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Fault slip-rate estimate for the right-lateral Beng Co strike-slip fault, from Quaternary dating of displaced paleo-lake shorelines

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ABSTRACT

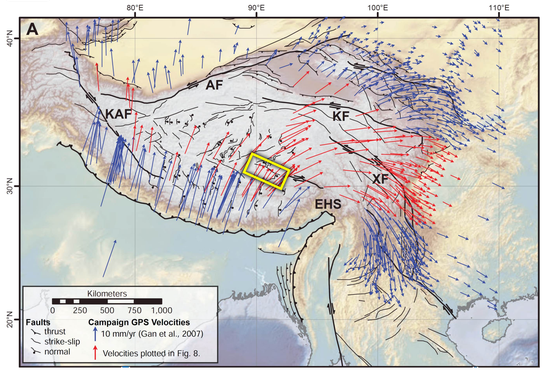
GPS data indicate that eastward extrusion of material across the Tibetan Plateau accommodates some of the northward motion of India, with respect to Eurasia (Zhang, et al., 2004). The Beng Co fault is a major right-lateral strike-slip fault, which strikes ESE for a distance of 150+ km across the eastern Central Tibetan plateau. Armijo, et al. (1989) suggested the Beng Co fault is one of a small number of important strike-slip faults in Central Tibet which accommodate the eastward extrusion of material. However, such a kinematic model requires the Beng Co fault slip-rate to be relatively high (~10 mm/yr), compared to the relatively slow rate (~1 mm/yr) expected if eastward motion is accommodated in a more distributed way across many active structures throughout the region.

Unfortunately, existing GPS data or measurements from Satellite Radar Interferometry (InSAR) collected over the decadal timescales are not currently able to resolve the slip-rate for the Beng Co fault with enough precision to resolve this issue (e.g. Zhang, et al., 2004, Taylor, et al., 2006). In this study, we use a variety of Quaternary dating techniques to determine the age of geomorphic markers which are displaced across the Beng Co fault. From this we calculate a slip-rate for this fault, averaged over the late Quaternary period, which allows us to test if a distributed or block model approach is more appropriate for describing active deformation in Central Tibet.

The Beng Co fault cuts across a number of paleo-lake shorelines around the southern margin of the Peng Co Lake, Central Tibet [**box 2**]. Three main sequences of beach berms are present around the present lake shoreline (1 being the oldest, 3 being the youngest), with each sequence comprising as many as 5 individual beach berms. At N31.389° E90.426°, the fault displaces sequence 2 beach berms in a pure right-lateral sense by ~13 m. These beach berms can be clearly traced 6 km eastwards around the lake, where they become incised and exposed by a river which drains into the Peng Co Lake. We collected shells for radiocarbon dating, and fine sand samples for OSL dating from beach berms within shoreline sequences 1,2 and 3, as well as samples for ^{36}Cl exposure dating from profiles through displaced fan material. Dating of these samples is ongoing. However, we present the results from carbon dating of snail shells found within various berms, and IRSL dating of storm deposits, thereby allowing us to determine the age of the **13 ± 3 m** displacement on the Beng Co fault, yielding a fault slip-rate of **2-4 mm/yr** (consistent over 6-7 ky and 60-70ky) for this section of the fault. Further ^{10}Be of granite boulders from a displaced and abandoned river system at another site along the Beng Co fault [**box 3**], yields a slip-rate of **3-4 mm/yr** (averaged over 100 ky). The Beng Co fault terminates to the SE in a major range-bounding normal fault (the Gulu rift), which trends perpendicular to the Beng Co fault. ^{10}Be dating of boulders collected from a Quaternary surface offset by this normal fault [**box 4**] yields an extension rate of **3-4 mm/yr** (averaged over 20 ky).

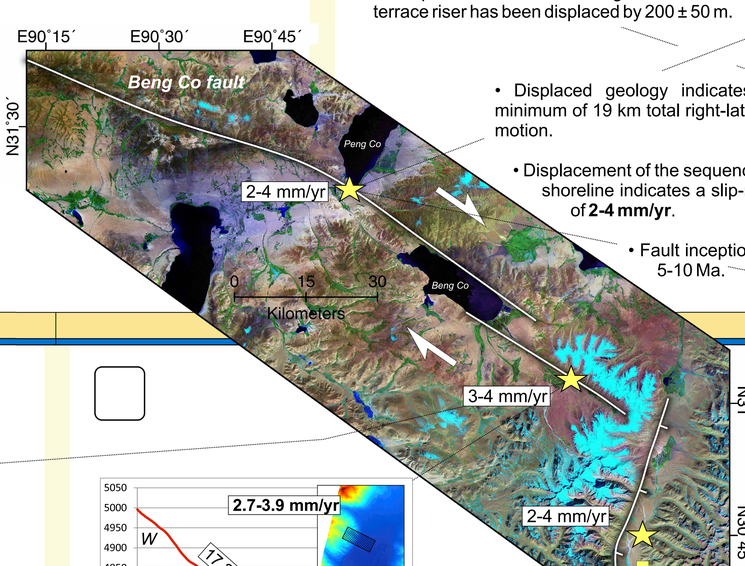
INTRODUCTION

1 *right-lateral Beng Co fault slip rate*



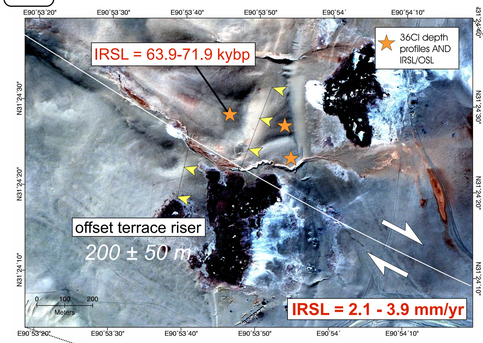
• The aim of this study is to determine the late Quaternary slip-rate for the right-lateral Beng Co fault in Central Tibet, and address the extent to which it allows eastward extrusion of material away from Tibet.

• Previous estimates of right-lateral shear in this region range from 15 mm/yr (Armijo, et al., 1989), 10-18 mm/yr (Taylor, et al., 2006) and 3-6 mm/yr (Zhang, et al., 2004 and Gans, et al., 2007).

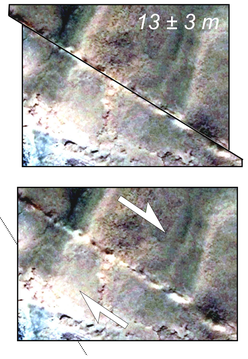


PENG CO LAKE SHORELINE DISPLACEMENTS

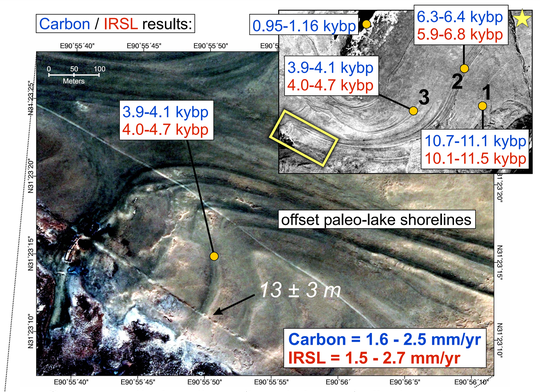
2 *Lake shoreline displacements*



• Sample locations on the Beng Co fault, where a terrace riser has been displaced by 200 ± 50 m.



• Sequence II beach berms offset by 13 ± 3 m.

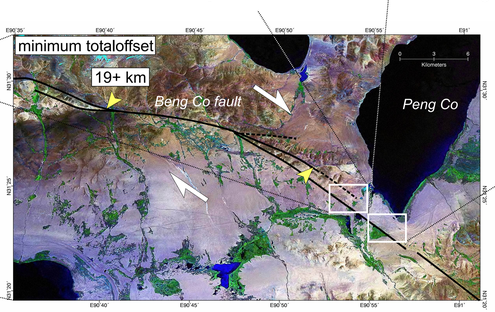


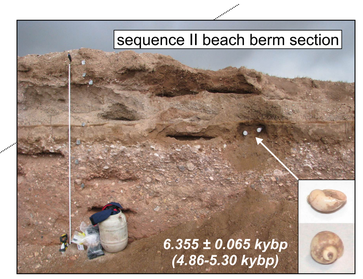
• Sequence II shorelines (beach berms) displaced across the Beng Co fault. Sample location lies 3 km to the NE (inset).

• Displaced geology indicates a minimum of 19 km total right-lateral motion.

• Displacement of the sequence II shoreline indicates a slip-rate of **2-4 mm/yr**.

• Fault inception is 5-10 Ma.

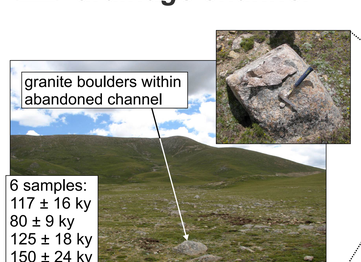


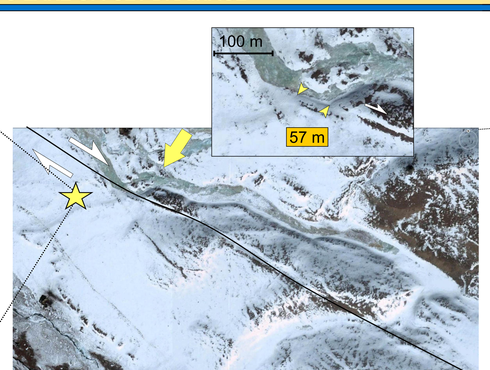


• Shell, OSL pedogenic CaCO3 and 36Cl depth profiles collected from sequence II berm.

SW BENG CO LAKE OFFSET DRAINAGE

3 *Abandoned drainage channel*





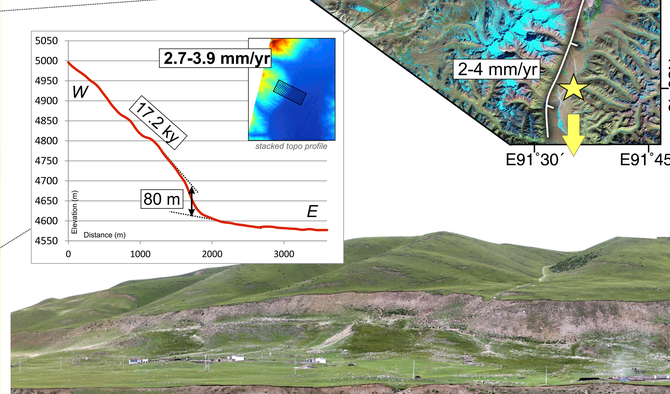
• The fault continues SE of Beng Co lake (a pull apart basin) where it displaces a number of drainage systems.

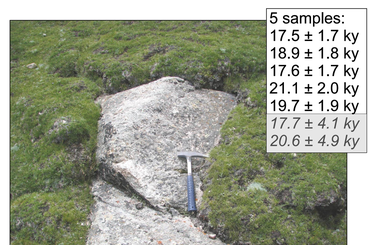
• The eastern riser of a river has been displaced 57 m, while a larger 350±50 m offset reconstructs numerous features in the Late Quaternary geomorphology.

• Granite boulders were collected from the abandoned river channel. ^{10}Be exposure dating of these boulders gave variable ages ranging between 44-150 ky (average=98 ky, std dev = 40 ky, median = 98 ky).

• The 350±50 m drainage displacements possibly date from the end of the last interglacial (slip-rate = **3.1-4.1 mm/yr**).

NYAINQÊNTANGLHA EXTENSION





• The Gulu rift bounds the eastern Nyainqentanglha Mountains. Quaternary activity on the Gulu rift has produced dramatic normal fault scarps in the granite bedrock bounding the range front.

• Granite boulders were collected from both the hangingwall and footwall surfaces for analysis by ^{10}Be exposure dating.

• The vertical offset determined from a stacked profile across an ASTER DEM is 80 m. Typical normal fault dips are 50-60° (Harvard CMT).

• The average age of 5 samples from the surface above the fault scarp, and 2 samples below the scarp indicate an average age of 17.2 ky (standard deviation = 4.3 ky). (Slightly younger ages from below the scarp may result from material eroding from the scarp.)

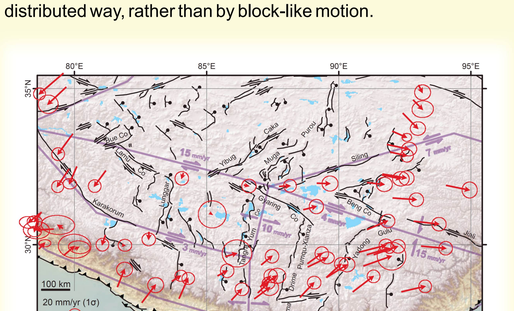
• Assuming a normal fault dip of 50-60°, the Gulu rift extends at **2.7-3.9 mm/yr**, consistent with the other sections of the fault.

CONCLUSIONS

• Late Quaternary averaged right lateral slip-rate for the Beng Co fault is 2-4 mm/yr.

• Future dating results from OSL and ^{36}Cl exposure dating will further refine our slip rate from different sites along the Beng Co fault and Gulu rift over longer timescales.

• Our results are consistent with GPS data, and supports the view that eastward extrusion of material is accommodated in a distributed way, rather than by block-like motion.



after Meade, 2007 and Gan, et al., 2007

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