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Enhanced workflow with effective In-house Integrated QC & visualization in Field Processing - An innovation in throughput & solution oriented approach

***Guha Randeep, Bakshi A.K, Sinha K.K, Pandey,** ONGC*

Summary

The upstream E & P organisations are now days equipped with the state-of-art hardware & software technology with advanced HPC computing / storage solutions in finding complex solution to geophysical problem in an integrated approach. Inline with the modern day requirements of field QC and facilitation of enhanced data quality through field data processing, most of the acquisition crews are equipped with scaled down system hardware/software with graphic capabilities to ensure recommended field processing at on- site facility. On board processing in marine vessels or processing for QC-Stack in on land acquisition has now become a worldwide phenomenon, whereby we can stringent the QC of attributes before submitting the data to the processing centers.

The current practice of kilo channel recording requires seamless integration of navigation data with the field seismic trace data which necessitates consolidation of the metadata containing statics, elevation and location coordinates through the SPS files showing Shot, Receiver & relational data either manually or by real time up-dation in the recording instrument. This saves lot of time while final data preparation prior to processing in Field Processing Units or subsequently at Processing Centres.

While analysing, constraints observed and cumbersome methodologies followed in adopting the available Conventional Processing Work-flow at Field Processing units lead to re-engineer the workflow for value-addition in effective utilization of Field processing facilities. Moreover, the limitation of ease-to-use integrated/ customised mandatory recommended QC tools to visualise attributes/positioning and other important acquisition parameters were very much felt at field facility.

To overcome this problem, an attempt was made to design and develop an integrated single-point solution in-house, which was centered on Geocluster software from M/s CGG Veritas, and its various supplementary formats for handling meta-data. In the endeavour for an enhanced workflow to supplement the "Fast Track Meta-Data Pre-Processing for FPU" an innovative approach for graphical QC of all field attributes (3D & 2D Mode) and post QC after Geometry merging like Field vs. SPS Header, NTBC QC, Min-Max QC were integrated in the single solution approach to strengthen the integrity/QC of data acquired at field facility.

The new methodology is very cost-effective, enables maximizing the utilization of QC checks with the scaled down processing systems available with field crews, value added outputs aimed at quality enhancement in data acquisition and substantial reduction in turn around time of total API cycle.

Introduction

Field processing for facilitating online QC of geophysical attributes are managed through scaled down system hardware/software with graphic capabilities to ensure recommended field processing at on-site facility. In-field QC and facilitation of enhanced onsite data quality through Field Processing Unit (FPU) has become a common

Room no 111c, 1st Floor, Gaveshana Building, Makarpura Road, Vadodara – 390009
Email- randeep.guha@gmail.com

industry practise for most of the acquisition crews operating in both the onshore and offshore areas. The conventional methodology as practised in the field as lacks the approach of doing rigorous QC primarily due to default non-database approach for auxiliary data management and non-availability of an integrated/single-window solution for manageability. Moreover, the methodology practised is very cumbersome due to running of multiple job sequences to attain the requisite auxiliary data and manual intervention at various stages.

To overcome such inherent limitations at FPUs, provisioning has been made to cater the field requirements of processing through introduction of an integrated solution, which facilitates generation of all requisite auxiliary data both is ASCII and database formats built in the software, thus enabling hassle free generation of requisite files. The solution has been designed as a simplified approach to attain the end-objective with all in-built features for effectively handling the interface in an error-free and intuitive manner. In order to further strengthen the single solution approach post generation of auxiliary data, independent graphical QC routines are enforced /integrated in the same solution to visualise the attributes in both 2D & 3D mode effectively. Moreover, as the QC workstation at field is capable of handling seismic data and it's associated QC, an innovative effort was made to raise the QC level on seismic data. The attempted solution for geometry merging supplemented by QCs like Field vs. SPS Header, NTBC QC, Min-Max QC adhering to subscribed standard header words for preservation has been effectively incorporated. The study of the enhanced workflow/approach along with the functionalities provided in the solution is detailed in the subsequent figures/sections as in methodologies & implementations.

The enhanced workflow provides value addition at the field facility through extensive QC options for various attributes like statics, elevation, spread definition etc and host of others QCs especially after Merging/Binning so that actual representation of seismic data and SPS could be analysed and preventive action, if required, could be taken before submitting the data acquired to the processing centres.

Methodology

The commencement of any Field Processing at online or offline camp facility basically requires raw seismic data, input navigation data i.e. SPS files for Shot, Receiver & Spread. There are various ways of consolidating these metadata either by manually preparing the data or output from recording instruments like UL 408/IO-Scorpion systems. The final data preparation prior to submission to RCC requires up-dation in statics, elevation and location coordinates.

Moreover, value addition is also done at the field facility through extensive QC of various attributes like statics, elevation, spread definition etc subsequently followed by Merging/Binning and QC stacks.

The recommended QC's at Field facility includes:

- Surface positioning errors pertaining to Shots/Receivers especially in case of shot recoveries. (Must be thru Graphical QC for error detection/correction)
- Statics & Elevation anomaly pertaining to Shots/Receivers and also Statics/Elevation correspondence map(Must be thru Graphical QC for error detection/correction)
- Matching between Shot & Receiver field header locations and post-merging internal header locations
- Matching between Shot Positioning thru LMO method with travel time estimation/correction

The problems generally faced by the field geoscientists in order to achieve above mentioned QCs (some with the auxiliary data and some post geometry merging with seismic data) is to deal with some cumbersome procedures which was effectively handled by introducing /conceptualizing the alternatively in-house methodology "**Fast Track Meta-Data Pre-Processing for FPU**" at FPUs which highlights on the following aspects

- All desired inputs required for field processing clubbed in single-package concept through single-entry-exit point through single input i.e. only SPS files. (Simplified approach)

- Outputs generated are geofile, coordinates for source & receiver and generation of statics & elevation library through a single-mouse click

- Customized validation of inputs like correct SPS type and mandatory parameters, in-built in the interface (User-friendly intuitive interface)

- All the outputs generated are both in specific LIBRI formats + XPS formats without any user intervention (Database Approach)

- Mapping of all necessary header words recorded in field by various instruments including multi-component relevant headers through suitable customization.

- Incorporation of Utility programs in the package like NTBC files recognition

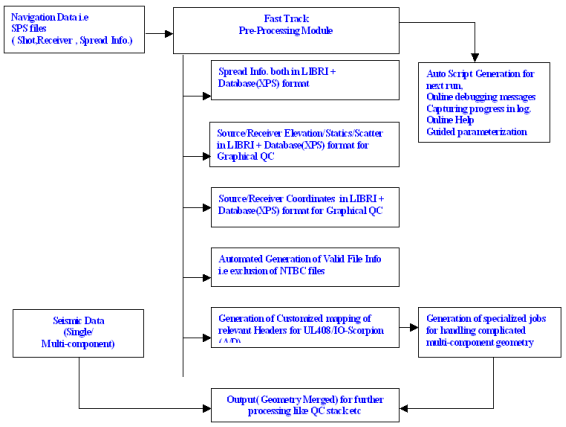


Fig 1 Flow diagram – Fast Track Meta-Data Pre- Processing Workflow

Thus the methodology/workflow provides a hassle free translation of navigation data into useful information required in field processing as depicted in Fig 1. An effort was made to overcome all the constraints faced in the conventional methodology enabling fast track decision-making, quality enhancements and drastic reduction in turn- around time at the field location itself.

Enhanced Processing Work-flow at Field Processing Units

Although most of the constraints/drawbacks were eliminated in "**Fast Track Meta-Data Pre-Processing**", a need was felt to strengthen the existing workflow by incorporating the seismic data to ensure it's integrity before submitting the data to processing centers. In-line with the requirements, an **innovative solution was designed** which was centered around the seismic data along the headers recorded in the field rather than performing QC only the auxiliary (SPS) data in isolation.

The value addition of this methodology could be exploited effectively as the conceived by-products are very useful in trouble-shooting/debugging the outputs and imperative corrective action could be easily achieved.

Fig 2 depicts the flowchart of the enhanced workflow carried out on **Navigation/Geometry merged** Seismic Raw data and it's associated QCs

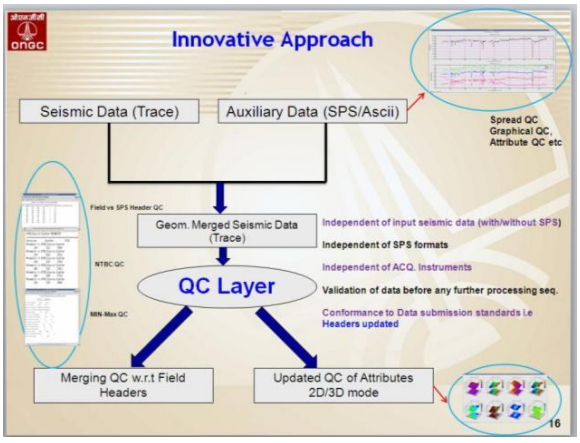


Fig 2 :Integrated QC flowchart with SPS and Seismic data

The conceived QCs following the approach, which revolves around, the seismic data attempts on the following

Analysis of Raw Field Parameters - Analyses relevant vital instrument specific parameters graphically record-

wise /day-wise like sensor scaling/orientation, setting of filter and slope of filter etc as depicted in **Fig. 8**

NTBC QC - Reports Shot Line/Shot-point along with FFID for reconsideration for which regular shot is not taken resulting in data gaps

Shot/Receiver Mismatch – Through QC on Field Headers (SEGD or SEGY) against supplied SPS and pinpoints error location as depicted in **Fig. 9 & 10.**

Min-Max of Attributes – Single window view of Min – Max of all possible attributes post merging like SL,RL, Inline/Xline, Offset, Azimuth etc. on real data as depicted in **Fig. 12**

Visualization of Attributes – 3D & 2D mode is possible for all shot/receiver attributes with positional QCs as depicted in **Fig. 4** (for Receiver), **Fig. 5**(for Shot)**, Fig.6 representing Statics (S/R)/ Elevation (S/R)/ Depth(S)/ Charge(S)/ Velocity(S) cubes for entire swath and Fig.7 representing the basemap**

Automated SPS generation – SPS regeneration on the fly after corrective action on either positional error / spread mismatch/ attribute alteration.

Whenever the SPS definitions don't exactly tally with the corresponding record/shot being taken at the field i.e. receivers not being laid or shot re-located due to logistics, there would be a mismatch. Thus it becomes imperative or more logical to QC the field attributes after collating seismic and auxiliary data i.e. Geometry Merging of data and further introducing the QC layer for stringent and close look at the data enabling a collaborative and synergic approach aiming towards effective integration of information.

The main advantage conceived (QC on Merged data) in this approach is enumerated as follows:

- Independent of input seismic data (with or without SPS data)
- Independent of auxiliary data format i.e. SPS/UKOOA or ascii.
- Independent of seismographs being used i.e. Digital or Analog Systems of different generations.
- Enforcing validation of data before any further processing sequence
- Portrayal of actual representation on ground i.e. one-to-one correspondence of Shot & receiver, as SPS and seismic data are integrated.
- Intuitive /accurate detection of errors and suggesting corrective action, if required.
- Conformance to data submission standards i.e. Headers duly updated etc.

Integrated Enhanced workflow along with QC /visualization Methodology- Implementations

Consequent upon the successful implementation of "**Fast Track Meta-Data Pre-Processing for FPU**", the enhanced workflow focusing primarily on integrated graphical visualization of the physical parameters of raw seismic data as well as intuitive QC of Geometry Merged Data as it is the actual representation of Seismic Data & navigation data supplied. In addition to the interface of **xFTP** as depicted in **Fig. 3**, **gnuplot** routines were used to plot all the attributes w.r.t. Shots & Receivers.

Subsequently, C programs were written to analyze/decode the binary format file in internal format to extract all the relevant headers followed by data synthesis to provide effective information as described elsewhere on the paper.

Following are some of the pictorial representations of the integrated interface along with the functionalities:

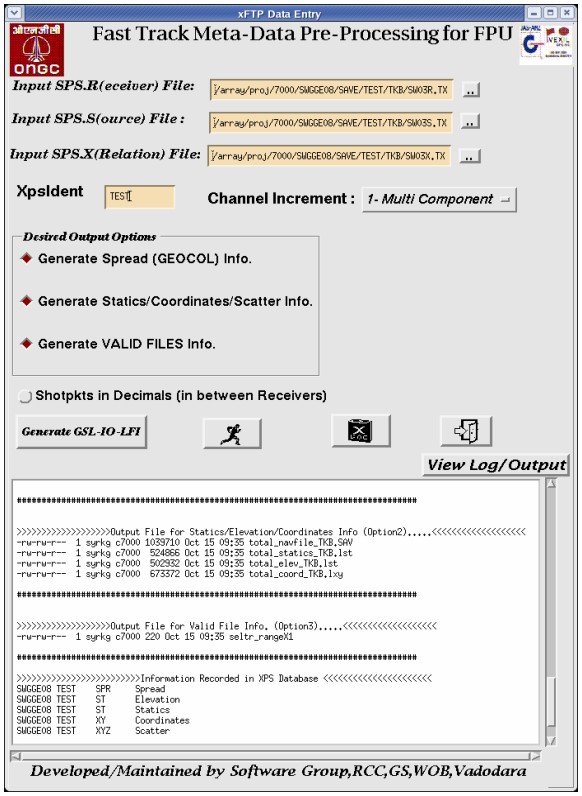


Fig 3 xFTP Interfaces showing analysis (MIN- MAX) of navigation data(SPS) (mandatory checks) along with various options for auxiliary data generation / Indication of Mandatory parameters / Progress indicated in Output Area

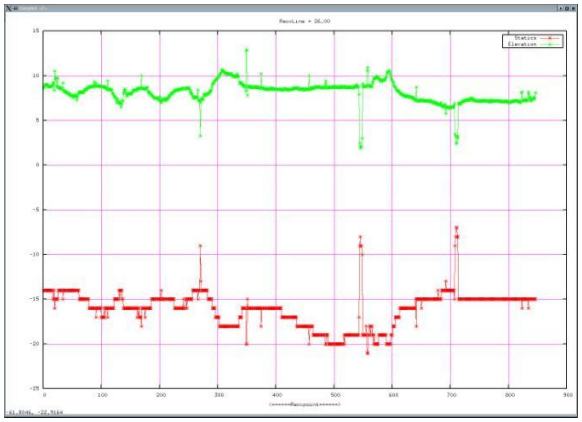


Fig. . 4 Visualization of Statics/Elevation correspondence map across a RL in 2D mode on Merged Data

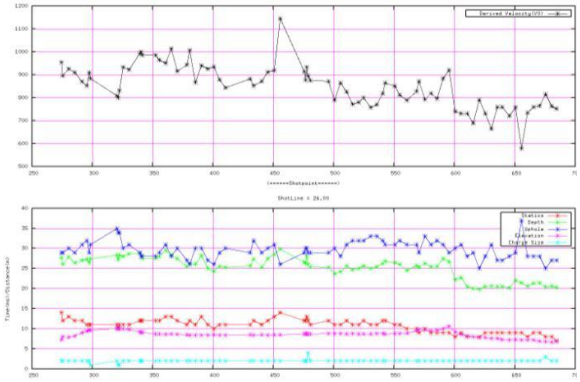


Fig 5 Visualization of Statics /Elevation/ Uphole / Depth/ Charge/ Derived Velocity correspondence map across a SL in 2D mode on Merged Data

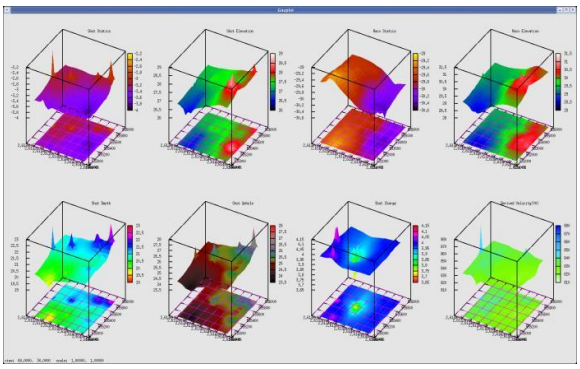


Fig 6 Visualization of Point attributes along the entire swath in 3D mode (Regional Variations) on Merged Data

Enhanced workflow with effective In-house integrated QC throughput & solution oriented approach

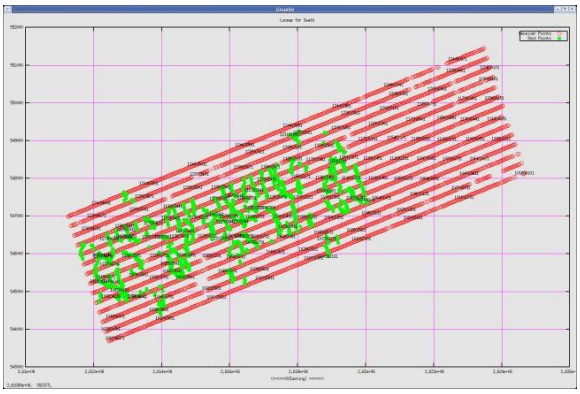


Fig 7 Visualization of Base map for Positional QC in 3D mode on Merged Data

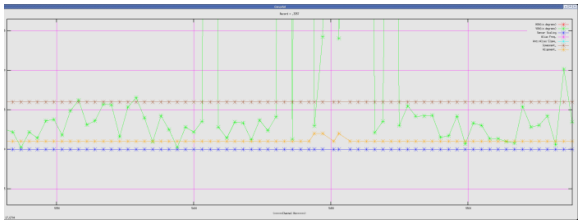


Fig 8 Visualization of RAW Field Headers of IO-Scorpion system Record/Day –wise Sensor scaling, Orientation Angle, Deployment (Horiz. Or Vert.)

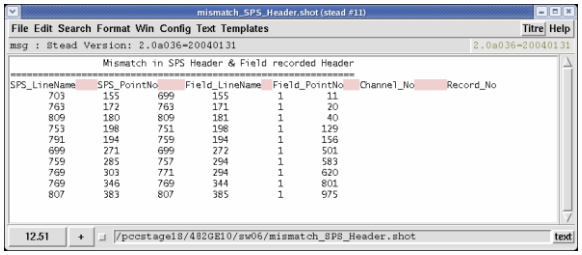


Fig 9 Summary of Mismatch in SPS & Field Headers(Shot)

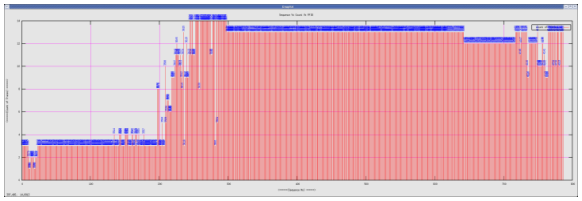
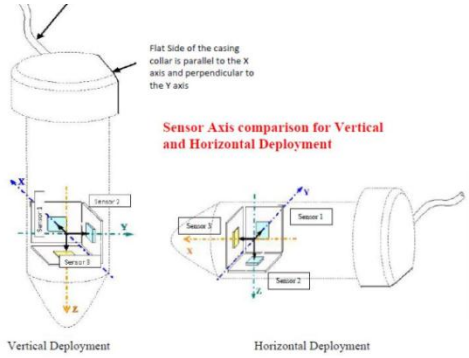


Fig 10 Graphical View of Mismatch in SPS & Field Headers (Receivers) – Count of errors/FFID, due to Horizontal Deployment of Sensor but not reported

The advantages derived out of the conceived enhanced workflow model would immensely help the field geoscientists to produce QC-Stacks at the field site facility and run through a set of graphical QCs of attributes either during the on-going field operations or before delivering the final data to respective processing data centers.

Time-to-Time feedback was obtained from end-users to facilitate the field processing requirements along with the deployment strategy to install and maximize the usage of such integrated approach enabling value additions at field facility.



Sensor Bd	Horizontal Axis: Nominal function	Vertical Axis: Nominal function	Data format order position
Sens 1	Cross-line (Y)	In-line (X)	1
Sens 2	Vertical (Z)	Cross-line (Y)	2
Sens 3	In-line (X)	Vertical (Z)	3

Fig 11 Representation of Sensor Axis w.r.t. Merging QC of traces with receiver identifiers.

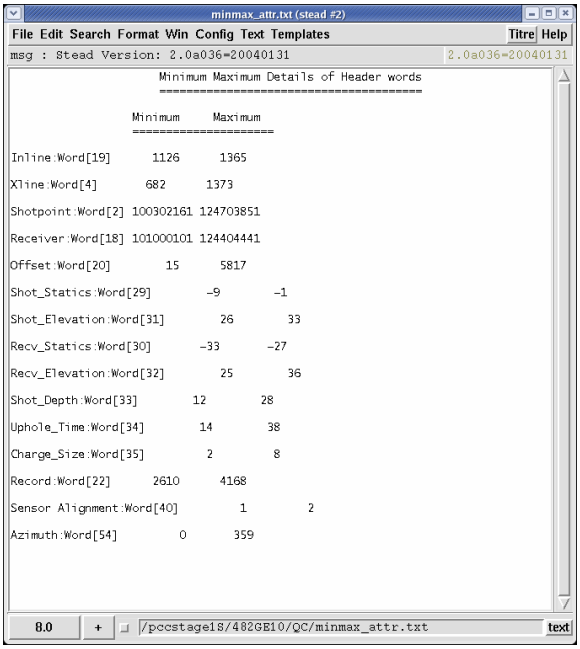


Fig 12 Single window view of Min – Max of all possible attributes post merging like SL, RL, Inline/Xline, Offset, Azimuth, Static, Uphole, Charge etc. on Merged Data

The following are the main imperative perceived benefits in this enhanced workflow with effective integrated QC & visualization especially on Seismic merged data as a

collaborative and synergic approach aiming towards effective integration of information and a supplement to "Fast Track Meta-Data Pre-Processing for FPU"

- Faster/efficient to execute as analysis is done on seismic headers rather the reading the entire seismic data to generate effective information.
- Graphical QC of vital acquisition instrument specific parameters like Sensor scaling/orientation & deployment, anti-alias frequency/slope etc.
- Regional variations of attributes along swath /survey (in 3D mode) as well as local variations along source/receiver line (in 2D mode)
- Graphical QC / Visualization of all possible attributes in a integrated window (Simplified approach)
- Isolation of mismatch between Field Headers and Auxiliary data (SPS) both in shot & receiver domain, enabling troubleshooting of merging errors i.e wrong header up-dation w.r.t shots and receivers, pinpoints errors & suggests preventive action
- Facilitation of single window view of Min – Max of most of the attributes post merging like SL,RL, Inline/Xline, Offset, Azimuth etc
- Facilitation of SPS re-generation on the fly after corrective action on either positional error / spread mismatches/ attributes alteration.
- Detection of general purpose merging errors like wrong spread definition as well as trace sequence altering due to SVSM deployment (Horizontal or Vertical) through a specific pattern as depicted in detail in Fig. 10 & Fig. 11

Conclusion & Future Scope

With the advent of state-of-the-art acquisition systems equipped at the fields crews with volumetric recording capabilities in terms of channels and quality of acquired data becoming a major concern, such consolidated /integrated package with all in-built helps/checks/QCs without having extensive knowledge about the internal data formats would immensely help geoscientists to attain exclusively the recommended QCs in stipulated time. Inclusion of the innovative approach to incorporate seismic data along with SPS is more meaningful and intuitive and ensures full integrity of information. Most importantly, outputs generated are self-explanatory enabling corrective actions in a cost-effective manner.

Moreover, it would drastically reduce the turn around time for recommended field quality checks ensuring minimization of human intervention, cost and time effectiveness, customer satisfaction and last, but not the least, significant reduction in overall API cycle time.

Some other auxiliary information near surface velocity, uphole information can also be incorporated in the same interface so that similar graphical QCs can be enforced.

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The views expressed in the paper are solely of the authors and do not necessarily reflect the views of the organization which they belong to.

References

Administration Guide/Documentation for Geocluster Application Software

Thomas Williams & Colin Kelley Guide to Gnuplot programming