Enhancing the bioavailability of subbituminous coal

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Recent scientific discoveries suggest that much of the coal bed natural gas (CBNG) within the Powder River Basin, located in Wyoming and Montana, was generated by anaerobic microbial systems within the coal seams long after the initial process of coalification. This type of natural gas, referred to as secondary biogenic natural gas, relies on the active biological conversion of coal-derived constituents into methane. Secondary biogenic CBNG can also be found in numerous other coal fields located throughout the world. Interest in secondary biogenic natural gas has grown significantly in recent years with the realization of its vast potential and the significant benefits that this energy source has over fossil fuels.

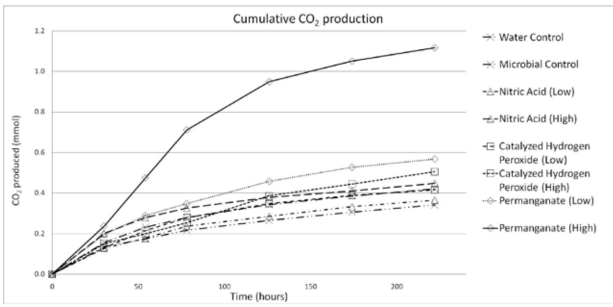

Figure 1: Cumulative CO_2 production.

The aim of this study was to evaluate several conventional groundwater remediation technologies including *in situ* chemical oxidation with permanganate and catalyzed hydrogen peroxide, and acid treatments for enhancing the biodegradability of coal. Although dissolved organic carbon was increased with each method, only the permanganate treatment resulted in a significant increase in coal bioavailability (Figure 1).

Enhanced shelf sediment weathering during glacial periods damps pCO_2 reduction: A negative feedback

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In the past 800 thousand years and before industrialization, the largest variations in atmospheric CO_2 concentration (pCO_2) occurred in connection with the glacial cycles that characterized Earth's climate over this period [1]. The mechanisms responsible for the glacial-interglacial pCO_2 changes have remained unresolved. One curious feature of at least the last four glacial-interglacial cycles is that pCO_2 reached about the same upper limit of 280 ppm during peak interglacial periods and about the same lower limit of 180 ppm during peak glacial periods. Here, we show using a numerical model of earth system [2] that enhanced shelf sediment weathering during glacial sea-level low stand will tend to raise pCO_2 and thus stabilize it from further reduction. This is contrary to the so-called shelf nutrient hypothesis [3], which proposed that increased weathering of nutrients (e.g. phosphate) would enhance the organic carbon pump of the ocean and thus reduce pCO_2. We demonstrate that weathering of exposed continental shelves would in fact raise pCO_2 because not all nutrients from weathering will be utilized by biology but more importantly because the spatial distributions of carbon and phosphate from weathering become decoupled in such a way that carbon is preferentially stored in the upper ocean and phosphate in the deep ocean. An extension of this finding suggests that the preferential dissolution of phosphate in shelf sediments during interglacial high stand would tend to enhance biological production and thus stabilize pCO_2 from further increase. The impact of sea level-driven continental shelf exposure and submersion on CO_2 is therefore a negative feedback that helps explain both the upper and lower limits of pCO_2 over the Pleistocene.

[1] Luthi *et al*. (2008) *Nature* **453**, 379–382. [2] Matsumoto *et al*. (2008) *Geosci. Model Dev*. **1**, 1–15. [3] Broecker (1982) *Prog. Oceanog*. **11**, 151–197.