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Active Seismics – A Comparative Study

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Seismics is the best geophysical technique not only to image shallow structures associated with different sedimentary basins located on the continent and off shore (for oil exploration) but also for imaging of shallower and deeper structures of geodynamic importance.

Since long this technique has been utilized successfully both in India and United States of America. However, due to various man made and natural limitations, varied level of adaptation to new techniques, the data acquisition modules varied in these two countries. Scientists of these two countries have made area specific changes independently, both in selecting the instruments and recording geometry. For example, in India for deep seismic refraction and reflection studies multi-channel recording geometry has been preferred compared to the internationally accepted deployment of stand-alone recording units of single and three-component category following the example of erstwhile Soviet Union. Deploying unicomponent multi-channel recording units has helped in generating denser data sets but introduced some logistic problems like non-adherence to the straight-line coverage, in addition to non-generation of useful shear wave data. For long, in United States long range refraction study was mostly confined to usage of nuclear explosions as energy, for getting refraction coverage to distances even beyond 500 kms. This technique of using nuclear explosion generated seismic energy yielded very useful information. This approach was discontinued after the international ban of nuclear explosions. To achieve a long list of scientific objectives, in US, subsequently the focus was diverted to deep reflection profiling using stand alone single and three-component systems. This shift from refraction to reflection has not affected the deep structural studies as major part of the country has already been covered by refraction, resulting in the availability of wealth of velocity-depth information to properly utilize/interpret the reflection derived two-way traveltime sections. Unfortunately, in India due to monitory constraints coupled with considerable logistic hurdles in using high energy explosive generated seismic energy (due to high density of population) major parts of the country could not be covered properly to generate quality seismic data. In addition the sponsored support for deep structural studies was minimal, (as the main sponsor: oil industry, was basically not interested in the subbasement crustal structure). However, credit should be given to couple of visionaries of O.N.G.C. and the then Project Leader of D.S.S project, N.G.R.I for generating deeper data as a bi-product of the main programme, till Department of Science and Technology (DST) started supporting the studies under it's Deep continental studies programme, starting from 1990 (nearly two decades after the initial D.S.S study). This lack of needed support has introduced considerable strain in meeting various scientific targets, especially in obtaining source controlled deeper structural images of the lower crust, MOHO and sub-crustal lithosphere.

Multichannel recording has resulted in repetition of high energy shots for long range refraction coverage, a costly and problematic exercise in logistically difficult terrains of India. Due to this hurdle and due to limited financial support for a comprehensive refraction coverage, invariably length of the profiles have been restricted to distances less than 150-160 km, resulting in non recording of Pn phase (a very valuable information). Out of more than 20 profiles, covering different parts of the continent we have Pn information along only 6 profiles. Non adherance to a one time coverage of entire profile length, at least upto 250 km, using a single high energy shot has deprived us in getting anisotropy details, a very usful information. In case of U.S., Pn and anisotropy information is available for each and every segment of the continent, as long range shots are optimally utilized by a good coverage of recording, extending to beyond 250 km.

In U.S and in the western world scientists do believe that there is a good relationship between basin development and lithospheric dynamics. So, they strongly project the importance of getting finer structural details of the entire crust and sub crustal lithosphere. Due to this strong belief they are in a position to even convince environment and disaster management lobbies about the need to utilize deep structural images in planning high resolution shallow

seismic studies to properly identify fault zones and image their deeper extension to address problems associated with inter and intra plate seismicity.

Four of the authors (G Kesava Rao , L Behera, ASSSRS Prasad and V Sridher) participated in high resolution shallow seismic data acquisition programs in California, Arizona, Virginia and San Bernadino. From the planning stage itself the leader of the team allowed the participants to get themselves directly involved, resulting in a strong participatory feeling by one and all. This could be possible in that environment as the total number of participants in a team never exceeded 10 in number. Every member of the team has been entrusted the responsibility of direct participation in attending to different phases of the field work, under a turn key mode with a holistic approach. The objective of the studies was to image micro/minor fault zones and their interconnection at depth, an essential input to understand the seismicity of a region. Prior to the study itself the team has been given an exposure to the available literature that includes shallow and deeper structural details. This exposure narrowed down the area of investigation, enabling selection of a proper and area specific recording geometry to achieve needed results within the stipulated target.

In India, unfortunately, neither the industry nor the academic circles are fully aware of the efficacy of seismics leading to a selective support that could neither satisfy the sponsor nor the real scientist involved in the very study. This approach of selective and truncated support coupled with logistic constraints has in reality produced only patches of quality data, eventhough this itself can be considered as a boon under the prevailing conditions.

Since coincidence high quality shallow and deep seismic refraction and reflection data can alone provide good answers to various geologic and tectonic questions we advocate the following:

- Judicious deployment of multichannel and standalone single/three component recording systems for generating quality data, under optimum utilization mode.
- A detailed refraction coverage using three component recording, is a prime requisitive before attempting deep reflection profiling.
- High resolution seismics needs deeper structural images support to decipher various seismic signatures.
- Generation of both P & S – wave velocity information is essential to properly analyse various reflection signatures.
- Passive experiments should be taken up as a part of the full package that contains both active and passive seismic components and not as an individual package, as the derived relatively average structural details cannot be fine tuned in the absence of active seismic data.
- Oil industry should as a rule insist on generation of deeper information, in addition to the detailed shallower information as any repetition of data acquisition in any part of the country, at any time is prohibitively expensive and problematic.

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