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Detailed Glaciochemical Investigations in Southern Victoria Land, Antarctica—A Proxy Climate Record

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Detailed glaciochemical investigations in southern Victoria Land, Antarctica—A proxy climate record

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Advances in climate prediction depend on a knowledge of historical climatic sequences ranging in scale from decades to millennia. Proxy data produced by pollen, sediment, tree rings, glacier fluctuations, and ice and snow cores are valuable in the construction of climatic sequences when direct observations of the atmosphere are either spatially or temporally lacking. Links between proxy data and the atmosphere generate the most confidence when actual components of climate are preserved in the proxy medium.

The best preserved data pertaining to former climate is found in the time-series available from snow and ice cores retrieved from appropriately chosen glaciers. Records from polar and high-altitude, low- to middle-latitude glaciers have proven valuable in obtaining time series relatable to climatic change for time periods of 10 to 100,000 years. Analysis of the physical and chemical components of ice and snow such as: stratigraphy, stable isotopes, radio-nuclides, and primary anions and cations can all be very effective in determining, on seasonal to multi-year levels, extremely detailed proxy records of climatic change, atmospheric chemistry, and volcanic activity.

The production of climatic change records using time-series retrieved from ice cores has seen minimal application in the Transantarctic Mountains even though glacial geologic studies in this area provide one of the primary bases for understanding the glacial history of Antarctica. Notably while the glacial geologic records provide relatively low-resolution, long-period records, the ice core records could provide an excellent view of an albeit shorter period but with relatively high resolution. Therefore, detailed ice-core records provide the resolution necessary to assess, expand, and utilize the longer, less-detailed glacial geologic records and more importantly allow us to compare in detail the modern environment in Antarctica with the paleoenvironment adding significantly to our understanding of global change.

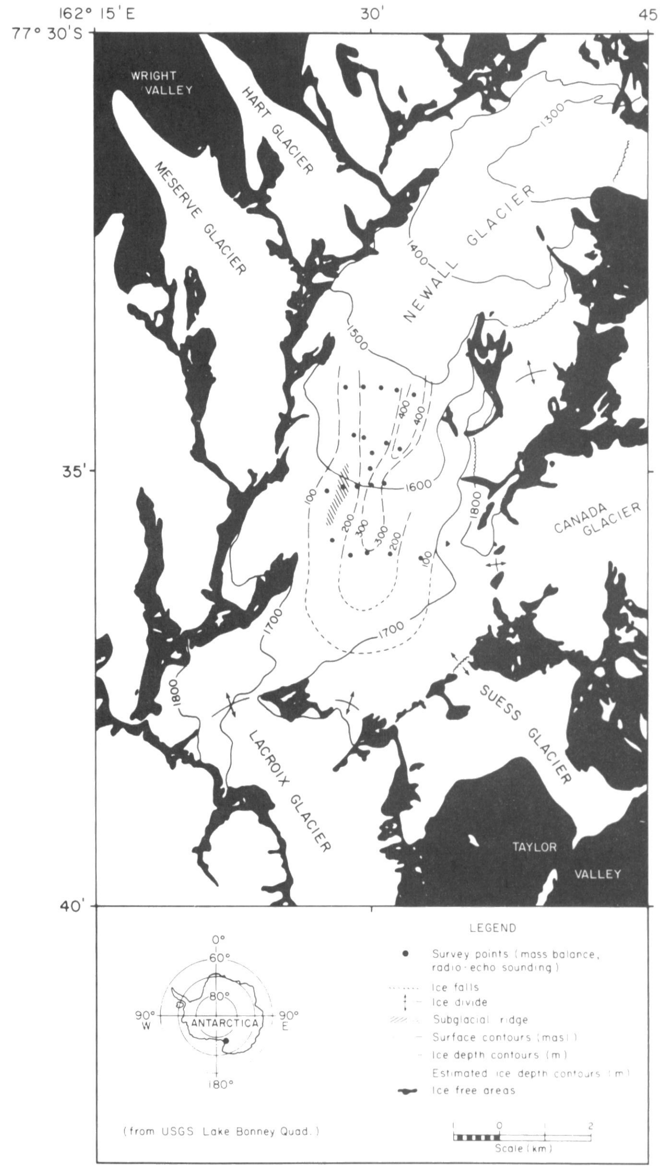
Three primary ice core sites were chosen for investigation during the 1987–1988 field season: the Royal Society Range, head of Emmanuel Glacier (approximately 78°07′S approximately 161°35′E, approximate elevation 3,000 meters); the Asgaard Range, head of Newall Glacier (approximately 77°37′S approximately 162°30′E, approximate elevation 1,700 meters); and the Convoy Range in the general area of Staten Island Heights/Dotson Ridge (approximately 76°50′S approximately 161°30′E, approximate elevation 1,500 meters).

All of these sites potentially could provide valuable ice core records because:

- mean annual temperatures are <25° yielding minimal to no melt and an undisturbed chemical record;
- Transantarctic Mountains ice coring sites are in a unique geographic position for monitoring changes in the position and magnitude of inland vs. coastal circulation systems since these mountains form a barrier between air masses originating over the ocean and the ice sheet;
- glacial geologic studies in the general region are available for comparison;
- information on meteorology and sea-ice extent is available for the region;
- the sites are close enough to Mount Erebus such that each can provide chemical records of the volcano's activity;
- the sites are close enough to seasonal open ocean such that marine chemical species can be used as seasonal indicators and as indicators of change in sea-ice extent;
- the sites are close to ice-free areas and, therefore, analysis of crustal chemical species will aid in assessing changes in ice-free exposure with time;
- there are ice core records from Dome C and one other Transantarctic Mountain site, the Dominion Range, which can be used for comparison to the north and south, respectively;
- results from the three preliminary study sites will be invaluable in assessing the spatial field for major anions and cations, and
- the detail and overlap in analyses proposed for these three sites provides a greatly needed cross-calibration of several chemical and physical techniques that will be useful in all future ice coring programs in Antarctica.

Between 2 November and 4 December 1987 Paul A. Mayewski (field leader), Mark Twickler, William Berry Lyons, and Mike Hussey were involved in field activities intended to determine which of the three preliminary sites would be the most suitable for a core recovery program in 1988–1989. The Royal Society Range site and an additional one on the lower Victoria Glacier were removed from consideration after field review due to poor on-site surface snow conditions. Detailed investigations in the Convoy Range and Newall Glacier (Asgaard Range) were undertaken including, radio-echo sounding and detailed 2.25-centimeter interval snow sampling of 2–6-meter snowpits for oxygen isotopes (currently being analyzed by P. Grootes, University of Washington); stratigraphy; major anions (sulfate, nitrate, chloride, fluoride); major cations (sodium, potassium, calcium, ammonium, magnesium); acidity; conductivity; total ionic balance; and alpha, beta and gamma spectroscopy.

A preliminary ice-thickness map was developed (figure) for the 1988–1989 study region in the upper Newall Glacier. The number of survey and radio-echo sounding sites will be expanded and refined during the early part of the 1988–1989 field season to locate accurately ideal sites for the recovery of two ice cores which will be drilled to bedrock by the Polar Ice Coring Office. A University of New Hampshire team will be at the site in 1988–1989 to complete the preliminary site survey, excavate, and sample more snowpits and process all of the core material.



Ice surface and ice depth contours for a portion of Newall Glacier, Asgaard Range, based on the 1987–1988 preliminary site selection program. (masl denotes meters above sea level, m denotes meter, km denotes kilometer.)

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