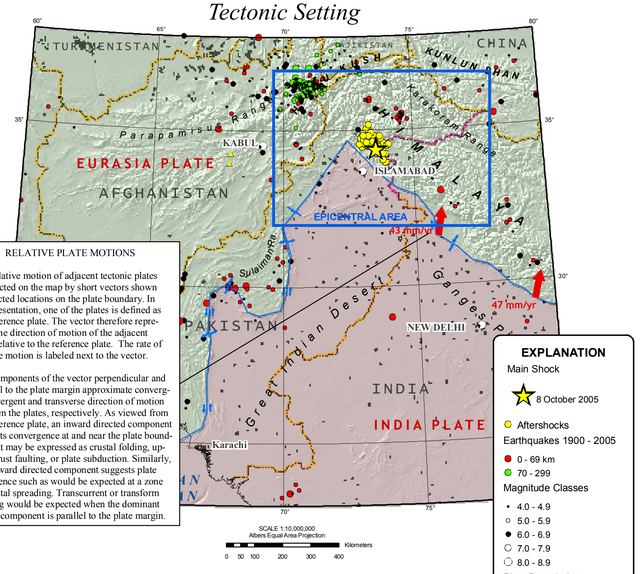
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

M7.6 Northern Pakistan Earthquake of 8 October 2005

Tectonic Setting



RELATIVE PLATE MOTIONS

The relative motion of adjacent tectonic plates is depicted on the map by short vectors shown at selected locations on the plate boundary. In this presentation, one of the plates is defined as the reference plate. The vector therefore represents the direction of motion of the adjacent plate relative to the reference plate. The rate of relative motion is labeled next to the vector.

The components of the vector perpendicular and parallel to the plate margin approximate convergent/divergent and transverse direction of motion between the plates, respectively. As viewed from the reference plate, an inward directed component suggests convergence at and near the plate boundary that may be expressed as crustal folding, uplift, thrust faulting, or plate subduction. Similarly, an outward directed component suggests plate divergence such as would be expected at a zone of crustal spreading. Transcurrent or transform faulting would be expected when the dominant vector component is parallel to the plate margin.

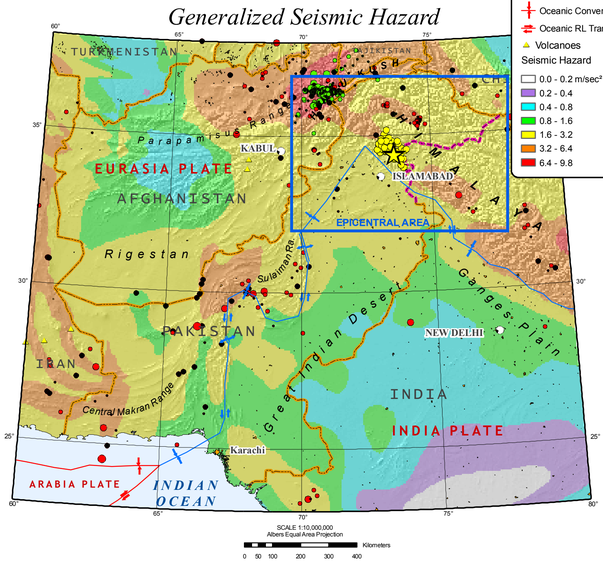
EXPLANATION

Main Shock
8 October 2005

Aftershocks
Earthquakes 1900 - 2005
0 - 69 km
70 - 299
Magnitude Classes
4.0 - 4.9
5.0 - 5.9
6.0 - 6.9
7.0 - 7.9
8.0 - 8.9

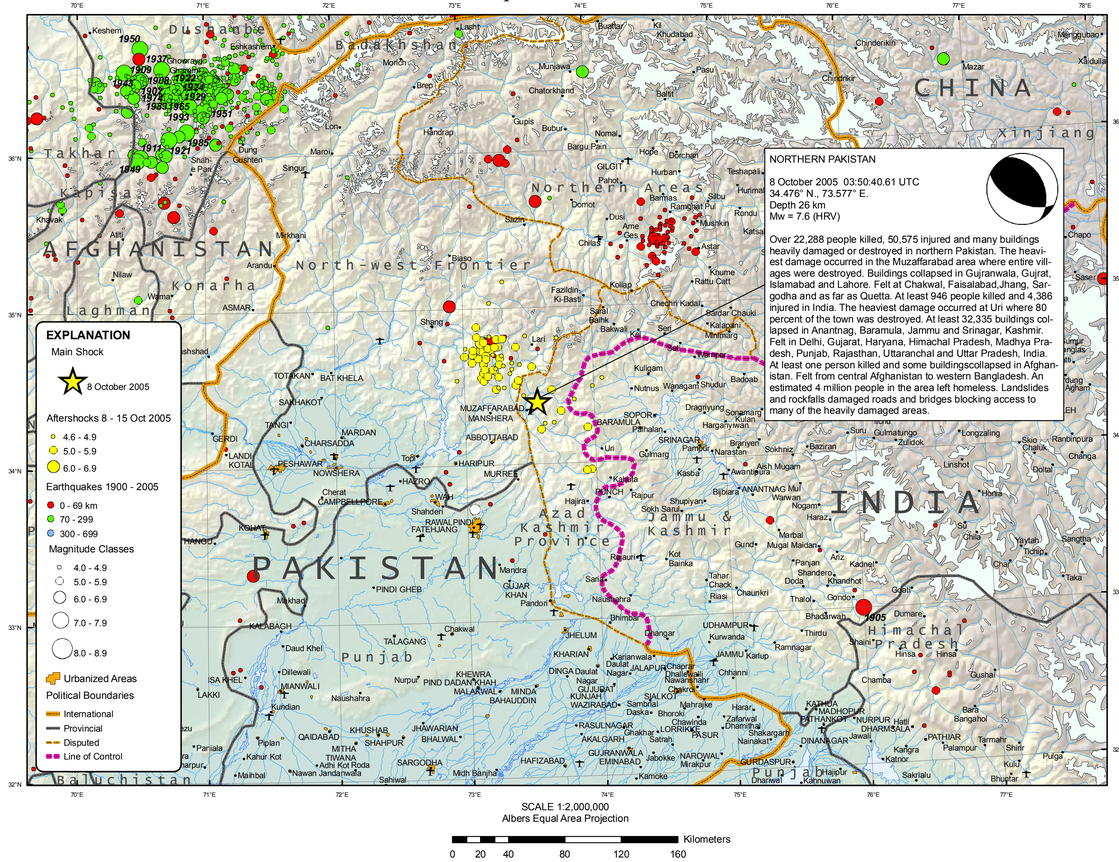
Plate Boundaries
Continental Convergent
Continental Rift
Continental LL Transform
Continental RL Transform
Oceanic Convergent
Oceanic RL Transform
Volcanoes
Seismic Hazard
0.0 - 0.2 m/sec²
0.2 - 0.4
0.4 - 0.8
0.8 - 1.6
1.6 - 3.2
3.2 - 6.4
6.4 - 9.8

Generalized Seismic Hazard



Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec², expected to be exceeded in a 50-yr period with a probability of 10 percent.

Epicentral Area



EXPLANATION

Main Shock
8 October 2005

Aftershocks 8 - 15 Oct 2005
4.6 - 4.9
5.0 - 5.9
6.0 - 6.9

Earthquakes 1900 - 2005
0 - 69 km
70 - 299
300 - 699
Magnitude Classes
4.0 - 4.9
5.0 - 5.9
6.0 - 6.9
7.0 - 7.9
8.0 - 8.9

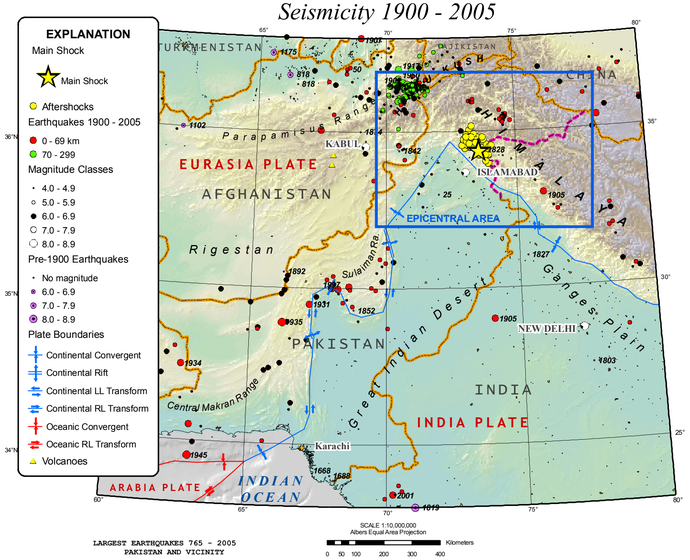
Urbanized Areas
Political Boundaries
International
Provincial
Disputed
Line of Control

NORTHERN PAKISTAN

8 October 2005 03:50:40.61 UTC
34.476° N., 73.577° E.
Depth 26 km
Mw = 7.6 (HRV)

Over 22,288 people killed, 50,575 injured and many buildings heavily damaged or destroyed in northern Pakistan. The heaviest damage occurred in the Muzaffarabad area where entire villages were destroyed. Buildings collapsed in Gujranwala, Gujrat, Islamabad and Lahore. Felt at Chakwal, Faisalabad,Jhang, Sargodha and as far as Quetta. At least 946 people killed and 4,386 injured in India. The heaviest damage occurred at Uri where 80 percent of the town was destroyed. At least 32,335 buildings collapsed in Anantnag, Baramula, Jammu and Srinagar, Kashmir. Felt in Delhi, Gujarat, Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan, Uttaranchal and Uttar Pradesh, India. At least one person killed and some buildingscollapsed in Afghanistan. Felt from central Afghanistan to western Bangladesh. An estimated 4 million people in the area left homeless. Landslides and rockfalls damaged roads and bridges blocking access to many of the heavily damaged areas.

Seismicity 1900 - 2005



EXPLANATION

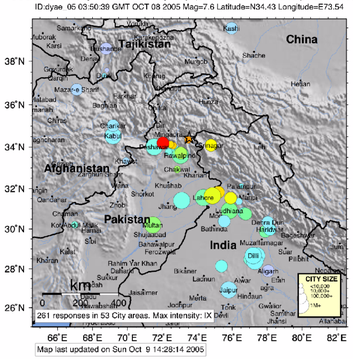
Main Shock
Main Shock

Aftershocks
Earthquakes 1900 - 2005
0 - 69 km
70 - 299
Magnitude Classes
4.0 - 4.9
5.0 - 5.9
6.0 - 6.9
7.0 - 7.9
8.0 - 8.9
Pre-1900 Earthquakes
No magnitude
6.0 - 6.9
7.0 - 7.9
8.0 - 8.9
Plate Boundaries
Continental Convergent
Continental Rift
Continental LL Transform
Continental RL Transform
Oceanic Convergent
Oceanic RL Transform
Volcanoes

LARGEST EARTHQUAKES 765 - 2005
PAKISTAN AND VICINITY

YR	MO	DY	LAT	LON	DEPTH	MAG
765			35.2	60.4	25	7.6
818	5	15	36.8	66.2	50	7.5
1175			37.5	65.5	15	7.1
1819	6	16	23.0	71.0	0	8.3
1896	9	23	37.0	71.0	160	7.5
1902	10	6	36.5	70.5	200	7.2
1905	4	4	33.0	76.0	0	7.8
1905	9	26	29.0	74.0	60	7.1
1907	10	21	38.0	69.0	0	7.2
1908	10	24	36.5	70.5	220	7.0
1909	7	7	36.5	70.5	230	7.6
1909	10	20	30.0	68.0	0	7.0
1911	7	4	36.0	70.5	190	7.4
1917	4	21	37.0	70.5	220	7.1
1921	11	15	36.116	70.724	152	7.6
1922	12	6	36.445	70.939	240	7.3
1924	10	13	36.522	70.831	179	7.2
1929	2	1	36.459	70.931	208	7.0
1933	8	27	29.473	67.172	35	7.1
1934	6	13	27.428	62.594	35	7.0
1935	5	30	28.994	66.176	35	8.1
1937	11	14	36.569	70.670	200	7.1
1943	2	28	36.500	70.500	210	7.1
1945	11	27	24.500	63.000	0	8.0
1949	3	4	36.000	70.500	230	7.4
1950	7	9	36.700	70.500	223	7.5
1951	6	12	36.300	71.000	223	7.5
1956	6	9	35.042	67.479	35	7.6
1965	3	14	36.400	70.716	210	7.5
1966	8	1	30.051	68.629	10	7.0
1974	7	30	36.368	70.732	214	7.1
1983	12	30	36.401	70.713	214	7.4
1985	7	29	36.164	70.864	100	7.4
1993	8	9	36.329	70.884	215	7.0
1997	2	27	29.970	68.220	22	7.1
2001	1	26	23.394	70.234	16	7.7
2005	10	8	34.476	73.577	26	7.6

USGS Community Internet Intensity Map (58 miles NNE of Rawalpindi, Pakistan)
ID:dyae 05 03:50:38 GMT OCT 08 2005 Mag=7.6 Latitude=N34.43 Longitude=E73.54



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

COMMUNITY INTERNET INTENSITY MAP

The Community Internet Intensity Map (CIIM) summarizes the online questionnaire responses provided by Internet users. An intensity number is assigned to each community from which a filled-out CIIM questionnaire was received; each intensity value reflects the effects of earthquake shaking on the people and structures in the community. The color of each circular symbol on the map represents the average of the individual intensity values from that community; the size of the symbol is related to the population of the community.

DISCUSSION

Earthquakes and active faults in northern Pakistan and adjacent parts of India and Afghanistan are the direct result of the Indian subcontinent moving northward at a rate of about 40 mm/yr (1.6 inches/yr) and colliding with the Eurasian continent. This collision is causing uplift that produces the highest mountain peaks in the world including the Himalayan, the Karakoram, the Pamir and the Hindu Kush ranges. As the Indian plate moves northward, it is being subducted or pushed beneath the Eurasian plate. Much of the compressional motion between these two colliding plates has been and continues to be accommodated by slip on a suite of major thrust faults that are at the Earth's surface in the foothills of the mountains and dip northward beneath the ranges. These include the Main Frontal thrust, the Main Central thrust, the Main boundary thrust, and the Main Mantle thrust. These thrust faults have a sinuous trace as they arc across the foothills in northern India and into northern Pakistan. In detail, the modern active faults are actually a system of faults comprised of a number of individual fault traces. In the rugged mountainous terrain, it is difficult to identify and map all of the individual thrust faults, but the overall tectonic style of the modern deformation is clear in the area of the earthquake; north- and northeast-directed compression is producing thrust faulting. Near the city of Muzaffarabad, about 10 km southwest of the earthquake epicenter, active thrust faults that strike northwest-southeast have deformed and warped Pleistocene alluvial-fan surfaces into anticlinal ridges. The strike and dip direction of these thrust faults is compatible with the style of faulting indicated by the focal mechanism from the nearby M 7.6 earthquake.

DISCLAIMER

Base map data, such as place names and political boundaries, are the best available but may not be current or may contain inaccuracies and therefore should not be regarded as having official significance.

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IOC, IHO, and BODC, 2003, Centenary Edition of the GEBCO Digital Atlas: CD-ROM(2), British Oceanographic Data Centre, Liverpool, UK.

DATA SOURCES

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USGS, National Earthquake Information Center
NOAA, National Geophysical Data Center
IASPEI, Centennial Catalog (1900 - 1999) and extensions (Engdahl and Villaseñor, 2002)
HDF (unpublished earthquake catalog) (Engdahl, 2003)
Global Seismic Hazard Assessment Program (GSHAP, 1999)

PLATE TECTONICS
PB2002 (Bird, 2003)

VOLCANOES
Smithsonian Institution, Global Volcano Program

BASE MAP
ESRI (1992), Digital Chart of the World
GLOBE (1999)
IOC, IHO, and BODC (2003)

NEWS SOURCES
Associated Press

Map prepared by U.S. Geological Survey
National Earthquake Information Center
17 October 2005
Map not approved for release by Director USGS