Extreme magmatic differentiation at Dabbahu Volcano, Afar, Ethiopia

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Dabbahu is a composite volcano at the north end of the Manda-Hararo segment of the Afar Rift, Ethiopia, which has experienced multiple dyking events since 2005. Dabbahu has erupted magmas ranging in composition from mildly alkaline basalt through trachyandesite to peralkaline rhyolites (comendites and pantellerites). Effusive eruptions predominate. On the basis of a new geological map, 93 new whole rock major and trace element data, mineral analyses from 65 samples, and 9 new ^{40}Ar / ^{39}Ar dates we show that Dabbahu has been active for a little over 70,000 yrs. Samples are aphyric or phenocryst-poor with olivine + clinopyroxene + feldpsar present in all rock types; minor Fe-Ti oxides and aenigmatite occur in some more evolved rocks. Continuous variations in whole rock chemistry, mineral compositions, e.g. Fo_{88-0} olivine, and calculated eruption temperatures support earlier findings [1] that the magma types are related through protracted (~90%) fractional crystallisation from a basaltic parent. Field evidence indicates that magmas were not erupted in fractionation sequence. Some magma mixing between cogenetic magmas is observed in intermediate rocks, but was not a primary cause of chemical varaitaion in the suite as a whole.

Geochemical modelling indicates recently erupted transitional basalts from the Manda-Hararo rift constitute plausible parents. MELTS modelling of differentiation provides an optimal match to rock and mineral chemistries with crystallisation at 100-300 MPa pressure and fO_2 ~1 log unit below FMQ buffer to suppress saturation with orthopyroxene, which is not observed in any samples. Melt inclusions from pantelleritic obsidians and pumices contains up to 6 wt% H_2O and ≤500 ppm CO_2, consistent with ~0.5 wt% H_2O in the parent basalt. Volatile saturation pressures are in the range 30-250 MPa, although solubilities in pantelleritic liquids are not well constrained experimentally. The CO_2-H_2O systematics are consistent with cooling-driven crystallisation of small magma batches over a range of depths, probably in a complex of stacked sills.

We propose that differentiation from basalt to rhyolite occurs in sills (or dykes) at relatively shallow depths (5-10 km) beneath the volcano, although some prior differentiation of mantle-derived basalts is likely to have occurred at greater depths. The sub-volcanic plumbing system must be configured in such a way that cogenetic magmas of different composition can be stored separately prior to eruption, rather than in a single large sub-volcanic reservoir. It is likely that the volcanic load facilitated focussing of magmas through a single summit fissure or vent.

[1] Barberi *et al*, 1974, A transitional basalt - pantellerite sequence of fractional crystallisation, the Boina centre, (Afar Rift, Ethiopia). *Jour Petrol*, **16**, 22-56.

Characterization of Microbial Communities Associated with Powder River Basin Coals, United States

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Introduction. A better understanding of the ecology and physiology of the methane-producing communities associated with coal-beds may promote new techniques that can improve coal-bed methane (CBM) production and enhance the sustainability of the wells. We have conducted initial phylogenetic diversity studies using inoculated coal and *in situ* samples from methane-producing wells in the Powder River Basin (PRB) (southeastern Montana and northeastern Wyoming). Advances in subsurface sampling and molecular techniques have provided a route to capture active microbial consortia from coal beds, but methods need to be refined in order to deal with the unique attributes of coal. We used coal-filled Diffusive Microbial Samplers (DMS) that were lowered into three wells in the PRB along a hydrogeochemical gradient and microbial communities were allowed to develop *in situ*.

Results and Conclusion. Coal slurry associated with the DMS had 100-fold more microbial cells as determined via epifluorescent direct counts. Coal slurry was immediately removed from the DMS in the field and fixed for FISH analysis. *Archaea* and *Bacteria* were detected and bacteria appeared to outnumber archaea within the *in situ* sample. Microorganisms appeared to be concentrated in the proximity of coal particles, and aggregates around coal particles contained both *Bacteria* and *Archaea*. Incubated materials from the DMS were used to inoculate enrichment cultures for the assessment of methane-production under different conditions, and archaeal diversity was low based upon both SSU rRNA and *mcr*A gene sequences. Sequences indicative of both hydrogentrophic and acetoclastic methanogens were detected. In addition, a coal-only enrichment contained higher bacterial diversity than an acetate-amended enrichment, and sequences indicative of presumptive fermenters and acetogens were observed. Nucleic acids were extracted from *in situ* material (DMS-coal and well-water), and 454 pyrosequencing libraries were used to characterize community composition and structure of *in situ* materials. Multivariate statistical methods were used to relate community composition and structure to hydrogeochemical parameters. The low sulfate well had low bacterial diversity compared to a well with intermediate sulfate levels while the archaeal diversity was higher in the low sulfate well compared to wells with higher sulfate levels. The described study aims to identify the relationships between populations of bacteria and archaea associated with CBM with the intent of identifying strategies for enhancement of *in situ* CBM production in terms of microbial structure-function relationships.