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A NOTE ON SOME POSSIBLE GEOLOGICAL ASSOCIATIONS OF EARTHQUAKE OCCURRENCES IN TRAPPEAN PROVINCE

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Abstract

A number of seismo-tectonic units are identified in the Deccan Trap province. The paper describes in brief the lithology and related structural lineaments in these units which appear to correspond to some of the past earthquakes in the region.

Introduction

The need to reassess the seismicity of entire Deccan Trap province has become imperative in view of the continued earthquake occurrences around Koynanagar as well as the few tremors which sometimes occur in central and N.W. Kathiawar and other regions. This fact along with the geological data from the region has confirmed that the area confined to the west of longitude 76°E and covered by lava flows is less stable and more prone to earthquakes. Hence there is no surprise that this region has distinct geological characteristics.

Thus it is seen that although majority of the lava flow occupying major portions of central and western India belong to the tholeiitic type ; the western traps show distinct alkaline affinites so as to be referred to as an Alkaline Olivine Basalt sub-province. Geotectonically, this region has a more complex set up with several identifiable seismotectonic units—the Cutch basin, Kathiawar Peninsula, Narmada-Tapti (Satpura) Rifts, Cambay basin, Western Maharashtra platform and West Coast Rift.

It has been pointed out earlier (Tipnis and Srivastava, 1968) that earthquakes within the Deccan trap province may be genetically related to rift structures, a reasoning which is supported on petrological and structural evidences. Many of the faults and fractures associated with the Satpura and West coast rifts are seismic, but have not been located as the are covered with lava flows or later sediments. It is essential to demarcate such "earthquake faults" by extensive geological and geophysical surveys, and monitoring their movements by network of instruments coupled with laboratory investigations of the physical ~~propeets~~ of rocks, so that the potentialities of the occurrence of an earthquake along them can be assessed. This study would also ultimately lead to earthquake prediction.

An attempt has been made in this note to indicate the possible associations of earthquake occurrences with faults and fractures, and assemblages of alkaline and undersaturated rock types.

Cutch Basin : Four sets of E–W trending faults occupying the area between Latitudes 23° and 24°N, show a close correspondence with the areas of active seismicity. It is not unlikely that two of these faults, are passing through Rann of Cutch and other running parallel to it form a graben (Poddar 1964), which may be similar to that of Cambay basin. The other two fault systems south of Bhuj are associated with basic intrusions and also follow the same trends. Out of these two the southern fault zone probably continues

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towards east and joins the Narbada rift zone. Table 1 shows possible geological associations of some of the earthquakes in Cutch basin.

Kathiawar Peninsula : This region is conspicuous for its many eruptive centres of the magmatic type (Fig. 1) which are known to be very closely associated with intersecting rift zones or fault systems (Sveshnikova 1967). These centres show a significant correspondence with some of the epicentres. Based on the petrological and seismic evidence there is a great likelihood of subsurface extensions in this region of faults associated with the Narbada rift and the West Coast. Table 2 shows geological association of some earthquake occurrences in Kathiawar Peninsula.

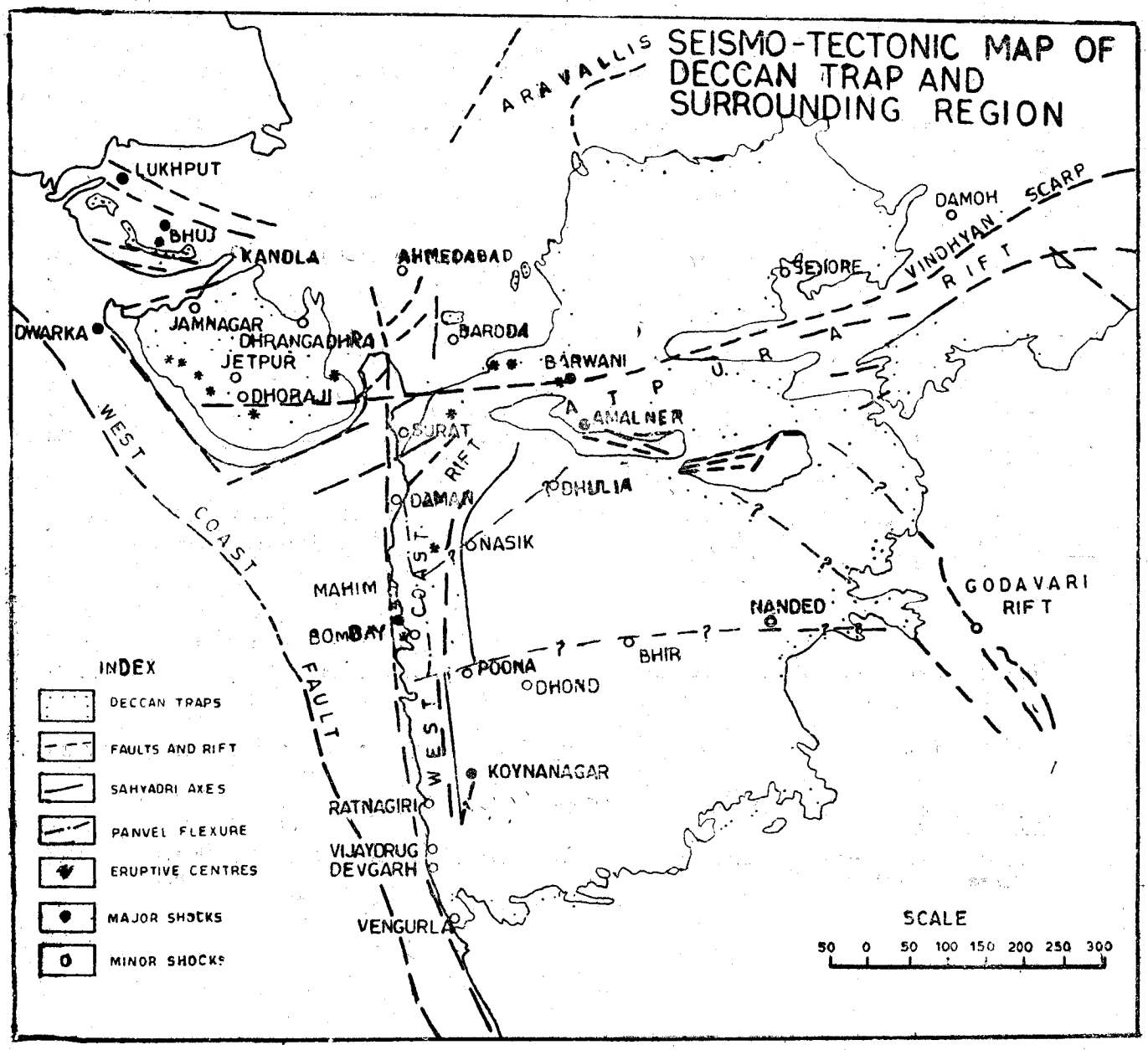

Table 1

Geological Associations of Some Earthquake Occurrences in Cutch Basin

Earthquake Occurrence	Place	Lithology	Relates Structural Lineaments
1819, 1845	Lakhpat (Rann of Kutch)		Fault passing through the Rann of Cutch in the north.
1920, 1940	Bhuj	Alkaline traps with nepheline and anatcite basalts associated with volcanic plug.	Fault passing due south of Bhuj.
1956	Anjar, Kandla	Alkaline Traps	Southmost fault a likely western extension of Narbada rift zone.

Table 2

Geological Associations of some Earthquakes in Kathiawar Peninsula

Earthquake Occurrence	Place	Lithology	Related Structures Lineaments
1938	Paliyad	Alkaline Traps	Eastward extension of southmost Fault of the Kutch Basin or westward continuation of the Narbada rift faults.
1961	Amreli	Alkaline Traps Centre of the Radial Net work of Dykes.	Westward continuation of the Narbada rift faults.
1968	Dhoraji, Jetpur	Alkaline Traps Near Eruptive Centres of Girnar, Junagarh.	Possibly at the intersection of N-S West Coast fault and E-W Narbada rift zone.
1968	Surendranagar (Dhrangadhra) Jamnagar (Balambha-Jodi)	Alkaline Traps	Eastward extension of southern most fault or Westward extension of the Narbada rift faults.

Cambay Basin : Cambay Basin which is a N–S oriented graben consisting of a central down faulted belt associated with longitudinal diagonal and transverse set of fractures (Sengupta 1967) within the Deccan Traps, occupies the area adjacent to Kathiawar peninsula situated between the longitudes 72°E–73°E and extends from latituted 20°N to nearly 24°N. It has shown mild seismic activity in the past whose geological associations are indicated in Table 3.

Narbada-Tapti Rift : Narbada rift, which was probably formed by the uplifting of ancient Satpura north of the Tapti river, is a zone replete with faults, fractures and igneous intrusions, all trending E–W and ENE–WSW. Significantly enough, the epicentres in this zone show a close relationship with rift faults (Table 4).

Western Maharashtra : From Surat in the north to Vijay drug in south the West Coast is covered by Deccan Traps. The area between Surat and Bombay is regarded to be faulted and associated with alkaline rocks showing N–S disposition. The entire coastal Maharashtra from south of Bombay upto Vijay drug, has ~~not been reported to, though has~~ neither indicated any surface evidence of faulting nor has shown the presence of alkaline rocks. But the straight alignment of the coast and other evidence indicate that the present configuration of this part of the coast has resulted from faulting. The belt of seismic activity from Mahim in the north to Vengurla in the south roughly follows the coastal tract and the focus of earthquakes in this belt mostly lie below the basalts. The West Coast Rift (Tipnis and Srivastava, 1968) follows this belt, which has also been affected by transverse faults. The rift structures as well as the transverse faults show seismic activity. Absence of sufficient field data makes it difficult to make definite conclusions regarding the extent of the West Coast Rift. However on the basis of seismicity and other general petrological and structural trends it is felt that the Sahyadri escarpment (faults) ~~from~~ forms the eastern boundary of the rift, and the other boundary lies off the coast.

Data about the epicetres therefore could be related to structural lineaments namely the faulted coast line, and the E–W to NE–SW oriented faults in the basement transverse to the postulated West Coast rift zone following the Sahyadri escarpment faults (Table 5). Based on the location of epicentres three possible major faults in the basement transverse to the West Coast Rift are indicated—Koyna fault with NNE–SSW trend, Poona–Nanded Fault with E–W trend and Nasik fault with NNE–SSW trend. A NW–SE fault system at the edge of the continental shelf (West Coast Fault) with down throw towards SW has been traced recently. A N–S fault occur in the city of Bombay in the valley east of Cumbala hills. Fractures having N–S, WNW–ESE and NNE–SSW trends are profusely met within the traps. These fractures may be related to the basement.

Conclusions

The above geological associations of some earthquake occurrences in the Deccan trap province indicate that the seismicity of its various parts is genetically related to distinct lithological assemblages and structural lineaments. It is therefore considered essential that detailed studies of Deccan Traps be undertaken in such regions so as to reveal more data for assessing their seismicity.

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Table 3

Geological Association of some Earthquake Occurrences in Cambay Basin Region

Earthquake Occurrence	Place	Lithology	Related Structures Lineaments
1821	Kaira	Alkaline Traps	Intersection of faults associated with Cambay Garben and Narbada Rift.
1942	Baroda	Alkaline Centres of eruption e.g. Pavagarh	-do-
1943, 1964	Ahmedabad	Alkaline Traps (Boring)	-do-
1962	Palanpur	Nepheline Syenite (Boring)	Intersection of faults associated with Cambay Basin and South Westren continuation of Great Boundary Fault of Rajasthan.

Table 4

Geological Association of some Earthquake Occurrence in Narbada Tapti Rift Zone.

Earthquake Occurrence	Place	Lithology	Related Structures Lineaments
1846	Narbudda (Narbada)	Deccan Traps	Eastern Most limit of Narbada rift and the start of Sone trough possibly related to the intersection of the orogenic trends of the two regions.
1858	Khandesh	Alkaline Traps likely presence of carbonatitites.	Related to the southern faults within the Narbada rift zone.
1863	Nimar and Barwani	Alkaline Traps likely presence of carbotites	Related to the northern fault within the Narbada rift zone.
1938	Amalner	Deccan Traps	Related to the Tapti rift fault due south of Satpura Range.

Table 5

Geological Association of some Earthquake Occurrences in the Maharashtra Region

Earthquake Occurrence	Place	Lithology	Related Structures Lineaments
Western coast upto Bombay			
1594, 1678, 1702, 1751–52, 1792	North Konkan	Alkaline Rocks e.g. at Jawahar	N–S fault parallel to coast of Bombay (Coast line fault)
1684	Surat	Deccan Traps	–do–
1618, 1751, 1752, 1849, 1854, 1858, 1951, 1965	Bombay and its vicinity upto Thana	Alkaline Traps and eruptive centres Trombay, Salsette, Bassein etc.	–do–
West of Sahyadris			
1751–52	Arabian Sea	Deccan Traps	West Coast fault
1792	Revadana	–do–	Coast line fault (Malabar Fault)
1826	Moravade	–do–	–do–
1941	Laccadives	–do–	West Coast fault
1962	Ratnagiri	–do–	Coast line Fault
1965	Ratnagiri	–do–	–do–
1966	Colaba and Alibag	–do–	–do–
1967	Mahad	–do–	Sahyadri fault
Region East of Sahyadris			
1757	Toke & Dhom	–do–	–do–
1764	Nasik	–do–	Nasik fault (?)
1869	Nasik and Chandor	–do–	–do–
1942	Nanded	–do–	Poona – Nanded Transverse Fault (?)
1951	Poona	–do–	–do–
1953	Phaltan	–do–	–do–
1953, 1955	Bhir	–do–	–do–
1967	Koyna	–do–	Koyna Fault (?)
1967–68	Koyna	–do–	–do–

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