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LINEAR FEATURES ON LAKEFLOOR SEDIMENTS: EVIDENCE FOR ICE SCOURING IN LAKE WINNIPEG

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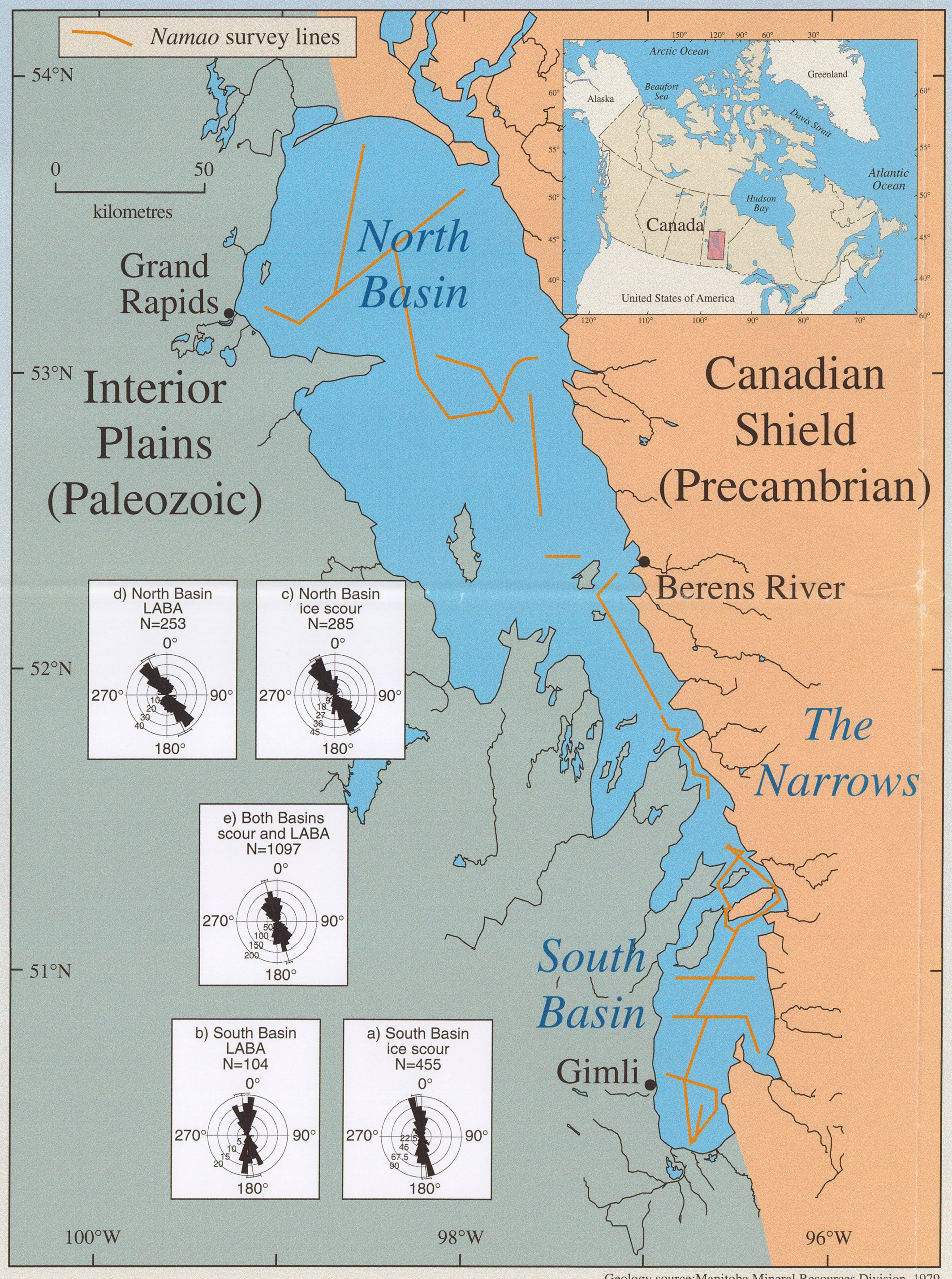
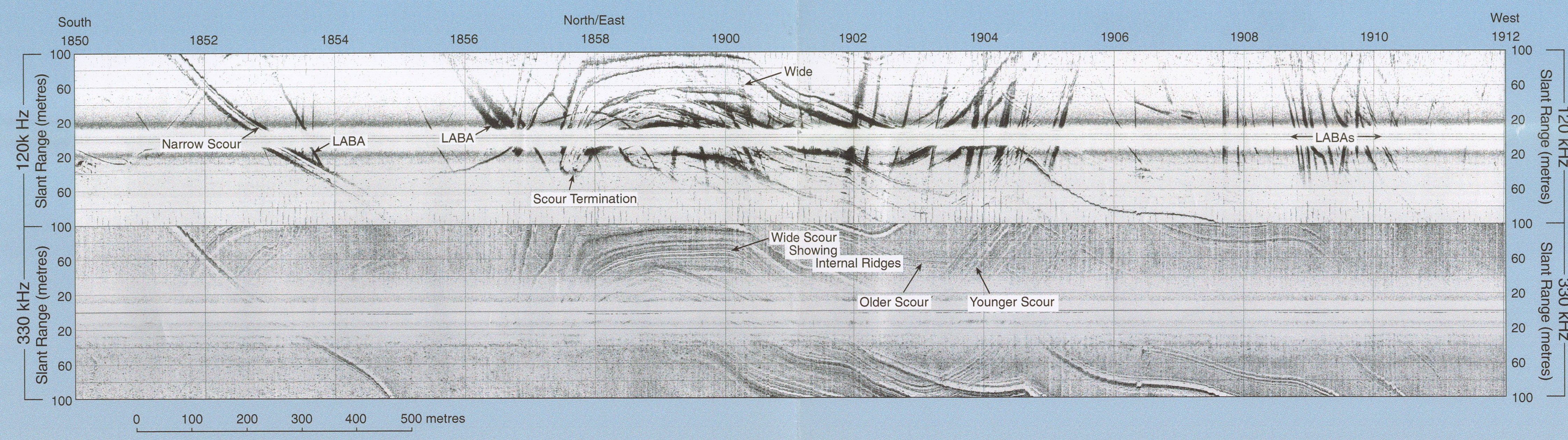
INTRODUCTION

Like glacial Lake Agassiz, its extensive predecessor, Lake Winnipeg overlies the boundary between the low-relief Interior Plains and the southwestern Canadian Shield in southern Manitoba (see map below). The lake extends 430 kilometres south to north and reaches 100 kilometres in width. In area, Lake Winnipeg is the seventh largest lake in North America. It consists of a small South Basin separated from a large North Basin by a constricted passage (The Narrows). Generally, the bathymetry is flat and shallow ranging from about 11 metres (South Basin) to 16 metres (North Basin).

By the early 1990s, concerns regarding shoreline erosion and water quality in Lake Winnipeg drew attention to the urgent need for a better understanding of the natural history of the lake, in order to put recent changes into a long-term perspective. Scientists from the Geological Survey of Canada and Manitoba Energy and Mines proposed the first-ever regional geological study of the lake basin to help address these concerns by elucidating the postglacial (thousands of years) and geologically recent (hundreds of years) lake history. Regional geophysical transects, sediment coring and nearshore surveys were undertaken from the Canadian Coast Guard Ship *Namao* during 1994 and 1996. These studies are reported by Todd et al. (1996, 2000) and Lewis et al. (2001).

This poster presents the discovery and analysis of ice scouring on the floor of Lake Winnipeg. During the 1994 and 1996 geoscientific surveys, sidescan sonar data were collected to investigate the morphology of the lakefloor, and high-resolution seismic reflection data were obtained to image the lateral and vertical geometries of unlithified sediment. Features present on the records were classified, measured, and mapped in order to address their distribution, character, and origin. Particular emphasis was placed on linear features in order to test for, and determine the extent of, ice scour. Results of the surveys were summarized by McKinnon (1996) and McKinnon et al. (2000).

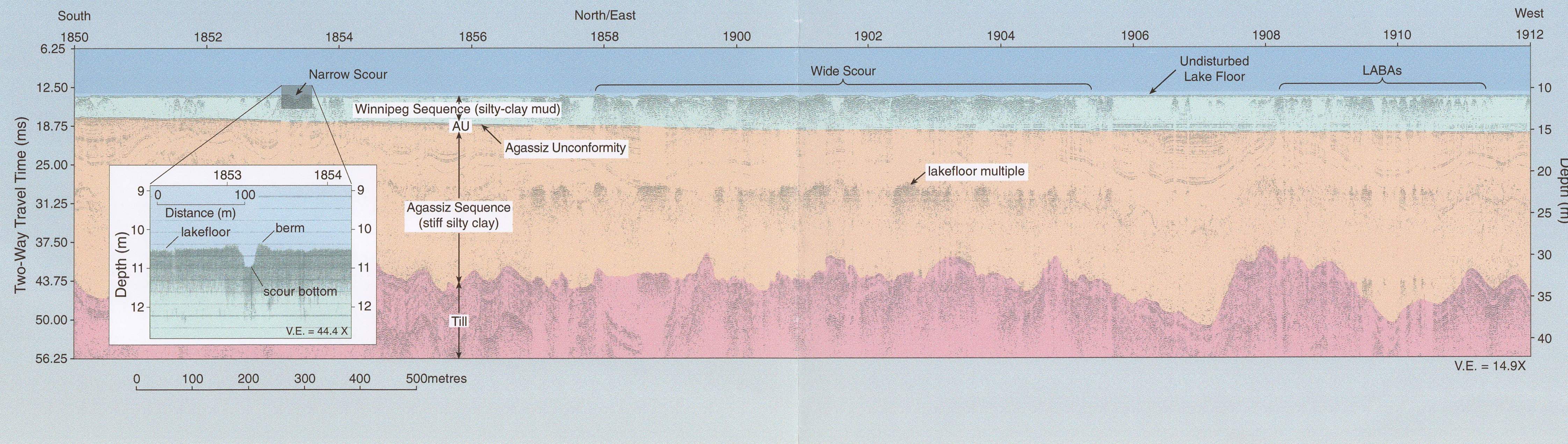




Sidescan Sonar Data

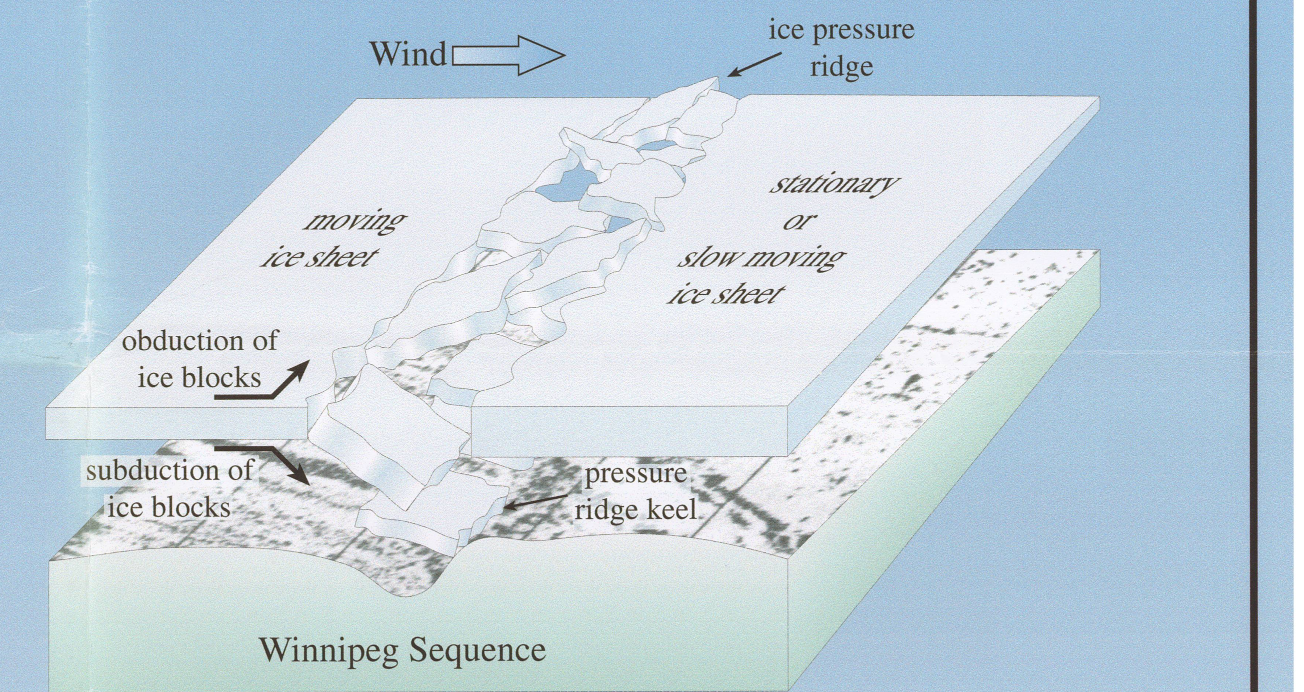
Simrad MS992 dual-frequency sidescan sonar records (above) show a two-dimensional view of the floor of Lake Winnipeg in the South Basin. At 120 kHz (upper record), the sidescan system penetrates deeper into the lakefloor sediment than the higher frequency, 330 kHz record (lower record). The higher frequency delineates greater detail on the lakefloor. The lower frequency record may image older ice scours which are veneered with younger sediment.

The lakefloor is dominated by two categories of curvilinear features. The first type, referred to as scours, are up to 200 m wide and several kilometres long on the sidescan sonar records. The wide scour in the central portion of the sidescan sonar record has multiple internal ridges highlighted in the 330 kHz record. The second type of curvilinear feature, referred to as LABAs (Linear Acoustic Backscattering Anomalies, Cameron and Lewis, 1994), consists of single, ~15 m-wide dark bands on the sidescan sonar records, several hundred metres long, with diffuse lateral boundaries. LABAs are recognizable in the 120 kHz record, but not in the 330 kHz record, indicating that they have little to no relief and are likely buried by sediment.



Seismic Reflection Data

The panel above shows the Seistec™ high-resolution seismic reflection system profile corresponding to the sidescan sonar record (top). The system operates over a frequency range of 1800 Hz to 6-8 kHz providing a vertical resolution of 10-20 cm. This seismic profile provides a cross-section view of the sediment layers beneath the floor of Lake Winnipeg. The morphology and relief of scours formed in the uppermost Winnipeg Sequence sediments (light green) are illustrated. The narrow scour on the left (at about 1853) is approximately 1 m deep and has berms of sediment deposited on the scour sides. The wide, internally-ridged scour (from about 1858 to 1905) shows disruption of the lakefloor with a high-amplitude (dark) reflection character underlying the extent of the scour. A group of LABAs (from about 1908 to 1911), prominent on the 120 kHz sidescan sonar record above, appear to be buried beneath a thin layer of sediment. The reflection amplitude beneath the LABAs is not as high as beneath the wide scour.



Interpretation

The disruption of lakefloor sediments is attributed to scouring by lake ice. The scouring process is initiated by the accumulation, or stacking, of slabs of lake ice into pressure ridges under the influence of wind (Kovacs and Mellor, 1974). The combined weight of the stacked ice slabs depresses pressure ridge keels into the lakefloor (see cartoon above). Wide ice sheets forming long pressure ridges have wide, multiple-ridged keels which produce wide, multi-furrowed ice scours in the lakefloor (as seen in the sidescan sonar image). The relative timing of scouring events is established by cross-cutting relationships: younger scours cross-cut older scours. LABAs are interpreted to be older, degraded scours buried by a thin layer of sediment deposited during lakefloor reworking by storm-generated waves.

Lake Winnipeg is covered with ice from mid-November to late April (Environment Canada, 1992). Ice scour and LABA orientations are dominantly NNW-SSE (see rose diagrams on map at far left). This trend is similar to the orientation of the prevailing winds in late winter and spring during the breakup of ice (McKinnon, 1996), suggesting that wind direction plays an important role in ice scour orientation.

The rate of lakefloor disturbance by lake ice is not yet known. Future re-mapping of previously surveyed regions can indicate the frequency of ice scour additions.

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