Towards improved geological maps of Antarctic rocks and surficial deposits

Datasets for studies of glacial dynamics and climate change

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Convenors

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Discussion Themes

1.10-1.40  Background
1.40-3.00  State of knowledge review
3.00-3.20  Break
3.20-3.40  Database model
3.40-4.00  Classification issues
4.00-4.30  Base datasets
4.30-5.00  Building the team and workplan
1. Background

Overview of the idea and need.

Discussion on the scope, usefulness and purpose of such a dataset.

Who are the key end-users?

Introduction: Simon Cox
Looking for a core group of people
Provide feedback
Provide data and work
Find students

Attendees: A full list of attendees was not collected at the workshop, but those present included:

Chris Carson  Geoscience Australia  Australia
Jo Whittaker  Institute for Marine and Antarctic Studies  Australia
Jacqueline Halpin  Institute for Marine and Antarctic Studies  Australia
Yingchun Cui  Institute of Oceanography SOA  China
Surya Sankarasubramanian  Indian Institute of Technology
Bombay  India
Shridhar Jawak  NCAOR  India
Amar Jeet  Panalink, Delhi  India
Massimo Pompilio  Istituto Nazionale di Geofisica e Vulcanologia
Offshore versus onshore geology: Simon Cox

Records of climate offshore are expensive to collect and spatially limited.

Records onshore provide a lot more spatial data, more cheaply and is logistically less complicated.

Other disciplines are looking onshore already.

Global sea level change is recorded in the ice change through the Transantarctic Mountains.

There is limited post Miocene morphology (surficial geology) in the old map series.

It's difficult to get a regional overview.

Many different scales, levels of detail and classification schemes. E.g. The New Zealand 1:250,000 geological map of southern Victoria Land (QMAP 22) turned two units (till and scree) into c. 70 units.
Context

There is still considerable uncertainty about the past effect that Antarctic ice has had on sea level, and its potential contribution to future sea level rise.

The TAM are a key target for climate change studies, containing sequences of glacial deposits and landforms that record the waxing and waning of Antarctica’s ice masses.

Studies to date have been mostly localised, whereas regional overviews spanning the continent, pinpointing the locations of deposits and indicating their mode of formation, age, and likely source, will improve understanding of Antarctica’s climate role.

Geological maps should provide key underpinning information!
Published Geological Maps

Numerous regional-scale geological maps published during the latter part of last century – at 1:250,000 scale or greater.

Mostly focussed on identification of basement rock-types and their distribution.

Spatial reliability is highly variable (!!!).

Relatively little attention paid to classification and description of glacial deposits and landforms.
Goals: Simon Cox
Define Qt unit by source (Transantarctic Mountains, EAIS, WAIS), age or composition, etc.
A spatially accurate, holistic map of all Antarctica will be the most relevant to other disciplines
Open discussion stimulated by Session 1

Comment: (Cliff Atkins) We are missing the capture of some data, e.g. wet-based glaciers leave little trace. We need to get better at recording this information. We need to find ways to map areas that have been ice affected but now leave little trace of that interation.

Comment: (Gary Wilson) The ice information in the rock record goes back to the Neogene or older, c.f. not just the Quaternary.

Comment: Chronology is very important and difficult to get.

Question: (Simon Cox) How (what quality) are the geological maps outside of Victoria Land?

Comment: (Jerónimo López-Martínez) A surficial geology map is very different from a morphological map. The Japanese Survey has an excellent database of maps. British Antarctic Survey has good maps and the Spanish have maps from the Antarctic Peninsula. Need to keep a wide focus on objectives, i.e. all of Antarctica.

Question: How do we integrate basement rock versus surficial deposits?

Question: Do we want bedrock geology? Answer: Yes. For example bedrock geology at a 1:250 k scale and surficial geology at a 1:100 k scale, and potentially down to 1:25 k in some areas.
2. State of Knowledge

Key geological datasets

Short overviews of past/current/future geomapping work by various national programs

Sources (Simon Cox)
Gondwana 1:5 million scale geology
Classify by either lithology or chronology
Bedrock Geology 1:10M - Geoscience Australia on OneGeology (Tingey data from the 1970’s)
Landcare New Zealand have created ‘environmental domains’ of Antarctica based on existing 1:10 million scale maps
SCAR geoscience map catalogue – is it up to date?
Alex Burton-Johnson (BAS; UK)

Largely bedrock geology
Limited (but developing) surficial geology
New BAS Geomap 2 series
Update of previous 500G series 1979-1982
Geomap1 not digitised
Laura Crispini (University of Genova; Italy)

Gigamap Project
Eight sheets published at 1:250 k scale from Northern Victoria Land
Three sheets published on geomorphology
German colleagues are also working in NVL.
Some geophysical maps exist
There are some petrophysical maps at a detailed scale.
We identify a need for projecting geology between outcrops
.TIF files are available but not yet GIS
Tamer Abu-Alam (Norwegian Polar Institute, Norway)

Creating a geological map of Dronning Maud Land
Creating one database from disparate sources
Bedrock geology map including chemistry data, structural data and age data.
1:250 k scale
Poor agreement between landsat and rock outcrop.
79 geological maps georeferenced
Moraines were mapped as a single unit
An ‘unknown’ unit was also used.

Comment: (Simon Cox) We record who went where in our GIS, this can be useful, for example to ecologists, who can identify areas where few people have visited.

Comment: Prioritise smaller scale maps over larger scale maps when assigning information (e.g. rock type) to a polygon. I.e. 1:1 k takes priority over 1:250 K.
Manuel Montes (IGME; Spain)

We have maps of the Antarctic Peninsula
Hope bay is mapped at 1:10 k scale
Seymour Island is mapped generally at 1:20 k scale with some areas mapped at 1:5 k scale.
Available online as a GIS through our webserver – see http://www.igme.es/infoigme
Jusun Woo (Korea Polar Research Institute; Korea)

Not specifically mapping focussed at this stage.
Expedition to the Mount Joyce area in 2011-2012.
Expedition to the Eureka Spurs area in 2013-2014 looking in particular at metamorphic geology and McMurdo Volcanic Group rocks.
Korea has mapped around the Jang Bogo station near Mount Melbourne looking at the McMurdo Volcanic Group rocks.
Subglacial mapping of the Weddel Sea.
Interpretive mapping with MODIS, MOA and radarsat AMM-1 data for ridges and valleys
Mapping at approximately 1:100 k scale
Definition of buried alpine landscapes
Currently mapping Ellsworth Mountains to Dronning Maud Land
This helps extend the geology beneath the ice
Mapping to same key as onshore geology
We map the nunataks first.

Comment: This landscape is comparable to NW Scotland
Chris Carson (Geoscience Australia, Australia)
Ad hoc digitising of (mainly) university projects of basement geology
Limited mapping of surficial deposits or geomorphology (at the moment)
The OneGeology data uploaded by Australia represents the Tingey data from the 1970’s.
Simon Cox (Presenting on behalf of Paul Morin, PGC Minnesota; USA
Entire continent at 32-42 cm stereo
Currently available to NSF funded projects but can be distributed once they make a derivative product
2m DEM resolution (precision) with accuracy ± 10m
2m – 8m DEMs posted down to 85°S
Still need people on the ground to calibrate
Affected by atmospheric correction, different shading, weathering and oxidation
Comment: There is an analogue here between Antarctica and Mars / other planets.
3. Database Model

How can we make such a collaboration work? - distributed vs. centralised database model.

Options for hosting web services?

International standards (GeoSciML).

What is needed to ensure adopted process retains an appropriate level of academic and custodial/sovereign rights?

Database Models (Simon Cox)

How do we deliver this information?

‘Geoscience Markup Language’ (GeoSciML) is a Geography Markup Language (GML) for the Earth Sciences. It is the language used for OneGeology. This is becoming the defacto GIS language for geology. It is ultimately based on ISO international standards for data exchange over the internet.

OneGeology covers the globe, except for Antarctica (some exceptions). See http://portal.onegeology.org. It is a distributed database model, not a centralised database model. Almost all of the Antarctic Treaty partners have their geological surveys at least participating in OneGeology if not serving geological map data through the portal. So where are all the Antarctic geological maps?

LIKE

Conversion of geological maps into GIS-databases accessible to ALL as smart **web feature services**

Retain academic and custodial rights (sovereignty) as/where necessary

e.g. web services utilising Geoserver or ArcGIS Server; in WMS smart image form or in WFS feature form (utilising GeoSciML)

Perhaps a distributed database model like OneGeology, not a centralised database model

Spatially accurate for integration with latest satellite data and DEM’s
Classification (Simon Cox)
Traditionally geologists have mapped using a ‘bottom up’ approach. Here we propose using a ‘top down’ approach where we assign geological information to rock polygons
We have started using the rock polygons from ADD v.6 rck01
This approach can be very useful to other end-users, for example biologists, ecologists, remote sensors, etc.
Question: (Simon Cox) At what stage do we distinguish between geology and geomorphology?
Typically geology maps use either a lithostratigraphic or chronostratigraphic classification
We map the presence of material
Geomorphology crosses the lith- and chrono-stratigraphic information.

Nomenclature (Simon Cox)
Lithology versus chronography

Comment: (Stewart Jamieson) Add top level labels to detailed data, possibly
Philosophical Change

Conventional “bottom up” construction

QMAP SVL built from 72 sheets @1:50,000

GNS Science
Philosophy

"Top down" construction starting from a continent-scale, low density, attribute-poor dataset that is added to and improved through multiple iterations.

geo01 dataset (Version 1 2014) based on ADD (Version 6) rck01 polygon
Slides: Simon Cox

Need a base dataset. Will eventually need to link to new m-scale satellite datasets and can inform assessment of hyperspectral data.

Rock Classification Example (Alex Burton-Johnson, BAS)
ADD is traced from aerial images so has problems
- Some areas are poorly georeferenced
- Some areas shadows are included in the rock polygon
- There was a tendency when making the ADD layer to over-estimate the rock outcrop. The philosophy being it was better to capture everything then miss something.

We are running automated rock classification from landsat tiles for the Antarctic Peninsula. This provides 30m resolution
This relies on choosing well illuminated tiles. Strato-cumulus clouds can cause problems.
The coastline has been updated.

Question: How did you compensate for shadow? Answer: (ABJ) I used the...
6. Team & Work Plan

Determine areas of international interest in providing existing map data and/or compiling different regions.

Establish a working team, timetable and action plan. What other resources are needed?

Should/can GeoMap science objectives be cross-mapped with the SCAR Horizon Scan questions?

Team Work and Plan (Simon Cox)

Phases:

- Phase 1: 2014 – 2015 Collaboration
- Phase 2: 2015 – 2016 The 1st phase of a continent-wide data set
- Phase 3: 2016 – 2017 Improvements
- Phase 4: 2017 - ? Modelling

Get involved
Re-marketing: this is a geosphere dataset for other scientists (c.f. geologists)

GeoMap can underpin many of the key 80 questions. See Mahlon C. Kennicutt II, Steven L. Chown et al.: “Six Priorities for Antarctic Research“, Comment in Nature 512, 23–25; 7 August 2014 (doi:10.1038/512023a). The catalogue of 80 questions is available in supplementary material. GeoMap probably maps to, or underpins: Q3, 5, 8, 21, 25, 26, 29, 32, 38, 39, 40, 43, 45, 74, 75, 79 (bold = stronger relationship). The Antarctic Roadmap Challenges Project: We should align ‘us’ to ‘them’ and provide feedback for August 15
GeoMAP Action Plan

Phase 1  2014-2015
Develop international collaboration (& recognition of need) for provision of underpinning spatial geological information.

Phase 2  2015-2016

Phase 3  2017-2019
Improve precision of regional geology and depiction of glacial sequences. Integrate remote sensing, detailed studies. Develop 1st dataset(s) outlining glacial deposits and landforms, their age and content.

Phase 4
Use in source characterisation, ice modelling, exploration for geo-indicators of climate change, biological and ecological studies.
1. Help identify and provide source maps and datasets.
2. Classify parts of continent-wide dataset.
3. Checking and peer review of bedrock data/classification.
4. Adopt areas of interest to undertake detailed work. Map geology and geomorphology. Build/improve data.
5. Deliver datasets (distributed model)
   or provide for compilation (central delivery)
   Help standardising/matching to other regions.
6. Use data and cite!
7. Promote and sell concept – obtain & secure FUNDING!