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Seismicity in and around Ongole, Andhra Pradesh – an appraisal

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ABSTRACT
Ongole and its surrounding area had been subjected to structural deformation for the past 3000 Ma in plate tectonic history. The faults in this region are seismically active since a long time. This is supported by a confluence of faults system in the region (including the conspicuous changes in the river courses) and a clear correlation between the fault pattern, the seismicity and the influence of Lithospheric dynamics. The continued seismicity of this area is attributable to a combination of neotectonic activity coupled with the effects of Indo-Antarctica breakup and periodical reactivation of faults, since geological past.

INTRODUCTION AND JUSTIFICATION OF THE STUDY

An attempt is made to explain the seismicity of the Ongole region that comes under zone III by the Bureau of Indian Standards (IS 2002) and surrounding regions in terms of tectonic framework of Indo-Antarctica breakup. A close look into Fig.1 (modified from Babu 2001; Krishna Brahmam 1989), the physiography and lineament map, indicates presence of all the three types of regional fault patterns, namely, NW-SE, NE-SE and E-W in the region. Babu (2001) has pointed out that between the rivers Pennar and Krishna three episodes of folding, namely the initially open type followed by closer and tight isoclinal folding and the final cross folding are noticed from Chundi and Ongole. The region is drained by Gundlakamma, Musi, Paleru and Manneru rivers. The NW-SE lineaments control the Musi, Paleru and Gundalakamma where as the E-W/ENE-WSW lineaments control Manneru.

Ongole and its surroundings are known to have experienced intermittent seismic activity, since a long time, including the three earthquakes of moderate magnitude (~5-5.8). Nageswara Rao et al. (2003) collected the earthquake data for the period of 1800-2002 and found that most of the Earthquakes are concentrated along NW-SE trending lineament.

Nellore-Sileru shear zone (NSSZ), East Coast Sedimentary Basins (ECSB), Eastern Ghat Granulite Belt (EGGB) and Eastern Ghat Mobile Belt (EGMB) are either closer or passing through the Ongole region. It is also interesting to note that the linearly extending gravity high associated with EGMB shows minor but conspicuous changes in and around the region of Ongole. Magnetic survey is carried out by Swamy & Radhakrishna Murthy (2003) around Ongole region shows strong magnetic anomalies to the north of $15^{0}21'$N latitude and flat towards south.

The above significant findings clearly emphasize the need for a re look into various sets of results, to come out with a more meaningful hypothesis for the regions seismicity.

ADAPTED APPROACH AND DISCUSSION

According to Babu (2001) superposed drainage patterns and paleochannels of the rivers in and around Ongole region confirm the uplift of the Eastern Ghats Physiographic Province which is well illustrated by change in the river courses, namely, river Pennar, river Palar (paleo delta north of Madras and at present south of Madras) and river Cauvery (Radhakrishna 1992), separation of the rivers Gundlakamma and Sagileru (Rao et al. 1992). Nellore Khammam Schist Belt and Eastern Ghat Granulite Belt were uplifted because of anticlockwise rotation of the Indian plate at 65 Ma resulting in the development of East Coast Sedimentary Basin (ECSB). According to Rao & Babu (1995) the stretching and faulting of the oceanic crust of the Bay of Bengal as a result of its subduction towards Burma played a role- in the development of the East Coast Sedimentary Basins, bottom topography of Bay of Bengal, neotectonism and seismic activity in the eastern part of South India and Bay of Bengal. All these clearly point out that the older faults reactivated and new ones developed by the northeastward drift of the Indian Plate. This tectonic phenomenon has in turn has affected the depo-centers in the Indian Plate. In this contest when we look into the assembly, break up and reassembly of East and west Gondwana super continent, we notice some remarkable signatures.

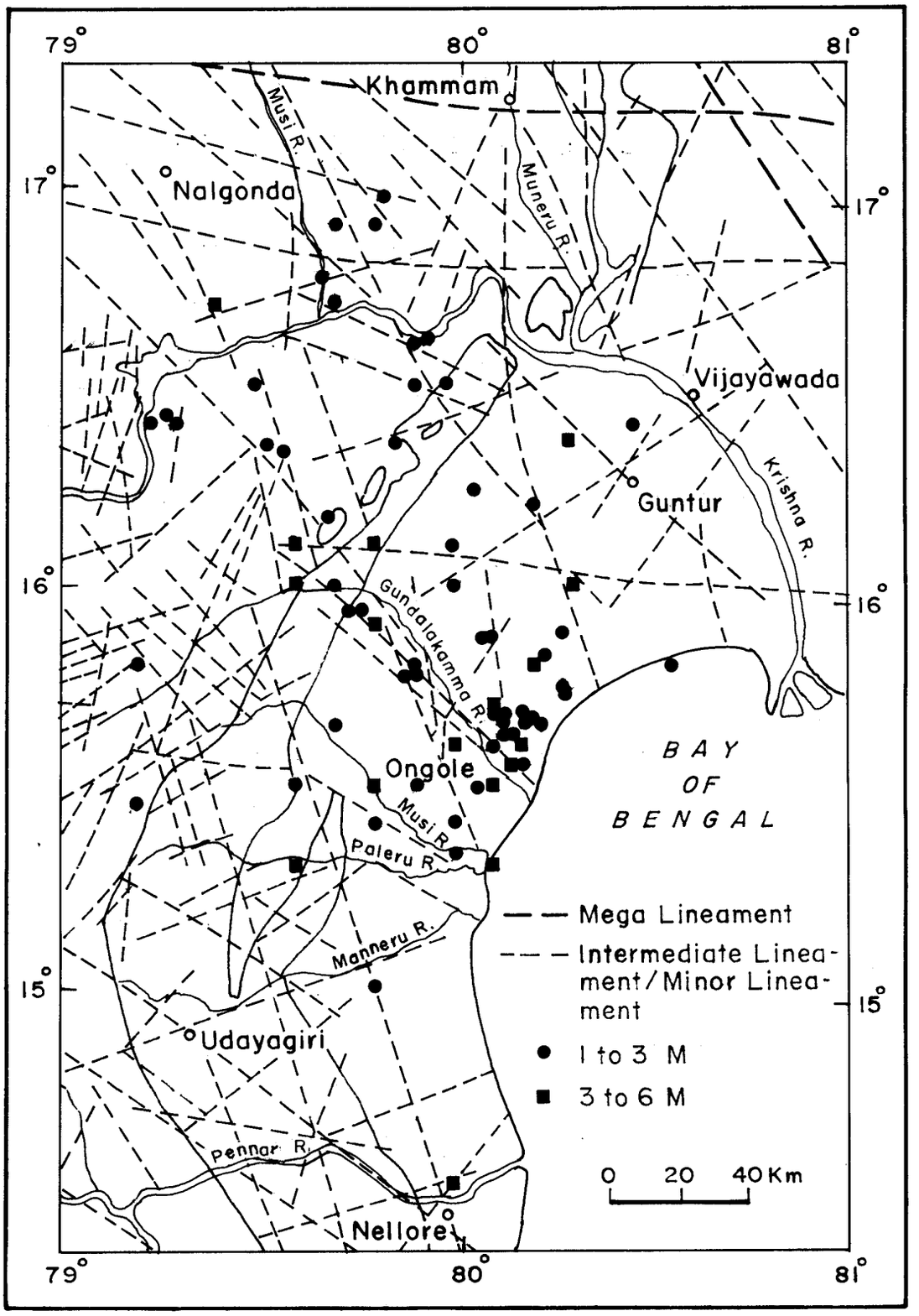

Figure 1. Map of physiography and lineaments in the Nellore Khammam Schist Belt region, along with epicentral data (Modified from Babu, 2001 and Krishna Brahmam, 1989).

According to Ramana et al. (1997) horizontal compression forces develop at the time of major plate reorganization. In Indian plate stresses developed at ca. 530 Ma and ca. 320 Ma were due to coalescence of the Gondwana and Pangaea whereas at ca 160 Ma and ca 230 Ma the stresses developed due to rift of the plates. They were also related to the spatial and temporal change of the curvature of the Earth with polar wandering, e.g. shift of the South Pole. Venkatarengan & Ray (1993) has mentioned that the four cross trends -the Pithapuram, the Chintalapudi, the Avani gedda and the Ongole–in the ECSB were result of coalescence stresses. So, the entire region was under series of stress cycles. This aspect has to be taken note of in understanding the variations in lithospheric dynamics, from geological past till to date, as this is the main mechanism behind varied tectonic episodes. This is well projected when we look in to the origin of alkaline rocks. It is now well established that the ultimate origin of these rocks is mantle rather than crust. It is also well established that the alkaline magmatism is structurally controlled by reactivation of old faults. Nepheline syenites, alkaline rocks (Leelanandam 1981) having an almost NE-SW trend, exposed in the region north of 15° latitude are correlated with seismcity.

Prakasam & Rai (1998) noticed that thin lithosphere exists beneath the eastern coastal margin. This in a way suggests that significant lithospheric dynamics has played in the formation of Krishna-Godavari basin. Wide spread volcanic activity and rheological stratification has taken place prior, during and subsequent to Indo-Antarctica breakup.. It is also relevant to state that the path of Marion and Crozet hotspots (Fig.2) lie very close to the region and the lithoshperic thinning up could be attributed to the combined effects of mantle plume activity and breakup of East Gondwana super continent. The granulite facies rocks of the Ongole Domain extend from Ongole in the south to the southwestern margin of the Godavari Rift and re-appear on the other side of the rift. This is exemplified by the occurrence of characteristic metasedimentary lithologies up to Upper Sileru. According to Veeraswamy & Raval (2003) horst like Balaghat range up lift (closely associated with Bhatsa, Ahemadnagar, Hyderabd, Nagarjunasagar and Ongole), appears to stretch from west to east coast. In this background Ongole and its surroundings being conspicuously located at a tectonic junction separating Krishna-Godavari basin and Eastern Ghat Mobile belt, need immediate attention through systematic seismic surveillance.

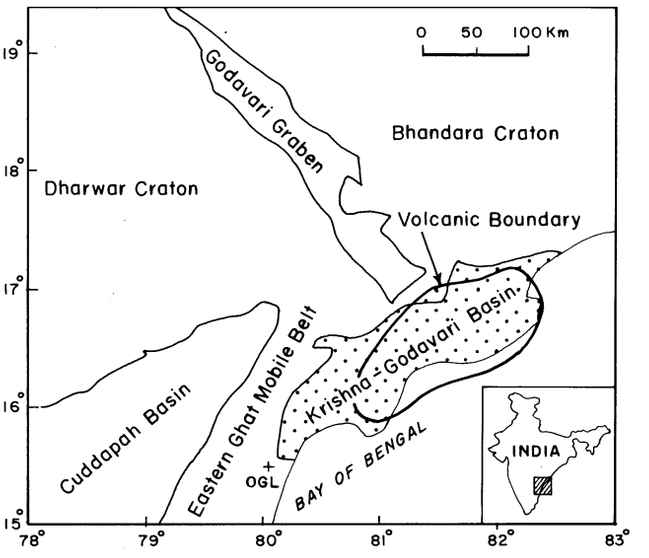

Figure 2. Map showing the geotectonic setting in Southeastern India (Prakasam & Rai 1998).

RECOMMEND FUTURE COURSE OF ACTION

1. Even though, we believe that the source of seismic activity is associated with the combined effect of local and regional tectonic activity, in order to better understand the aspects contributing to seismic activity in Ongole region it is essential to conduct high resolution integrated geophysical surveys including seismic refraction and reflection, magnetotelluric, deep resistivity sounding coupled with close spaced gravity-magnetic.

2. Since the flow pattern of four rivers indicates probable focusing offshore up to 81°E longitude it may be assumed that submerged rivers are also probably controlled by lineaments. Hence we feel that it is essential to study the bathymetric and other geophysical details between 15°N-16°N latitude and 80°E-81°E longitude, to ascertain the linkage between structures on and off the coast, eventually the study provides an important input to substantiate presence of Neo tectonic activity.

3. The multiple stress fields have guided the dynamics of the Indian landmass on the Indo-Australian lithosphere. To understand this multiple stress field, it is very important to study the tectonic and structure of the floor of Bay of Bengal lying under a huge pile of the Ganga fan sediments, and fractured continental basement under volcanic trap and volcanic Arcs of Andaman Nicobar region.

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