

## 1. Tectonic Setting

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The 2001 Gujarat earthquake occurred in western Gujarat state in an area about 300 km south of the Himalayan Frontal Fault System, where the Indian and Eurasian plates collide, and about 400 km east of the junction between the Owens Fracture Zone, Makran subduction zone, and Chaman Fault (Figure 1.1). This area is considered to be a stable continental region (Johnston, 1996) or a transition between stable continent and the active plate boundary. Even though the area is located away from the major plate boundaries, there are large east-west trending compressional features that cross the Kachchh Peninsula. The east-west structures include the Kachchh Mainland (uplifted and folded highlands of

Mesozoic rocks) which is bordered on the north by the Kachchh Mainland fault and on the south by the Katrol Hill Fault (Malik et al., 2000). North of the Kachchh Mainland is the broad Banni Plain and farther north are the large salt flats that comprise the Rann of Kachchh (Photo 1.1). In the Rann of Kachchh are several more east-west trending faults, including the Island Belt, Allah Bund, and Nagar Parkar faults. These features are thought to be reactivated Mesozoic rifts (Rajendran and Rajendran, 2001). The Kachchh rift basin was created in successive stages during the migration of the Indian plate after its break from Gondwana in Late

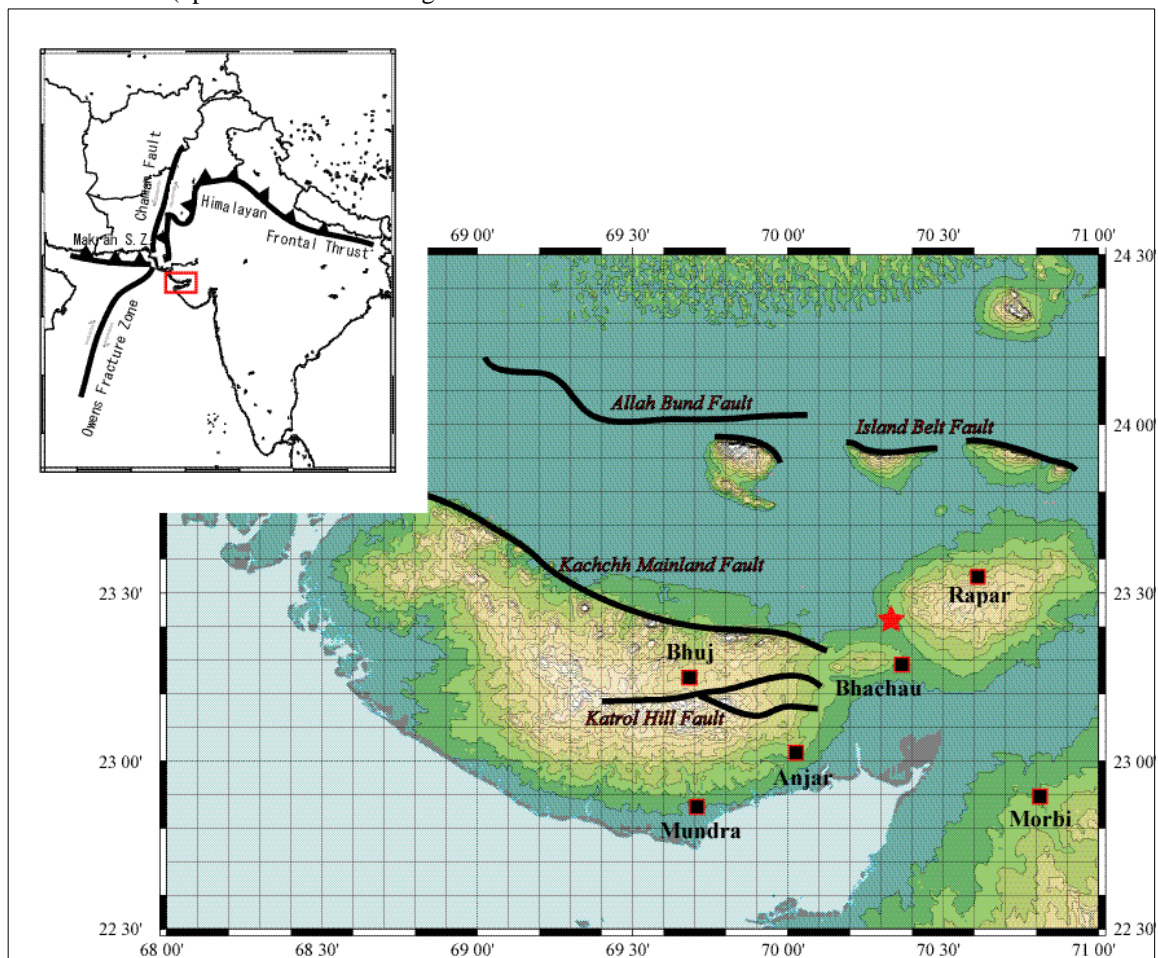


Figure 1.1. Tectonic and regional map of the area of the 2001 Gujarat Earthquake. Red star denotes the epicenter of the 2001 earthquake determined by IRIS. Faults are after Malik et al. (2000).

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Photo 1.1. Looking northward over the Banni Plain from the Kachchh Mainland.

Triassic or early Jurassic (Biswas, 1982). The onset of collision of India with the southern margin of Eurasia occurred in late Paleocene-Eocene time (Patriat and Achache, 1984; Jaeger et al., 1989) and following collision the Kachchh rift basin sustained stress reorientation. By late Miocene the east-west trending Kachchh rift basin had formed and was being subjected to a north-south compressive stress field. The maximum horizontal stress that is responsible for current tectonic activity is oriented N-S to NNE-SSW (Gowd et al., 1992).

The Kachchh Peninsula has a history of active seismicity (Table 1.1) with several large damaging earthquakes in the magnitude 6 to 7 range over the last several hundred years (Quittmeyer and Jacob, 1979, Rajendran and Rajendran, 2001). The largest known historical event in the region was the 1819 earthquake (M7.5) that caused considerable damage in Bhuj and Anjar and 1500 casualties. This earthquake is notable for producing the Allah Bund (Wall of God) which is a 90km long feature with vertical uplifts of up to 4.3 m. Rajendran and Rajendran (2001) claim that this feature is a composite scarp formed from a series of earthquakes. Prior to the 2001 Gujarat earthquake, the 1819 event was considered to be the 4<sup>th</sup> largest historical earthquake in a stable continental region (Johnston and Kantor, 1990).

More recently the 1956 Anjar earthquake (Ms 6.1) occurred south of Bhuj with a thrust mechanism and compression in a north-northwest direction (Chung and Gao, 1995), similar to the 2001 event.

Slightly further away, the October 24, 1969 Mt. Abu earthquake (M5.3) to the northeast and the March 23, 1970 Broach earthquake (M5.4) to the southeast, also had thrust mechanisms with north and north-northwest compression directions, respectively (Chandra, 1977). There are also numerous other small events (M3 to 5) scattered throughout the region (Malik et al., 2000).

Table 1.1. List of events in the Kachchh Peninsula up to 1996 after Rajendran and Rajendran (2001).

Date	Lat.(°N)	Lon.(°E)	Magnitude
00-05-1668	24.00	68.00	Moderate?
16-06-1819	24.00	70.00	7.5
13-08-1821	23.00	70.00	5
19-06-1845	24.00	69.00	>6
25-12-1856	20.00	73.00	5
29-04-1864	24.00	70.00	6
14-01-1903	24.00	70.00	6
18-11-1927	21.05	68.00	>5
31-10-1940	23.70	69.90	>5
21-07-1956	23.34	70.20	6.0
23-03-1970	21.60	72.96	5.2
18-07-1982	23.40	70.66	4.8
30-04-1991	20.78	73.30	--
24-08-1993	20.60	71.30	5.0
31-12-1993	21.20	68.70	4.3
01-08-1995	22.10	40.00	4.2
17-02-1996	23.20	69.40	4.5
17-11-1996	21.50	73.00	4.2

The 2001 Gujarat earthquake occurred east and north of the mapped Kachchh Mainland fault under the Banni Plains. The hypocenter parameters posted by IRIS currently are

OT= 1/26/2001 03h16m41s (UT)

Epicenter= (23.40°N, 70.32°E)

Depth=23.6 km

Mw = 7.7

The parameters revised by USGS/NEIC most recently are

OT= 1/26/2001 03h16m40.50s (UT)

Epicenter= (23.42°N, 70.23°E)

Depth=16 km

Ms = 8.0

The fault plane solutions by different institutes all indicate a reverse fault striking in east-west direction with the axis of maximum compressional stress roughly in north direction, in agreement with the east-west trending structures in the Kachchh Peninsula. Its shallow focal depth and large magnitude suggested that the fault of this earthquake would have manifested itself at the surface. Despite of efforts made by many geologists, however, the causative fault had not yet been found at the surface when our reconnaissance team arrived at the epicentral area.

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