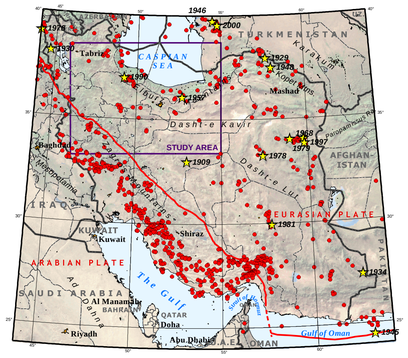
U.S. Department of the Interior
U.S. Geological Survey

General Interest Product xxx

Changureh (Avej), Iran Earthquake of 22 June 2002

Seismicity of Iran and Vicinity



LARGEST EARTHQUAKES, 1900 - 2002					
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

EXPLANATION

Largest Earthquakes M >= 7

1900 - 2002

Earthquakes M >= 5

1900 - 2002

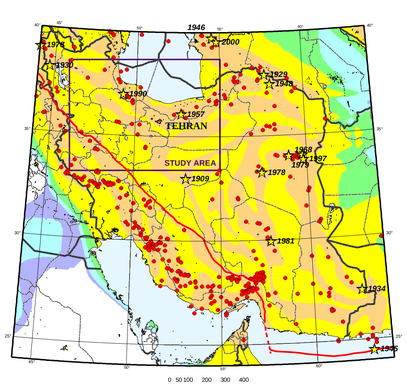
Peak Ground Acceleration

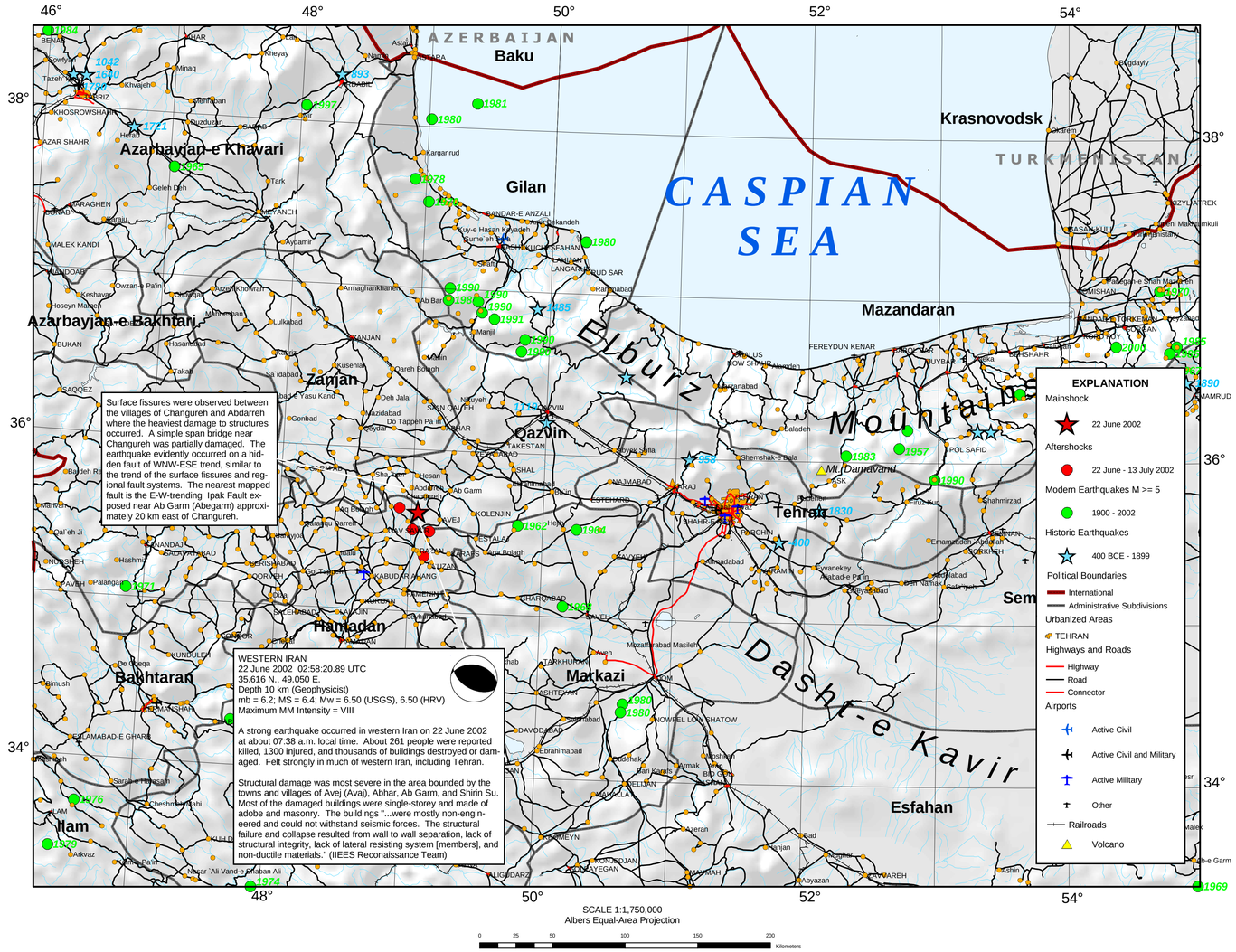
- 0.0 - 0.2 m/sec**2
- 0.2 - 0.4
- 0.4 - 0.8
- 0.8 - 1.6
- 1.6 - 3.2
- 3.2 - 6.4

Plate Boundary

Seismic hazard is expressed as peak ground acceleration (PGA) in meters/sec**2 expected in a 50-yr period with a probability of 10 percent.

Seismic Hazard of Iran and Vicinity





Surface fissures were observed between the villages of Changureh and Abdarreh where the heaviest damage to structures occurred. A simple span bridge near Changureh was partially damaged. The earthquake evidently occurred on a hidden fault of WNW-ESE trend, similar to the trend of the surface fissures and regional fault systems. The nearest mapped fault is the E-W-trending Ipak Fault exposed near Ab Garm (Abegarm) approximately 20 km east of Changureh.

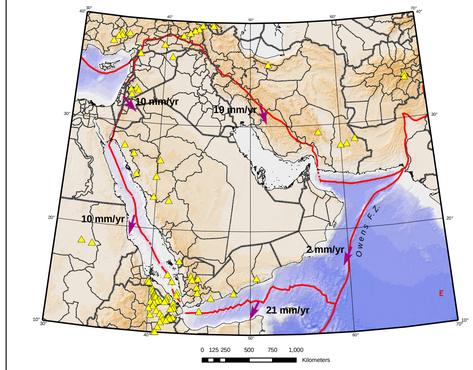
WESTERN IRAN
22 June 2002 02:58:20.89 UTC
35.616 N., 49.050 E.
Depth 10 km (Geophysicist)
mb = 6.2; MS = 6.4; Mw = 6.50 (USGS), 6.50 (HRV)
Maximum MM Intensity = VIII

A strong earthquake occurred in western Iran on 22 June 2002 at about 07:38 a.m. local time. About 261 people were reported killed, 1300 injured, and thousands of buildings destroyed or damaged. Felt strongly in much of western Iran, including Tehran.

Structural damage was most severe in the area bounded by the towns and villages of Avej (Avaj), Abhar, Ab Garm, and Shirin Su. Most of the damaged buildings were single-storey and made of adobe and masonry. The buildings "...were mostly non-engineered and could not withstand seismic forces. The structural failure and collapse resulted from wall to wall separation, lack of structural integrity, lack of lateral resisting system [members], and non-ductile materials." (IIEES Reconaissance Team)

SCALE 1:1,750,000
Albers Equal-Area Projection
Kilometers

Plate Tectonics of the Arabian Plate



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 rigid and fixed. The vector therefore represents the direction of the moving plate relative to the fixed plate. The rate of relative motion is labelled 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 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 predominant vector 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 (19 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.

EXPLANATION

Political Boundaries

- International
- Administrative subdivisions
- Plate Boundaries

Volcanoes

DATA SOURCES

Seismicity
- National Earthquake Information Center (2000 - 2002)
- IASPEI Int'l Handbook of Earthquake Engineering and Seismology (1900 - 1999)
- NOAA, NGDC (pre-1900)
- Press reports (casualties and damage)

Seismic Hazard
- GSHAP (1999 map)

Tectonics and Geology
- University of Texas (plate boundaries)
- Smithsonian Institution, Global Volcano Research Program (volcanoes)
- NUVEL-1 (plate motions)

Base Maps
- NIMA and ESRI, Digital Chart of the World
- NOAA, NGDC, ETOPO2 (digital elevation model)
- WSI, Inc. (topographic image)

SELECTED HISTORIC EARTHQUAKES (400 BCE - 1899) IN THE STUDY AREA					
YEAR	MO	DY	LAT	LON	MAG
-400	0	0	35.500	51.800	7.60
856	12	22	35.900	54.000	6.50
893	0	0	38.300	48.300	6.30
958	2	23	36.000	51.100	7.70
1042	11	4	38.200	46.300	7.60
1119	12	10	36.200	50.000	6.50
1301	0	0	36.200	53.400	6.50
1485	8	14	36.900	49.900	6.50
1608	4	20	36.500	50.600	6.50
1640	2	27	38.200	46.300	5.10
1721	4	26	37.900	46.700	7.70
1780	1	17	38.200	46.200	7.70
1800	0	0	36.200	53.300	6.50
1830	5	9	35.700	52.100	6.50
1890	7	11	36.500	54.900	6.50

TECTONIC SETTING

This Iranian earthquake occurred in the Zagros fold-and-thrust belt. This highly seismic region forms the boundary between the Arabian and Eurasian plates. The Arabian Plate is a small plate split from the African Plate by rifting along the Red Sea. As it collides with the massive Eurasian Plate, it causes uplift of the Zagros Mountains and produces numerous damaging earthquakes.

EARTHQUAKE HISTORY

Several severe earthquakes have occurred near this recent Iranian event. The most deadly was a magnitude 7.4 earthquake that struck on June 20, 1990, located about 150 km to the north of this recent event. This earthquake killed an estimated 40,000 to 50,000 people, injured more than 60,000, and left 400,000 or more homeless. There was extensive damage and landslides in the Rasht-Qazvin-Zanjan area and nearly all buildings in the Rudbar-Manjil area were destroyed. Another nearby devastating quake struck on September 1, 1962. This magnitude 7.3 quake killed about 12,000 people. More distant recent events include a February 28, 1997 magnitude 6.1 earthquake occurring about 300 km to the north (near the Armenia-Azerbaijan-Iran border), and a May 10, 1997 magnitude 7.3 event occurring about 1000 km to the east. The February 28th earthquake killed at least 1,100 people, injured 2,600, and left 36,000 homeless. The May 10th earthquake killed at least 1,567 people, injured 2,300, and left about 50,000 homeless.

Other deadly earthquakes occurring within 150 km of this earthquake include:

Date (UTC)	Magnitude	Comments
1957 12 13	7.3	1130 killed *
1958 08 16	6.8	137 killed *
1963 03 24	7.2	About 100 killed *
1983 07 22	5.6	3 killed, 41 injured
1990 06 21	5.8	At least 20 killed (aftershock of 1990 06 20)
1991 11 28	5.6	1 killed, 70 injured

* Data from NOAA

MODERN EARTHQUAKES (1900 - 2002) IN THE STUDY AREA (M >= 5)					
YEAR	MO	DY	LAT	LON	MAG
1935	4	11	36.432	53.621	6.60
1957	7	2	36.090	52.701	7.10
1957	12	13	34.278	47.712	6.80
1958	8	16	34.259	47.869	6.50
1962	9	1	35.556	49.810	6.90
1964	11	3	35.544	50.256	5.10
1965	2	10	37.667	47.033	5.00
1967	9	2	36.566	54.787	5.10
1968	4	26	35.067	50.170	5.20
1969	11	11	33.391	54.955	5.00
1970	4	3	37.066	54.699	5.00
1970	7	11	37.535	49.024	5.20
1971	1	20	35.057	46.869	5.00
1971	8	9	36.202	52.762	5.30
1974	1	7	33.254	47.935	5.00
1976	12	11	33.723	46.587	5.00
1978	11	4	37.673	48.911	6.30
1979	4	18	33.436	46.414	5.10
1980	5	4	38.047	49.018	6.50
1980	7	22	37.324	50.256	5.20
1980	12	19	34.476	50.646	6.10

MODERN EARTHQUAKES (1900 - 2002) IN THE STUDY AREA (M >= 5) (CONT.)					
YEAR	MO	DY	LAT	LON	MAG
1980	12	22	34.425	50.634	5.50
1981	8	4	38.155	49.370	5.30
1983	3	25	36.040	52.286	5.10
1983	7	22	36.933	49.210	5.00
1984	8	24	38.456	45.975	5.10
1985	10	29	36.722	54.828	5.70
1985	10	29	36.682	54.773	6.00
1990	1	20	35.899	52.974	5.80
1990	6	20	37.006	49.218	7.40
1990	6	20	36.930	49.440	5.20
1990	6	20	36.863	49.473	5.20
1990	6	20	36.705	49.811	5.10
1990	6	21	36.631	49.786	5.50
1991	11	28	36.826	49.569	5.30
1997	2	28	38.096	48.035	6.00
2000	8	16	36.723	54.362	5.00
2002	4	19	36.567	49.810	5.20
2002	4	24	34.642	47.400	5.20
2002	6	22	35.616	49.050	6.50
2002	6	22	35.637	48.907	5.10

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.