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3D seismic analysis of the Coast Shear Zone in SE Alaska and Western British Columbia: Broadside analysis of ACCRETE wide-angle data

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Abstract

The multidisciplinary ACCRETE project addresses the question of continental assemblage in southeast Alaska and western British Columbia by terrane accretion and magmatic addition. The previous studies of this project yielded important information for understanding the structures across the Coast Shear Zone (CSZ) and the formation of the CSZ and the Coast Mountains Batholith (CMB). The present study extends these interpretations into pseudo-3-D by using two additional wide-angle ACCRETE seismic lines. By analyzing the broadside wide-angle data using a series of laterally homogeneous 2-D models, we derive a lower-resolution 3-D velocity model of the outboard terranes and constrain variations in crustal thickness across and along the CSZ. Models of the broadside data confirms major structural and compositional trends extend along strike to the northwest. The key features are: a) a steep Moho ramp only ∼15-km wide is coincident with the CSZ and divides thin (∼25±1 km) crust to the west below the west-vergent thrust belt (WTB) from thicker (∼31±1 km) crust to the east below the CMB, (b) low-velocity mantle (7.7–7.9 km/s) extends beneath the entire study region indicating high crustal and upper-mantle temperatures below the WTB and CMB, and (c) the Alexander terrane is characterized by strong mid-crustal reflectivity and high lower crustal velocities that are consistent with gabbroic composition. This study extends the earlier interpretation and implies that the ramp is indeed likely associated with transpressional tectonics and magmatic crustal addition east of the CSZ.
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1. Introduction

The accreted terranes and the continental arc in southeastern Alaska and western British Columbia represent one of the best areas to study the processes of continental crustal growth. During the Mesozoic and early Cenozoic, large-scale magmatism and terrane accretion took place as a result of oblique convergence between the Farallon and Kula plates and the North America plate (Chardon et al., 1999). This process led to the formation of one of the largest and most continuous magmatic arcs in the world, extending ∼2000 km from the Southeastern Alaska and the Yukon to Northwestern British Columbia (Fig. 1). This Paleogene arc complex is referred to as Coast Plutonic Complex or Coast Mountain Batholith (CMB; the name used in this paper). This arc was formed by a combination of west-to-east stacking of the Insular (outboard) terranes to the Intermontane (inboard) terranes and accompanying magmatism (Crawford et al., 2000).

One of the outstanding tectonic problems of this area is the nature of the boundary between the Insular terranes consisting of the Alexander and Wrangellia terranes and the western margin of late Mesozoic North America, i.e., the Intermontane terranes (Rubin and Saleeby, 1992). Despite the advances in geological and geophysical studies, a controversy still remains about the nature of the accretion and the significance of the post-accretionary processes. Two unresolved questions are: locating the original accretionary front and determining the role

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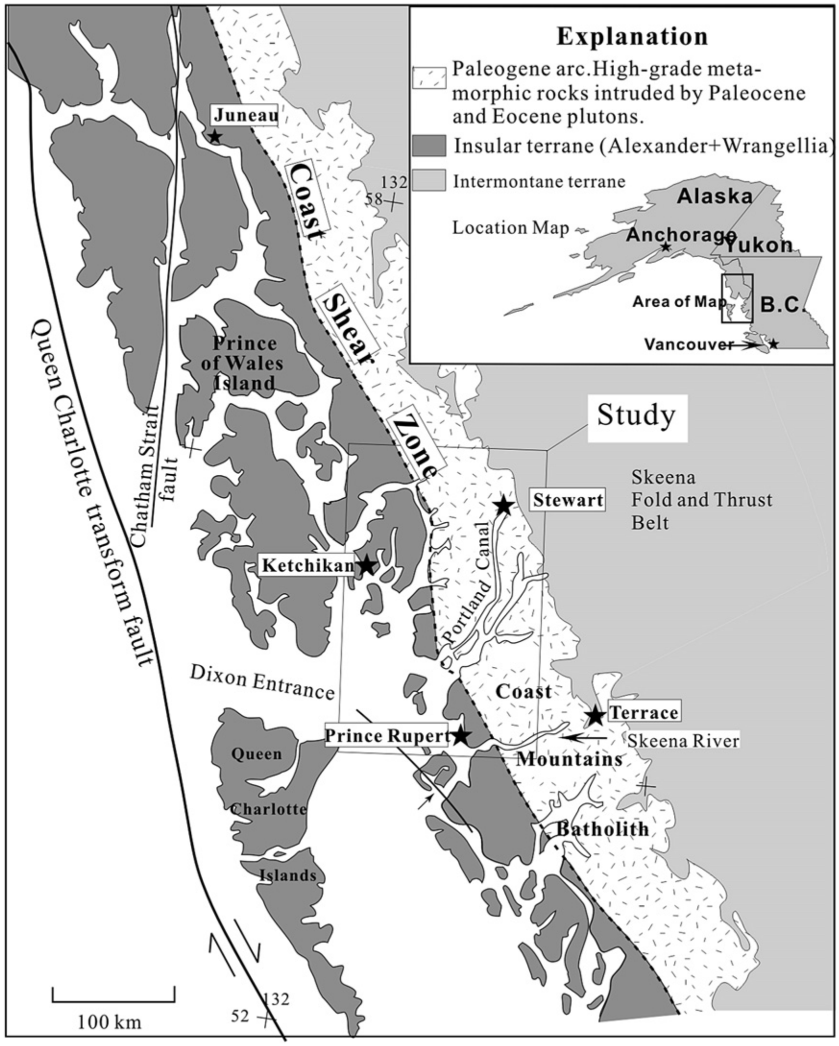

Fig. 1. Simplified terrane and assemblage map of southeastern Alaska and northwestern British Columbia (Morozov et al., 1998). The rectangle is the study area of ACCRETE project.

over time of the crustal-scale Coast Shear Zone (CSZ). From the previous seismic studies (Morozov et al., 1998, 2001, 2003), the CSZ marks the western boundary of the CMB and may truncate the thrust belt to the west. Based on the patterns of wide-angle seismic reflectivity, the CSZ was interpreted as subvertical through the crust separating terranes with different crustal thicknesses. The lower-crustal sections of these terranes exhibit strongly contrasting *S*-wave velocities suggesting a fundamental difference in their origins (Morozov et al., 2001, 2003).

Because of its cost, 3-D seismic reflection coverage of crustal structure is practically non-existent; yet, such coverage is extremely important to understand the behavior of structures in the third dimension. We take advantage of the flexibility of marine-land seismic recording suing marine-air guns from numerous ship tracks to obtain partial 3-D, wide-angle reflection coverage over the CSZ and are thus able to present a new, 3-D interpretation of the CSZ.

The interdisciplinary geological and geophysical project, ACCRETE, targeted the continental assemblage (Fig. 1) in the southeast Alaska and western British Columbia. The associated seismic study focused on the deep crustal structure, and particularly on elucidation of the crustal thickness across the CSZ (Fig. 1). The *P*-wave velocities beneath the CMB were interpreted in terms of its thermal and deformational processes, which might be manifested by the seismic velocity and reflection structure in the crust. In a broader framework, this study was incorporated with the overlapping Lithoprobe SNORCLE profiles that provided upper mantle velocity data and coverage across the eastern boundary of the CMB (Hammer et al., 2000).

In the previous analysis of ACCRETE data, 2-D wide-angle crustal *P*- and *S*-wave velocity models were derived for the main corridor following the Portland Canal fjord across the CSZ and CMB (Morozov et al., 1998, 2001), and the results were correlated with laboratory measurements using rock samples from the same area (Morozov et al., 2003). Marine-land acquisition in a fjord provided strong *P*–*S* wave conversion at the bottom of the fjord and resulted in well-constrained *P*- and *S*-wave velocity structures along the transect. The key findings of these studies leading to the present work were:

1) When corrected for high temperatures and erosion due to exhumation, the seismic properties under the CMB correspond

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