Estimating submarine groundwater discharge in the range 10^1 to 10^8 km^2 using Ra Isotopes

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The flux of submarine groundwater discharge (SGD) provides an important pathway for enriching coastal waters in nutrients, carbon, and metals. Here SGD is defined as all flow of subsurface water from the continental margin to the ocean, regardless of composition or driving force. Regional quantification of SGD is difficult because direct measurement over large temporal and spatial scales is not possible by conventional means. Measurements of naturally-occurring radionuclide tracers at the aquifer-marine interface and in the coastal ocean provide a method to produce integrated flux estimates of discharge not possible by other means. In this talk I will explore the use of four radium isotopes to quantify SGD at scales ranging from small tidal creeks to the entire Atlantic Ocean. Radium is especially useful in this regard because it has high concentrations in SGD relative to coastal waters, low reactivity in the ocean, and four isotopes with half lives ranging from 3.7 days to 1600 years.

At small and intermediate scales, the technique requires a measure of the Ra inventory in the surface water and its concentration in SGD, evaluation of other sources of Ra, and a measure of the residence time of the water body. With this information, the inventory of Ra in the water is converted to the SGD Ra flux. This Ra flux must be replaced by new inputs of Ra from SGD. Thus, Ra concentrations in SGD convert the Ra flux to the SGD flux.

On a large scale, the decay of the ^{228}Ra inventory in the upper 1000 m of the Atlantic must be balanced by a flux from the continental margins. By evaluating other sources of ^{228}Ra and concentrations in SGD, a total flux of SGD to the Atlantic is obtained. This flux is in the range 0.5 to 1.0 of the river flux to the Atlantic. Because SGD is generally higher than river water in nutrients, metals, and carbon, the SGD fluxes of these materials probably exceed their riverine fluxes to the Atlantic.

The evidences of magma mixing and mingling in the Aran area (central Iran zone)

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This area is located in Eurmia-Dokhtar zone. The Eocene volcanism in this area is related to the orogeny activities in middle Alp. The tectonic activities in central Iran indicate most movement in this time. There are some deep marine sedimentary within volcanic-sedimentary rocks (i.e. ash and pumice tuff). There are some magma mixing evidences in this area which contain existence three different glasses (acidic, basic and hybrid glasses) in the matrix of hyaloclastic breccias and some plagioclases and pyroxenes with sieve texture, absorption and corrosion in their rims. Existence of basic micro pillows in acidic matrix and amphiboles with opaque rims. There are some mingling evidences in this area which are result of entrance of hot basic magma into co-magmatic and differentiated acidic magma in the magma chamber like two basic glasses with different composition and reverse, oscillatory zonation in the minerals