Comparison of methods and results in recent studies of direct groundwater discharge to the Atlantic coast and Great Lakes

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Submarine and Sublacustrine Groundwater Discharge

Groundwater/surface water interaction has been the subject of intense investigation in both marine and freshwater settings in recent years. Although many study methods can be used interchangeably in these systems (e.g., seepage meters), those that rely on salinity contrasts to distinguish surface water from groundwater (e.g., electrical resistivity profiling) cannot. A schematic spatial framework that was recently developed for dividing submarine groundwater discharge (SGD) phenomena [1] can also be applied to large lakes with some modifications. Some natural radioisotopic tracers of SGD developed in marine systems can be used in freshwater settings [2]. Conversely, a regional approach to examining groundwater occurrence and flow in a watershed containing large lakes, as has been undertaken for the Great Lakes [3], might be productively applied to a coastal ocean region.

In addition to the salinity contrasts, one major geochemical difference between discharge of groundwater to fresh or saline surface water is the influence on eutrophication. Because nitrogen is typically the limiting nutrient in marine systems, whereas phosphorus limits productivity in most freshwater systems [4], SGD plays a much larger role in eutrophication of marine systems than in freshwater systems. Dissolved nitrogen species tend to be concentrated in coastal groundwater, but phosphorus is particle reactive and unlikely to be delivered to surface water in large quantities from groundwater in most lakes. Most phosphorus comes from runoff and sediment recycling in freshwater systems.

Unusual groundwater vent features have been documented in both marine and lake settings, especially along carbonate-dominated coasts. Among the most spectacular are brackish sinkhole springs in Florida and Lake Huron, the latter of which include extensive purple cyanobacterial mat communities [5].

Conclusion

Significant opportunities exist for advancing understanding of elemental cycling and other features of groundwater/surface water interaction in large water bodies with more exchange of methods and results among scientists that work in marine and freshwater settings.

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Contemporary saprolite production rates and aggressiveness of pore waters: Comparison between Nsimi and Mule Hole small experimental watersheds

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Introduction

Thanks to geochemical, mineralogical and hydrological studies and using Chloride Mass Balance approach, we compare two ridge top weathering profiles (WP) developed on granodioritic basement from Mule Hole (South India) and Nsimi (South Cameroon) small experimental watersheds (SEW). The objective is to get deeper insight into (i) the contemporary saprolite production rates and (ii) the combined effect of precipitation and evapotranspiration on the aggressiveness of the draining solutions.

Field settings

The Nsimi SEW presents the contemporary weathering conditions for a 36 meter deep, mature weathering cover under humid climate (Mean Annual Rainfall = 1660 mm/yr, Actual EvapoTranspiration (AET) = 1270 mm/yr) with a Recharge (R) = 332 mm/yr out of which 90% of the solutes are discharged into the springs/brook and 10 % through the groundwater[1][2]. The Mule Hole SEW presents the contemporary weathering conditions for a 17 meter deep, immature weathering cover under sub-humid climate (MAR = 1280 mm/y, AET = 1100 mm/yr) with R = 45 mm/yr out of which 100% of the solutes are discharged through the groundwater as underflow from the watershed[3][4][5]. Moreover, the Nsimi groundwater saturates the entire saprolite whilst the Mule Hole groundwater saturates the fractured bedrock only.

Results and conclusions

Considering (i) Na as representative of the dissolution of plagioclase crystals and conservative during saprolitization processes and (ii) steady state of the inter-annual recharge for a 10 years period, the current saprolite production rates (SPR) are of 22 mm/kyr for Mule Hole and 2 mm/kyr for Nsimi, respectively.

Even with a very low R/MAR ratio (0.04) compared to Nsimi, the chemical weathering at Mule Hole is active and related to the groundwater exports. However, the high Nsimi R/MAR ratio (0.2) allows the solution to be still aggressive with respect to the plagioclase at the bedrock interface leading to their complete breakdown in a few centimeters. For Mule Hole, plagioclase are still present in the saprolite and the soil cover.

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