

PRELIMINARY STRUCTURAL MAP OF PART OF THE
OFFSHORE GULF OF ALASKA TERTIARY PROVINCE

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INTRODUCTION

The purpose of this report is to provide a brief preliminary structural interpretation of a portion of the offshore Gulf of Alaska Tertiary Province (GATP) between Icy Bay and Montague Island. This is an area of possible high petroleum potential; and parts of it are scheduled for leasing at an early date for petroleum exploration. Some of the data and interpretations presented herein were summarized in a paper presented orally at the 1975 Pacific Section meeting of the American Association of Petroleum Geologists (Bruns and Plafker, 1975).

The seismic data on which this summary is based are being made publicly available in Open File (von Huene and others, 1975).

GENERAL SETTING

The GATP is a compound continental margin basin made up almost entirely of terrigenous clastic rocks with minor coal that are intercalated with subordinate mafic volcanic and volcanoclastic rocks. The topography, basin architecture, structural style, and seismotectonic activity within the GATP, to a considerable extent, reflect the interactions that have occurred during late Cenozoic (post-Oligocene) time along the interface between the North American continent and the Pacific Ocean basin. As a consequence of these movements, the western part of the GATP adjacent to the Aleutian Trench and arc is essentially

a zone of compressive deformation along which the Pacific oceanic plate is underthrusting the continental margin, the easternmost part of the province is a zone of shear in which the oceanic plate is moving laterally past the continent along the Queen Charlotte transform and related strike-slip faults, and the central part of the province is a zone of combined compression and shear due to oblique underthrusting of the continental margin (Plafker, 1969). Both the availability of structural traps for petroleum accumulation and the geologic hazards in the GATP are a direct result of its unique setting in an arc-transform transition zone.

The sedimentary sequence in the GATP ranges in age from Paleocene through Pleistocene (Plafker, 1971). It is broadly divisible into (1) a thick lower unit of well-indurated, intensely deformed deep marine to continental rocks, mainly of Paleocene and Eocene age, and (2) an upper unit, largely of bedded marine sedimentary and volcanic rocks of Oligocene through Pleistocene age, that is notably less deformed and indurated. Most of the known indications of petroleum in the basin are in rocks of the younger sequence, which has a composite thickness on the order of 6,100-7,600 m. The early Tertiary sequence is too indurated and too intensely deformed to have more than modest potential for petroleum.

DATA INTERPRETATION

During September and October, 1974, the U. S. Geological Survey collected 6575 km of marine geophysical data in this area. These data consisted of gravity, magnetic, single channel seismic reflection

profiles, and five reversed seismic refraction profiles. Interpretation of offshore structure is derived mainly from the unprocessed analog single channel air gun seismic records with line spacings of between 9 and 15 km., and acoustic penetration of generally less than 2 seconds (two way time). Interpretation is complicated by the relatively shallow penetration achieved and by the presence of persistent water bottom multiples, especially in areas of shallow dip.

Preliminary interpretation of the data indicates that the offshore GATP is structurally complex and consists of several areas with markedly differing structural styles. Complexity in the near surface section appears to increase from east to west. The accompanying map shows offshore structural contours and trends in the near surface based on a highly interpretative study of the available data. For comparison, major onshore structural trends also are depicted, and have been evaluated previously by Plafker (1971). Offshore contours are in unmigrated, two way travel time (seconds); no attempt has been made to convert to depth due to lack of adequate velocity control. Mapping of the horizons is based on dip projections, record characteristics, and the assumption that geologic horizons are relatively conformable within the near surface, thereby allowing projection of mapped horizons based on the dip of overlying events. This assumption appears valid based on the available data. The structural contouring represents primarily the shallow structure, probably within the upper part of the Yakataga Formation of late Miocene and younger age (Plafker, 1971). Although the configuration of the deeper

basins as shown must be considered to be speculative, the relatively shallow structural highs are probably more accurately shown. It is not possible to determine from the data the presence or absence of deeper structural complexities. By analogy with the adjacent onshore geology, the deeper offshore structure may be considerably more complex than the indicated near surface structure.

Structural contours in the area between Kayak Island and Icy Bay are shown on two different horizons. The westernmost horizon is structurally the deeper of the two by from $3/4$ to 1 second. Here the section appears to thicken towards the shelf edge, particularly in the area where the change in horizons occurs. Total section penetrated is a maximum in the area around Icy Bay and thins to the west, based on the truncation at the ocean bottom of recognizable events on the seismic records. No estimate of total thickness of section in the basin is possible from the reflection data because of the shallow penetration. However, relatively low velocities encountered in the sedimentary column on the five seismic refraction lines that were acquired during 1974 suggest a clastic section, predominantly sandstone and shale, as much as 12 km thick in the eastern part of the area south of Icy Bay and at least 9 km thick southeast of Kayak Island (Ken Bayer, personal communication).

Structural contours in the area between Kayak Island and Montague Island are shown on three different horizons. Due to the structural complexity and lack of data in critical places, no adequate determination can be made of the relationship between these horizons. It appears that the contoured horizon between Kayak Island and Middleton Island is

structurally deeper than the contoured area landward of it; no comparison is possible for the area southwest of Middleton Island due to the complexity of the Middleton Island Platform. Contouring is more speculative in this area than that between Icy Bay and Kayak Island. Shoreward of the contoured areas, and in the area immediately west of Kayak Island, acoustic basement appears to be high, and the structure is not well defined with the available marine data. No contouring was possible due to this lack of definition.

OFFSHORE STRUCTURAL FEATURES

Between Icy Bay and Kayak Island the shelf is underlain by two types of structures. The first type is a series of asymmetric linear folds that trend obliquely across the shelf, roughly between northeast-southwest and east-west. These structures are apparently more open and less complex than those on the adjacent land areas. Some of the offshore anticlines are bounded on the southeast by north - dipping thrust faults along which there may have been substantial displacement. The second type of structure is a large shelf-edge arch east of Kayak Island trending sub-parallel to the coast and with very gentle surface dip. Between this arch and the coast is a broad downwarp as much as 48 km. wide within which there are some upwarped areas. A possibly similar arch occurs southwest of Icy Bay at the shelf edge although more data is required to define the nature of the structure in this area. Between Pamplona Ridge and the shelf edge high to the west, no structure is revealed on the profiles, although weak indications of deeper structural complexity are seen on one line extending off the edge of the shelf into deep water.

The shelf between Kayak and Middleton Island includes a broad zone of complex structures trending between east-west and northeast-southwest, subparallel to major on-land structures and to the eastern Aleutian Trench. Structural highs tend to be asymmetric and bounded by thrust faults on their south or southeast limbs. Uplift, deformation and faulting are greater than on the Icy Bay structural features, and the crests of many of the highs appear to have undergone extensive erosional truncation apparently exposing complexly deformed Tertiary rocks at or near the seafloor. Northwest of Middleton Island are two large northwest-southeast trending high areas separated by a deep basin. These complex structures, which are divergent from the Icy Bay and Kayak-Middleton trends, show severe deformation and probable faulting on the flanks of the highs, and no structure is resolvable within the cores. Middleton Island lies on the northwest flank of a large northeast-trending structural high and appears to be separated from the northwest trending structures by a relatively deep basin. Although most of the highs between Kayak and Montague Islands are shown as closed anticlines, lack of definition in the profiles does not preclude these highs being primarily the result of block faulting. If so, the presence of closure as shown may not be entirely accurate.

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