Contribution of seismic processing to put up the scaffolding for the 3-dimensional study of deep sedimentary basins: the fundaments of trans-national 3D modelling in the project GeoMol

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Within the framework of the transnational project GeoMol geophysical and geological information on the entire Molasse Basin and on the Po Basin are gathered to build consistent cross-border 3D geological models based on borehole evidence and seismic data. Benefiting from important progress in seismic processing, these new models will provide some answers to various questions regarding the usage of subsurface resources, as there are geothermal energy, CO_2 and gas storage, oil and gas production, and support decisions-making to national and local administrations as well as to industries.

More than 28 000 km of 2D seismic lines are compiled reprocessed and harmonized. This work faces various problems like the vertical drop of more than 700 meters between West and East of the Molasse Basin and to al lesser extent in the Po Plain, the heterogeneities of the substratum, the large disparities between the period and parameters of seismic acquisition, and depending of their availability, the use of two types of seismic data, raw and processed seismic data. The main challenge is to harmonize all lines at the same reference level, amplitude and step of signal processing from France to Austria, spanning more than 1000 km, to avoid misfits at crossing points between seismic lines and artifacts at the country borders, facilitating the interpretation of the various geological layers in the Molasse Basin and Po Basin. A generalized stratigraphic column for the two basins is set up, representing all geological layers relevant to subsurface usage. This stratigraphy constitutes the harmonized framework for seismic reprocessing.

In general, processed seismic data is available on paper at stack stage and the mandatory information to take these seismic lines to the final stage of processing, the migration step, are datum plane and replacement velocity. However several datum planes and replacement velocities were used during previous processing projects. Our processing sequence is to first digitize the data, to have them in SEG-Y format. The second step is to apply some post-stack processing to obtain a good data quality before the final migration step. The third step is the final migration, using optimized migration velocities and the fourth step is the post-migration processing.

In case of raw seismic data, the mandatory information for processing is made accessible, like from observer logs, coordinates and field seismic data. The processing sequence in order to obtain the final usable version of the seismic line is based on a pre-stack time migration. A complex processing sequence is applied. One main issue is to deal with the significant changes in the topography along the seismic lines and in the first twenty meter layer, this low velocity zone (LVZ) or weathered zone, where some lateral velocity variations occur and disturb the wave propagation, therefore the seismic signal. In seismic processing, this matter is solved by using the static corrections which allow removing these effects of lateral velocity variations and the effects of topography. Another main item is the good determination of root mean square velocities for migration, to improve the final result of seismic processing. Within GeoMol, generalized 3D velocity models of stack velocities are calculated in order to perform a rapid time-depth conversion.

In final, all seismic lines of the project GeoMol will be at the same level of processing, the migration level. But to tie all these lines, a single appropriate datum plane and replacement velocity for the entire Molasse Basin and Po Plain, respectively, have to be carefully set up, to avoid misties at crossing points.

The reprocessing and use of these 28 000 km of seismic lines in the project GeoMol provide the pivotal database to build a 3D framework model for regional subsurface information on the Alpine foreland basins (cf. Rupf et al. 2013, EGU2013-8924).

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