A NOTE ON THE SIMPLE BOUGUER GRAVITY FIELD IN THE EASTERN STRAIT OF JUAN DE FUCA, WASHINGTON

by

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INTRODUCTION

Structural trends and major geologic units mapped in the vicinity of the San Juan Islands are not evident in the generalized gravity mappings available (Bonini et al., 1974; MacLeod et al., 1977). Addition of one hundred-five land gravity stations and six marine gravity tracklines to the existing data has resulted in a revised gravity mapping (Fig. 1) that is in better agreement with the major structural trends delineated by geologic mapping on land. The revision gives some evidence for structural features hidden beneath the straits adjacent to the San Juan Islands. It also defines areas where inadequate control emphasizes the need for additional data.

INSTRUMENTATION, OBSERVATION AND REDUCTION

Land measurements were made using Worden gravity meter W422 and LaCoste and Romberg gravity meter G426. The longest loop with the LaCoste and Romberg meter was twenty-seven hours. Reoccupation misties averaged 0.05 mgal. A single loop with the Worden meter of sixty-two hours yielded a reoccupation of +0.8 mgals. All the data were tied to standard stations at either Seattle (Seattle A ACICØ252) or Everett (Everett B), Washington.

Vertical control ashore was from USGS topographic sheets and from NGS vertical control data. Horizontal control onshore is from USGS topographic sheets. Stations were established only on bench marks or spot elevations.

Horizontal positioning for land stations on topographic sheets meets national map accuracy standards and is accurate to twelve meters. Vertical control on spot elevations ashore is, at worst, accurate to eight meters. The newer mappings give spot elevations to within 2-3 meters. Bench mark elevations are accurate to a small fraction of a meter.

The marine measurements were made in vessels of opportunity, using Askania sea gravity system Gss2, number 22, mounted on an Anschütz table. Horizontal control was entirely by visual piloting with fix intervals of five to fifteen minutes. Vertical control was taken from NOS and Canadian charts. Eötvös corrections were derived from computed velocities between fixes.

Accuracy of vertical control and horizontal control on the charts varies with the scale and with the bathymetric data base. In general, it does not meet national map accuracy standards. There is an order of magnitude difference in precision between the sea and land data; the sea data are precise to $\pm$ 5 milligals when both position uncertainty and gravity measurement precision are expressed together in gravity terms.

Reduction to a simple Bouguer anomaly utilized IGSN-71, with the 1967 reference ellipsoid and reduction densities 2.67 g/cm^3 and 1.03 g/cm^3.

DISCUSSION

While a bight in the gravity contours over Orcas Island has been shown earlier (Bonini et al., 1974), the relatively gentle curvature from a westerly trend north of Orcas Island to a northwesterly trend over the Gulf Islands did not parallel the structural trends (Fig. 2) now established by Whetten (Whetten et al., 1978). Two marine gravity lines from Haro Strait and Rosario Strait into northern waters and additional land stations document a pronounced curvature, in accord with the structural trend (Fig. 2).

Whetten suggests a westerly-trending fault across the northern end of Guemes Island and of Cypress Island that he does not extend into Rosario Strait (Fig. 2). Similarly, a northeasterly-trending fault across the southeastern tip of Orcas Island is not extended into the Strait west of Cypress Island. The marine gravity line in Rosario Strait shows a pronounced 20 milligal negative Bouguer gravity anomaly beneath the Strait between these two fault zones. Furthermore, land data from Carlson (Carlson, 1977) and the present survey show a steep gradient in the gravity field ashore to the east of the channel. The presence of the gravity low in the channel between the onshore mappings of the fault zones suggests that the zones may be continuous across the Strait.

Land stations established on Marrowstone Island and Indian Island and sea gravity data from Admiralty Inlet show a steepened northerly trending gradient over Marrowstone Island. The addition of the closed low across the channel west of Whidbey Island, based on three marine gravity lines, is accordant with a magnetic high reported elsewhere (MacLeod et al., 1977). The anomaly is on a topographic high. As schist with a density less than the reduction density crops out on Whidbey Island, to the north of the anomaly, it is possible that the anomaly results from local shallowing of the underlying schist.

The increased detail in the gravity field in the head of Admiralty Inlet brings the contouring into accord with a known northerly trending fault zone (Mark Holmes, pers. comm.). This northerly trend turns northwest in the low west of Whidbey Island and then into a westerly trending anomaly extending across the eastern end of the strait, possibly joining a plexus of faults mapped onshore on Vancouver Island as the Leech River fault, and others.

These examples show the utility of sea gravity data in defining the structural features in this region. The addition of a modest number of marine lines apparently has confirmed structures found ashore or from the air by other methods. However, the sea data are for the most part in a few isolated lines only. Replicate sea lines and increased coverage in inshore waters adjacent to the islands and in the southern Strait of Georgia should provide a basis for further upgrading of the gravity map. In turn, this should permit refined interpretations regarding important regional structures, especially if reliable rock density data can be obtained also.

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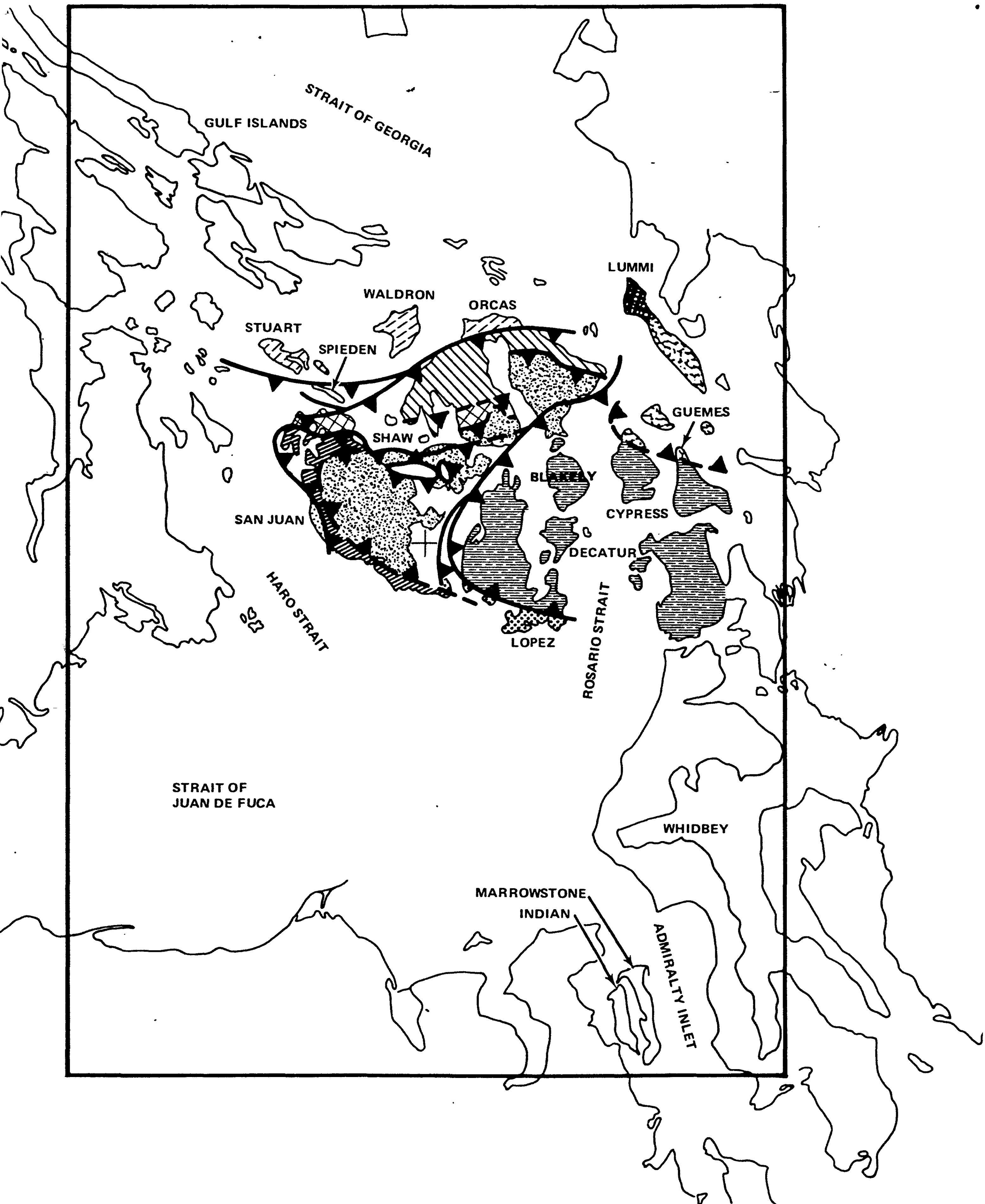
ILLUSTRATIONS


STRAIT OF GEORGIA
GULF ISLANDS
LUMMI
WALDRON
ORCAS
STUART
SPIEDEN
GUEMES
SHAW
BLAKELY
SAN JUAN
CYPRESS
DECATUR
HARO STRAIT
ROSARIO STRAIT
LOPEZ
STRAIT OF JUAN DE FUCA
WHIDBEY
MARROWSTONE
INDIAN
ADMIRALTY INLET

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