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Marine geophysical data from the Wilkes Land continental margin, Antarctica

by

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In 1984, a geophysical survey (L1-AN-84) of the continental margin of Wilkes Land, Antarctica, was conducted by the U. S. Geological Survey aboard the R/V S. P. Lee (Figs. 1 and 2). This survey yielded approximately 1,800 km of 24-fold multichannel seismic reflection data, 400 km of single channel seismic reflection data, and other geophysical profile data including gravity, magnetic gradiometer, 3.5 and 12 kHz high-resolution echo-sounding, and sonobuoy refraction profiles. Gravity and echo-sounding data were collected along the transit lines from New Zealand prior to the survey, and to McMurdo Sound after the survey (Fig. 1). Eittreim et al. (1984) have summarized the scientific objectives and preliminary results of this survey. More complete descriptions of the geophysical data collection and interpretation are published in Eittreim and Smith (in press) and Childs and Stagg (in press).

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 1 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 multichannel seismic reflection data;

4. Digital navigation, bathymetry, gravity, and magnetic gradiometer data on magnetic tape.

Multichannel seismic reflection profiles

The multichannel seismic reflection data were collected along 15 lines (1 thru 14B, Fig. 2). Icebergs and sea ice limited the southern extent of the survey, permitting only one line (14B) to extend substantially onto the continental shelf. Small heading changes were necessary along some lines, especially those at the landward limits of the survey, to avoid icebergs and sea ice. The survey conditions were excellent, and wave-induced noise was minimal.

The source and receiver equipment, and recording parameters are shown in Table 1. The seismic source consisted of a tuned, 5 airgun array totaling 1311 cubic inches, pressurized to 2000 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. Recording and equipment problems were minimal.

The basic processing steps are shown in Table 2. Particular attention was devoted to accurate velocity estimation, through the use of standard semblance plots and constant velocity stacks. The semblance velocity analyses were performed every 2.5 km (50 CDP's) along each line, using a summation of 3 adjacent CDP gathers for each analysis. The high signal-to-noise ratio of the data resulted in highly coherent semblance plots and correspondingly low uncertainty in the velocity picks.

Magnetic gradiometer

Magnetic data were recorded continuously with a Geometrics proton-precession marine gradiometer. The survey was conducted in a geological regime that is magnetically quiet (e.g. characterized by an absence of seafloor-spreading magnetic anomalies) and the magnetic profiles for the most part reflect this. The magnetic field at high latitudes is very susceptible to large temporal variations (storm activity and diurnal changes) which render interpretation of the magnetic anomalies highly problematic. In an effort to filter the temporal variations from the geologic anomalies of interest, the magnetic field was measured with a gradiometer system, which consists of two proton-precession magnetometers separated horizontally by 150 m. The near sensor was towed 300 m aft of the ship, and both sensors were towed at a depth of approximately 50 m. Data were measured at 4 second sample intervals, with a sensitivity of 1 nanotesla (nT). The method used to reconstruct the magnetic profile from the gradiometer data has been described by Hansen (1984, 1985), while the advantages and limitations of the method , based on data from the Ross Sea, Antarctica, are described by Hansen and Childs (in press). Because the temporal variations are otherwise indistinguishable from the geologic anomalies, gradiometer reconstruction of the magnetic field is considered essential for accurate interpretation. Base station records from the Dumont d'Urville base magnetometer near the south magnetic pole were examined, but did not prove useful in verifying the validity of

the reconstruction method, probably because of the large distance between the survey area and base station location. However, the comparision of the magnetometer base station records from Scott base with the temporal variations determined from gradiometer reconstruction of the subsequent Ross Sea (Leg 2, Fig. 1) survey were highly coherent (Hansen and Childs, in press). Total field measurements have been reduced to residual or anomolous magnetic values by removal of the IGRF 1980 reference field (IAGA, 1976).

Gravity

Gravity data were recorded continuously with a LaCoste and Romberg sea gravimeter 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. Cross-coupling analysis and correction were considered unnecessary because of remarkably calm sea conditions during the survey, and because of the lack of tie lines with which to judge the effectiveness of the corrections. Absolute gravity values were achieved by tying to IGSN-71 (International Association of Geodosy, 1974) at Christchurch, New Zealand. Free-air anomalies were calculated by removal of the 1967 reference field. (International Association of Geodosy, 1971). The data were edited to remove spurious values at turns, and to remove erroneous Eotvos corrections introduced by navigational errors. Comparision of the LEE data with other data published in the region (Konig, 1980) indicates a consistent offset of 21 to 25 mGals throughout the LEE data set. The source of this offset is unresolved, but could arise from one of several causes. The most probable cause is an unrecorded tare in the data. The gravimeter was repaired at sea during the first multichannel line of the survey, and subsequently prior to the start of the second Antarctic leg. No tie was possible at McMurdo Station. and the meter ties performed in Christchurch, New Zealand, before and after the Antarctic surveys, were separated by approximately 9 weeks. The 21 to 25 mGal discrepancy has not been corrected in the analog or digital data included in this report.

Digital data

All digital navigation, bathymetry, gravity, and magnetic gradiometer data has 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 field values for the

two gradiometer sensors, but the residual field is calculated from the gradiometer reconstruction rather than either sensor individually. 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
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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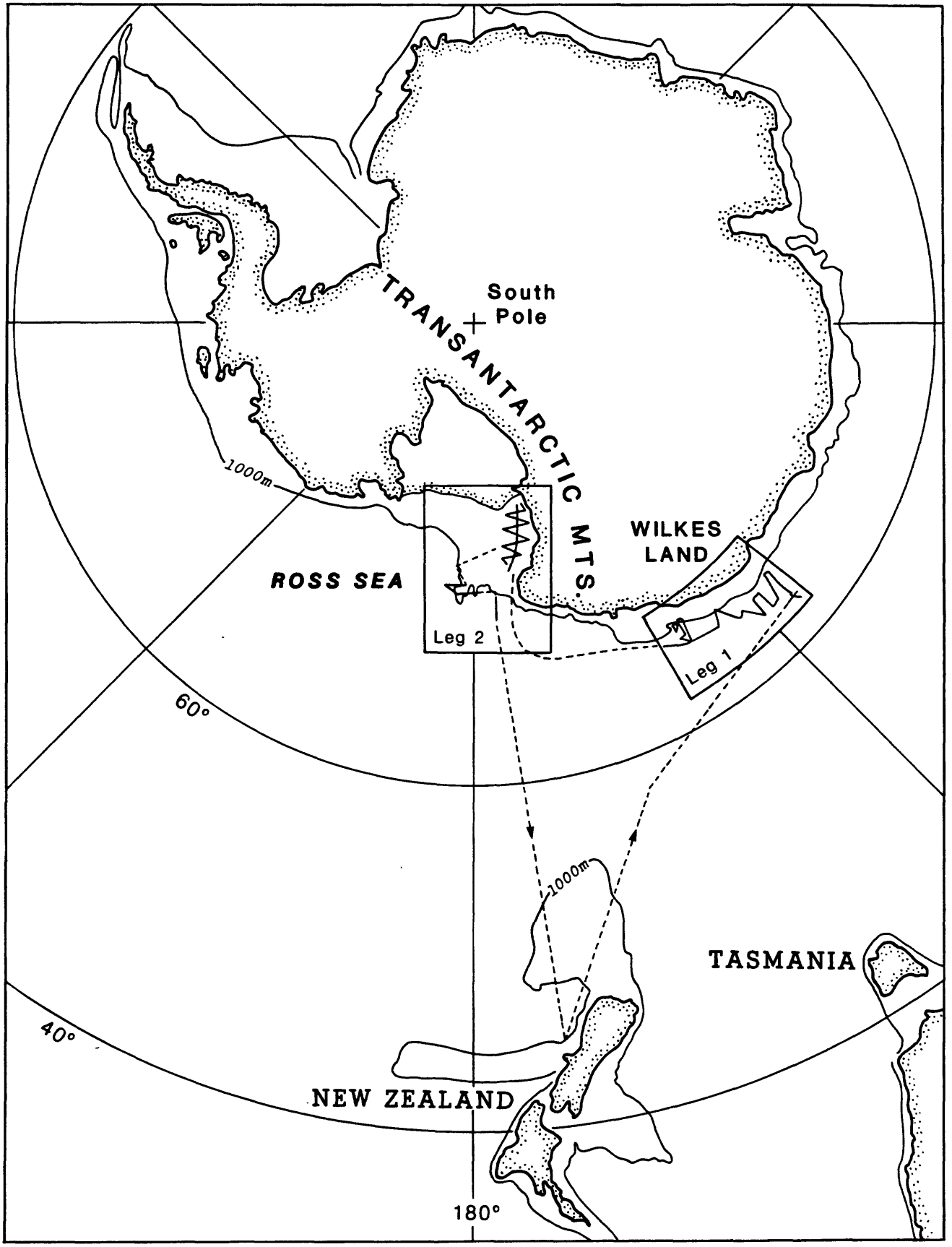

Figure 1. Regional map of Antarctica showing tracklines for the Wilkes Land margin survey (Leg 1) and Ross Sea survey (Leg 2) carried out by the U. S. Geological Survey in January-February, 1984. Dashed tracks indicate transit lines before and after each survey.

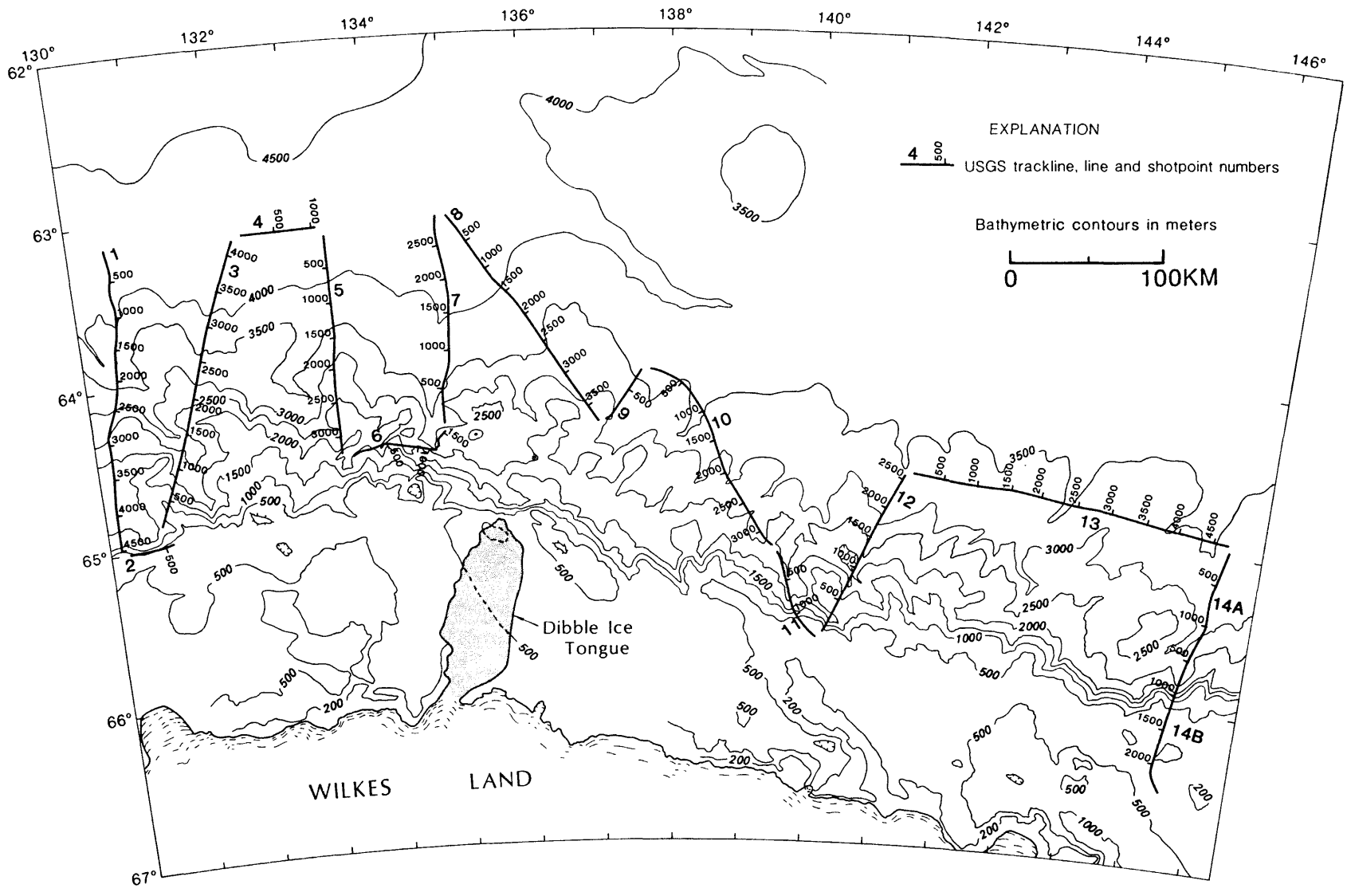

Figure 2. Bathymetric map (Chase, in press) of the Wilkes Land coast annotated with multichannel seismic reflection lines and shot point numbers.

TABLE 1. RECORDING PARAMETERS AND EQUIPMENT USED DURING CRUISE L1-84-AN

SOURCE:	BOLT AIR GUNS
AIR GUNS IN ARRAY:	5
NET VOLUME:	1311 CU. IN.
MANIFOLD PRESSURE:	1800 - 2000 PSI
GUN DEPTH:	10.5 M
SHOT INTERVAL:	50 M
STREAMER:	SEI MULTIDYNE.CHARGE COUPLED
GROUP INTERVAL:	100 M
AVERAGE DEPTH:	12.5 M
GROUP LENGTH:	100 M
PHONES/GROUP:	60
DEPTH CONTROLLERS:	SEI VARIABLE WING BIRDS
RECORDING:	GUS HDDR 4200. BINARY GAIN
SAMPLE INTERVAL:	2 MS
RECORD LENGTH:	10 S
RECORDING FILTER:	5-110 HZ
NUMBER OF CHANNELS:	24
NAVIGATION:	MAGNAVOX SYSTEM
PRIMARY:	"TRANSIT" SATELLITE
SECONDARY:	"GPS" SATELLITE

TABLE 2. 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
4. CDP SORT:	
5. VELOCITY ANALYSIS:	
WINDOW LENGTH:	60 MS
WINDOW INTERVAL:	4 MS
BAND PASS FILTER:	3-6-40-50 HZ
VELOCITY RANGE:	1400-4900 M/S
6. NMO CORRECTION:	
7. 24-FOLD STACK:	
8. BANDPASS FILTER:	HANNING
FILTER POINTS:	64
TIME WINDOW:	0.0 - 12.0 S
FREQUENCY:	4-8-50-60 HZ
9. AGC:	350 MS WINDOW