FUNDAMENTAL STUDIES OF CO_2-COAL INTERACTIONS USING NEUTRON SCATTERING AT CONDITIONS RELEVANT TO SUBSURFACE CARBON SEQUESTRATION

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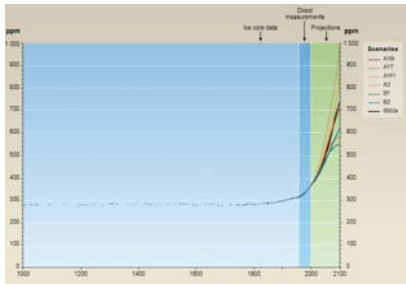
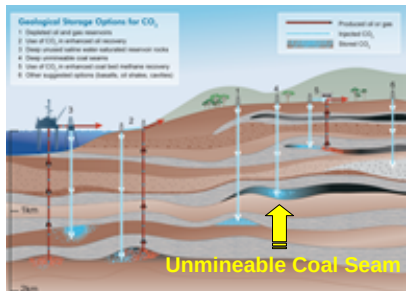
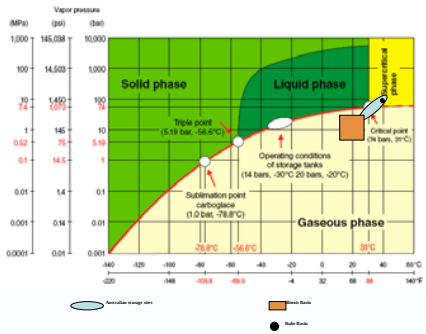
GREEN HOUSE GASES (CO_2) LEAD TO GLOBAL WARMING AND BY THE END OF THE 21st CENTURY CONCENTRATION OF CO_2 MAY REACH FACTOR OF 2 TO 3 THAT OF PREINDUSTRIAL TIMES



CARBON CAPTURE AND STORAGE IN UNMINABLE COAL SEAMS IS IMPORTANT COMPONENT OF A PORTFOLIO OF CO_2 MITIGATION MEASURES



PHASE STATE OF CO_2 DEPENDS ON THE DEPTH: IN SHALLOW SEAMS CO_2 IS GAS, 800 M BELOW THE SEA LEVEL CO_2 IS SUPERCRITICAL FLUID



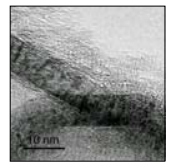
PROBLEM: FIELD STUDIES REVEALED UNEXPECTED CHANGES IN MIGRATION RATES AND SORPTION CAPACITY FOR CO_2 IN DIFFERENT COAL SEAMS

NEEDS: ACHIEVE FUNDAMENTAL UNDERSTANDING OF FLUID-INDUCED STRUCTURE MODIFICATION AND PHASE BEHAVIOR OF THE SUB- AND SUPERCRITICAL CO_2 IN POROUS COALS

SOLUTION: APPLY SANS FOR *IN SITU* CHARACTERIZATION OF THE STRUCTURE AND SORPTION CAPACITY OF COAL AT CONDITIONS SIMILAR TO THOSE IN DEEP COAL SEAMS

COAL IS CHARACTERIZED BY COMPLEX FRACTAL IERARCHY OF PORE. INFORMATION ON ADSORPTION IIN MICROMETER PORES IS PROVIDED BY USANS

µm SCALE



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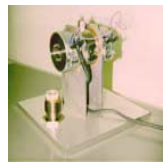

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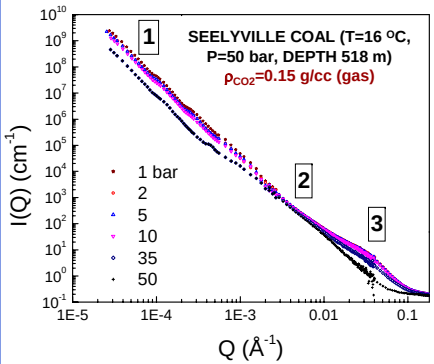
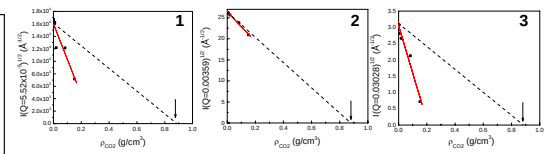
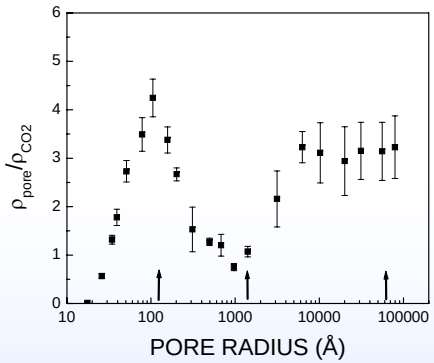




TWO-PHASE APPROXIMATION

$$I(Q) \sim \left(C_1\rho_{SiO2} - C_2\rho_{CO2}\right)^2$$

$$\sqrt{I(Q)} \sim \rho_{CO2}$$



THREE-PHASE APPROXIMATION [1,2]

$$I(Q) \sim \kappa_n = (\rho_1^* - \rho_3^*)^2\phi_1(1-\phi_1) + (\rho_2^* - \rho_3^*)^2\phi_2(1-\phi_2) - 2(\rho_1^* - \rho_3^*)(\rho_2^* - \rho_3^*)\phi_1\phi_2$$

IN SEELYVILLE SEAM (T=16 °C, DEPTH 518 m) 40% OF MICROPORES AND 90% OF NANOPORES ARE FILLED WITH ADSORBED CO_2, WITH THE DENSITY 3-4 HIGHER THAN THE EXPECTED DENSITY (ρ_{CO2}=0.15 g/cc) [3]

- COAL STRUCTURE REMAINS ESSENTIALLY UNCHANGED AFTER EXPOSURE TO CO_2 UP TO 200 BAR.
- SANS DATA DEMONSTRATE SIGNIFICANT FLUID DENSIFICATION INSIDE NANO- AND MICROPORES OF SEELYVILLE COAL
- SANS/USANS PROVIDES PORE-SIZE-SPECIFIC INSIGHT IN THE DENSITY AND VOLUME OF THE ADSORBED CO_2

[1] Y. B. Melnichenko et al., Int. J. Thermophys, in press; [2]. A. P. Radlinski et al., Langmuir, in press; [3]. Y. B. Melnichenko et al., Int. J. Coal Geol., in press.