

Detrital zircon ages of metamorphic and sedimentary rocks from the Maya block (Middle America)

B. WEBER¹, V.A. VALENCIA² AND U.C. MARTENS³

¹Departamento de Geología, CICESE, Ensenada, BC, México (bweber@cicese.mx)

²Department of Geosciences, University of Arizona, Tucson AZ, USA (victorv@geo.arizona.edu)

³Department of Geological & Environmental Sciences, Stanford University, Stanford, CA, USA (umartens@stanford.edu)

The pre-Mesozoic basement of the Maya block is exposed in the Maya Mountains of Belize and in the Chiapas Massif Complex (CMC) of SE Mexico. In the CMC medium- to high-grade metasedimentary rocks occur as isolated domains in predominantly metaigneous rocks. The CMC was affected by a Late Permian tectonothermal event, culminating in partial anatexis and the intrusion of the Chiapas batholith. This strong overprint has obscured the origin of the metasedimentary precursors and hindered correlations with other basement units.

Our in-situ U-Pb dating by LA-MC-ICPMS and SHRIMP is focused on detrital zircon cores from CMC metasediments and detrital zircons from Paleozoic strata exposed in the Maya block. This allowed unraveling the provenance of the CMC, which is summarized in the Figure below. The early Paleozoic sedimentary rocks from Belize were shed mostly from a Grenville orogen and from a ~1.5 Ga old source (Rondonia, SW Amazonia). Pan-African zircons are characteristic for the Carboniferous-Permian sequence (Santa Rosa Formation) in which zircons of mid-Proterozoic ages are less abundant. This dichotomy can be observed in a similar way for the detrital zircon cores of metasediments from the CMC and, hence, both sedimentary units were involved in the late Permian orogeny of the CMC.

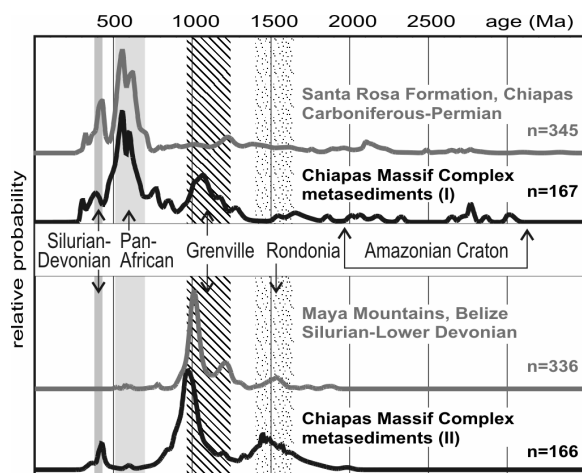


Figure 1. U-Pb apparent ages from individual spots on detrital zircons. (grey = sedimentary rocks from the Maya block; black = metasediments from the CMC.)

Formation of copper sulfide nanoparticles in a flooded soil: Potential for colloid-facilitated transport of contaminants

F.-A. WEBER¹, A. VOEGELIN¹, R. KAEGI² AND R. KRETZSCHMAR¹

¹Institute of Biogeochemistry and Pollutant Dynamics, ETH Zurich, Switzerland (faw@env.ethz.ch)

²Particle Laboratory, EAWAG, Dübendorf, Switzerland

The role of colloids in facilitating the transport of strongly sorbing contaminants has been demonstrated under oxic conditions [1], but little is known about their importance in reduced environments. In microcosm experiments, we have studied *in situ* formation of biogenic sulfide minerals during flooding of a heavy metal contaminated soil. We especially investigated the precipitation of sulfide nanoparticles forming in the pore water upon soil reduction and evaluated their effect on the mobility of contaminants (Cu, Cd, Pb), combining electron microscopy, X-ray absorption fine structure (XAFS) spectroscopy, and wet-chemical analyses.

Results

In the bulk soil, 25% of the initially organic matter bound Cu(II) was transformed into Cu(I) sulfide minerals within just 7 days of flooding, controlling dissolved Cu to <0.4 μM . In the colloidal phase, we concomitantly observed the formation of up to 20 μM of Cu sulfide particles, comprising (i) nanoparticles with diameters <30 nm; and (ii) ~200 nm-hollow Cu sulfide structures associated with free living bacteria. Both types were apparently mobile in the reduced soil and carried substantial quantities of Cd and Pb, dominating their pore water speciation. We attribute the distinct properties of the nanoparticles compared to the hollow structures to different mechanisms of formation involving homogeneous nucleation [2, 3] and bacterially-induced biomineralization [4], respectively. Parallel to an increase in pore water ionic strength during soil reduction, both types of colloids were slowly removed from solution by deposition [5], following an apparent first-order kinetics.

Conclusion

We demonstrate that the formation of mobile Cu sulfide colloids drastically enhanced Cu, Cd, and Pb mobility in a flooded soil, albeit concomitant sequestration in immobile sulfide minerals. Our results thus point to a potentially important pathway for the translocation of class B metals from contaminated floodplain soils to adjacent surface and groundwater bodies.

References

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