Thermal regime and slab dehydration in the subducted Juan de Fuca plate beneath the Cascadia subduction zone based on 3D numerical simulation

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Giant earthquakes are considered to have occurred historically and may take place in a near future in the Cascadia subduction zone. In contrast to the cold and thick Pacific (PAC) plate subducted beneath the northeast Japan characterized by numerous interplate earthquakes and comparatively fewer slow earthquakes, the warm and hot Juan de Fuca (JF) plate subducted beneath the North American plate witnesses much more episodic occurrences of tectonic tremors and slow slip events, accompanying less regular earthquakes. This has enabled us to compare and understand the different generation mechanisms between regular and slow earthquakes. Possible candidates to interpret such differences may attribute to slab brittle failure largely determined by different slab thermal regime, while pore fluid pressure variation in the fractures greatly affected by slab metamorphism. We constructed a 3D time-dependent thermal convection model with a size of 1150×700×400 km along the Cascadia Trench, initiating subduction in the northeast direction with calculation time up to 15 Myr. The geometry of the JF plate has been prescribed, being based on the extrapolated data of Slab1.0. Results show a distinct 3D slab dehydration belt and temperature transition zone along the clustered hypocenters of episodic tremors immediately beneath Vancouver Island in the northern part and almost 100 km east of coast of Washington and Oregon in the southern part with temperatures of 500-700℃. Water content in MORB decreased from 2 wt% to 0 wt%. Interestingly, megathrust earthquakes occurred mostly near the triple plate junctions, such as the JF-NA-Explorer and PAC-NA-Gorda plate junctions, and beneath Washington where slab convex portion exists. Regular earthquakes are fewer observed beneath Oregon. The interplate temperatures of the JF plate are averagely 200-400℃ higher than those of the PAC plate beneath Japan at the same depth range (<100 km) with less amount of calculated slab dehydration ratio.

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