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Analysis of Faulting and Sediment Velocity Characteristics Outboard of the Cascadia Deformation Front from Multi-Channel Seismic Data.

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Abstract:
Faulting of the sediment section on the downgoing Juan de Fuca Plate (JdF) outboard of the Cascadia deformation front is explored using multi-channel seismic (MCS) data collected in 2012 during the JdF Ridge to Trench Survey (MGL1211). MCS data were collected along two full plate transects ("Oregon" (ORT) and "Washington" (WAT)) and one trench parallel line. Sediment velocity analysis is conducted via semblance spectrums on common mid-point super gathers spaced at a 625 m interval. Higher sediment velocities are found in the north, which may reflect the regional differences in sediment composition evident in existing drill holes located along our transects (DSDP site 174 - ORT and ODP site 1027 - WAT) that indicate higher smectite content along the ORT (bulk composition +44%). Accordingly, observations of fault frequency, dip, and throw along both transects show significant differences in faulting characteristics across the JdF plate. Faulting extends ~175 km (8.2 – 1.9 Ma plate age) from the deformation front along the WAT, and reaches a maximum fault density of ~0.48 fault/km in the region between 25 - 113 km (7.5 – 4 Ma plate age). Evidence of faulting extends ~300 km (8.9 – 2.6 Ma plate age) from the deformation front along the ORT and reaches a similar high fault density of ~0.48 fault/km in the region between 113 - 138 km (7.07 – 5.96 Ma plate age). Analysis of fault offset indicates growth faults along both transects. Along the ORT, maximum fault throws remain ~uniform at 10 - 15 m for crustal ages of 7.07 – 5.96 Ma and beginning ~75 km from the deformation front increase landward to maximum throws of 30 m, consistent with increasing fault strain due to flexural bending of the downgoing plate. In contrast, along the WAT, there is no evidence of increasing fault throw toward the deformation front. High fault dips (45 - 70°) are found in the region of highest fault density on both transects. Lower dips (35 - 60°) are measured in the region of increasing fault strain near the deformation front along the ORT. Overall, fault characteristics indicate greater subduction-bend related faulting along the ORT. Additionally, complex intra-plate stresses and/or differential compaction may contribute to the abundant faulting found within the plate interior to young crustal ages along both transects.

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