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1. Multi-parametric and Multi-station Facility for Earthquake Precursory Study:

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The "Geochemical Monitoring Research Group" from Variable Energy Cyclotron Centre (VECC), Department of Atomic Energy (DAE) in association with the Ministry of Earth Sciences (MoES) recently upgraded their field station laboratories located at hot spring sites at Bakreswar (W.B.) and Tatta Pani (Jammu, J&K) and mud volcano site at Baratang (A&N) with advanced instrumentation to facilitate the research activities on "Multi-parametric and Multi-station Facility for Earthquake Precursory Study". These laboratories are situated in diverse regions having dissimilar geology and different seismic zones of the country. All three laboratories are located near to the active faults. Location of these field laboratories are shown in seismic zoning map of India (Fig. 1.1).

The field laboratories were equipped with on-line monitoring equipment such as Micro Gaschromatograph (Agilent Technologies), Alpha GUARD Radon Monitor (Saphymo GmbH), Doseman Pro (Sarad GmbH) to record hourly concentration changes in hydrothermal system emanated stable gases He, CH4, N2 etc. as well as the radioactive constituents ^{222}Rn, ^{218}Po, ^{214}Po and gamma dose rate (Fig. 1.2). To enable automatic data downloading facility at the headquarter at VECC, Kolkata and to analyze the data, a tailor-made software has been developed based on Java script using My SQL database. Recorded data sets are then utilized for statistical analysis, data comparison to find out helium and radon anomalies and to correlate the anomalies with subsequent earthquakes. Thereafter non-linear analyses by means of FFT, wavelet, multi-fractal etc of the time series data are performed to understand the underlying dynamics of the helium and radon emanation, and their relation with earthquake preparation phase. Earthquake catalogs are collected from the India Meteorological Department (IMD) and U.S. Geological Survey (USGS) websites.

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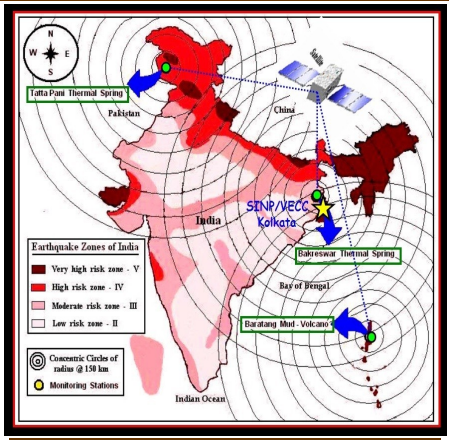

Figure 1.1: Location of the field laboratories in seismic zoning map of India.

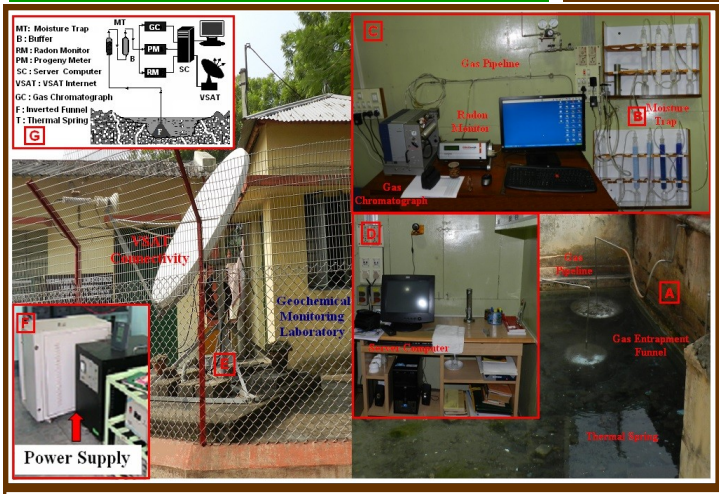

Figure 1.2: Integrated experimental set up installed at geochemical monitoring laboratory at Bakreswar

From the President's Desk

I am very happy to announce the 3rd annual convention "Earthquake Science – The future Challenges" with special theme on "Seismic Microzonation and Hazard Assessment". The convention will be jointly organised by Institute of Seismological Research (ISR) and Indian Society of Earthquake Science (ISES), during 6th – 8th January, 2014 at Institute of Seismological Research, Gandhinagar, Gujarat. All are cordially invited to participate and contribute towards the Earthquake Science.

NEWS / EVENTS

- Institute of Seismological Research (ISR) and Indian Society of Earthquake Science (ISES), will jointly organise the 3rd annual convention "Earthquake Science – The future Challenges" with special theme on "Seismic Microzonation and Hazard Assessment" during 6th – 8th January, 2014 at Institute of Seismological Research, Gandhinagar, Gujarat
- Indian Society of Earthquake Science (ISES) calls research articles for its open e-jounal "Journal of Earthquake Science (JOES)" .

Inside this issue:

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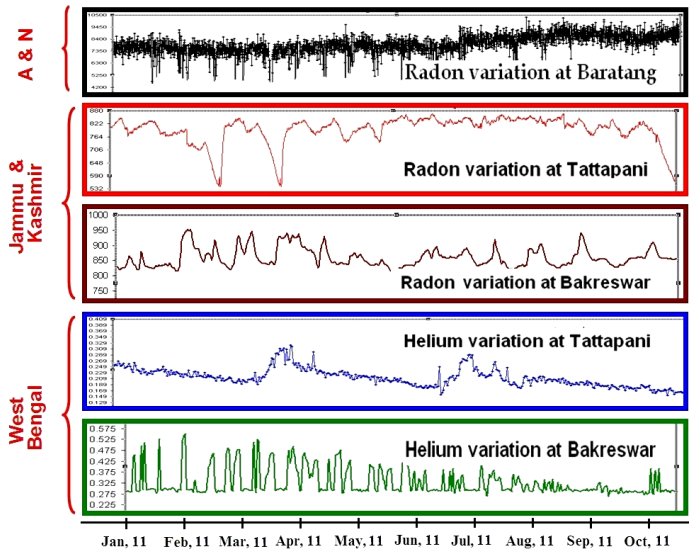


Figure 1.3: Helium and radon time series data recorded at field laboratories at Bakreswar (WB), Tatta Pani (J & K) and Baratang (A & N).

Helium and Helium / Methane Ratio anomalies recorded at Bakreswar during May 9-13, 2012

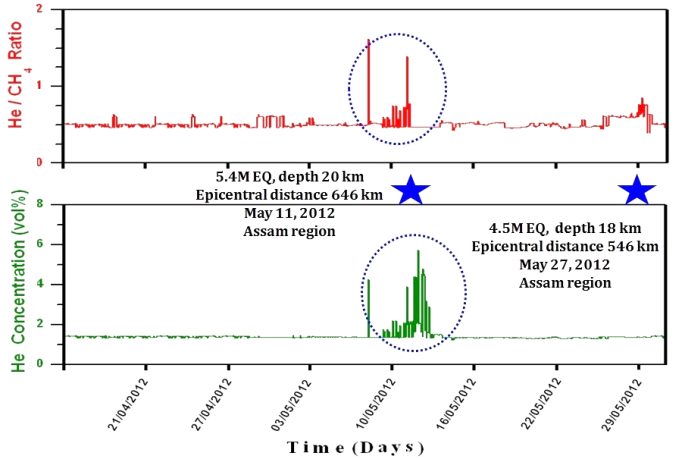


Figure 1.4: He and He/CH_4 anomaly recorded at Bakreswar (WB) during May 9-13, 2012.

Attempts have also been made to develop a model to reliably predict the precursory time and probable zone of epicenter using the multi-parametric data recorded at multi-station.

The temporal variations of helium and radon recorded during the period of January 02, 2011 – October 30, 2011 at three field laboratories are shown in Fig. 1.3. Further, five anomalies were recorded in the last 12 months, and subsequently correlated with regional and trans-regional earthquakes of M ≥ 4.0.These events occurred at hypocentral distances ranging from ~250 km to ~1500 km from the said test sites. Large fluctuations (>2σ, where σ is the standard deviation of the time series data) in the He and He/CH_4 time series were observed at Bakreswar laboratory during May 9-13, 2012 as shown in the lower window and upper window of Fig. 1.4, respectively. The observed He burst and He/CH_4 anomaly could be treated as precursors to either (i) the Assam earthquake (M 5.4, depth 20 km) on May 11, 2012 or (ii) Kamrup Assam earthquake (M 4.5, depth 18 km) on May 27, 2012 or (iii) Sikkim-Nepal Border region earthquake (M 4.0, depth 10 km) on May 30, 2012. However, the primary attempt of this research is to develop the seismo-geochemical algorithms which will assist to identify the probable location and time of an impending earthquake with higher degree of probability. Moreover, statistical and non-linear analyses of multi-parametric and multi-station geochemical data may serve as a potential tool in earthquake prediction research.

2. Extraction of linear and anomalous features over a part of the 85°E ridge and its importance in subsurface monitoring

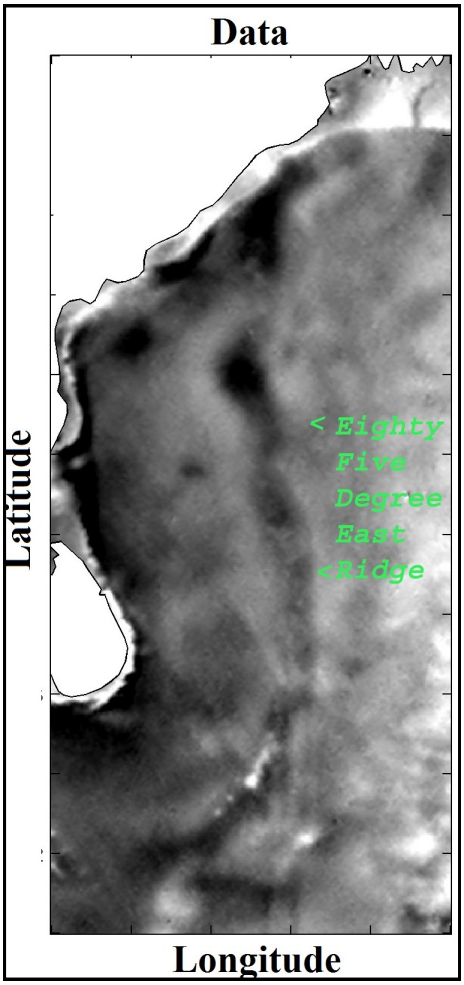
T.J. Majumdar, CSIR Emeritus Scientist, and S. Chander, MPSG/EPSA, Space Applications Centre (ISRO), Ahmedabad

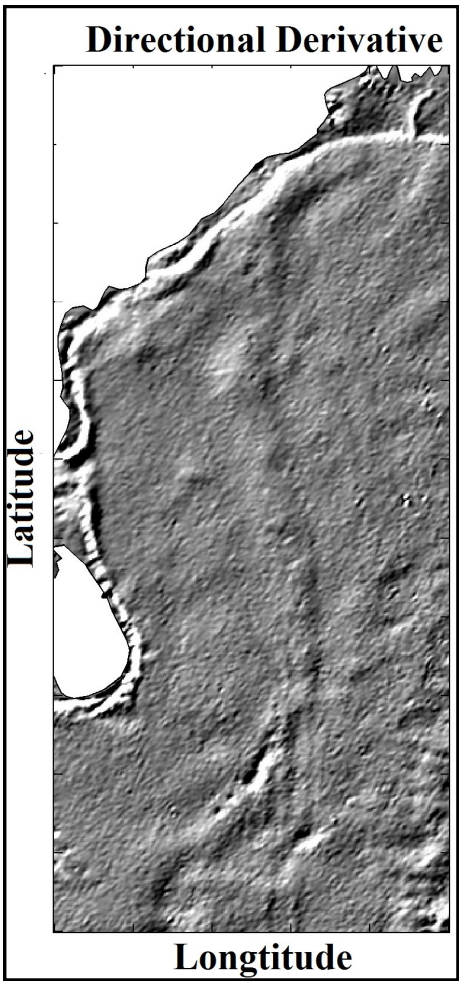
Lineaments are frequently observed in remote sensing imagery as combinations of stream patterns or topographic alignments. Lineaments, which may be continuous or discontinuous, be regarded as the surface manifestation of fault or fracture zones. These have been linked with local or regional tectonics and used as a tool for geophysical exploration. In addition, surface anomalous patterns, as observed in satellite imageries, may also be found useful for such activities. An image transform is a two-dimensional spectrum derived from the decomposition of image data. Transforms have been utilized to extract features from images. Dimensionality reduction is another application. To study these aspects various two-dimensional unitary transforms may be considered, e.g., Haar, Hadamard, Fourier, etc.

The Bay of Bengal (BOB) sedimentary basin is one of the largest offshore sedimentary basins of the world having the thickest accumulation of sediments which mask the underlying crust and it is the geopotential data that offers the unique opportunity of seeing below the thick sediments. The Eighty Five East Ridge or 85°E Ridge is a near-linear, aseismic, age progressive ridge in the northeastern Indian Ocean. The feature extends from the Mahanadi Basin in the north, off the northeastern coast of India, shifts westwards by about 250 km around 5°N, southeast of Sri Lanka and continues south to the Afanasy Nikitin Seamount in the Central Indian Basin. The volcanism that created the ridge started ~80 Ma in the Mahanadi Basin and the process continued southwards, ending at ~55 Ma near the Afanasy Nikitin Seamount. The 85°E ridge runs close to the 85°E longitude from 17° N almost up to 9°N latitude and then turns westwards south of Sri Lanka and runs almost up to equator. In the north, it turns NE and enters the Bengal Basin as the Barisal ridge and the Tripura uplift. During 1900 and 1980, a total of 348 earthquakes were recorded in the area of Bay of Bengal bounded by 7.0°N to 22°N and 88°E to 100°E with magnitudes between 3.3 and 8.5. However region over the 85°E ridge (0°-22° N and 80°-90° E) in BOB was comparatively calm and no such high intensity earthquake had been reported.

No wells have so far been drilled on the 85°E ridge. Samples of the ridge from the Afanasy Nikitin Seamount were ultramafic dunite. Seismic studies have shown that the morphology of the ridge including its depth of occurrence varies along the ridge track and that, in general, the ridge has been buried beneath sediments deposited since the Oligocene. The ridge is associated with complicated gravity and magnetic signatures. The northern part of the ridge is buried beneath thick sediments of the Bengal Fan and shows a negative gravity anomaly. Ridge structures in the south occasionally rise above the sea floor and are associated with a positive gravity anomaly. Satellite altimeter-derived high resolution gravity over a part of the Bay of Bengal has been utilized in this study. Figure 2.1 shows the satellite free-air gravity anomaly over a part of the northeastern Indian Ocean with subtle delineation of the 85°E ridge (0°- 22° N and 80°- 90° E). The 85°E ridge is shown as a gravity low in this region.

The horizontal gradient of a potential field dataset (for example, gravity) in a given direction enhances features which trend at 90° to that direction, while diminishing those which lie parallel to that direction. Such directional derivatives are commonly applied to enhance features e.g. lineaments, faults and trends. Another filter that is commonly used to enhance linear features is sunshading which considers the data as a topphic surface, illuminated by a light source (or, 'Sun'), and calculates the reflectance. Different reflectance models can be used, though the common one is a Lambertian reflector. Figure 2.2 shows the directional derivatives over the area of interest. A number of linear and anomalous





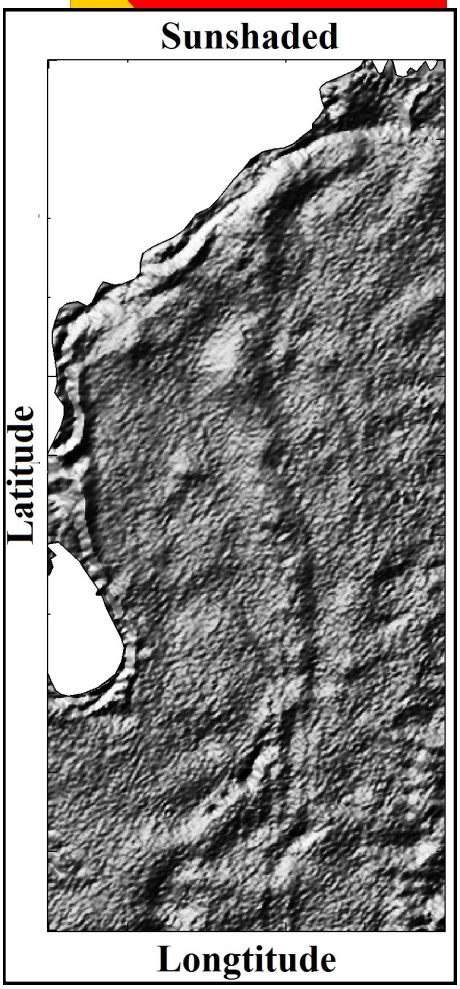


Figure 2.1: Original free-air gravity data as obtained from satellite altimetry over a part of the Bay of Bengal.

Figure 2.2: Results after applying the directional derivatives over the area of interest.

Figure 2.3.:Sunshaded image over the area of interest which shows similar features in a 3D perspective .

**** Due to the prevailing security restrictions, Lat./Lon. Markings have been omitted in the imageries*.**

features over the region are enhanced sharply including the coastal lineament patterns. The major lineament trends include N-S, NE-SW, NW-SE and NNE-SSW. Also, the extension of 85°E ridge towards the BOB coast has been clearly demarcated. Figure 2.3 shows the sunshaded image over the area of interest which shows similar features along with 3D perspective to some extent.

Free-air gravity image over the 85°E ridge region has been enhanced using derivative-based filter as well as sunshading techniques. Results are quite satisfactory and a good number of linear and anomalous patterns over the 85°E ridge could be obtained which has far reaching applications for lithospheric/tectonic studies. Moreover, pattern of extension of 85°E ridge toward the coastal region in the Bay of Bengal as enhanced in Figs. 2.2 and 2.3 will bring new light in this study which is still considered as controversial.

3. Evidences suggest that South Tibetan Detachment System was active during the last 20 ka:

Falguni Bhattacharya, Institute of Seismological Research, Gandhinagar, Gujarat and Naresh Rana, Dept. of Geology, HNB Garhwal University, Garhwal.

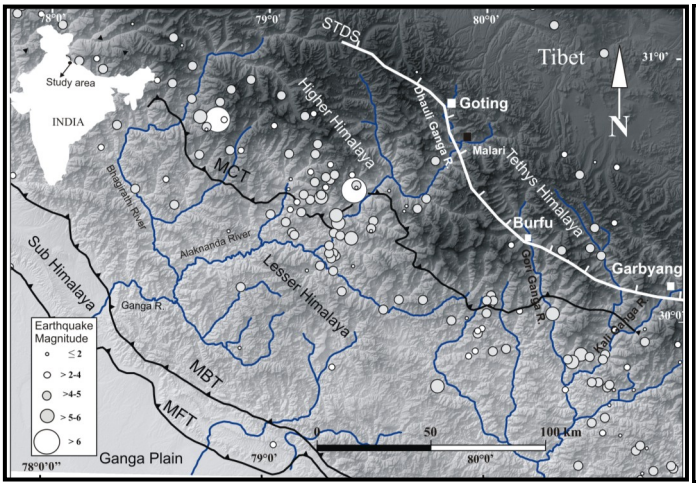


Figure 3.1

Two important structural features, with very different characteristics, that developed in the Himalayan orogen are (i) north dipping thrusts (compressional structures) and the (ii) north dipping normal faults (extensional structures). The later is known as the South Tibetan Detachment System (STDS) which is developed near the crest of the Higher Himalaya along the southern margin of the Tibetan plateau. Studies suggested that the STDS came into existence along with the MCT during the Miocene. Several studies show that the terrain that lies between the MCT and the Himalayan Frontal Thrust (HFT) witnessed episodic tectonic activity during the Late Quaternary. Compared to this, although the structural and geochronological data indicate that the STDS was active during the Miocene, however, its subsequent activation remains poorly understood.

The present demonstration based on the occurrence of the Soft Sedimentary Deformation Structures (SSDS) in relict proglacial lake sediments and optical chronology that the STDS was active during the late Quaternary (<20 ka). This study was undertaken in the Dhauli Ganga, Gori Ganga and Kali Ganga valleys of **Continued in Page 4**

ISES at a Glance

- *ISES invites research articles for its open e-Journal,* ***Journal of Earthquake Science (JOES) .***
- *All the instructions related to manuscript submission are available at* ***http://www.joes.org.in*** *or alternatively contact us by e-mail at* ***editor.joes.org.in@gmail.com*****.**
- *JOES will be freely available around the world and it is an open access online e-journal in the field of Geoscience/Earthquakes.*

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Miscellaneous News

On 9 May 2013, Dr. Shailesh Nayak, Secretary of the Ministry of Earth Sciences (MoES), Government of India , New Delhi with earth scientist delegation visited the GFZ, Potsdam, Germany and the KTB deep laboratory of the GFZ in Windischeschenbach. The visit served the preparation of several cooperation projects between the MoES, the National Geophysical Research Institute (NGRI) and the GFZ including Deep Drilling Project (DEEPAK) near Koyna, Maharashtra. The drilling is being carried out as part of a major scientific programme funded by the MoES to investigate seismicity in the Koyna-Warna region. As a part of International Continental Scientific Drilling Program (ICDP), the MoES will set up a drill core repository with support from the GFZ to curate samples from the planned drilling.

In addition, collaboration is planned between NGRI and GFZ on the new secondary ion mass spectrometer (SIMS) at the GFZ , as well as, a German-Indian joint project to study the regional climate variability in South Asia. ***Source:*** *GFZ, Potsdam, News (http://www.gfz-potsdam.de)*

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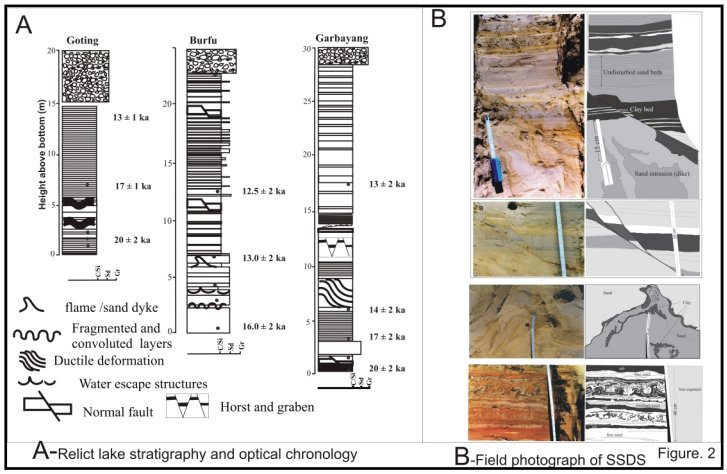
Uttrakhand Himalaya (Fig. 3.1; 30°5-30°49' N and 79°20'- 80°50' E). It has been observed that following the recession of the valley glacier that was obstructed by the rising footwall of the STDS during the late Quaternary period, proglacial lakes were developed on the hanging wall of the STDS. These lakes have preserved the SSDS which we ascribed to the infrequent seismicity associated with the STDS for the following reasons. (i) Their occurrences at three locations ~130 km apart in a similar geological and hydrological setting (Fig. 3.1), (ii) The presence of deformed layers (e.g. *fragmented and convoluted laminae, water escape structures, flame structures, normal listric faults) separated by* undeformed layers (Fig. 3.2) (iii) The optical chronology suggests that majority of the events in the three lakes occurred during 13.5 ka and 17 ka (Fig. 3.2) which implies that they were triggered by common earthquake. Based on a global data curve on known earthquake magnitudes and the distance of SSDS from the epicenter of shallow and deep-focused earthquakes in various tectonic and sedimentary settings, the unknown earthquake magnitude is estimated in the present case to be between M_w 6.5 and 7.0, having an epicenter in the vicinity of the STDS (Fig. 3.3).

The present study has implication towards the suggestion that movement along the STDS did not end in the middle Miocene but persisted episodically or continuously into the Quaternary. The activity seems to be an expression of providing accommodation space to the ongoing crustal shortening arising due to north-south compression in the Himalaya.



A-Relict lake stratigraphy and optical chronology B-Field photograph of SSDS Figure. 2

Figure 3.2

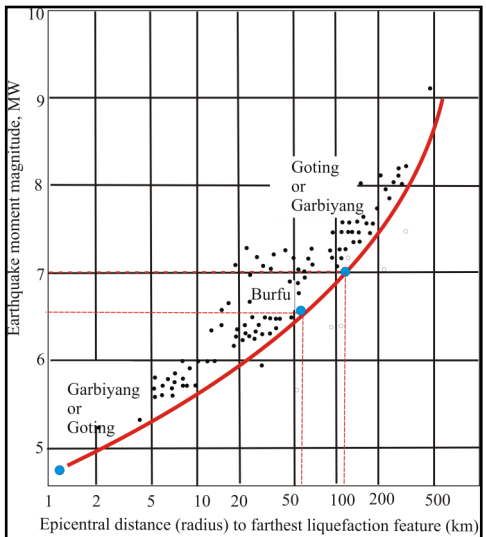


Figure 3.3