The biogeochemistry and ecology of deep sediment-buried basement biosphere: Juan de Fuca Ridge Flanks

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Our Deep Biosphere project is designed to exploit the unprecedented opportunities provided by new generation long-term borehole-CORK observatories installed on the flanks of the Juan de Fuca Ridge (JdFR) by the IODP, to study the microbial geochemistry and ecology of the sediment-buried ocean basement. We describe the new CORK's attributes with respect to deep biosphere studies, and supporting instrumentation sleds and associated equipment. Our GeoMICROBE sled allows for '*in situ*' (i.e., seafloor) geochemical analyses (e.g., electrochemistry: O_2, H_2O_2, HS^-, S(0), S^{2-}, $S_2O_3^{2-}$, $S_4O_6^{2-}$, Fe(II), Fe(III), FeS_{aq}, Mn(II), and Zn(II)) of the 30-65°C fluids circulating within the basement, as well as the *in situ* filtration of fluids for molecular biology, culture, biomass and geochemical procedures. Preliminary results of our August '08 cruise to the JdFR flank CORKs indicate that basement fluids there have elevated NH_4^+, CH_4 and H_2, reduced SO_4 and DOC relative to deep ocean water. Basement fluids from nearby (<1 km) boreholes showed distinct geochemical differences (e.g., Borehole 1301A: ~40 uM free sulfide, ~100 uM Fe^{2+}, trace of FeSaq clusters; Borehole 1026B: <1 uM free sulfide, detectable Fe^{2+} but no detectable FeSaq clusters). Differences between *in situ* e^--chem and subsequent ship-board analyses illustrate changes in speciation and oxidation states that occur between sample collection and delayed (few hours) analyses. Future access to multiple depth horizons within basement should help to elucidate relative contributions of *in situ* microbial activity vs diffusion across sediment-basement interface. Analysis of community structure is underway using environmental genomic DNA successfully extracted from 1301A basement fluids. Cell counts in 1301A basement fluids were $\sim10^5$ cells/ml. Results of volatile dissolved organics (e.g., amino acids and LMW organic acids) will also be reported.

Spatial distribution of soil erosion in southwestern France watersheds—Modelling sediment transport by interpretation of rating curves

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Suspended Particulate Matter (SPM) transport in rivers reflects soil erosion processes and controls fluxes of many contaminants. This study is based on water discharges (Q) and SPM concentrations of 15 contrasting watersheds of the Adour-Garonne River systems obtained by our high temporal resolution observation network (> 1 sample per day during 3-18 years covering different hydrological situations). Spatial analyses of soil erosion risk were performed with an expert system based on the RUSLE equation and from land cover, soil and climatology databases, DEM managed by a GIS (ArcView®, IDRISI®). The range of sediment yields (5-180 $t.km^{-2}.yr^{-1}$) reveals high spatial variability of erosion, mainly attributed to key factors such as lithology, runoff and human disturbance (e.g. agriculture, dam trapping). We propose alternative approaches using statistical relations in order to develop models for SPM flux estimates as final recourse in case of an inappropriate sampling frequency. The latter may induce inacceptable errors in flux estimates as demonstrated by numerical simulation for different watershed typologies [1]. Rating curves relate SPM concentration to Q, with Q measurement data as the independent variable. Comparisons of actual and rating curve-predicted SPM concentrations show that the use of common rating-curves partially suffers from data scattering around the regression line and often underestimates annual flux. Therefore, we have developed truncated regressions based on log-transformed-SPM and -Q values for each watershed for data representing Q values superior to 1.5 times the mean annual Q (Q_m), where $SPM_\#$ data represent y-intercept:

$$[SPM] = [SPM_\#] \times \left(\frac{Q}{1.5Q_m}\right)^{\alpha}$$

The regression coefficients, $SPM_\#$ and α, are respectively attributed to lithology and soil erosion sensitivity index. The use of watershed properties allows estimating annual SPM flux and the deviation from modelling values can be used to evaluate human disturbances (e.g dam trapping).

[1] Coynel *et al.* (2004) *Sci. Tot. Envir*. **330**, 233-247.