Infield Processing of an ISS™ Dataset South-East Algeria

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Summary

This paper describes a case study of infield processing in the desert terrain of south-east Algeria. 2560 km^2 of high fold, wide azimuth 3D seismic data, acquired using ISS**™**, were processed onsite in 9 months during 2009. Key challenges faced by the team included; maintaining a high performance compute (HPC) cluster in a remote desert environment; daily quality control and processing of very large volumes of data from an ISS**™** crew; solving complex near surface statics from the sand dunes; and ensuring seamless merges between the successive zippers which were imaged and delivered during the project.

Approximately 30 days after the last shot, poststack migration volumes were complete for the entire survey along with AVO attribute volumes, thus completing what we believe to be the industry's first infield processing at this complexity and scale - on time, on budget and to the required quality.

Introduction

Exploration teams face increasing pressure to shorten the timeline between acquisition of seismic data and the drill bit in order to monetize assets as rapidly as possible. This places increasing importance on infield processing. The decision to use high productivity acquisition techniques such as BP's DSSS or ISS™, which provide a ten-fold increase in production, places extremely high demands on the infield processing team. High quality project management and front end loading are both essential for the successful delivery of a quality oncrew dataset. Project management deliverables crucial for this project were: the design and testing of a processing system large enough to handle the data volumes involved and robust enough to deliver near-zero downtime; problem solving ahead of the field operation; remote IT support; "just in time" software development; provision of rotational senior staff; continuous geophysical oversight by team leaders; and data structures which enabled rapid reorganization of large volumes of data to various optimal sort domains for any given process.

Planning Process

BP and Global/Weinman created a virtual team across five locations to prepare for the infield processing efforts. Global/Weinman brought their technical expertise in building processing systems and creating innovative tools and workflows to the team. BP contributed their experience with ISS™ cross talk noise removal and area specific processing experience. BP also provided sample data volumes for use in software and workflow development. Efficient, lightweight modules were written for combing/correlation of the ISS™ data that allowed sufficient overnight QC of each day's shooting. Each morning the crew had a program of VPs that needed to be reacquired the next day prior to moving a receiver line. The field team was able to exercise all the software, data structures, and workflows on the field system prior to the remote deployment.

Real-time Remote Support

The internet umbilical into the processing trailer was critical to the success of the project. Senior processors and client QC personnel worked on a traditional rotation schedule. The immediacy of that field presence was crucial. However there was a risk that, despite superb knowledge management which captured the day to day operations in the trailer, there would be a loss of critical organizational memory in the shift changes. Therefore, a senior project team was also assigned to work remotely via satellite connections. These personnel were never rotated and therefore able to maintain total continuity throughout the duration of the project.

HPC professionals continuously monitored the cluster itself. Individual trouble spots were identified and solved often before the team in the field was even aware a problem was developing. Numerous software upgrades from the research and development team were also implemented on the fly via the remote connection. Redundant power capacity to the trailer made unplanned downtime a brief and rare occurrence.

Key Processing Strategies

The area of the survey as shown in Figure 1 is characterized by ribbon dunes, rough rocky cliffs, very soft sand, and salt flats. A map of NMO datum was created by using high resolution satellite data to interpret a base hard pan as it would extend beneath the mobile dunes. Due to the variability of the near surface velocity, 700 – 2300 mps, a map of spatially variant velocities was created to use with the measured elevations at the time of acquisition for computing the near surface statics. In practice then, the elevation statics were computed on the fly using the GPS elevations, the interpreted NMO datum (assumed to be hard pan at the base of the dunes), and the interpreted V1 map. The V1 map was updated as the survey progressed based on the response of the data. In addition to making the near surface statics process fast and efficient in the field while responding to the dune effects, the smooth full area maps ensured seamless ties between the zippers.

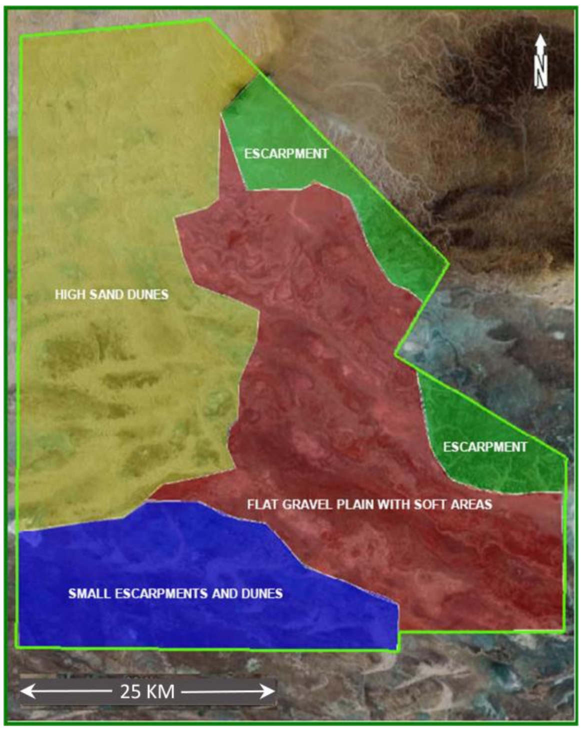

Figure 1: Terrain map

Prior work in the region presented by BP[1] revealed that crosstalk from the competing ISS™ sources was most easily attenuated along the SLINE axis in the cross spread domain. Figure 2 illustrates a sample shot record before and after the cross talk noise attenuation. The processing flow also included linear noise removal, two iterations of surface consistent residual statics and velocities as well as single trace deconvolution and gain prior to imaging.

Proper evaluation of noise removal processes run on cross spreads requires full 3D stack and migration after each test. Figures 3a and 3b show a comparison between two noise attenuation approaches. The first flow is a velocity filter with adaptive subtraction followed by a deburst. The second flow is a random noise attenuation approach. Strictly evaluated on the appearance of the shot records, the second flow seems to do a better job of enhancing event continuity and removing noise. However, a comparison of the full volume stack and migration on each flow makes it readily apparent that the improved continuity on the random noise attenuation shots comes at the price of a significant linear footprint.

Capacity therefore had to be built into the field system which would be sufficient to run full volume 3D stacks and imaging in a testing timeframe for each key step in the processing flow. The satellite link which engaged the entire virtual team was also essential in evaluating these tests.

Figure 4 shows a timeslice from the final post migrated infield volume


Figure 2: Shot record before and after ISS™ crosstalk noise removal

Data Structures

The workflows in the trailer heavily leveraged data structures which enabled fast parallel i/o processing as well as efficient resorting. Noise attenuation was cascaded in the shot domain and cross spread domain followed by CDP and offset domain processing. Although not an element of the processing infrastructure that generally draws much attention, with 500 million to two billion traces in a single zipper, data structures that would support numerous rapid resorts of the entire prestack volumes were essential to meeting the project timeline.

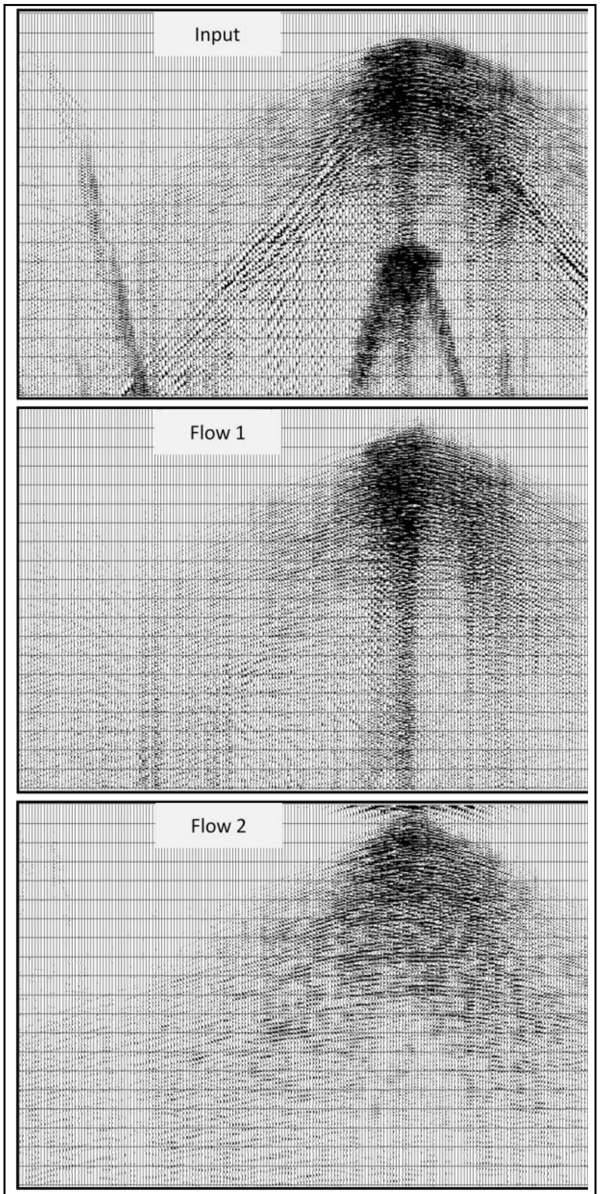

Figure 3a: Shot records before noise attenuation, with flow 1 (cascading velocity filter and deburst), and with flow 2 (random noise attenuation). The random noise attenuation flow appears to have removed more noise and the events are more continuous.

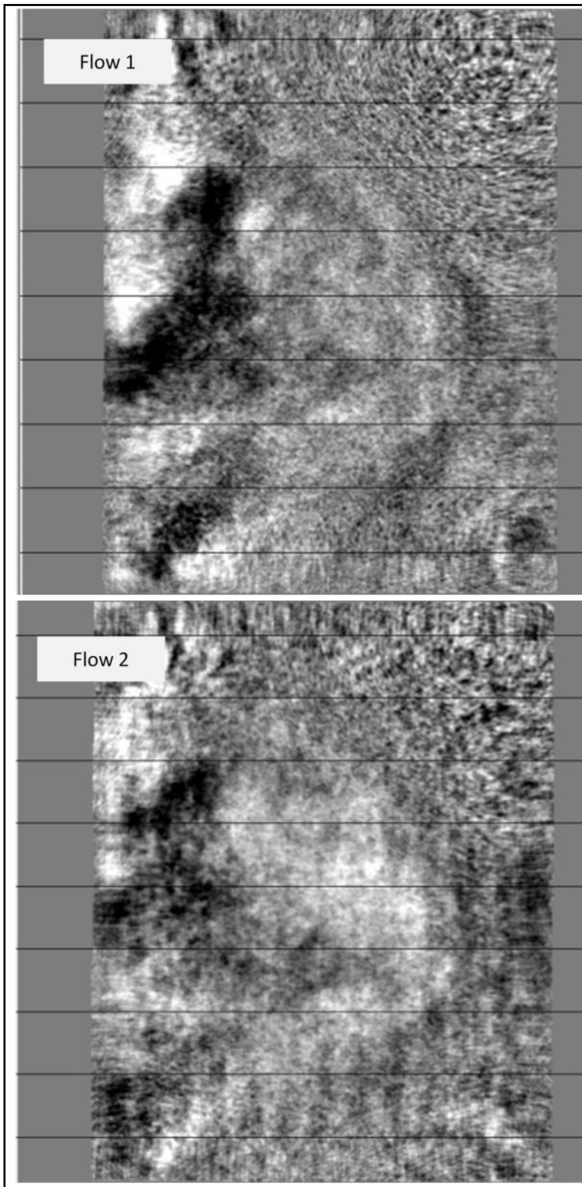

Figure 3b: Timeslice displays with flow 1 (cascading velocity filter and deburst) and with flow 2 (random noise attenuation). A strong footprint is readily apparent on the random noise attenuation flow and alters the processing decision which may have been made from inspection of shot records and/or inline stacks.

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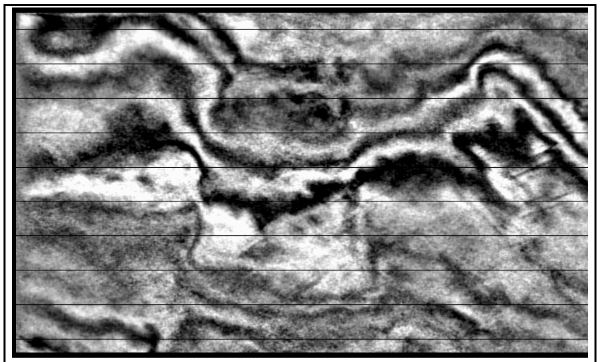

Figure 4: Time slice from final post-stack migration

Conclusions

30 days after the last shot, poststack migration volumes were complete for the entire 2560 km^2 area along with AVO attribute volumes, thus completing what we believe to be the industry's first infield processing at this complexity and scale. Further, the data were delivered within budget and the quality was at least comparable to the final contractor processing of other similar surveys in the area.

We have shown that by combining good planning processes and light and efficient software with real-time remote support, it is possible to move sophisticated processing techniques into a high production field operations environment.

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