Characterization of sites for geological storage of carbon dioxide

Stefan Bachu and Matthias Grobe

Interpretation of the temperature record on a scale of centuries to millennia indicates a slight increase in global average annual temperatures in the last 100–150 yr, in the order of 0.4–0.6°C (IPCC, 2001), with 2005 being the warmest year on record. The melting and retreat of polar ice caps and mountain glaciers corroborate this increase. Some severe weather effects around the globe, such as hurricanes and droughts, are attributed by some to global warming, and predictions are that humankind is facing significant climate change by the end of this century as a result of continuing warming forecasted to be in the order of 2–5°C (IPCC, 2001). The climatic changes anticipated during the next few hundred years are well within the range experienced during the Pleistocene, and the rates of change projected for the next 100 yr are no more rapid than those experienced on half-century scales (Jenkins, 2001). Although current data indicate a trend of change that is severe, it is probably no greater in rate and magnitude than many changes that have occurred in Earth’s past (Bluemle et al., 2001).

It is generally but not unanimously accepted that the main cause of the observed global warming is the increase in atmospheric concentrations of greenhouse gases, such as carbon dioxide (CO₂) and methane (CH₄). This increase, observed since the beginning of the industrial revolution at the middle of the 19th century, is caused by human activity in land use (agriculture and deforestation) and an ever-increasing consumption of fossil energy resources. Of all the greenhouse gases, CO₂, whose atmospheric concentrations have risen from preindustrial levels of 280 to 360 ppm, is responsible for about two thirds of the enhanced greenhouse effect (Bryant, 1997). The relationship between CO₂ emissions (expressed by the amount of carbon C), economic growth (expressed by the gross domestic product, GDP), and energy production (E) is best illustrated by Kaya’s (1995) identity:

$$C = \text{GDP} \times \left( \frac{E}{\text{GDP}} \right) \times \left( \frac{C}{E} \right)$$  \hspace{1cm} (1)

In the above expression, (E/GDP) is the energy intensity of the economy, and (C/E) is the carbon intensity of the energy system.