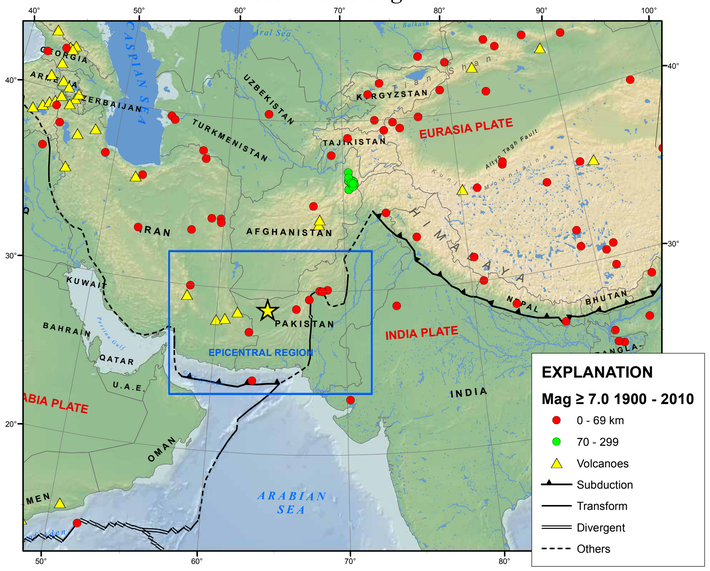
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

EARTHQUAKE SUMMARY MAP XXX

*Prepared in cooperation with the Global Seismographic Network*

# M 7.2 Southwestern Pakistan Earthquake of 18 January 2011

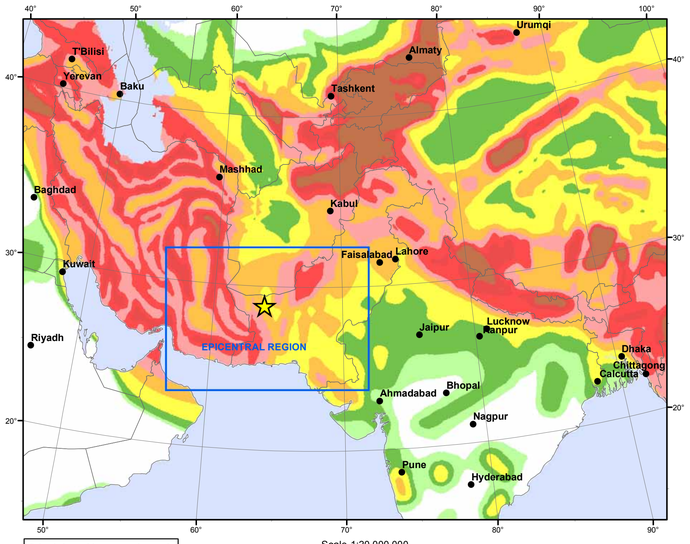
## Tectonic Setting




RELATIVE PLATE MOTIONS

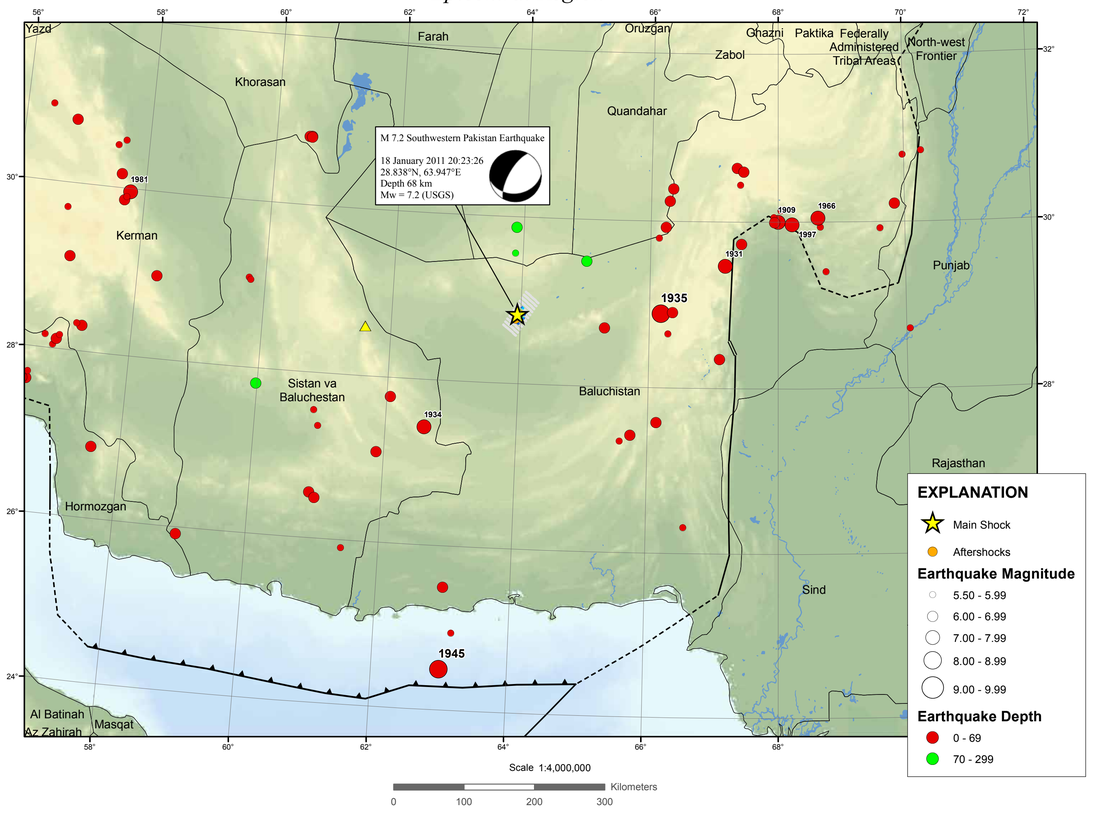
The red vectors represent the motion of the India Plate relative to the Eurasia Plate in the region. The motion of the Inda Plate is generally 40 - 50 mm/yr northward with respect to the Eurasia Plate.

## Seismic Hazard

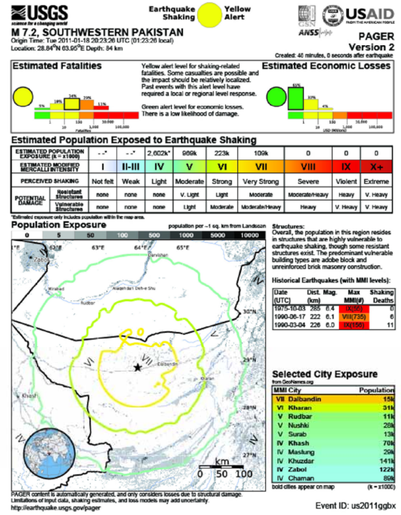



Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec$^2$, expected to be exceeded in a 50-yr period with a probability of 10 percent.

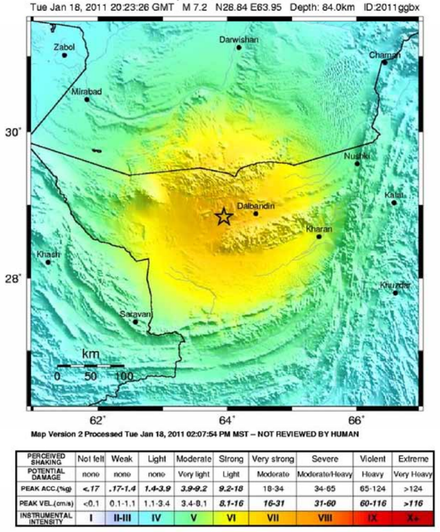
## Epicentral Region




## PAGER




## ShakeMap




| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | <.17 | .17-1.4 | 1.4-3.9 | 3.9-9.2 | 9.2-18 | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | 8.1-16 | 16-31 | 31-60 | 60-116 | >116 |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

## TECTONIC SUMMARY

This major earthquake occurred as a result of normal faulting within the lithosphere of the subducted Arabian plate. The present-day tectonic environment of Pakistan is determined by the motions of the Arabian and Indian plates north-northeast with respect to the Eurasian plate at velocities of 35 – 40 mm/y at the longitude of this earthquake. Arabian-plate lithosphere is subducted beneath the Eurasia plate at the Makran coast of Pakistan and Iran, and becomes progressively deeper to the north. The subducted Arabian plate is known to be seismically active to depths of about 160 km. The frequency of moderate and large earthquakes within the subducted Arabian plate is not high compared with the frequency of such events in some other subducted plates worldwide, but several earthquakes have occurred within this slab in the region of today's event over the past 30 years, including a magnitude 6.7 shock two hundred kilometers to the southwest in 1983.

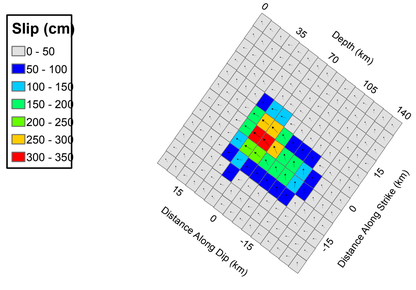
**Significant Earthquakes Mag >= 6.5**

| Year | Mon | Day | Time | Lat | Long | Dep | Mag |
|---|---|---|---|---|---|---|---|
| 1909 | 10 | 20 | 2341 | 30.000 | 68.000 | 0 | 7.0 |
| 1911 | 04 | 18 | 1814 | 32.000 | 56.000 | 50 | 6.7 |
| 1914 | 02 | 06 | 1142 | 29.500 | 65.000 | 100 | 6.8 |
| 1923 | 09 | 22 | 2047 | 29.120 | 56.928 | 35 | 6.9 |
| 1928 | 10 | 15 | 1419 | 28.351 | 67.094 | 35 | 6.8 |
| 1931 | 08 | 24 | 2135 | 29.733 | 67.425 | 35 | 6.7 |
| 1931 | 08 | 27 | 1527 | 29.473 | 67.172 | 35 | 7.1 |
| 1934 | 06 | 13 | 2210 | 27.428 | 62.594 | 35 | 7.0 |
| 1935 | 05 | 30 | 2132 | 28.894 | 66.176 | 35 | 8.1 |
| 1945 | 11 | 27 | 2156 | 24.500 | 63.000 | 0 | 8.0 |
| 1947 | 08 | 05 | 1424 | 25.500 | 63.000 | 0 | 6.9 |
| 1947 | 09 | 23 | 1228 | 33.000 | 59.000 | 0 | 6.8 |
| 1966 | 08 | 01 | 2102 | 30.051 | 68.629 | 9.8 | 7.0 |
| 1975 | 10 | 03 | 0514 | 30.241 | 66.293 | 15 | 6.7 |
| 1977 | 03 | 21 | 2118 | 27.608 | 56.358 | 35.6 | 6.7 |
| 1978 | 09 | 16 | 1535 | 33.268 | 57.387 | 15 | 7.4 |
| 1981 | 06 | 11 | 0724 | 29.858 | 57.686 | 14.3 | 6.6 |
| 1981 | 07 | 28 | 1722 | 29.964 | 57.766 | 13.8 | 7.3 |
| 1983 | 04 | 18 | 1058 | 27.767 | 62.056 | 62.7 | 6.7 |
| 1990 | 11 | 06 | 1845 | 28.266 | 55.484 | 11 | 6.6 |
| 1997 | 02 | 27 | 2108 | 29.970 | 68.220 | 22 | 7.1 |
| 1998 | 03 | 14 | 1940 | 30.167 | 57.606 | 9 | 6.6 |
| 1999 | 03 | 04 | 0538 | 28.306 | 57.232 | 23 | 6.6 |
| 2003 | 12 | 26 | 0156 | 28.995 | 58.311 | 10 | 6.6 |
| 2011 | 01 | 18 | 2023 | 28.838 | 63.947 | 84 | 7.2 |

## Finite Fault Model

Distribution of the amplitude and direction of slip for subfault elements of the fault rupture model are determined from the inversion of teleseismic body waveforms and long period surface waves. Arrows indicate the amplitude and direction of slip (of the hanging wall with respect to the foot wall); the slip is also colored by magnitude. The view of the rupture plane is from above.

The strike of the fault rupture plane is N26E and the dip is 65 NW. The dimensions of the subfault elements are 5 km in the strike direction and 4 km in the dip direction. The rupture surface is 60 km along strike and 60 km downdip. The seismic moment release based upon this plane is 7.77e+26 dyne.cm




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.

DATA SOURCES

EARTHQUAKES AND SEISMIC HAZARD
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

PLATE TECTONICS AND FAULT MODEL
PB2002 (Bird, 2003)
Finite Fault Model, Chen Ji, UC Santa Barbara (2007)

BASE MAP
NIMA and ESRI, Digital Chart of the World
USGS, EROS Data Center
NOAA GEBCO and GLOBE Elevation Models

REFERENCES


Bird, P., 2003, An updated digital model of plate boundaries: Geochem. Geophys. Geosyst., v. 4, no. 3, pp. 1027- 80.

Engdahl, E.R. and Villaseñor, A., 2002, Global Seismicity: 1900 - 1999, chap. 41 of Lee, W.H.K., and others,eds., International Earthquake and Engineering Seismology, Part A: New York, N.Y., Elsevier Academeic Press, 932 p.

Engdahl, E.R., Van der Hilst, R.D., and Buland, R.P., 1998, Global teleseismic earthquake relocation with improved travel times and procedures for depth determination: Bull. Seism. Soc. Amer., v. 88, p. 722-743.



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