

Tu P09 06

Modelling for Statics Correction

S. Tlalka* (Geofizyka Torun SA) & R. Sobocinski (Geofizyka Torun SA)

SUMMARY

Proper solution of static corrections in land challenging areas is crucial for the following steps of seismic data processing. For huge 2D or 3D datasets where complex, near surface structures coexist with poor quality of first breaks and data processing is burdened with short execution time, modelling methods for statics estimation could be applied. Simple and advanced modelling of low velocity layer, pre-processing or modelling of refraction first breaks, interactive surface consistent semiautomatic statics corrections, in many cases are the only correct solution for statics.

Introduction

Computation and application of static corrections is important component of land seismic data processing. There are many methods of static estimation, but only a few give possibility to resolve static problems even in case of very complex near surface structures. Methods of estimation depends on the region, near surface geology in areas of prospection, and on client requirements. In many cases approach to estimation of statics must be sophisticated because of: poor quality of first breaks, too complex refractors and/or near surface model, limitation of processing time. In these cases the best way is to use static solutions based on modelling which ensure robust and reliable result.

Static corrections based on modelling can be performed in a few ways. One possibility is **modelling the low velocity layers (LVL) directly**, and in that case information from refraction first breaks is not necessary. The second possibility is **pre-processing and/or modelling of first breaks**. Pre-processed or modelled refraction first breaks allow to compute refraction statics based on blocky or gradient near surface velocity model. **Interactive, surface consistent semiautomatic static corrections** complement the set of static correction modelling methods.

Low velocity layer modelling

In challenging areas such as deserts, where air is present inside sand gravel, poor first breaks occur. Refractions, which are mixed with noise, create sometimes complex patterns and cannot be recognized correctly. In such cases first breaks are difficult to pick because their coherency is strongly disturbed. Remedy for that problem is direct modelling of low velocity layer. There are two main types of low velocity layer modelling: simple and advanced. Simple modelling, can be used when static corrections are related to terrain elevation, and near surface layers have low but almost constant velocity, so it is possible to design simple model built of few constant velocity layers which imitate real near surface velocity model. In advanced modelling method, three issues are characteristic: vertical and/or horizontal velocity gradient usually occurs (e.g. from compaction in dunes), predicted and/or hypothetical information (predicted upholes) is applied to near surface velocity model, statistical information based on direct/predicted measurements from part or from the whole area are taken and applied to the near surface velocity model.

Case 1: comparison of statics from desert is shown in Figure 1. It was decided to model LVL because refraction first breaks were very poor quality and automatic first break picking methods failed. For large 3D dataset, manual or semiautomatic first break picking was very time consuming. Two constant velocity layers was applied in this case. Boundary between first and second layer was defined on the basis of shifted and smoothed surface elevation. Velocity in the first layer was predicted and tested nonetheless uphole information was partially used for model creation.

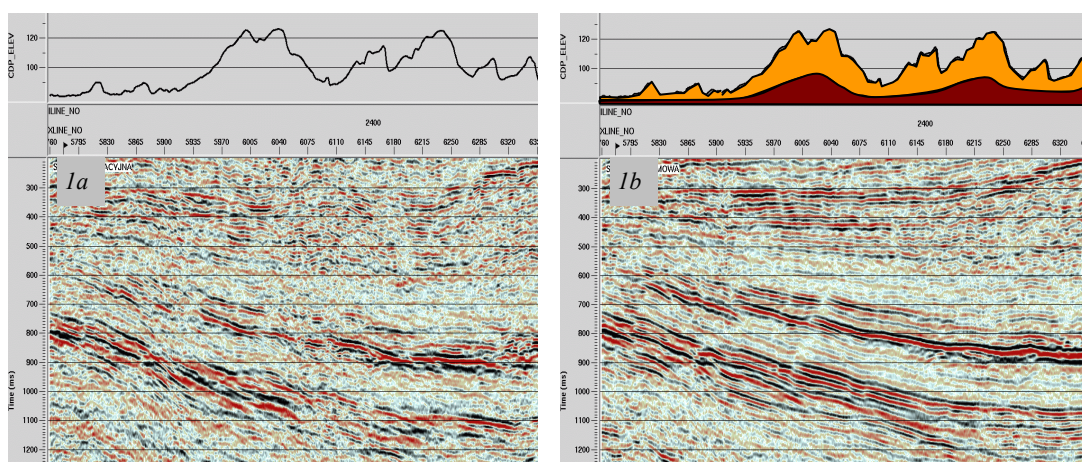


Figure 1 Example of simple modelling method in desert case. Comparison of raw stacks with elevation statics (1a) and statics based on simple LVL model (1b).

Case 2: comparison of statics from desert is shown in Figure 2. Advanced model of low velocity layer was used. Insufficient amount of field upholes (direct measurement) was replenished by predicted upholes. Hypothetical information was used during construction of weathering model (blue vertical segments). Ambiguous first breaks, near surface high velocity anomaly, and lack of direct measurement in zone where high irregularities of elevation exist, forced to use advanced method of LVL modelling.

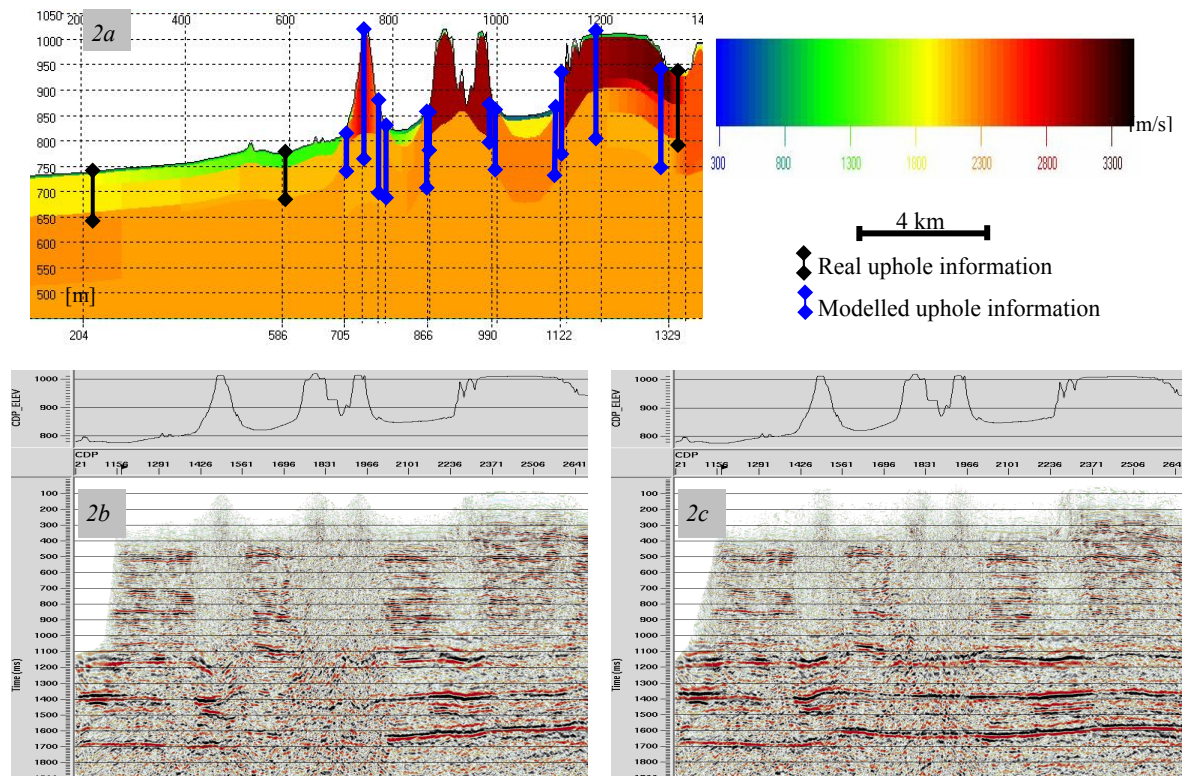


Figure 2 Statics based on advanced LVL modelling in the desert case. Near surface velocity model with real and predicted upholes (2a). Comparison of raw stacks with refraction statics (2b) and modelled statics (2c).

Simple and advanced LVL modelling can be also used in areas where a result of seismic data processing is needed urgently, or when static solution based on first breaks is not demanded. These efficient methods allow to perform processing for in-field QCs, fast track processing and when elevation or field static corrections are not solved acceptably.

First breaks pre-processing and modelling

Refraction static corrections which are based on the pre-processed or/and modelled first breaks can be used in areas where refractors make a complex pattern at the background of the noise.

In some cases pre-processing of first breaks is far enough to achieve satisfactory solution for automatic or semiautomatic first break picking. Procedures such as random noise elimination in time or frequency domain, wavelet processing with filtering, proper amplitude scaling usually help to improve quality of first breaks and enable direct picking.

In areas where refractors are very poor quality, their continuity is strongly destroyed, and the dip is only partially visible - the first breaks should be modelled. For the first breaks modelling the processes which are based on the frequencies, dips, velocities, common reflection surfaces (e.g: f-k, tau-p, trace mixing, CRS) can be applied separately, or mixed together (cascade or hybrid methods of refraction modelling).

Modelling of refractors for 3D data can also be carried out in cross-spread domain. FKK or 3D Radon can be used in this case. In cross-spread, traces with the same offset are located in circle with radius

equal to half of this absolute offset. In this domain refractions are seen as a 3D phenomena and can be easily defined.

Modelling of refractions destroys short wavelength static components, but increases uniqueness of the automatic first break picking. It is very important for large land 3D datasets when short processing time is demanded, and refraction statics method is needed in spite of very poor first breaks.

By far, refraction statics obtained from modelled first breaks include only low wavelength statics component. It is very dangerous to model changes of first breaks from receiver to receiver. On the other hand short wave-length statics component strongly influences quality of the stack, what is very important for the static solution. In this case rapid changes of first breaks can be partially restored.

Predicted first breaks which come from modelled refractors can be applied to the original and pre-processed data, tuned and shifted to the position in declared time corridor. Low wavelength static trend is based on the modelled first breaks, short wave-length static component can be based on the tuned predicted picks. First iteration of residual static corrections also helps if short wavelength static component cannot be properly solved.

Instead of the field statics (information from upholes) which gives information about the weathering layers at point, refraction statics give information from the whole area of prospection.

Modelled first breaks only predict the refractors behaviour so important is to compare obtained refraction statics to the direct measurement. Usually static calibration to the field upholes is performed.

First break refraction modelling in transition zone is shown in Figure 3 and 4. Polygonal FK (velocity and frequency ranges) was used. FK polygon was defined in areas where quality of first breaks was the best. These parameters were extrapolated to areas of very poor quality of first breaks. Modelling was performed in signed source-receiver offset plane, independently for each source gather.

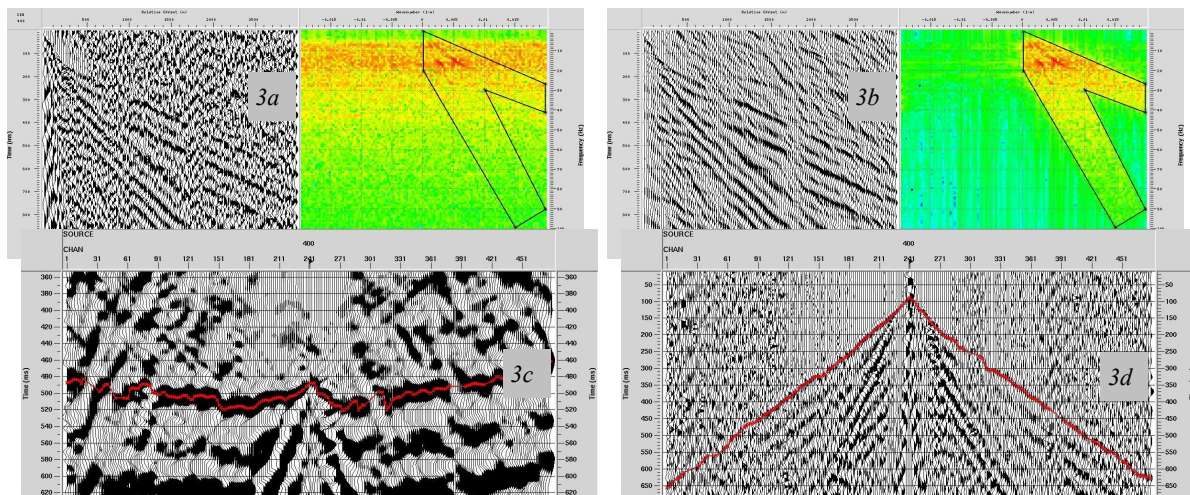


Figure 3 First breaks modelling in transition zone. Source record in FK domain with picked polygon (3a). Source record in FK after modelling (3b). Record prepared to semiautomatic first break picking after FK, random noise elimination and linear moveout application (3c). First break picks location after automatic picking on the modelled refractors - relation to the raw data (3d).

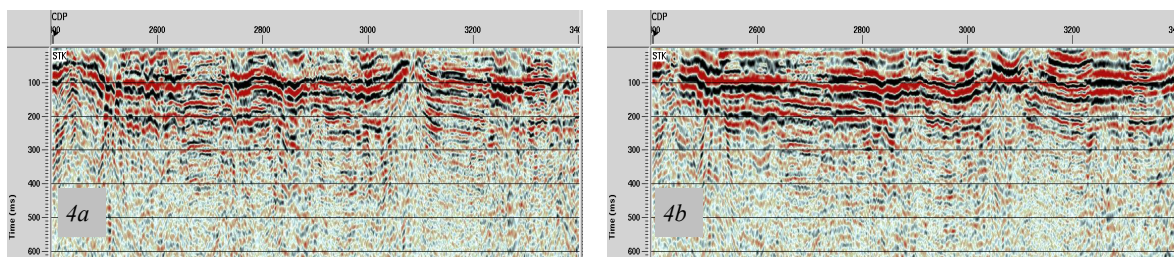


Figure 4 Stacks comparison – transition zone: Field statics (uphole) (4a). Refraction statics - first break modelling and blocky two layer model was used (4b).

Interactive static corrections

Interactive static corrections complement set of statics estimation methods, and modelling methods in particular. Interpretation of selected horizons can be performed in common shot, common receiver, or CDP gathers with reference to modelled horizons, frequently based on non-seismic information. This correction is iterative and interactive. Convergency of the process is determined by correctness of interpretation of horizons and quality of seismic data (Figure 5). This method originally used for cycle skips removal is also useful as complementary technique for modelling. Sometimes cycle skips are difficult to be noticed in CDP domain, but are well defined in CRP or/and CSP stack. Interactive approach to that issue allows to correct for cycle skips.

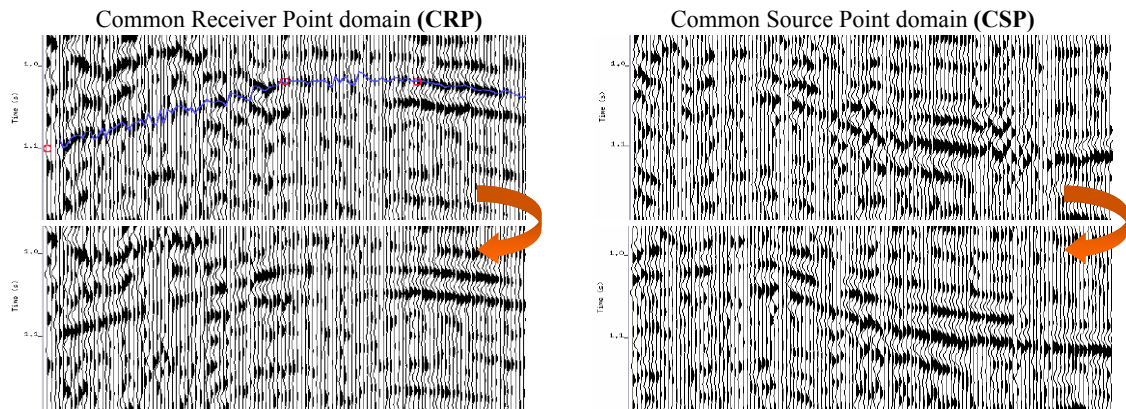


Figure 5 Interactive static corrections in CRP and CSP domain. Top pictures show CRP and CSP stacks before static correction. Bottom pictures show the same stacks after interactive statics correction.

Conclusions

Methods of estimation and application of static corrections are important in land areas where complex near surface structures exist and/or poor quality of seismic data occur. Right solution of static corrections in these areas frequently is very problematic, but is crucial to following steps of seismic data processing. For huge 2D and 3D land datasets, or when fast data processing is expected, manual correction of automatically picked, poor quality first breaks is very time-consuming. Static solutions based on: direct low velocity layer modelling, refraction statics when first breaks pre-processing and/or modelling is applied, or interactive static corrections, in many cases give the best statics in the short time.

Acknowledgments

The author wish to thank the Geofizyka Torun SA for encouraging this work and for permission to present this paper. Thanks to G. Szwed for some illustrations attached to this paper. Thanks to prof. dr hab. R. Slusarczyk.

References

- Cox, M. [1999] *Static Corrections for Seismic Reflection Surveys*. Society of Exploration Geophysicists, USA.
- Yilmaz, O. [2001] *Seismic Data Analysis, Volume I*. Society of Exploration Geophysicists, USA.
- Diggins, Ch. [2009] Static Corrections with Seismic Studio. *Workshop delivered to GT*, Torun.
- Glogowski, L., Ogonowski, W. and Ornoch, K. [2006] Statics correction in practice. *GT Technical Brochure*.
- Tlalka, S. [2010] *Static corrections in challenging cases*. Society of Petroleum Geophysicists, India.