

Location and magnitude of the 1833 Nepal earthquake and its relation to the rupture zones of contiguous great Himalayan earthquakes

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Accounts of an earthquake on 26 August 1833 which was felt over a large part of northern India have been interpreted by some authors to represent a great Himalayan thrust event beneath Western Nepal. However, details of the event in the Indian press of 1833 and scientific journals of that time suggest that the epicentre of the earthquake was near Kathmandu, within or close to the inferred rupture zone of the 1934 Bihar earthquake. Estimates of the moment magnitude based on reported intensities indicate that the earthquake was of $7.5 < M < 7.9$, and as such may have done little to release the elastic strain accumulating in the region of the Central Himalayan Seismic Gap, contrary to the expectation of some authors. The location of the epicentre was probably N or NE of Kathmandu, adjoining or overlapping the rupture area of the great 1934 Bihar/Nepal earthquake. The moment magnitudes of great Himalayan earthquakes in 1897, 1905, 1934 and 1950, and of smaller recent events, are compared using recently published empirical relations between isoseismal areas and moment magnitude. When due allowance is made for deficiencies in field data, reasonable fits are obtained for all events except for the 1905 Kangra earthquake. The intensity VIII area for this event is anomalously small for an $M \geq 8$ earthquake associated with several meters of slip. It is proposed that the Kangra earthquake may have been a slow earthquake.

APPROXIMATELY half of the Himalayan arc has ruptured in four great earthquakes in the past 100 years (Figure 1). The largest region between the rupture zones of these recent events is a 500–800 km segment of the Himalaya between the 1905 Kangra and the 1934 Bihar earthquakes, approximately between the longitudes of Kathmandu and Delhi. Of importance in estimating the present slip potential of this segment, termed the *Central Gap* by Khattri and Tyagi¹, is the existence and severity of great historic earthquakes that may have ruptured all or part of the gap. A severe earthquake occurred in Nepal in 1255 when 'innumerable towns were utterly destroyed and thousands of their inhabitants killed'² but the regional extent of this event is unknown. Other large pre-XX century earthquakes in Nepal (1408, 1681, 1810, 1833 and 1866) are mentioned by Chitrakar and Pandey³ but none appear to have been as damaging as the 13th century event, causing concern that considerable elastic strain may be available presently to drive one or several $M > 8$ earthquakes in the Central Gap.

An alternative mechanism to absorb slip between Tibet and India is to invoke the possibility of aseismic slip (slow earthquakes or creep) over at least a part of the region. Levelling data and recent GPS measurements

between India and central Nepal^{4–6} suggest that creep processes that might otherwise release Indo-Asian convergence aseismically have been insignificant in the past few years. If similar creep rates (2.5 ± 2.5 mm/yr) exist elsewhere along the arc throughout the seismic cycle, they are evidently inadequate to accommodate completely the slip budget between India and southern Tibet, although they may delay rupture⁷. The possibility that some Himalayan earthquakes may be slow events, with large slip but little radiated high-frequency seismic energy, cannot be excluded^{8,9}. Such events would not appear in the historical record as great earthquakes although they could, in principle, release the elastic strain associated with one.

Earthquakes in 1803, 1833 and 1866 appear to have occurred at least partly within the Central Gap¹⁰ and the largest of these in terms of felt area is believed to be the 1833 event. Reports of the 1833 earthquake are found in newspapers starting the day after the earthquake, and these and other data are collated in three issues of the *Journal of the Asiatic Society of Bengal* in the months following the earthquake by Prinsep¹¹ and Campbell^{2,12}, and by Baird-Smith^{13,14} in two articles a decade later. Summaries of these summaries are found subsequently in various catalogues and comparative studies^{15–21}. The compilation by Dunbar *et al.*²¹ lists the event as severe

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