

A photograph of a vast, icy Antarctic landscape under a clear blue sky with scattered white clouds. In the foreground, there are large, jagged ice formations. In the distance, a person is standing on a high, snow-covered peak, providing a sense of scale to the immense environment.

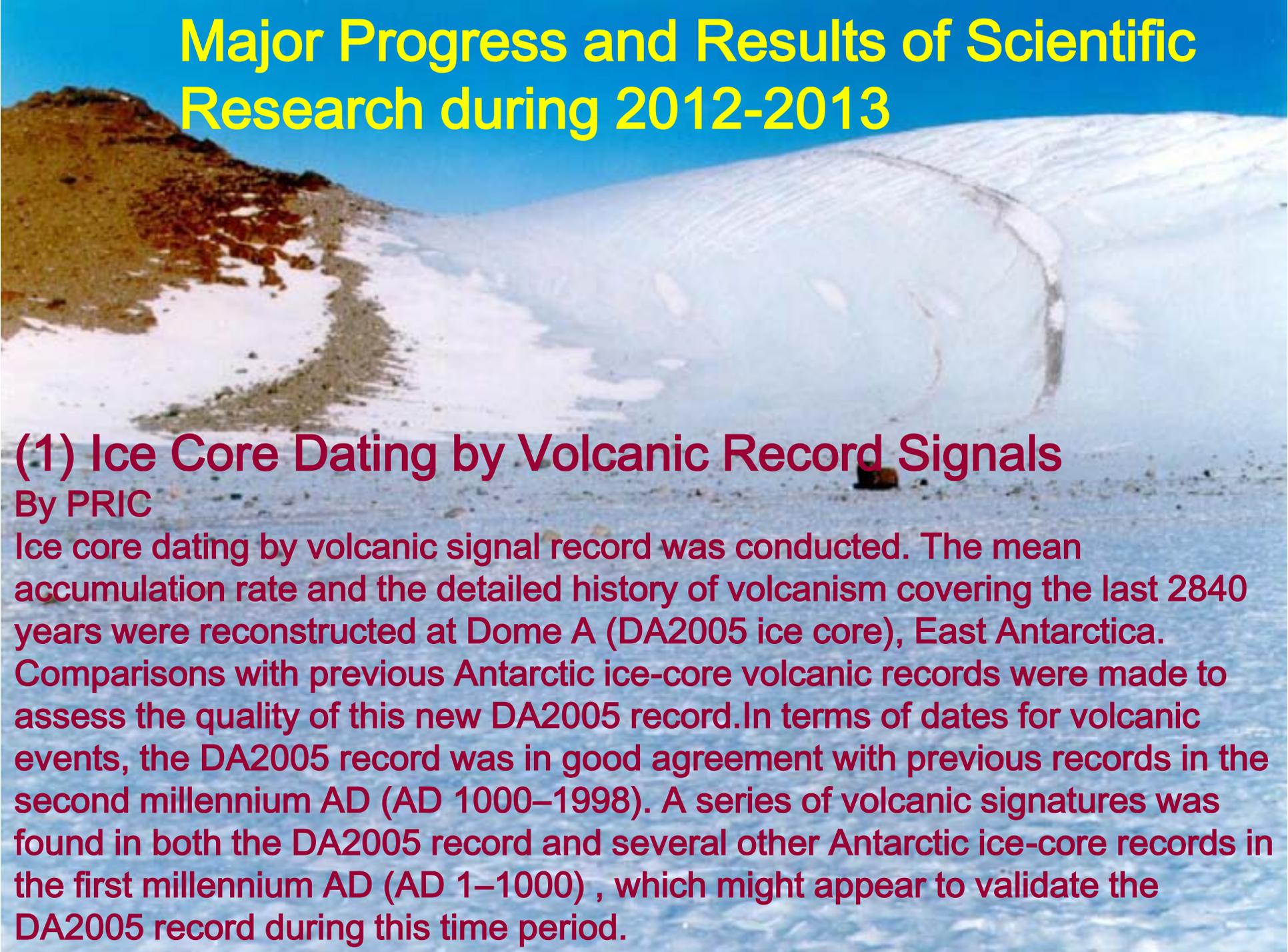
# National Report

Antarctic Earth Science Program of China  
2012-2015

To the 33th SCAR SSGs

Chinese Arctic and Antarctic Administration (CAA)  
2014.8

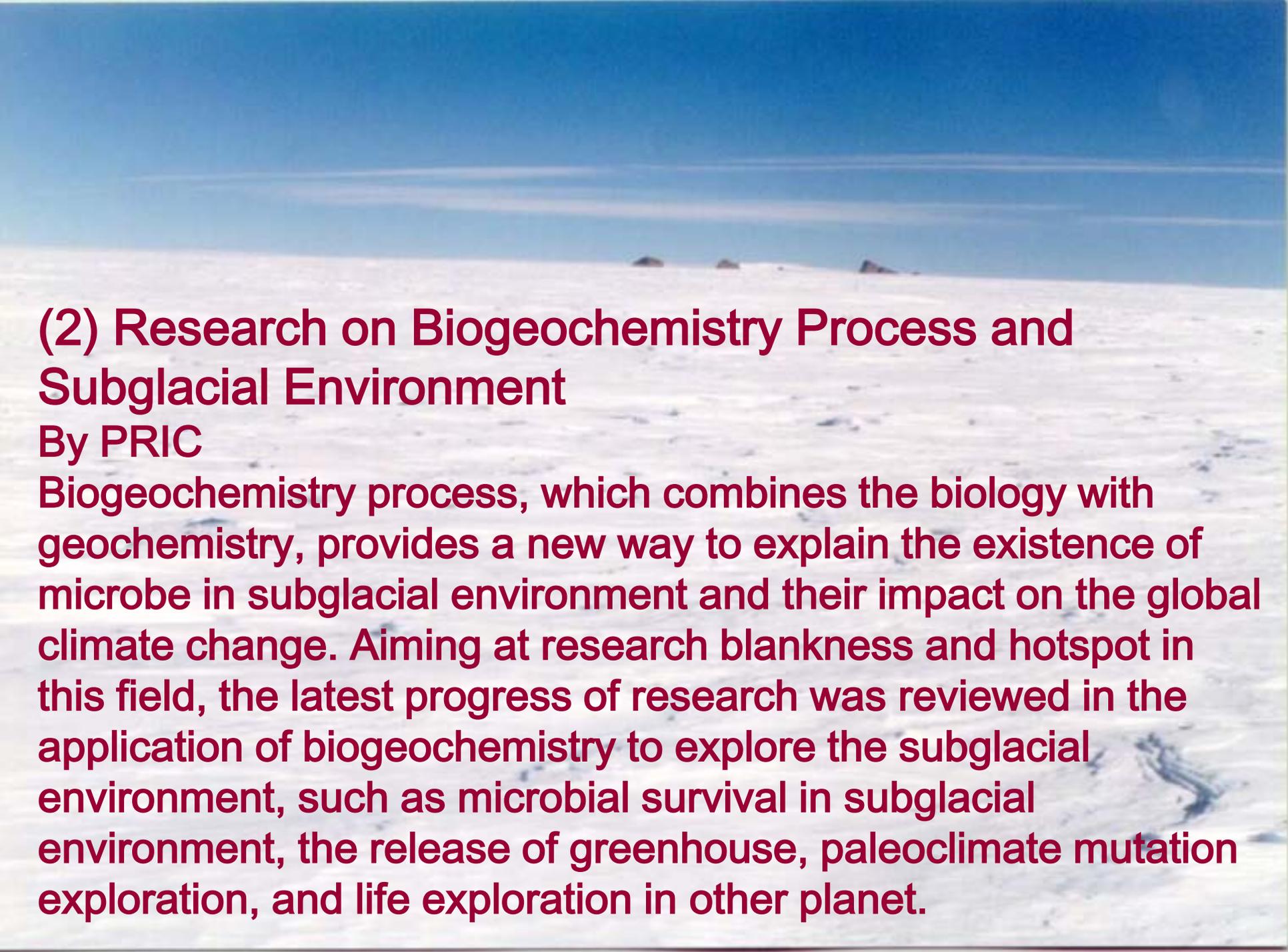
# Major Progress and Results of Scientific Research during 2012-2013



## (1) Ice Core Dating by Volcanic Record Signals

By PRIC

Ice core dating by volcanic signal record was conducted. The mean accumulation rate and the detailed history of volcanism covering the last 2840 years were reconstructed at Dome A (DA2005 ice core), East Antarctica. Comparisons with previous Antarctic ice-core volcanic records were made to assess the quality of this new DA2005 record. In terms of dates for volcanic events, the DA2005 record was in good agreement with previous records in the second millennium AD (AD 1000–1998). A series of volcanic signatures was found in both the DA2005 record and several other Antarctic ice-core records in the first millennium AD (AD 1–1000), which might appear to validate the DA2005 record during this time period.



## **(2) Research on Biogeochemistry Process and Subglacial Environment**

**By PRIC**

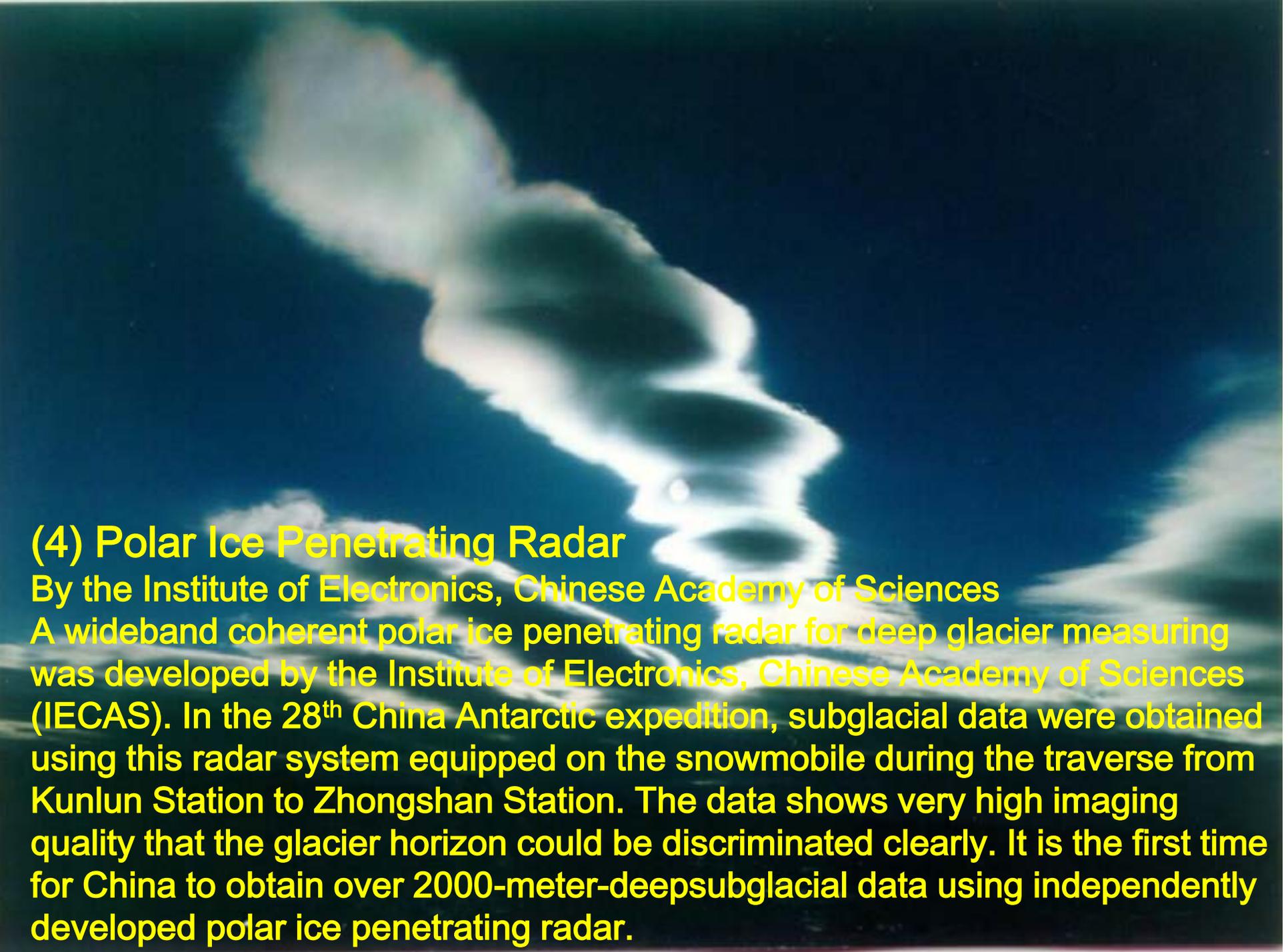
**Biogeochemistry process, which combines the biology with geochemistry, provides a new way to explain the existence of microbe in subglacial environment and their impact on the global climate change. Aiming at research blankness and hotspot in this field, the latest progress of research was reviewed in the application of biogeochemistry to explore the subglacial environment, such as microbial survival in subglacial environment, the release of greenhouse, paleoclimate mutation exploration, and life exploration in other planet.**

### (3) Monitoring Study on Antarctic Digital Elevation Model Mapping System

By the Institute of Remote Sensing Applications, Chinese Academy of Sciences

Radar altimeter (RA-2) data from ENVISAT and laser altimeter (GLAS) data from ICESat acquired in 2003-2009 are integrated to create an up-to-date DEM of Antarctic continent. A relative correction method based on speckle geometry intersection was used to correct ENVISAT RA-2 elevations to ICESat/GLAS. The data were interpolated to a regular 1000 m polar stereographic grid using ordinary kriging after semi-variance analysis using developed software named "Antarctic Digital Elevation Model Mapping System". The accuracy of the final DEM was assessed through a comparison with two airborne LiDAR datasets, a field GPS strip from China's Zhongshan Station to Dome A. The comparison result shows that the error of the new DEM is from 3.21 m to 27.84 m, and the distribution of errors depends on the surface slope. The new DEM shows an obvious improvement on steep slopes, including the quickly changing ice sheet margin areas.



A photograph showing a snowmobile's exhaust trail as a series of white, billowing clouds against a clear blue sky. The trail starts from the bottom left and extends towards the top right, with several distinct, rounded cloud-like sections. The overall scene is bright and clear.

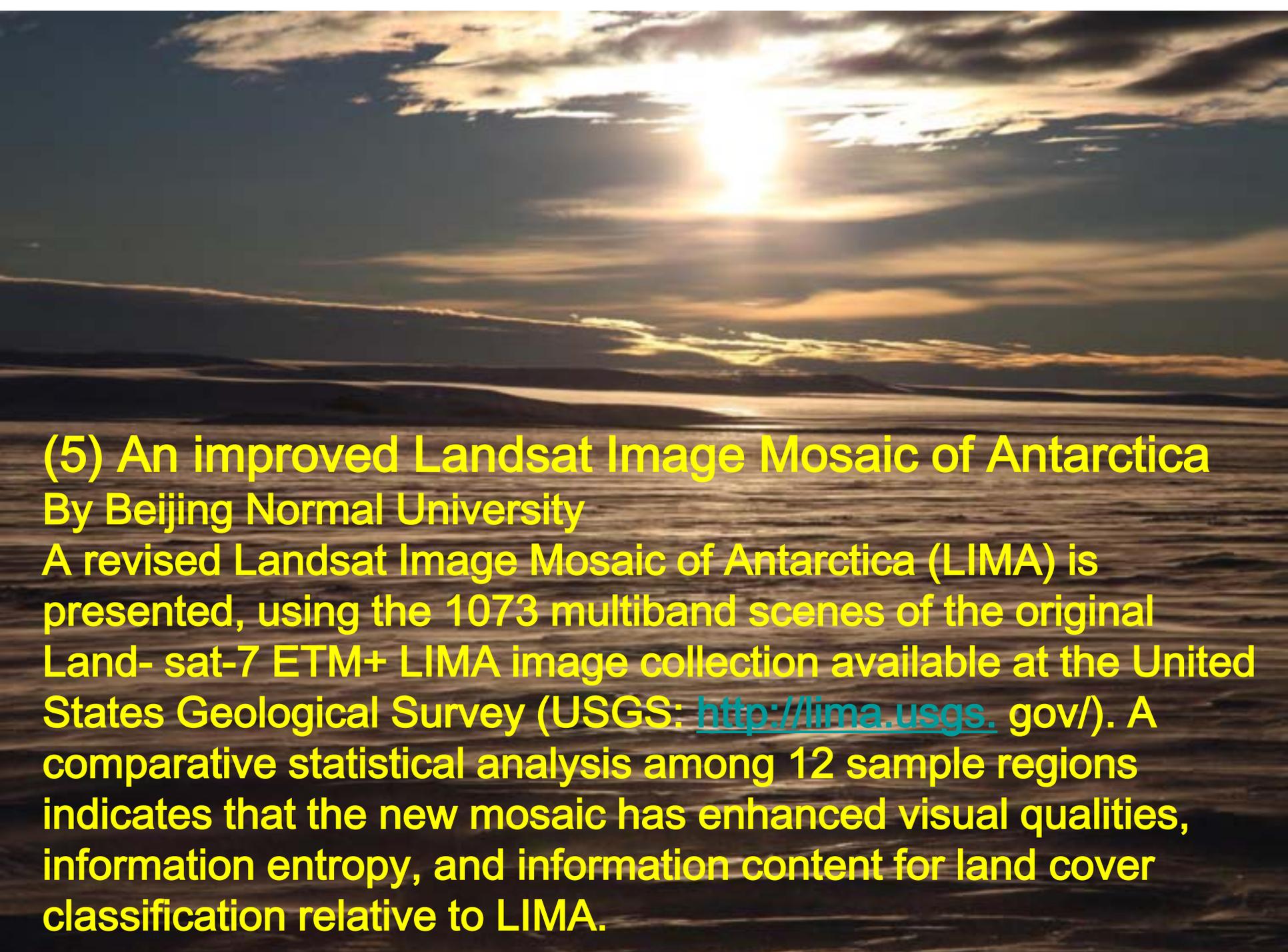
#### **(4) Polar Ice Penetrating Radar**

**By the Institute of Electronics, Chinese Academy of Sciences**

**A wideband coherent polar ice penetrating radar for deep glacier measuring was developed by the Institute of Electronics, Chinese Academy of Sciences (IECAS). In the 28<sup>th</sup> China Antarctic expedition, subglacial data were obtained using this radar system equipped on the snowmobile during the traverse from Kunlun Station to Zhongshan Station. The data shows very high imaging quality that the glacier horizon could be discriminated clearly. It is the first time for China to obtain over 2000-meter-deep subglacial data using independently developed polar ice penetrating radar.**



*Figure: Experiment of Polar ice penetrating radar in Antarctica*



**(5) An improved Landsat Image Mosaic of Antarctica  
By Beijing Normal University**

**A revised Landsat Image Mosaic of Antarctica (LIMA) is presented, using the 1073 multiband scenes of the original Land- sat-7 ETM+ LIMA image collection available at the United States Geological Survey (USGS: <http://lima.usgs.gov/>). A comparative statistical analysis among 12 sample regions indicates that the new mosaic has enhanced visual qualities, information entropy, and information content for land cover classification relative to LIMA.**



## (6) Krill population changes along the West Antarctic Peninsula caused by climate change

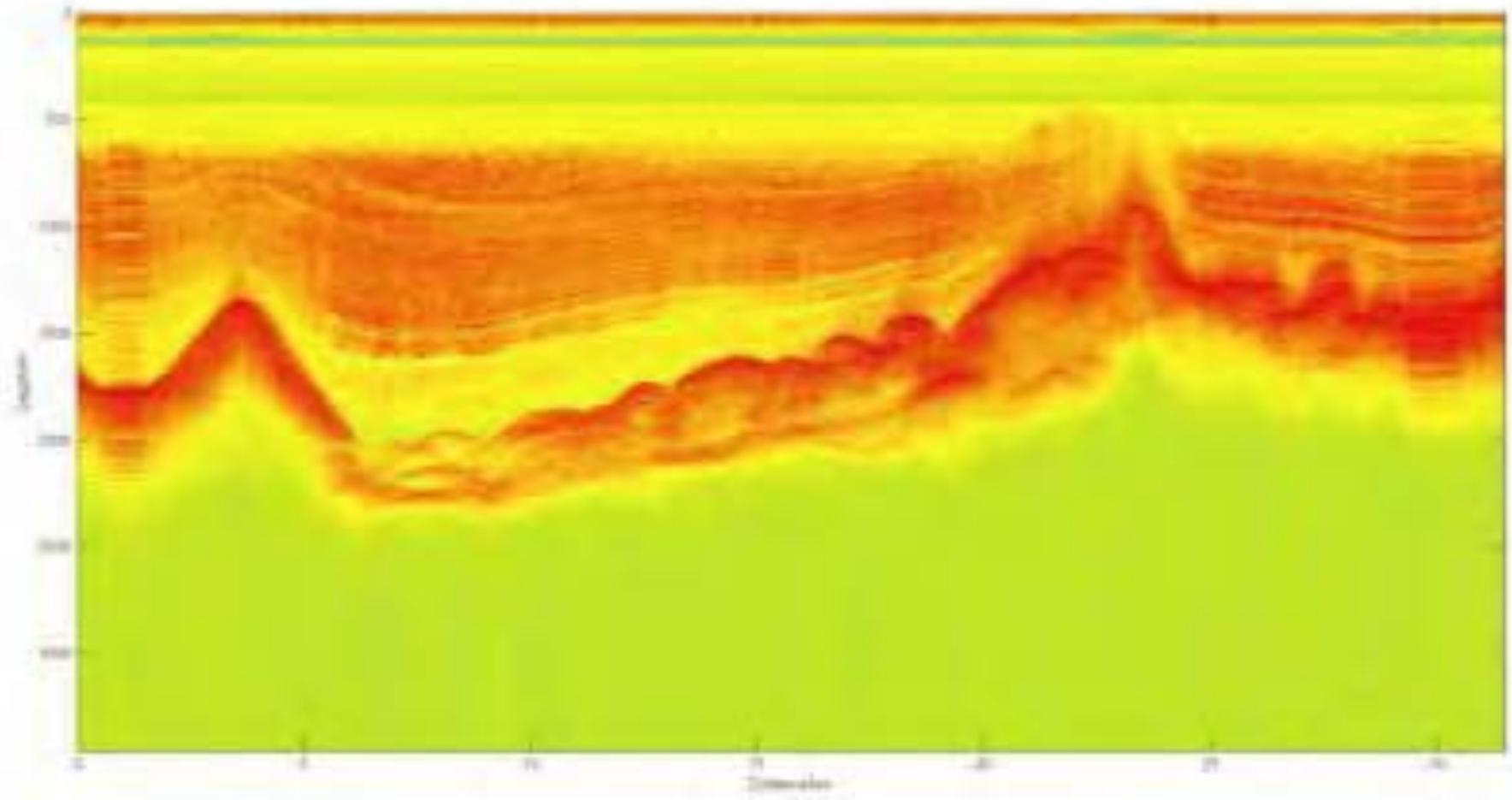
By University of Science and Technology of China

The research inferred the relative krill population changes along the West Antarctic Peninsula (WAP) over the 20th century from the trophic level change of Antarctic fur seal *Arctocephalus gazella* using stable carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotopes of archival seal hairs. The variation of  $\delta^{15}\text{N}$  in seal hair indicates a change in the proportion of krill in the seal's diets and thus the krill availability in local seawater. For the past century, enriching fur seal  $\delta^{15}\text{N}$  values indicated decreasing krill availability. This novel method makes it possible to infer past krill population changes from ancient tissues of krill predators, and the relationship between past krill abundance and climate change.

## (7) Deep ice detecting and changing research of the Antarctic ice sheet

By PRIC

Multiple sets of ice radar systems, including both a deep ice penetrating radar system and a shallow FMCW (Frequency- Modulated Continuous-Wave) radar system developed independently by China, were used in inland ice sheet surveying during the 29th Chinese National Antarctic Research Expedition. The high quality resulting radar data in the field season make China the second country after the United States has this deep-ice detecting technology. With the further survey in central region around Kunlun Station and key areas along the Chinese inland traverse using ice radars, the maximum resolution three dimensional deep ice structure and subglacial topography was found until now. The important discoveries, such as the evidence of the fast growth of the ice sheet from the bottom in three dimensional radargram, will provide new insight to the research of the ice sheet instability and global sea level changing.



*Figure: The radargram from high-resolution ice-penetrating radar (the ice-bedrock interface, subglacial progress and isochronous layers can be found clearly)*

## (8) Numerical modelling the depth and age relationship of ice layers at Dome Argus

By PRIC

Finite Element Method package Elmer/ Ice had been used to establish a three dimensional, thermo-mechanically coupled full-Stokes model. Using isotropic and different prescribed anisotropic ice fabrics and the radar data from Dome A, the model was applied to simulate the ice basal temperature and estimate the age profile of the ice core. basal age and thermal state sensitivities to geothermal heat flux and surface conditions was also assessed. Results showed that the ice beneath Kunlun station was probably undergoing melting and ages may not exceed 700000 years at the base. However, considering the complex subglacial topography, sub-basal hydrology and accretion processes observed by radar surveys of the area, the real age profile may be older.

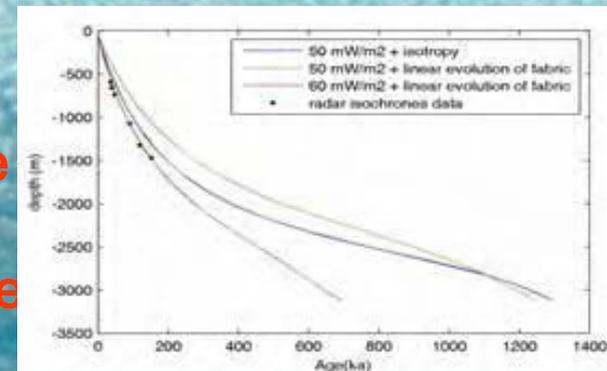
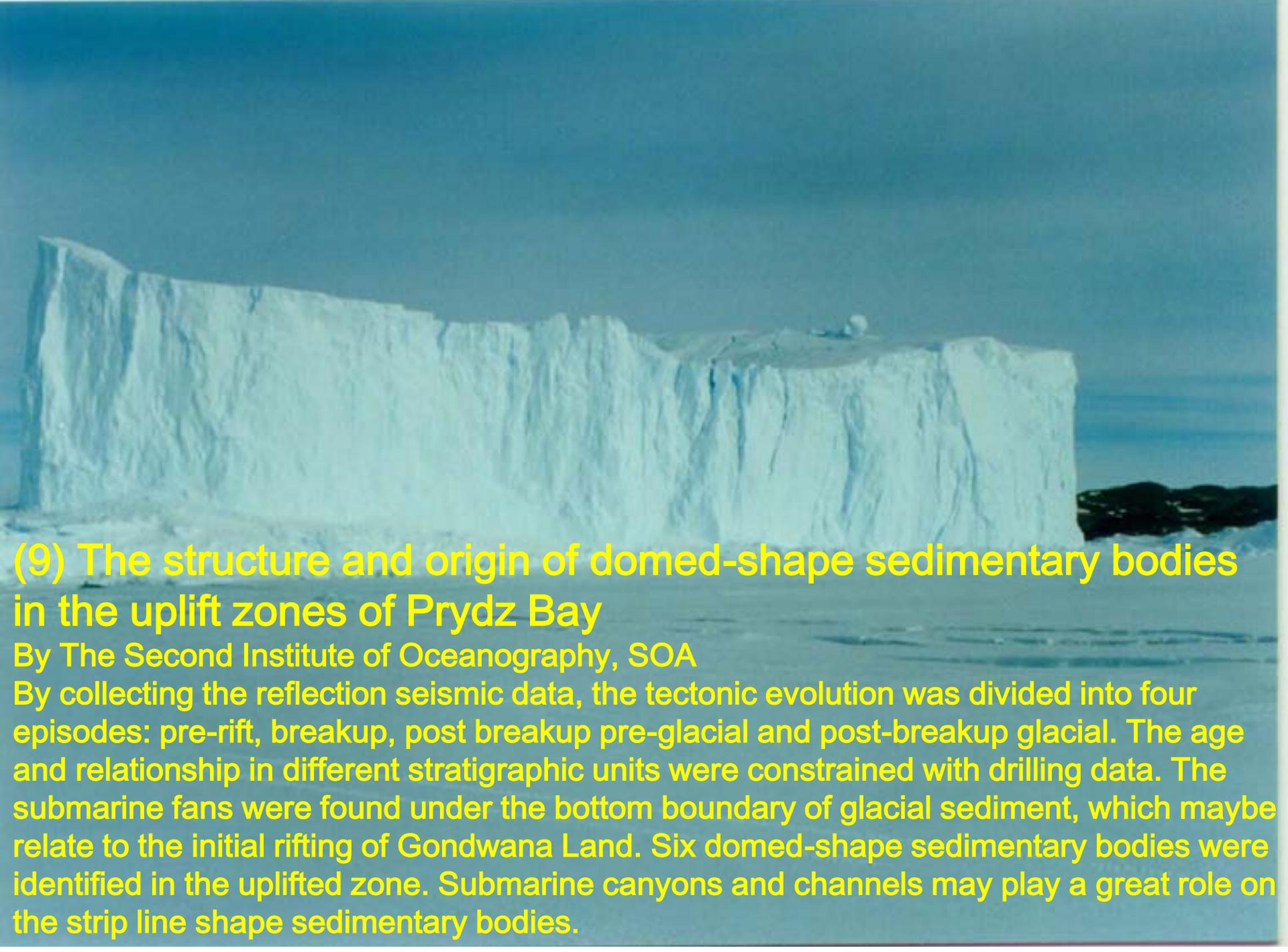


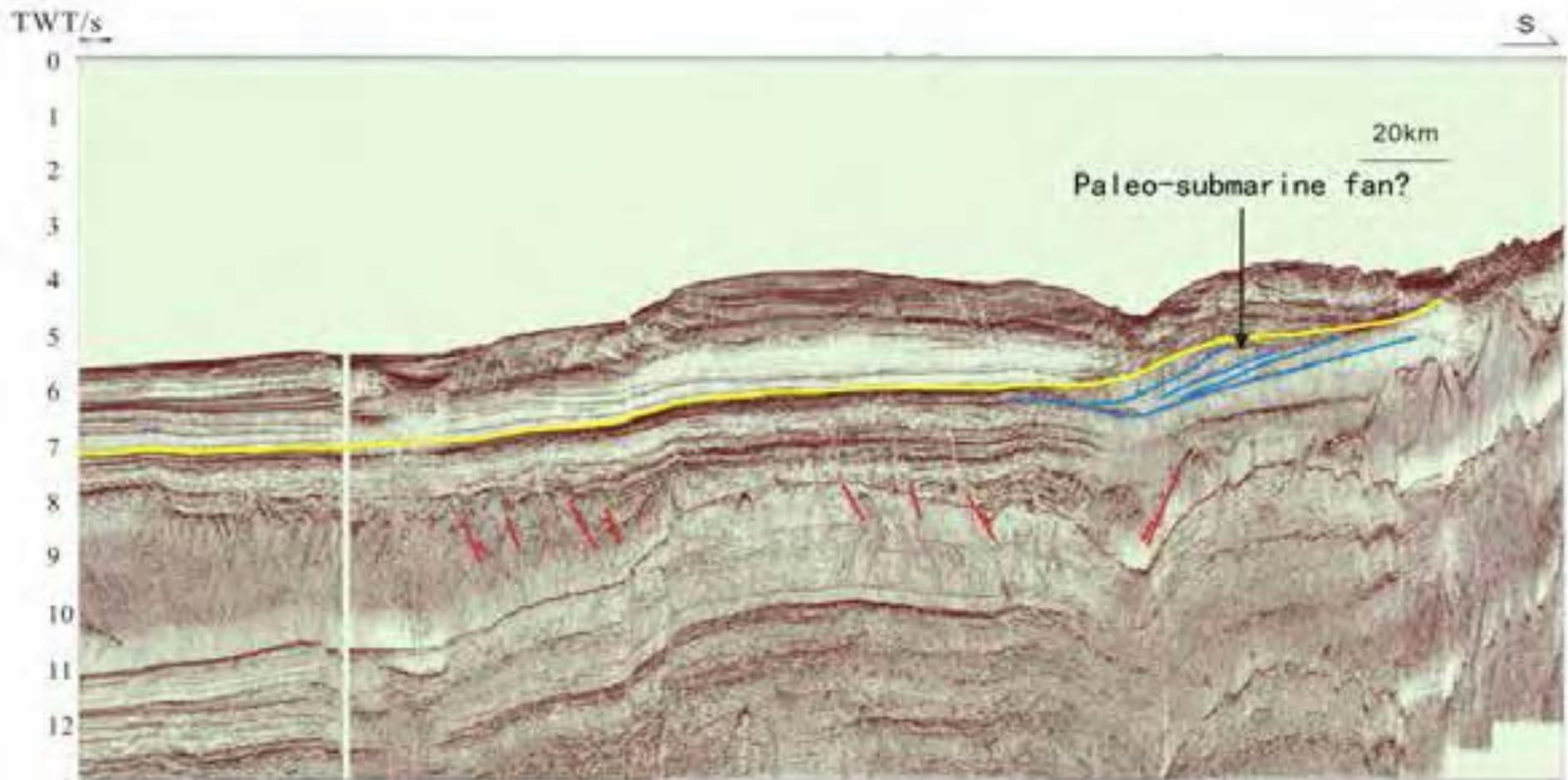
Figure: Age-depth profile at Dome A (Kunlun station) Simulations at steady state steady state simulations with present day surface temperature, using girdle fabric 1/3 and 60mW m<sup>-2</sup> heat flux, and using girdle fabric 2/3 and 50mW m<sup>-2</sup> heat flux.



## **(9) The structure and origin of domed-shape sedimentary bodies in the uplift zones of Prydz Bay**

**By The Second Institute of Oceanography, SOA**

**By collecting the reflection seismic data, the tectonic evolution was divided into four episodes: pre-rift, breakup, post breakup pre-glacial and post-breakup glacial. The age and relationship in different stratigraphic units were constrained with drilling data. The submarine fans were found under the bottom boundary of glacial sediment, which may relate to the initial rifting of Gondwana Land. Six domed-shape sedimentary bodies were identified in the uplifted zone. Submarine canyons and channels may play a great role on the strip line shape sedimentary bodies.**



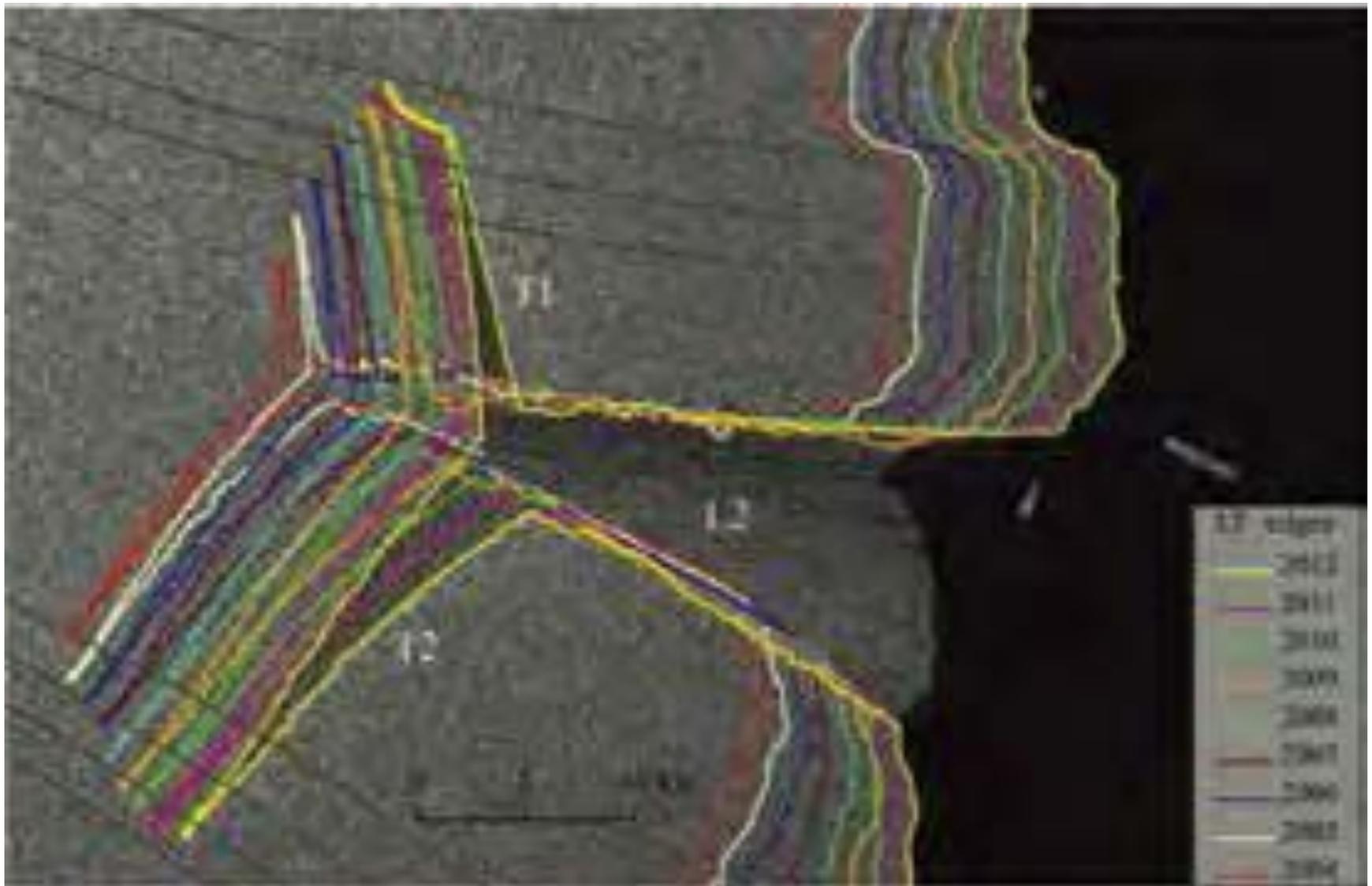
*Figure: The seismic profile across the Prydz Bay*



## (10) The slow-growing tooth of the Amery Ice Shelf from 2004 to 2012

By Beijing Normal University

The Loose Tooth rift system is an active rift system located at the front of the Amery Ice Shelf, Antarctica, which was expected to calve and produce a large iceberg around 2012 to 2015. A time series of Envisat advanced synthetic aperture radar (ASAR) images from February 2004 to February 2012 had been used here to observe the system. The results showed that both the west (T1) and east (T2) rifts propagated rapidly over 9 years at average rates of  $4.49$  and  $2.53\text{m}\cdot\text{d}^{-1}$ , respectively. The rift system will not break before 2015 as previously projected, unless unforeseen events occur. Additionally, it was found that the heading direction of T1 turned dramatically in 2009–2010. However, most surprising was that the propagation rates of both rifts had shown a decreasing trend since 2005, which might be due to increasing thickness of melange ice filling in the rifts. Other environmental factors (e.g. wind forcing and air temperature) may influence the rift motion by changing the melange ice thickness and other properties.



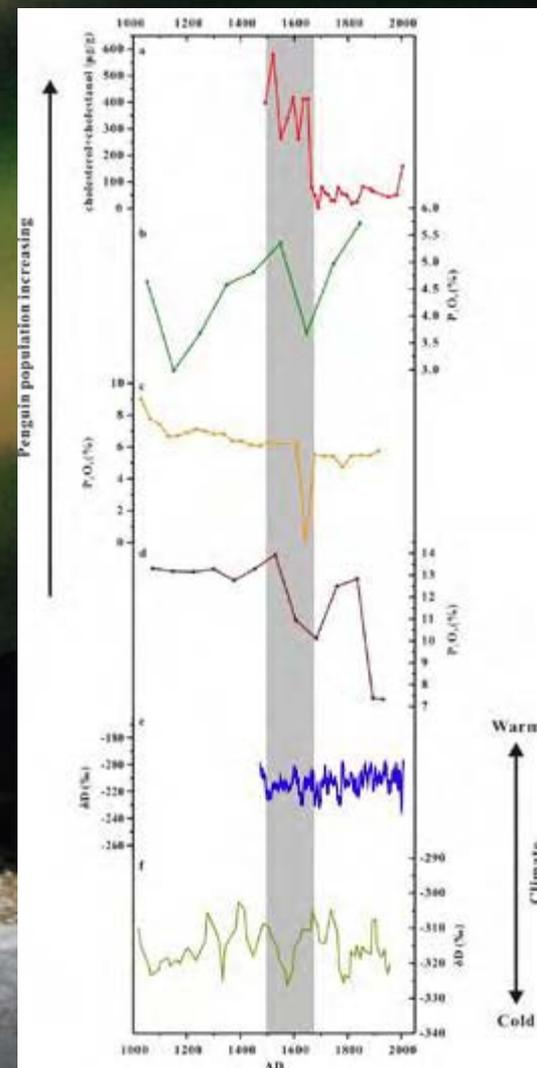
*Figure: Loose Tooth edges extracted from Envisat ASAR (2004–12) with the background image of Envisat ASAR on 17 February 2012. The gray curve is the suture zone formed where two ice streams merged.*

## (11) A study on different responses of penguins to climate change

By University of Science and Technology of China

The organic markers in a sediment profile collected at Cape Bird, Ross Island, high Antarctic were determined, and the history of Adélie penguins, seals and vegetation at this location over the past 700 years was reconstructed.

Penguins became the dominant species when the Little Ice Age (LIA; 1500 - 1800 AD) began and had a significant impact on vegetation at and near the colonies. Generally, algae species were positively correlated with penguin presence while lichens declined. Penguin populations were at high levels during the LIA but decreased during later warm time, which was contrary to previous results in other regions much farther north. Different responses to climate change may occur at low latitudes and high latitudes in the Antarctic, even if for same species. This study was in favor for more comprehensive understanding of the response of ecosystem to climate.

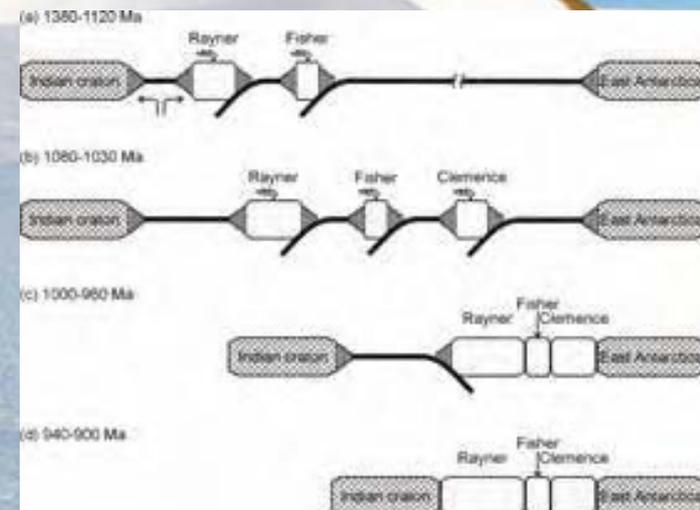


## (12) Study on Geochemistry and geochronology of Mesoproterozoic basement rocks from the eastern Amery Ice Shelf and southwestern Prydz Bay, East Antarctica

By Institute of Geomechanics, Chinese Academy of Geological Sciences

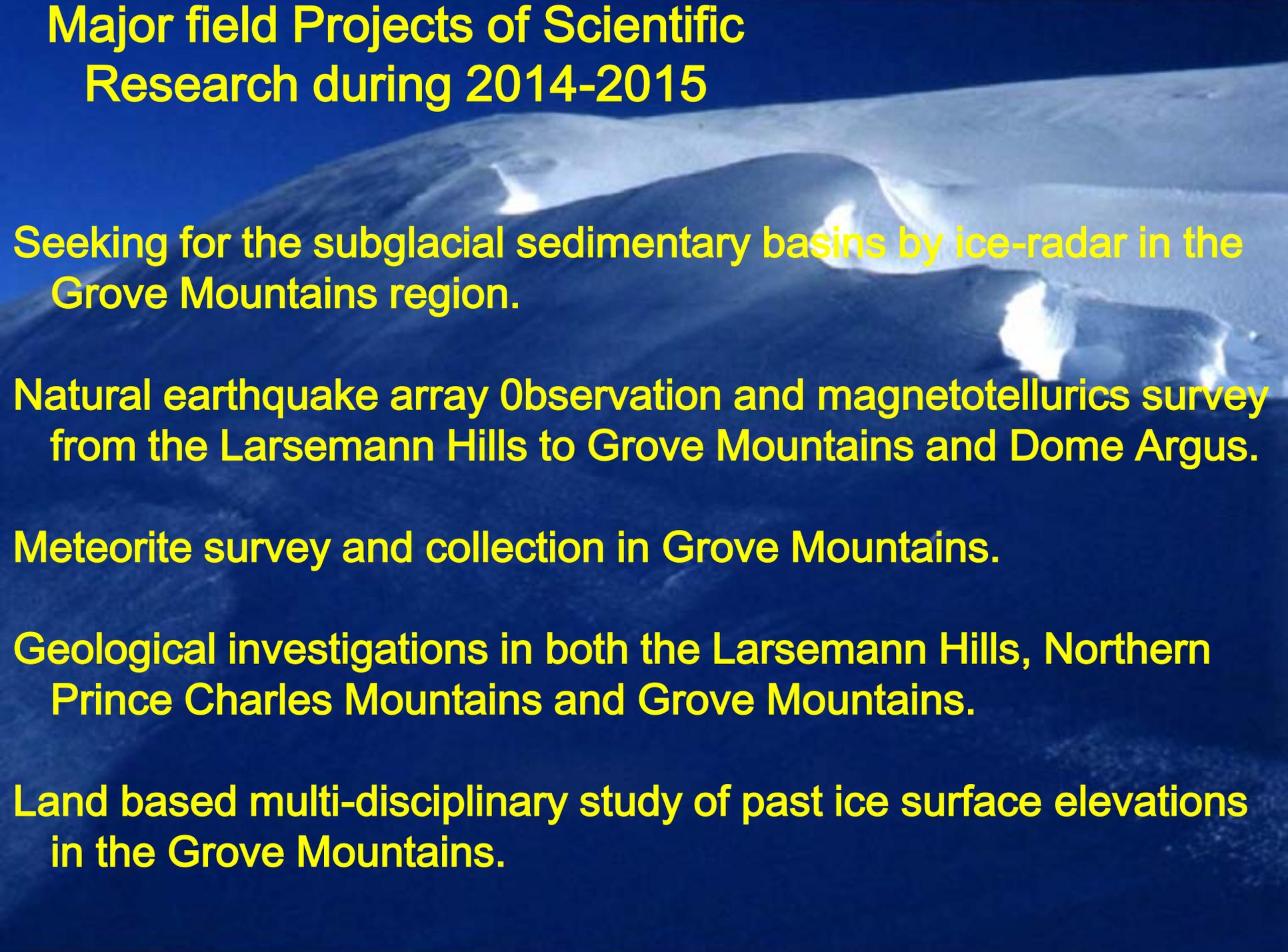
The high-grade metamorphic rocks from the eastern Amery Ice Shelf and southwestern Prydz Bay of East Antarctica represent reworked Rayner Complex during the Pan-African metamorphism. These Mesoproterozoic basement rocks can provide important information for the earlier tectonic evolution of the Rayner orogen.

Based on a combined geochemical and geochronological study of the rocks, a new tectonic model was proposed for the Rayner orogen, involving the collision of several island arcs with East Antarctica (the Lambert Terrane or the Ruker craton) followed by the closure of ocean and final collision of the Indian craton with the newly accreted Antarctic margin during the Grenvillian time.



*Figure: Schematic cartoon showing the tectonic evolution between the Indian craton and East Antarctica (the Lambert Terrane or the Ruker craton)*

# Major field Projects of Scientific Research during 2014-2015

An aerial photograph of a snow-covered mountain range. The snow is bright white, and the sky is a clear, deep blue. The mountains are rugged and have a jagged appearance. The lighting suggests a bright day, with some shadows cast by the peaks.

Seeking for the subglacial sedimentary basins by ice-radar in the Grove Mountains region.

Natural earthquake array Observation and magnetotellurics survey from the Larsemann Hills to Grove Mountains and Dome Argus.

Meteorite survey and collection in Grove Mountains.

Geological investigations in both the Larsemann Hills, Northern Prince Charles Mountains and Grove Mountains.

Land based multi-disciplinary study of past ice surface elevations in the Grove Mountains.



**Maintenance of the low power magnetometers along the Zhongshan-Dome-A magnetometer chain.**

**Deep ice drilling in the Dome Argus.**

**Preparation of ice-penetrating geological drilling at the Gumbertsev subglacial mountain.**

**Ice-radar subglacial topography investigation around the Dome Argus.**

**Astronomic optic observation at the Kunlun Station.**

**Tectonic evolution investigation of South Shetland Islands and Northern Antarctic Peninsula.**



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are welcom!**