Oroclinal bending in the Cascadia subduction zone forearc and its relation to concave plate margin geometry

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Many convergent margins worldwide are concave in map pattern towards the overriding plate, but some (e.g., Cascadia, Bolivia) exhibit concavity towards the lower plate. In Cascadia, this geometry persists throughout the forearc, and backarc-foreland, and likely results from a persistent tectonic process affecting the long-term evolution of the margin. We examine the concave-outboard Cascadia margin and find that several datasets are consistent with continuous oroclinal bending of the forearc. Paleomagnetic declinations, structural measurements, and volcanic arc migration rates indicate that oroclinal bending began in the forearc in the Eocene to Miocene. Crustal rotations derived from both paleomagnetic declinations and GNSS (Global Navigation Satellite System) measurements share a NE-SW axial trace across the Olympic Peninsula, suggesting that oroclinal bending continues in the present day. Crustal fault kinematics and stress inversions from crustal earthquakes are consistent with tectonic models of oroclinal bending, where compression in the core of the orocline and extension on the periphery result in opposing strike-slip kinematics in each limb. Compression in the core of the orocline may also have a physiographic manifestation in the form of the Olympic Mountains, a prominent topographic feature in the forearc. Both the shape of the locked portion of the plate interface and the obliquity of convergence may have causative roles in orocline formation. The coincidence of the widest part of the locked-zone with the maximum interseismic forearc velocity and the axial trace of the orocline leads us to suggest that some inelastic strain in the Cascadia forearc occurs in direct response to locking on the subduction

megathrust; thus the shape of the subduction megathrust has long-term effects on the shape of the upper plate. Alternatively, orocline formation may be a product of margin parallel translation of the upper plate arc and forearc, and the shape of the subduction zone a response to, rather than a cause of, oroclinal bending.