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Salt inclusion during rapid CO_2 hydrate formation

Camps, A. P.(1,2), Milodowski, A. E.(1), Rochelle, C. A.(1), Lovell, M. A.(2), Brewer, T. S.(2), Jackson, P. D.(1), and Williams, J. F.(2).

(1) British Geological Survey, Keyworth, Nottinghamshire, NG12 5GG, UK, (2) Department of Geology, University of Leicester, LE1 7RH, UK (apcamps@bgs.ac.uk / Phone: 01159363100 ext 4036)

A potential carbon dioxide geological storage method - storage as a liquid and hydrate, in cold sub-seabed sediments, beneath deep oceanic waters, could offer additional storage sites to those currently proposed for supercritical storage. Injection of slightly buoyant liquid carbon dioxide below its hydrate stability zone could lead to the formation of a hydrate 'cap', which would create an impermeable trapping mechanism. Carbon dioxide hydrates have been synthesized within sediments and water of seawater salinities, in a laboratory controlled high pressure, low temperature environment, to simulate potential storage conditions. These samples have been cryogenically frozen and analyzed using variable pressure cryo-Back Scatter Electron Microscopy. Analysis of the samples discovered precipitated salt crystals along crystal boundaries and within the hydrate crystals. Different salt structures and hydrate morphologies have been identified with different growth rates and conditions. Hydrates are well known to exclude salts from their crystal structure during formation; however, under these conditions salts have been included within the crystals due to very rapid formation, forming at salt saturation. Should CO_2 storage as a liquid and hydrate be actively considered, it would be necessary to take into consideration the precipitation and inclusion of salt during rapid formation for further conceptual development. These results are highly applicable to research in many fields including carbon storage as a liquid and hydrate, static desalination systems, and in natural hydrate research on Earth and elsewhere in the solar system.