Gas entry into unconfined clay pastes at water contents between the liquid and plastic limits.

Author Affiliation: British Geological Survey, Keyworth, Nottingham NG12 5GG, UK.
Author Email: stho@bgs.ac.uk
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Abstract: A programme of 143 simple gas injection experiments was performed on...
unconfined and initially water-saturated clay pastes at water contents between the plastic and liquid limits. The aim was to investigate the relationships between gas entry pressure, water content and plasticity for a range of clay types (kaolinite, london clay, blauton, gault clay, and bentonite), to define the principal mechanisms of gas entry and flow by simple visual observations and to determine the effects of previous gas injection and residual gas content on entry pressure. Gas movement was found to be entirely through pressure-induced pathways, including highly-dilated tension fractures, flattened ellipsoidal cavities and bubbles. By examining entry mechanisms across the range of water contents, it was possible to delineate three zones of behaviour. Gas entry pressures in the region of the plastic limit were surprisingly large, particularly for clay types with high total specific surface and plasticity index. The highest individual entry pressure recorded in the study was 1810 kPa for Wyoming bentonite. There was no evidence in any test that gas actually penetrated, or flowed through, the intergranular porosity of the clay matrix. In all cases, gas made its own volume by pushing back the paste and lifting the free surface of the sample. After gas injection, remnant gas-filled voids and cracks remained within the clay. These were re-opened during repeated gas injections at pressures which were only a fraction of the entry pressures of the gas-free pastes. Gas entry at high pressures was audible and occasionally violent. The significance of these findings to gas migration modelling and the quantitative prediction of gas fluxes in clay formations is briefly examined.

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