Mon. Apr. 23, 2018

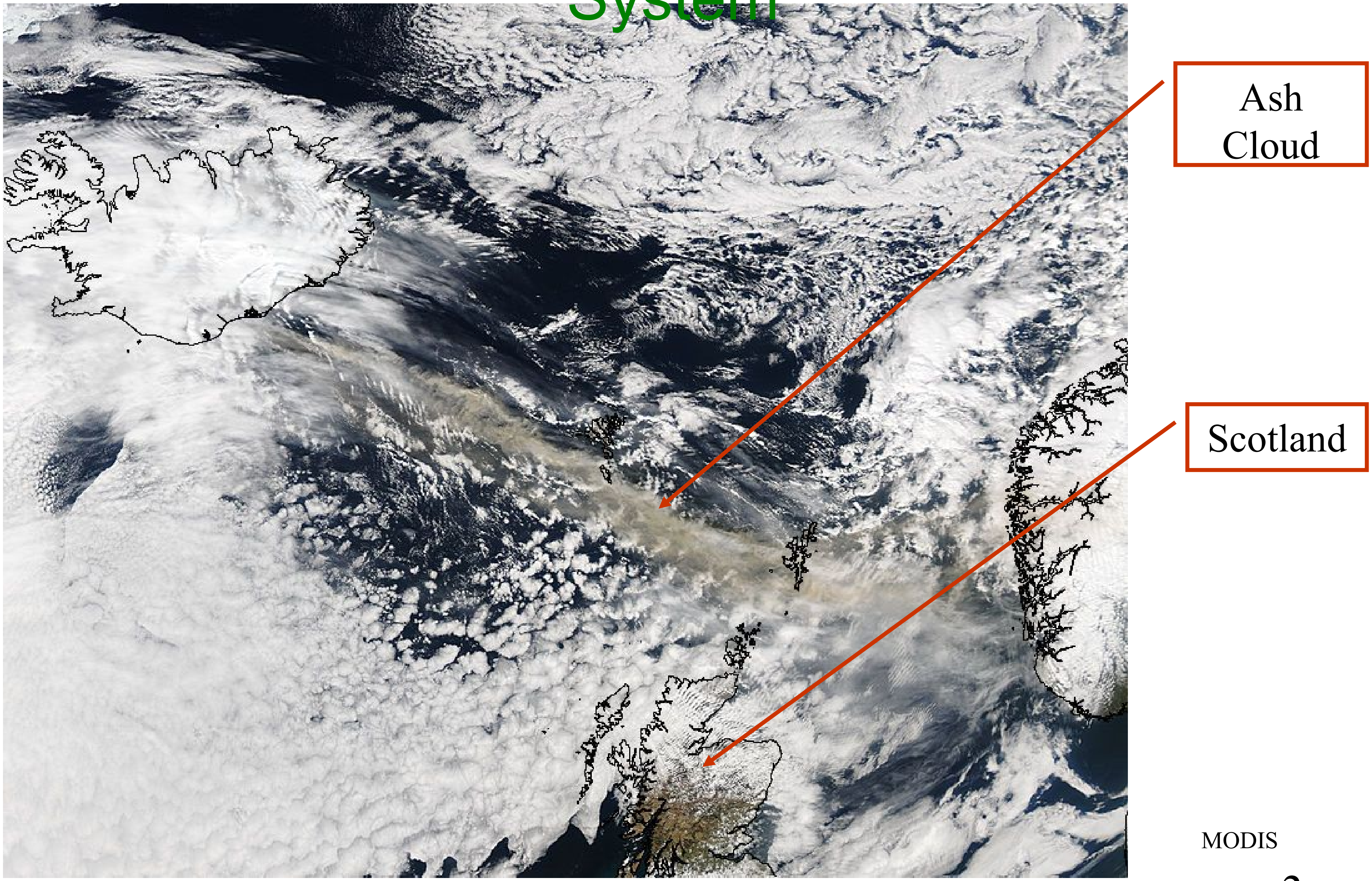
- Reading:
    - Ch. 13 -- Natural Hazards

Eyjafjallojokull

AP Photo by Jon Gustafsson

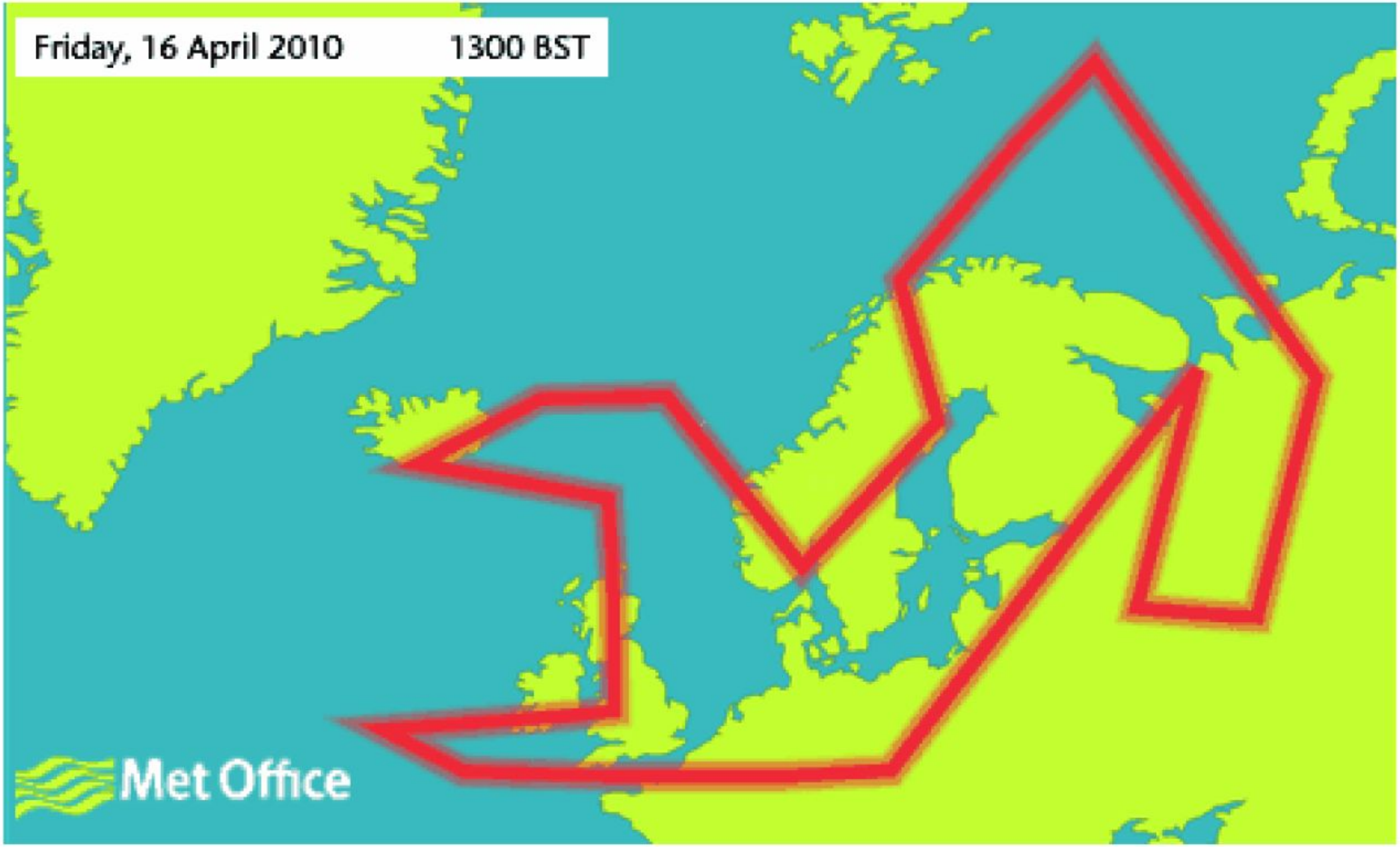
- Eruption under ice cap
  - Lava / meltwater interactions generate fine grained ash
- Covers 52,000 km^2 area (i.e. ~230 km on-a-side square)

Eyjafjallojokull – MODIS Rapid Response System



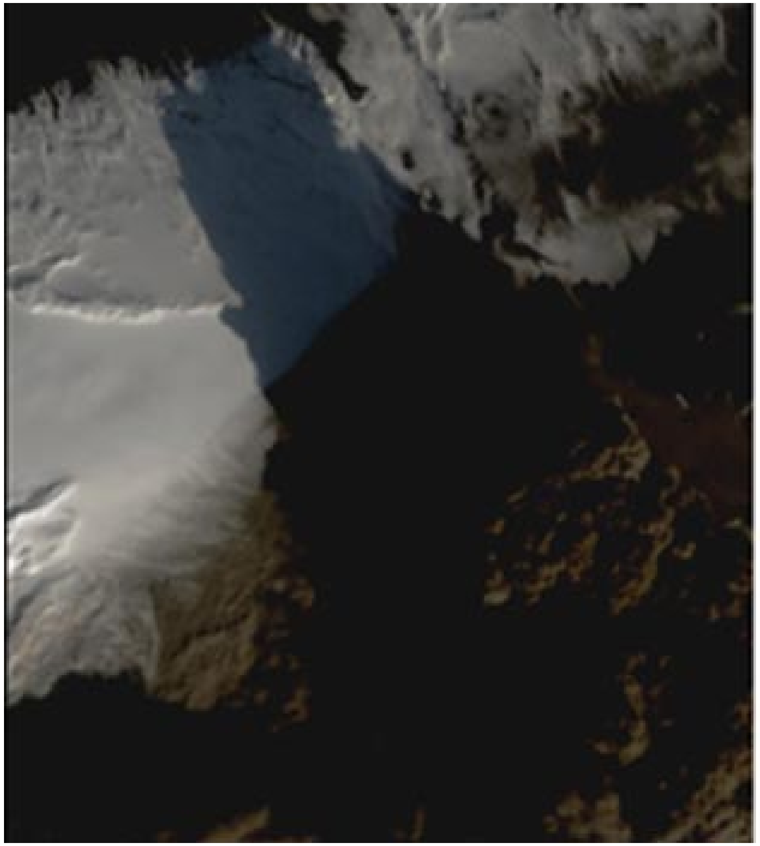
- Aqua / MODIS image 2010_04_15 1330UT   (Terra / MODIS gives AM images)

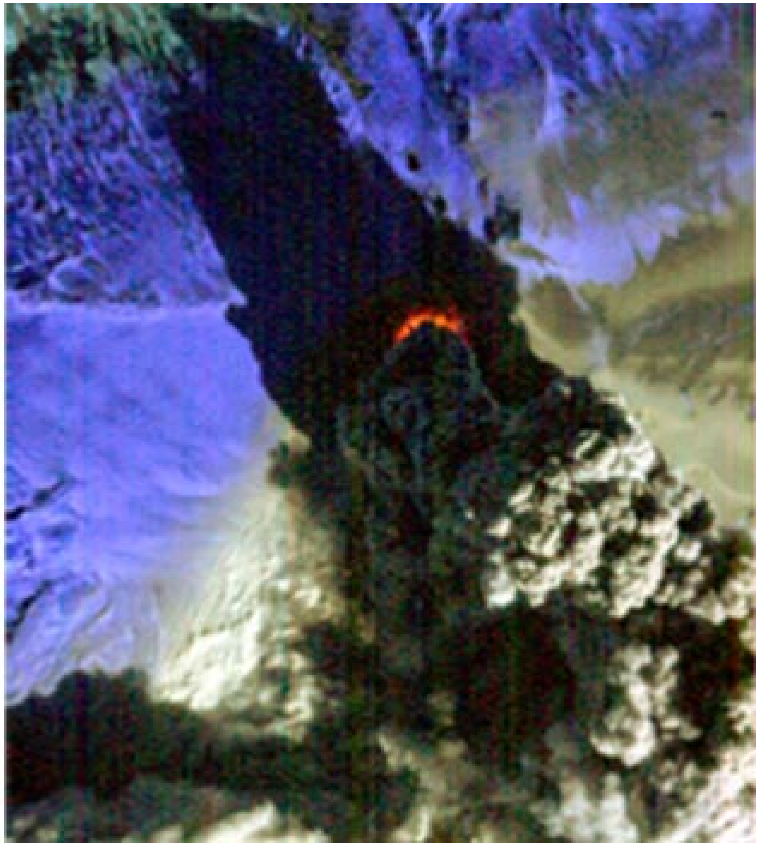
British Met Office: Plume Extent



- Flights restricted in Britain (and much of Europe)

Eyjafjallojokull



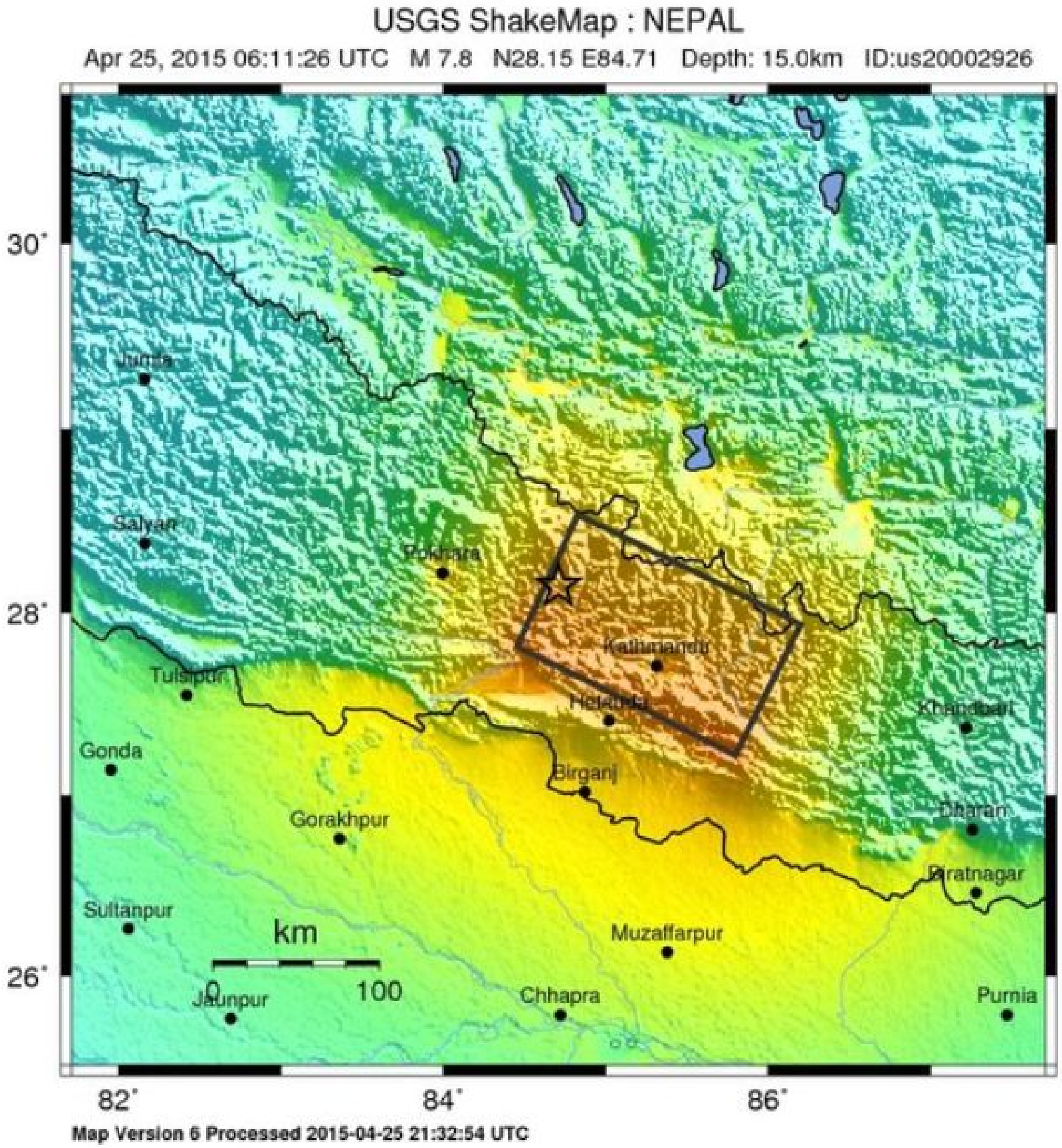


- Hyperion (on EO-1) images in visible light and near-infrared from April 17
- 220 spectral bands from 0.4 to 2.5 μm
- 30-m resolution   7.7 km $\times$ 100 km strip
- Used to estimate effusion rates (but not quoted this press release)

Remote Sensing of Earthquake Hazards

- USGS Earthquake Hazards GIS System
- Recognition and mapping of faults in poorly mapped regions
- Estimates of deformation from
  - Radar Interferometry
  - Subpixel effects in visible/IR images (along fault trace)

USGS Shakemap



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

USGS Mercalli Map

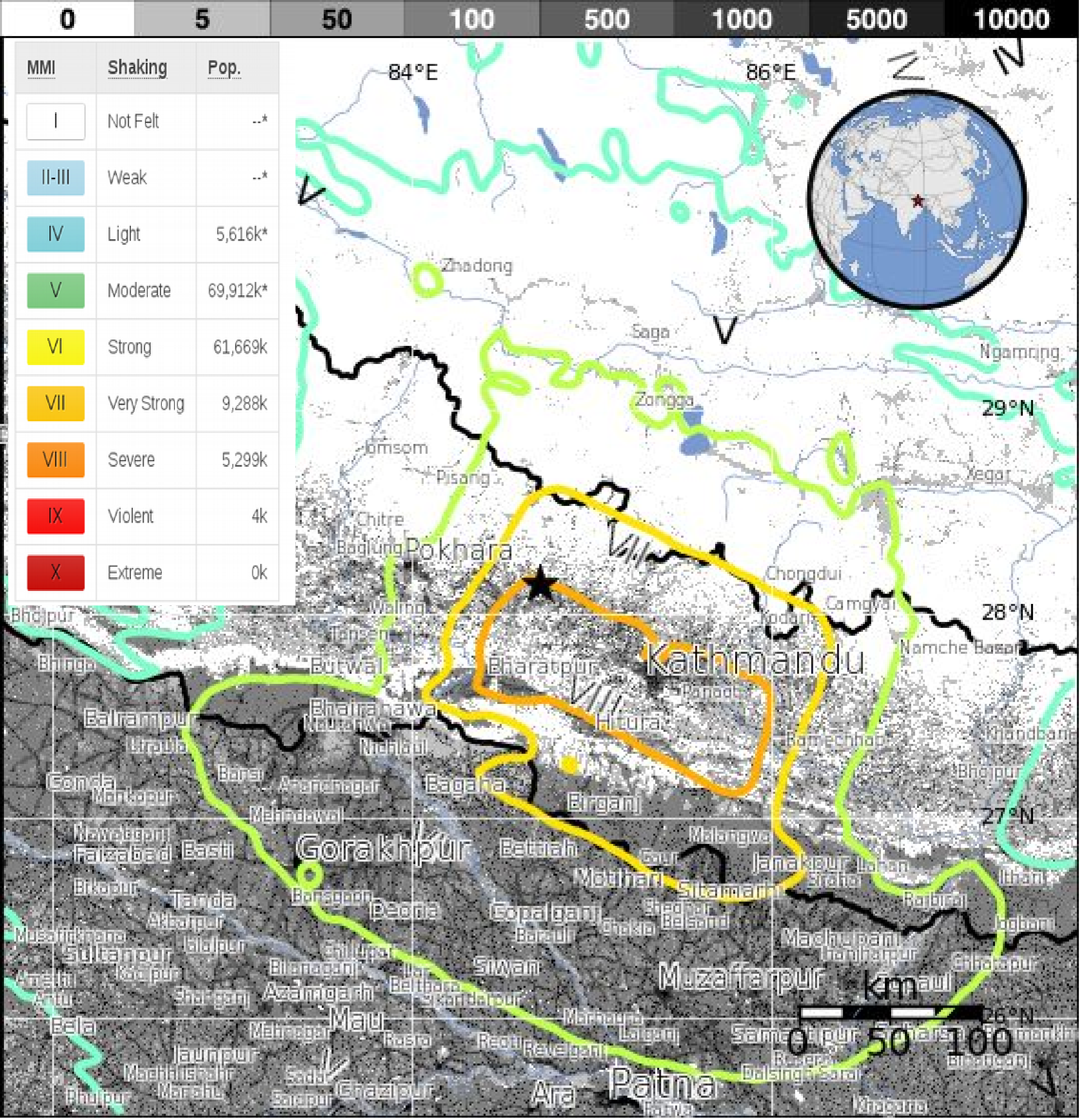


Table 11.1 Modified Mercalli Intensity Scale

Intensity	Abbreviated Description of Effects
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

(Source: USGS—http://neic.usgs.gov/neis/general/mercalli.html)

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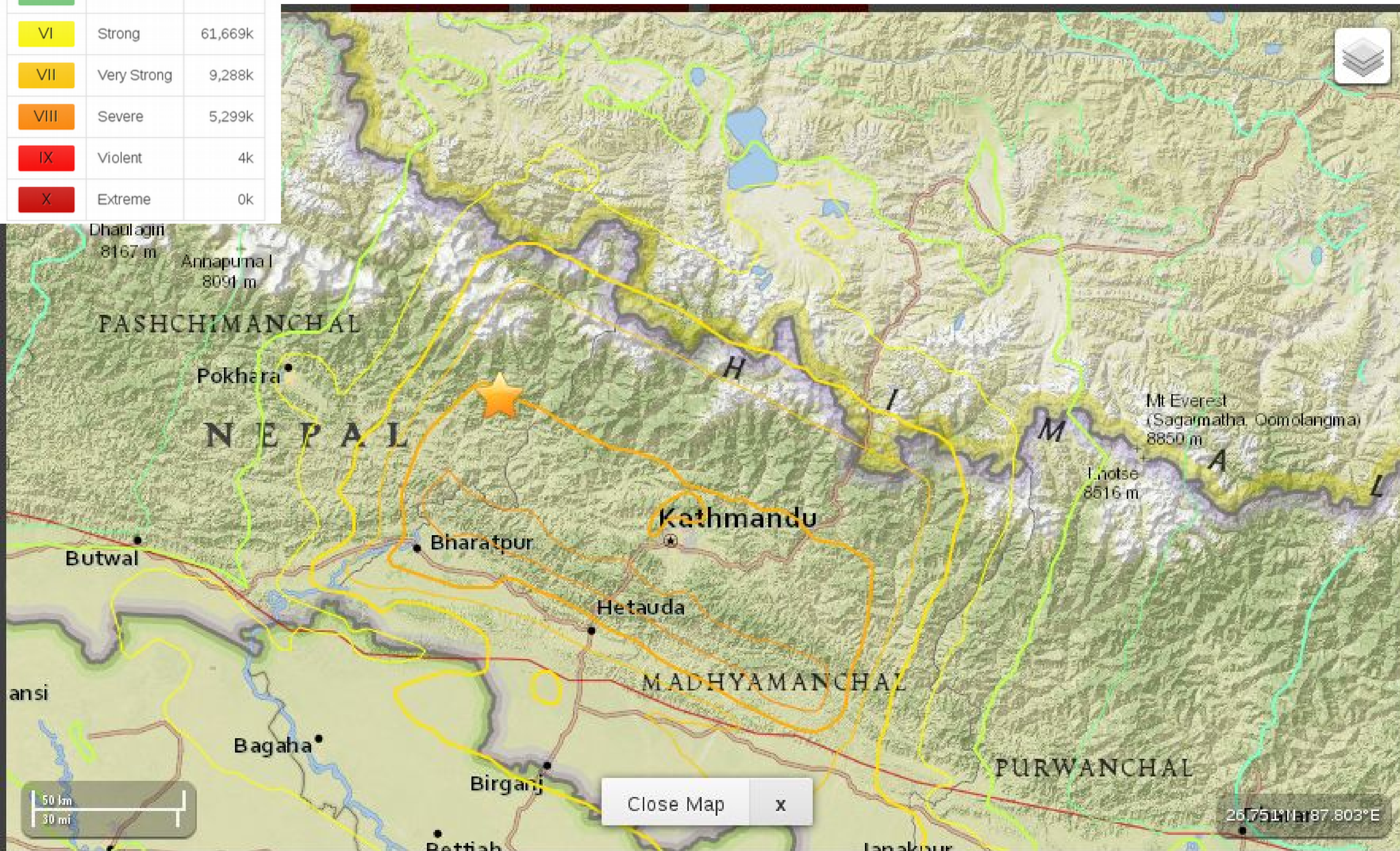
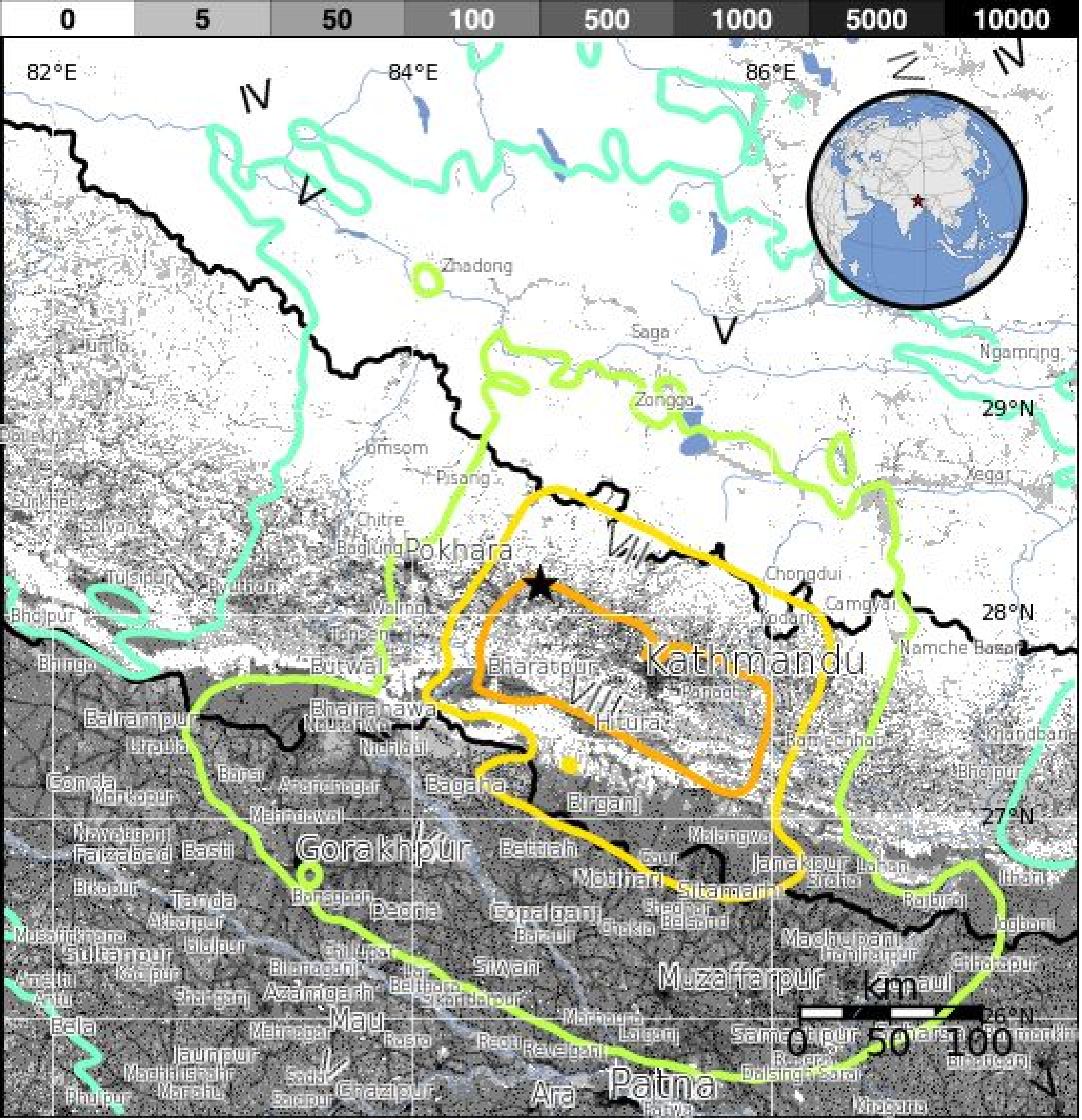
USGS Mercalli Map

MMI	Shaking	Pop.
I	Not Felt	--*
II-III	Weak	--*
IV	Light	5,616k*
V	Moderate	69,912k*
VI	Strong	61,669k
VII	Very Strong	9,288k
VIII	Severe	5,299k
IX	Violent	4k
X	Extreme	0k





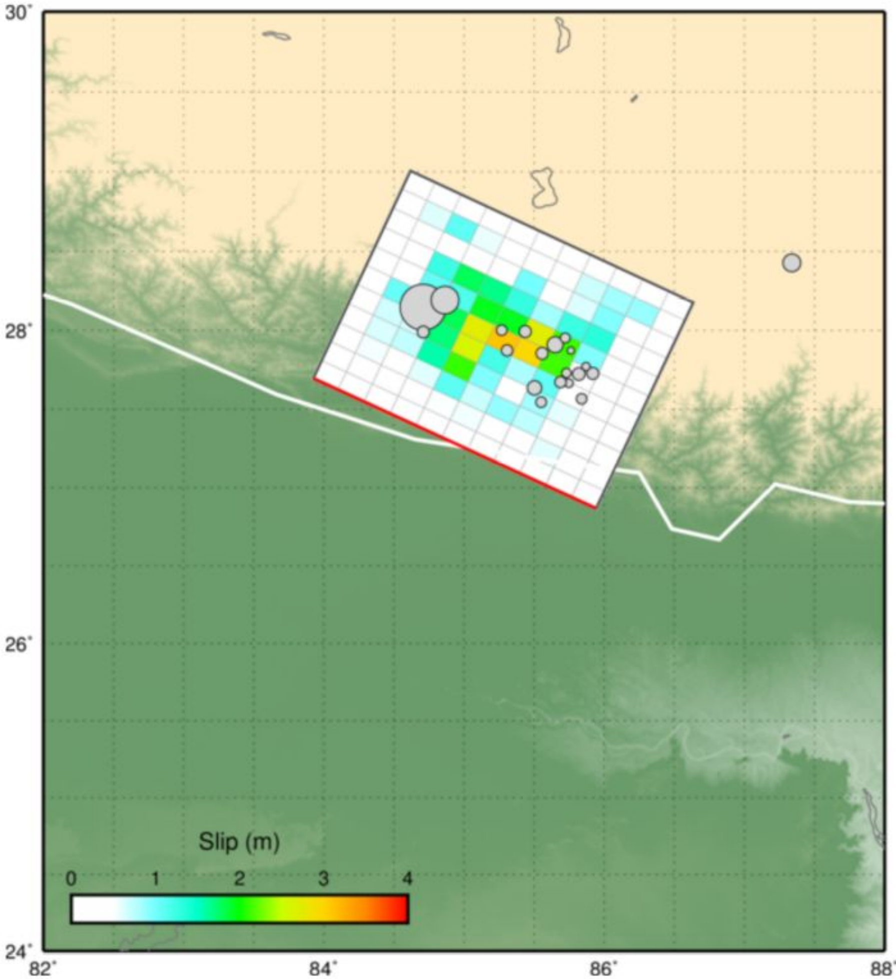
Cities

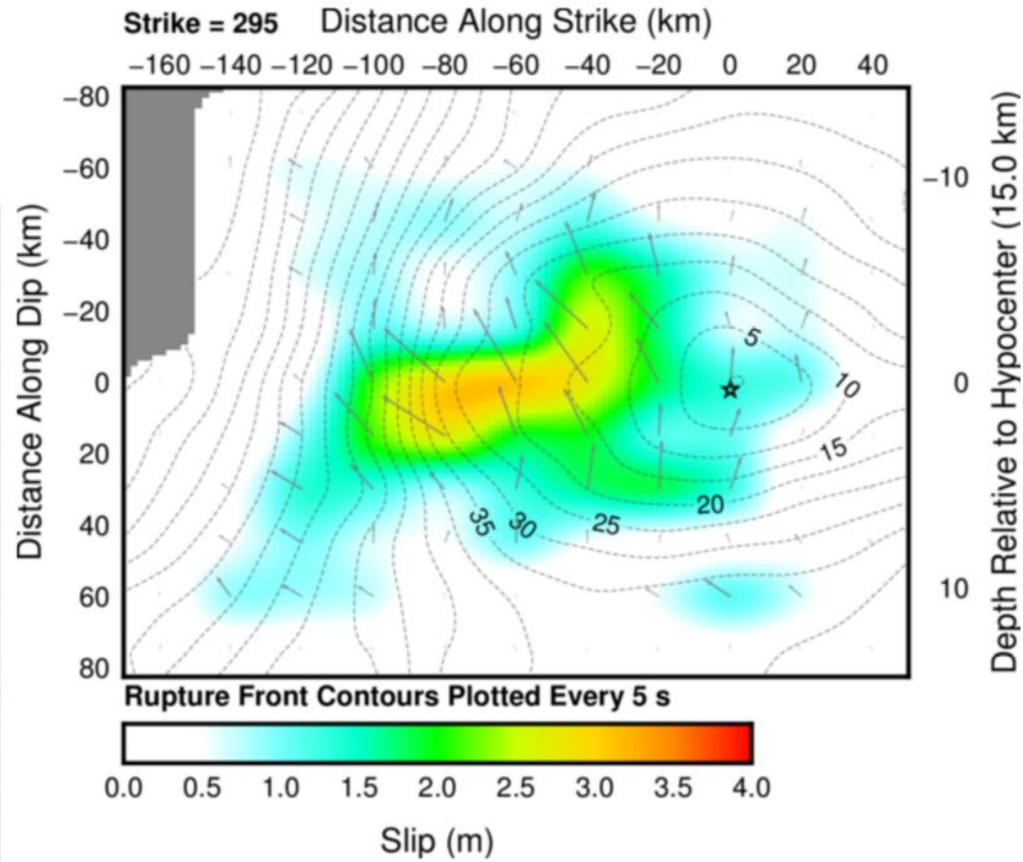
Selected Cities Exposed

Show/Hide Full City List

MMI	City	Pop.
VIII	Panaoti	28k
VIII	Banepa	17k
VIII	Bharatpur	107k
VIII	Kathmandu	1,442k
VIII	kankrabari Dovan	10k
VIII	Patan	183k
VI	Pokhara	200k
VI	Muzaffarpur	333k
VI	Gorakhpur	674k
V	Patna	1,600k
V	Dhankuta	22k

Fault Motion





Initial fit to observed seismic data indicates motion along fault with strike 295.0°, dipping at 10.0°

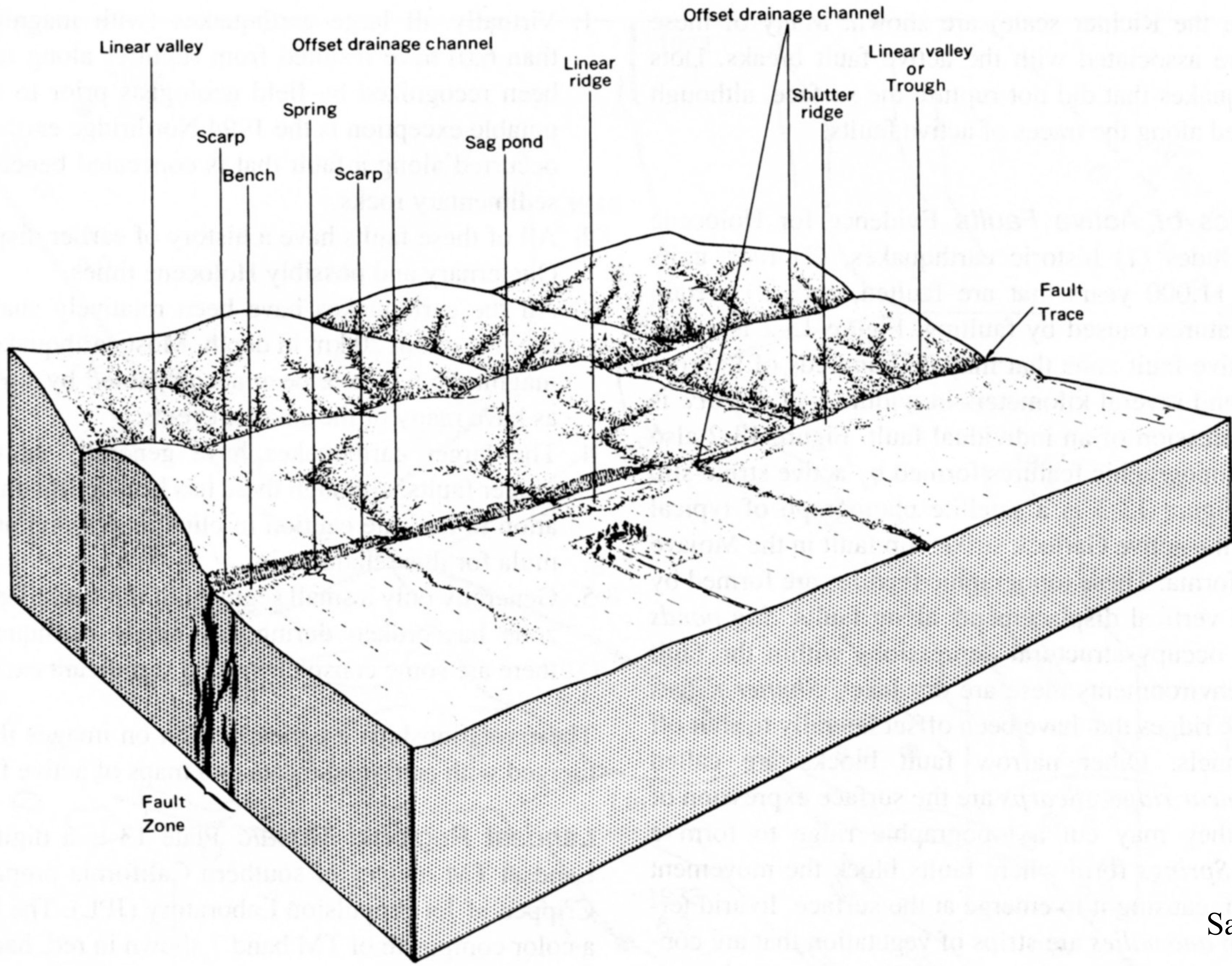
Peak displacement was about 3 meters over ~80 km of fault

Contours show time for rupture to propagate

Seismic Moment = 8.1×10^{27} dynes-cm = 8.1×10^{20} joules (Mw=7.9)

Image by
Omar Havana
/ Getty
Images,
retreved from
CBS News
2015_04_27

Fault Recognition



Sabins 1997

Figure 13-2 Typical topographic features along an active strike-slip fault. From Vedder and Wallace (1970).

Fault Recognition

Figure 13-3 Satellite photograph of the topographic features along the left-lateral, strike-slip Garlock fault, in the Mojave Desert of southern California. The following features indicate that the fault is active: D = depression, SR = shutter ridge, OC = offset channel, LR = linear ridge, LV = linear valley, FR = faceted ridge. From Merifield and Lamar (1975, Figure 2). Courtesy P. M. Merifield, UCLA.

Sabins 1997

Fault recognition in China

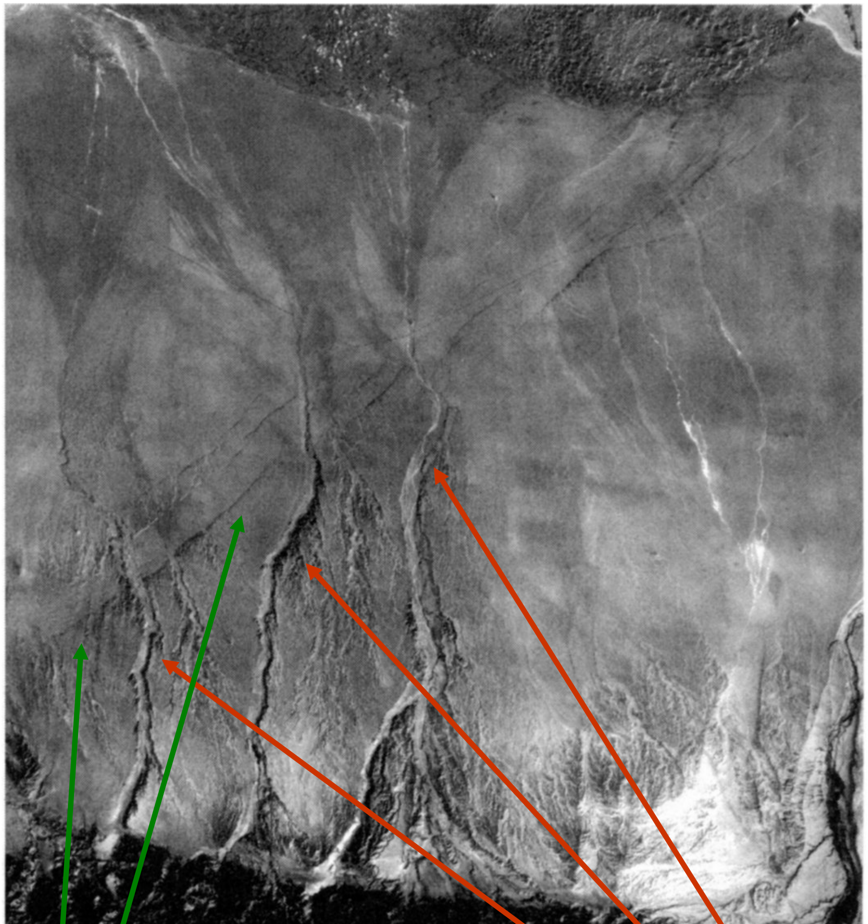


Figure 13-12 SPOT pan image of the Hotan-Qira zone of active faults in southern Xinjiang, China. The sun was shining toward the northwest (upper left corner). From Avouac and Peltzer (1993, Figure 3A). Courtesy G. Peltzer, JPL.

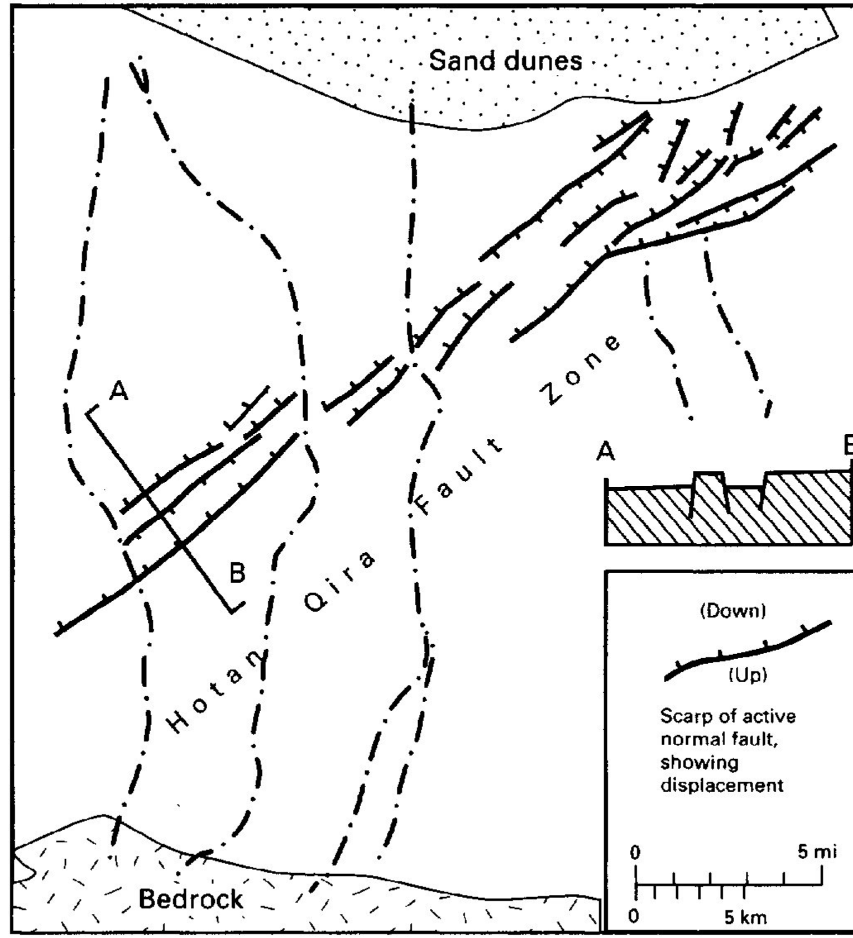


Figure 13-13 Interpretation map and cross section of the SPOT image of the Hotan-Qira fault system (Figure 13-12). Modified from Avouac and Peltzer (1993, Figure 3A).

Sabins 1997

Scarps from normal component

Offset channels, from slip-strike component

Sabins 1997

Landers Earthquake of June 28, 1992

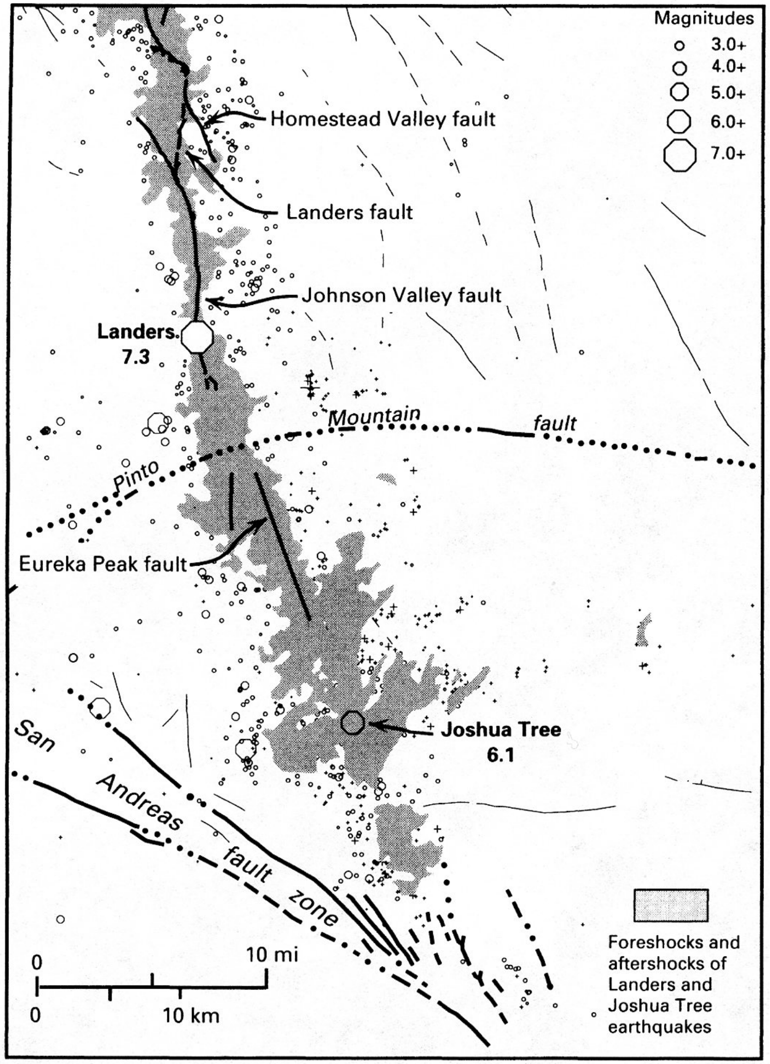
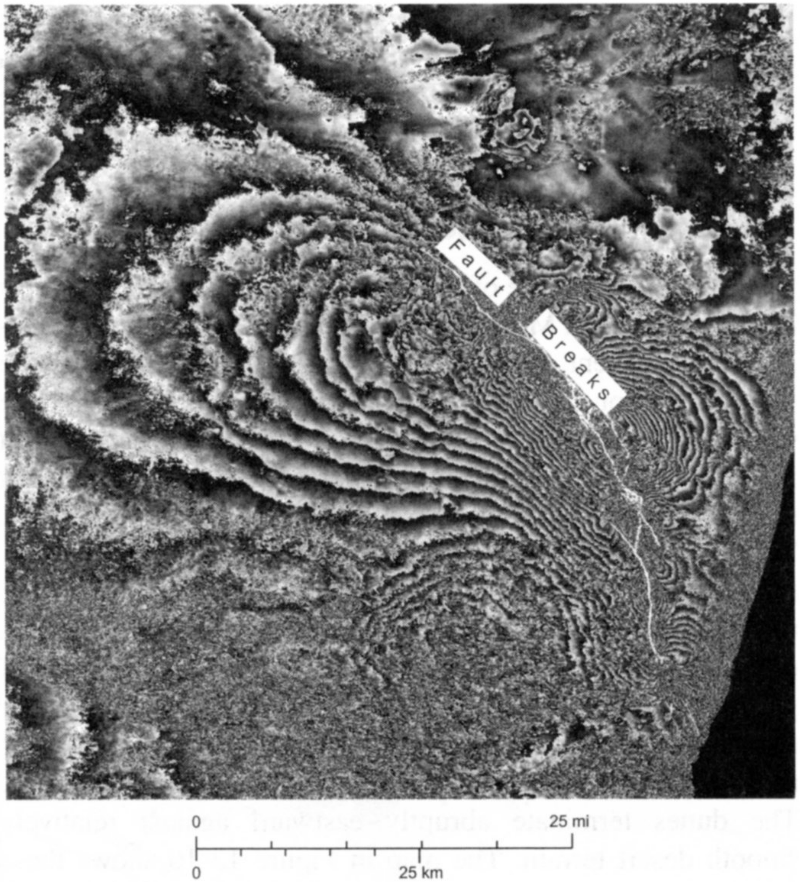
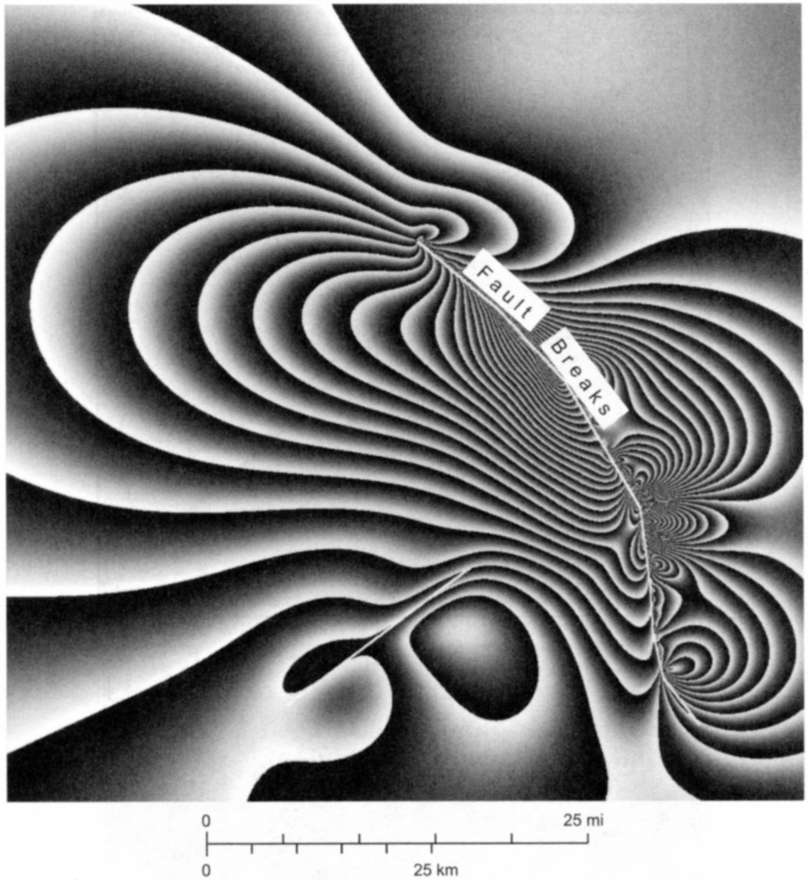


Figure 13-4 Seismicity (January 1 to August 18, 1992) for the Landers earthquake of June 28, 1992. Solid lines are exposed faults; dotted lines are faults concealed by young deposits; dashed lines are inferred faults. Modified from Yeats, Sieh, and Allen (1996, Figure 8-51). Courtesy K. Sieh, California Institute of Technology.

Sabins 1997

Landers Earthquake of June 28, 1992



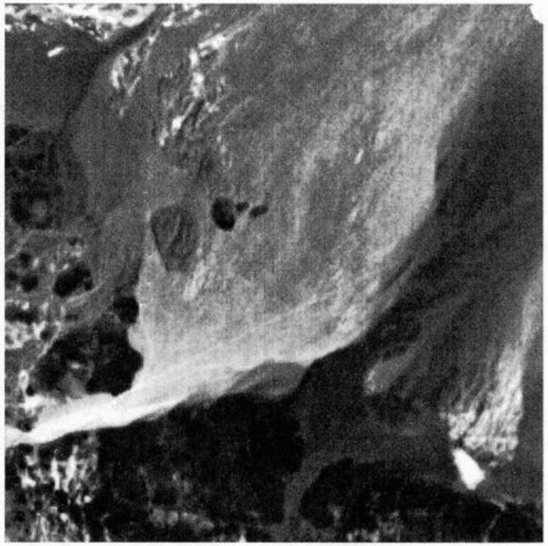


ERS-1 April 24 vs. Aug. 7 1992 interferogram, plus model based on fault displacement

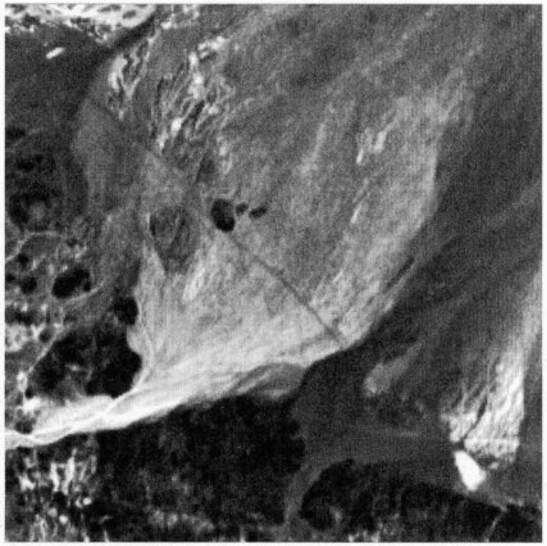
Each cycle is 28 mm.   20 cycles (560-mm evident)

Sabins 1997

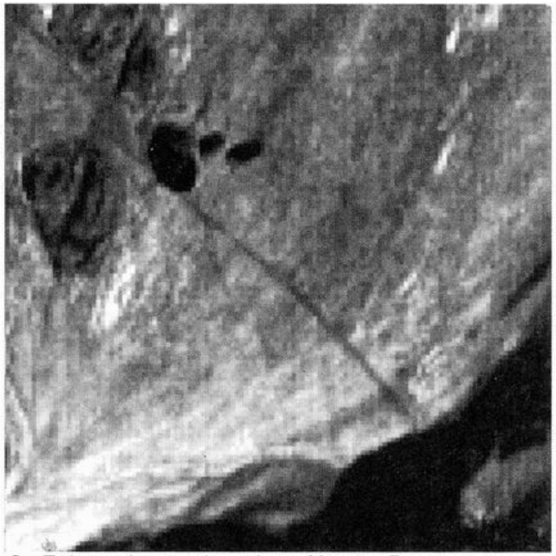
Landers Earthquake of June 28, 1992



A. Image acquired July 27, 1991 (before earthquake).



B. Image acquired July 25, 1992 (after earthquake).



C. Enlarged central portion of image B.

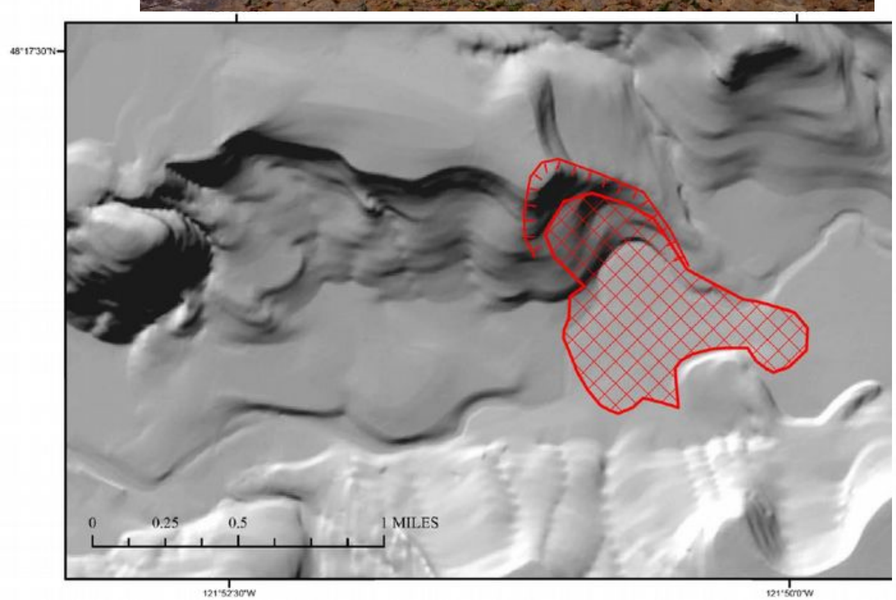
Sabins 1997

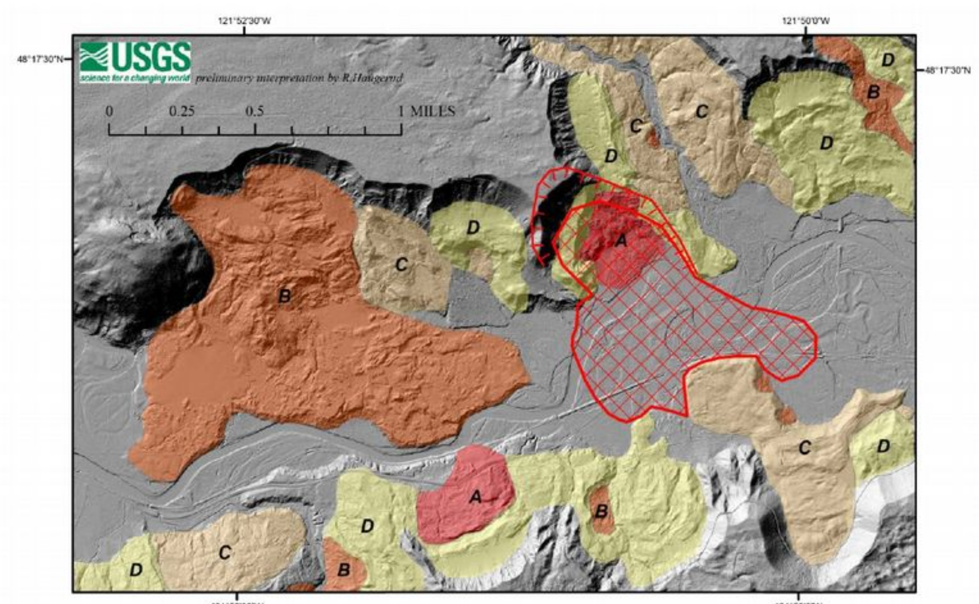
Fault rupture can also be mapped in SPOT data

Landslides

- Remote sensing provides wide view – can recognize unknown prehistoric slides
    - Mechanisms of "long run-out" slides not completely understood
    - Present on other planets too – where not all terrestrial mechanisms could work
    - Blackhawk Slide in CA is classic example – used as analog to planetary ones
- Submarine slides off Hawaii islands recognized with sonar.
    - Mega-slides – caused prehistoric mega-tsunami

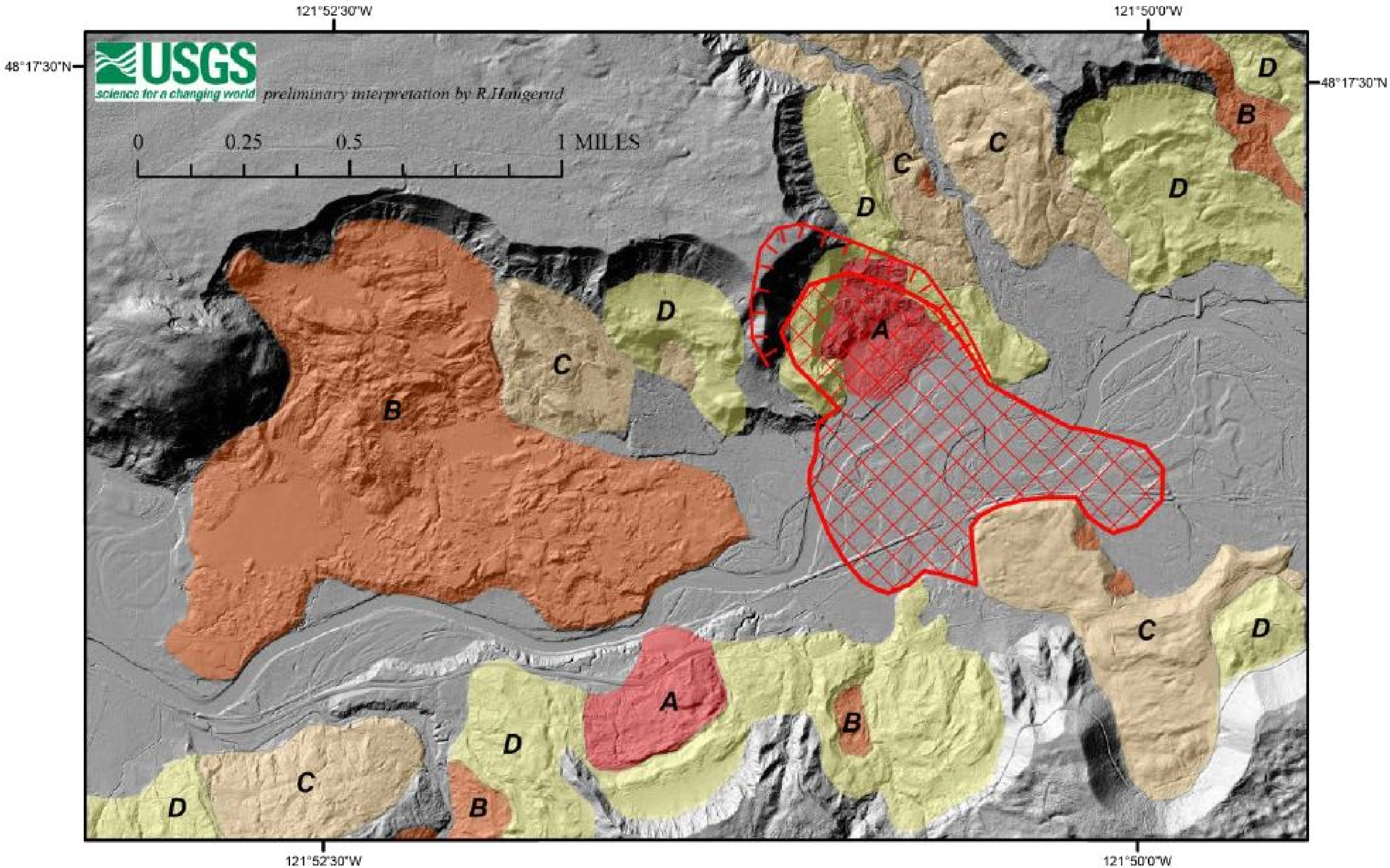
Oso Washington Slide (2014)





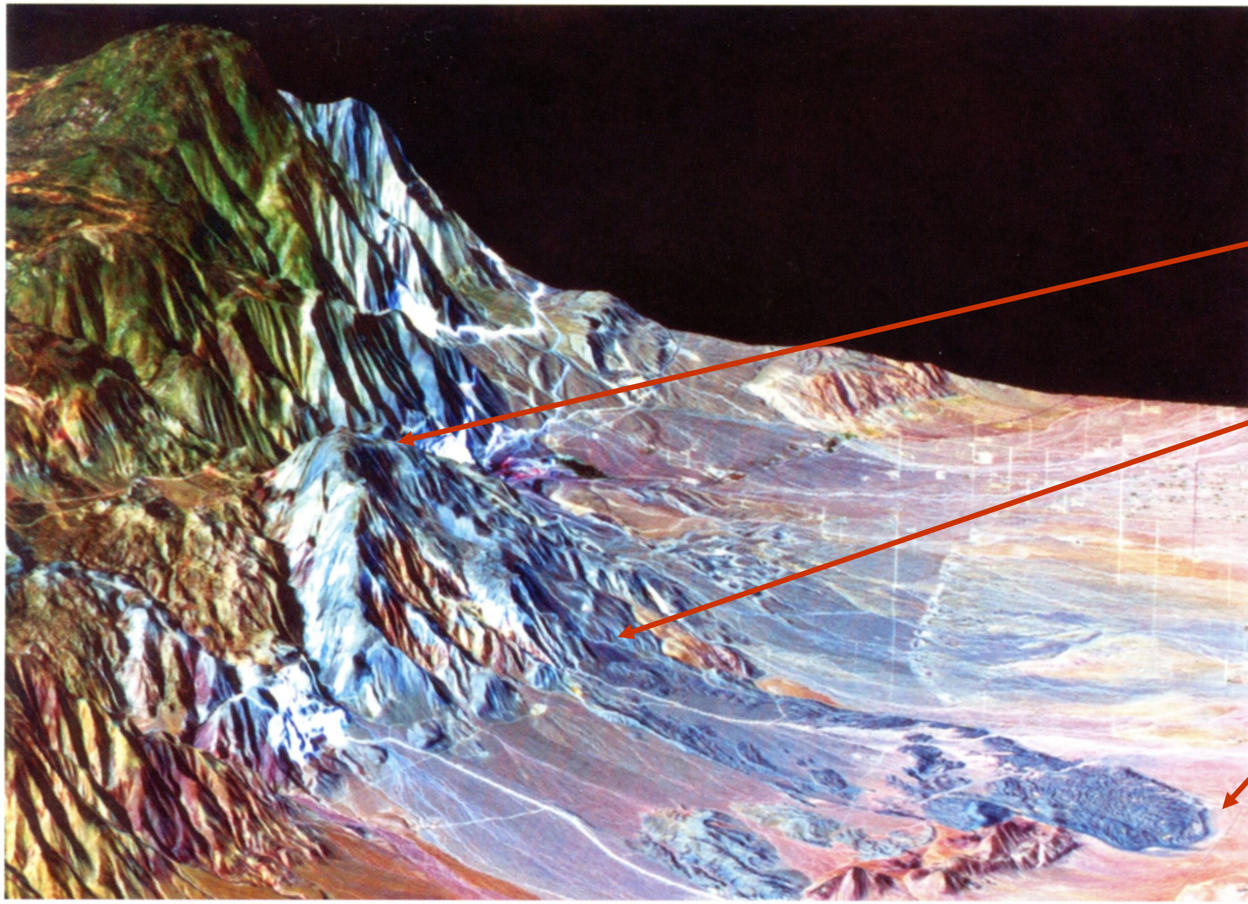
•Lidar, by providing high resolution topography which sees through trees, can show previous landslide deposits

Oso Washington Slide (2014)



Lidar, by providing high resolution topography which sees through trees, can show previous landslide deposits

Blackhawk Slide. CA

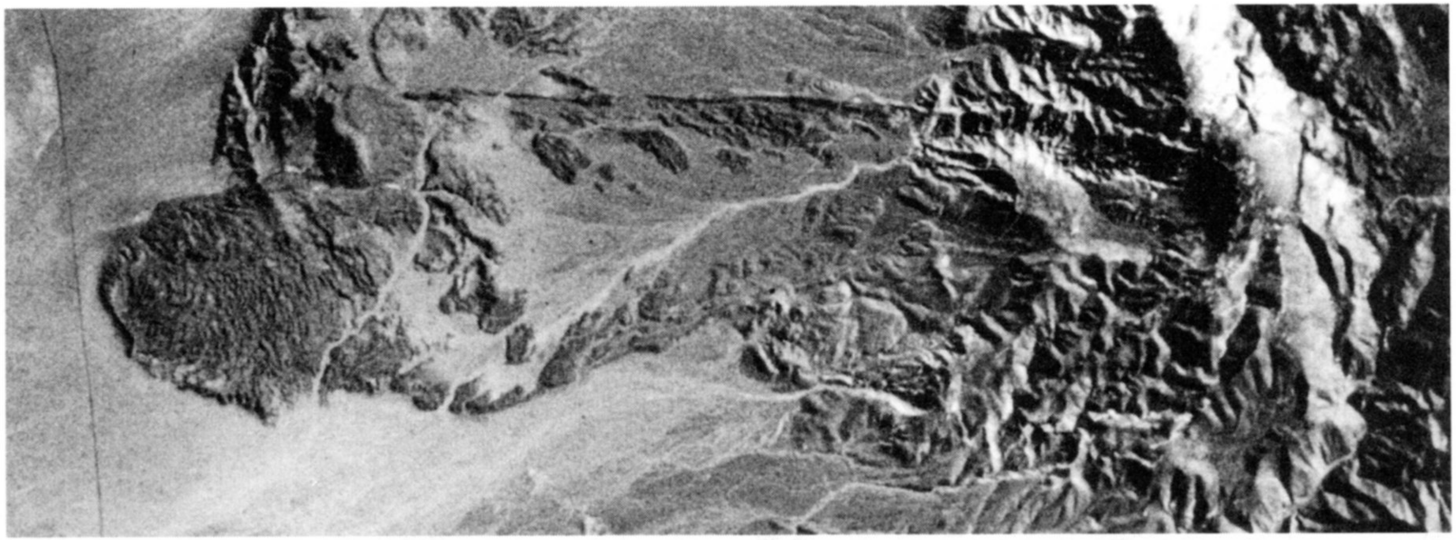


A. Composite of TM 2-4-7 image, SPOT pan image, and digital elevation data. Blackhawk landslide, California. Courtesy R. E. Crippen, JPL.

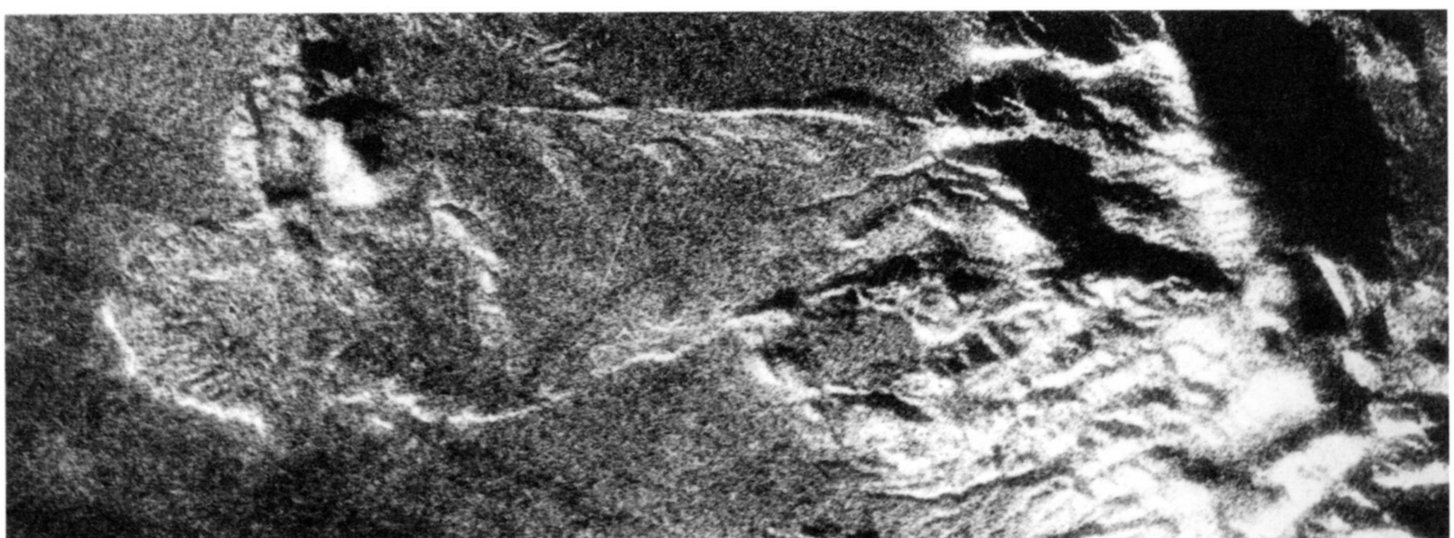
Sabins 1997, Plate 14

- Blackhawk slide on N side of San Bernadino Mountains
- Classic example of "long run-out" slide – studied as analog of many planetary slides
  - Mechanism (trapped air?) not as certain as Sabins indicates
- Image is combination of Landsat TM + SPOT data draped over Digital Elevation Model

Blackhawk Slide, CA



A. Satellite photograph.



B. Aircraft X-band radar image.

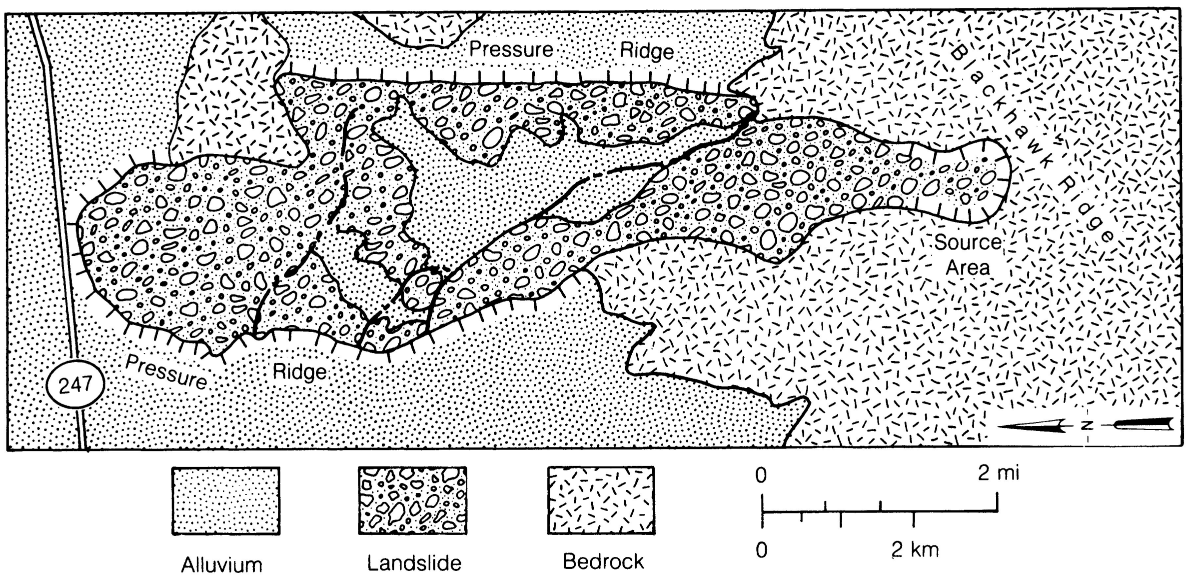
Toe and lateral margins stand 15 to 30 m above surface of slide.

Slide itself is brighter than superposed alluvium.

Sabins 1997

Blackhawk Slide, CA

A. Satellite photograph.



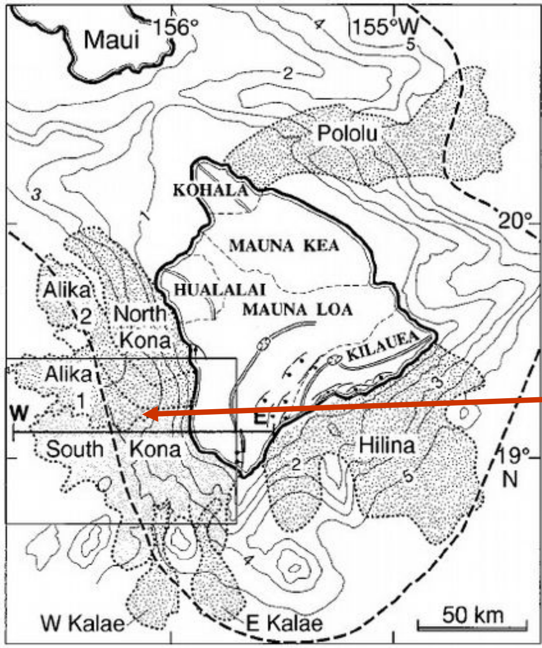
C. Interpretation map.

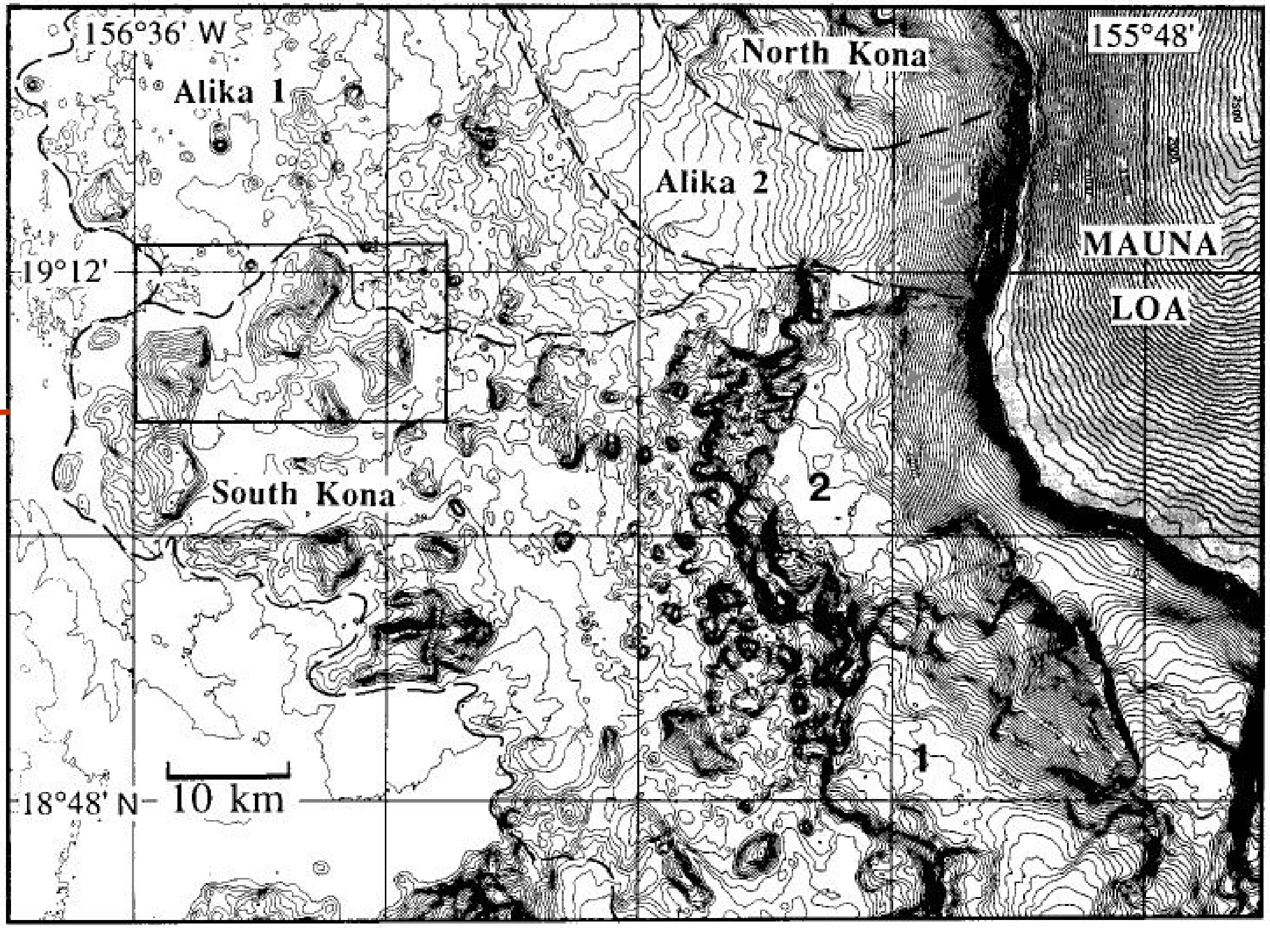
- Possible mechanisms
  - Acoustic fluidization
  - Trapped air
    (Earth only?)
  - Fluids
    (arid region?)

- Also studied with Remote Sensing to provide comparison for planetary observations

Sabins 1997

Hawaii submarine landslides





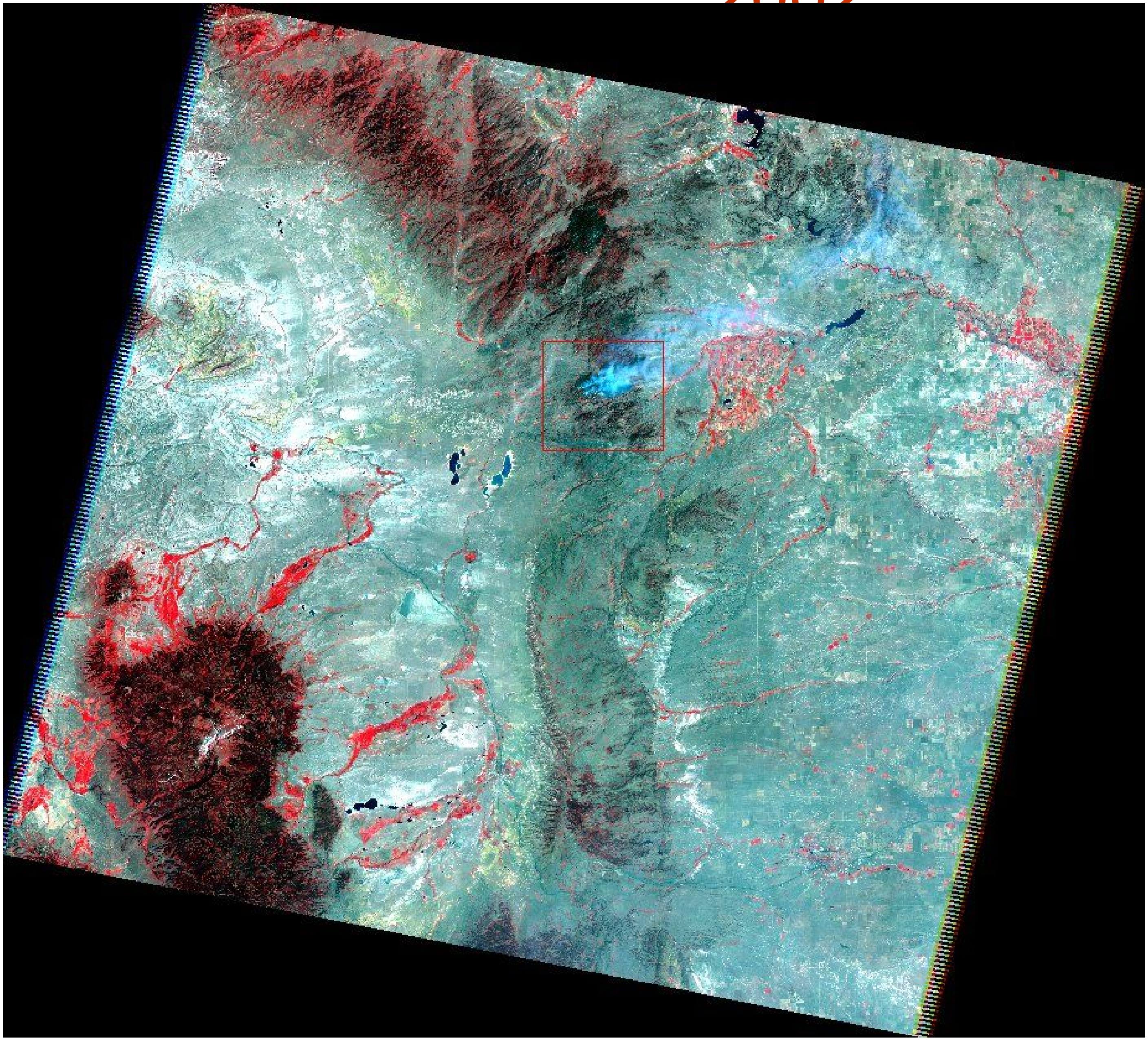
Moore et al. 1995

Stippled areas in map are landslide deposits – recognized at higher resolution by hummocky nature.

As volcano builds, underwater slopes are "oversteep" and fail periodically

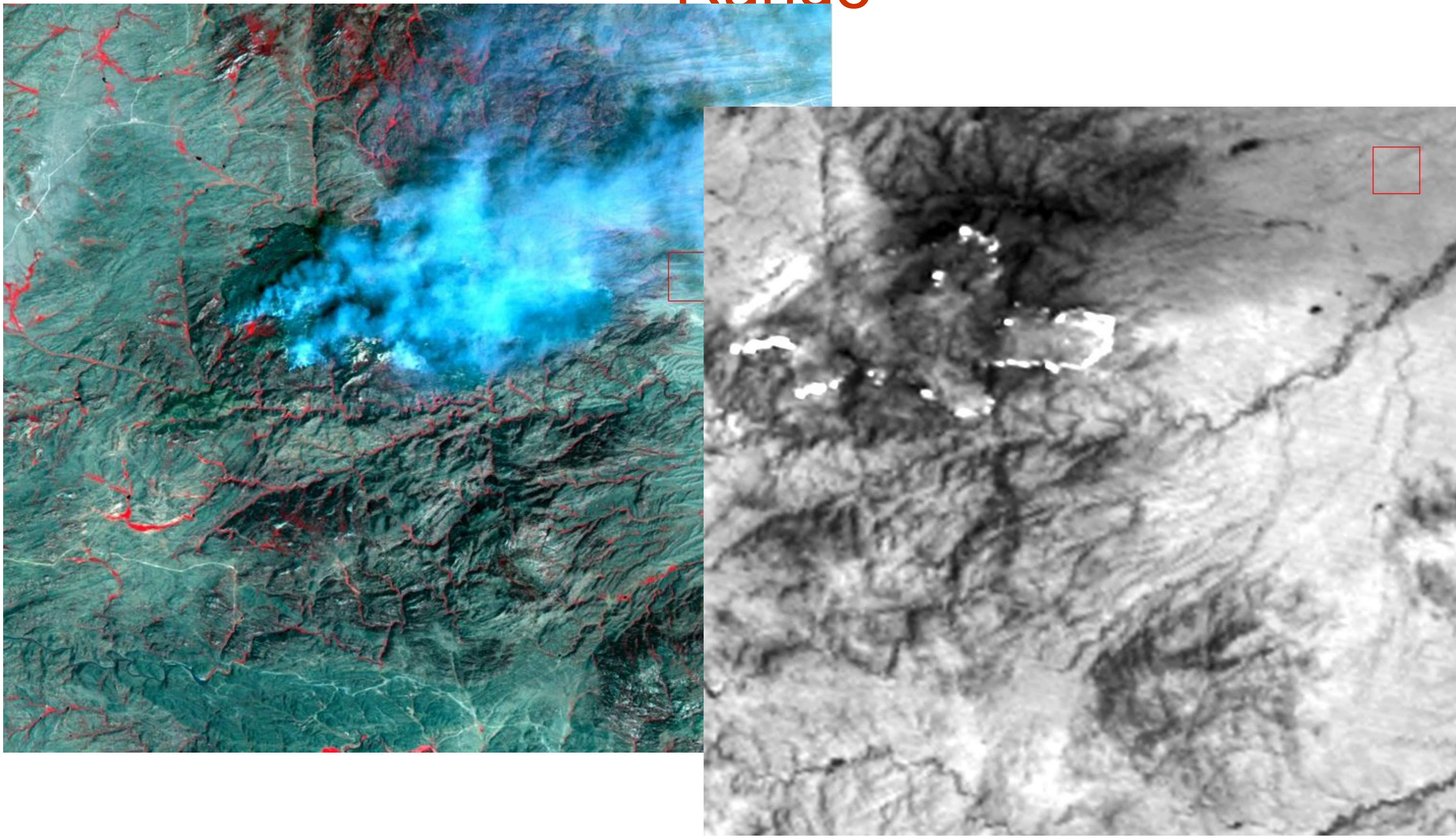
Can cause massive tsunami

Laramie Landsat 4 July 1, 2002



Additional Hazards remote sensing

Fire in northern Laramie Range



Note transparency of smoke in TIR

Outline of active hot regions at edge of burn