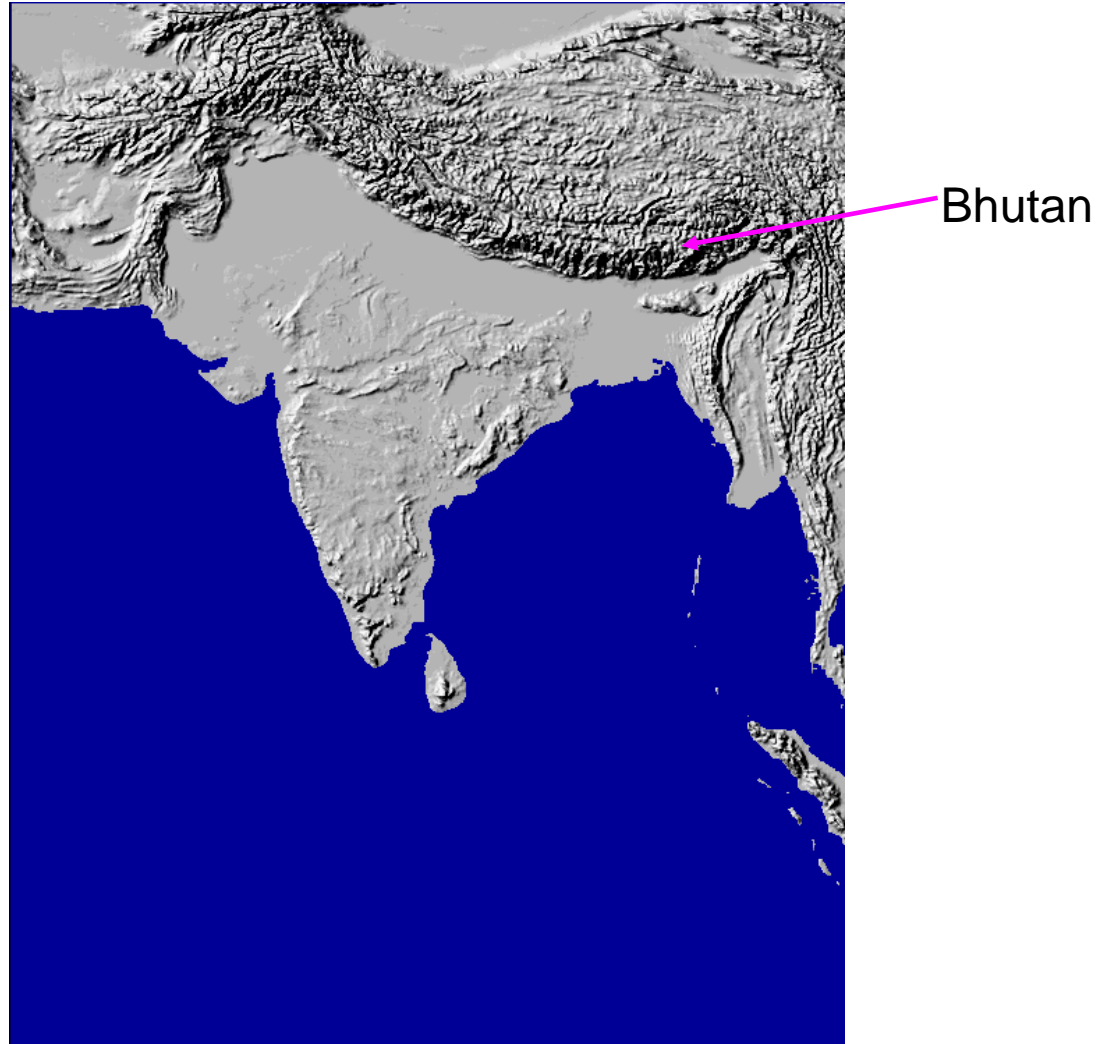
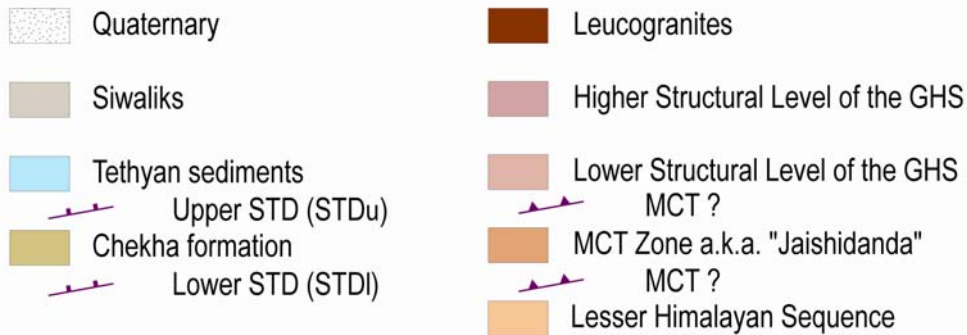
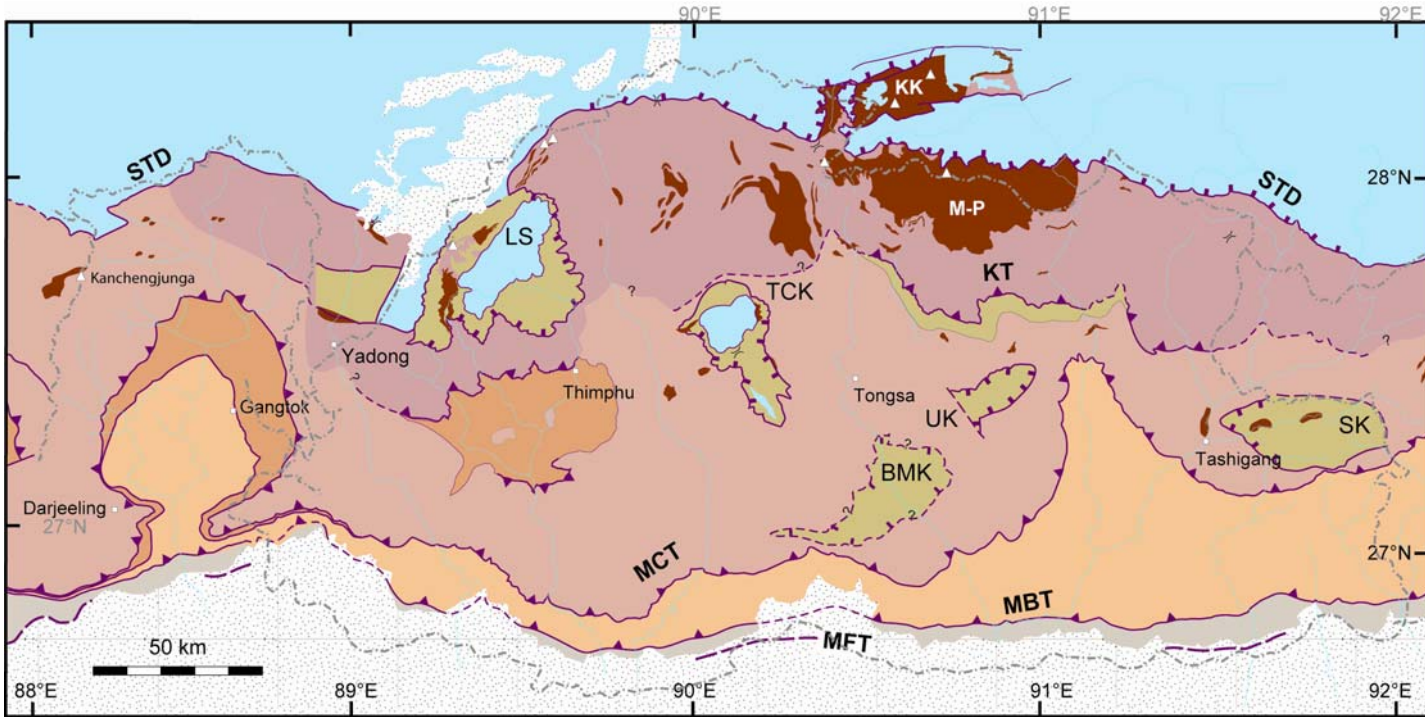


# SEISMIC HAZARD ASSESSMENT IN THE BHUTAN HIMALAYA



By: Tobgay

# Geology of the Bhutan Himalaya



(from Grujic, 2004)

# HISTORICAL EARTHQUAKES

## Magnitudes

- 1897 – 8.1
- 1905 – 7.8
- 1934 – 8.1
- 1950 – 8.5-8.7

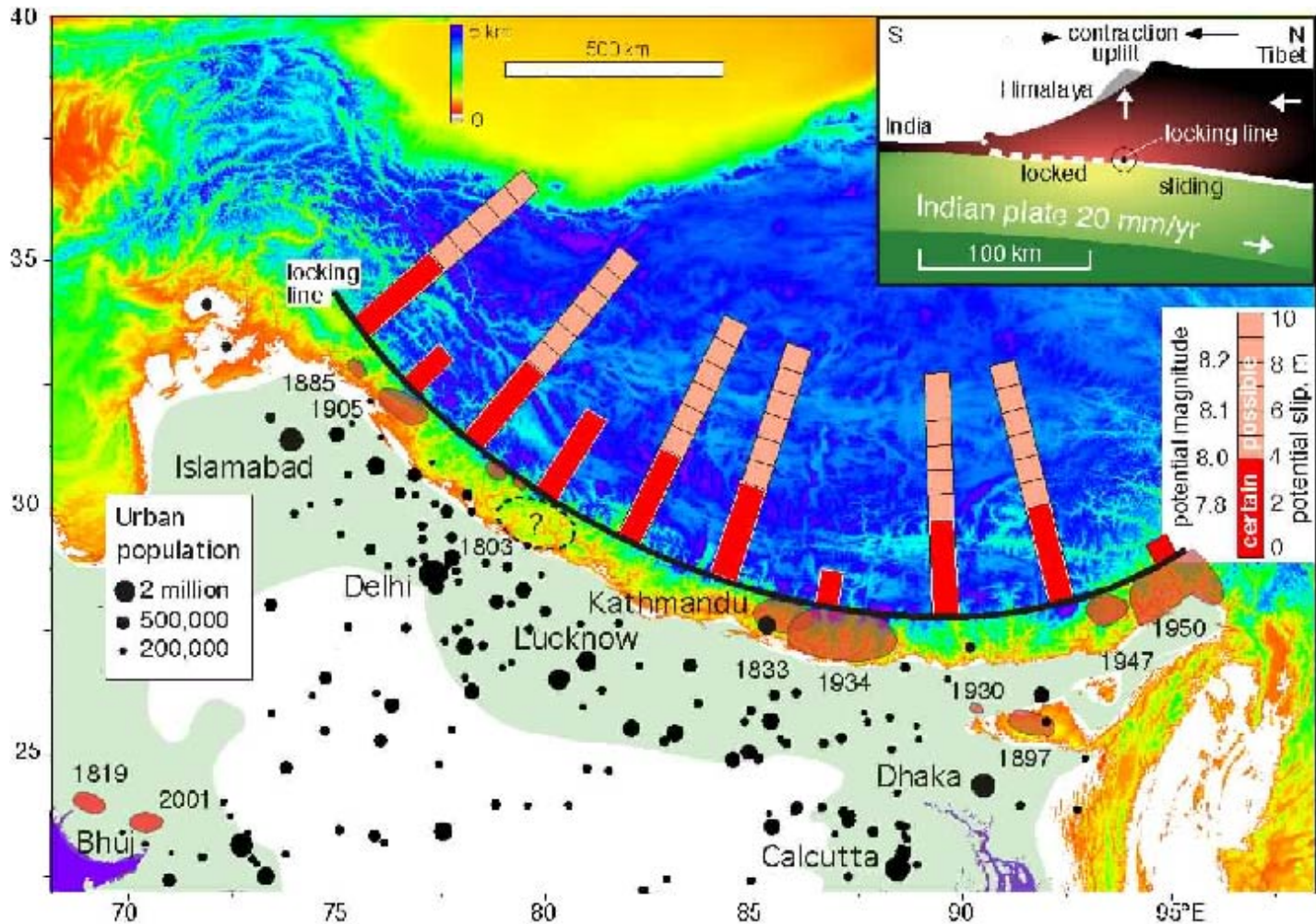


Figure 3. Location of great earthquakes and locking line, along the Himalayan arc. The slip potential is also depicted along with the potential magnitude (from Bilham et al., 2001).

## Seismic Gaps in the Region

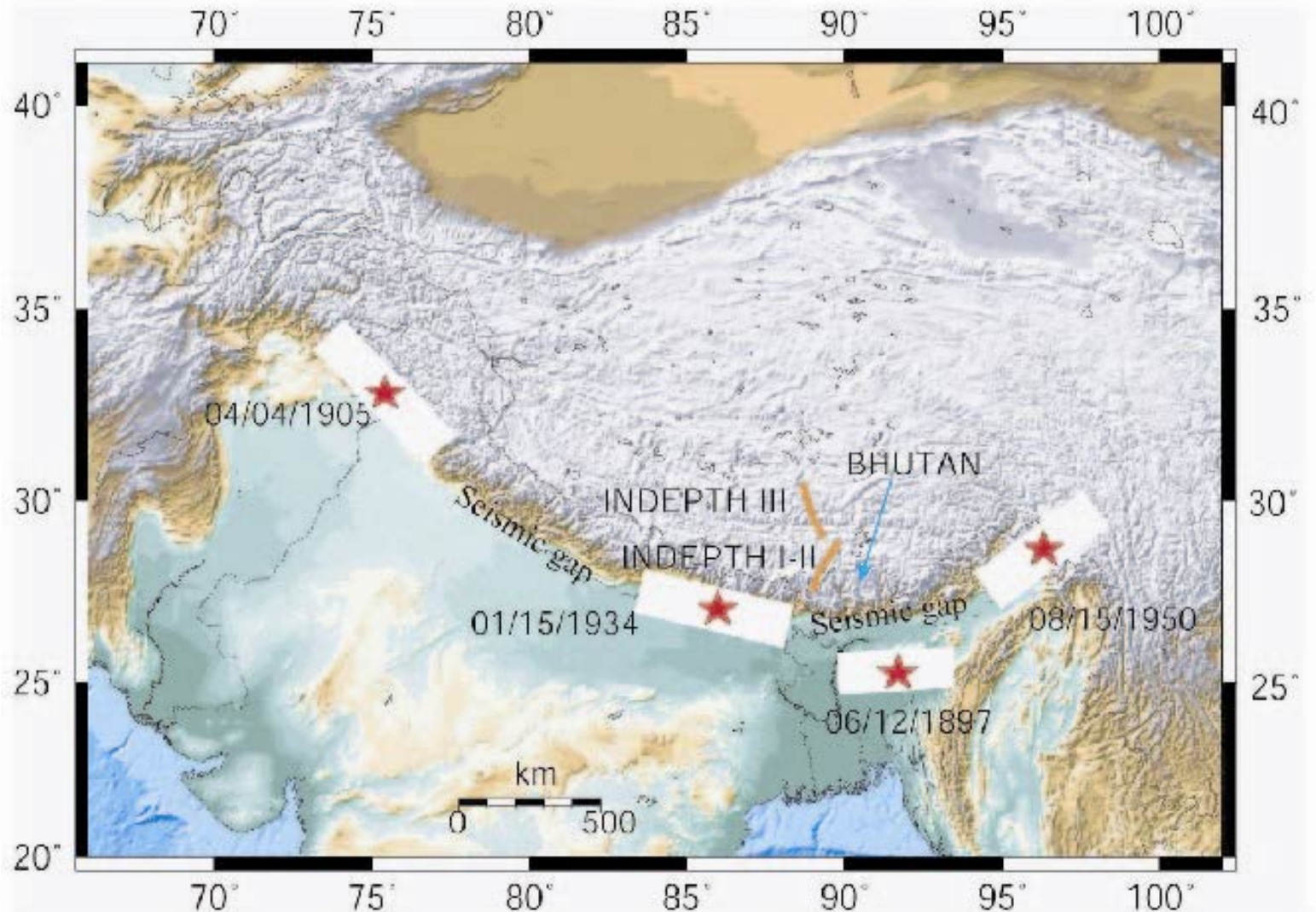


Figure 4. Four great earthquakes (red stars) with their estimated rupture zones and seismic gaps (from Drukpa, 2002).

# Results from the UTEP Temporary Network

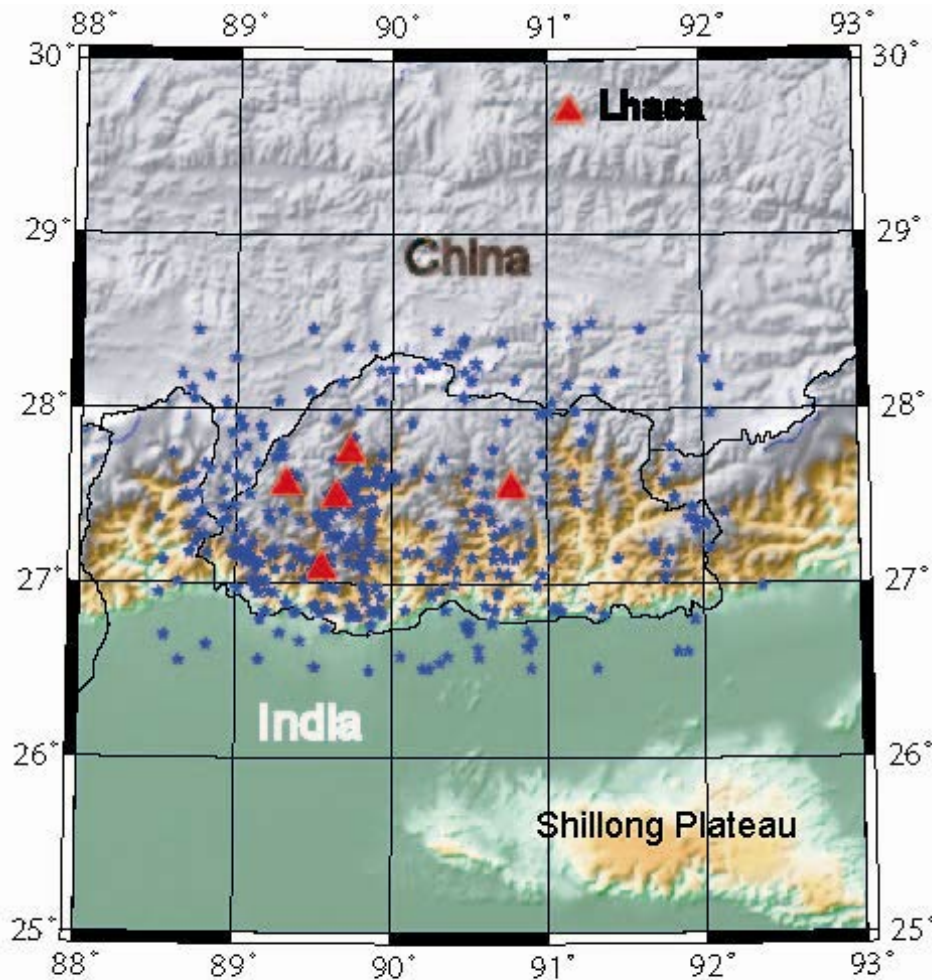
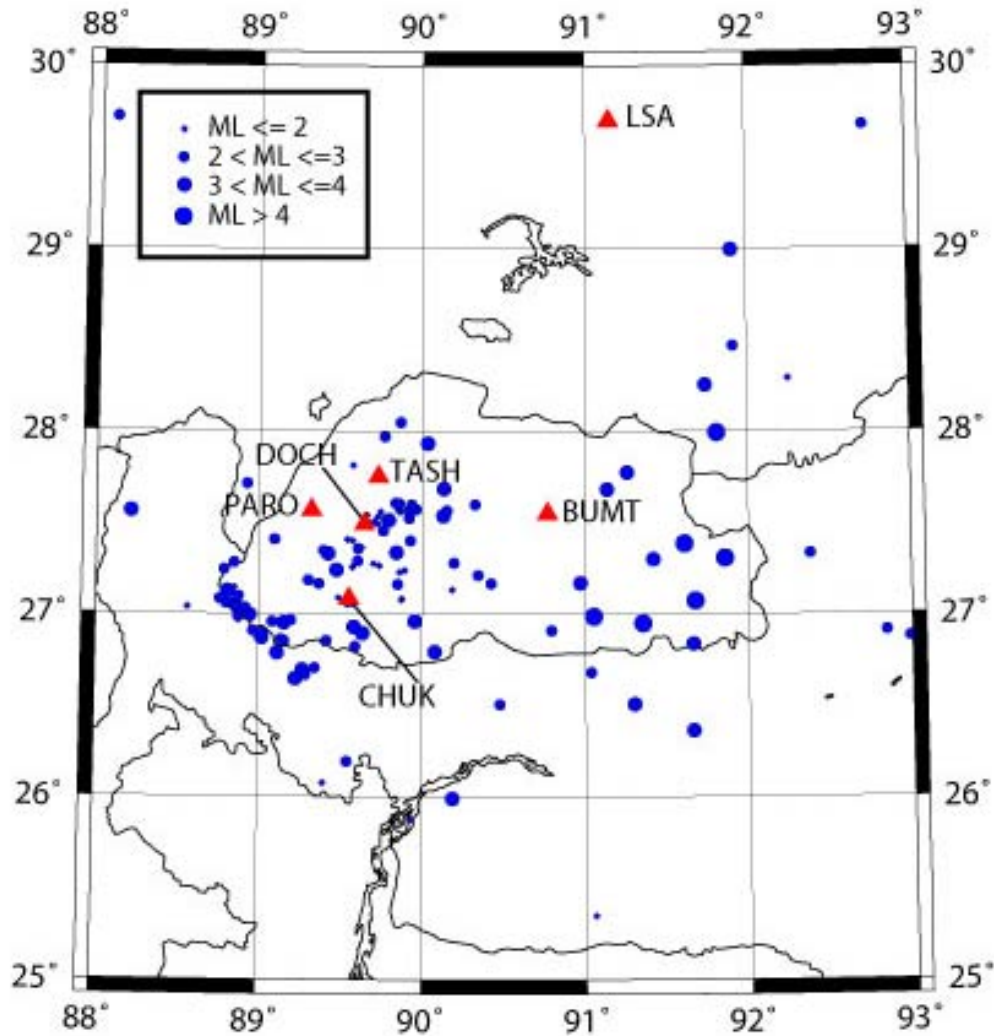


Figure 5.

Regional events (within 0.5° of Bhutan) recorded by the seismic network deployed by the University of Texas at El Paso from January 2002 - March 2003. Stations are shown as red triangles, blue stars are the local events in the region of Bhutan that were detected by the UTEP network.

More than 2,000 events were detected by the network including more than 700 events not in the USGS PDE catalog (from Gee et al., 2004).

# Bhutan Earthquake Locations with Local Magnitude Sizes



(from Gee, 2004)

# Geodetic Measurements

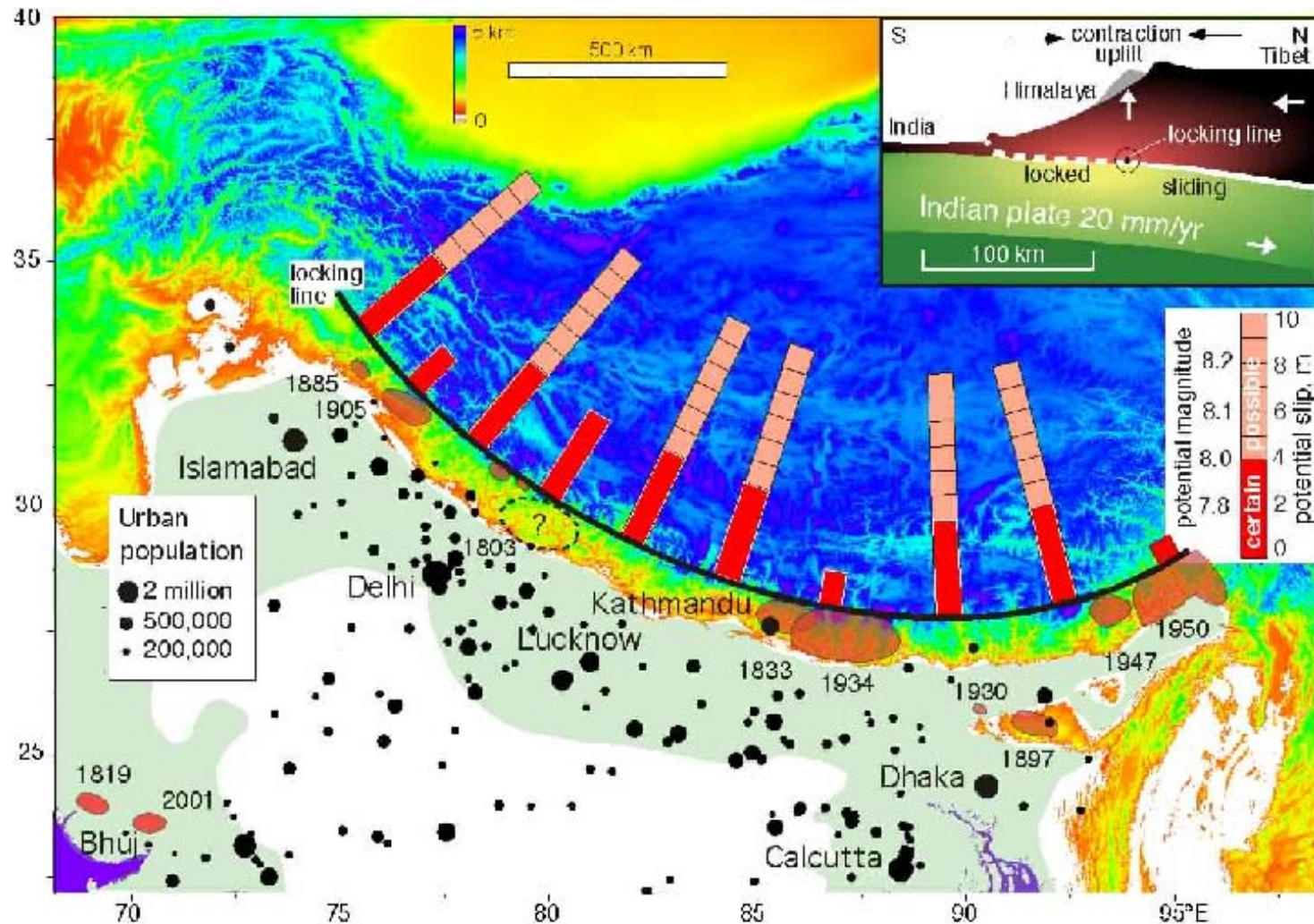


Figure 3. Location of great earthquakes and locking line along the Himalayan arc. The slip potential is also depicted along with the potential magnitude (from Bilham et al., 2001).

# Mapping of active faults

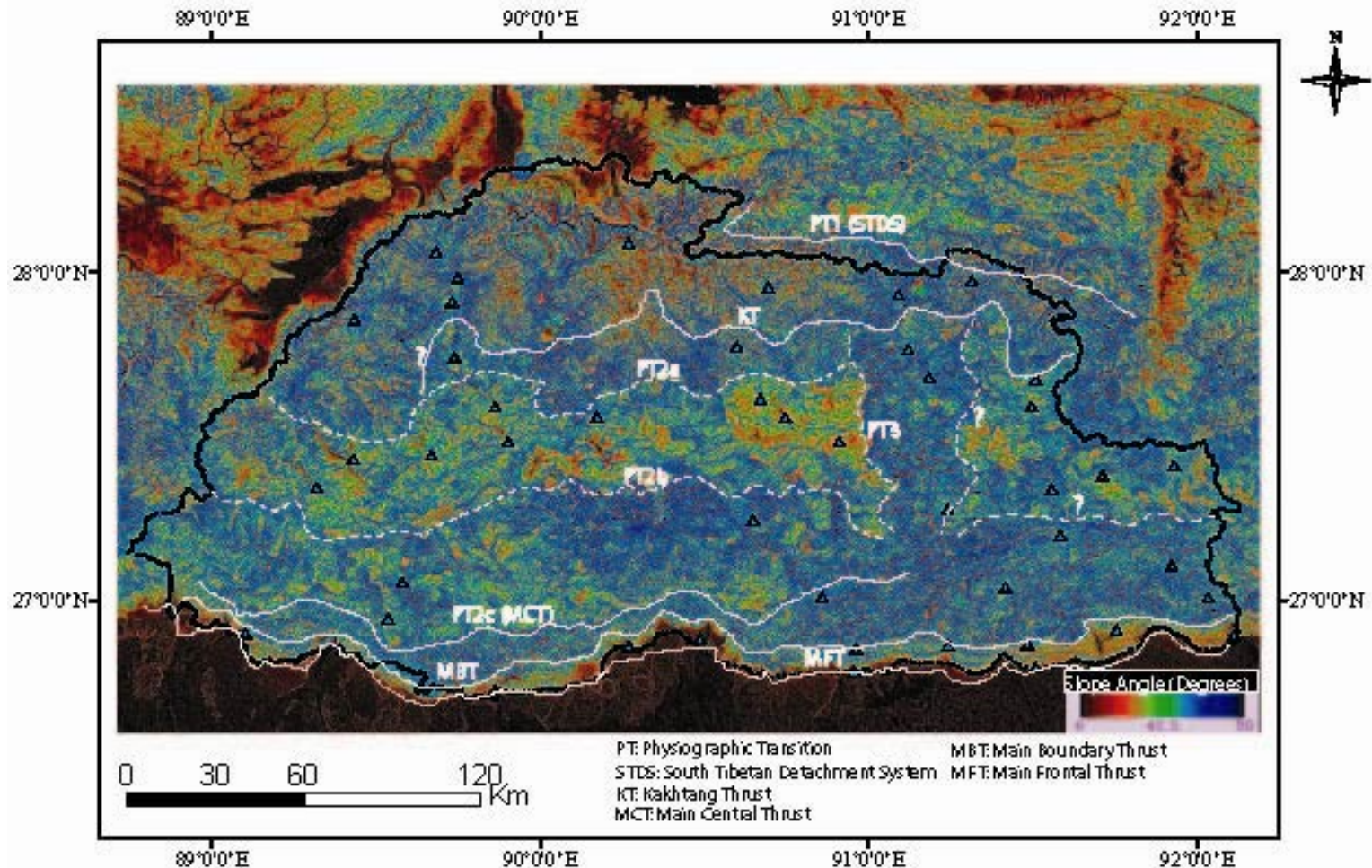


Figure 7. Slope map showing east-west striking physiographic transitions (PT1, PT2a, PT2b, PT2c) and north-south striking physiographic transition PT3.

# Seismicity in the Sikkim Himalaya

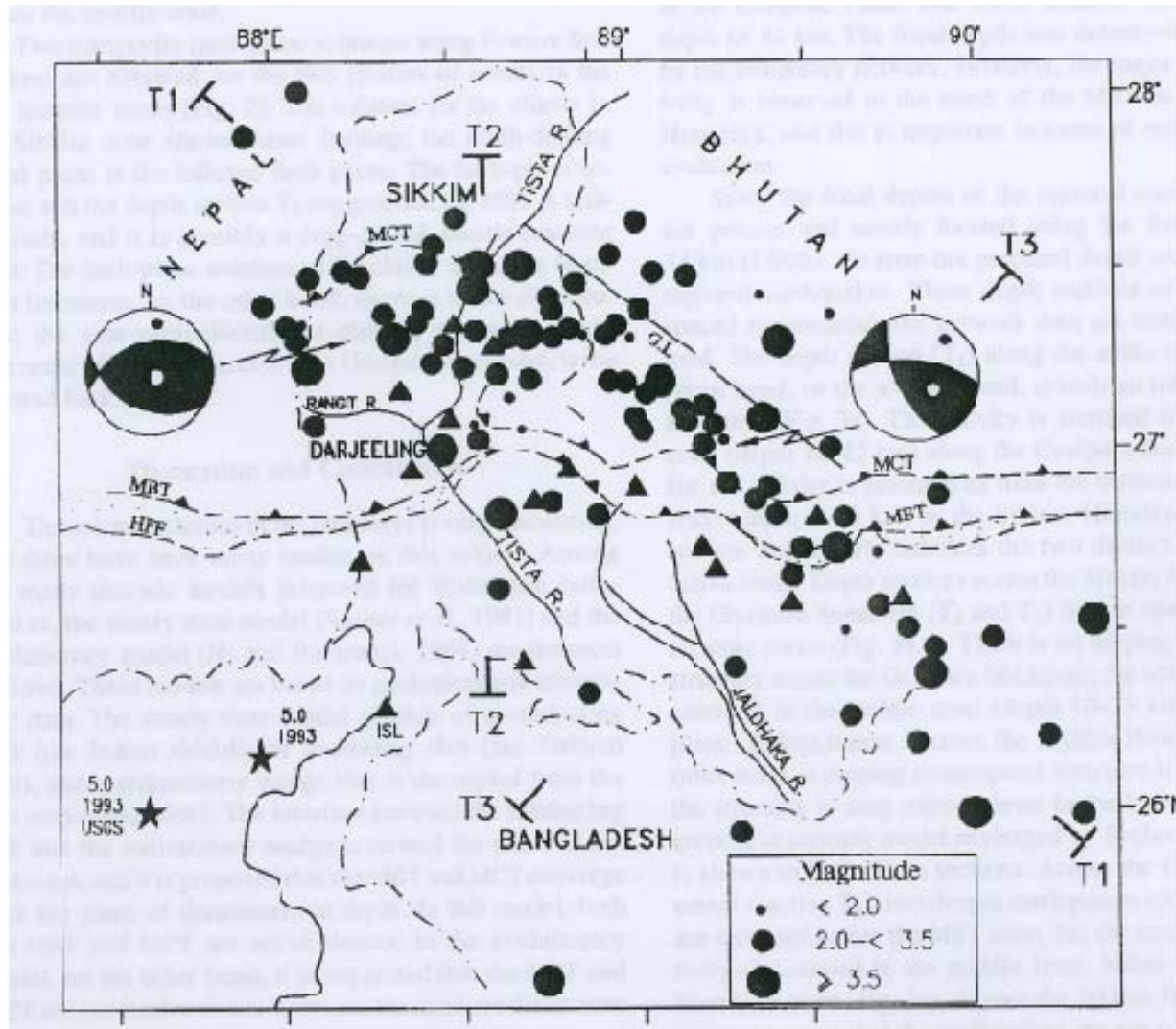


Figure 9. Epicenter map of the earthquakes recorded by temporary microearthquake network (1993-1999). Note the intensity of the seismicity (from De and Kayal, 2003).

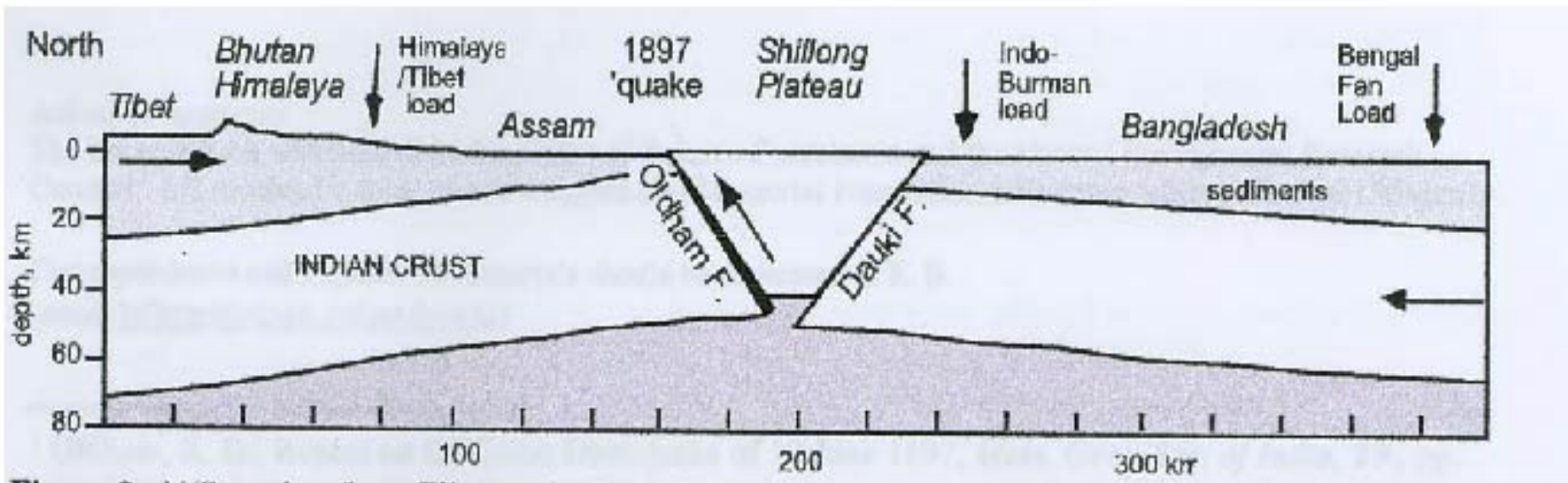


Figure 6. North-South from Tibet to the Bay of Bengal showing the geometry of the Shillong Plateau pop-up. Also shown is the rupture along the Oldham F ault which caused the 1897 great Assam earthquake.

## CONCLUSIONS

- i) Bhutan as a whole has high seismic risk.
- ii) Seismic hazard zonation - Difficult to zone due to lack of enough data. However, if we extend the seismic hazard zonation of India, Bhutan falls within zone IV and V.
- iii) Shillong Plateau “pop-up”: Does it really reduces the seismic hazard in Bhutan?

The answer is “NO”.