

## Using Radium isotopes to evaluate the mixing timeline and relative age of waters in a leaky coastal lagoon

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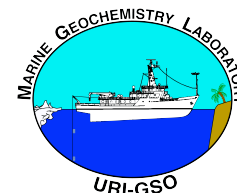
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### Abstract

The Ria Formosa wetland system is classified as a leaky coastal lagoon and covers approximately 100 km<sup>2</sup> of the South of Portugal, with roughly 50% being intertidal. Its hinterland is set in an arid region and on a coastal plain subject to intensive agriculture since the 50's. In spite of high exchange coefficients with the coastal ocean (50 and 75% at neap and spring tides, respectively) and the annual total potential freshwater discharge from the hinterland a fraction of the daily tidal prism, worrying signs of eutrophication have been detected during the past couple of decades. These include fish- and clam-kill episodes, increased occurrence of nuisance algal blooms and substitution of native sea grass communities by macroalgae. Notwithstanding its critical importance for the evaluation of pollutant exposure period, the literature includes a wide range of estimates for the 'residence time' of waters within the lagoon (16 hours to 11 days, with an the apparent consensus falling within the 1-2 day interval) and this point is a clear obstacle for a correct environmental risk assessment, including management of the system. This lack of clarity is due in our view to two main factors: i) the lack of proper physical definition of the term 'residence time', with its consequent misuse and misapplication in context, a misconception that is unfortunately too common within the environmental community, and different concepts in the application of transport time scales ii) the geomorphological and hydraulic complexity of the system.. As part of ongoing research evaluating the role of Submarine Groundwater Discharge (SGD) as a loading vector for nutrients (especially Nitrate) into the lagoon, we use the radium quartet in combination with remote sensing and isotope mixing models to develop and discuss a mixing timeline for the system, We conclude that the average, whole-system residence time of waters within the lagoon is at least 4 days.



## 4<sup>th</sup> International Ra-Rn Workshop: Detailed Program

**Sunday (6/3)**      All day      Arrival & Hotel Check-In  
**18:00-19:30**      **Registration & Welcome Reception (The Village Inn)**

**Monday (6/4)**      08:30-08:55      Welcome

**Session: Ra isotopes as tracers of mixing processes. Leader: Aaron Beck**

08:55-09:20 C. A. Waters and H. Dulaiova: Comparison of apparent radium ages determined using short-lived radium isotopes using different approaches

09:20-09:45 C. Rocha, J. Scholten, Jean Wilson, C. Veiga-Pires: Using Radium isotopes to evaluate the mixing timeline and relative age of waters in a leaky coastal lagoon

09:45-10:10 W. Burt, H. Thomas, E. Horne: Enhanced pore-water diffusive fluxes of <sup>224</sup>Ra, CO<sub>2</sub> and nutrients related to a deep-water renewal event

**10:10-10:40 Break**

10:40-11:05 P.J. Morris, M.A. Charette, W.J. Jenkins, P.B. Henderson, W.S. Moore: Radium-derived mixing rates in the North Atlantic

11:05-11:30 H. Dulaiova: Radium isotopes as tracers of lateral fluxes off the continental margin of northwest Africa

11:30-11:55 B. Lansard, V. Sanial, P. Van Beek, M. Souhaut and F. D'Ovidio: What do we learn from radium isotopes about natural iron fertilization off Crozet and Kerguelen Islands, Southern Ocean?

**12:00-13:30 Lunch at Village Inn**

**Session: Ra and Rn as Tracers of Submarine Groundwater Discharge. Leader: Henrieta Dulaiova**

13:30-13:55 G. Wang, Z. Wang, S. Wang, Y. Xu, W. Jing, M. Dai: Fluctuation of submarine groundwater discharge with tides in a coastal coral reef system in Sanya, China

13:55-14:20 J. Scholten, C. Rocha, J. Wilson, M. Pham, C. Veiga-Pires, J. Aníbal: Estimating submarine groundwater discharge into the Ria Formosa lagoon, Portugal: Uncertainties in the lagoon-open ocean radium exchange

14:20-14:45 R. Peterson, R. Viso, I. MacDonald, S. Joye: Ongoing Fluid Discharge Near the Macondo Wellhead Revealed by Radium Isotopes

**14:45-15:15 Break**

15:15-15:40 D. E. Hammond, S. L. Colbert, H. Talsky, R. J. Schwartz: Use of Pore water Rn and Ra Profiles to Evaluate the Nature of Flow through Permeable Coastal Sands and Nutrient Inputs in Huntington Beach, Southern California

15:40-16:05 V. Rodellas, J. Garcia-Orellana, G. Basterretxea, A. Tovar-Sánchez, D. Sánchez-Quiles, P. Masque: When Ra isotopes trace vessel circulation...

16:05-16:30 A. Eisenach, J. Rapaglia, J. Scholten and A. Vafeidis: Finding the needle in a haystack: utilizing a GIS to aid in SGD research

16:30-16:55 M. Schubert, R. Stollberg, K. Knoeller, J. Wilson, C. Rocha: Evaluation of a three step approach for the straightforward localization of SGD zones

**19:00-20:30 Newport Sunset Sail (POSSIBLE)**

**Tuesday (6/5)**

**Session: Ra and Rn as Tracers of Submarine Groundwater Discharge. Leader: Doug Hammond**

08:30-08:55 J. L. Kelly, H. Dulaiova, C. R. Glenn: Quantifying groundwater discharge from the largest spring complex in the Hawaiian Islands

08:55-09:20 J. Ellis, N. T. Dimova, G. Tick, D. Honeycutt: Numerical modeling for evaluation of SGD rates constrained by radon-derived assessments

09:20-09:45 N. Su, W.C. Burnett, K. Eller, H.L. MacIntyre, B. Mortazavi, J.D. Liefer: Radon and Radium in Little Lagoon: Implications for Harmful Algal Blooms

09:45-10:10 J. Garcia-Orellana, V. Rodellas, N. Casacuberta, E. López-Castillo, M. Vilarrasa, V. Moreno, E. Garcia-Solsona and P. Masqué: Coastal groundwater discharge: a source of natural radioactivity

**10:10-10:40 Break**