UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY GRAVITY AND MAGNETIC MAPS OF THE STRAIT OF JUAN DE FUCA BRITISH COLUMBIA, CANADA AND WASHINGTON, UNITED STATES

BY

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A Cooperative Marine Geologic Program

between the

U.S. Geological Survey and the

Geological Survey of Canada

Open-file report

1974

74-1096

Preliminary Gravity and Magnetic Maps of the Strait of Juan de Fuca

Introduction

The contoured gravity and magnetic data of the Strait of Juan de Fuca presented on the accompanying two preliminary maps represent part of the geophysical data collected during a cooperative marine geologic study of the Strait of Juan de Fuca by the Geological Survey of Canada and the U.S. Geological Survey (fig. 1). The maps and data are released in preliminary form in order to make them expeditiously available to the public. Later reports will integrate the geophysical data with single channel seismic reflection profiles and bathymetric data acquired during the investigation and with detailed surface geologic mapping currently being conducted by the Canadian and U.S. Geological Surveys adjacent to the Strait. It is anticipated that the interpretation of these new data will contribute to a better understanding of the stratigraphic and tectonic framework of the Tertiary sedimentary and volcanic rocks that lie beneath the Strait.

Acknowledgements

We wish to thank our associates at the Geological Survey of Canada, Vancouver, who assisted in collection, reduction, and compilation of the magnetic, bathymetric, and navigational data, and our associates at the U.S. Geological Survey, Menlo Park, California, who assisted in the collection or processing of gravimetric and seismic data. We wish to express our appreciation to I. R. Mayer, H. G. Greene, and J. E. Case who assisted in the operation of the geophysical equipment during the cruise and to A.G. McHendrie and R. J. Graf who processed the geophysical data. The writers are particularly appreciative of the outstanding cooperation afforded by Captain K. J. Sjolholm and the crew of the CHS PARIZEAU; their superior seamanship contributed measurably to the success of the survey.

DATA ACQUISITION AND REDUCTION

The gravity and magnetic data were collected along 2,300 km of track line aboard the CHS PARIZEAU from May 15 to June 3, 1972. The area of investigation extends from Whidby Island that borders the eastern end of the Strait of Juan de Fuca to beyond Carmanah Point west of the Pacific entrance to the Strait. Figure 1 shows the location of the surveyed area and the approximate position of individual track lines.

Precision navigation was provided by a Decca Minifix system for all except the southwesternmost part of the survey area where radar fixes were used. Slave stations for the Minifix system are shown on the gravity and magnetic maps. Positions located by Minifix are accurate to within 180 m; they are least accurate where located directly between two slave stations. Radar positions were determined during the time that Minifix slave stations were being moved and for that part of the cruise that lay southwest and west of Cape Flattery where land masses interfered with direct signal paths of the Minifix system. Accuracy of radar determined positions is ± 150 m except in the southwestern part of the survey area, which was farther from radar targets, it is ± 250 m. The type of navigation used on individual lines is shown on figure 1. The ship's speed over most of the survey was approximately 6 knots to accomodate seismic profiling.

The total magnetic field was recorded with a Barringer OM104 Proton Precession magnetometer system with the sensor towed approximately 200 m astern. Both analog and the digital values were recorded at a 6-second sampling rate. The magnetic values were transferred from punch paper tape to magnetic tape for processing and editing. The 6-second readings were averaged to give 1-minute readings. Noise spikes that occasionally resulted from impulses generated by a concurrently operating sparker profiler were either deleted or replaced by interpolated values. The magnetic data were corrected for diurnal variations obtained from a land sensor located at the Geophysical Observatory near Victoria. The magnetic anomalies were calculated using the International Geomagnetic Reference field (IAGA Commission, 1969). The mean value of the difference in recorded magnetic field at 119 track line intersections was 10.7 gammas. In addition, thirteen intersection values were greater than 50 gammas and were chiefly on lines controlled by radar navigation over steep magnetic gradients; line segments around these intersections were not used in constructing the contour map. A histogram showing total magnetic field differences at track line intersections is shown in figure 2; the 13 anomalous intersection values are not plotted.

Gravity measurements were made with a Lacoste-Romberg Model S-53 gravimeter mounted at the ship's center of motion. Six functions were recorded including filtered and unfiltered horizontal accelerations, spring tension, average beam position, total correction, and gravity. The gravity data were recorded on magnetic tape at a 10-second sampling rate. Eötvös corrections were calculated from the ship's heading and speed for 5-minute intervals. Free air anomalies were determined from the Eötvös corrected filtered gravity data using the 1930 International Gravity Formula (Cassinis and others, 1937), a 3.5 minute meter correction factor, day 143/1850 - 968822.8, day 144/1540 - 968824.1, day 155/0110 - 968824.0 for meter drift corrections and gravity base station value of g=98077.12 milligals at Graving Dock, Esquimalt, B.C. (Canadian Gravity Network base station no. 9600-68). The resulting free air values were outputted at a 2.5 minute sampling rate. Bathymetric data, corrected for water velocity using Matthews Tables (Matthews, 1939), were combined with the free air data to calculate simple Bouguer anomalies using a water density of 1.027 g/cc and standard crustal densities of 2.67. The mean crossing difference in simple Bouguer anomaly for 90 track intersections where the ship was not making short radius turns is 2.6 milligals with a 2.5 standard deviation. The track intersection differences result from errors in gravity, navigation, and bathymetric data. The exceptionally calm sea state during the cruise minimized erratic ship's accelerations and thus provided excellent gravity data. A histogram showing gravity differences at track intersections is shown in figure 3. Gravity data for approximately 5 minutes after the sharp turns at the end of track lines are generally unreliable because of the normal recovery delay of the gravimeter after rapid ship's accelerations and, therefore, were not used in preparing the contour map. One leg of the cruise between Admiralty Inlet and Port San Juan was made at an average speed of nearly 30 km/hr, about three times that of other legs. The gravity data collected on this leg were not used to construct the contour map as the crossing differences of this leg with other legs was commonly high (mean, 3.9 mg). A few other anomalous gravity values have associated anomalous Eötvös corrections and are also unreliable. Onshore-gravity data on both Vancouver Island (Walcott, 1957) and Olympic Peninsula (Stuart, 1961) sides of the Strait are generally compatible with the data of this survey.

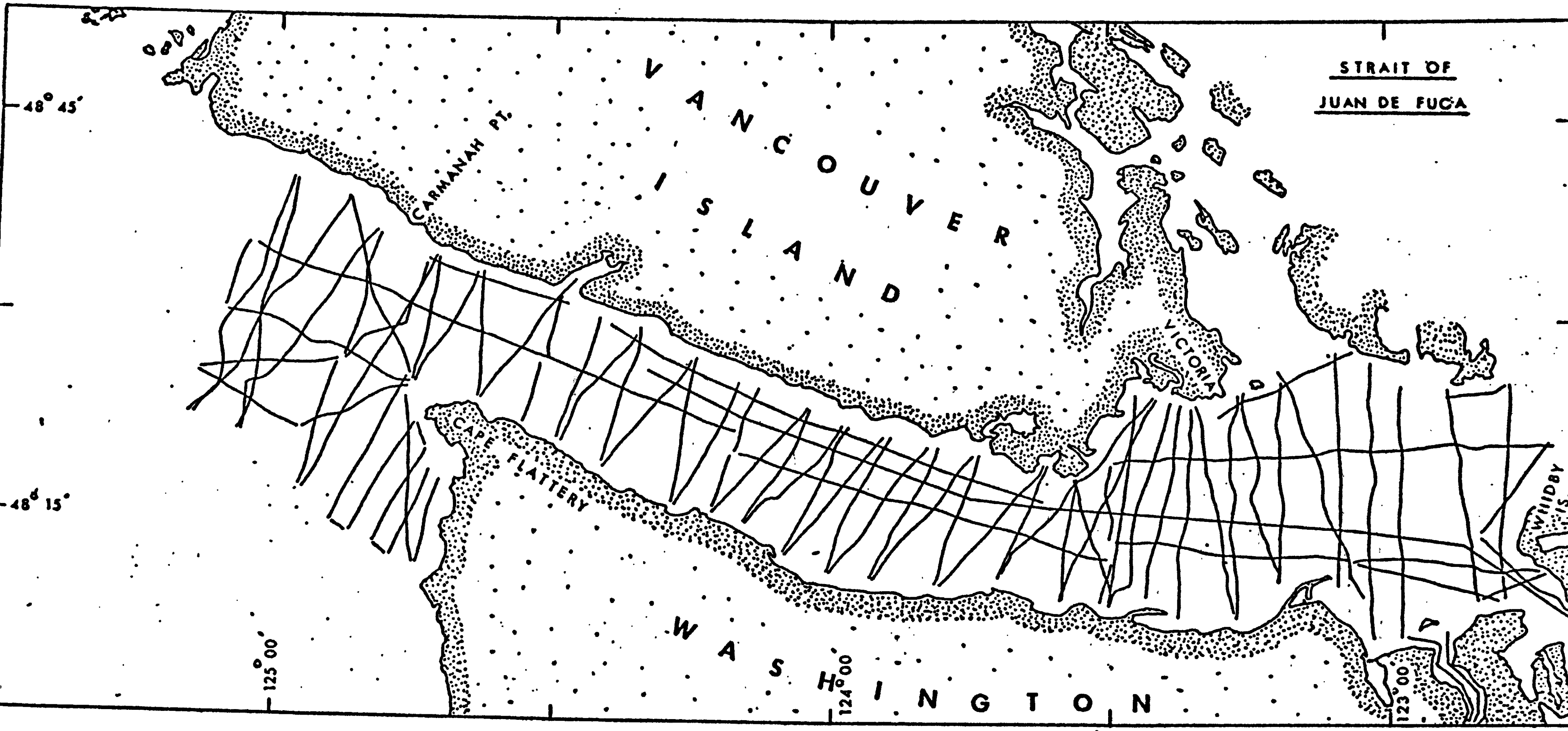

Figure 1. Approximate ship's track of cooperative marine geologic study of the Strait of Juan de Fuca by the Geological Survey of Canada and the U.S. Geological Survey.

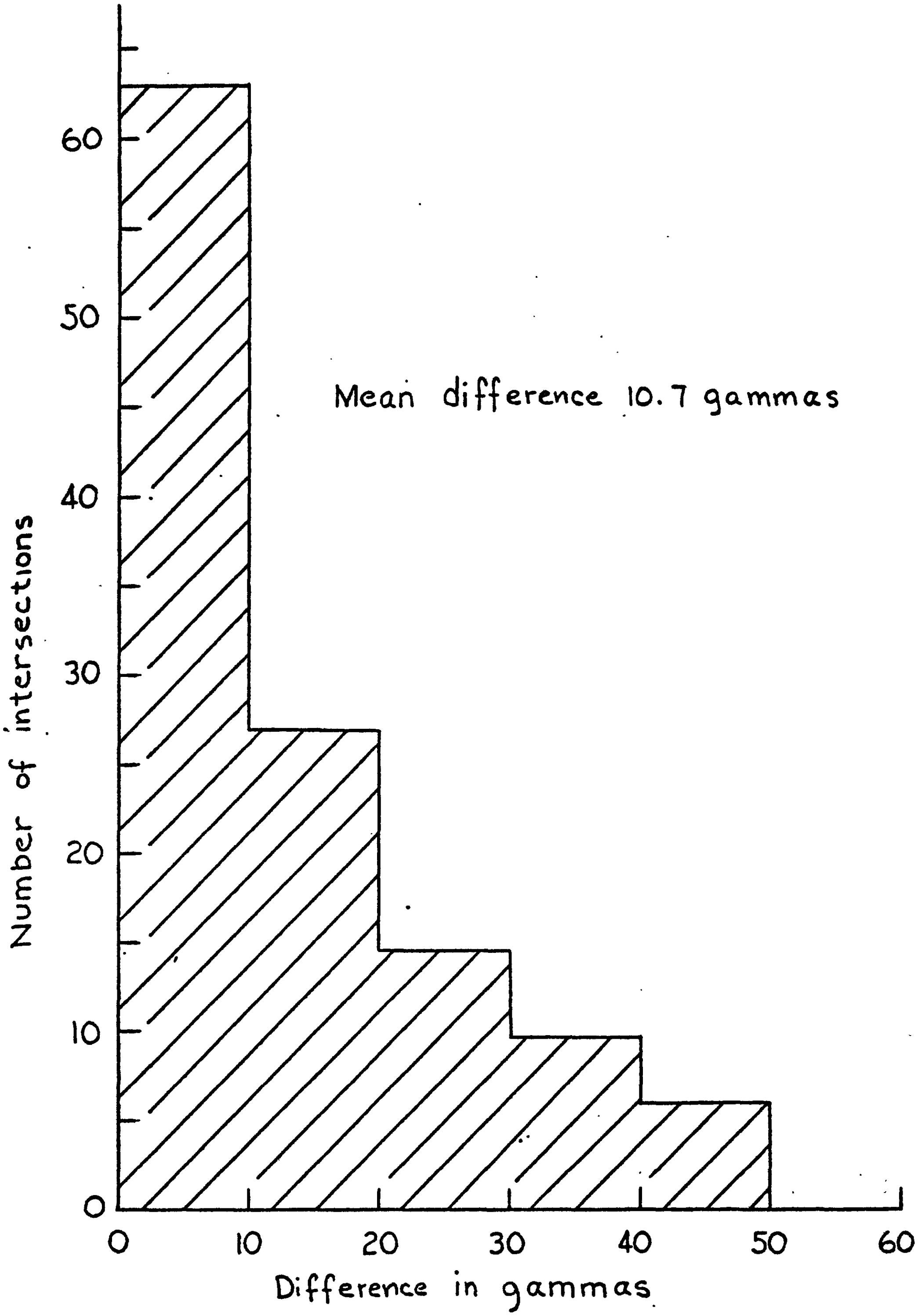

Figure 2. Histogram showing difference in magnetic field at 119 track line intersections in the Strait of Juan de Fuca

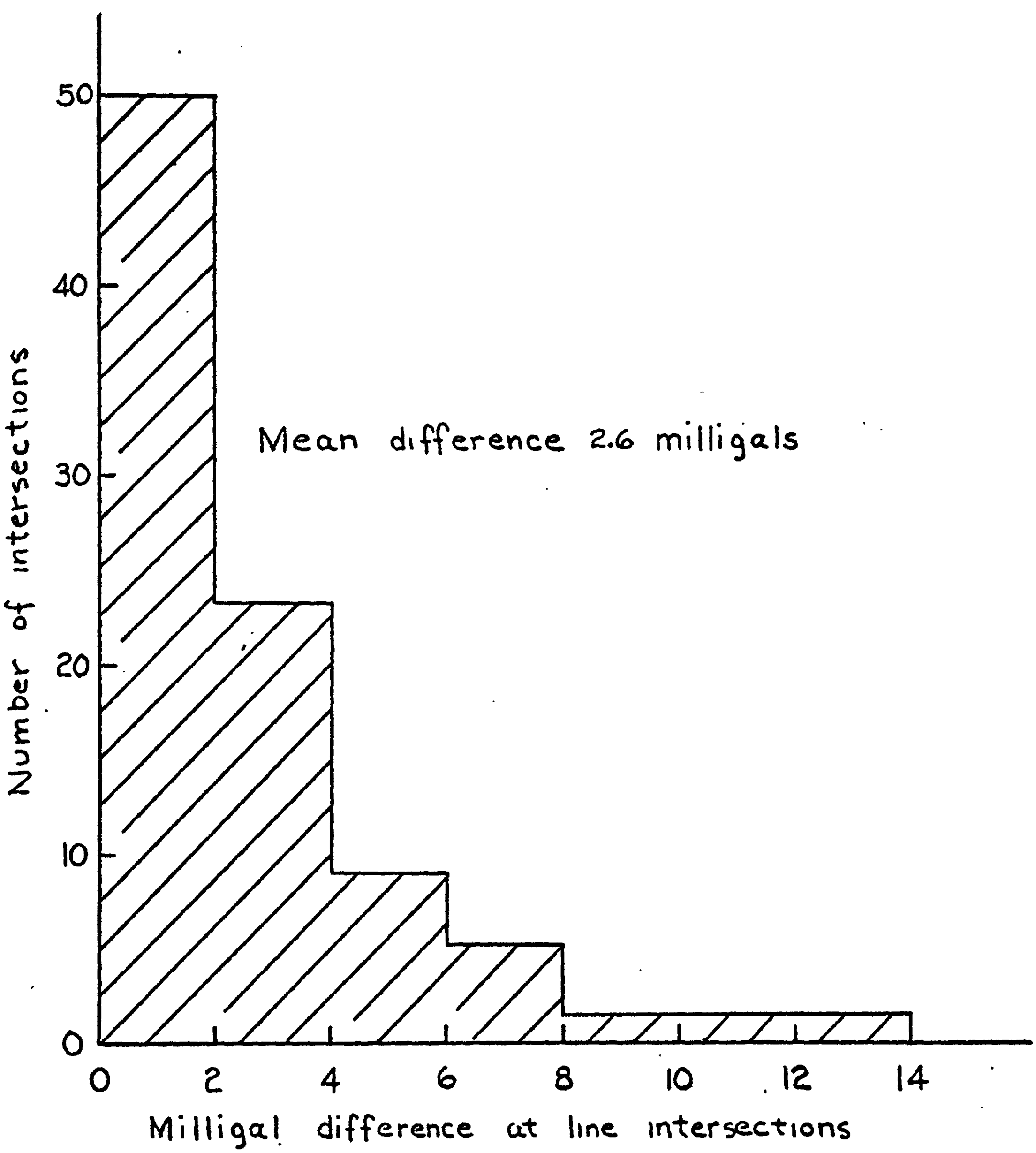

Figure 3. Histogram showing difference in recorded gravity values at 90 intersecting track lines

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