

# Crustal architecture from geophysics: Reprocessing the Mt Isa Seismic Transect

Piter Lepong<sup>1</sup>, Bruce Goleby<sup>2</sup> and Tom Blenkinsop<sup>1</sup>

<sup>1</sup>*pmd\*CRC, School of Earth Sciences, James Cook University, Townsville, QLD 4811*

<sup>2</sup>*pmd\*CRC, Geoscience Australia, GPO BOX 378, Canberra, ACT 2601*

*Piter.Lepong@jcu.edu.au*

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## Introduction

The Mt Isa deep seismic section was acquired and processed in about 10 years ago. Interpretation of the deep seismic transect indicates that the Eastern Fold Belt is dominated by large-scale horizontal offsets of supracrustal rocks that were decoupled from the basement along a subhorizontal detachment that spawned numerous east-dipping thrust faults (MacCready et al., 1998). This west-directed fold and thrust system was then broadly warped and dissected by a number of reverse and strike-slip faults that involve the basement and may link to a major mid-crustal structure (inferred from alignment of high-velocity rocks interpreted from seismic refraction).

On the other hand, surface geology and potential field data (i.e. gravity and aeromagnetic data) indicate that the major structure of the Mt Isa Eastern Succession is generally steeply dipping and extends down to the middle of the crust in contrast to the shallowly dipping seismic interpretation. The resolution of this paradox is a vital for understanding the formation of mineral deposits and depends essentially on understanding the deep structure of the crust.

Seismic sections can not directly image structures with steep to vertical dips. Any interpretation of the crustal structure from seismic sections alone may therefore be biased towards shallow-dipping structures. The Mt Isa area offers an opportunity to evaluate crustal structure in three dimensions by combining interpretation of seismic sections with potential field data and advanced geological knowledge. This article presents reprocessing of the seismic section to investigate if it is possible to increase temporal and spatial seismic resolution and facilitate more accurate interpretation of the data.

## Reprocessing of Deep Seismic Transect

The Mt Isa deep seismic transect were reprocessed using the Disco/Focus seismic data processing system using updated techniques and algorithm processing methods. Processing sequences and parameters used by Goleby et al. (1996) provided a useful starting point for designing the processing sequence for this data set. The data were reprocessed through a basic sequence of noise attenuation, spiking deconvolution, dip moveout and scaling prior to stack. The post-stack data were subsequently migrated using the Kirchhoff algorithm. Further filtering was applied post-migration. Preprocessing included demultiplex, editing, gain recovery, field geometry and field statics mostly adopted from previous processing. This reprocessing focused on increasing the signal to noise ratio within the seismic records and improving continuity of the reflection events. The following is a summary of the updated techniques and parameters used in this current reprocessing sequence.

### *Deconvolution (Pre-Stack)*

To increase temporal resolution and sometimes, to remove the effects of multiples, deconvolution is applied before stack. The Wiener-Levinson algorithm was used to sharpen

seismic events and extend the frequency bandwidth. Spiking deconvolution used 160-millisecond operator length and 0.1% pre-whitening parameters applied to all traces in two gates window, near and far offset.

### *Spectrum Balancing*

Spectrum Balancing is particularly useful for balancing the spectrum of the data contaminated by source generated noise. The input is prestack data, sampled at 4 milliseconds. Spectral whitening is achieved using four frequency bands. The AGC length is set to 500 milliseconds. The frequency and amplitude parameters supplied to control output trace.

### *Bandpass Filter*

Filtering for temporal frequency (in time) and also for spatial frequency (in wavenumber) is applied in this processing. A band pass filters with slopes in decibels per octave is applied to traces in all shots. A four time gate is designated for filtering with a 160 millisecond length. Lower frequencies are attenuated at 18 decibels per octave and higher frequencies are attenuated at different ranges of decibels per octave.

### *Dip Moveout*

The Dip Moveout (DMO) correction applied before stack used the F-K DMO algorithm as described by Cabera and Levy (1989). The input to this DMO routine are Normal Moveout (NMO) corrected shot records. The group interval for this data is 20 m. The maximum frequency of the data is approximately 75 Hz. The minimum time start of DMO operation is 150 milliseconds.

### *Kirchhoff Migration*

The objective of migration is to move (migrate) data from an observed point of reference to the point of actual origin. Implemented ideally, this procedure essentially collapses diffractions to a single point, and spatially orients dipping events to their correct position. A poststack data set is migrated for all traces using time space Kirchhoff migration. The imaging operation is based on an algorithm derived from the description of Kirchhoff migration in Stolt and Benson (1986). The CDP trace spacing is 20 m and the dip limit is 70° with an interpolation filter. The velocity model used for the migration has previously been stored in the database.

## **Summary and Conclusion**

The reprocessing methodology described here resulted in seismic profiles with increased temporal and spatial resolution, which should facilitate more accurate interpretation of the data. The major difference in the sections between the original processing and current processing is attributed to the application of spiking deconvolution, dip moveout and Kirchhoff migration. The application of DMO eliminated the dip dependency of the NMO velocity field and removed the midpoint noise on dipping events. The DMO technique appeared to be very efficient in areas of the Mt Isa Inlier where structure is associated with steeply dipping features. The overall quality of the reprocessed data shows better noise suppression and increase of continuity reflection events, especially after DMO and post-stack Kirchhoff migration section (Figure 2) compare to original processing after Finite Difference migration (Figure 1).

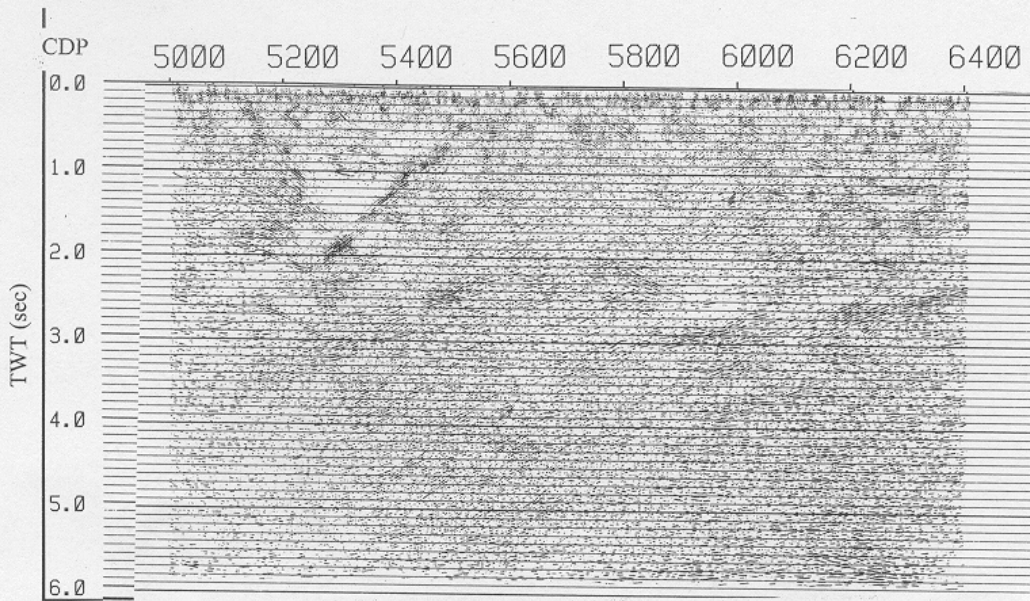


Figure-1. After Finite Difference Migration

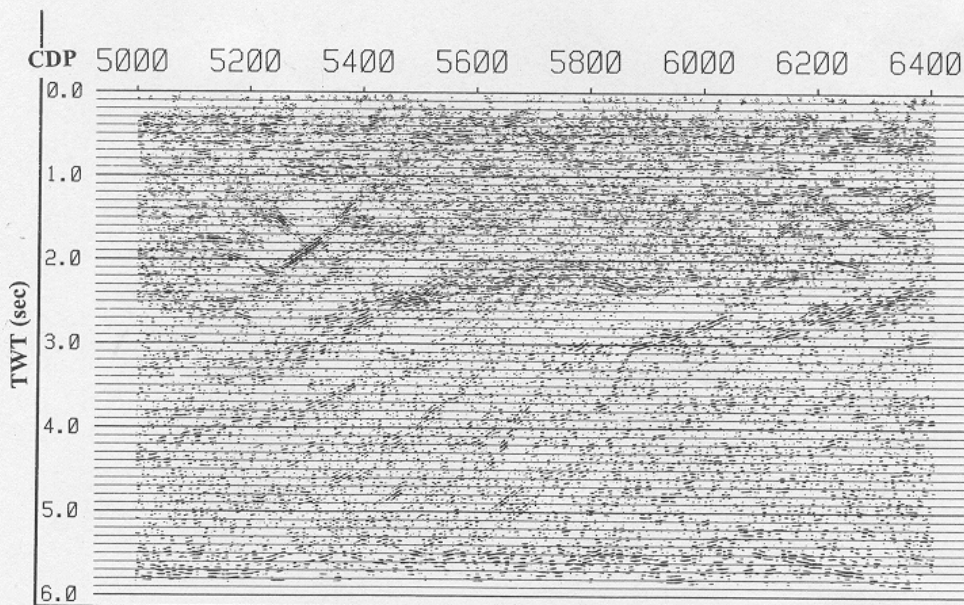


Figure-2. Applied DMO and Post-Stack Kirchhoff Migration

Clearly visible improvements in the new profiles are:

- 1) Much better signal to noise ratio
- 2) Greater length and continuity of reflections in some areas

3) More reflections visible in the interval from 4 to 10 s two way travel time, which is characterized on both the former and newly processed sections by homogeneity.

4) Apparent reflections on the previous sections are not visible on the newly processed sections because they may be diffractions removed by the new migration technique.

The new profile casts doubt on the evidence for a moderate easterly dip for the Cloncurry fault. Reflectors previously considered to be continuous with the surface trace of the Cloncurry fault may be due to the inverted fold limb of the Snake Creek anticline. Under the Duck Creek anticline, west-dipping reflectors that were previously interpreted as part of a gently dipping folded decollement are not apparent in the newly processed section. These two examples illustrate that the model of west vergent thin-skinned thrust tectonics that was a consequence of the previous seismic section needs to be questioned.

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