Kachchh mainland (*Malik et al*., 2000) are now subjected to compressional stress and reverse faulting resulting from India's collision with Asia (*Gowd*, 1996; *Chandra*, 1977). Compresssional features appear to be of at least two different ages, with folding events occurring prior to 120 Ka and a distinct set of new features activated much more recently (*Rockwell*, personal communication, 2001).

The first historical Kachchh earthquake to attract international attention was the 1819 Allah Bund (Dam-of-God) earthquake, which created a 6-m-high, 6-km-wide natural dam across the Puran or Nara river (which enters the Rann of Kachchh from the north). A lake 30 km in diameter, Lake Sindri, was formed south of oET ms199t12 Tf2kghsouis ing events dipping rupture for the nodal plane of the 2001 mainshock (*Johnston*, personal communication 2001).

Figure 2a. GTS Geodesy and post-seismic GPS points in the Kachchh region. The inferred rupture is shaded and its area and location may change following processing of the 2001 data. Figure 2a & 2b illustrate estimated dilatational strain changes following the 1819 and 2001 earthquakes assuming simplified planar faults dipping 45°to the north and south respectively. Two red lobes of dilatational (Δ) contraction (+ compressive stress) extend eastward and westward from the Allah Bund region in 1819. The recent earthquake and earthquakes in 1856, 1857 and 1956 occurred in the eastern quadrant of maximum compressive stress (strain contraction) that has now shifted eastward toward Ahmedabad. Figure 2d indicates post-seismic changes predicted to occur in the year following the post-seismic survey. The model

Slip appears to have been less in 2001 than in 1819, although it is possible that a careful occurred in the easterly-directed lobe of increased compressive stress from the 1819 event.

The region now inferred to be subject to enhanced strain contraction (compressive stress) has extended eastward, although its detailed geometry depends critically on the availability of the coseismic deformation field which is currently ambiguous. We know of no specific earthquake in the Ahmedabad region in the historical record, however, a large tsunami is reported to have occurred in 1524 that caused considerable alarm to the Portugese fleet assembled offshore at 17°34' *(Bendick and Bilham, 1999)*. A violent earthquake occurred in southern Gujarat in 1705, and minor shaking is reported at Surat in 1663 (*Iyengar and Sharma*, 1998) and 1684 (*Oldham, 1869, Bapat et al., 1983)* .

Geodesy

The 2001 Bhuj earthquake occurred near the northern edge of a dense network of primary and secondary triangulation points of two first-order triangulation networks (Figure 2) – the Cutch Coast Series (*Strahan*, 1893) and the Kathiawar Meridional Series (*Thullier*, 1894). These triangulation networks form part of the Great Trigonometrical Survey of India (GTS) that was completed towards the end of the 19th century (*Phillimore*, 1968). The principal triangulation of the Kachchh region was completed in May 1858 with a mean angle measurement accuracy of 7 μradians, with the exception of a small number of angles in western Kachchh that included lines-of-sight that grazed hillsides (±15 μrad). Anticipated co-seismic epicentral angular changes are expected to exceed 100 μradians. The original survey monuments consist of subsurface marks on bedrock, or on a buried stone tablets, surmounted by masonry columns with cemented upper marks. Each mark government archives that may now be available. Subsequent to the earthquake several Indian groups of geodesists from the Indian Institute of Geomagnetism (IIG), the Indian Institute of Technology Bombay (IITB), the Centre for Mathematical Modelling & Computer Simulation (CMMACS), Bangalore; and the Wadia Institute of Himalayan Geology, Dehra Dun, undertook a series of measurements in the Kachchh region. A subset of measurement points measured by these several groups is shown in Figure 2. The measured points extend approximately 100 km east, west and south of the epicenter.

Although preliminary, the intensity maps already show several interesting features. The event was felt only lightly at the higher-elevation cities on Deccan lavas throughout central and southern India. Away from the Kachchh region, intensities were clearly

Figure 4. Our MMI values for the Bhuj earthquake are shown as a function of distance (blue circles) along with those determined by *Hough et al*

have contributed to our knowledge of the 2001 Bhuj earthquake, and thank Ken Hudnut

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