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► To cite this version:

A Akerman, S Audry, J Riotte, S Muddu, P Oliva, et al.. Contribution of forest fire ashes to weathering fluxes in the Moole Hole experimental watershed (South India). Goldschmidt Conference, 2008, Vancouver, Canada. hal-03170281

HAL Id: hal-03170281

<https://hal.univ-lorraine.fr/hal-03170281>

Submitted on 17 Mar 2021

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Contribution of forest fire ashes to weathering fluxes in the Moole Hole experimental watershed (South India)

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The Moole Hole experimental watershed (4.3 km²; South India) is located near the Western Ghâts within a climatic transition zone (1100 mm/y rainfall). The chemical fluxes exported to the outlet through flash floods are strongly influenced by the variability of the SW monsoon intensity and occasionally by dissolution of ashes from forest fires, like in 2004. The aim of the present work was to quantify the chemical fluxes originating from ashes at the stream outlet and their temporal evolution. For this, we characterised the chemical signatures of the local ashes and their temporal evolution by using an experimental approach (420-min batch dissolution). Then, the quantification was performed by an inverse modelling.

Results from batch dissolution experiments performed on both plant ashes retrieved from the watershed (PA) and from specific ashes of *Terminalia crenulata*, *Dyospiros sp.*, *Tectona grandis* and *Pennisetum purpureum* show high and variable dissolution rates of Si and cations (Ca, Mg, K), e.g., 2.6 10⁻³ molCa/g/day and 1.0 10⁻³ molSi/g/day for PA. Constant rates of Ca and Si dissolution were observed for PA while, for the specific ashes, Si dissolution rates decrease up to two orders of magnitude (*Dyospiros sp.*) from the beginning to the end of the experiments. However, these dissolution rates are several order of magnitude higher than those of soil minerals, confirming the extreme reactivity of the ash compartment. Between the beginning and the end of the experiments, the Si/Ca ratio in the PA leachate increases by one order of magnitude. This evolution is consistent with a rapid dissolution of cation-based salts together with a relatively slow dissolution of amorphous silica. Based on these results, the contribution of ashes dissolution to the stream fluxes was calculated by inverse modeling. Significant contribution was found for K, Ca and Mg on hourly timescales, i.e. during the two first flash floods of the rainy season (April-May), and on daily-monthly timescales for Si, i.e. till the middle of the rainy season (August).

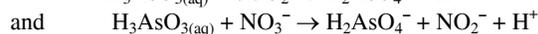
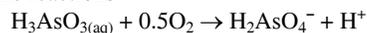
Chemolithotrophic energy and Archaeal communities in arsenic-rich, shallow-sea hydrothermal sediments of Papua New Guinea

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The hydrothermally-influenced sediments of Tutum Bay, Ambitle Island, Papua New Guinea, are ideal for investigating the chemolithotrophic activities of microbes involved in arsenic-cycling because hydrothermal vents in the bay expel fluids with As^{III} arsenite concentrations as high as 950 µg/L [1]. These hot (~98°C), slightly acidic (pH ~6), chemically reduced shallow-sea vent fluids mix with cooler, oxidized seawater to create steep gradients in temperature, pH, and As-, N-, Fe-, and S-redox species concentrations.

We collected porewaters at 11 sites along a 300m sampling transect, analyzed their geochemistry and combined these data with standard Gibbs energies to evaluate energy yields of 19 potential chemolithotrophic metabolic reactions. Both of the reactions



were exergonic at all sites, the former yielding between 69 and 84 kJ/mol e⁻ and the latter yielding 16 to 23 kJ/mol e⁻. Both reactions represent potential metabolic strategies for Tutum Bay microbes. A number of Bacteria are known to catalyze As^{III} oxidation reactions using O₂ or NO₃⁻ as terminal electron acceptors, but no Archaea are presently known to gain energy from arsenite oxidation.

To investigate the role of Archaea in the Tutum Bay system, we constructed Archaeal 16S clone libraries from bulk DNA extracted from sediment samples at sites 7.5, 30, 60, 140, and 300m along the transect. Phylogenetic analyses revealed all sites were dominated (39-90%) by 1 phylotype of uncultured Crenarchaeota, except for the 30m site where ~50% of the community consisted of 1 phylotype of uncultured Euryarchaeota. Euryarchaeota were present at the 2 sites closest to the vent; Korarchaeota were present at only the 140m site, which also contained clones similar to *Nitrosopumilus maritimus*, the first chemolithoautotrophic nitrifying archaeon [2]. The 7.5 and 140m sites, which had the highest As concentrations, showed the most diversity with 8 phylotypes of Archaea, and the 60m site was the least diverse, with only 3 phylotypes of uncultured Crenarchaeota.

[1] Price *et al.* (2007) *Appl. Geochem.* **22**, 2595–2605.

[2] Könneke *et al.* (2005) *Nature* **437**, 543-546.