AAPG Datapages/Search and Discovery Article #90310 ©2017 AAPG/SEG International Conference and Exhibition, London, England, October 15-18, 2017

Seismic Forward Modeling of Fluid Escape Pipes Based on Novel PSDM Method

Zhihua Cui[1], Isabelle Lecomte[2], and David Iacopini[1]

[1]Dept. of Geology and Petroleum Geology, University of Aberdeen, Aberdeen, United Kingdom.
[2]Institutt for geovitenskap, Universitetet i Bergen, Bergen, Norway.

ABSTRACT

During the last decade leakage structures commonly referred to in literature as “fluid escape pipes” have been widely documented globally. Fluid escape pipes, can be described, as structures allowing the migration of fluids from a reservoir toward the surface, bypassing reservoir seals and cutting the stratigraphic sequence. They are important structures unraveling information about fluid/gas migration. Understanding their mechanism, distribution and origin is often key as they may affect the risk and safety during exploration and/or production phase. The study area is the Loyal Field (Scotland) and is located within the Faeroe-Shetland Trough, that divides the Faeroe Platform, from the Shetland Platform. The largest and deepest fluid pipes identified on 3D seismics and partial stacks are up to km length, scattered across the basin slope, apparently associated with the main reservoirs currently under production. The internal structures of the roots imaged using near-to-far offset dataset are often characterized by low signal/noise and a more diffuse geometry with depth. Based on previous research works (Carthwright et al., 2007), describing pipe-shaped seismic anomalies, using interpreted seismic, well data and outcrops analogue with their petrophysical characterization we built some appropriate geological models of the fluid-escape structures.We then applied 2D/3D seismic forward modelling using a recent method generating prestack-depth migrated (PSDM) seismic images (Lecomte et al., 2015). This ray-based modelling approach is an extended 3D prestack-depth convolution method, which goes beyond the limitations of the standard 1D-based convolution and includes diffraction effects. In addition, we can take into account wave-propagation effects in realistic overburden models and for actual survey geometries, leading to modelling of 3D incident-angle dependent illumination and resolution effects. In this contribution we present different tests across various geological scenarios for either deep or shallow fluid escape structures representing the seal bypass at different intrusive stages. The modelled PSDM seismic images are matched with real seismic data, in order to determine the best-fitting geological model for the observed structures. Finally, we study the seismic imaging limitations such as offset-dependent illumination and resolution effects, which may be encountered for these near-vertical and narrow structures.