Editorial

I am happy to tell that the editorial on **MAGMA**, published in January, 2017 issue received positive comments from elders Dr.Rabinarayan Mishra and Dr.Y.V.Ramana; former a well known geologist from Geological Survey of India and the later a well known High Pressure and Rock Mechanics expert from NGRI. Dr.Ramana in response to my request through the editorial of January issue for an intellectual debate/interaction on definition of **MAGMA** has sent the following, as an additional input. I am sure the readers will be happy to go through the details and keep the debate active. I urge my young research friends to learn from such highly motivated elders and strengthen their knowledge base, making their research output recognised by the peers.

Dr.Y.V.Ramana has sent the following:

------I am writing my views to sustain the discussions with a positive note.

"**MAGMA** connotes geological materials, subcrustal in nature, taking the form of solid to semisolid state, or states, derived from the prevailing interior Pressure and Temperature conditions creating a mass with a semi-viscous to viscous formation states responding to form elasto - plastic flows introducing creep enabling periodic, or even aperiodic flows of extensive rocky materials; whose movement, movements or displacements cause to be causative factors for earthquakes, coupled with massive structural upward lifts, subduction zones, major fault zones, changes in oceanic rifts, geologic plate movements (major or minor), volcanic eruptions, etc., whose cumulative effect over a geological time scale to restore a cyclical balance through even continental drift.

MAGMA formation is very complex dependent on multiple variable factors, mostly Natural in origin over geologic time scales that are mostly cumulative and earthquakes are Telltales for humans to understand and draw inferences within the realms of the scientific investigator, or researcher governed by his / her analytical comprehension and limitations of knowledge. The presence or the existence of Magma is the causative factor for the very classification of crust, mantle, and core, as well as the further subdivision of upper mantle, lower mantle, outer core and inner core supported by geological and geophysical picturization of mother earth.

Dynamic earth has a regenerative process or processes of its own, with its own cyclical systems, equilibrium states at different depths, changing P and T conditions and so on, apart from the influence of the other planets in the earth's solar system, of which it is a part, and

the influence of these being more visible in the oceanic part with its tidal changes, atmospheric changes; as well as ionospheric variations impacting communications.

Trust these views find a place in the Journal, as well as the proposed discussions on Magma".

The above details communicated by Dr.Ramana are interesting.

As we need to make use of the present discussion to have better insight in to **MAGMA** composition, I place below an interesting article. The cited study helps to know about how the mantle melts, to understand **MAGMA** composition. Geochemical and isotopic data suggest that the source regions of oceanic basalts may contain pyroxenite in addition to peridotite. In order to incorporate the wide range of compositions and melting behaviours of pyroxenites into mantle melting models, Lambart et al (2016) have developed a new parameterization, Melt-PX, which predicts near-solidus temperatures and extents of melting as a function of temperature and pressure for mantle pyroxenites.

Before going into specifics of the above study let us know in detail about mantle composition.

"The bulk of the Earth's volume is composed of the mantle—the layer of silicate rocks sandwiched between the dense, hot core and the thin crust. Although the mantle is mostly solid rock, it's generally viscous: Slowly, over millions of years, the material within the layer drifts, driving tectonic plates together and apart. Thus, the mantle's influence can be seen on the planet's surface on both large and small scales—from fuelling volcanoes and seafloor expansion down to the composition and characteristics of igneous rocks. The mantle is a heterogeneous mixture of peridotite and pyroxenite, largely due to the continuous subduction of basaltic oceanic crust. This is becoming increasingly clear as our studies of basaltic **MAGMA** chemistry grow ever more detailed. However, nearly all models of mantle melting assume homogenous peridotite compositions. A few experimental studies have studied pyroxenite melting, and there have been some attempts at empirical modeling of melting of heterogeneous mantle. Igneous rocks composed primarily of pyroxenes, minerals that contain 40% more silicon than olivine—may also be a source of oceanic lavas".

New research by Lambart et al. seeks to better model how pyroxenites influence melting that occurs in the mantle. Pyroxenites make up between 2% and 10% of the upper mantle, depending on the region, but determining the amount of pyroxenites in hot mantle plumes that reach the surface requires more information. Researchers have found that at the same pressure, pyroxenites tend to melt at lower temperatures than peridotites, which means that any pyroxenites in peridotite-rich mantle regions might make up a larger portion of the liquid material than their small fraction of mantle bulk would suggest. To understand how the varying source materials in the mantle contribute to the characteristics of igneous rocks at the surface, researchers need to understand the melting characteristics of pyroxenites—a broad and variable group of rocks. That variability in composition makes predicting the phase changes of pyroxenites more complicated. And that complexity means that current models of mantle melting, like pMELTS, overestimate the temperature range over which pyroxenites melt. So, the authors created a new parameterization for mantle melting models that seeks to rectify the problem. The new parameterization accounts for the fact that temperature, pressure, and the bulk chemical composition of the rocks together determine their near-solidus temperature. The authors used a compilation of 183 experiments on pyroxenites with 25 varying chemical compositions, carried out over pressures from 0.9 to 5 gigapascals (GPa) and temperatures ranging from 1150°C to 1675°C. They charted the temperature when 5% of the materials was molten and the temperature at which clinopyroxene, a dominant mineral in pyroxenites, in each sample was gone—parameters that are easy to detect accurately and consistently. This analysis helped the authors create a new model based on experimental data from the literature, dubbed Melt-PX, which predicts the temperature at which the pyroxenites start to melt within 30°C and the amount of melting within 13%. It showed that at low pressure—less than 1 GPa— pyroxenites melt at lower temperatures than peridotites, but as pressure increases, more and more pyroxenites melt at higher temperatures than peridotites. Lambart et al is the first study to make a thermodynamic model of pyroxenite melting based on the experimental studies and represents an important step forward in accurate modeling of heterogeneous mantle melting. The model produced (Melt-PX) will be an important tool for future studies looking at **MAGMA** compositions and trying to use them to understand melting conditions in the mantle. As the new model will be a useful tool to understand **MAGMA** composition it ultimately helps researchers have a window into the Earth and the source of oceanic basalts. (Citation: Journal of Geophysical Research: Solid Earth, doi:10.1002/2015JB012762, 2016).

Let us know from the learned the necessity to know more about oceanic basalts, to keep the debate on **MAGMA** interesting. I am stressing this as many processes originating from deeper depths are linked to near surface features due to the primary contribution made by **MAGMA**.

Deciphering the Bay Of Bengal`s Tectonic origins

Since the day I led a Deep seismic Refraction team to bring out crustal velocity-depth model of West Bengal basin in 1988, I have been fascinated by the intricate subsurface crustal images of the study area. It was evident from then that the link between continental and oceanic segments is rather blurred and unique. And as such one has to view at various hidden mysteries of the oceanic and continental segments of this part of South Asia, by integrating both geologic and geophysical signatures not only to decipher the Bay of Bengal`s tectonic origin but also the entire continental span from the West Bengal and Bangladesh coastal corridor to Tibet crossing Himalayas. I felt happy to go through an interesting article published in 15th Oct, 2016 issue of EOS, while hearing soothing music from my favourite TV musical channel.

I cover below some salient points of this article in EOS and the original article published in JGR, hoping our youngsters will be benefitted.

"Although researchers have long understood that the tectonic evolution of the Bay of Bengal, located east of India, is intertwined with the opening of the Indian Ocean, the specifics of these events have yet to be unravelled. Because the standard methods of resolving the age and origin of the underlying crust—the crucial information needed to solve this puzzle—have so far yielded ambiguous results. Talwani et al(2016) have combined new, multidisciplinary data sets to obtain a better understanding of the region's tectonic history. They are able to decipher the tectonic evolution of the Bay of Bengal, a puzzle which has not been satisfactorily solved in the past. They are also able to shed new light on origin of the buried 85°E Ridge. They have done so by incorporating a number of disparate items into a unified solution. These items are the marine magnetic anomalies in the Western Basin of the Bay of Bengal, the Rajmahal and Sylhet traps, and Deep Seismic Sounding lines in India, a prominent magnetic anomaly doublet and seismic Seaward Dipping Reflectors in Bangladesh, and a new precise gravity map of the Bay of Bengal. They have identified seafloor-spreading magnetic anomalies ranging in age from 132 Ma (M12n) to 120 Ma (M0) in the Western Basin. These anomalies are "one sided"; the conjugate anomalies lie in the Western Enderby Basin, off East Antarctica. The direction of spreading was approximately NW-SE, and the half-spreading rates varied from 2.5 to 4.0 cm/yr. With the arrival of the Kerguelen plume around M0 time, seafloor spreading was reorganized and a new spreading axis opened at or close to the line joining the Rajmahal and Sylhet traps. The prominent magnetic anomaly doublet connecting the Rajmahal and Sylhet traps indicates that these traps are not individual eruptions at about 118 Ma, but rather, together, define the new line of opening. Spreading started at this line, and subsequently, India changed direction from west to north. The new oceanic crust, thus generated, underlies Bangladesh and the Eastern Basin of the Bay of Bengal and is younger than 118 Ma. The western boundary of the new ocean floor is a transform fault, which was generated by the spreading axis jump. This transform fault appears as the 85°E Ridge, and further north, on land, as a negative free-air gravity anomaly strip. A unique feature of the northern boundary of the new oceanic crust is that due to the later deposition of enormous sediments derived from the Himalayan orogeny, it lies onshore Bangladesh, in contrast to most continent-ocean boundaries in the world, which lie offshore. Despite the progress made in this study, many questions remain, according to the researchers. Additional studies, including a seismic refraction survey, will be necessary to further refine the details regarding this region's complex tectonic evolution". (Citation: Journal of Geophysical Research: Solid Earth, doi:10.1002/ 2015JB012734, 2016).

During 1988 to 1990 NGRI DSS project covered 4 seismic refraction profiles covering a significant part of West Bengal basin. Number of scientific publications (mostly by me and my younger colleagues)have come out in print. One of the articles clearly pointed out that the path of Kerguelen hot spot track followed NW-SE trend covering both oceanic and continental segments of West Bengal basin. As researchers could not cover in the similar way relevant segments of Bangladesh proper crustal velocity –depth models of the entire span of west and east Bengal basin could not be built to substantiate the proposed continental extension of Oceanic crust proposed by Talwani et al (2016). Composite deep refraction and seismic reflection data based structural models in co-ordination with other geophysical results can bring out the suggested presence of region's complex tectonic evolutionary details indicating presence of a new spreading centre along a line that now joins two volcanic provinces, called the Rajmahal and Sylhet traps. In this context a paper (in press) in Geophys. J. Int. (2017) doi: 10.1093/gji/ggw461 by Damodara et al (2017) is interesting. They have analysed first arrival refraction and later arrival wide angle reflection data (DSS data) using travel-time tomography along four profiles. The models have been successfully assessed for their reliability by checkerboard tests. The study identifies a regional feature, known as the Shelf break or the Hinge zone, where stable Indian shield ends and a sharp increase in sediment thickness occurs. The Hinge zone may represent the relict of continental and proto-oceanic crustal boundary formed during the rifting of India from Antarctica. The similar processing procedure could be used in deciphering the overall characteristics of unique crustal fabric of wider Bengal basin that contains both Rajmahal and Sylhet traps. It is time for NGRI DSS project to have a collaborative programme with Bangladesh, using the good offices of SAARC secretariat. Once data acquisition is accomplished and an integrated crustal velocity-depth model is produced, as stated by Talwani (2016) many issues pertaining to area specific and region`s complex tectonic evolution can be resolved.

In this issue

This issue contains 9 research articles, apart from the editorial and News at a glance. I do hope you would enjoy reading all the contents. Quality of many articles has been considerably improved by the stellar role played by learned reviewers including a couple of editorial board members. I thank both the authors and evaluators for the excellent contributions**.**

I thank one and all for the continued support extended to JIGU.

P.R.Reddy

Congratulations :

ISRO's PSLV-C37 Successfully Launched 104 Satellites in a Single Flight on 15th February, 2017. After successful expedition by Mangalyan voyager to Mars this success further confirms the outstanding capabilities of Indian Space scientists. We extend our warm greetings and congratulate one and all associated with this launch---

.... Editorial Board of JIGU & Executive committee of IGU

Elastic Wave propagation and the Coriolis force -- Recent Scientific Achievement

Earthquake generated seismic waves (elastic waves) propagate through Earth and scatter off places where material properties change suddenly, notably at the core-mantle boundary. To investigate whether rays of elastic waves are deflected by Earth`s rotation Roel Sneider and collaborators used the seismometers of USArray. They found that even after eight hours after a major earthquake, elastic waves continue to propagate along the great circle defined by the earthquake site and the array. The absence of any deflection indicates that seismic rays co-rotate with Earth. In other words the ray is not subject to the Coriolis force. Intuitively, the reason is that seismic waves are carried by a medium-the rotating Earth. In case of electromagnetic waves, which are not carried by a medium, it is significantly different: The direction of propagation of electromagnetic waves is not influenced by Earth`s rotation.

The study further pointed out that polarization of P-waves (Longitudinal) does not change in response to the Coriolis force, where as for S-waves (transverse) whose polarization is in a plane perpendicular to the propagation direction, in contrast to P-waves the polarization of S waves does rotate. Measuring the change in S-wave polarization due to Earth`s rotation presents a challenge because transverse elastic waves do not propagate for long in a pure S-wave state. By measuring the individual polarizations and difference in polarization between ScS and ScS2 waves the researchers have noticed the polarization change due to inhomogeneities in Earth`s structure is opposite in direction for eastward and westward propagating waves. But the polarization change induced by the Coriolis force is always clockwise in the Northern Hemisphere, no matter the direction of propagation. Roel Sneider et al (2016) concluded from their study that given a measurement of polarization rotation in an S wave, the Coriolis induced component can be subtracted to give the contribution from inhomogeneities alone, an approach that might lead to a better understanding of how Earth`s structure influences seismic waves (**Citation:** Roer Sneider et al, 2016, Vol 69, no 12, pp-90 & 91).