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The geological risks of drilling a borehole for CO_2 storage

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A hydrocarbon exploration borehole may be unsuccessful because the target reservoir is of low porosity, is too thin or has no seal, even when drilled in an area of well-known geology, such as the North Sea. The same geological problems could cause a new CO_2 storage borehole or project to be unsuccessful, especially when drilled into a previously untried structure in a saline aquifer. As experience worldwide of developing new CO_2 storage projects is limited, hydrocarbon exploration provides a useful analogue to assess both the absolute range of risk factors, and their historical occurrence. In this study, we reviewed the results of 382 unsuccessful hydrocarbon boreholes in the UK North Sea to analyse the geological risks of drilling. We found that absence of the target reservoir (19 $\pm$ 3 % of cases), low reservoir quality (16 $\pm$ 5 %) and lack of trap (16 $\pm$ 3 %) are the most significant risk for a new borehole. We suggest that boreholes drilled for CO_2 storage will have a similar risk profile, even when drilled into a highly explored area such as the North Sea. From the drilling records, we estimate that the probability of a reservoir having an effective caprock is 95 $\pm$ 2%; and for any bounding faults to provide an effective seal to be 82 $\pm$ 4 %. Based on the probability data, 48 $\pm$ 8 % of subsurface structures, which appear to be suitable for CO_2 storage on pre-drill prognosis, are predicted to actually be suitable for the storage of CO_2. For storage sites that have been penetrated by existing boreholes, then the geological risks are greatly reduced. The most significant remaining risk is reservoir compartmentalization.