Proper Treatment of Amplitude and Phase of Seismic Data for Preserving Geology

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INTRODUCTION

Preserving the amplitude and phase of Seismic data is of paramount importance in modern day data analysis and subsequent evaluation. Unlike previous years where the Seismic was used only to image and map structures, modern application ranges from lithology, fluid and pressure prediction, rock-property analysis extending as far as to reservoir and fluid monitoring (4D) at production stage. The processed and imaged seismic section has to represent geology. The high quality of modern 3D seismic data is enabling us to confirm old geological ideas and develop new concepts and models, particularly of deep water turbiditic depositional system.

The data work flow we adopt in Carigali today, in order to meet this objective, would be to follow wave phenomena and correct in a deterministic manner all the earth propagation and filtering effects.

A seismic pulse is represented by its arrival time (T), its amplitude (A) and phase (phi). Currently we are generally using only T to map the structures and (sometimes) the amplitude to create amplitude maps. However, we should emphasize also the importance of phase information in seismic to well correlation, coherency sections for fault delineation and dip azimuth in fracture studies. Phase along with polarity is of significance in discriminating a hard from a soft impedance, in discriminating sands from shale's or in flat spot identification. Likewise, another variable frequency defines resolution aspects in our ability to detect thin beds.

FACTORS AFFECTING SEISMIC AMPLITUDES AND PHASES

Preservation of amplitudes in seismic data acquisition and processing are key factors in recovering geology and rock properties. Anstey(1971) defined several key factors:

1) Wavefield divergence or spreading
2) Angle dependent reflection
3) Angle dependent transmission losses
4) Angle dependent ghosting
5) Absorption
6) Pegleg multiples

All these factors will be discussed and corrected for from the wave propagation standpoint. Phase preservation is also crucial and will be discussed in detail.

SEISMIC ACQUISITION AND PROCESSING CONSIDERATION

The way our data is acquired and processed has profound effect on the reliability, integrity and the ultimate data quality. Modern acquisition techniques of multi source and multi streamer acquisition although is cost effective way of acquiring large volume of data has detrimental effects on data. The flip flop manner of shooting causes amplitude and time jitter, also the offset distribution at a given CDP is poor and causes noise elimination processes to be less effective and has leaky stack response. Further apart from OBC shooting, marine surveys are essentially 2D with its ill effect manifested in amplitude stripping and other subsurface illumination problems in salt and basement related geology.
Long Cable and AVO

Modern acquisition deploy long cables that has the following advantages apart from logistic problems that it poses.

- better velocity determination
- better multiple discrimination
- AVO effects
- better noise separation
- deep prospectively

Seismic velocities
This is a crucial step in ensuring proper imaged data for specialised studies like

- AVO Inversion
- Lithology and fluid prediction
- Pressure prediction
- Structural imaging
- Time lapse seismic

CONCLUSION

It is extremely important to preserving the integrity of data recorded. Indiscriminate scaling, equalization, AGC, hard whitening deconvolution could lead to artifact not related to geology, or possible hydrocarbon accumulation. Wave propagation principles have to followed in data handling.

We have demonstrated that proper treatment of amplitude, phase and frequency and adherence to is a key to proper interpretation of geology and deviation of rock properties from seismic and well information.

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