Appendix 2

Practical implementation of the seis2sim and CtL workflows

The seis2sim is developed on a similar basis to the in-house sim2seis package of ETLP (Amini, 2014), with which it shares some common functions. Generally, the implementation of the seis2sim and CtL is carried out over a number of software platforms, in three stages: pre-processing and sim2seis, seis2sim and CtL (see Figure A2.1).

Pre-processing includes the reservoir simulation performed by the Schlumberger ECLIPSE reservoir simulator. An in-house Fortran code is used to extract the static and dynamic reservoir parameters after simulation. The extraction converts the data into a so-called ETLP format, which is used by sim2seis and seis2sim. Wavelets are required for both forward modelling and inversion, therefore the CGG Hampson-Russell package is used to conduct well-ties, which provide the sim2seis and seis2sim with wavelets at various offsets. The necessary petro-elastic model (PEM) and rock-physics analysis is calculated in MATLAB, with a manual script. Calibration of the PEM has been discussed in Chapter 3 and 5 when demonstrating the Heidrun and Girassol examples. The rock-physics analysis will define the bounds for the later inversion, as well as providing the relationship between inverted elastic parameters ($V_p, V_S$ and $\rho$) and the petro-physical parameters ($\phi$ and NTG), as discussed in Chapters 4 and 6.

The sim2seis predictions need to be introduced into seis2sim as a priori information and EC (engineering consistent) constraints. To perform this, a MATLAB script is coded which inputs the sim2seis predictions, and outputs them as matrices of the means and covariances of 4D changes (see Chapters 2, 3 and 5). Practically, seis2sim is firstly carried out at well locations to verify the settings and constraints. This quick test is executed by a MATLAB version of seis2sim which is fully consistent with the parallel version (coded in C language with GNU OpenMPI), with additional options to
Figure A2.1 The practical workflows for the seis2sim and CtL implementation.
output intermediate results for QC and visualization purposes.

The seis2sim results are automatically written in the Generic ECLIPSE Grid Properties format, which can be directly loaded by the Schlumberger PETREL package. This is where the CtL workflow is primarily carried out at the model updating stage. With the sim2seis and seis2sim results stored on the same reservoir model grid, the reservoir loop, static loop and dynamic loop can be closed by performing cell-by-cell comparisons. The results of the CtL update can be directly visualised by PETREL by re-launching the sim2seis process with updated parameters in the reservoir model.

In addition, the practical proceedings for the 3D and 4D seis2sim can be found on pages 40 and 53, for future practitioners to replicate the workflow.