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Metals in carbonate platform and island karst rock and waters to delineate hydrogeological flow paths and anthropogenic plumes: Eastern Yucatán Peninsula, Mexico

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This research aims to use metal concentrations to provide a diagnostic aqueous geochemical fingerprint for anthropogenic impacted water in young karst terrains, that may equally be used to trace anthropogenic plumes from infrastructure and urban centers, as well as reveal novel hydrogeology dynamics and connections. We anticipate that the use of exogenous metals in karst waters as a tracer may provide advantages over the use of introduced fluorescent dye tracers, which serve for point-to-point connections when those are included in the sampling sites, but often provide ambiguous results that are highly dependent on antecedent recharge conditions.

Eogenetic carbonate platforms and islands at low latitudes broadly remain close to their deposition location. In the absence of continental discharge, the eogenetic coastal carbonates are highly soluble, have typically low terrigenous content, resulting in limited insoluble residuum. Most metals are in low concentration, or arguably absent from the geology. Eogenetic karst is globally distributed, including iconic sites through the Mediterranean, Caribbean, Western Pacific, and SE Asia.

For our study region in the eastern Yucatán Peninsula, we have developed a chemostratigraphy with ICP-OES to quantify an array of 28 elements, for nearly 400 rock samples, from along ~350 km of transect, including outcrops, quarries, and vadose and phreatic caves. Nearly 300 water samples from surface exposed groundwater in cenote (sinkholes) and also depth profiles and transects along phreatic caves collected using cave diving, are now being analyzed using ICP-OES for metals. Initial results of a subset of samples show elevated concentrations for some metals including for Cr, Mn, Fe, Co, Ni, Cu, Zn, Nb, Mo, Cd, and notably only in select sites. The majority of sites present low concentrations for the exogenous metals, including below detection limit. These initial results encourage further work, including additional water sample collection to be undertaken in March 2026 that will repeat sample sites of elevated concentration, and furthermore expand the geographic scope of samples notably along the suspected flow path of the anthropogenic plumes.