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Deriving Relationships Between Diapir Spacing and Salt Layer Thickness

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ABSTRACT

Reservoirs associated with salt diapirs have been being drilled by the oil industry in the North Sea since the 1970's. Successful petroleum recoveries require reliable reservoir description, for which the associated salt diapir’s geometry and mechanics contribute. However, whilst new seismic migration and imaging processing techniques have improved the characterization of salt structure, the rheology of the salt still isn't well known. Nevertheless, the geometries of salt structures potentially contain information of the material involved. Rayleigh-Taylor and other theories have attempted to explain how the spacings between salt diapirs vary with the thickness of the salt layer before diapiric deformation became well established. Diapirs are generally expected to be more widely spaced where the salt was originally thicker. Here, we examine issues with deriving data for tests of such theories using data on the salt layer topography and thickness from the southern North Sea. These data were derived by the Geological Survey of the Netherlands (TNO) and from industry 3D seismic reflection data combined with a dense network of well information. First, as the direction of halokinetic deformation is usually unclear, the original layer thickness is best estimated by spatially filtering and then sampling the present thickness over lengthscales larger than the diapir spacing. As we cannot rule out loss of some evaporite minerals by dissolution or erosion during exposure, such a value is a minimum. Second, the spacing was derived in two dimensions by locating the minimum separation of lines representing the ridgelines of diapirs, which are commonly elongated in this part of the Red Sea. Attempting to implement such a scheme leads us to conclude that the results can easily be non-unique, as the lengthscale of the spatial filtering depends on the dependent variable, diapir spacing, which also varies with the filter lengthscale. Furthermore, diapir spacing needs to be determined in two-dimensions, casting uncertainty on previous results that were based on single profiles of 2D seismic reflection data. Nevertheless, choosing an apparently optimal filter length of 50 km for this dataset, we find the relationship between diapir spacing and original thickness from 11 to 18 m/m. Such a relationship is greater than has been reported for pillow province of the UK North Sea sector, as expected if pillows typically evolve into diapirs with progressive halokinetic deformation.