SINT-2: Sismotectónica, el ciclo de terremotos y paleosismología a lo largo del margen chileno

Deep megathrust earthquakes and their relation to the seismic cycle in Chile

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The concept of the cycle of subduction earthquakes describes the main phases of accumulation, release and relaxation of tectonic stresses in the years to decades between and after great events. While there is a number of geodetic observations that suggest spatial relations between interseismic and coseismic deformation patterns evidencing heterogeneous frictional fault properties, little is known about the mechanical control on the timing and size of great earthquakes. The 25 December 2016 southern Chile earthquake (Mw=7.6) is the first large event within the rupture zone of the 1960 earthquake (Mw=9.5), and therefore exploring the mechanical relationship between both events can provide new insights into the frictional conditions controlling the progressive accumulation and release of stress within the seismic cycle. The 2016 earthquake resembles previous Chilean megathrust events (i.e., 1985 Central Chile, 1995 Antofagasta, 2007 Tocopilla) in that most slip occurred in the deeper section of the seismogenic zone. By combining geodetic and seismological data with numerical modeling, we show that the 2016 event ruptured the downdip limit of a previously well-detected locked asperity, which also slipped during the 1960 event. We propose that the deeper segments of the seismogenic subduction megathrust fault are interseismically squeezed (i.e. strained and stressed) because of the transition between two regions of contrasting frictional behavior. Shear stress is concentrated within the deeper seismogenic region, which is weaker and fails with lower stress build-up than the shallower part, producing recurrent moderate-size seismic events before the shallower region fails in a major tsunamigenic earthquake. Deeper 2016-class earthquakes may be considered as a first phase of energy release that precedes failure of the shallower region during great earthquakes. We further investigate the relation of plate coupling with historical and instrumental deep earthquakes, and background seismicity at different segments of the Chilean margin, aiming to describe the current stage of stress build-up within the seismic cycle. These results strengthen our understanding of the frictional control on the timing of great megathrust earthquakes and contribute to better describe the current seismic hazard in Chile. This study has been supported by *Iniciativa Científica Milenio* (ICM) through grant NC160025 'Millennium Nucleus CYCLO: The Seismic Cycle along Subduction Zones'.