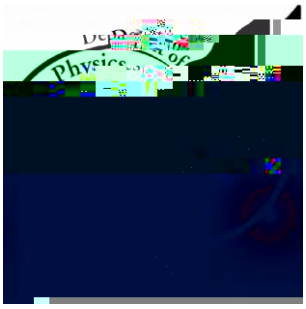

PHYSICS AND ASTRONOMY
COLLOQUIUM

Dr. Pascal Audet

University of Ottawa, Department of Earth Sciences

Structural Controls on Subduction Zone Slow Earthquakes

Abstract

Recent discoveries of slow slip events that recur at intervals of <6 to >24 months (also called episodic tremor and slip, or ETS) on the subduction zone thrust fault have elucidated a down-dip transition in slip behavior from frictionally-controlled slip to continuous plastic creep. In this presentation I review seismic evidence for the role of fluids on the seismogenic behaviour of slow earthquakes. In the slow slip region there is evidence for subducting low seismic wave-speed channel with extremely high P-to-S velocity ratio (Vp/Vs) interpreted to manifest elevated pore-fluid pressures generated through the release of water from pro-grade metamorphic dehydration reactions within the subducting oceanic crust. Elevated pore-fluid pressures weaken the fault and allow slip to occur at low differential stress. Accordingly, the plate interface likely represents a low-permeability boundary that controls vertical migration of fluids into the overlying crust. Direct evidence of factors controlling the variability in recurrence times is more elusive. We compile seismic data from subduction zone forearcs exhibiting recurring slow earthquakes and show that the average Vp/Vs of the overlying forearc crust ranges between 1.6 to 2.0 and is linearly related with the average recurrence time of slow earthquakes. In northern Cascadia, forearc Vp/Vs values decrease with increasing depth of the plate interface and with decreasing tremor-episode recurrence intervals. Low Vp/Vs values require significant addition of quartz in a dominantly mafic forearc environment. We propose that variable silica enrichment by 5-15% from slab-derived fluids and upward mineralization in quartz veins can explain the range of observed Vp/Vs values as well as the downdip decrease in Vp/Vs. The solubility of silica depends on temperature, and deposition prevails near the base of the forearc crust. We further propose that the strong temperature dependence of healing and permeability reduction in silica-rich fault gouge controls overpressure development and low effective fault-normal stress, and therefore recurrenactors 4661 0 0 1 462.22 19 Tinc ETBT

development play an important role in controlling slow earthquake behavior.