Geological Observations on History and Future of Large Earthquakes along the Himalayan Frontal Fault Relative to the April 25, 2015 M7.8 Gorkha Earthquake near Kathmandu, Nepal

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ABSTRACT

The 2015 Gorkha earthquake earthquake produced displacement on the lower half of a shallow decollement that extends 100 km south, and upward from beneath the High Himalaya and Kathmandu to where it breaks the surface to form the trace of the Himalayan Frontal Thrust (HFT), leaving unruptured the shallowest ~50 km of the decollement. To address the potential of future earthquakes along this section of the HFT, we examine structural, stratigraphic, and radiocarbon relationships in exposures produced by emplacement of trenches across the HFT where it has produced scarps in young alluvium at the mouths of major rivers at Tribeni and Bagmati. The Bagmati site is located south of Kathmandu and directly up dip from the Gorkha rupture, whereas the Tribeni site is located ~200 km to the west and outside the up dip projection of the Gorkha earthquake rupture plane. The last earthquake displacement at Bagmati occurred 1031 - 1321 AD to produce a scarp of ~10 m vertical separation. The most recent rupture at Tribeni occurred 1221 – 1262 AD to produce a scarp of >7-8 m vertical separation. The temporal constraints and large displacements allow the interpretation that the two sites separated by ~200 km each ruptured simultaneously, possibly during 1255 AD, the year of a historically reported earthquake that produced damage in Kathmandu. In light of geodetic data that show the equivalent of ~20 mm of crustal shortening across the HFT occurs on an annual basis, the sum of observations is interpreted to suggest that the HFT extending from Tribeni to Bagmati may rupture simultaneously, that the next great earthquake near Kathmandu may rupture an area significantly greater than the section of HFT up dip from the Gorkha earthquake, and that it is prudent to consider that the HFT near Kathmandu is approaching or in the later stages of a strain accumulation cycle prior to a great thrust earthquake, much greater than occurred in 2015.