DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Marine geophysical data from the western Ross Sea, Antarctica

by

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Introduction

In 1984, a geophysical and geological survey (L2-84-AN) of the western Ross Sea, Antarctica, was conducted by the U. S. Geological Survey aboard the R/V S. P. Lee (Figures 1 and 2). This survey yielded approximately 2350 km of 24-fold multichannel seismic-reflection data, as well as 4500 km of other geophysical profile data including single-channel seismic-reflection, gravity, magnetic gradiometer, 3.5 and 12 kHz high-resolution echo-sounding, and sonobuoy refraction profiles. Rock samples and heat flow measurements were also collected at several sites. Gravity and echo-sounding data were collected along the transit lines to New Zealand after the survey (Figure 1). Eittreim, Cooper et al. (1984) have summarized the scientific objectives and preliminary results of this survey. More complete descriptions of the geophysical data collection and scientific findings are published in a volume of papers edited by Cooper and Davey (1987).

With the publication of this open-file report, the following data are being released:

1. Analog (variable area/ wiggle trace) sections of the stacked, multichannel seismic-reflection profiles at a horizontal scale of 2 km/in and a two-way travel-time scale of 1.5 in/sec; stacking velocity data is displayed across the top of the section;
2. Magnetic tapes of digital multichannel seismic reflection data, unstacked (CDP sort) and stacked, in SEG-Y format;

3. Bathymetric, free-air gravity, and magnetic gradiometer profiles plotted at a horizontal scale identical to the seismic-reflection data;
4. Digital navigation, bathymetry, gravity, and magnetic gradiometer data on magnetic tape.

Multichannel Seismic-reflection Profiles

The multichannel seismic-reflection (MCS) data were collected along 19 lines (Figures 2 and 3). Operating conditions (weather, seas, ice) were generally good. However, deteriorating weather and increasing seas on the last few lines (417,418.419) caused greater seismic noise and eventually required termination of MCS operations. During the first half of the cruise open water extended nearly to the coast of Victoria Land. Later in the cruise, ice conditions deteriorated and some ship maneuvering was necesssary to avoid brash ice (Lines 414, 415/416). Midway through the cruise (Line 405), the entire multichannel streamer was severed from the ship when the streamer tail buoys snagged on an ice-growler. The streamer was recovered and operated normally, even though at least half of the streamer had sunk to the seafloor (800 m). Further information on the multichannel operations and data processing is given by Dadisman et al. (1987).

The source and receiver equipment, and recording parameters are shown in Table 1. The seismic source consisted of a tuned, 5 air-

gun array totaling 1311 cubic inches. pressurized to 1900 psi, towed at a depth of 10.5 m. Individual gun volumes were usually 148, 194, 194, 309, and 466 cubic inches; the array was modified temporarily at times during the survey for repair. The receiver consisted of a 24-channel hydrophone streamer, with 100 meter group lengths containing 60 hydrophones in each group. The near-channel offset from the airguns was 297 m, and far channel offset 2611 m. The streamer was towed at a depth of 12.5 m. The data were recorded with a GUS Model HDDR-4200 recording system. All lines were recorded to 12 sec, with exception of Line 407 (15 sec) and Line 419 (8 sec).

The multichannel seismic-reflection data were processed by the U.S. Geological Survey on a Digicon DISCO system. The processing sequence (see Table 2) was designed for deep-water multiple removal and enhancement of deep crustal reflections. Consequently, dip-filtered velocity analyses, offset weighted stacks and low-pass filtering were used but deconvolution and migration were not applied. Record sections given in this report are displayed only to 10 seconds; however. the sort and stack tapes contain 12 seconds of data (except line 419 which has 8 seconds).

One field recording problem is noteworthy for those planning to reprocess data from the sort tapes. Static shifts were introduced into the field data along several lines. These shifts were removed during the processing and the necessary corrections are contained within the header word "STATS" for each sort tape.

Magnetic Gradiometer

Magnetic data were recorded continuously with a Geometrics proton-precession marine gradiometer to remove the large temporal magnetic-variations (magnetic storm and diurnal changes) commonly recorded at polar latitudes. The gradiometer system consisted of two proton-precession magnetometers separated horizontally by 500 feet (152 m), with the forward sensor lying 225 m aft of the ship. Both sensors were towed at a depth of approximately 20-40 m (forward sensor slightly shallower than aft sensor). Data were sampled at 4 second intervals, with a sensitivity of 1 nanotesla (nT). Total field measurements have been reduced to residual or anomolous magnetic values by removal of the IGRF 1975 reference field (IAGA, 1976). corrected to 1984.

The method used to reconstruct the magnetic profile from the gradiometer data has been described by Hansen (1984, 1985); the advantages, limitations, and results of the method, as applied to the Antarctic data, are described by Hansen and Childs (in press).

Because temporal variations recorded in the marine magnetic profiles are commonly indistinguishable from the geologic anomalies, gradiometer reconstruction of the magnetic field is essential for accurate geologic interpretation. Comparision of magnetometer base station records from Scott Base (Ross Island) with the temporal variations determined from gradiometer reconstruction of the Ross Sea gradiometer data were highly coherent (Hansen and Childs, 1987) indicating:

1. Temporal variations in the Ross Sea region are large -

amplitudes reaching 200-250 nT and wavelengths commonly up to 2 hours, and

2. Reconstructed magnetic-gradiometer data give a more accurate description of the magnetic anomalies in the western Ross Sea than the observed magnetic data.

Gravity

Gravity data were recorded continuously with a LaCoste and Romberg sea gravimeter (S53) on a two-axis stabilized platform. Gravity data were collected at 20 second intervals, and subsequently desampled to two minutes or greater for plotting and modelling. The data have been Eotvos corrected, and reduced to free-air anomalies. Absolute gravity values were achieved by tying to IGSN-71 (International Association of Geodesy. 1974) at Christchurch, New Zealand. Free-air anomalies were calculated by removal of the 1967 reference field (International Association of Geodesy, 1971). The data were edited to remove spurious values at turns, and to remove erroneous Eotvos corrections introduced by navigational errors.

Base station ties were made in Christchurch, New Zealand one month before the beginning of the Ross Sea cruise and at the end of the cruise. No tie was possible in McMurdo sound at the start of the cruise. Two gravity meter failures occurred during the period between the New Zealand base ties leaving some uncertainty in the gravity meter drift corrections added to the field data. Davey and Cooper (1987) give further information on gravity meter performance as well as mapping and interpretation of the data.

Digital Data

All digital navigation, bathymetry, gravity, and magnetic gradiometer data have been condensed into a a single file conforming to the marine geophysical data exchange format "MGD77", which is described in NOAA/EDIS (1981). Minor modifications to the MGD77 format were required to accomodate the inclusion of the gradiometer reconstructed magnetic data. The geophysical data record contains the total observed field values for the two gradiometer sensors. but the residual field is calculated from the gradiometer reconstruction rather than either individual sensor. Therefore. the residual field has had temporal variations removed. The MGD77 record field indicating "sensor used for residual field" is unspecified.

The CDP sort (unstacked) and stack tapes of the multichannel seismic data are written in SEG-Y format, as described by Barry and others (1975).

Data Availability

Analog reproductions of the stacked multichannel seismic records, copies of the multichannel seismic tapes. digital shot point navigation, bathymetry, gravity, and magnetic gradiometer data may be obtained from the National Geophysical Data Center (NGDC). Instructions for ordering data from these sources may be obtained by contacting:

National Geophysical Data Center

National Geophysical Data Center
NOAA/EDIS/Code D64
325 Broadway
Boulder, Colorado 80302

Additional copies of this report may be obtained by contacting:

Open File Service Section
U. S. Geological Survey
P. O. Box 25425
Federal Center
Denver, Colorado, 80225
Telephone: (303) 236-7476

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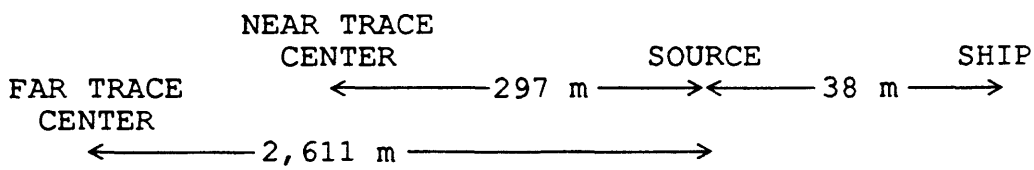
Table 1. Equipment and recording parameters used for the collection of multichannel seismic-reflection data in the Ross Sea, Antarctica.

SOURCE:	Bolt air guns
AIR GUNS IN ARRAY:	5
NET VOLUME:	1,311 cu in
MANIFOLD PRESSURE:	1800-1900 psi
GUN DEPTH:	10.5 m
SHOT SPACING:	50 m
STREAMER:	Seismic Engineering Inc. Multidyne, charge coupled
GEOMETRY:	



GROUP INTERVAL:	100 m
AVERAGE DEPTH:	12 m to 20 m
GROUP LENGTH:	100 m
PHONES PER GROUP:	60
DEPTH CONTROLLERS:	Seismic Engineering Inc., variable wing birds
RECORDING :	Global Universal Scientific Inc. (GUS) High Density Digital Recorder (HDDR) Model 4200, binary gain
SAMPLE INTERVAL:	2 ms
RECORD LENGTH:	12 s (line 407-15 s, line 419-8 s)
RECORDING FILTER:	10-110 Hz
NUMBER OF CHANNELS:	24
NAVIGATION:	Magnavox Integrated System
SHOT ON:	Distance or time
PRIMARY NAVIGATION:	Satellite

Table 2. Outline of the processing sequence for multichannel seismic-reflection data collected in the Ross Sea, Antarctica.

PROCESSING SEQUENCE

1.	DEMULTIPLEX:	
	DESAMPLE:	4 ms
	GAIN RECOVERY:	
	REFORMAT:	Phoenix I
2.	TRACE SHOT EDIT:	
3.	STATIC CORRECTIONS:	
	RECORDING STATICS:	276 ms
	DATUM:	Sea level
	SHOT STATICS:	Variable
4.	CDP SORT:	
	SPACING:	50 m
5.	VELOCITY ANALYSIS:	
	DIP FILTER:	
	WINDOW LENGTH:	100 ms
	BAND PASS FILTER:	4-8-30-35 Hz
	VELOCITY RANGE:	1400-6500 m
6.	NMO CORRECTION	
7.	MUTE	
8.	24-FOLD STACK:	
	WEIGHTED:	by offset (100 m)
9.	BANDPASS FILTER:	
	FILTER POINTS:	101
	TIME WINDOW:	0.0-10 s
	FREQUENCY:	4-8-30-35 Hz
	TAPER:	Hanning
10.	AGC WINDOW:	500 ms

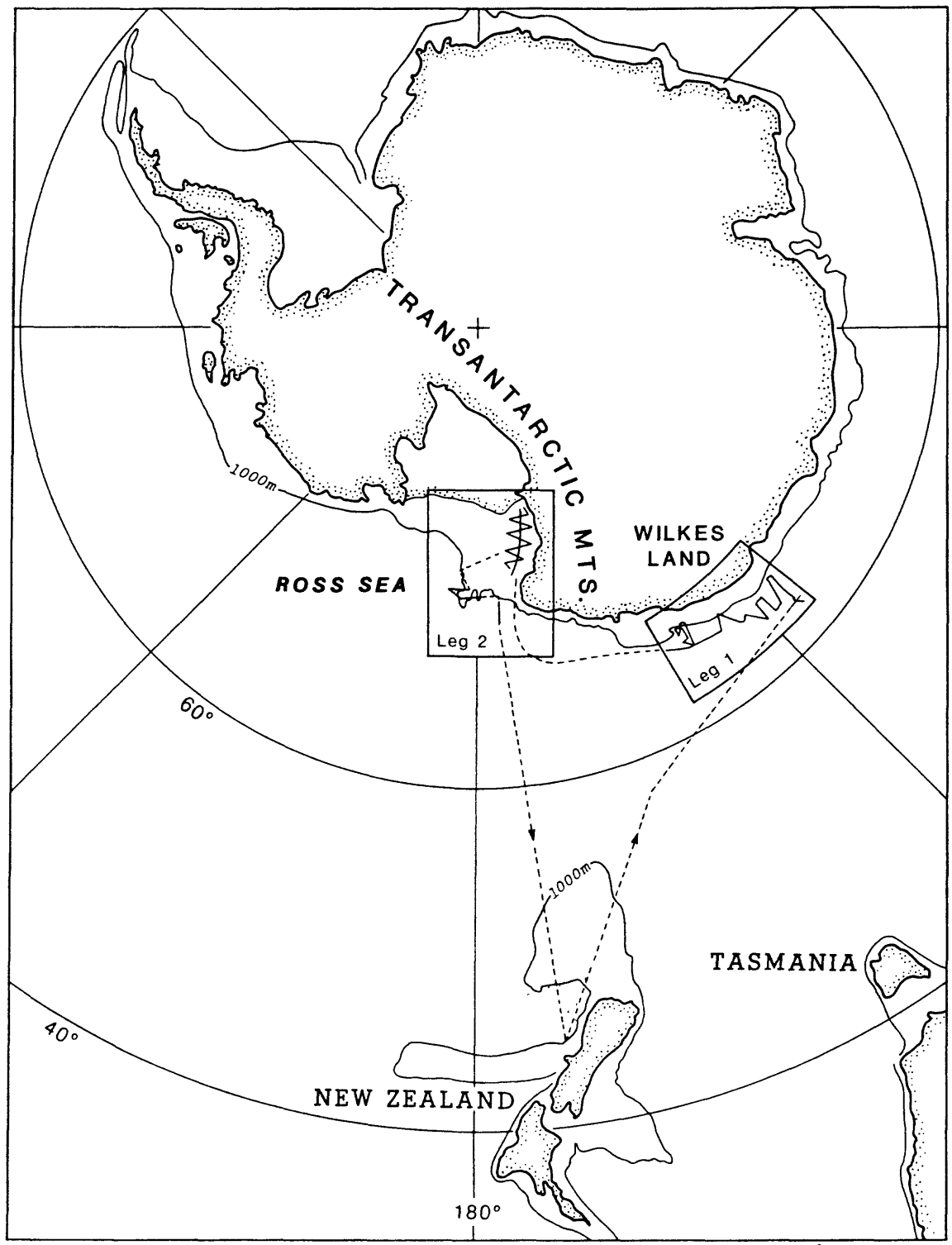


Figure 1. Regional map of Antarctica showing tracklines for the Wilkes Land margin survey (Leg 1) and Ross Sea survey (Leg 2) carried out by the U. S. Geological Survey in January-February, 1984. Dashed tracks indicate transit lines before and after each survey.

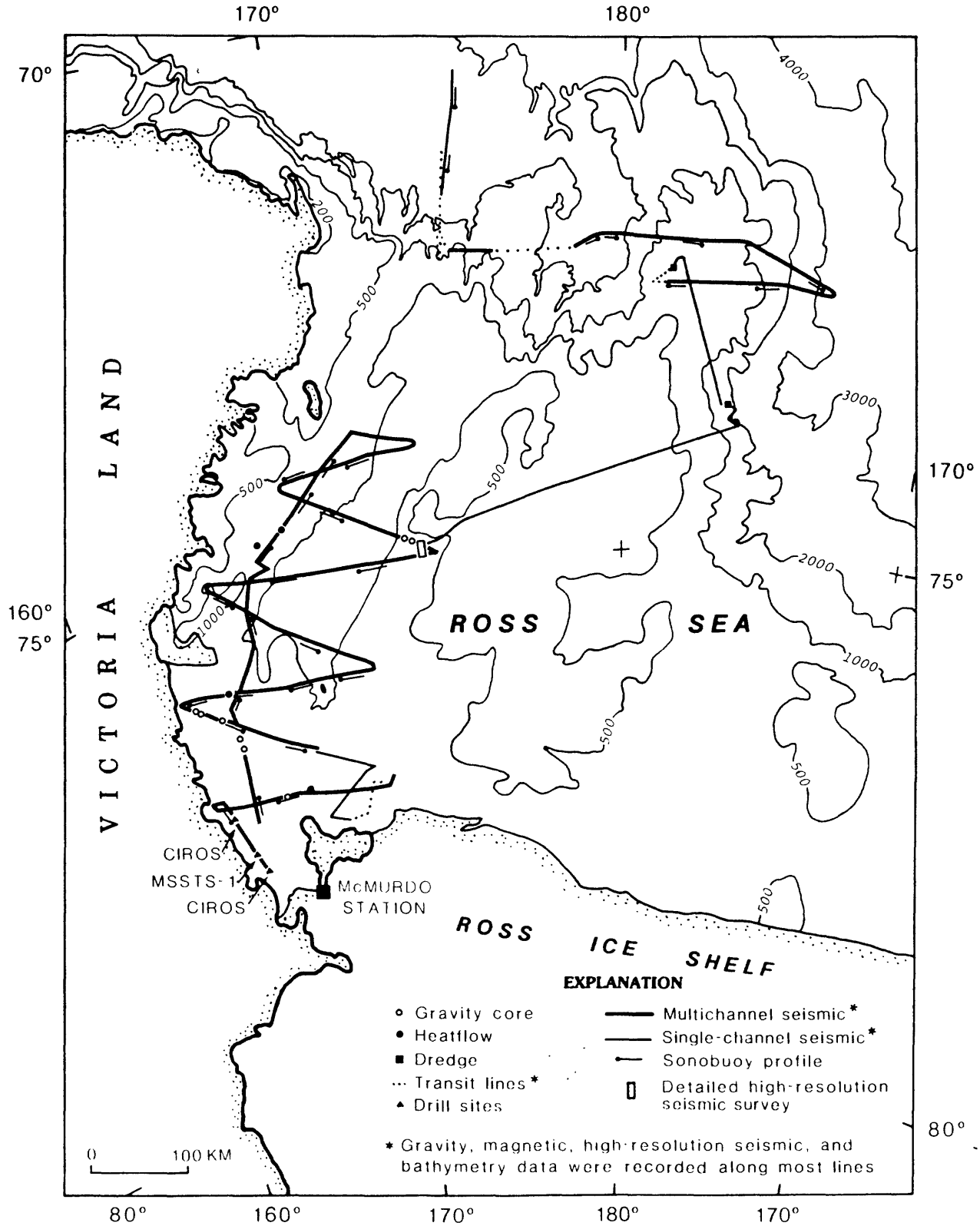


Figure 2. Index map of the Ross Sea showing location of geophysical tracklines and geologic sampling sites occupied by the S.P. LEE during February 1984 (from Eittreim, Cooper et al., 1984). Bathymetry in meters. Polar stereographic projection.

SEE ATTACHED FOLDOUT MAP

Figure 3. Shotpoint map for multichannel seismic-reflection tracklines recorded by the U.S. Geological Survey in the Ross Sea, Antarctica during February 1984. Polar stereographic projection.