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Geological Storage of CO_2 by Hubbert's Force Potential and Gravitational Groundwater Flow Systems

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In 1937 and 1940, two basic treatises on fluid flow in the subsurface were published. Muskat, 1937, shaped the development of reservoir engineering while Hubbert,

1940, introduced the physically consistent Theory of Force Potentials [energy related to mass] to petroleum exploration and hydrogeology. The advanced hydrogeological methods of gravitational Groundwater Flow Systems (Tóth, 1962) are based on Hubbert's Force Potential.

Muskat's, 1937, methods lead to very successful and prosperous hydrocarbon productions. Muskat's methods are, however, based on continuum mechanics [energy related to volume] and hence physically inconsistent. In petroleum production the actual flow paths are not of great importance as long as the hydrocarbons and other fluids enter the production wells. The same is applicable to EOR. The large scale injection of CO_2, however, will remove the sink conditions of hydrocarbon production and EOR application and replace it with source conditions causing long term rise of the pressure potential. From the source injection wells the CO_2 will flow along pathways which cannot be determined by using methods based on Muskat [1937]. Methods based on Hubbert's Force Potential and gravitational Groundwater flow systems are , however, particularly suitable for the determination of the flow paths for hydrous fluids, hydrocarbons and CO_2 on their migration away from the CO_2 injection sites.

The presentation will address the interplay between gravitational, pressure potential and capillary forces. It will also shed light on the role, within Carbon Sequestration, of so-called 'Buoyancy Forces', of pressure potential forces, of the physical conditions leading to the occurrence of 'Buoyancy Reversal' (Weyer, 1978) and how all these conditions can be beneficially applied in carbon sequestration.

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