Focusing of Pliocene and Younger Deformation in the Cook Inlet Basin, Alaska, Caused by Mantle Dynamics Related to Subduction and Collision of the Yakutat Microplate

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The Cook Inlet basin is a forearc basin above the southern Alaska subduction zone, and has been for roughly 200 million years. We present a new compilation of faults and folds in the Cook Inlet basin, which shows that young deformation is focused in the northern part of the basin. Data sources are previously published maps, well locations, published and proprietary seismic reflection and aeromagnetic data. Some structures are remarkably well displayed on frequency-filtered aeromagnetic maps, which are a useful tool for constraining the length of some structures. Most anticlines in the basin have at least shows of oil or gas, and some are considered to be seismically active. The new map better displays the pattern of faulting and folding. Shortening in Pliocene to recent time is greatest in upper Cook Inlet, where structures are oriented slightly counterclockwise of the major basin bounding faults. Also, the north end of these structures bend to the northeast, which gives a pattern consistent with right-transpressional deformation.

Subduction and collision of the buoyant Yakutat microplate likely caused deformation to be preferentially focussed in upper Cook Inlet due to both crustal shortening and mantle dynamics. The upper Cook Inlet region has both the highest degree of shortening and the deepest part of the Neogene basin. This forearc region has a long wavelength magnetic high, a large isostatic gravity low, high conductivity in the lower mantle, and low p-wave velocity (Vp) and high p-wave to shear-wave velocity ratio (Vp/Vs). These data indicate fluids in the mantle wedge caused serpentinization of mafic rocks, which may, at least in part, contribute to the long-wavelength magnetic anomaly. This area lies adjacent to the subducting and buoyant Yakutat microplate slab. We suggest the buoyant Yakutat slab acts as a squeegee to focus mantle wedge fluid flow at the margins of the buoyant slab. Such lateral flow is consistent with observed shear-wave splitting directions and a recent numerical model. The additional fluid in the adjacent hydrated mantle wedge then reduces its viscosity and allows greater corner flow. This results in focussed subsidence, deformation, and gravity anomalies in the forearc region.