

2015年ネパール・Gorkha地震 テクトニクス・震源・地震動について

三宅弘恵

(東京大学大学院情報学環/地震研究所)

1

2015年ネパール・Gorkha地震 (Mw 7.9)

- ・ 2015年4月25日(土) 現地時間11:56
- ・ カトマンズ北西約 80 km, 深さ 15 km
- ・ 死者数は8000人を超えたとの情報あり
- ・ 背景となるテクトニクス
- ・ 地震動を含む観測記録
- ・ 震源

2

震源メカニズム解 (Mw 7.8-7.9)



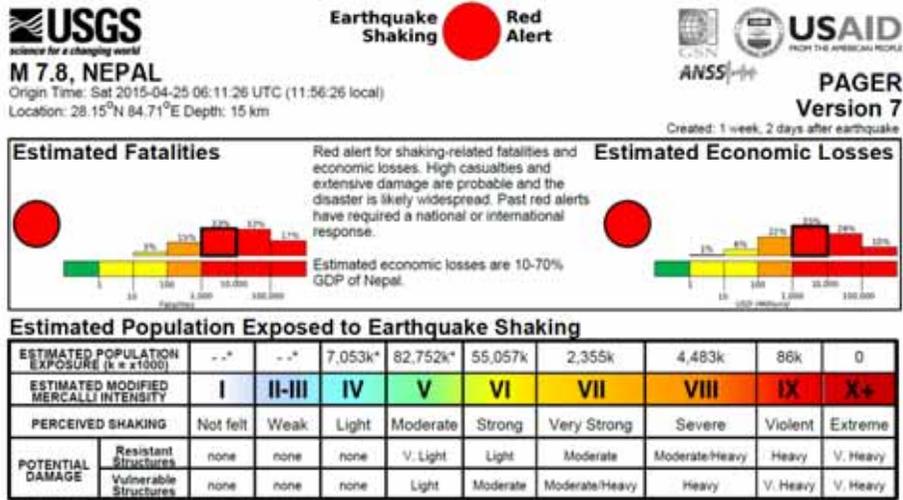
USGS (2015)

震源メカニズム解 (Mw 7.9 GCMT)



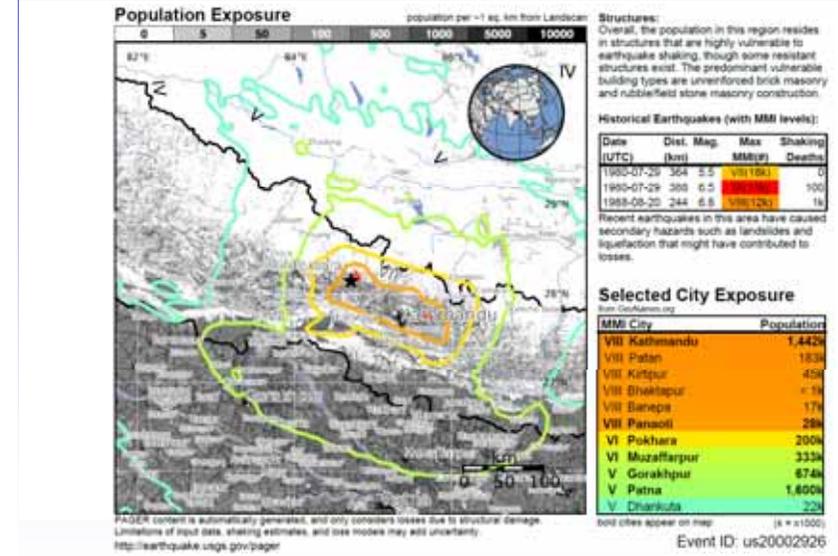
Global CMT Project (2015)

USGS Pager (Seismic Risk)



USGS (2015)

USGS Pager (Seismic Risk)



USGS (2015)

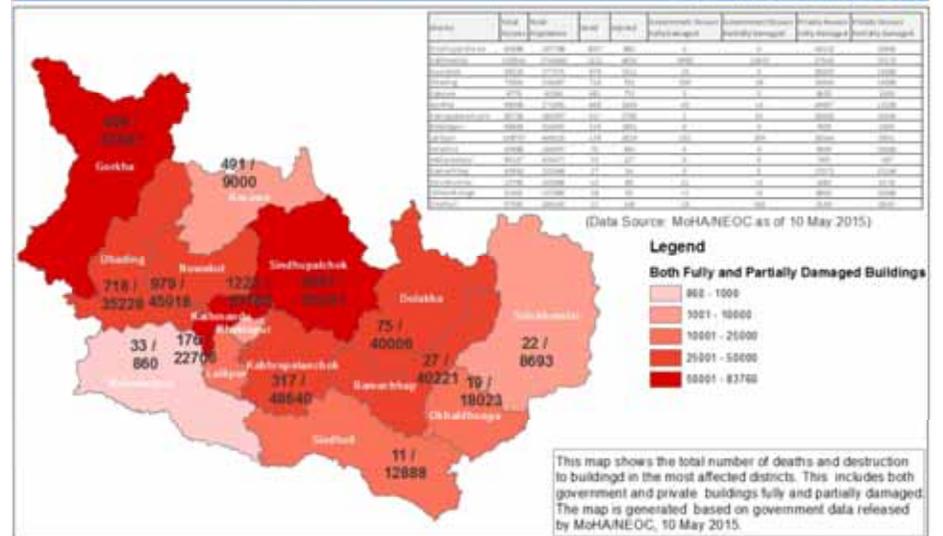
NEPAL



Map Sources: UNCS, ESRI.
 The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Map created in Sep 2013.

NEPAL EARTHQUAKE 2015

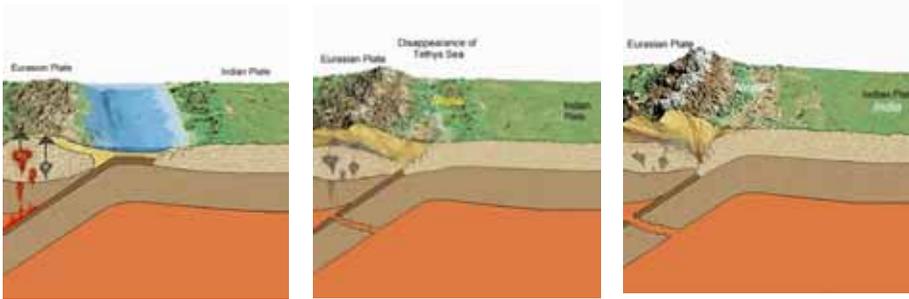
Human Casualties and Fully/Partially Damaged Buildings



Source: Assessment Registry (<https://www.humanitarianresponse.info/en/operations/nepal/assessment-working-group>)
 Share Information report at nepalassessments@humanitarianresponse.info

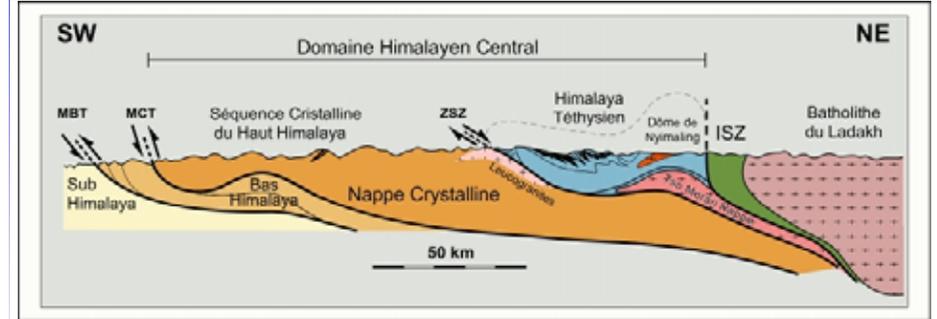
Map produced on: 10 May 2015

ヒマラヤ衝突帯



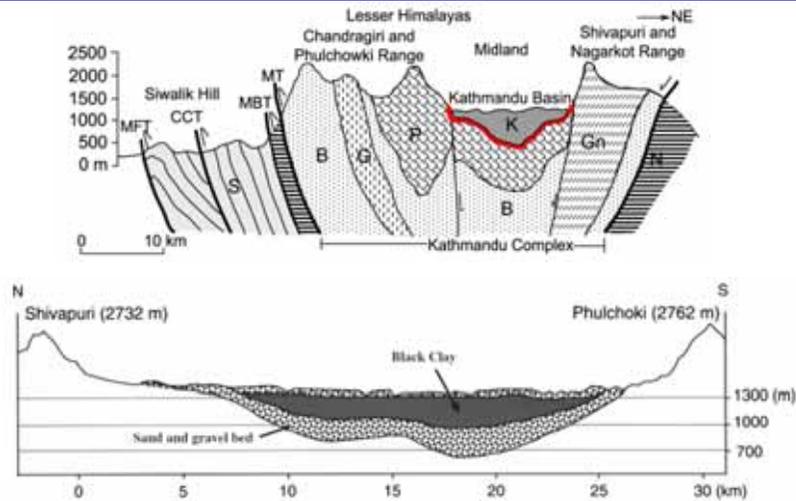
Dahal (2002) from 纈纈・他 (2015)

テクトニクス (ヒマラヤ衝突帯)



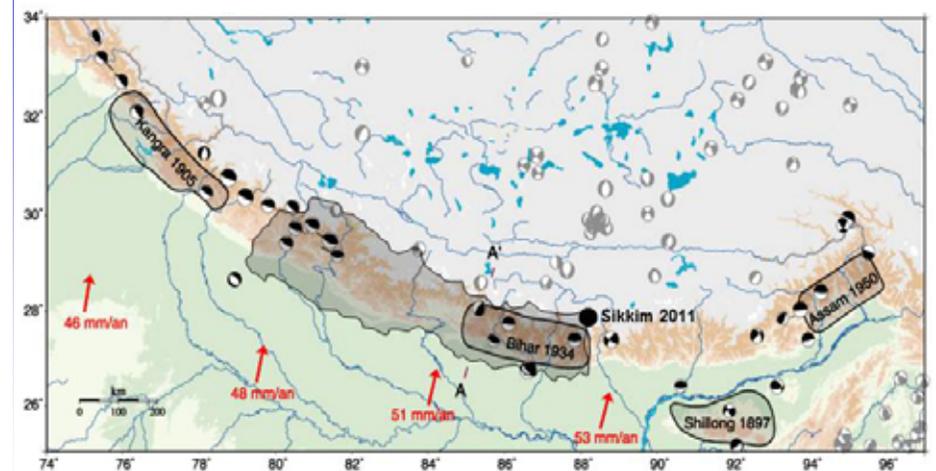
Dèzes (1999)

テクトニクス (カトマンズ盆地)



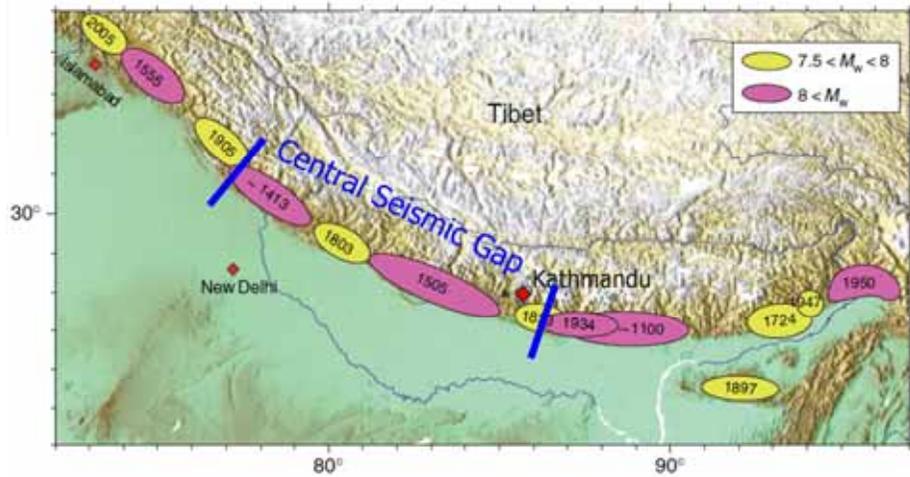
Stöcklin and Bhattarai (1981) Katel et al. (1996)
Sakai et al. (2002) Paudyal et al. (2013)

プレート衝突速度



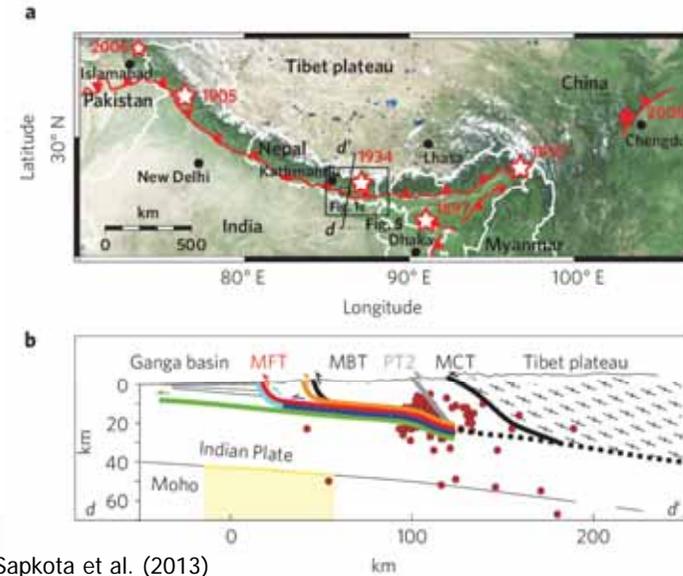
Avouac et al. (2001)

Central Seismic Gap



Avouac (2007)

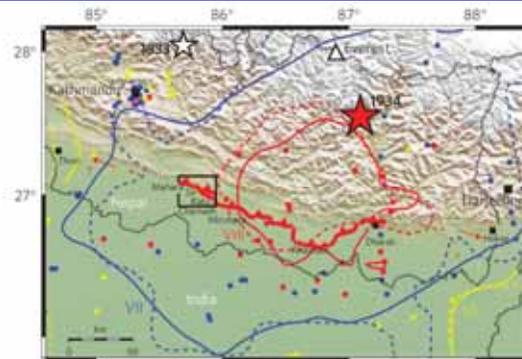
Main Frontal Thrust



Sapkota et al. (2013)

- 50 mm/yr
- MFT
Main Frontal
Thrust
- MBT
Main
Boundary
Thrust
- MCT
Main Central
Thrust

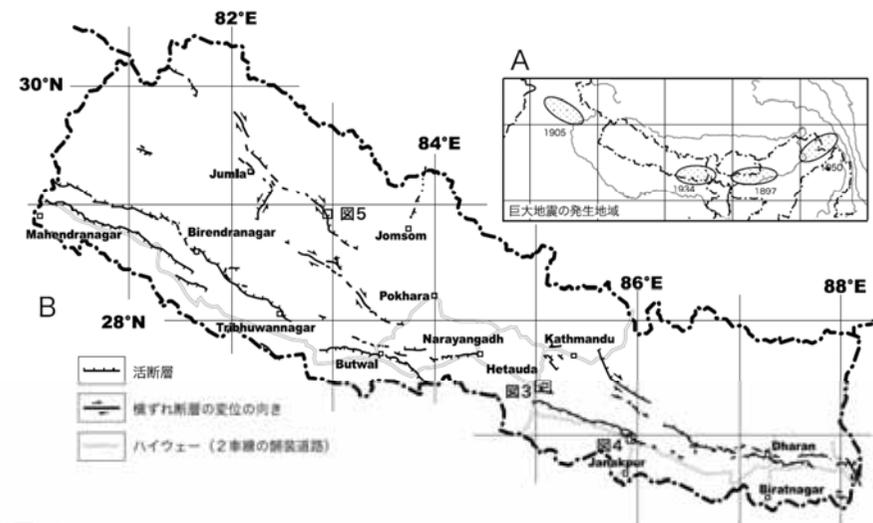
1934 Nepal-Bihar Earthquake (Mw 8.2)



Primary surface ruptures of the great Himalayan earthquakes in 1934 and 1255

S. N. Sapkota¹, L. Bollinger^{2*}, Y. Klinger³, P. Tapponnier⁴, Y. Gaudemer³ and D. Tiwari¹

ネパールの活断層

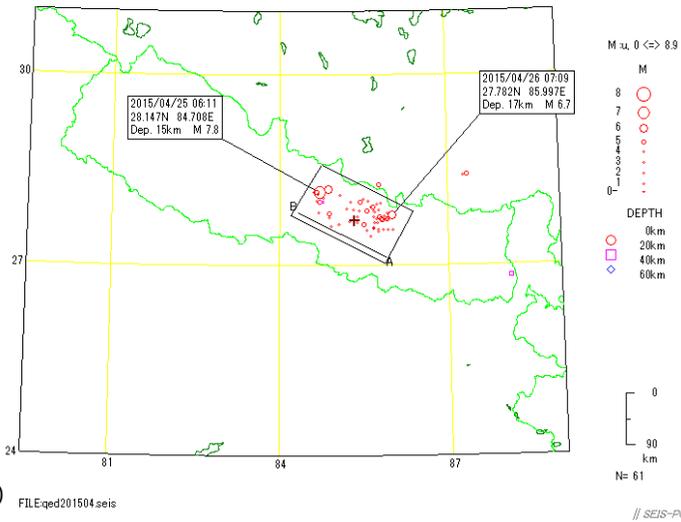


熊原・中田
(2005, 地誌研年報)

図1 本研究で明らかになったネパールの活断層の分布

地震活動

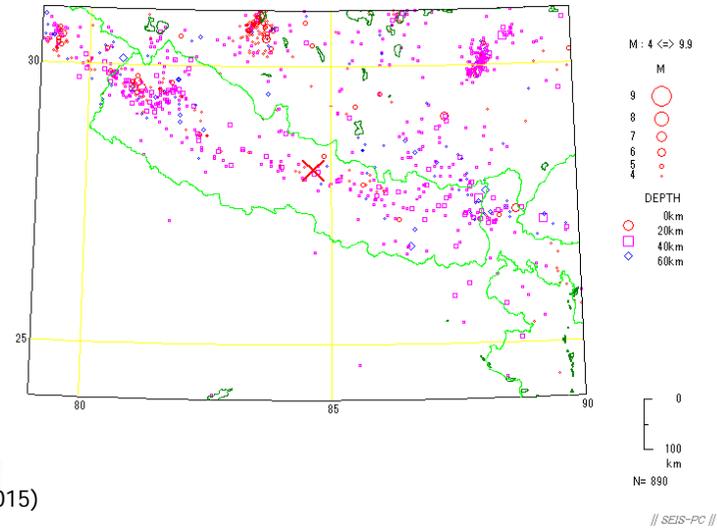
2015 4/25 0:0 -- 2015 4/30 3:0



石川 (2015)

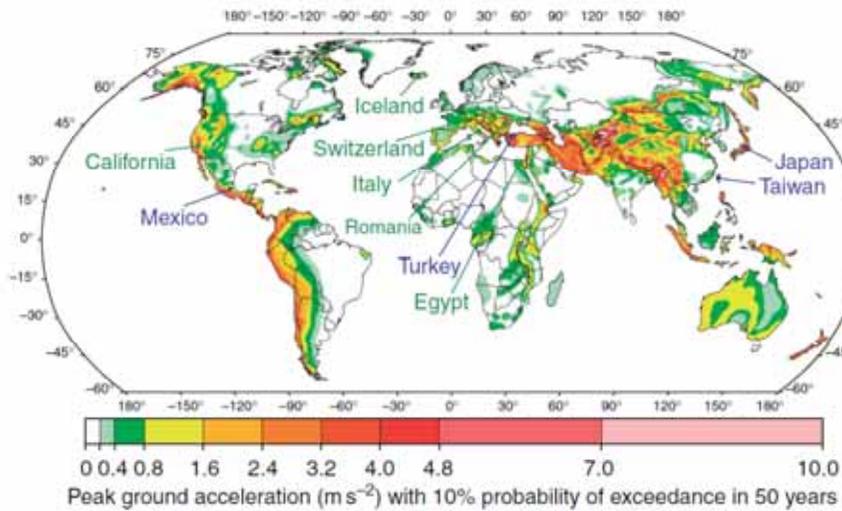
地震活動

1964 1/1 0:0 -- 2015 4/25 6:0



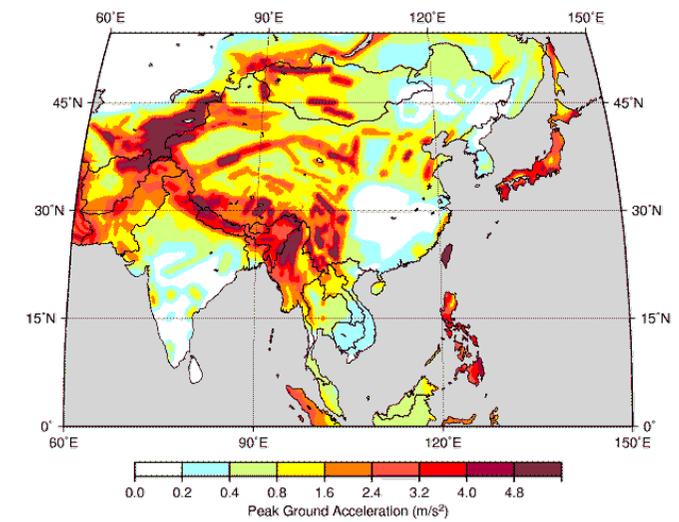
石川 (2015)

地震ハザード (GSHAP)



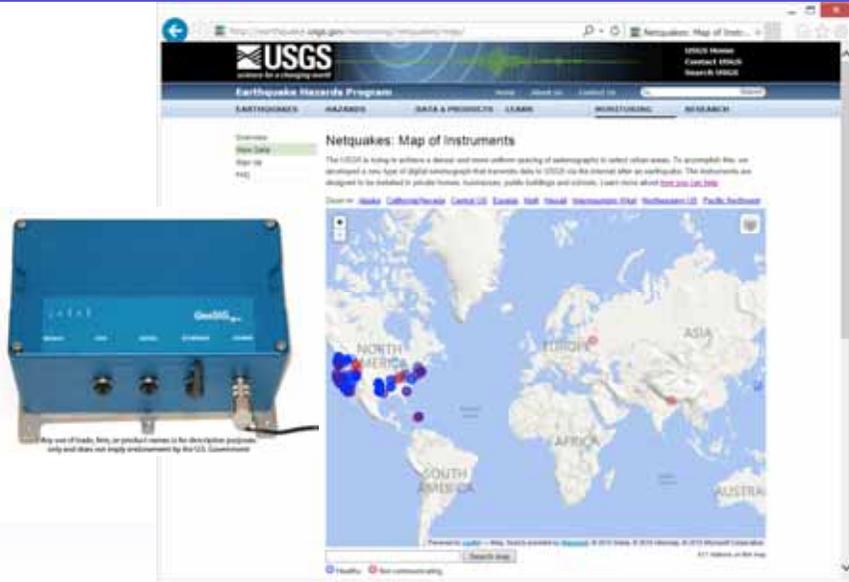
Giardini (1999)

地震ハザード (GSHAP)



Giardini (1999)

強震動 (USGS Netquakes)

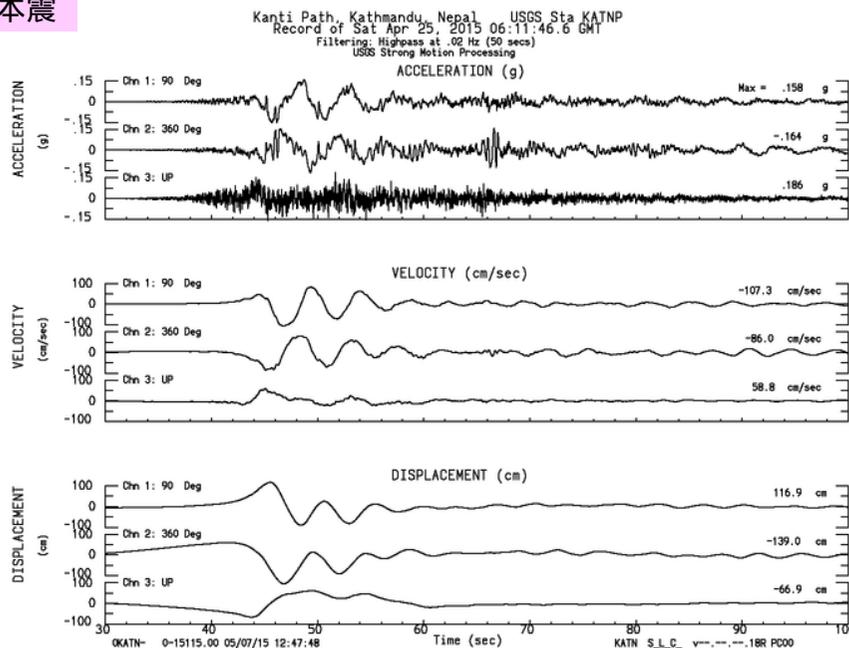


強震動 (USGS)

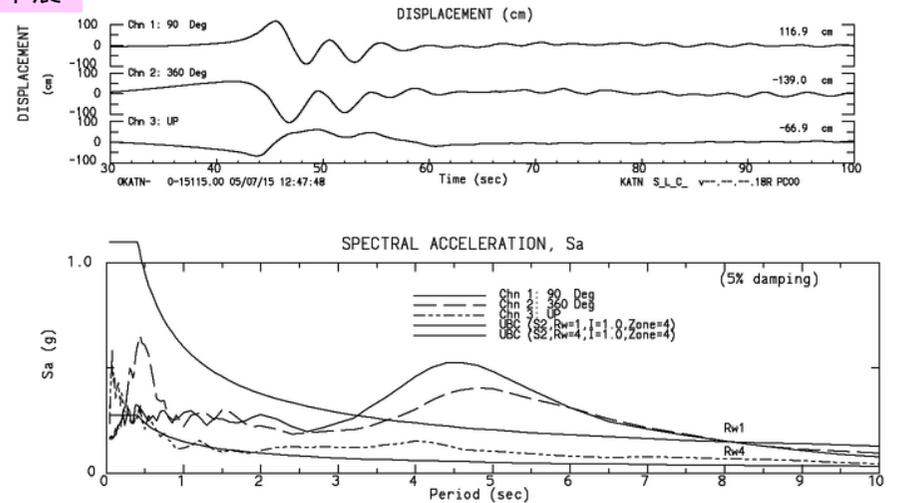


緯度経度と、建物内の設置場所の詳細について、情報の収集・確認が必要
謝辞記載に関する情報もあり

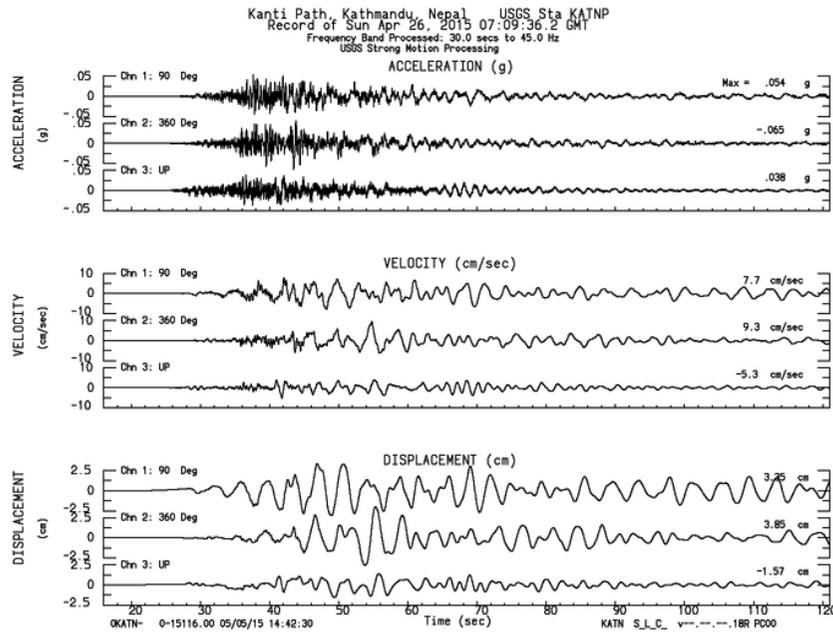
本震



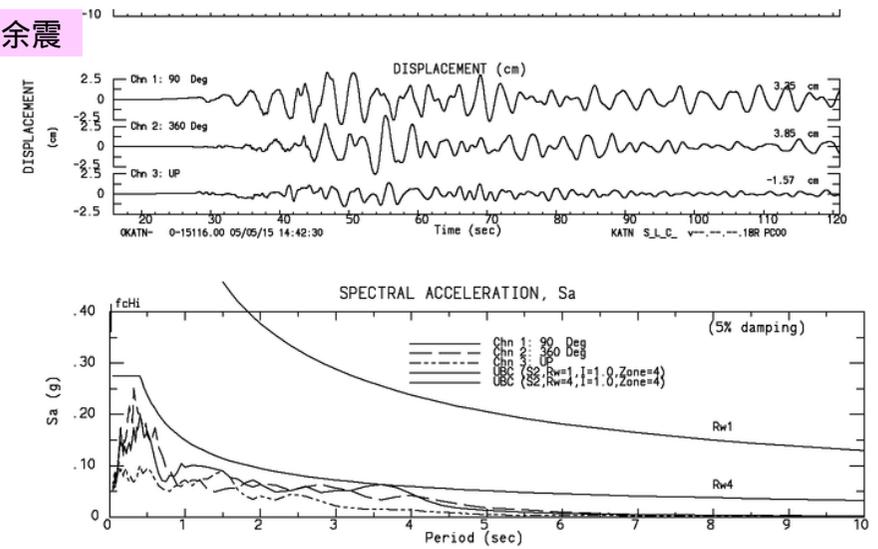
本震



余震



余震



USGS (2015)

26

強震動 (北大・高井先生提供スライド)

Strong Motion Observations in the Kathmandu Basin, Nepal

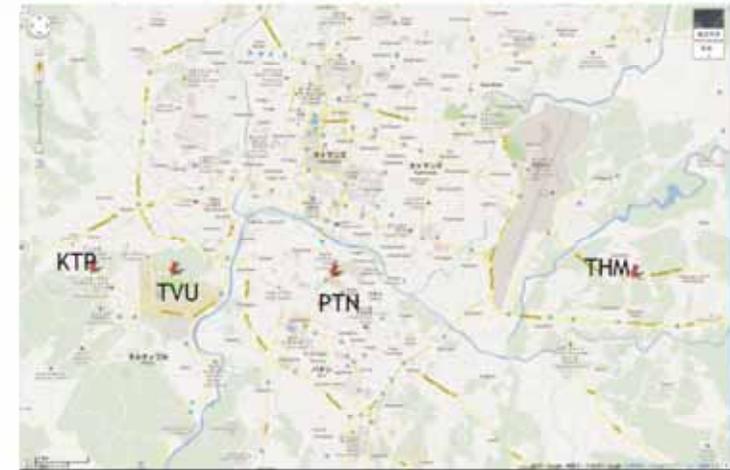
Nobuo TAKAI, Michiko SHIGEFUJI,
 Subeg BIJUKCHHEN,
 Masayoshi Ichiyonagi and Tsutomu SASATANI
 Hokkaido University, Japan

Sudhir RAJAURE
 Ministry of Industry, Nepal

Megh DHITAL
 Tribhuvan University, Nepal



Location of Strong Ground Motion Observation Sites



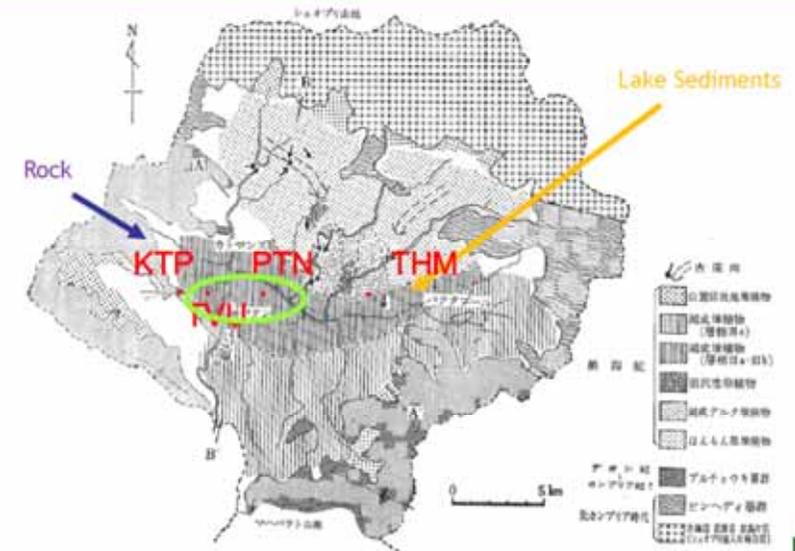
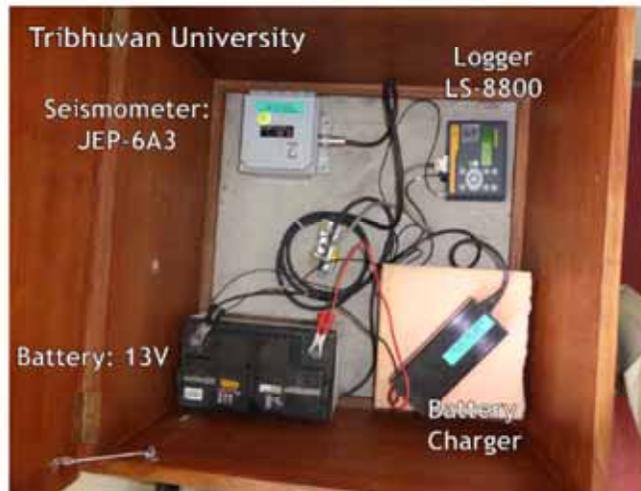
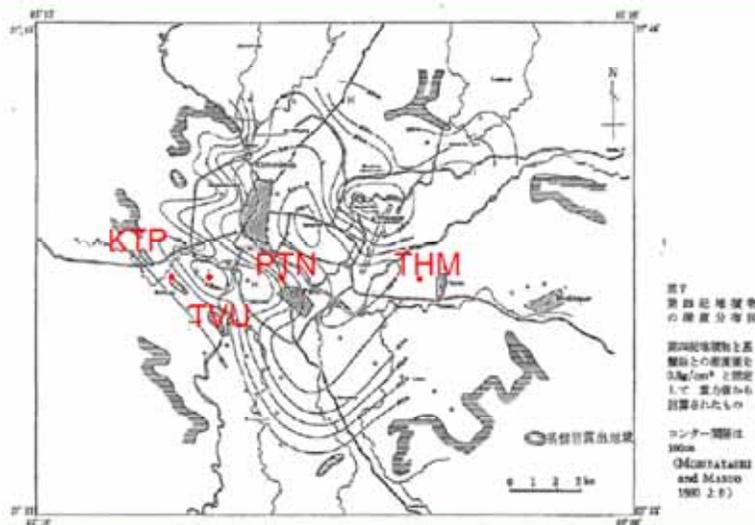
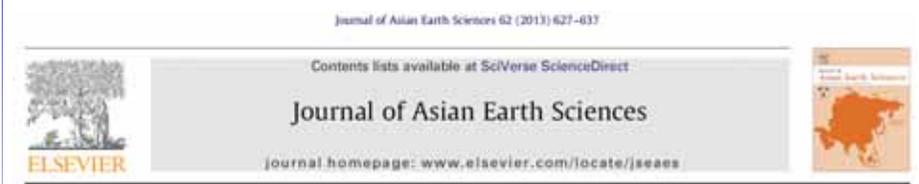


図5 カトマンズ盆地の地質図 (A-A' 断面線) は 図1の地質図と一致する。名取・他 カトマンズ盆地の天然ガス(その1) 地質) 地質ニュース 2000 (1) 加筆



カトマンズ盆地の微動探査

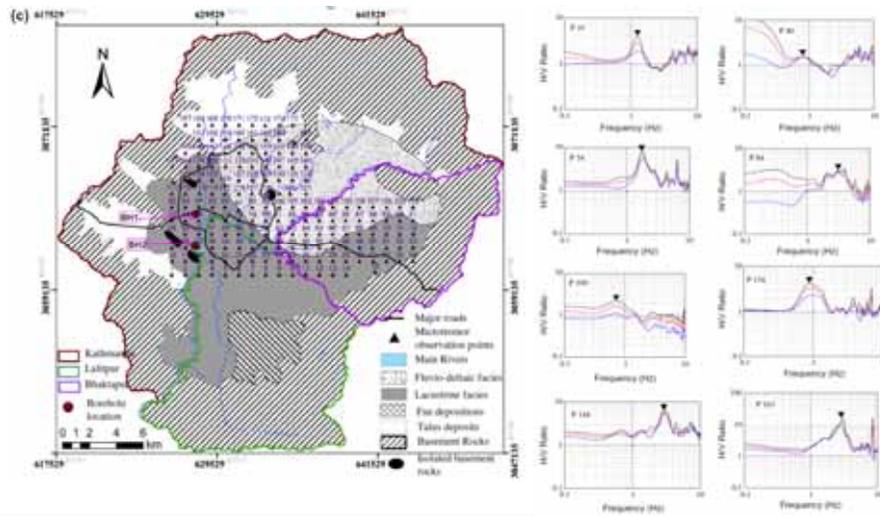


Basement topography of the Kathmandu Basin using microtremor observation

Youb Raj Paudyal*, Ryuichi Yatabe, Netra Prakash Bhandary, Ranjan Kumar Dahal

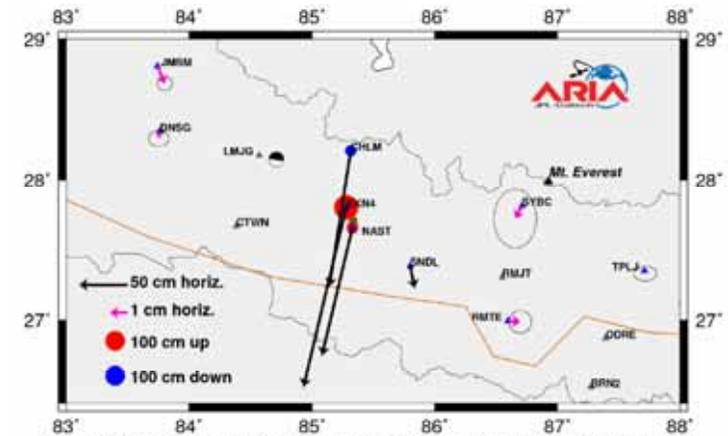
Geo-disaster Research Laboratory, Graduate School of Science and Engineering, Ehime University, Ehime, Matsuyama, Japan

カトマンズ盆地の微動探査



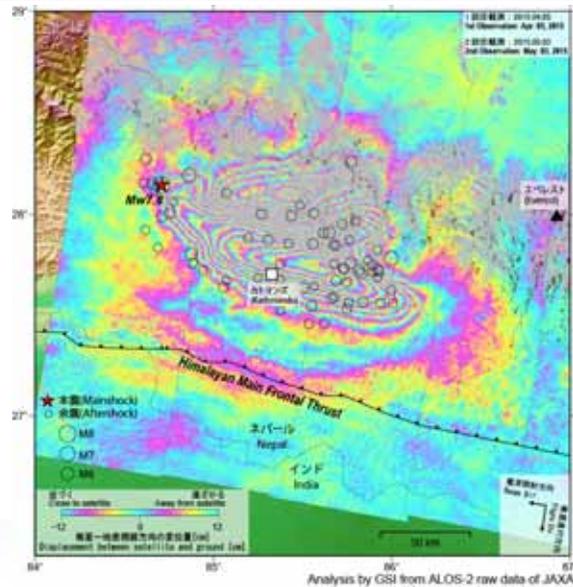
Paudyal et al. (2013)

GPS (UNAVCO JPL)

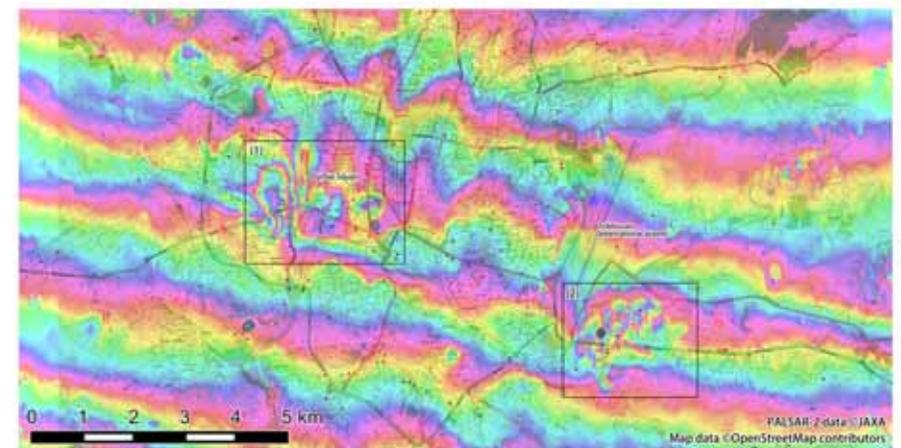


Preliminary coseismic offsets for the April 25, 2015 M7.8 Nepal earthquake (focal mechanism shown). Blue triangles are Tectonics Observatory GPS sites that have data downloads since the earthquake; gray triangles are additional network sites. Katmandu shown by green square and plate boundary (Bird) indicated by brown line. All raw GPS data provided by Jean-Philippe Avouac (California Institute of Technology and University of Cambridge). ARIA data analysis used GIPSY-OASIS software and JPL orbits.

InSAR (ALOS-2 PARSAR-2 国土地理院)



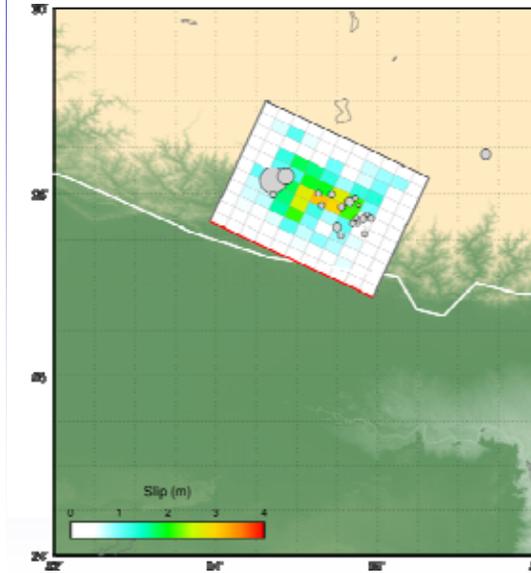
InSAR (ALOS-2 PALSER-2 JAXA)



InSAR (JAXA) の一解釈

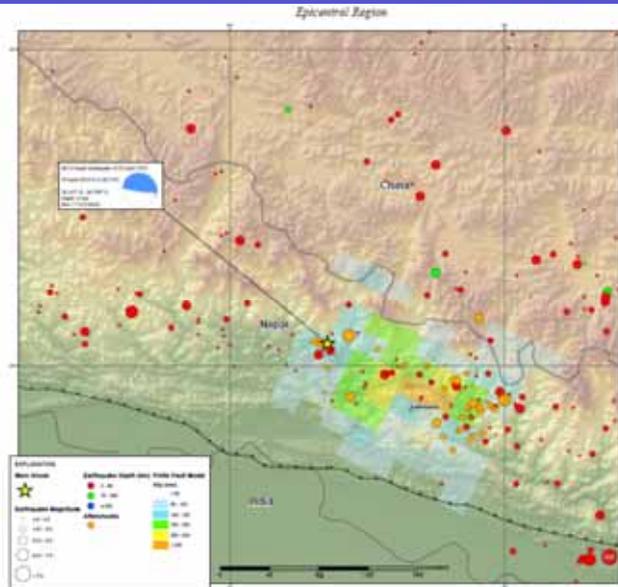


震源過程 (遠地記録 USGS)

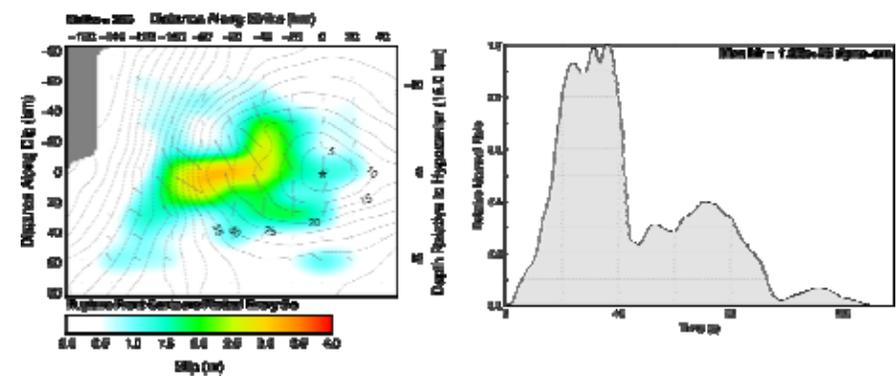


After comparing waveform fits based on the two planes of the input moment tensor, we find that the nodal plane (strike= 295.0 deg., dip= 10.0 deg.) fits the data better. The seismic moment release based upon this plane is 8.1×10^{27} dyne.cm ($M_w = 7.9$) using a 1D crustal model interpolated from CRUST2.0 (Bassin et al., 2000).

震源過程 (遠地記録 USGS)

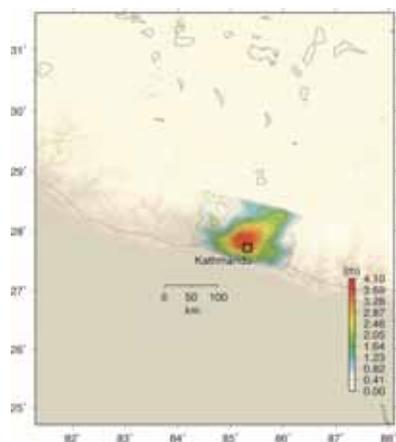


震源過程 (遠地記録 USGS)



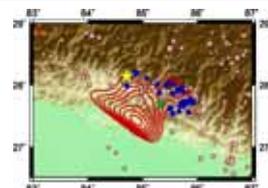
平均破壊伝播速度 V_r 2.12 km/s
小断層の平均破壊継続時間ライズタイム 7.3 s

震源過程 (遠地記録 筑波大・名大・東大)

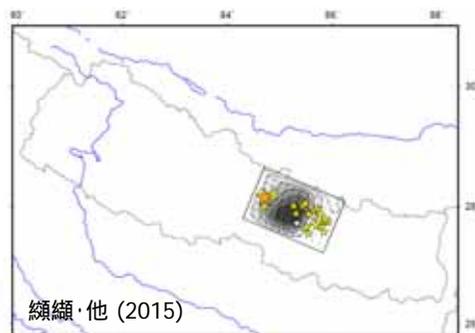


八木・奥脇 (2015)

同一
スケール
比較
(距離)

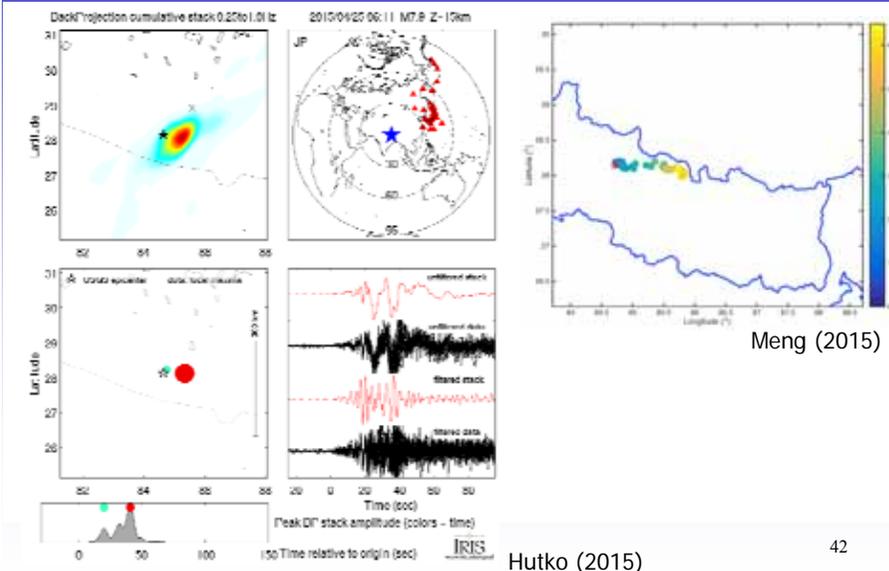


山中 (2015)



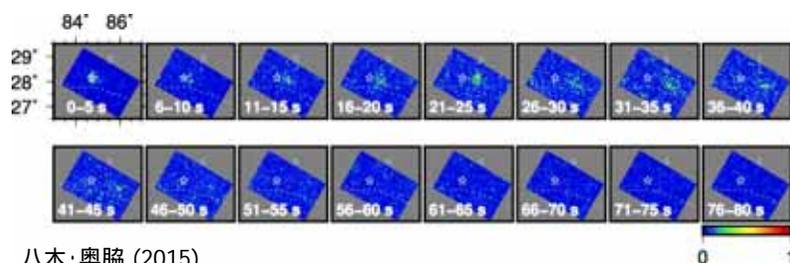
瀧縄・他 (2015)

震源過程 (Back Projection IRIS)

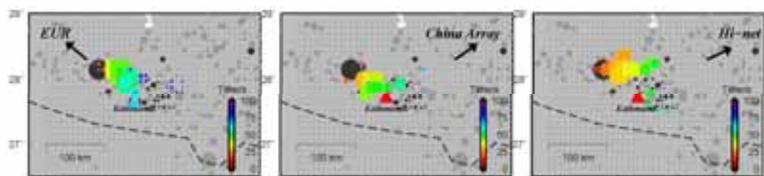


Hutko (2015)

震源過程 (Back Projection 筑波大・東大)

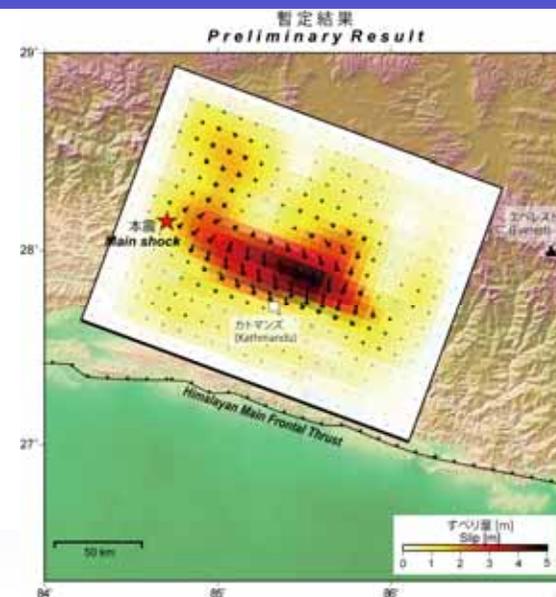


八木・奥脇 (2015)

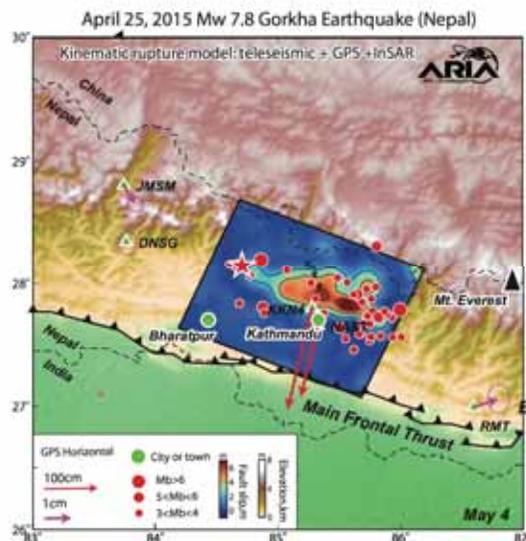


Wang (2015)

震源モデル (InSAR 国土地理院)

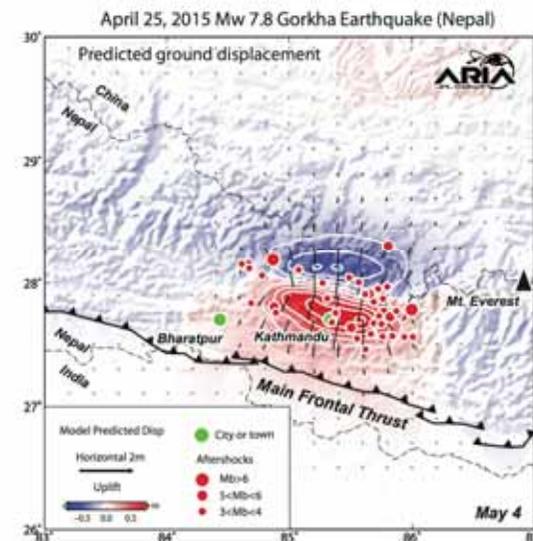


震源モデル (遠地+GPS+InSAR JPL)



45

予測変位 (遠地+GPS+InSAR JPL)



46

まとめ

- ・ 巨大地震の発生が懸念されていたネパールにおいて、Mw 7.9 の内陸地震が発生した。
- ・ 衝突帯における極めて低角の逆断層であった。
- ・ 地球物理学的な観測として、遠地記録に加え、震源域の強震・GPS・InSAR 記録が報告された。
- ・ 震源過程解析の結果、震源から首都カトマンズが位置する、東側に破壊が進行した。
- ・ 長大活断層や海溝型地震とは震源や強震動の性質が異なる可能性があり、留意が必要である。

47