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Sill Emplacement and Forced Folding in the Canterbury Basin, Offshore South East New Zealand

Craig Magee[1], Jennifer Reeves[1], Chris A. Jackson[1]

[1]Imperial College London, London, United Kingdom.

ABSTRACT

Sill-complexes are common in sedimentary basins worldwide. The geometry of sill-complexes and their associated deformation can be used to unravel tectono-magmatic events. For example, intruding magma may uplift the overburden and the free surface to produce forced folds that are typically either dome-shaped or flat-topped. These four-way dip closures can form suitable hydrocarbon traps and dating of onlapping of sedimentary strata allows the timing of emplacement, relative to hydrocarbon generation and migration to be assessed. Furthermore, these forced folds directly overlie the forcing intrusion and their volume is commonly assumed to equal that of the emplaced magma. This relationship between folds, which may be expressed that the Earth's surface, and magma volume is fundamental for volcano predication due to the use of ground deformation as a proxy for the location and magnitude of future eruptions. However, recent studies have demonstrated that fluidization of weak host rock can accommodate magma during non-brittle emplacement, producing little or no overburden deformation. Assessing the mechanics of intrusion-induced forced folding is therefore critical to a variety of Earth Science disciplines. Here, we use 3D seismic reflection data map four sills at a high-resolution within the underexplored, frontier Canterbury Basin, offshore SE New Zealand. We demonstrate that: (i) despite similar emplacement levels, forced folds are only developed above two of the sills, with no apparent uplift above the other two sills; (ii) onlap of sedimentary onto forced folds and associated hydrothermal vents indicates two episodes of sill emplacement in the Whaingaroan (34.6-31.8 Ma) and Opoitian (5.33-3.7 Ma); and (iii) intra-fold thickness is variable, with lower intervals within the folds displaying a flat-topped geometry overlain by sedimentary strata displaying dome-shaped folding. We discuss the formation of these forced folds as assess the role of non-brittle and inelastic deformation on the geometry and growth of forced folds.