# Advances in the Geological Storage of Carbon Dioxide

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**Series II: Mathematics, Physics and Chemistry – Vol. 65**

# Advances in the Geological Storage of Carbon Dioxide

## International Approaches to Reduce Anthropogenic Greenhouse Gas Emissions

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# Preface

As is now generally accepted mankind's burning of fossil fuels has resulted in the mass transfer of greenhouse gases to the atmosphere, a modification of the delicately-balanced global carbon cycle, and a measurable change in world-wide temperatures and climate. Although not the most powerful greenhouse gas, carbon dioxide ($CO_2$) drives climate change due to the enormous volumes of this gas pumped into the atmosphere every day. Produced in almost equal parts by the transportation, industrial and energy-generating sectors, atmospheric $CO_2$ concentrations have increased by about 50% over the last 300 years, and according to some sources are predicted to increase by up to 200% over pre-industrial levels during the next 100 years. If we are to reverse this trend, in order to prevent significant environmental change in the future, action must be taken immediately. While reduced use of fossil fuels (through conservation, increased efficiency and expanded use of renewable energy sources) must be our ultimate goal, short to medium term solutions are needed which can make an impact today.

Various types of $CO_2$ storage techniques have been proposed to fill this need, with the injection of this gas into deep geological reservoirs being one of the most promising. For example this approach has the potential to become a closed loop system, whereby underground energy resources are brought to surface, their energy extracted (via burning or hydrogen extraction), and the resulting by-products returned to the subsurface. In fact the re-injection of waste $CO_2$ even has the potential to recover energy reserves that would otherwise be trapped forever, such as is seen in $CO_2$ Enhanced Oil, Gas or Coal Bed Methane Recovery, while at the same time isolating the $CO_2$ deep underground.

The present volume organises contributions given at a NATO Advanced Research Workshop entitled "*Advances in $CO_2$ Geological Sequestration in Eastern and Western European Countries*", held in Tomsk, Russia from November 15-18, 2004. This workshop was a unique opportunity for researchers from all over the world to share experiences and to describe innovative approaches to this highly promising environmental technology. The book is divided into 5 parts. Part 1 provides a background for the discussion by describing various examples of how human activities are modifying the atmosphere in industrially-active areas in Siberia. Part 2 outlines the innovative idea of using deep permafrost layers as either an impermeable boundary, below which $CO_2$ could be injected, or as a cooling source for the formation $CO_2$ clathrates. Part 3 gives numerous examples of recent studies conducted on naturally-occurring sealed or leaking $CO_2$ reservoirs, sites which have the potential to help us understand what geological characteristics can result in the long-term isolation of $CO_2$, what are the effects on the ecosystem should $CO_2$ leak to surface, and what are the most promising technologies for the monitoring of an engineered $CO_2$ geological storage site. Part 4, which outlines various industrial-scale applications of $CO_2$ geological storage, shows that this approach is technically practical, economically feasible and, to date, is very safe. Finally Part 5 gives us a view of the future, showing how energy uses are predicted to change in the future, how the public must be involved in any future decisions regarding climate change abatement and how Europe has decided to move forward in its research on geological storage of $CO_2$.

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