Microbial survival mechanisms in the cold subsurface

PIERRE AMATO*, SHAWN DOYLE AND BRENT CHRISTNER

Department of Biological Sciences, Louisiana State Univ., LA 70803 Baton Rouge, USA (*correspondence: pierre.amato@avignon.inra.fr) (sdoyle2@lsu.edu, xner@lsu.edu)

Viable micro-organisms have been recovered from ancient permanently frozen environments (i.e, ice sheets and permafrost) that have been isolated from the Earth's surface for millions of years. Macromolecular components of the cell (e.g., DNA) would be expected to incure damage over extended periods of frozen dormancy, and the question remains wheter it is possible for microorganisms to repair under these extreme conditions. Using cryomicroscopy, we observed that cells are partitioned into liquid-filled veins along ice crystal junctions [1]. Within this highly saline microenvironnment, bacteria and yeast isolated from permafrost and glacial ice are capable of synthetizing up to 370 proteins and 4.5 % of their total DNA length per year and per cell under laboratory conditions at -15°C (Fig. 1). Ability of microbes to remain active in frozen matrices opens the possibility that cells may repair macromolecular damage as it occurs and before a lethal threshold is achieved. Measurements of background ionizing radiation were used to estimate the inferred increase in cell longevity if populations were metabolically active under frozen conditions. Our data and related calculations imply that microbial survival and longevity would only be limited by nutrient availability in a frozen subsurface if cells remain metabolically active.

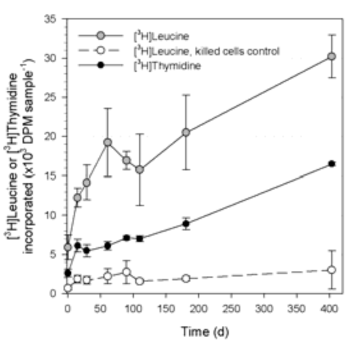

Figure 1: Incorporation of [3H]leucine and [3H]thymidine by frozen suspensions of *Psychrobacter cryohalolentis* K5 at -15°C ($2.0 \pm 0.9 \times 10^6$ cells mL^{-1} in 0.1 mM M9 mineral medium (solid lines) or in 5% TCA (controls, dashed line)).

[1] Amato *et al.* (2008) *Environ. Microbiol.*, doi:10.1111/ j.1462-2920.2008.01829.x.

Modeling large scale geogenic contamination of groundwater, combining geochemical expertise and statistical techniques

M. AMINI[1]*, C.A. JOHNSON[1], K.C. ABBASPOUR[1], K. MUELLER[1], M. BERG[1], W. LENNY[2] AND S.J. HUG[1]

[1]Eawag, Ueberlandstrasse 133, CH-8600 Duebendorf, Switzerland (*correspondence: manouchehr.amini@eawag.ch)
[2]University of Grenoble, 38041 Grenoble, France

Consumption of groundwater with high arsenic or fluoride concentrations poses a health threat to millions of people around the world [1-3]. In this study we used a large database of georeferenced arsenic (20,000) and fluoride (60,000) measurements in groundwaters from around the world as well as a global multi-layer GIS database including soil, geology and climate to model probability of arsenic and fluoride concentrations exceeding their respective WHO thresholds. A knowledge-based statistical procedure was developed and used to combine the available data and expert knowledge to delineate regions with similar geochemical properties. Arsenic and fluoride concentrations were then modeled in each region using adaptive neuro-fuzzy inferencing system followed by Latin hypercube sampling for uncertainty propagation to produce probability maps. Using some proxy surface information, the models explained between 30 to 70% of fluoride variation in different regions [3]. While for arsenic the developed models explained around 60% of variation [2]. The global arsenic and fluoride models could benefit from more accurate geological information and further information regarding chemistry and physics of the aquifers. The probability maps based on the above models correspond well with the known contaminated regions around the world and delineate new, untested areas that have a high probability of fluoride or arsenic contamination. Although the probability map does not replace fluoride testing, it gives a first indication of a possible contamination and thus may support the planning process of new drinking water projects.

[1] Winkel *et al.* (2008) *Nature Geosci*. **1**, 536-542. [2] Amini *et al.* (2008a) *Eviron. Sci. Technol*. **42**, 3669–3675. [3] Amini *et al.* (2008b) *Eviron. Sci. Technol.* **42**, 3662–3668.