Geophysical Research Abstracts
Vol. 20, EGU2018-11568, 2018
EGU General Assembly 2018

Interaction of fluid migration structures with polygonal faults imaged by 3D seismic data in the Canterbury Basin (New Zealand)

Jasper Hoffmann (1), Andrew Gorman (1), and Gareth Crutchley (2)

(1) University of Otago, Geology, New Zealand (jasper.hoffmann@otago.ac.nz), (2) GNS Science, PO Box 30-368, Lower Hutt, New Zealand (g.crutchley@gns.cri.nz)

Fluids seeping through the seabed, potentially forming pockmarks, play a crucial role in seabed ecological systems and can be used to constrain the distribution of hydrocarbons in underlying geological units. Recent and buried pockmarks revealed by 3D seismic datasets and multibeam imaging indicate repeated fluid expulsion along the Canterbury slope, that seems to have been triggered by a number of processes. All seafloor depressions along the shelf exhibit the same longshore north-eastward facing crescent form that we associate with water current modification.

We present data from an Eocene succession of dense polygonal faulting that exhibits two near vertical structures creating slightly uplifted cylindrical shapes with diameters of 4 and 6 km. Seismic sections through these circular features reveal upward-bent reflections in their centres interpreted as ancient fluid migration pathways. Sets of concentric faults, surrounding these fluid pathways, are confined to an interval of polygonal faulting below the Oligocene Marshall Unconformity. The basin-wide mostly continuous reflection that marks the Marshall Unconformity seems chaotic and disrupted above the concentric faults, in what appears to be a large scale depression on the ancient surface (>3 km in diameter). Concentric as well as most polygonal faults terminate at this boundary.

The seismic reflection strength, quantified using the energy envelope, is particularly suited to evaluate sediment deformation. We suggest that the deformation of sediments during fluid propagation created a V-shaped structure (as imaged by the seismic energy envelope) indicating that fluids are sourced from a mounded root. We infer that the concentric faults mark the lateral extent of this fluid induced deformation within the polygonal fault system. South of the large-scale depression, buried pockmarks between 100 and 300 m in diameter are observed on the upper tips of polygonal faults which are also incised into the Marshall Unconformity. These pockmarks indicate active fluid expulsion and fault propagation of the polygonal faults during the same time as fluids propagated through upward-bent reflections creating the V-shaped structure. This may be evidence for fluid induced sediment deformation interacting with active polygonal faulting to create concentric faults around vertically migrating fluids.

By analysing the amplitude variation with angle (AVA) in seismic common depth point gathers, we relate a Class 3 AVA anomaly around shallow bright spots to a 300-m-wide near vertical structure emerging from the same horizon as the fluid pathways surrounded by the concentric faults. We interpret this vertical structure to be a fluid migration pathway feeding shallow gas pockets beneath the seafloor. Bright spots are located only $\sim$10 ms below the seafloor, which indicates recent fluid flow through the chimney, although the structure itself might have been used repeatedly over time. Continuous reflections in the seismic section through this chimney structure suggests that fluid migration causes only minor modifications of the original sedimentary fabric in this case.