Rhyl Field: developing a new structural model by integrating basic geological principles with advanced seismic imaging in the Irish Sea

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Abstract: A new model of compression in the Upper Triassic overlying the Rhyl Field has been developed for the Keys Basin, Irish Sea. This paper highlights the significance of the overburden velocity model in revealing the true structure of the field. The advent of 3D seismic and pre-stack depth migration has improved the interpreter's knowledge of complex velocity fields, such as shallow channels, salt bodies and volcanic intrusions. The huge leaps in processing power and migration algorithms have advanced the understanding of many anomalous features, but at a price: seismic imaging has always been a balance of quality against time and cost. As surveys get bigger and velocity analyses become more automated, quality control of the basic geological assumptions becomes an even more critical factor in the processing of seismic data and in the interpretation of structure. However, without knowledge of both regional and local geology, many features in the subsurface can be processed out of the seismic by relying too heavily on processing algorithms to image the structural model. Regrettably, without an integrated approach, this sometimes results in basic geological principles taking second place to technology and has contributed to hiding the structure of the Rhyl Field until recently.

Objective

This paper summarizes the history of the Rhyl Field and its regional setting before describing the hydrocarbon system and late-stage volcanic intrusions that have played a part in hiding the Rhyl Field from discovery until recently. The complexity of the Rhyl Field is described with reservoir geology and the different seismic datasets used to image, interpret and map the structure in detail. This leads on to a discussion about the fundamental principles used to derive a final reservoir depth structure surface that adheres to the data and to the commonly accepted principles of extensional and compressive stresses with their associated faulting.

The objective of this paper is to highlight the significance of compression in the Upper Triassic, overlying the newly discovered Rhyl Field of the Keys Basin, in the East Irish Sea. The structure of the overburden has been complicated further by the presence of Tertiary dyke intrusions. Up until recently, the velocities used to stack and migrate seismic volumes have not recognized these complexities, and have historically smoothed through these features, resulting in a deformed reservoir depth surface. The mapping of the Rhyl Field, both pre- and post-discovery, and pre- and post-field development, went through several iterations until a geological model existed that matched the data and rationalized the role of Tertiary compression in the basin, something that has not been recognized before in the northern part of the Keys Basin.

There is a need for an integrated approach to structural mapping if multi-phase tectonic regimes are to be understood, and an accurate depth model of a field is to be generated. This involves multiple techniques and datasets, and discussions with colleagues to piece together the relevant information (and, indeed, reject irrelevant data) that is available to the subsurface professional.

Three-dimensional interpretation platforms and leaps in processing power have made huge improvements over old 2D paper sections in terms of 3D visualization of fault geometries and integration of seismic attributes to name but two. However, all too often, seismic interpretation is treated as simple 'wiggle' picking on high-specification workstations or laptops. As a result, the term 'Nintendo Geophysics' was coined, and parts of the industry have evolved from geoscientists understanding the role of seismic processing in their datasets, to a situation where some geoscientists only look at the screen in front of them with a 2D slice from a 3D seismic data cube, and do not make an interpretation if there isn't a consistent seismic reflector to pick. The basic information in the processing report, the side label, and information about the stacking and migration velocities are all too frequently considered to be part of the old world of paper sections. However, this information is also vital if the subsurface professional is to understand the role of the seismic image in the geoscience model.

The authors would therefore argue that, in these cases, seismic interpreters need to engage the second word in their role name, and that is to 'interpret' the data and use other subsurface information to guide the construction of the subsurface depth model.

Field history

The Rhyl Field is located in UKCS Block 113/27b (Fig. 1), 11 km north of the North Morecambe Field and 9 km NE of the Millom Field. Hydrocarbon Resources Limited (HRL) was awarded Block 113/27b (licence P.1483) in 2007 as part of a 24th Round Licensing application. Exploration well 113/27b-6 was spudded on 12 November 2009 and reached a total depth (TD) at 5319 ft measured depth (MD) (5185 ft true vertical depth subsea (TVDSS)) on 27 November 2009. The well was declared a gas discovery, encountering a gas column of 495 ft (151 m). After successful testing with a maximum flow rate of 15.24 MMscf/d, the well was plugged and abandoned.

Structurally, the Rhyl Field is the central part of a north–south-orientated horst block to the west of the Tynwald Fault Zone, complicated by the combination of an extensional, relay-ramp and compressive shear fault systems. The Rhyl Field reservoir is formed by the Lower Triassic, Ormskirk Sandstone Formation (Fig. 2), which is equivalent to the Bunter Sandstone in the Southern North Sea. The vertical seal is provided by the overlying Upper Triassic, Mercia Mudstone Group that is downfaulted to form western and eastern lateral seals. WNW–ESE-trending igneous dykes of Tertiary age (part of the Fleetwood Dyke Complex) and associated normal faults are believed to form lateral seals to the north of the horst system.

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