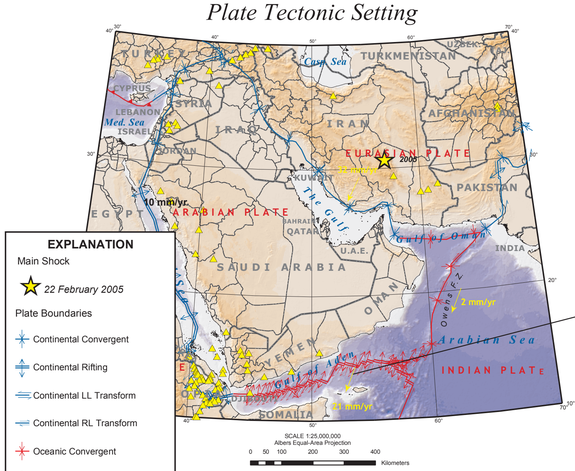
U.S. Department of the Interior
U.S. Geological Survey

EARTHQUAKE SUMMARY MAP XXX

M6.4 Zarand, Iran Earthquake of 22 February 2005

Plate Tectonic Setting



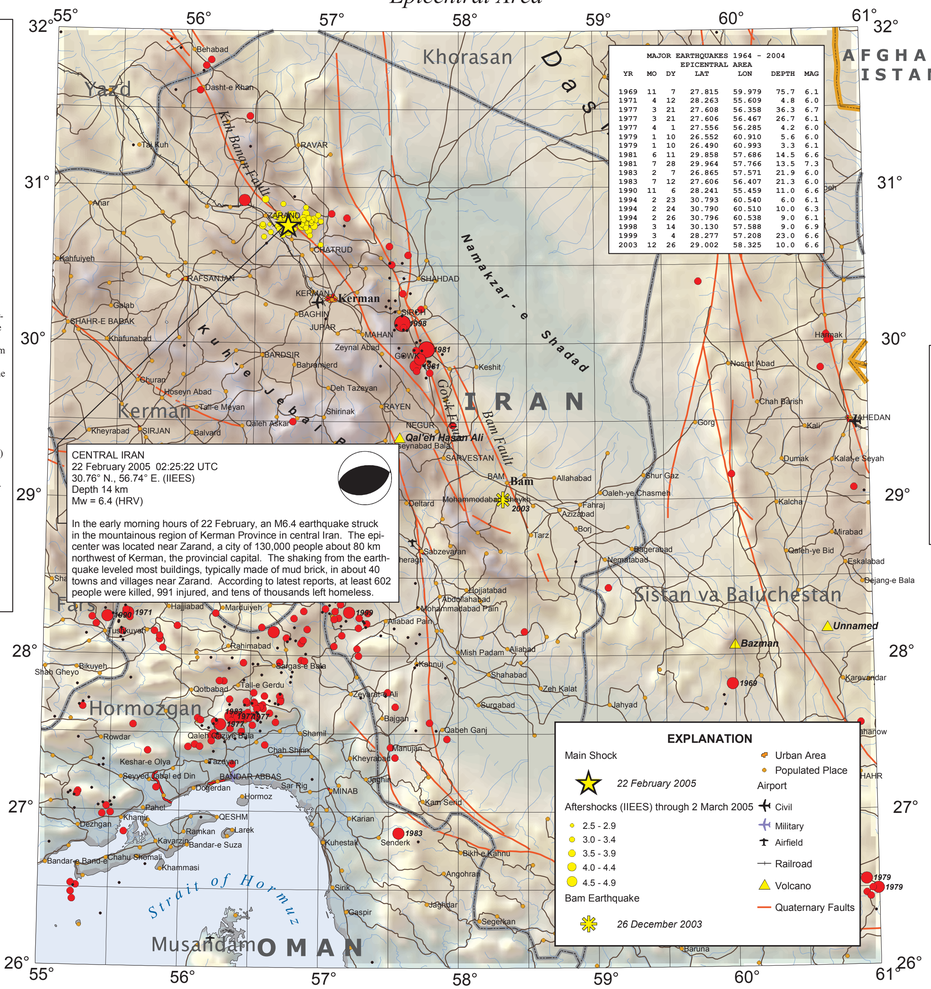
RELATIVE PLATE MOTIONS

The relative motion of adjacent tectonic plates is depicted on the map by short vectors located at selected locations on the plate boundary. In this presentation, one plate is assumed to be the reference plate. The vector therefore represents the direction of the moving plate relative to the reference plate. The rate of relative motion is labelled next to the vector. In this case, the Arabian plate is the reference plate.

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 rigid plate, an inward directed component suggests compression 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 predominantvector component is parallel to the plate margin.

As an example, the relative plate motion vector in Iran along the Zagros Mtns. suggests both compression and right-lateral motion of the Eurasian Plate against the Arabian Plate margin. The rate (32 mm/yr) is relatively high in this area and explains the frequent occurrence of large earthquakes in SW Iran. Conversely, the vector in the Gulf of Aden represents relatively rapid divergence at a rifted spreading zone and nearby transverse motion on short transform fault segments bounding the African Plate. Finally, in the Arabian Sea, the slow (2 mm/yr) rate and nearly parallel relative motion vector against the Indian Plate are consistent with right-lateral displacements along the Owens Fracture Zone where the seismicity is low.

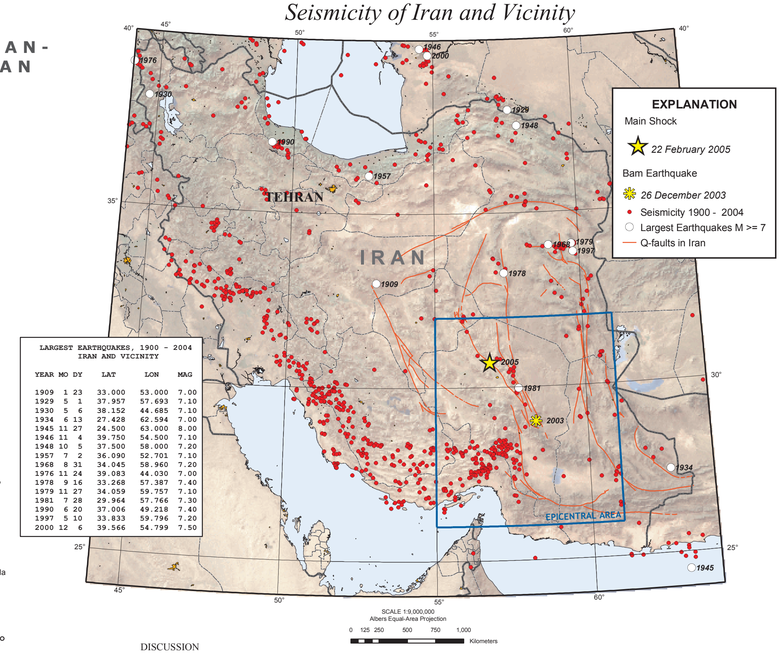
Epicentral Area



MAJOR EARTHQUAKES 1964 - 2004
EPICENTRAL AREA

YR	MO	DY	LAT	LON	DEPTH	MAG
1969	11	7	27.815	59.979	75.7	6.1
1971	4	12	28.263	55.609	4.8	6.0
1977	3	21	27.608	56.358	36.3	6.7
1977	3	21	27.606	56.467	26.7	6.1
1977	4	1	27.556	56.285	4.2	6.0
1979	1	10	26.552	60.910	5.6	6.0
1979	1	10	26.490	60.993	3.3	6.1
1981	6	11	29.858	57.686	14.5	6.6
1981	7	28	29.964	57.766	13.5	7.3
1983	2	7	26.865	57.571	21.9	6.0
1983	7	12	27.606	56.407	21.3	6.0
1990	11	6	28.241	55.459	11.0	6.6
1994	2	23	30.793	60.540	6.0	6.1
1994	2	24	30.790	60.510	10.0	6.3
1994	2	26	30.796	60.538	9.0	6.1
1998	3	14	30.130	57.588	9.0	6.9
1999	3	4	28.277	57.208	23.0	6.6
2003	12	26	29.002	58.325	10.0	6.6

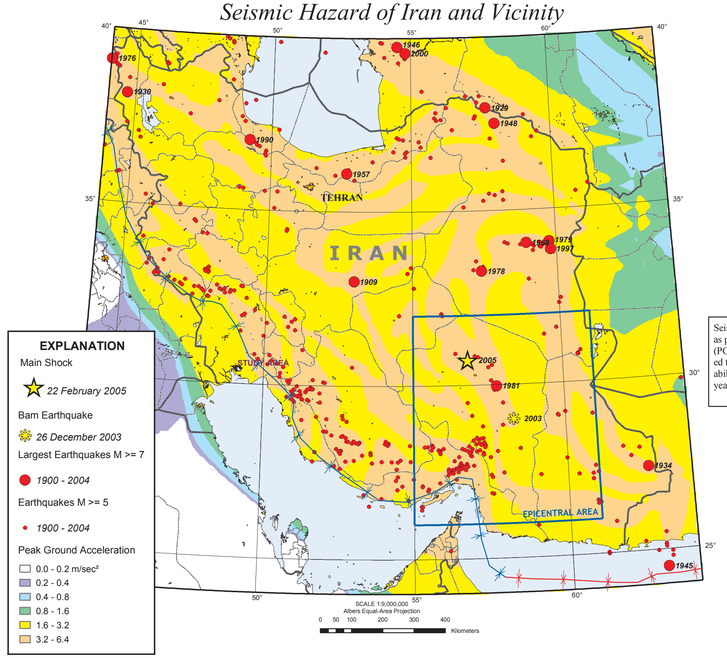
Seismicity of Iran and Vicinity



LARGEST EARTHQUAKES, 1900 - 2004
IRAN AND VICINITY

YEAR	MO	DY	LAT	LON	MAG
1909	1	23	33.000	53.000	7.00
1929	5	1	37.957	57.693	7.10
1930	5	6	38.152	44.685	7.10
1934	6	13	27.428	62.594	7.00
1945	11	27	24.500	63.000	8.00
1946	11	4	39.750	54.500	7.10
1948	10	5	37.500	58.000	7.20
1957	7	2	36.090	52.701	7.10
1968	8	31	34.045	58.960	7.20
1976	11	24	39.083	44.030	7.00
1978	9	16	33.268	57.387	7.40
1979	11	27	34.059	59.757	7.10
1981	7	28	29.964	57.766	7.30
1990	6	20	37.006	49.218	7.40
1997	5	10	33.833	59.796	7.20
2000	12	6	39.566	54.799	7.50

Seismic Hazard of Iran and Vicinity



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

DISCUSSION

This earthquake occurred as the result of stresses generated by the motion of the Arabian plate northward against the Eurasian plate at a rate of 2 to 3 cm/yr (about one inch per year). Deformation of the Earth's crust in response to the plate motion takes place in a broad zone that spans the entire width of Iran and extends intoTurkmenistan. Earthquakes occur as the result of both reverse faulting and strike-slip faulting within the zone of deformation. Preliminary analysis of the pattern of seismic-wave radiation from the February 22 earthquake is consistent with the earthquake having been caused by reverse slip on an ENE- or E-striking fault. The fault that caused the earthquake has not yet been identified; the shock took place in a region within which east-trending reverse-faults have been mapped.

The February 22 earthquake is 125 km northwest of the destructive earthquakes of June 11, 1981 (magnitude 6.6, approximately 3,000 deaths) and July 28, 1981 (magnitude 7.3, approximately 1,500 deaths) and about 250 km northwest of the devastating Bam earthquake of December 26, 2003 <http://earthquake.usgs.gov/eqinthenews/2003/uscvad/uscvad.htm> (magnitude 6.6, over 30,000 deaths).

Photo Gallery

Photos courtesy of Ministry of Building & Urban Development, Islamic Republic of Iran

REFERENCES

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

E.R. Engdahl, 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, pp. 722-743.

Engdahl, E.R. and Villasenor, A., 2002, Global Seismicity: 1900-1999 in International Earthquake and Engineering Seismology, Part A: v. 81A, ch. 41, 26 p.

DISCLAIMER

This map is preliminary and has not been edited for conformity with U.S. Geological Survey standards. 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
U.S. Agency for International Development
IASPEI, Centennial Catalog (1900 - 1999) and extensions (Engdahl and Villasenor, 2002)
HDF (unpublished earthquake catalog) (Engdahl, 2003)
Global Seismic Hazard Assessment Program
International Institute of Earthquake Engineering and Seismology (IIEES) Research Center, Tehran

PLATE TECTONICS
PB2003 (Bird, 2003)

VOLCANOES
Smithsonian Institution, Global Volcano Program

BASE MAP
NIMA and ESRI, Digital Chart of the World
USGS, EROS Data Center

NEWS SOURCES

Agence France-Presse
IranMania (http://www.iranmania.com)
The New York Times (http://www.nytimes.com)

ONLINE RESOURCES
http://www.iiees.ac.ir/English/eng_index.html
http://www.gsi-iran.org/
http://www.bhrc.ac.ir/

Map prepared by U.S. Geological Survey
National Earthquake Information Center
2 March 2005 @ 0800 MST
Map not approved for release by Director USGS