Notice of the Final Oral Examination
for the Degree of Master of Science

of

AUDREY GRAHAM

BScH (University of Victoria, 2013)

“Geometry, Kinematics, and Quaternary Activity of the Leech River Fault Zone, Southern Vancouver Island, British Columbia, Canada”

School of Earth and Ocean Sciences

Friday, December 1, 2017
9:00 A.M.
Bob Wright Centre
Room A319

Supervisory Committee:
Dr. Kristin Morell, School of Earth and Ocean Sciences, University of Victoria (Co-Supervisor)
Dr. Victor Levson, School of Earth and Ocean Sciences, UVic (Co-Supervisor)
Dr. Lucinda Leonard, School of Earth and Ocean Sciences, UVic (Member)

External Examiner:
Dr. John Clague, Earth Sciences, Simon Fraser University

Chair of Oral Examination:
Dr. Adam Ritz, Department of Physics and Astronomy, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

Southern Vancouver Island lies on the forearc of the Cascadia subduction zone, north of a concave bend in the plate boundary centred around the Olympic Mountains. The bend in the margin coincides with a significant decrease in northward-directed trench-parallel forearc migration, and a network of active crustal faults in the Puget Lowland east of the Olympic Mountains accommodates permanent north-south shortening and transpression. The nature of forearc deformation on southern Vancouver Island is less well constrained, due in part to the unknown extent and kinematics of active crustal faulting. Recent work has shown that a brittle fault zone associated with the Eocene terrane-bounding Leech River fault has produced at least two surface-rupturing earthquakes in the late Quaternary.

We use LiDAR-derived topographic data, slip-sense indicator analysis of slickenlines on fault planes, electrical resistivity tomography (ERT), and ground-penetrating radar (GPR) to investigate the geometry, kinematics, and Quaternary activity along the eastern half of the active, brittle Leech River fault zone. Our mapping reveals a complex, near-vertical zone up to 3 km wide and 25 km long that exhibits many characteristics of a strike-slip fault. Displaced Quaternary deposits are observed directly on the western 8 km of the study area, and inferred through geophysical imagery, topographic data, and liquefaction features to extend to the eastern terrestrial extent of the fault zone towards previously mapped active faults in the Juan de Fuca Strait and the Darrington-Devil’s Mountain fault zone in western Washington. We use fault kinematics and geometry to show that the eastern Leech River fault zone has been reactivated as a right-lateral strike-slip fault that accommodates forearc deformation within the modern stress field north of the Olympic Mountains.