	0.01
QML-WL	94E-124E	0.64	0.65	0.37	0.58	0.38	0.53	0.01	-0.05
GL-OL	124E-165E	0.60	0.60	0.34	0.54	0.34	0.52	0.00	-0.02
Totals for East Antarctic drainages:		3.86	3.87	2.21	3.48	2.24	2.92	0.03	-0.56
VL/ROSS	165E-150W	1.50	3.00	1.03	2.62	1.27	2.25	0.24	-0.37
WED	0E-60W	2.70	4.90	1.85	4.28	2.35	3.81	0.50	-0.47
Totals for East/West drainages:		4.20	7.90	2.88	6.90	3.62	6.06	0.74	-0.84
PEN	60-80W	1.00	3.00	0.64	2.45	0.08	0.17	-0.56	-2.28
ADM	80-150W	1.10	2.10	0.70	1.72	0.82	1.13	0.12	-0.59
Totals for West Antarctic drainages:		2.10	5.10	1.34	4.17	0.90	1.30	-0.44	-2.87
Totals for East + West Antarctica:		10.16	16.87	6.44	14.55	6.76	10.28	0.32	-4.27

Table 1: Measured and estimated offshore sediment volumes and modelled sediment volumes in millions of km^3 . Offshore Volumes are provided by CASP and are then adjusted to account for biogenic fraction and compaction to become 'onshore' volumes. These can be compared with the 'total volume restored' by the model and the associated absolute error between measured and modelled volumes. Min and Max indicate the error in offshore measurement and are retained throughout the modelling to produce a minimum and maximum restoration volume. DML=Dronning Maud Land; EL=Enderby Land; MRL=Mac. Robertson Land; PEL=Princess Elizabeth Land; QML=Queen Maud Land; WL=Wilkes Land; GL=George V Land; OL=Oates Land; VL=Victoria Land; ROSS=Ross Sea; WED=Weddell Sea; PEN=Antarctic Peninsula; ADM=Amundsen Sea.

Preliminary output maps of the distribution of sediment are shown in Figure 1, and the resulting palaeotopographic reconstructions are shown in Figure 2. Key features include: the infilling of the Ross and Weddell Seas to produce extensive new land above sea level, the movement of Marie Byrd Land closer to Victoria Land, the removal of post-Oligocene volcanic provinces, adjustment for thermal subsidence in the Ross Sea, the infilling of the Lambert Graben to near sea level, and the retention of pre-Oligocene topography in the Gamburtsev Subglacial Mountains and small portions of Dronning Maud Land.

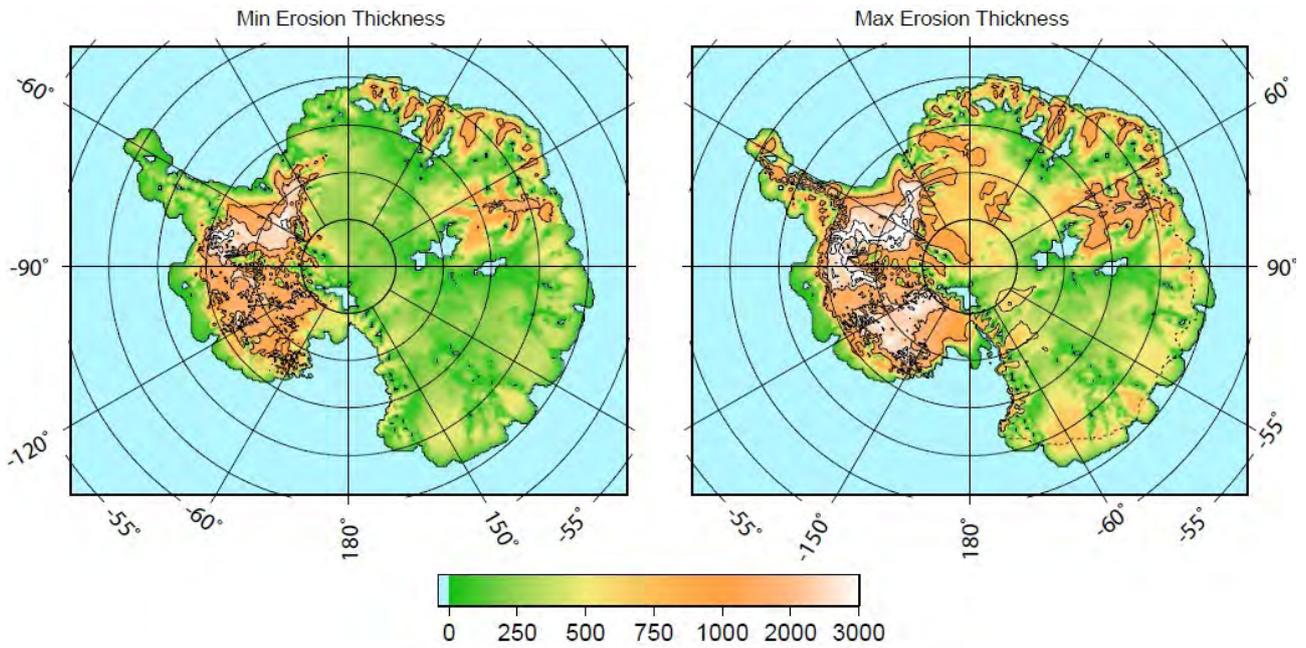


Figure 1: Modelled thickness of material removed by erosion. Left: Minimum, Right: Maximum.

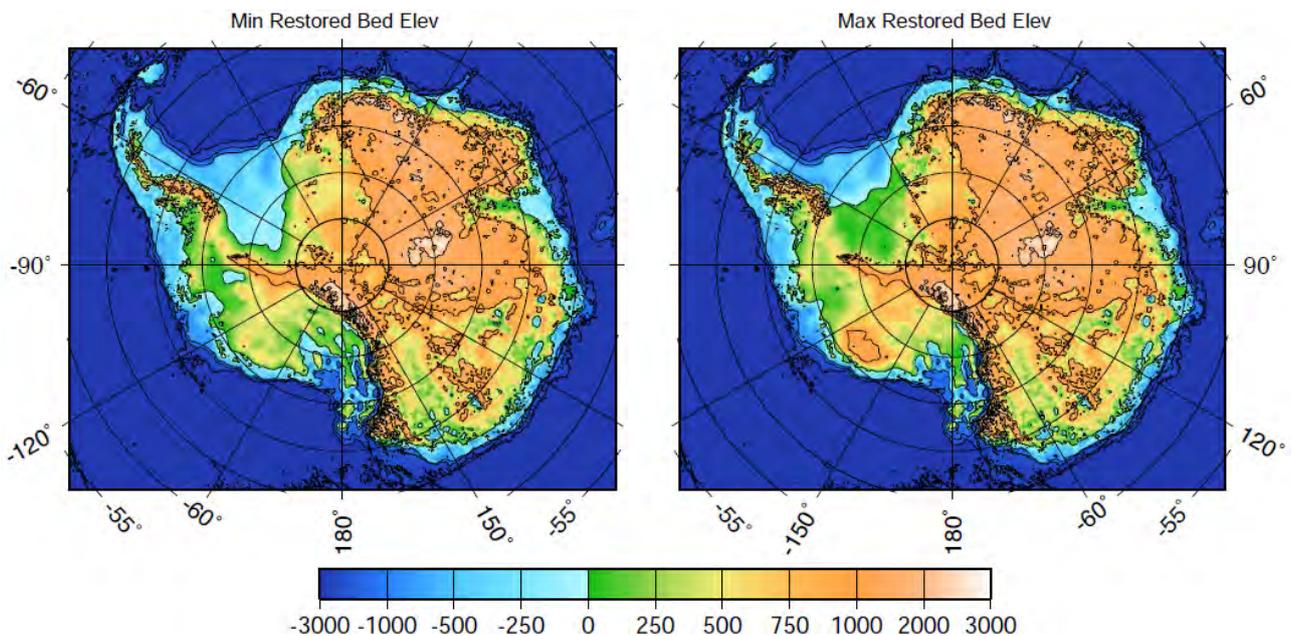


Figure 2: Modelled palaeotopographies at 34 Ma. Left: Minimum, Right: Maximum. Higher resolution version attached in pdf document.

Publication of 34 Myr timeslice

The aim was to produce a skeleton of the 34 Myr paper for upcoming submission to the special issue of *Palaeo*³, with the aim of submitting by mid-November 2010 at the latest.

~70 Myr Cretaceous reconstruction

The aim was to develop a theoretical and technical framework for the adjustments required for the ~70 Myr reconstruction. This included: a decision on the large-scale process to be incorporated, and a 'routemap' detailing the magnitude and spatial extent of particular topographic changes to be incorporated (including differences that will occur between maximum and minimum reconstructions).

Technical/computational details were discussed and modelling tools were transferred to Graeme Eagles to ensure that a consistent methodology can be maintained between the 34 and 70 Myr (and the following) timeslices. In particular, the model for calculating flexural isostatic compensation over elastic plates of uniform thickness is now working at Royal Holloway.

Timeline: The aim is to have a draft 70 Ma reconstruction ready for presentation by the time of ISAES in Edinburgh (July 2011).

The framework for the ~70 Myr timeslice is below.

For the 70 Ma ANTscape time slice, the following list of essential adjustments were discussed:

- *Restoration of Gondwanan continents to their 70 Ma positions with respect to Antarctica.*
- *Flexural adjustments for undoing the cooling of continental margins and the adjacent oceanic lithosphere.*
- *Adjustment for thermal subsidence of ocean floor surrounding Antarctica.*
- *Resurrection of subducted oceanic lithosphere.*
- *Adjustments for vertical tectonics in the Transantarctic Mountains.*
- *Sediment backstacking from Antarctic margins to the continental surface.*
- *Uplift/volcanism at the Antarctic Peninsula.*
- *Motion of small continental fragments in the Scotia Sea and south of Tasmania.*