2D Seismic Data Acquisition with Node Technology
in complex terrain for Thrust/Fold Belt Imaging: Chindwin Basin, Myanmar

*BVSSR Murty, Ajeet K Yadav, Virendra Kumar
ONGC Videsh Limited

bvssr_murty@ongcvidesh.in

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Summary
Seismic imaging in geologically complex thrust/fold belt area is a known challenge for acquisition and processing geophysicist world over. Due to inaccessible, rough terrain and logistically challenging areas, like drastic variations in surface elevation, where conventional cables could not be laid down for Seismic data acquisition, a different technology has been adopted for the first time in Myanmar.
This paper summarizes how Node-Technology was adopted to handle these logistical issues and get better results, covering more area in shorter time in comparison with Normal Seismic Data Acquisition with cable telemetry.
In the current case study, events upto 8 km have been successfully imaged especially steep dip events and thrust /folds.

Introduction
This paper deals with Cable-less 2D Seismic data acquisition with Nu-Seis Nodes of GTI (Geophysical Technology, Inc) in the logistically difficult terrain (elevations vary from 150 to 950 mts from MSL), less approachable roads and dense forests in this block to image strati-structural features and steep dip events upto 60°.
Location of the block in the study area is shown in (Fig.1). Topographic variations, Logistics are shown in Fig 2 to 5.
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Advantage of Nodes:

1. Easy to Handle/carry.
2. It works 46 days (12 hours /day) once battery is charged.
3. Less damage to crops and not necessary to cut plants in the forest.
4. Less manpower is required than data acquisition with conventional cables.
5. Faster way in Data Acquisition. (681 LKM data was acquired in one field season with nodes whereas it took 3 years to acquire 506 LKM in Eastern part of the study area of the block with conventional cable data acquisition.)
6. Better coupling in comparison with SM-24 geophones, (30 cm/upto collar of the node in side the
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soil in comparison to 6cm spike of SM-24). The final integrated node is the GTI NuSeis among all nodes (ZLand, SmartSolo, Quantum, GCL & GTI NuSeis). This node clearly has a different factor to the others and has been specifically designed to ensure that the node is well coupled to the ground (the node is inserted into the ground up to the metal collar, although it can also be fully buried).

7. Output in SEG-Y Format

Details of a Node are as follows:

![Node Features](image)

**Product Features**
- GNSS-GPS, Glonass, Galileo
- High speed data download via TransferJet™
- Highly visible LED status
- 10 Ah Li-Ion battery <100mW power consumption
- Unit/sensor status via BLE™ (Bluetooth Low Energy)
- Internal high sensitivity geophone or optional external connector
- 24 bit Sigma Delta
- Industrialized micro SD data storage – 8 – 64 GB

**Operation of Nodes:**
- Charge nodes 4-6 hours
- Plant nodes: To enable the node to be planted special tools are used to create an appropriately sized hole in the ground into which the node is placed. (A. Dig hole with a tool, B. Node after plantation; C. Tool to remove Node)
- Power on with cell for first time after plantation
  - Node will be powered-on 46 operational days (from 6am to 6pm, 12 hours per day) automatically after setting the time period
  - Automatic test of Node
  - Transfer this information to NUSITE tab through bluetooth technology
  - Records any signal during this period
  - After completion of data recording on every line, bring back the Node to camp. Keep it in PTCC box, meant for data off loading and charging.
  - Downloading data: through electromagnetic induction with 4.6 GHz, between memory chip and computer box inside PTCC
  - Data transfer to computer through wires to Interface.
  - Transfer nodes information from NUSITE tab to computer.
  - Transfer shot file information from boom boxes (blasting units) to know the time of shot.
  - Now merge all information
  - Separate traces of 10 sec record length
  - Now generate receiver gathers in SEG-Y Format

**Geology of the Block:**

Block is located at Zepyutaung-Nandaw area in the northern part of Chindwin Basin, Myanmar (Fig.1). Chindwin River flows parallel to syncline (Fig 7).

![Geological Map](image)

**Fig.7: Surface Geological Map**

Chindwin Basin covers (Fig. 8)

1) Steep Dipping events in western Fold Belt with Inversion structure.
2) The Lawtha Syncline separates these two eastern and western structure.
3) Highly thrusted Eastern Fold Belt.
4) Wuntho Massif covers the eastern most part of the Block (Fig 7)

Geological section along A-A' is shown in the Fig.8a. Dip of beds varying from 10° to 60°
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Experimental work:
Experimental work was carried out to find out Shot hole depth and charge size. 4 holes for every depth 12mts, 14mts, 16mts and 18mts and charges are 2kg, 4kg, 6kg and 8 Kg. (Fig 9 & 10) were used.

Based on the experimental results (signal at far offset and spectrum of frequencies) 16mts depth and 4 kg charge size were selected. Shot hole depths were selected by Uphole surveys/shallow refraction surveys and it varies from 12 to 18mts in the block.

### Acquisition Parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Vintage data (1990-1992)</th>
<th>New Data 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shot Point Interval</td>
<td>25m &amp; 75m</td>
<td>50m</td>
</tr>
<tr>
<td>Group Interval</td>
<td>25 m</td>
<td>25 m</td>
</tr>
<tr>
<td>No.of Geophones</td>
<td>12 per group</td>
<td>Single</td>
</tr>
<tr>
<td>Array length</td>
<td>25 mts</td>
<td>No</td>
</tr>
<tr>
<td>CMP Interval</td>
<td>12.5 m</td>
<td>12.5 m</td>
</tr>
<tr>
<td>Shot hole depth</td>
<td>2mts * 8 holes Or Single hole 12-18 mts</td>
<td>Single Hole 12-18 mts</td>
</tr>
<tr>
<td>Charge Size</td>
<td>8 Kg</td>
<td>4 Kg</td>
</tr>
<tr>
<td>Far Offset</td>
<td>3000 m</td>
<td>4487.5 m</td>
</tr>
<tr>
<td>No. of channels</td>
<td>120-120</td>
<td>180-180</td>
</tr>
<tr>
<td>Geometry</td>
<td>Symmetrical Split Spread</td>
<td>Symmetrical Split Spread</td>
</tr>
<tr>
<td>Foldage</td>
<td>120 /40</td>
<td>90</td>
</tr>
<tr>
<td>Sampling Interval</td>
<td>2ms</td>
<td>2ms</td>
</tr>
<tr>
<td>Record Length</td>
<td>5/8/10 Sec</td>
<td>10 Sec</td>
</tr>
</tbody>
</table>
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**Processing Steps in Field and its Result**

Following processing steps have been used for field level processing and QC:

- RECEIVER GATHER TO SHOT GATHER
- TAR GAIN (dB/sec correction constant 3)
- TRACE EQUALIZATION
- BANDPASS FILTER(10-20-40-60Hz)
- Remove all types of NOISE
- DATUM STATICS APPLY
  (final datum elevation 700m/replacement velocity 2500m/s)
- SURFACE CONSISTENT DECON
  (Decon operator length:210ms ,Operator prediction distance: 20m)
- Velocity analysis(At every 600m point)
- Normal movement correction
- CDP/ Ensemble Stack
- Residual Stack

An example of the acquired receiver gathers and shot gathers are shown in Fig.11 and Fig.12 respectively.

**Processing Steps:**

Processing softwares (M/s GeoTomo LLC., Geo-depth, Echos and ES-360© by Emerson-Paradigm) were used to process this 2D Seismic data.

**Final Seismic reference datum:** 1000 mts AMSL

1. *Preliminary Data Preparation*
   a. Data Loading and Reformatting
   b. Geometry Merging
2. *Near Surface Characterization*
   a. First Break Picking
   b. Tomography and Near Surface Model Estimation:
     c. Statics Computation
3. *Pre-Migration Signal Conditioning and Residual Statics*
   a. Editing and Reverse Channel Correction
   b. Band Pass Filtering
   c. Band Limited Anomalous Noise Attenuation
   d. Ground Roll Attenuation through Radial Filtering
   e. True Amplitude Recovery
   f. Multiple Passes Surface Consistent Scaling
   g. Deconvolution
   j. Multi-Channel Based Noise Attenuation
4. *Velocity Analysis and Time Migration*
   a. Velocity Analysis
   b. Pre-Stack Time Migration
   c. Residual Moveouts Corrections
   d. Post-Migration Stack and Gather Conditioning
5. *Depth Velocity Model Building and Common Reflection Angle Based Migration*
   a. Layer-Based Half-Space Initial Velocity Model Building
   b. Data Loading to Emerson-Paradigm Software
   c. Common Reflection Angle Migration (CRAM)
   d. Multi-Line Tomography
   e. Post-Migration Processing
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It is observed that continuity of events has been improved in newly acquired data in comparison with Vintage data (Fig 14 &15) in PSTM stack. Events are seen upto 8 Km in PSDM stack in the new Seismic Line. Steep dip events/plane of thrust is visible upto 7 KM (Fig.16)

Fig.14: Vintage Line after Reprocessing : PSTM section

Fig. 15: New Line after Processing : PSTM section

Fig.16: New Line after processing : PSDM section

Conclusions:

Node-technology is helpful to protect the environment (leaving less footprint), easy to handle, enabling more number of shots per day in comparison with regular data acquisition with cables, and requires less man power. Dynamite of 4Kg in place of 8Kg (which was used in Vintage data acquisition) was sufficient to map subsurface. In the current case, around 15000 shots were fired in one field season. This technology was successfully implemented in logistically difficult terrain. State-of-art-technology in Processing brought out signal which was masked by severe back ground noise and mapped complex thrust setting upto 8 km.

References:

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