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THE KHARDI EARTHQUAKES, 1983

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THE township of Khardi (Lat. 19°35'13"; Long. 73°23'02"), located about 90 km northeast of Bombay, in the Shahapur taluka of Thane district, Maharashtra recently experienced earthquakes of magnitudes 4.0 and 4.8 on 17 August 1983 and 15 September 1983 respectively. These followed the first records of tremors in mid-May and initiated speculations regarding the possible relationship of the earthquakes to the filling up of the Bhatsa reservoir situated about 7 km to the southeast of Khardi. Analyses of satellite imageries and seismicity data, and extensive fieldchecks, support the view that the Khardi phenomena are cases of reservoir-induced seismicity.

The area around Khardi forms a part of the Deccan Volcanic Province and is constituted of basaltic flows of varying thickness. A study of LANDSAT-1 imageries in bands 4, 5 and 7, on scale 1:250,000, covering the region, reveals a structural fabric characterised by major lineaments dominantly trending N330°–N340°, N10°–N20° and N50°–N60°. While some of these lineaments represent basic dykes, others reflect fracture zones (figure 1).

The township of Khardi is located within a NW-SE trending belt, about 5 km wide, exhibiting a high density of lineaments largely oriented in the same direction. It is margined on the northeastern side by the Kengri Nadi lineament and on the southwestern side by the Kalu-Surya lineament, both of which can be traced on LANDSAT-1 imageries over several hundred kilometres. The Kengri Nadi lineament appears to be a continuation of the Ghod lineament[1] of the Deccan Plateau region.

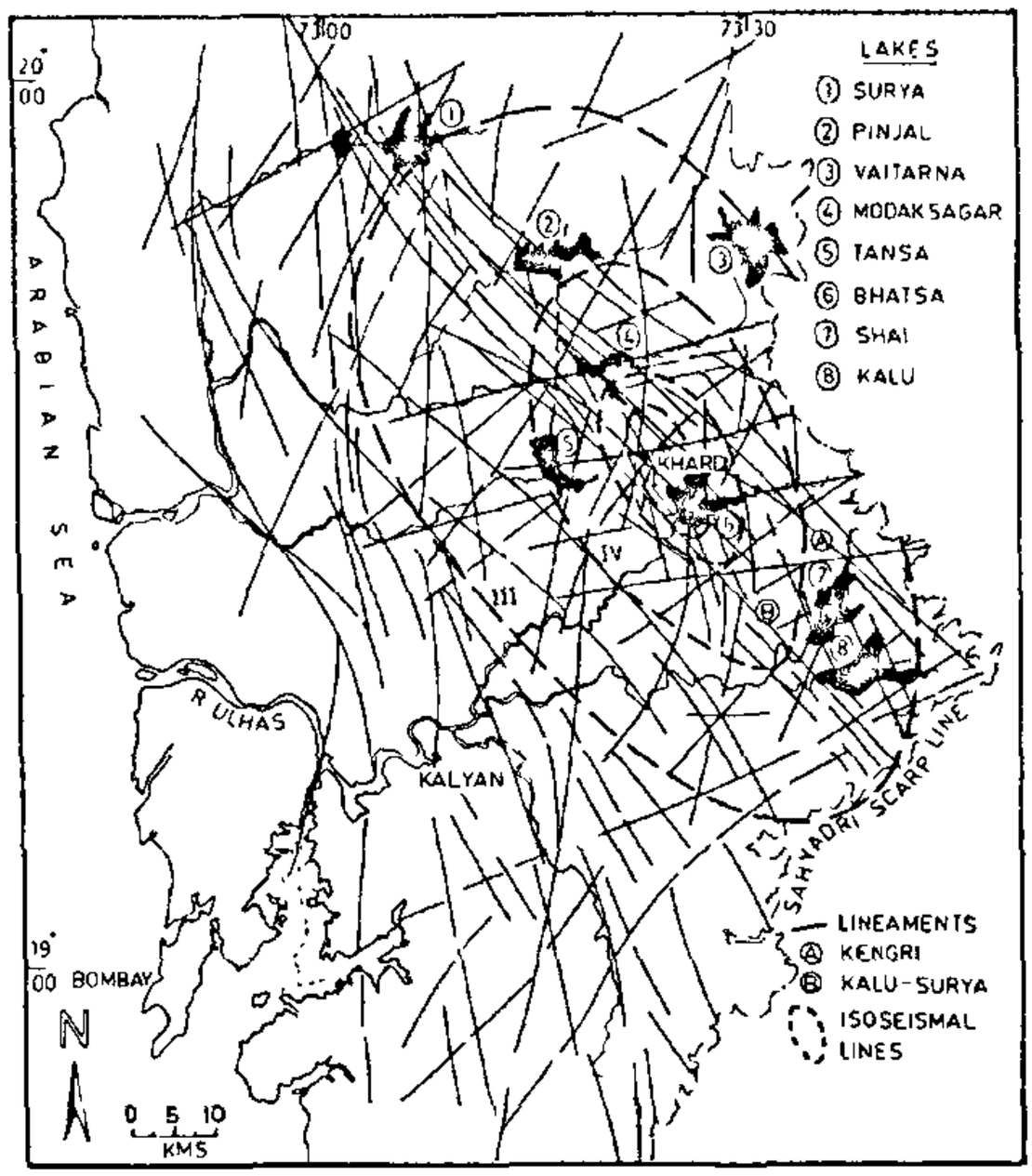

Figure 1. Generalised map of Khardi area showing lineaments and isoseismal lines.

This lineament belt is intersected at Khardi by two lineaments trending N15° and N75°. Field checks show that they correspond to gabbroic dykes, each about 40 m thick, which have evidently been emplaced along fracture zones. Khardi is thus located at the intersection of major fractures. Likewise, two lineaments corresponding to dykes, respectively trending N-S and E-W, intersect about 6 km south of the Bhatsa dam.

Interestingly, geomorphological evidences suggest that the Kengri Nadi lineament is a boundary between two geomorphological units. The area to the northeast of this lineament exhibits a youthful topography characterised by deep gorges, narrow 'V' shaped valleys, rapids and waterfalls. Southwest of this lineament the topography is in a mature to old stage with rolling water divides and broad 'V' to 'U' shaped valleys. This suggests that the northeastern block is

being uplifted in relation to a sinking southwestern block.

The damage to property due to the two Khardi earthquakes is not significant. It is mainly in the form of vertical to highly inclined cracks that, in houses, are developed along doors and window frames, and at wall intersections. Anticlockwise rotation of bricks through 10° to 15° is also recorded. In a few cases plaster has been dislodged from walls. The field surveys undertaken, suggest that both the earthquakes have their epicentres at Khardi with the 'felt area' upto a distance of about 50 and 130 km in respective cases. At Khardi, the maximum intensity (Io) of the earthquake of 15 September was VI on the modified Mercalli scale. The isoseismal pattern is elongated in a direction parallel to the lineament belt (figure 1).

The Bhatsa dam, located within the lineament belt, is 938 m long and about 60 m in height, with the river-bed level being 58 m. The water level which was about 92.5 m on 20 June 1983 rose to a little more than 110 m one month later. A seismograph was installed on Bhatsa dam on 1 July 1983 and in the ensuing two and half months, more than a thousand shocks, down to magnitude −1, were recorded. The majority of these, including the two strong shocks of 17 August and 15 September 1983, were recorded after the water level had exceeded 110 m. There is thus an evident relationship between water-level in the Bhatsa reservoir and seismicity.

Since the first record, in 1938, of seismicity due to water impoundment, at Lake Mead, Colorado, USA[2], over 70 cases of reservoir-induced seismicity have been reported[3], including those at Hsinfengchiang, China (1962)[4], Kariba, Zambia-Zimbabwe (1963)[5,6], Kremasta, Greece (1966)[7] and Koyna, India (1967)[6,8,9] which were of magnitude greater than 6 on Richter scale.

Significantly like Bhatsa, the reservoirs at Kariba, Kremasta and Koyna are situated in regions having a volcanic history, and are located on sinking blocks[10]. It is evident that the impoundment of a large volume of water, in a structurally unstable zone, where the permeability is necessarily high, has been one of the factors responsible for the Khardi earthquakes. The occurrence of earthquakes, following rapid increase of water level to peak reservoir load, shows that though the water load may not have been directly responsible for the earthquakes, it possibly triggered off the release of pre-existing strain. It is suggested that percolation of water along fractures resulted in a build-up of pore-water pressure which was transmitted downwards to a stress zone with a potential to slip. Consequent reduction in the effective stress (tectonic stress-pore pressure) induced the earthquakes.

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ON THE KOMATIITE OF PALASBANI, SINGHBHUM DISTRICT, BIHAR

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OCCURRENCE of Komatiite has been reported from Palasbani (22° 22′ 54″ : 86° 28′ 00″) in the Singhbhum district of Bihar[1]. Komatiite occurs within the Dhanjori metabasalt which itself is in general tholeiite in nature[2,3] (including alkaline, ultramafic and