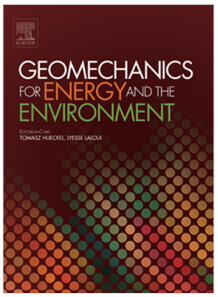
Accepted Manuscript



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PII: S2352-3808(17)30070-9
DOI: https://doi.org/10.1016/j.gete.2018.05.002
Reference: GETE 88

To appear in: *Geomechanics for Energy and the Environment*

Received date : 7 August 2017
Revised date : 24 April 2018
Accepted date : 24 May 2018

Please cite this article as: Liu J., Fokker P.A., Peach C.J., et al., Applied stress reduces swelling of coal induced by adsorption of water, *Geomechanics for Energy and the Environment* (2018), https://doi.org/10.1016/j.gete.2018.05.002

Applied stress reduces swelling of coal induced by adsorption of water

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Abstract

This paper investigates whether or not applied stress reduces swelling of coal upon water adsorption, and, if so, what mechanisms are responsible. With this aim, thermodynamic models were developed addressing the effect of a general applied stress on water adsorption capacity and associated swelling behaviour of coal matrix material, assuming monolayer, multilayer and mixed mono/multilayer adsorption mechanisms. These all predict applied stress reduces water adsorption capacity and hence swelling. Experiments were performed on both a solid disc and on pre-compacted powders of Brzeszcze high volatile bituminous coal at a constant temperature (40˚C), using a uniaxial compaction apparatus. The mechanical response of the samples to stepwise axial loading was determined under both evacuated and water-exposed conditions. The evacuated samples showed reversible, elastic behaviour. Water-exposed samples exhibited elastic deformation, time-dependent reversible deformation, plus plastic strains with time-dependent processes. Axial swelling strains upon introduction of distilled water at a constant fluid pressure (0.1 MPa) were also measured for samples subjected to fixed axial stresses (25-100 MPa). The results demonstrated the applied stress reduces swelling upon water adsorption. Comparison with predictions made using the three models shows that stress-driven reduction in sorption-induced swelling is caused by the combined effects of a) permanent time-dependent (compressive) deformation (creep), b) the thermodynamic effect of a stress-driven reduction in water sorption capacity and c) stress-driven closure of transport paths within the coal matrix. Nonetheless, our results show the above effects of stress on the swelling response of (Brzeszcze) high volatile bituminous coal to water are minor at typical in-situ stresses (10-30 MPa). This