Geophysical Research Abstracts
Vol. 12, EGU2010-3188-1, 2010
EGU General Assembly 2010

Experimental evidence for effects of stress on the CO_2 sorption capacity of coal under conditions relevant to ECBM

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Enhanced Coalbed Methane production (ECBM) involves the injection of CO_2 to desorb CH_4 from coal seams, while trapping CO_2 as a preferentially adsorbed phase. Successful ECBM relies on a clear understanding of coal-CO_2 interaction processes under the relevant subsurface conditions. Though adsorption of CO_2 by coal has been extensively studied in experiments, few systematic studies have been done on the effects of stress state on CO_2 sorption by coal. We have directly investigated the effects of stress on CO_2 adsorption by coal matrix material. To do this, we performed experiments in a one-dimensional oedometer-type compaction cell, using granular (crushed and sieved) coal matrix material. The loose, granular material was first equilibrated with CO_2 at pressures of 10.0-20.0 MPa and at a temperature of 40°C. The samples were then compacted at 40.0 MPa. After unloading and re-equilibration with respect to CO_2, the samples were re-loaded in a stepwise manner to axial stresses up to 35.0 MPa. Changes in the volume of CO_2 present in the sample during this stepping procedure were measured using a syringe pump. Our data show that stress reduces the adsorption capacity of the coal matrix for CO_2 by up to 20-50% under the conditions investigated. We explain our observations in terms of an effect of the external applied effective stress upon the free energy of adsorption in the nanoscale pores of the coal matrix. As reservoir models currently do not consider the role of overburden and horizontal stresses on the adsorption capacity in the coal seams, the effects of stress observed here may have important implications for predictions of the in situ CO_2 storage capacity of deep coal formations.

Acknowledgements
The authors acknowledge Shell International for funding the research presented in this paper (Contract No. 4600003671). Rick Wentinck, Niels van Wageningen and Claus Otto are thanked for their support and valuable suggestions during the course of this study. Eimert de Graaff, Gert Kastelein and Peter van Krieken are thanked for their technical support.