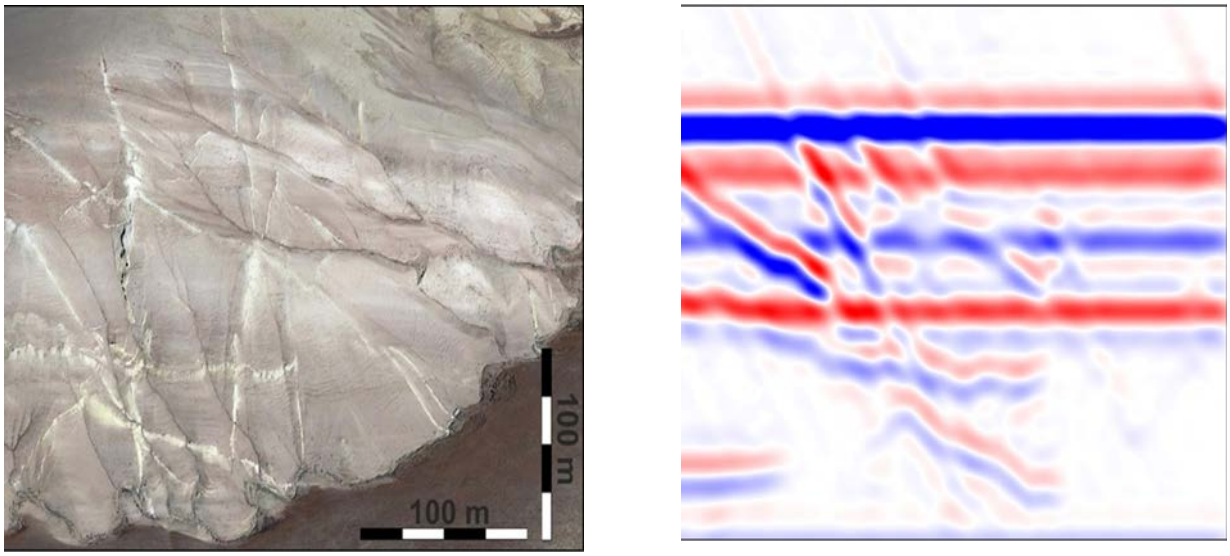
NERC Centre for Doctoral Training in Oil & Gas (2017 start)

Project Title: **Enhancing sand injectite resolution using diffraction seismic imaging methods**

Host institution: University of Aberdeen
Supervisors : ***Dr David Iacopini, (University of Aberdeen), Prof Evgeny Landa, (University of Tel Aviv), Prof Andrew Hurst, (University of Aberdeen)***



A b

Figure 1. a) SAND Injectite, Marca Canyon, USA. b) Marca Canyon, seismic imaging using PSTM forward modelling (40 Hz)

Project description: In this proposal an innovative diffractive approach will be developed and applied to enhance imaging of thin, small and/or non-bedding-parallel poorly consolidated sandstones with complex geometry (Fig 1a). Thus far, imaging solutions have used the combination of improved, low-end frequency content, which allows deeper signal-penetration (using optimal streamer broadband technology), sophisticated pre-stack migration, and post-stack coherency attribute analysis. Those approaches are largely based on backscattered reflections from continuous, smooth-reflecting boundaries and have limited potential to resolve small-scale scattering features below the tuning thickness, typically not “seeing” 15 to 40% of the reservoir volume. Recent advances using a diffractive approach suggest that the seismic response from small-scale geological features is encoded in diffractions wave (Fig 2). Here, we will pursue a diffraction-based, data-oriented approach with the aim of providing an alternative method for identifying subsurface scattering features that will have improved resolution relative to conventional seismic reflection imaging. The method has the potential to recover details of geological features smaller than the seismic wavelength. We aims to apply the methodology to explore disrupted turbiditic channel systems that are partly remobilized, poorly-consolidated and characterized by very low acoustic impedance contrast with the surrounding mudstone. Within this geological framework a correct identification of geological discontinuities, such as faults, sub-seismic fracturation and small-size scattering objects, is one of the main objectives of seismic imaging and interpretation (Fig 1b). A successful diffraction imaging experiment requires separating diffraction events from reflection events and then detecting the spatially-variable velocity necessary for focusing of different diffraction events. Different techniques for separation exist, including plane-wave destruction (PWD) and apex destruction in the migrated dip-angle domain (AD). Using raw seismic data provided by SIRG (sand

injection research group, Aberdeen) and building on existing diffraction imaging code (Tel Aviv) this project will test and fine tune recent separation techniques (PWD, AD) and develop novel methods for imaging seismic diffraction (Fig 2). The project will involve: a) Training on up-to-date physics of diffractions, diffraction modeling and imaging; b) Test of techniques for separation and inversion of diffraction; c) Development and coding of innovative diffraction Imaging in the Time and depth Domain ; d) Interpretation and comparison of the diffraction images with existing pre stack migrated 3D cubes.

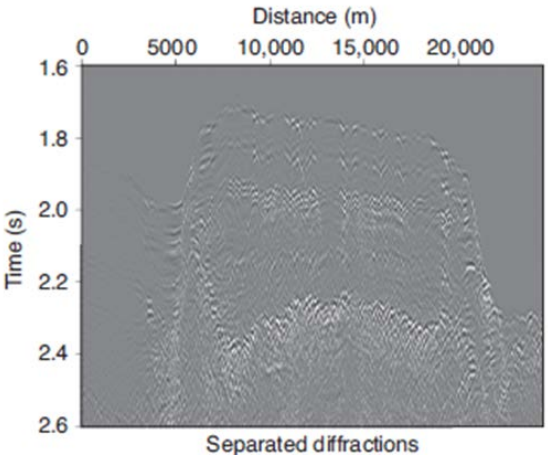


Fig 2 Example of Migrated diffractions (from Fomel et al., 2007)

CDT Research theme(s): Extending the life of mature basins, exploration in challenging environments and effective production of unconventional hydrocarbons.

Research context: The student will be part of SIRG in which research into the geophysics, petrophysics and integrated characterisation of sandstone intrusions is in progress. Training will be given in innovative diffraction physics, coding, processing methods and, the interpretation of the 3D seismic images that are generated.

Research costs: University Aberdeen will provide equipment: computers, software and access to SeisLAB. Fieldwork, travel, training, visit to the Tel Aviv laboratory and consumables will be covered with RTSG funds.

Career routes: The student will become an expert in diffraction imaging, seismic processing, forward seismic modelling and the petrophysics of poorly-consolidated reservoirs. Because the project requires integration of a wide variety of geophysical data and manipulation of frontier imaging methods, the student will be very well placed to follow a career in the E&P industry doing cutting-edge research to develop enhanced methods in seismic processing and/or as specialist seismic processing consultant.

Applications: The closing date for applications is 31st January 2017. Instructions on how to apply can be found by clicking here. Please contact David Iacopini (d.iacopini@abdn.ac.uk) for further information or if you would like to apply.

References:

Landa, E., and S. Keydar, 1998, Seismic monitoring of diffraction images for detection of local heterogeneities: Geophysics, 63, 1093–1100.

Fomel, Landa E., Taner. 2007. Poststack velocity analysis by separation and imaging of seismic Diffractions. Geophysics, 72, 89-94.

Szarawarska, E., Huuse, M., Hurst, A., De Boer, W., Lu, L., Molyneux, S. & Rawlinson, P. (2010). 'Three-dimensional seismic characterisation of large-scale sandstone intrusions in the lower Palaeogene of the North Sea: completely injected vs. in situ remobilised sandbodies'. Basin Research, vol 22, no. 4, pp. 517-532. DOI