Modeling ground surface deformation at the TAG hydrothermal field using feedbacks between permeability and poroelastic fluid flow

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Recent measurements of ocean bottom pressure suggest that hydrothermal flow induces mm-scale periodic ground surface displacements (GSD) at the Trans-Atlantic Geotraverse (TAG) hydrothermal field on the Mid-Atlantic Ridge [1]. The pressure measurements contain spectral peaks and harmonics with periods ranging from 22 to 53 min, none of which can be attributed to oceanographic or Earth tide processes. It is hypothesized that GSD cycles in this system may result from a nonlinear feedback between pore pressure and permeability in the hydrothermal system.

To test this hypothesis we have developed a poroelastic convection model representing the upper crustal section at TAG that includes a 'switching' type pressure-permeability feedback in the stockwork zone of the hydrothermal system. In this zone, the permeability increases when the pressure reaches a critical high value, and decreases when it reaches a critical low value. This behavior simulates the opening and closing of cracks within the hydrothermal system, and is similar to mechanisms that have been proposed for dike propagation in magmatic systems [2].

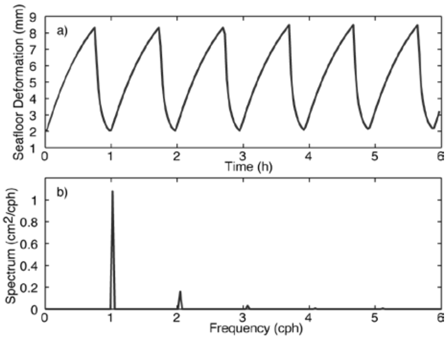

Figure 1: a) Modeled GSD and b) the spectrum of the modeled GSD signal above the TAG hydrothermal field.

Our modeling suggests that this mechanism can generate GSD that are similar to those observed at TAG. We are currently using these models to explore the sensitivity of inflation and deflation rates to system properties such as the geometry of the stockwork zone, the temperature of fluid in the upflow zone, the elastic properties of the lithosphere, and the relationship between pore pressure and permeability.

[1] Sohn *et al.* (2009) *Geophys. Res. Lett.* **36**, L19301.
[2] Buck *et al.* (2006) *J. Geophys. Res.* **111**, B12404.

Biogeochemistry and microbial ecology of a modern, ferruginous chemocline

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Lake Matano, Indonesia has a chemistry and physical structure remarkably similar to that envisaged for the ferruginous oceans, which dominated much of the Archean Eon [1]. Matano is thus garnering special attention as a modern analogue for the ecology of these ancient, Fe-rich oceans. At Matano, a unique combination of geological, climatic and biological features has culminated in a persistently stratified, iron-rich, sulfur-poor, end-member ecosystem. In this presentation, we highlight the physical and chemical aspects of Lake Matano that set it apart from other modern environments and discuss how these features translate to an Fe-centric microbial community. This community comprises novel, low light adapted Chlorobiaceae, pelagic methanogens of the R-10/Fen cluster, pelagic sulfate reducers, and deeply branching Crenarchaeota, among others. In addition to ecology, this talk will discuss the rates and pathways of carbon fixation and decomposition and examine factors, such as nutrient availabilty, which regulate carbon cycling. In light of our observations from Lake Matano, we speculate on ancient ocean productivity and the earliest marine carbon cycle.

[1] S.A. Crowe *et al.* (2008) *PNAS* **105**, 15938–15943.