The Tibetan Plateau: From Ocean Floor to Roof of the World

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India started to collide with Asia about ~55 million years ago. Following the initial stage of the collision between these two pieces of continental crust, the Tibetan Plateau has been continuously growing, up-lifting successive 300- to 500-kilometer-wide crustal wedges to an average elevation of about 5000m. Today, this collision has given birth to one unique geomorphic feature, the Tibetan Plateau. How such a major tectonic feature has been growing and is currently accommodating deformation is still a major field of research in Earth Sciences, with different competing models. Here, we focus more specifically on how deformation is accommodated both at the front of the Tibetan Plateau by major thrust faults and along major crustal strike-slip faults on the plateau. GPS measurements over a decade show that about 2 cm/yr of the total 4 cm/yr of shortening between India and Asia are accommodated at the front of the Himalayan Range. This shortening at the front translates into large earthquakes and deformation of the landscape at different time scales. A recent analogue of such frontal deformation is the magnitude Mw7.8 Sichuan earthquake, in China.

The Tibetan Plateau is also the place for major crustal strike-slip faults. Several of these faults are more than 1000 kilometers in length. Although these faults are not accommodating any significant vertical motion, they are key to the finite deformation of the plateau as they allow for horizontal extrusion of the up-lifted Tibetan Plateau Eastwards. Slip-rates along these faults have been difficult to measure due to remoteness and harsh conditions on the plateau. New techniques, mixing the use of high-resolution satellite images, field measurements and dating of samples by cosmogenic isotopes have been developed to determine slip-rates at the scale of a few thousands of years. Several sites where geomorphologic features offset by strike-slip faults, such as glacier deposits or alluvial fans, have been targeted that yield horizontal slip-rate ranging between 1 cm/yr and 2 cm/yr depending on faults. Long term deformation is accommodated through catastrophic events, namely major earthquakes. Such a major earthquake of magnitude Mw7.8 occurred along the Kunlun fault in 2001. The total length of the rupture is 430 km with an average horizontal slip of 5m, peaking to 10m in some places. This earthquake stands among the largest continental events ever recorded since beginning of the instrumental seismology. Therefore special efforts have been carried out to better understand this event and all the details of the seismic rupture, from surficial deformation to seismic wave radiation at super-shear speed. Finally, work are currently underway to try to link present seismic activity, and associated deformation, to the past history of earthquakes along the same fault, in order to better understand the seismic cycle, a crucial concept if one wants to deal with seismic hazard.