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A fluid pressure model for the development of strata bound fracture systems and its application to the assessment of caprock integrity.

Christopher McDermott, Katriona Edlemann, Alexander Clapham, and R. Stuart Haszeldine
School of Geoscience, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JW, Scotland, United Kingdom (cmcdermo@staffmail.ed.ac.uk)

During CO_2 injection in a reservoir the fluid pressure of the reservoir will increase. In CO_2 storage systems the engineering function of the cap rock is to prevent fluid movement out of the reservoir vertically and thereby mechanically retain the increase in fluid pressure. In many proposed CO_2 storage sites the in situ principal horizontal stresses are less than the vertical stress (e.g. North Sea), therefore increased reservoir fluid pressure can lead to vertical strata bound tensile failure of the caprock. Such behaviour can be investigated examining natural analogue fracture patterns in strata bound systems. Here we present a tensile failure model which predicts the spacing of fractures due to fluid pressure increase in a multi-layered sedimentary sequence comprising different typical sedimentary deposits such as mudstones, siltstones, sandstones. Although strata bound fracture systems are normally assigned to pull apart models, this fluid pressure model also predicts many of the field observations made in such strata bound fracture systems. A standard normalised relationship is derived for most sedimentary systems predicting the spacing of discontinuities based on the variability of the tensile strengths of the layers of a sedimentary sequence and the thickness of the beds. The model provides a tool for assessing the historic fluid pressures in beds based on fracture spacing observations, and will aid in the prediction of the behaviour of such strata and understanding the development of discontinuities during engineered fluid injection. The model identifies important parameters which need to be addressed in the field characterisation of the integrity of caprocks and can be used as a simplified approach to coupling fluid pressure increase and caprock failure in numerical coupled process simulations.