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Describing earthquakes potential through mountain building processes: an example within Nepal Himalaya

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How to reconcile earthquake activities, for instance, the distributions of large-great event rupture areas and the partitioning of seismic-aseismic slips on the subduction interface, into geological mountain building period is critical in seismotectonics. In this paper, we try to scope this issue within a typical and special continental collisional mountain wedge within Himalayas across the 2015 M_w7.8 Nepal Himalaya earth- quake area. Based on the Critical Coulomb Wedge (CCW) theory, we show the possible predictions of large-great earthquake rupture locations by retrieving refined evolutionary sequences with clear boundary of coulomb wedge and creeping path inferred from interseismic deformation pattern along the megathrust-Main Himalaya Thrust (MHT). Due to the well-known thrusting architecture with constraints on the distribution of main exhumation zone and of the key evolutionary nodes, reasonable and refined (with 500 yr interval) thrusting sequences are retrieved by applying sequential limit analysis (SLA). We also use an illustration method-'G' gram to localize the relative positions of each fault within the tectonic wedge. Our model results show that at the early stage, during the initial wedge accumulation period, because of the small size of mountain wedge, there's no large earthquakes happens in this period. Whereas, in the following stage, the wedge is growing outward with occasionally out-of-sequence thrusting, four thrusting clusters (thrusting 'families') are clarified on the basis of the spatio-temporal distributions in the mountain wedge. Thrust family 4, located in the hinterland of the mountain wedge, absorbed the least amount of the total convergence, with no large earthquakes occurrence in this stage, contributing to the emplacement of the Greater Himalayan Complex. The slips absorbed by the remnant three thrust families result in large-great earthquakes rupturing in the Sub-Himalaya, Lesser Himalaya, and the front of Higher Himalaya. The portion rupturing in Sub-Himalaya is mainly great Himalaya earthquakes ($M>8$), with enough energy to rupture the whole MHT, while the thrusting family 2 and 3 will cause mainly large earthquakes. The averaged lifespan of single segment (inclined short lines) is growing from the deformation front to the hinterland, while the occurrence frequency is just in the opposite way. Thrusting slips in family 1-3 will enhance the coulomb wedge development resulting in mountain building. Note that, all the large earthquake behaviors described in this paper is a statistical characteristic, just the tendency distribution on the MHT in one interval. Although our research domain is a section of the Nepal Himalaya, the treatment proposed in this paper has universality in continental collisional orogenic belt which having the same interseismic pattern. We also summary the differences of seismogenic zones in oceanic subduction zone (Cascadia subduction zone) and arc-continental subduction zone (Taiwan area). The different types of interseismic pattern(mechanical patterns) are the controlling factors controlling seismic potential on megathrust and thus impacting the mountain building history.