

**Statement from Dr. Malcolm Wilson, CEO, Petroleum Technology Research Centre, on the opinion article by Drs. Mark Zoback and Steven Gorelick on seismic risk of geological storage of carbon dioxide**

**By Dr. Malcolm Wilson, Chief Executive Officer  
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The Petroleum Technology Research Centre, as manager of both the *IEAGHG Weyburn-Midale CO<sub>2</sub> Monitoring and Storage Project* and the *Aquistore Project* (our research into deep saline aquifer storage) has watched with interest the recent release of the opinion paper<sup>1</sup> by Drs. Mark Zoback and Steven Gorelick, on the seismic risks associated with the geological storage of carbon dioxide (CO<sub>2</sub>), and the public and scientific responses to it. Both authors are well respected Earth scientists. PTRC welcomes such opinions being expressed and agrees that this issue warrants continued debate. The issue is not new and has not been ignored in research; indeed, there is already much science- based debate on the impacts of induced seismicity. Below are some of our own research details to add to the debate:

**21 Million Tonnes CO<sub>2</sub> Stored: 11 Years of Research**

The Weyburn research project was initiated to allow some of the best researchers in the world to look at the integrity of storage and start asking the right questions about storage and providing science based answers to these questions. Our goal has always been to identify concerns and respond to them. We have spent eleven years conducting extensive research into the integrity of storage at Weyburn through geological characterization of this oil field in southeastern Saskatchewan, and conducting advanced measurement, monitoring and verification work (including modeling, seismic imaging and passive monitoring, soil gas and well water monitoring, and performance assessments), the *Weyburn-Midale Project* offers the best current means possible of putting claims of CCS seismic activity into context, and offering best practice for what needs to be done ahead of, and during, CO<sub>2</sub> injection.

The PTRC is currently in the final stages of writing and editing a Best Practice Manual for validating CO<sub>2</sub> geological storage, arising from the completion of research in the *Weyburn-Midale Project*, and can offer the following points:

- **Seismic activity in context:** As noted in some media coverage of Drs. Zoback's and Gorelick's piece, any oilfield work (whether drilling a well or deploying enhanced oil recovery techniques such as water flooding) has the potential to produce microseismic activity, and in some cases small magnitude earthquakes. The *Weyburn-Midale Project* has used various measurement methods, including underground seismic monitoring and 3 and 4-dimensional seismic imaging, during the characterization of the Weyburn oilfield and the subsequent monitoring of CO<sub>2</sub> in the subsurface. Microseismic events having moment magnitudes of less than -1 have been recorded. This sort of activity is so minute that it is measurable only with the most sensitive equipment deployed deep underground.

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<sup>1</sup> Zoback MD and Gorelick SM, (2012) Earthquake triggering and large-scale geologic storage of carbon dioxide. PNAS 2012 109 (26) 10164-10168; published ahead of print June 18, 2012, doi:10.1073/pnas.1202473109.

- Trapping mechanisms and seismic activity: The theoretical implications of Drs. Zoback's and Gorelick's work suggest seismic activity (earth quakes) associated with large-scale injection of CO<sub>2</sub> may potentially compromise the trapping mechanisms of these reservoirs (caprock). In the case of Weyburn and Midale, this would suggest that the mechanisms which have kept the oil and gas in place in the reservoir (and into which the CO<sub>2</sub> is being injected) may be compromised by either the reactivation of faults or the creation of new ones by such seismic events. In 11 years of research, no such fault reactivation or creation has occurred at Weyburn and the Caprock remains intact – this, despite the industrial scale injection of close to 2.8 million tonnes of new CO<sub>2</sub> per year (more than 5 million tonnes annually if recycled CO<sub>2</sub> is included). Faults are, in many cases in relation to the trapping of oil and gas, actually a desirable geologic structure, and offer increased retention of fluids and gases in the subsurface.
- Cap rock integrity: Cap rocks differ by type, thickness and location in a reservoir. Work prior to injection should provide, and in the case of the Weyburn and Midale fields, has provided characterization that illustrates the resilience of this trapping mechanism.
- Industrial-scale research: The *Weyburn-Midale Project* must be considered an industrial-scale and no longer a demonstration scale project. Total CO<sub>2</sub> in the reservoirs exceeds 21 million tonnes, and the EOR operations themselves have proven that there is economic justification for the capture, transport and storage of CO<sub>2</sub> in depleted oil reservoirs, both for the increased oil production it offers the purchaser of the CO<sub>2</sub> and the cost recovery to the capture company through the sale of CO<sub>2</sub>.

#### **Much Needed Saline Aquifer Research Underway**

- Saline Aquifer Research - Continued research is needed into the feasibility and long term stability of storing CO<sub>2</sub> in saline aquifers in order to reach accurate conclusions on the safe storage of CO<sub>2</sub>. *PTRC's Aquistore Project* expects to make significant contributions to the global CCS knowledge base.
- Ahead of Injection - In their article, Drs. Zoback and Gorelick state that formations suitable for large scale injection of CO<sub>2</sub> must carefully be chosen. Indeed, the front end geological characterization in determining the location is paramount in the future of all potential sequestration sites. This up-front due diligence is expected of such projects and has been a key part of all current storage projects globally. This due diligence will be continued throughout such research projects. The *Aquistore Project* will see CO<sub>2</sub> test injections (with intent for progression to commercial scale) into a reservoir whose characterization is thorough and follows sound scientific principles. The injection well and observation well will also be heavily instrumented, ensuring a comprehensive MMV program.
- GHG Reductions - In their article, Drs. Zoback and Gorelick state that the interest in saline aquifers is for their potential capacity to store enormous volumes of CO<sub>2</sub>. The *Aquistore Project* at commercial scale will be the first to integrate with the carbon capture from a coal fired power plant.

In most respects, the opinions expressed by Drs. Zoback and Gorelick – about the importance of selecting safe sequestrations sites and the use of seismic and monitoring methods to assure the safety of such sites – have been anticipated and carried out by the *Weyburn-Midale Project*. None of the anticipated potential problems, however, have been observed. The *Aquistore Project* will follow the same rigorous research.

We encourage all stakeholders – scientific, industrial, and the general public – to come to understand the science involved with Carbon Capture and Storage and to subject the extensive scientific work to a reasoned not alarmist debate. As noted above, the science work has been proactive, not reactive as could be understood from many recent news articles emanating from the opinion paper of Drs. Zoback and Gorelick. The PTRC hopes the upcoming publication of the Best Practice Manual from Weyburn, this fall, will lead to effective development of CCS as an important tool in the fight against climate change.

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Based in Regina Saskatchewan Canada, the Petroleum Technology Research Centre (PTRC) is a not-for-profit corporation whose primary focus is on research of sustainable development technologies for the petroleum industry. The PTRC is a world leader in the study of the geological storage of carbon dioxide through management of the *IEA GHG Weyburn-Midale CO<sub>2</sub> Monitoring and Storage Project* and its new project based in Estevan Saskatchewan, *Aquistore*. Visit [www.ptrc.ca](http://www.ptrc.ca) and [www.aquistore.ca](http://www.aquistore.ca).

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