Controls of the Pre-Existing Structures on Post-Jurassic Deformation Within the Porcupine Basin, Offshore West Ireland

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ABSTRACT

Over the NW European continental shelf hydrocarbons have most often been encountered within Upper Jurassic traps, though increasing numbers of both structural and stratigraphic traps are hosted within younger Mesozoic and Cenozoic sequences. Many potential traps have been subjected to later deformation resulting in both localized compressional and extensional reactivation of Jurassic structures with both negative and positive implications for trap integrity and charge. This study focuses on the control of pre-existing Jurassic rift faults on the distribution and style of Cretaceous and Cenozoic normal faults within the Porcupine Basin as they could play an important role in hydrocarbon leakage from lower to higher structural levels and also in providing up-dip seal to post-rift stratigraphic plays. The location and geometry of post-Jurassic faulting is, to varying degrees, controlled by Jurassic structures. Here we classify the degree of this localisation into weak, moderate and strong depending on the geometrical relationships between Jurassic and later structures. Where localisation is weak, the locations of overlying faults are clearly influenced by and soft-linked to underlying faults and/or structural ‘highs’, though their strike can be unrelated and they do not have a dominant dip direction. Moderate localisation is characterized by pronounced relationship in both strike and dip direction of faults, with displacements on overlying faults at a maximum within the Cretaceous or Cenozoic section to produce a predominantly soft-linked system, with only occasional hard-linkage into the Jurassic structures. By contrast, strong localisation is marked by hard-linked faults with displacements that are constant or decrease upwards through the post-Jurassic sequence, and with reactivation arising from upward propagation of Jurassic faults either as single fault surfaces or bifurcating array of oblique faults. Our analysis of faults across the Porcupine Basin indicates that the degree of localization and linkage is controlled by three main factors: (a) relative orientation of later stretching and pre-existing Jurassic faults, (b) fault size (i.e. displacement), and (c) thickness and rheology of the intervening layer. Whatever the controlling factor, strong localization during reactivation can provide up-fault pathways into post-rift strata, whilst weak localization is unlikely to facilitate hydrocarbon leakage from lower to higher structural levels.