Geochemical characteristics and microbial community composition of toxic metal-rich sediments contaminated from mine tailings

MAN JAE KWON[1], BAKNOON HAM[1], YUNHO HWANG[1], JAEYOUNG CHOI[1], MAXIM BOYANOV[2], KEN KEMNER[2], EDWARD O'LOUGHLIN[2] AND JUNG-SEOK YANG[1]

[1]Korea Institute of Science and Technology (KIST) – Gangneung Institute, Gangneung 210-340 S. Korea, mkwon@kist.re.kr

[2]Biosciences Division, Argonne National Laboratory, Lemont, IL 60439 USA

The effects of extreme geochemical conditions on microbial community composition were investigated using two distinct sets of sediment samples collected near weathered mine tailings from the Songcheon Au-Ag mine, Korea. One set (SCH) was gray-colored and showed extraordinary geochemical characteristics: As (6.7-11.5%), Pb (1.5-2.1%), Zn (0.1-0.2%), and pH (3.1-3.5). The other set (SCL) was brown-colored and had As (0.3-1.2%), Pb (0.02-0.22%), and Zn (0.01-0.02%) at pH of 2.5-3.1. Terminal Restriction Fragment Length Polymorphism revealed that the bacteiral communities in SCL were more diverse than those in SCH. The clones identified in SCL were closely related to acidophilic bacteria within the genus of *Acidobacterium* (18%), *Acidomicrobineae* (14%), and *Leptospirillum* (10%). Most clones in SCH were closely related to *Methylobacterium* (79%) and *Ralstonia* (19%), both of which are well-known metal-resistant bacteria. The archaeal community in SCL was relatively simple: *Thermogymnomonas* (32%) and unclassified Euryachaeota (48%). No archaeal community was detected in SCH sediments. Although total As was extremely high, over 95% of it was in the form of scorodite ($FeAsO_4{\cdot}2H_2O$), as confirmed by XAFS analysis. Water-soluble As was only ~208 and ~0.06 ppm in SCH and SCL, respectively, which is not known to be toxic to bacteria; As(V) as much as 1000-1300 ppm did not influence bacterial growth. Because As was present in an oxidized and stable form it is likely that other metals released from the sediment were responsible for the differences in microbial community structure (e.g., water soluble Zn was ~234 and ~6.8 ppm in SCH ad SCL, repectively).

Titanite Geochronology by LA-ICPMS: Advantages and Future Objectives

ANDREW R.C. KYLANDER-CLARK, BRADLEY R. HACKER, PAUL R. RENNE AND MICHAEL A. STEARNS[123]

[1]University of California, Santa Barbara, 93106-9630

[2]Berkeley Geochron Center, Berkeley, CA 94709

*correspondence: kylander@geol.ucsb.edu

Titanite has been dated by U/Pb TIMS for many years, but the application of this technique has been tempered by the recognition that titanite in single samples can yield a range of dates, and moreover, titanite dating by TIMS relies on either time/cost-intensive analysis of multiple titanite fractions, or on Pb measurement of an assumed-coeval low-U/Pb phase, such as feldspar, to establish an isochron. One of the great strengths of LA-ICPMS dating is rapid throughput; by analyzing many spots with differing concentrations of common Pb, isochrons can be established from titanite analyses alone, in a fraction of the time it takes for a single TIMS analysis. Furthermore, measuring composition at the same time—in this case laser ablation split-stream ICP petrochronology (LASS)—allows one to discriminate among titanite populations.

Here, we present two examples of the strength of the LASS technique on titanite: 1) grains from the Western Gneiss Region in Norway that (re)crystallized during exhumation, and 2) those from volcanic tuffs at/near the Cretaceous–Tertiary boundary. Both cases yield dates equivalent to those produced by conventional techniques. For the Norwegian samples, younger grains contain elevated Al, Ce/Ce*, and Eu/Eu* and depleted Fe,Ta,Zr,Hf, and LREE compared to the inherited portions of the grain, exemplifying the opportunities this techinique offers with respect to understanding petrologic/geochemical systematics of metamorphic/igneous processes.

Although natural standards exist with little variability in age, the incorporation of variable amounts of common Pb results in variable $^{23X}U/^{20X}Pb$ ratios, thus negating the use of that material as a primary reference material. New standards (natural or synthetic) and/or data processing methods are required to enhance the effectiveness of this technique in the future.

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