New Directions for Near Surface Refraction Seismology

by

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I have attached the extended abstracts of the seven papers that I recently presented at the 21st ASEG Conference and Exhibition in Sydney in August, 2010. The abstracts can be separated into several groups.

The first group addresses the fundamental issue of non-uniqueness, colloquially known as GIGO – garbage in, garbage out. In particular, these extended abstracts demonstrate that the commonly used smooth vertical velocity gradient starting model, more appropriately referred to as a Claytons starting model – the starting model you have when you don't have a starting model – generates low resolution tomograms which usually contain artifacts. Furthermore, VIRT demonstrates that the starting model is more important than the method of forward modeling. Many geotechnical geophysicists still have considerable reluctance in accepting the reality of non-uniqueness.

(Claytons (From Wikipedia): Claytons is the brand name of a non-alcoholic, non-carbonated beverage coloured and packaged to resemble bottled whisky. It was the subject of a major marketing campaign in Australia and New Zealand in the 1970s and 1980s, promoting it as "the drink you have when you're not having a drink" at a time when alcohol was being targeted as a major factor in the road toll. Although the product is no longer being actively marketed, the name has entered into Australian and New Zealand vernacular where it represents a "poor substitute" or "an ineffective solution to a problem". It can also be used to describe something that is effectively in existence but does not take the appropriate name, eg. a common-law couple might be described as having a "Clayton's marriage".)

This group consists of the following extended abstracts:

Palmer, D., 2010, Non-uniqueness with refraction inversion – a syncline model study. 21st ASEG Conference & Exhibition, Sydney, Extended abstract.

Palmer, D., 2010, Non-uniqueness with refraction inversion – the Mt Bulga shear zone. 21st ASEG Conference & Exhibition, Sydney, Extended abstract.

Palmer, D., 2010, Is VIRT an efficacious strategy for refraction inversion? 21st ASEG Conference & Exhibition, Sydney, Extended abstract.

The second group addresses the innovative concept of extracting more value from refraction data using refraction attributes. Many of the useful benefits of these methods are best realized with data acquired with multi-fold CMP methods. Unfortunately, such acquisition is the exception rather than the rule with most geotechnical data, which is usually acquired with inefficient field operations using under-capitalized systems.

The second paper in this group demonstrates the use of attributes for generating starting models for gravity inversion. This use of refraction-derived density models will probably see increasing application with airborne gravity gradiometer data, especially where terrain and Bouguer corrections are critical for detecting deep targets. One interesting observation from this extended abstract is that surface “outcrop” need not necessarily correspond with seismic “outcrop.” Furthermore, the Mt Bulga massive sulphide ore body, which remains essentially invisible with Claytons tomography, again illustrates the importance of the starting model with traveltime inversion.

Finally, many of the refraction attributes and the transformed attributes of the density ratio and the P-wave modulus can be usefully employed as starting models for full waveform inversion. Representative starting models are even more critical with FWI than with traveltime inversion!

This group consists of the following extended abstracts:

Palmer, D., 2010, The computation of attributes from multi-fold seismic refraction data. 21st ASEG Conference & Exhibition, Sydney, Extended abstract.

Palmer, D., 2010, Generating density models with seismic refraction data. 21st ASEG Conference & Exhibition, Sydney, Extended abstract.

The third group addresses the exciting topic of full waveform seismic refraction methods. The last extended abstract demonstrates that it is possible to generate accurate time models of the weathering by stacking shot records, usually without the need to pick first breaks as a prerequisite. As reflection field systems rapidly approach 100,000 live channels, the need to employ efficient methods for generating accurate statics for land data will become even more important.

This group consists of the following extended abstracts:

Palmer, D., 2010, Detailed refractor imaging with the RCS. 21st ASEG Conference & Exhibition, Sydney, Extended abstract.

Palmer, D., 2010, Imaging the base of the weathering by stacking shot records. 21st ASEG Conference & Exhibition, Sydney, Extended abstract.

Finally, I would like to refer you to six of my recent publications for further information.

Palmer, D., 2009. Integrating long and short wavelength time and amplitude statics. *First Break* **27(6)**, 57-65.

Palmer, D., 2010a, Non-uniqueness with refraction inversion – a synclinal model study: *Geophysical Prospecting* **58**, 203-218.

Palmer, D., 2010b, Non-uniqueness with refraction inversion – the Mt Bulga shear zone. *Geophysical Prospecting* **58**, 561-575.

Palmer, D., 2010c, Are refraction attributes more useful than refraction tomography?: *First Break* **28(7)**, 43–52.

Palmer, D., 2010d, Characterizing the near surface with detailed refraction attributes. *in* R. D Miller, J. H. Bradford and K. Hollinger, eds., Advances in near-surface seismology and ground-penetrating radar: SEG Geophysical Development Series No. 15, Chapter 14, 233-250.

Palmer, D., 2010e, Is visual interactive ray trace an efficacious strategy for refraction inversion? *Exploration Geophysics* **41**, 260-267.

Much of this material presents a significantly different vision of near-surface seismic refraction methods to the current widespread use of Claytons tomography.

I would welcome the opportunity to present any aspect of my recent research to either your organization or to a future meeting of your local professional society.

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