The sensitivity of *Mytilus* shell microstructure and geochemistry to environmental change

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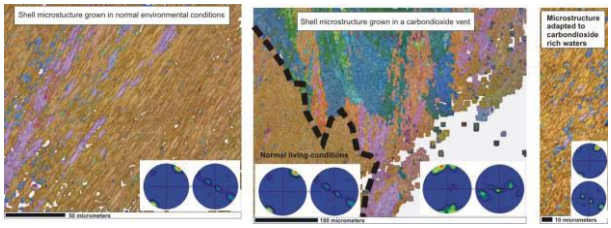
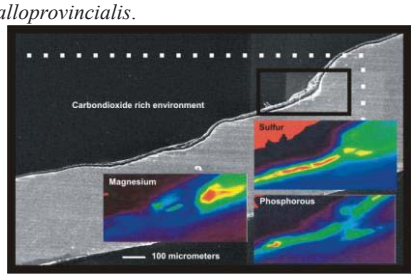
Preservation of biological hard tissues offers unique opportunities for reconstructing environments of formation. Prerequisites for a precise reconstruction are the profound understanding of the studied biological material as well as their ability to record environment derived signatures. Even though bivalves are perfect archives for past environmental change they have not yet been used to interpret ocean acidification events. In a multianalytical approach combining microstructure imaging, crystallographic texture analysis and trace element geochemistry we investigated the microstructural and geochemical responses of *Mytilus galloprovincialis* shells to seawater acidification. Live specimens of *M. galloprovincialis* were transplanted from Ischia harbour (Mediterranean Sea) to nearby CO2 vents and exposed to mean seawater pH of 8.07 (harbor) and 7.25 (vent). The shells recorded the shock of transplantation and environmental change in both, their microstructure, texture (Figure 1), trace element (Figure 2) and carbon and oxygen isotope record [1]. We explore in this paper the potential of three different proxies within the same carbonate archive and test the potential of *Mytilus* to preserve in its shells acidified seawater conditions.



Figures 1. The shock of transplantation from normal to acid environmental conditions recorded in the microstructure and texture of *Mytilus galloprovincialis*.



Figures 2. The transplantation from normal to an acid environment is manifested in the shells ultrastructure and in its major and minor element chemical variation.

[1]. S. Hahn, R. Rodolfo-Metalp2, E. Griesshaber, W. W. Schmahl, D. Buh1, J. M. Hall-Spencer, C. Baggin2, K. T. Fehr, and A. Immenhauser (2012) *Biogeosciences Discuss*. **8**, 10351–10388.

Coal-to-gas: Uncertainty in CH_4 emissions and climate impacts

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Section Heading

Increasing the use of natural gas (NG) for power generation and other industrial purposes is perceived as an part of a portfolio to decarbonize the domestic and global economy. While many studies indicate greenhouse gas (GHG) emissions reductions from NG production and use relative to coal [1], the potential climate benefits remain largely uncertain and depend on three main factors. First, CH_4 emissions from NG production, distribution and use are uncertain, and some estimates eliminate the overall GHG reductions [2]. Second, the combined climate response due to direct and indirect radiative forcing from GHG and aerosol emissions remains to be quantified [3]. Third, the rate of a potential coal-to-gas transition can influence future temperature change trajectories [4], and has not been analyzed in detail.

Our analysis addresses these issues by combining data and models from life cycle assessment (LCA), an emissions accounting tool, and climate science. We determine a reduced range of possible life cycle CH_4 emissions through comparison with atmospheric observations and modeling results from the literature. Methods to generate these top-down estimates include a combination of (a) measuring CH_4 concentrations from a global observation network, (b) employing atmospheric emissions transport models, and (c) measuring CH_4 isotope ratios to distinguish emissions sources [5]. We further establish coal-to-gas transition scenarios based on constraints for resource availability and industry development. A probabilistic climate model is used to translate the emissions distributions and scenarios into temperature change trajectories. The model accounts for uncertainty in the magnitude of aerosol forcing and climate feedbacks, which represent low probability and high impact events [6].

Results and Conclusion

Preliminary results show that CH_4 emissions estimates can be significantly constrained. For example, over a 10-year period the upper bound life cycle CH_4 emissions overestimate observed absolute emissions by 75-100%. In terms of climate impacts, the degree to which lower CO_2 and aerosol emissions from reduced coal combustion compensate for higher CH_4 emissions due to higher NG varies depending on the transition scenario. Work in progress investigates the probability of each scenario to cross the policy relevant 2 degree celsius temperature threshold.

[1] Venkatesh et al. (2011) *Env. Sci. Tech*. **45**, 8182-8189. [2] Howarth et al. (2011) *Climatic Change* **106,** 4, 679-690. [3] Wigley (2011) *Climatic Change* **108,** 3, 601-608. [4] Schwietzke, Griffin, Matthews (2011) *Env. Sci. Tech*. **45**, 8197-8203. [5] Bousquet et al. (2006) *Nature* **443**, 439-443. [6] Goes et al. (2011) *Climatic Change* **109,** 3-4, 719-744.