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Reply to comment by R. Bilham on "Interpreting the style of faulting and paleoseismicity associated with the 1897 Shillong, northeast India, earthquake: Implications for regional tectonism"

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[1] The source of the 1897 earthquake is central to longstanding controversies about the genesis of the Shillong Plateau and the shortening of the Indian plate at the foot of the Himalaya. Debate on the location and geometry of the 1897 rupture began during the lifetime of R. D. Oldham, a leading geologist during the British colonial period. For nearly 100 years, the 1897 earthquake was attributed to a hypothetical, north dipping fault proposed to extend from the Himalayan thrust system. Instead, *Bilham and England* [2001] invoked a south dipping fault, which they called the Oldham fault. They further proposed that the Oldham fault is one in a pair of reverse faults of opposing vergence that raised the Shillong Plateau as a pop-up structure. Our paper [*Rajendran et al.*, 2004], while supporting the south dipping geometry, pointed out that the hypothetical Oldham fault lacks known expression along its supposed trace in the exposed crystalline rocks. We also explored potential alternatives, including a buried fault beneath the Brahmaputra Valley. In his comment, *Bilham* [2006] defends the Oldham fault by pointing out that the Brahmaputra alternative appears to conflict with old triangulation data. In response, we remind readers that the geodetic model by *Bilham and England* [2001] is a nonunique solution, which remains unsupported by geology.

[2] The model of *Bilham and England* [2001] is based on two sets of triangulation data of doubtful accuracy The 1898 trigonometrical survey south of the hypothetical Oldham fault, across the Shillong Plateau, failed to meet the triangle closure standards of the Survey of India [*Oldham*, 1899]. Problems also plagued the postearthquake Assam Valley Triangulation Series, north of the hypothetical fault. Writing for the survey as its superintendent, *Bomford* [1939, p. 32] of the Royal Engineers stated that the triangulation data from Assam (1859–1937) is suitable for nongeodetic purposes only, provided that "pairs of stations can be found whose mark-stones can be trusted to have undergone no relative movement." *Oldham* [1899] speculatively ascribed these errors to postseismic crustal movement. *Bilham and England* [2001] praised this idea as "ahead of its time" without addressing Bomford's concerns.

[3] If, despite these geodetic uncertainties, the Oldham fault is real, one would expect to see it in the geology and geomorphology of the Shillong Plateau [*Rajendran et al.*, 2004]. To explain the fault's apparent lack of expression, Bilham proposes that as in the case of the 2001 Bhuj earthquake, the faulting in the 1897 earthquake was blind. The thick sediment-fill in the Kachchh rift favored folding and flexuring above the upper part of the fault rupture in 2001, which occurred on an imbricate thrust fault within the rift [*Rajendran et al.*, 2001]. By contrast, the Precambrian crystalline rocks of the Shillong Plateau are unlikely to inhibit surface rupture, especially on a steep dipping fault (50°) as proposed by *Bilham and England* [2001]. Even the small-scale structures that would be expected of a major fault are absent in this region. A recent study by *Srinivasan* [2003], suggests that only 6–7% of the fractures on the Shillong Plateau strike E-W or ENE-WNW, the direction of the hypothesized Oldham fault. Although the proposed Oldham fault coincides with a change in relief, this change need not represent any faulting. The Shillong Plateau slices across granitic plutons, some of which are evident by remote sensing. Differential erosion along their contacts with the host rocks is known to produce high relief. Bilham's comment does not acknowledge such geological complexities. Fieldwork by a team including Bilham and two of us (B. P. Duarah and C. P. Rajendran), subsequent to the publication of the papers being discussed here, uncovered no evidence for the Oldham fault. By contrast, the Dauki fault, conjugate to the Oldham fault, according to *Bilham and England* [2001], is geologically conspicuous.

[4] Like the geodetic evidence used by *Bilham and England* [2001], gravity and seismic data in this region do not point to a unique tectonic explanation for the 1897 earthquake [*Rajendran et al.*, 2004]. However, while the gravity data do not suggest anything anomalous where the Oldham fault is projected, they give a weak signal farther north [see *Rajendran et al.*, 2004, Figure 4]. The Oldham fault is not apparent, either in our compilation of microseismic data or in a recent larger and better data set (J. R. Kayal et al., Shillong Plateau earthquakes in northeast India region: Complex tectonic model, unpublished manuscript, 2005). As proposed in our paper, this recent

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compilation reiterates a south dipping fault that projects to the ground surface in the Brahmaputra Valley.

[5] Landforms of the Brahmaputra Valley are consistent with faulting in 1897 beneath the alluvium. In his comment, Bilham ignores the possibility that such faulting could have been largely blind. He therefore predicts a ~10-m-high and >100-km-long scarp, a large region of uplift south of the river, and a lake to its north. In fact, our paper [*Rajendran et al.*, 2004] discusses the observations like the remnants of older alluvium occurring at an elevation of 4–8 m above the present riverbed and the presence of waterlogged depressions on the northern bank as evidence of uplift and subsidence, respectively.

[6] The fault model by *Bilham and England* [2001] thus depends entirely on geodetic data of questionable accuracy, and it gives no consideration to regional geology or geophysics. The model requires a plateau-bounding fault in Precambrian crystalline rocks to terminate at a depth of 9 km, with no expressions in surface geology, landforms, gravity, or microseismicity. It is premature to rule out alternative sources of the 1897 earthquake, including a fault in the Brahmaputra Valley.

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