Large Erosional Features on the Cascadia Accretionary Wedge Imaged with New High-Resolution Multibeam Bathymetry and Seismic Datasets

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Abstract

Utilizing new high resolution multibeam bathymetric data along with chirp sub-bottom and multichannel seismic reflection (MCS) data, we identified remarkable erosional features on the toe of the Cascadia accretionary wedge near Willapa Canyon, offshore Washington, USA. Bathymetric data was compiled from the Cascadia Open-Access Seismic Transects (COAST) cruise and from the site survey cruise for the Cascadia Initiative. These features loosely resemble slope failures of the frontal thrust, but can be distinguished from such failures by several key features: They incise the crest of the frontal thrust and encompass the landward limb; They have floors below the level of the abyssal plain, similar to plunge pool morphology; They show no evidence of landslide blocks at the base of the slope indicative of block sliding. The features where likely formed during the latest Pleistocene based on post event deposition, cross-cutting relationships with Juan de Fuca Channel and the Willapa Channel levees and wave field, and post event slip on the frontal thrust of the Cascadia accretionary prism. The Holocene levees of both Willapa Channel and Juan de Fuca Channel overlap these older features, and clearly place an upper bound on the age of the erosional features in the latest Pleistocene. A lower bound is estimated from a sub-bottom profile that images

~30 meters of post scour sediment fill. Using existing literature of Holocene and Pleistocene sedimentation rates we estimate a lower age bound between ~23,000 - 56,000 y.b.p. We also map a fault scarp within the erosional feature, with ~60 m of vertical offset. Using multi-channel seismic reflection profiles from the COAST cruise we interpret this scarp as the surface expression of the landward vergent frontal thrust fault. The apparent short duration of the erosional event along the seaward margin of the accretionary wedge, coupled with the presence of the fresh fault scarp within the erosion zone, are indicative of a dormant feature with significant time required to develop the scarp after cessation of the causative process. Based on morphology, dissimilarity with other submarine features, and available age constraints, we infer that these features were most likely formed during the glacial lake outpouring in the Pacific Northwest known as the Missoula floods which occurred 13,000-19,500 y.b.p. The features themselves bear a strong resemblance to “coulees” formed during the same glacial events onshore, and the outpourings through Willapa Channel are consistent with previous inferences of the deposition of Missoula Flood deposits in Escanaba Trough. If this timing is correct, the slip rate along the Cascadia frontal thrust can be estimated using fault geometry and scarp height as 2.8 - 4.1 mm/yr.

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