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# **GRAVITY MAP SERIES**

of the

# **DOMINION OBSERVATORY**

**Preliminary Results of  
Underwater Gravity Surveys  
in the  
Gulf of St. Lawrence  
With Map**

**No. 46—Gulf of St. Lawrence**

**A. K. Goodacre**

**OTTAWA, CANADA**

**Department of Mines & Technical Surveys**

**DOMINION OBSERVATORIES**

**1964**

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INTRODUCTION

During 1962 and 1963 the Dominion Observatory carried out underwater gravity measurements in the Gulf of St. Lawrence aboard ships chartered by the Department of Mines and Technical Surveys. Bouguer anomalies have been calculated from the underwater measurements and compiled with existing data for adjoining land area. To make this compilation available as soon as possible it is being published as a part of the Gravity Map Series of the Dominion Observatory. Principal facts of all stations and descriptions of control stations are available upon request from the Dominion Observatory. A general interpretation of the Bouguer anomalies is given elsewhere (Goodacre and Nyland, 1964).

SURVEY PROCEDURE

The survey was carried out during three ten-day cruises, one in July 1962, and two during July and August 1963. As in regional land surveys the gravity stations were placed in a grid pattern at about 8-mile (13-km) intervals. The positions of the gravity stations were obtained from the Decca navigation system. Depth measurements were taken at each station with an echo sounder. The gravity measurements were obtained with a LaCoste and Romberg underwater gravimeter. This is essentially a remote-controlled land unit mounted in gimbals in a water-tight case, with the instrument reading panel installed in the ship's chart room. About 450 stations were occupied including several repeat stations during the course of the survey.

REDUCTION OF THE MEASUREMENTS

The underwater readings were reduced to give Bouguer anomalies for direct comparison with the gravitational features observed on the mainland. The observed gravity readings were extrapolated to sea level with the aid of the observed depths using the standard free-air vertical gradient of gravity and allowing for the attraction of the water above the instrument. The sea-level value of theoretical gravity, calculated from the International Gravity Formula for each station was then subtracted from the extrapolated observed gravity values. Corrections for the mass deficiency of water compared to rock were then applied to obtain the Bouguer anomalies.

Errors in the Bouguer anomalies for the underwater stations, due to errors in observed gravity, observed depth, navigation, the adopted vertical gradient of gravity - and neglecting marine tide variations - are estimated to be of the order of one milligal.



## THE BOUGUER ANOMALIES

The Bouguer anomalies over the map area have a range of about 100 mgals, varying from -70 mgals to +30 mgals. Consistent with isostasy, the anomalies show an inverse correlation with elevation. Areas of the negative anomaly (-30 to -50 mgals), north of the St. Lawrence River in Quebec and in western New Brunswick, are also areas of higher elevation. On the other hand over most of the lowland areas, and over the Gulf of St. Lawrence the anomalies (-30 to +30 mgals) tend to be more positive with a mean value that approaches zero.

Generally, it may be said, that the underwater measurements show that the crust underlying the Gulf is continental in character as several gravitational features observed on land have been traced considerable distances offshore. One of the most prominent features is the arcuate positive anomaly belt some 40 km wide, extending eastward from Gaspé towards Newfoundland. In the Gaspé peninsula the positive anomalies correlate (Tanner and Uffen, 1960) with basic and ultrabasic intrusive rocks of the Appalachian orogenic belt. The underwater measurements would tend to confirm that this belt is continuous between Gaspé and Newfoundland as has been suggested by King (1951) and others.

Another positive anomaly belt trending northeast across New Brunswick and Prince Edward Island has been interpreted by Miller (1946) and Garland (1950) as due to both uplift and density variations in the pre-Carboniferous basement. The underwater measurements show that this feature extends into the Gulf beyond Prince Edward Island and terminates abruptly about forty miles southwest of the Magdalen Islands. Positive anomalies are also associated with the Caledonian highlands of New Brunswick, the Cobequid and Antigonish highlands of Nova Scotia and the highlands of Cape Breton Island. These positive anomalies extend northwesterly from Cape Breton to the limit of the underwater survey. An apparent isolated positive anomaly lies to the south of Sept Îles in Quebec. This anomaly appears related to the basic intrusive complex (Faessler, 1942) outcropping on the mainland, and suggests that this complex underlies a considerable area of the St. Lawrence River.

The underwater survey reveals two areas of distinct negative anomaly. A small circular area centred about sixty miles east of the Bay of Chaleur is believed due to an underlying granitic intrusion, perhaps an extension of the Devonian granite masses which underlie central New Brunswick and are characterized by negative gravity anomalies. A much larger negative anomaly extends northeast from the eastern part of Prince Edward Island reaching minimum values some 20 to 30 miles east of the Magdalen Islands. While lower density of the basement rocks may contribute to this negative anomaly field, a thickening of the sedimentary column and evaporite deposits are believed to provide the major control.

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