Present-Day Vertical Motion of the Tibetan Plateau and Surrounding Area

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The Tibetan Plateau is by far the largest area of high topography on the planet, and it deforms actively today. Is it growing taller due to ongoing contraction as India continues to collide with Eurasia? Is it collapsing due to extension driven by its excess gravitational potential energy? Is it in a rough state of balance, no longer growing higher, but simply changing shape? Or are different parts of the Plateau evolving in different ways? GPS measurements from the Tibetan Plateau and its surroundings are dense enough and precise enough to make meaningful measurements of vertical motions in Tibet and the rest of the India-Eurasia collision zone, but this data resource has not yet been exploited. We are estimating the vertical motions of hundreds of geodetic sites in the Tibetan Plateau and its surroundings in order to map out the pattern of vertical motions, and construct models to explain the uplift rates and their variation.

Chen and others (2004) showed that if tectonic blocks are defined based on the known major strike-slip faults, there is nearly as much deformation within the blocks as on their boundaries. However, the net areal dilatation in the region studied by Chen and others (2004) is small, because NNE-SSW shortening is nearly balanced by ENE-WSW extension. Later studies have shown similar results based on the horizontal GPS velocities. Vertical motions were ignored in these studies, but careful reprocessing of all the data using the latest GPS analysis methods, models, orbits, and reference frame makes it possible to characterize vertical motions as well as horizontal.

Figure 1 shows a preliminary map of vertical motions, based on a reprocessed version of the Chen and others (2004) data set. The general trend is toward uplift, although the sites with the smallest uncertainties tend to have uplift rates <4 mm/yr except within the Himalaya. We are now reprocessing the data set again taking advantage of a number of significant model improvement and bug fixes, including using a newly-reprocessed and homogeneous series of GPS orbits, improved GPS antenna calibration models, improved ocean tidal loading models, improved atmospheric models, and a more accurate reference frame model. Initial tests show that the scatter of vertical position estimates over a few days has been reduced by nearly a factor of 2 over previous solutions. We will use this improved vertical velocity field to evaluate tectonic and non-tectonic (i.e., changes in surface loads) causes of vertical motion, and then expand the data set to include all of the more recent data now available in China.

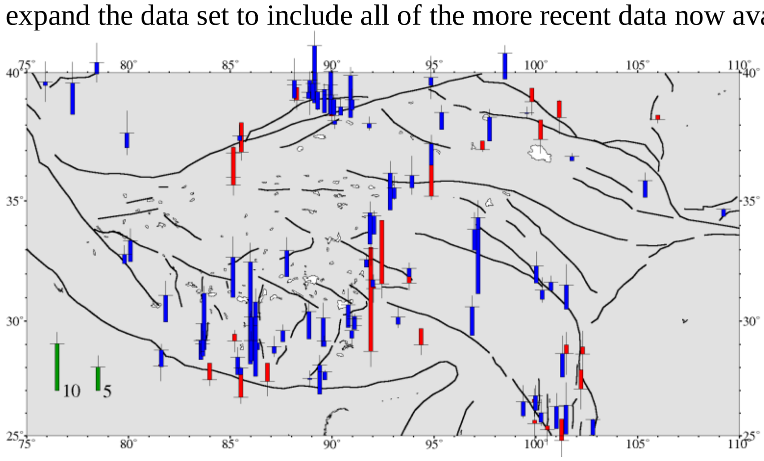

Figure 1. Preliminary estimated vertical velocities for Tibet and the surrounding area. Blue (dark) bars indicate uplift, whereas red (light) bars indicate subsidence, and a horizontal line is drawn at the end of each velocity vector. Error bars are 2σ. The general trend is toward uplift, although the sites with the smallest uncertainties tend to have uplift rates <4 mm/yr except within the Himalaya. Sites displaying large subsidence rates may reflect subsidence if groundwater is being pumped.

Reference

Chen, Q., and others, 2004, A deforming block model for the present-day tectonics of Tibet, J. Geophys. Res., 109, B01403, doi:10.1029/2002JB002151.

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