

27 April 2010

Response to the article in Business by Terry Macalister .

On line at <http://www.geos.ed.ac.uk/sccs/publications.html>

Original article

<http://www.guardian.co.uk/business/2010/apr/25/research-viability-carbon-capture-storage>

The possibility of carbon dioxide storage underground, to enable carbon capture and storage lasting many thousands of years, does of course require guarantees of possibility and reliability. The research referred to by Terry Macalister (25 April 2010, Guadian Business) has been undertaken and published by two Texas academics, who are noted for their assertive views and scepticism of climate change evidence. The original articles by M J Economides and C A Ehlig-Economides propose the idea that CO<sub>2</sub> cannot be injected below ground, because of the resulting pressure increase. Their punch line being that "bulk CO<sub>2</sub> injection is not feasible at any cost". These articles have become notorious for taking an extreme view, which most experts consider to be profoundly incorrect and fatally flawed.

In essence, this unusual theory assumes that storage of CO<sub>2</sub> will be injected to the deep subsurface into a sealed container, with no-flow of existing water through the lid, sides, or base. Un-surprisingly, if extra CO<sub>2</sub> fluid is added to a sealed container, the pressure within the container will increase.

However, the result of the analysis depends entirely on the assumptions made by te authoring academics. If different assumptions are made, a different result is deduced.

The most profound error, is that the subsurface is not made of sealed boxes. If it were, then oil and gas would not have been able to move for tens or hundreds of kilometers laterally and vertically, to be caught in the traps where these fluids are discovered today. The oil industry would not exist.

There are numerous additional technical errors and flaws: for example elementary but important mistakes include the temperature profile which is too low, and the pressure profile is also incorrect. Most importantly, the reservoir is assumed by the Texas authors to be only 30 metres thick. By contrast, it is well known from all petroleum

provinces, as well as the iconic images from the Grand Canyon cutting through literally kilometre thicknesses of rock, that deep below ground are many hundreds of metres of porous rock, laterally widespread, which is suitable for storage of immense volumes of CO<sub>2</sub> .

Some 20 experiments of CO<sub>2</sub> injection into the deep subsurface have been, and are, underway around the world during the last 10 years. Several of these have successfully injected many millions of tonnes of CO<sub>2</sub> – just as required for CO<sub>2</sub> storage from large power plants. Only one experiment has experienced any pressure problems of the type predicted by Texas authors, and several experiments have successfully injected millions of tonnes of CO<sub>2</sub> with no pressure increase. In addition, we have scientifically looked at locations of natural CO<sub>2</sub> storage, such resources have been used for decades – as sparkling mineral water, and the fundamental geological conditions for long timescale CO<sub>2</sub> storage are well known.

Additional technical information on the worldwide experiments to date can be obtained at [www.geos.ed.ac.uk/scs/publications.html](http://www.geos.ed.ac.uk/scs/publications.html) Working Paper 2010/3. An additional technical critique of the fatal flaws in the proposition that CO<sub>2</sub> injection is impossible are at [www.geos.ed.ac.uk/scs/publications.html](http://www.geos.ed.ac.uk/scs/publications.html) Working Paper 2010/4.

Sophisticated errors have been made in the past in popular science – for example it can be mathematically ‘proven’ that bumblebees cannot fly. That was based on mis-guided assumptions about the relevant mathematics to be employed. The Economides’ proposition that CO<sub>2</sub> can never be injected for storage is also based on an incorrect mathematical analysis. It has already been proven wrong in the real world.

We remain convinced, based on a combination of theory, pragmatic oil industry evidence, and real experimental evidence, that CO<sub>2</sub> injection into the deep subsurface is feasible at a very large size scale.

Sincerely

Professor Stuart Haszeldine FRSE, Schol of GeoSciences, University of Edinburgh

Professor Martin Blunt, Department of Earth Science and Engineering, Imperial College, London

Dr Andrew Cavanagh, Senior scientist, Permedia Research, Ottawa

Dr Mark Naylor Postdoctoral Fellow, Schol of GeoSciences, University of Edinburgh