The Central Pacific Transect; Cruise Report of the Research Vessel AKADEMIK SELSKIY

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Introduction

In 1989 the Far East Branch of the USSR Academy of Sciences initiated the PACTRAN Program, a 10-year plan to study a series of major transects crossing the Pacific basin (Fig.1). The objectives of PACTRAN are to conduct intensive studies of the ocean floor and crust along three east-west transects, or corridors, in the north, central and southern Pacific Ocean (PACTRAN, 1989). The PACTRAN program proposes a range of studies in each transect corridor, such as side-scan sonar mapping, high-resolution swath-mapped bathymetry, seismic refraction and reflection profiling, geopotential field measurement, and geologic sampling. One stage of the PACTRAN program is multichannel seismic (MCS) reflection profiling along the axial zone of each of the transects, with double parallel lines where possible. These MCS investigations along the Pacific transects are designed to reveal similarities and differences in the crustal structure and, therefore, geodynamic evolution of these segments, of varying ages, of Pacific seafloor.

The Institute of Marine Geology and Geophysics (IMGG) in Yuzhno-Sakhalinsk, the Hawaii Institute of Geophysics (HIG), and the U.S. Geological Survey (USGS) joined in a cooperative effort to execute the first of the three planned transects of the Pacific with the sailing of the seismic-exploration vessel AKADEMIK SELSKIY from Korsakov, USSR, in January, 1990. This cruise report describes the activities during this initial Central-Pacific Transect (CPT) expedition in the equatorial Pacific.

The principal objective of the initial cruise was an MCS reflection profile along a track beginning in the western Pacific above Mesozoic crust of the Pacific plate and progressing eastward, between the Clarion and Clipperton fracture zones. The profile then proceeds along a flow line of crustal growth to the axis of the mid-ocean ridge system at the East Pacific Rise.

The AKADEMIK SELSKIY was contracted from the Soviet Oil and Gas Ministry and is operated by the Far East Marine Oil

and Gas Exploration Trust of Yuzhno-Sakhalinsk. The SELSKIY, built in Poland in 1986, is a 3600-ton vessel, 82 m in length, and was designed for oil and gas exploration. The ship has an enclosed, large-capacity streamer reel, port and starboard support frames for four airguns each, and four compressors, each of 30-liters per minute capacity at 400 atm pressure.

This preliminary report documents the initial PACTRAN data collection effort along the CPT, and will be followed by more formal data reports after processing is complete. Data processing, which will be done at the USGS Marine Seismic Processing Center in Menlo Park, is expected to be completed by June, 1992.

Data Collection

The MCS transect was conducted in three legs, Korsakov-Hilo (January 20-March 14), Hilo-Acapulco (March 18-April 19) and Acapulco-Mazatlan (April 21-May 19). Onboard participants included 33 members of the ship's crew and seismic technical staff from the Ministry of Oil and Gas, 27 scientists and support staff from the IMGG, 3 scientists from the USGS and 2 scientists from the HIG.

The part of the track southeast of Japan crossed the M-series magnetic anomalies (Nakanishi, et al, 1989) and was designed to follow a crustal-generation flow line (Fig. 3). The east-west line north of the Clipperton fracture zone also follows a flow line, starting at crust estimated to be 90 million years old (based on extrapolation of sea floor ages farther east, Bukry et al, 1973) and progressing to zero-age crust at the East Pacific Rise in the ROSE study area (Ewing and Meyer, 1982). Care was taken to follow a track that avoided possible subsidiary fracture zones, as far as they could be deduced from satellite-derived geoid data (Haxby, 1987).National exclusive economic zones were also avoided. In addition to MCS data, gravity and magnetics and some single-channel seismic data were also recorded.

MCS data were recorded with a Hungarian-built "Volna-96" seismic recording system, which controlled the data flow, the recording parameters and the 1600-bpi tape recorders. Three different seismic streamers were used in this work. First, in the area southeast of Japan, a Soviet-built 48-channel 2400-m-long streamer was used; it was lost however,in a mishap

during the survey. Next, starting from the area of the Line Islands north of the Clipperton fracture zone, 1000 km of data were recorded along the east-west track with a Soviet-built 24-channel 1200-m streamer. From this point, at 147 degrees West, the remaining 5000 km of the east-west profile was recorded with a US-built 24-channel 2400-m streamer. Three different Russian-built airgun arrays were used in the transect. The arrays used on most of the transect consisted of either 4 guns with a total volume of 23 L, or 8 guns with 46 L total volume. The seismic system parameters are shown in Table 1. The data were recorded at 24-fold coverage while the first and last-mentioned streamers were used, and at 12-fold with the 1200-m streamer.

Gravity-field accelerations were measured with four independently operating Soviet-built gravimeters (GMN-K type), and magnetic-field intensity was recorded with a Soviet-built proton-precession magnetometer (MPM-7 type). Both systems recorded data on digital magnetic tape. Navigation control was provided by a West German Krupp-Atlas SUSY 30/11 system which logged and integrated satellite fixes with sonar-doppler speed log information used for navigating between satellite fixes. Those systems generated 50-m shot-spacing signals to trigger the airguns, and provided real-time positional updates and displays in various laboratories about the ship.

Preliminary Results

A total of 6800 km of MCS, gravity and magnetics line were obtained, shown in Figs.3 and 4. In the eastern area (Fig. 4), in addition to the long east-west line north of the Clipperton fz, one cross line was obtained at 117 West that was part of a Texas A & M University research program (T. Hilde).

The seismic data show a sedimentary layer above the volcanic oceanic basement that ranges in thickness from about 1-sec two-way travel time in the west to zero at the ridge crest. In shipboard analog records of individual streamer channels, the volcanic basement surface is typically obscure, apparently due to the chert-rich sediments that immediately overlie the basement in this area of the Pacific (van Andel and Heath, 1973). Weak reflections from crustal layering below the basement surface are present in the single-channel monitor records, and are expected to be better-defined in the processed multifold data. A short sample of brute-stacked

data, in which estimated velocities were used to correct for normal move out before stacking the data, is shown in Fig. 5.

Magnetic anomalies of about 100-nTesla amplitudes and 50-200 km wavelengths were observed along the trackline north of the Clipperton FZ. Gravity anomalies of 20-mgal amplitude were common along this profile, normally associated with topographic features.

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Table 1 - Seismic system used

The "Volna-96" recording system:	
channels	24, 48
tape drives	BS-165, 1600 bpi
format	SEG-B
sampling	4 msec
frequency band	5-62 Hz
digital converter	14 bit
digital gain controller	0 to 84 db
sound source:	
airgun array 1	10, 7.5, 3.5, and 2 L
airgun array 2	array 1 X 2
airgun array 3	10, 10, 3.5 and 3.5 L
streamers:	
Lines 5 and 6	48 channel, 2400 m
Lines 12, 13, & 113	24 channel, 1200 m
Lines 213, 313, 014, 15, 115, 16, 116, 216, 316 416 17, 117	24 channel, 2400 m

Captions

Figure 1. Proposal for northern, central and southern transects of Pactran program (from PACTRAN, 1989).

Figure 2. Age of oceanic crust given in Ma according to Larson et al.,(1985). "Clipp. f.z." indicates trace of Clipperton Fracture Zone. Boxes show locations of detailed maps in Figs. 3 and 4.

Figure 3. Locations of multichannel seismic lines 5 and 6 recorded by R/V AKADEMIK SELSKIY in the western area. Basemap shows contoured SEASAT gravity anomalies (Haxby, 1987), which represent bathymetric trends of the seafloor.

Figure 4. Locations of multichannel seismic lines recorded by R/V AKADEMIK SELSKIY in the eastern area. Basemap shows contoured SEASAT gravity anomalies (Haxby, 1987), which represent bathymetric trends of the seafloor. Line numbers shown along lines.

Figure 5. Example of brute-stack, 24-fold processed data, collected along east-west corridor in Fig. 4. Shot points are indicated along top.

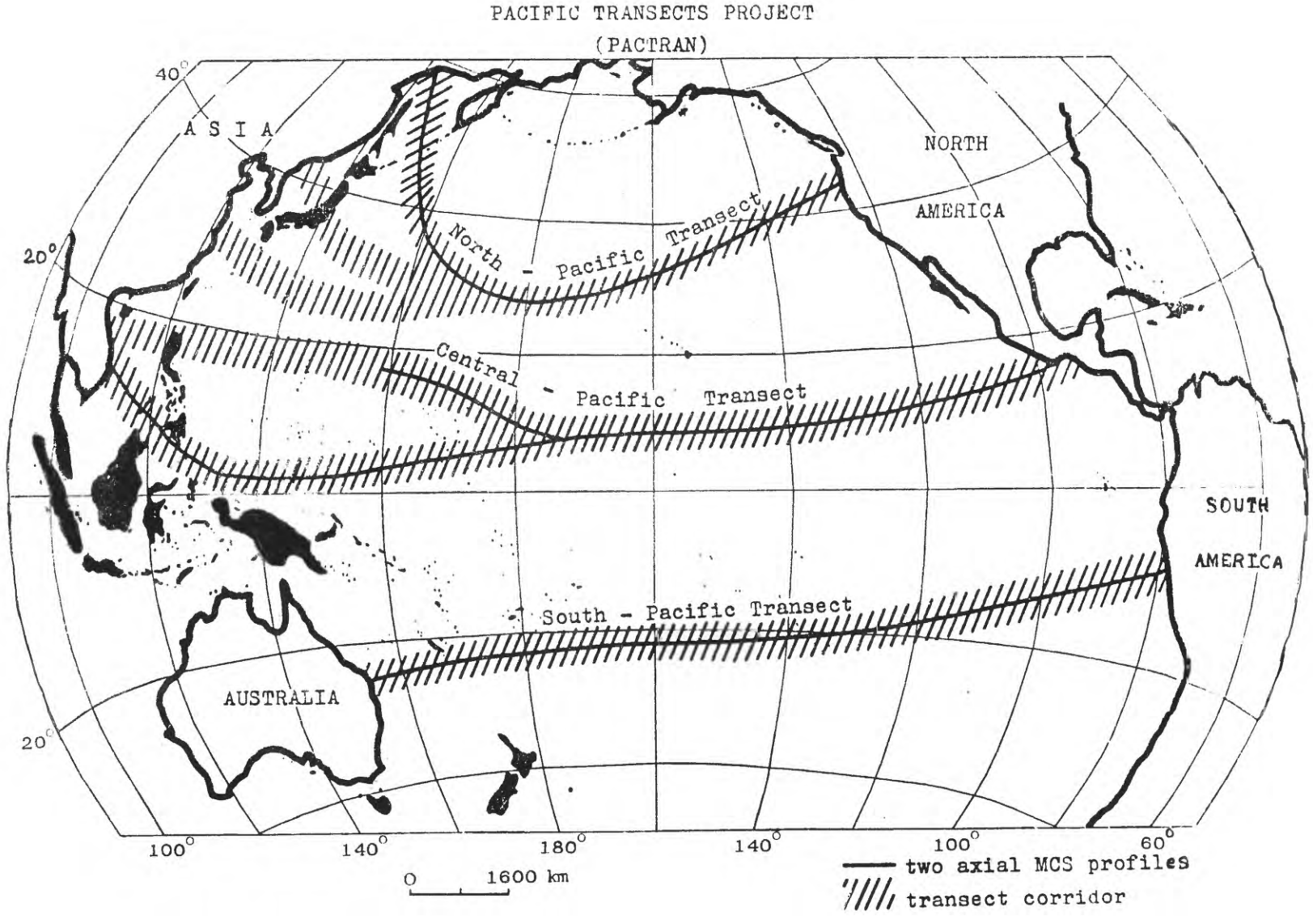
PACIFIC TRANSECTS PROJECT
(PACTRAN)
40°
A S I A
NORTH
AMERICA
20°
North - Pacific Transect
Central - Pacific Transect
SOUTH
AMERICA
South - Pacific Transect
AUSTRALIA
20°
100°
140°
180°
140°
100°
60°
0 1600 km
two axial MCS profiles
transect corridor

Fig 1

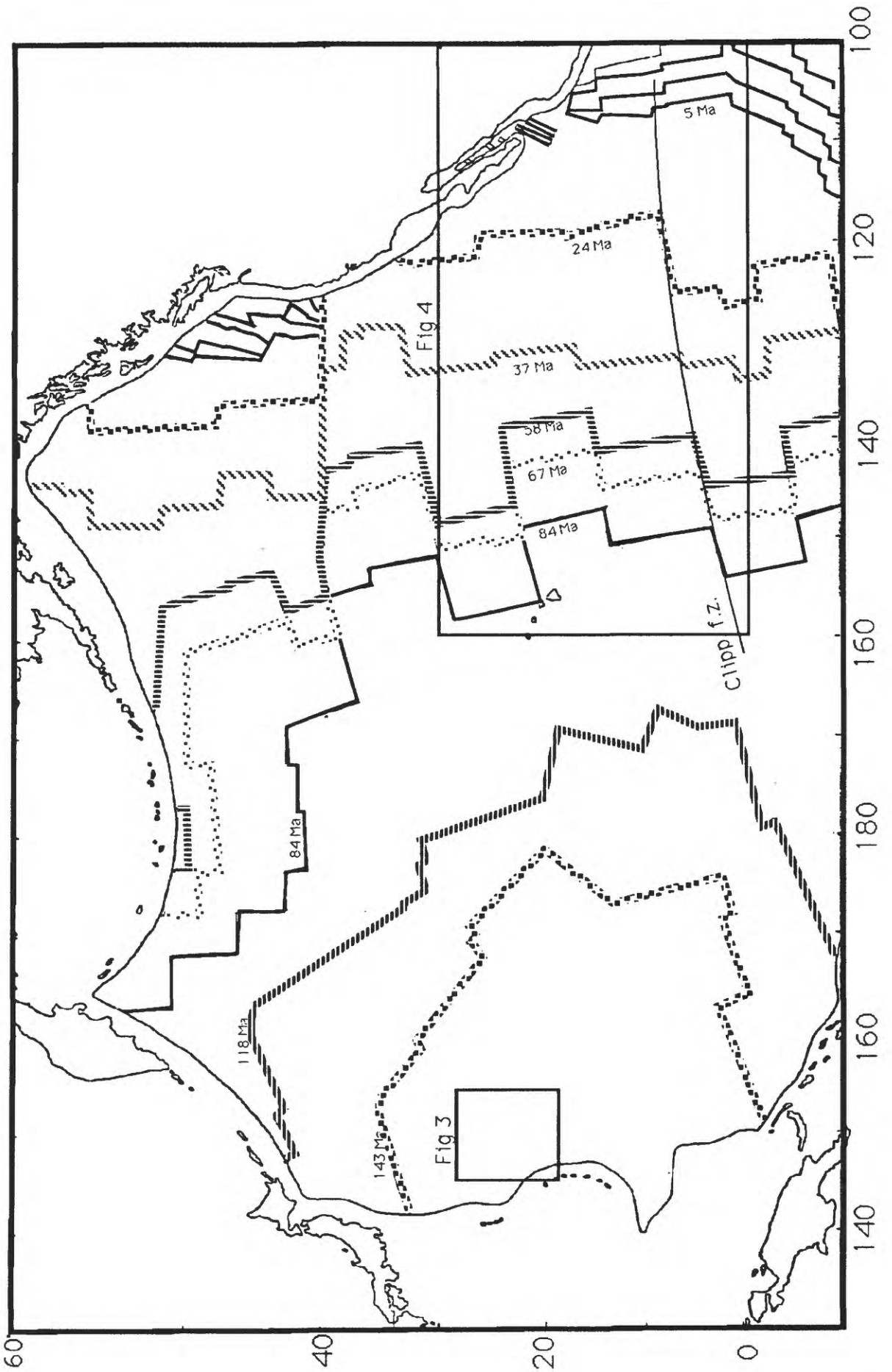
5 Ma
24 Ma
37 Ma
58 Ma
67 Ma
84 Ma
Fig 4
Clipp f.z.
84 Ma
118 Ma
143 Ma
Fig 3
100
120
140
160
180
160
140
60
40
20
0

Fig 2

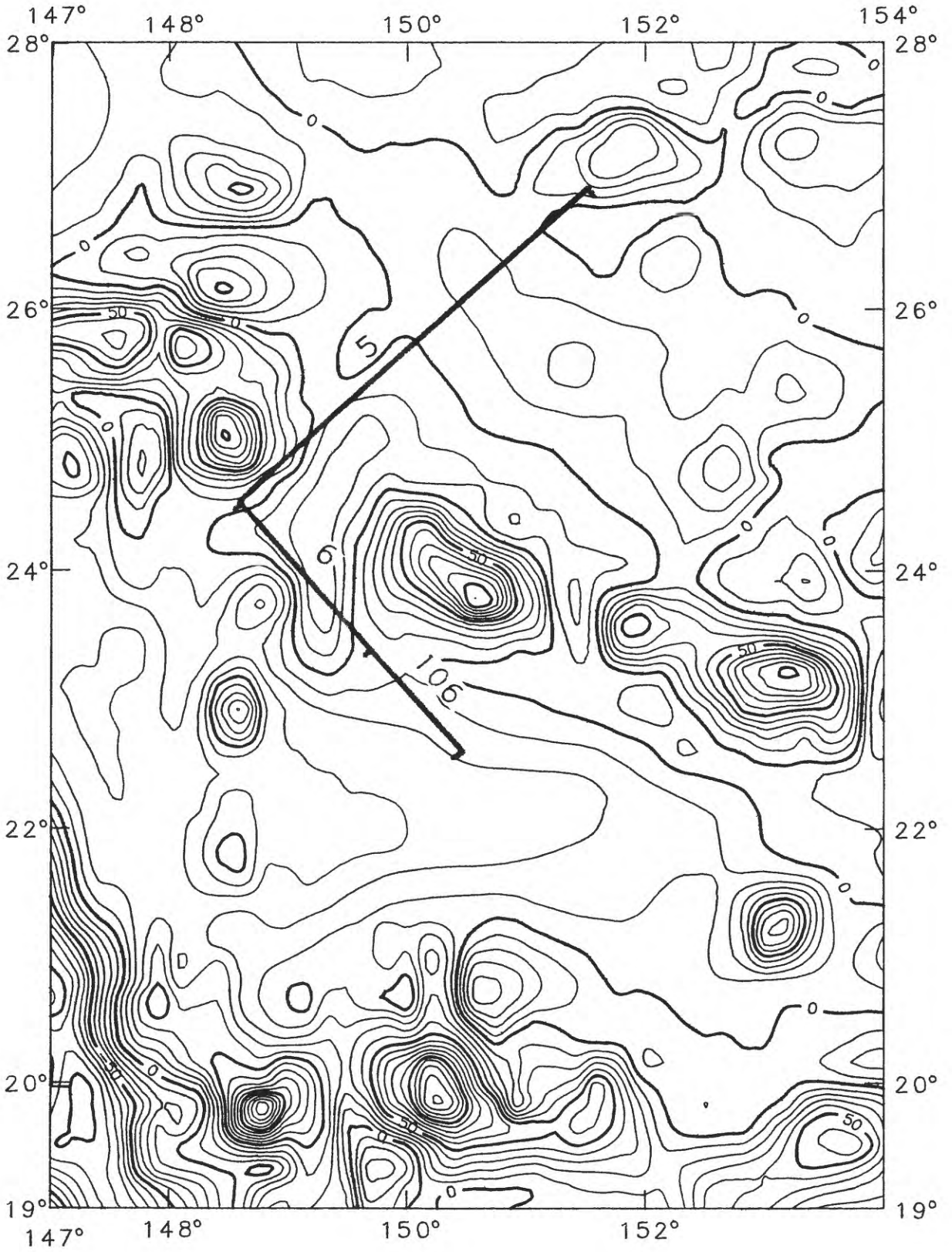

Fig 3

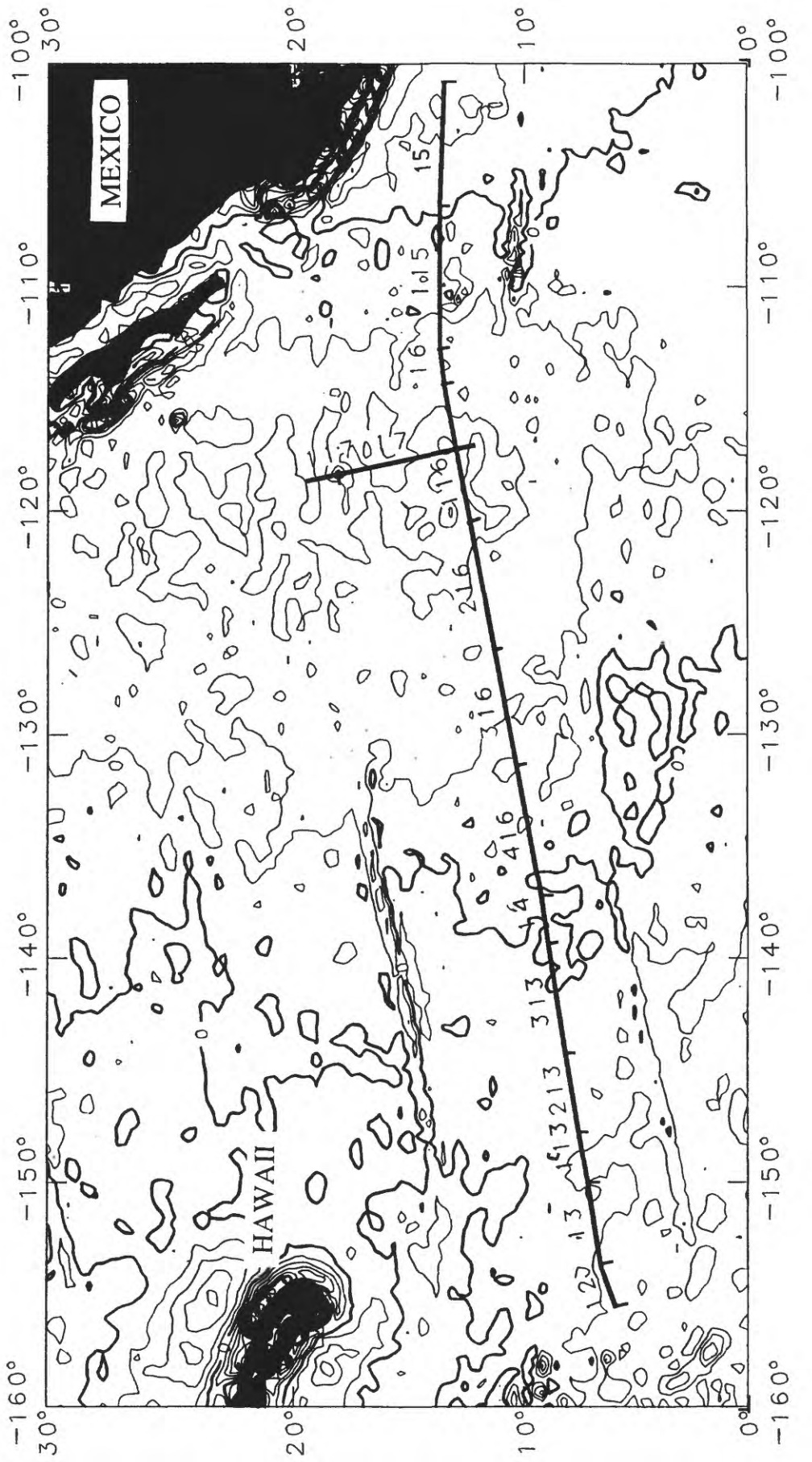

Fig 4

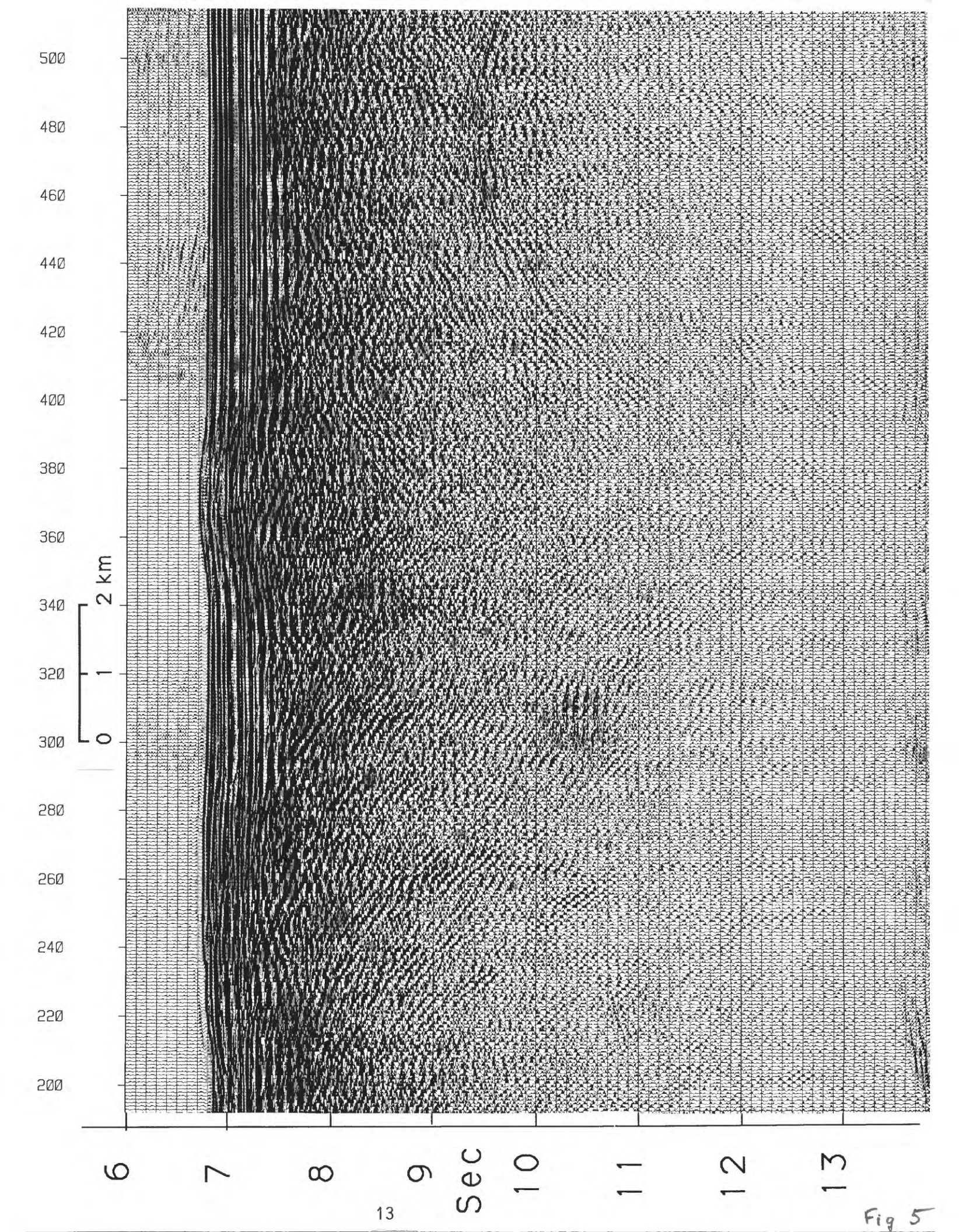
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
0
1
2 km
6
7
8
9
Sec
10
11
12
13

Fig 5