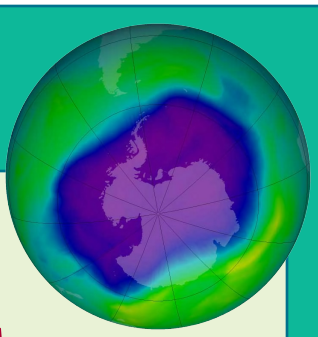
MATH MATTERS

Apply It.

The Math Behind Carbon Capture and Storage



Technical terms used:

CO_2 sequestration, flow in porous media, transport, partial differential equations, finite element methods.

Uses and applications:

Instead of release of harmful carbon dioxide (CO_2) into the environment, CO_2 can be captured and stored. In the process known as CO_2 sequestration, the gas is pumped underground and stored in layers of porous rock. Old oil and natural gas fields are good sites for this process because they have already been used to trap liquids and gases for long periods of time.

How it works:

Currently the world produces a large volume of CO_2 in generating energy for everyday life. In 2013, the United Kingdom emitted 467.5 million tons of CO_2 into the atmosphere. One of the biggest challenges for the 21st century is how to reduce the volume of harmful gases that enter our atmosphere to minimize the harmful effects on the environment. CO_2 sequestration provides one potential solution.

When the CO_2 is injected into layers of rock, it can begin to dissolve into the groundwater. Background flow of this water allows continual dissolution of the gas into the water instead of its just dissolving vertically down into the aquifer or rock layer. This is because the gas usually pools in structural traps in rock layers, such as anticlines. Using mathematics, the partial differential equations that describe this movement can be solved so that the concentration and velocity profiles for the aquifer can be predicted. This tells us how much CO_2 can ultimately be dissolved in the aquifer, the timescales over which this happens and the mechanisms that govern the transport. Techniques such as finite element methods enable the analysis to be completed easily using computers.

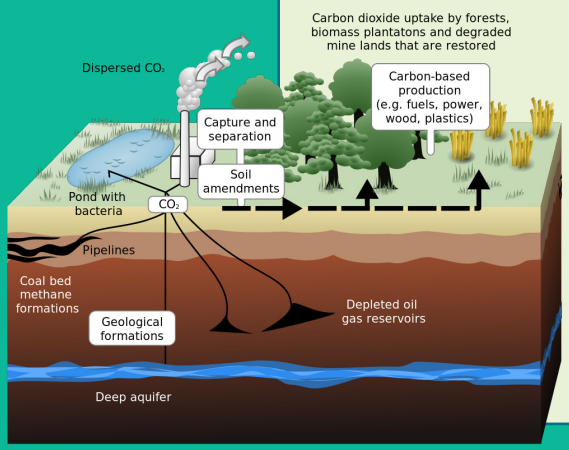
Interesting fact:

In a typical aquifer used for CO_2 sequestration, it will take around a million years to fully dissolve the gas injected into it. Once the gas has dissolved, it removes the risk of leakage from fractures in the rock layer, which could lead to the re-entrance of the gas into the atmosphere.

References:

Energy Consumption in the UK, UK Government, 2014. Final UK greenhouse gas emissions national statistics: 1990- 2013. UK Government, 2015.

H. J. T Unwin, G. N Wells, A. W. Woods, CO_2 dissolution in a background hydrological flow, Journal of Fluid Mechanics 2016. To appear. http://arxiv.org/abs/1506.04433



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