

Spring residence times: Role in weathering rates

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Estimation of plagioclase (Pl) weathering rates ($W_{Pl} = ([Pl]/t) \times (Q/A_{Pl})$) at the watershed scale of springs requires the prior evaluation of a number of parameters which include the mole fractions of Pl ($[Pl]$) and their fracture surface areas (A_{Pl}), the residence times of springs (t) and their annual discharge (Q). An attempt to relate the weathering of plagioclase to mixtures rich in halloysite and to quantify the W_{Pl} for a number of very small spring watersheds from the Vila Pouca de Aguiar region (VPA, North of Portugal) is documented in [1]. In this paper we take a step further by focusing our attention on adjusting the previously used advective flow equation and introducing hydraulic turnovers for the assessment of t . Now, the advective flow equation ($t = (n_e/K)(F^2/D_h)$) replaces the average watershed depth (D) by the average depth of the saturated aquifer (D_h), whereas hydraulic turnovers assign $t = V_h n_e / Q$. V_h is the saturated volume of the aquifer characterized by an effective porosity n_e and a hydraulic conductivity K , and F is the average lateral path from the recharge area to the spring site.

The evaluation of n_e , K , F and Q has been addressed by [1]. The D_h of the VPA springs could be related to their isotopic composition ($^{87}\text{Sr}/^{86}\text{Sr}$) and to annual precipitation (P): $D_h = [(^{87}\text{Sr}/^{86}\text{Sr})_{\text{spring}} - (^{87}\text{Sr}/^{86}\text{Sr})_{\text{rain}}] / (5.62 \times 10^{-7} P - 4.66 \times 10^{-4})$. The corresponding V_h 's were determined from the total watershed volumes (V) as calculated by a terrain modeling software: $V_h = V \times (D_h/D)$.

The plagioclase log rates (Figure 1) are: -12.4 ± 1.8 (adjusted flow equation) and -13.5 ± 1.1 (turnover times). Relative to the former results, there is a decrease in the average log rates, by 0.2 in the first case and 1.4 in the second case.

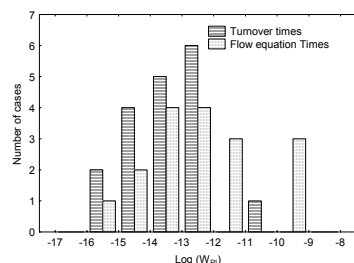


Figure 1: Log rates of plagioclase.

[1] Pacheco F.A.L., Van der Weijden C.H. (2008). *Geochimica et Cosmochimica Acta*, v. 72, no. 17, Page A715.

Methane oxidation rates by AMS

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In the marine environment methane (CH_4) oxidation consumes up to 84% of the CH_4 produced and mitigates the release of CH_4 , a potent green house gas, to the atmosphere [1]. The microbially mediated process is an important sink in the global CH_4 budget, yet it remains poorly quantified because only a small number of direct oxidation rate measurements are available.

Traditional oxidation rate measurements use regulated levels of radiotracers (^{14}C - and ^3H - CH_4) in conjunction with scintillation counting and come with certain limitations: safety and contamination factors restrict the measurements to isotope vans, and radioisotope use may not be permitted in foreign venues and may complicate shipping.

We have developed a rate measurement that utilizes non-regulated levels of ^{14}C - CH_4 tracer ($<50\text{nCi/g}$) [2] in conjunction with accelerator mass spectrometry (AMS). The high sensitivity of AMS allows for a 10^3 reduction in tracer activity which relaxes complications with tracer shipping, handling and waste disposal. Together with ease of performance, this method could provide a larger sample throughput and therefore a better quantification of the marine CH_4 oxidation sink. Further, it allows for easy quantification of the fraction of CH_4 taken up in microbial biomass as well as the fraction oxidized, thereby providing important information about the activity of methanotrophs in the ocean.

Our rate measurements compared to ^3H - CH_4 rate measurements on water from the same Niskin bottles are generally consistent. The two measurements are similar when ambient rates are high, but diverge when rates are low.

[1] Reeburgh (2007) *Chem. Rev.* **107**, 486-513. [2] Vogel (2000) *Nucl. Instrum. Methods Phys. Res. B* **172**, 885-891.