

Ra and Rn isotopes as SGD tracers

Project is coordinated by:





Catia Milene Ehlert von Ahn

Geochemistry & Stable Isotope Biogeochemistry

Project is implemented in partnership with:











(Adapted from Lee, 1977, Kaleris et al., 2002, Wassman & Olli 2004, Burnett et al., 2006, Bejannin et al., 2017, Virtasalo et al., 2019,)



Introduction – Raisotopes





Introduction – Ra isotopes

₽₫₽



(Adapted from Rodellas et al., 2015)

Production
A Ra
$$(\tau) = \frac{P}{R_{Ra}} (1 - e - \lambda R_{Ra})$$

R_{Ra} = 1 + Kd $\frac{\rho_b}{\phi}$

Distribution coefficient (which is basic the reaction of desorption and adsorption)



Introduction – Ra isotopes Atmosphere



Sediment





Endmembers











Introduction – Raisotopes



























Measuring ²²³Ra and ²²⁴Ra





Radium Delayed coincidence counter





ELSEVIER

Available online at www.sciencedirect.com



Continental Shelf Research 26 (2006) 852-861

CONTINENTAL SHELF RESEARCH



www.elsevier.com/locate/csr

Radium isotopes as tracers of submarine groundwater discharge in Sicily

Willard S. Moore*

Department of Geological Sciences, University of South Carolina, Columbia, SC 20208, USA Received 31 March 2004; received in revised form 22 June 2005; accepted 1 December 2005 Available online 9 February 2006



CrossMark

Available online at www.sciencedirect.com

ScienceDirect

Geochimica et Cosmochimica Acta 196 (2017) 58-73

Geochimica et Cosmochimica Acta www.elsevier.com/locate/gca

ORI

doi: 10.338

Using the radium quartet to quantify submarine groundwater discharge and porewater exchange

Valentí Rodellas^{a,b,*}, Jordi Garcia-Orellana^{a,c}, Giada Trezzi^a, Pere Masqué^{a,c,d,e}, Thomas C. Stieglitz^{b,f}, Henry Bokuniewicz^g, J. Kirk Cochran^g, Elisa Berdalet^h

^a Institut de Ciència i Tecnologia Ambientals (ICTA), Universitat Autònoma de Barcelona, 08193 Bellaterra, Catalunya, Spain ^b CEREGE, Aix-Marseille Université, CNRS, IRD, Coll France, 13545 Aix-en-Provence, France ^c Departament de Física, Universitat Autònoma de Barcelona, 08193 Bellaterra, Catalunya, Spain ^d School of Natural Sciences, Edith Cowan University, 270 Joondalup Drive, Joondalup, WA 6027, Australia

^eOceans Institute & School of Physics, The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia ^f Centre for Tropical Water and Aquatic Ecosystem Research, James Cook University, Townsville, Queensland 4811, Australia ^g School of Marine and Atmospheric Sciences – Stony Brook University, Stony Brook, NY 11794-5000, USA ^hInstitut de Ciències del Mar (CSIC), 08003 Barcelona, Catalunya, Spain

Received 19 April 2016: accepted in revised form 15 September 2016: Available online 22 September 2016



Radium Mass Balance Sensitivity **Analysis for Submarine Ground Discharge Estimation in Semi-Enclosed Basins: The Cas** Study of Long Island Sound

Joseph Tamborski^{1,2,3*}, J. Kirk Cochran⁴, Henry Bokuniewicz⁴, Christina Hei Jordi Garcia-Orellana^{5,6}, Valentí Rodellas⁵ and Robert Wilson⁴

¹ Department of Geosciences, Stony Brook University, Stony Brook, NY, United States, ² Department of I Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, MA, United States, ³ Centre for Wa Studies, Dalhousie University, Halifax, NS, Canada, ⁴ School of Marine and Atmospheric Sciences, Stony Stony Brook, NY, United States, ⁵ ICTA, Institut de Ciència i Tecnologia Ambientals, Universitat Autònom Bellaterra, Spain, ⁶ Department de Fisica, Universitat Autònoma de Barcelona, Bellaterra, Spain

SCIENT

^a School of Environment, Harbin Insti ^b School of Environmental Science and Engineering, Souther ^c School of Water Resources and Hydropower E ^d State Key Laboratory of Biogeology and Environmental G

OPEN Radium tracing nutrient inputs through submarine groundwater discharge in the global ocean

ived: 18 October 2017 pted: 24 January 2018

RESEARCH ARTICLE

Groundwater discharge to the western Antarctic coastal ocean

& Isaac R. Santos 3

Kimberly A. Null¹, D. Reide Corbett^{1,2}, Jared Crenshaw², Richard N. Peterson³, Leigha E. Peterson³ & W. Berry Lyons⁴

¹ Institute for Coastal Science and Policy, East Carolina University, Greenville, NC, USA; ² Department of Geological Sciences, East Carolina University, Greenville, NC, USA; ³ Department of Coastal and Marine Systems Science, Coastal Carolina University, Conway, SC, USA; ⁴Byrd Polar and Climate Research Center, Ohio State University, Columbus, OH, USA

is F. H. Niencheski² · Pedro J. Depetris⁵

Submarine groundwater discharge at Forsmark, Gulf of Bothnia, provided by Ra isotopes

Lindsay Krall*^{1,2,3}, Giada Trezzi⁴, Jordi Garcia-Orellana⁴, Valenti Rodella⁵, Carl-Magnus Mörth², Per Andersson'

¹The Swedish Nuclear Fuel and Waste Management Company, Sweden ²Department of Geological Science, Stockholm University, Stockholm Sweden ³Department of Geosciences, Swedish Museum of Natural History, Stockholm, Sweden ⁴Institue de Ciència I tecnologia Ambientals, Universitat Autònoma de Barcelona, Spain ^o CEREGE, Aix-Marseille Université, Aix-en-Provence, France



Available online at www.sciencedirect.com Water Science and Engineering

journal homepage: http://www.waterjournal.cn

Estimating submarine groundwater discharge and associated nu into Daya Bay during spring using radium isotopes

Jing-yan Gao^{a,b}, Xue-jing Wang^{b,c}, Yan Zhang^d, Hai-long Li^{b,d,*}

Received 10 October 201 Available onl

Hyung-MiCho¹, Guebuem Kim¹, EunYoung Kwon², Nils Moosd orf 3, Jordi Garcia-Orellana 3*

ELSEVIER

Submarine groundwater discharge revealed by ²²⁸Ra distribution in the upper Atlantic Ocean

WILLARD S. MOORE^{1*}, JORGE L. SARMIENTO² AND ROBERT M. KEY² ¹Department of Geological Sciences, University of South Carolina, Columbia, South Carolina 29208, USA ²AOS Program, Princeton University, Princeton, New Jersey 08544, USA *e-mail: moore@geol.sc.edu

Journal of Hydrology 466-467 (2012) 11-22

Contents lists available at SciVerse ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

Quantifying groundwater discharge from different sources into a Mediterranean wetland by using ²²²Rn and Ra isotopes

> er Garcia-Solsona^c, Pere Masqué^{a,b}, Miguel Mejías^d, Mario Zarroca^e celona, Campus UAB, 08193 Bellaterra, Spain

Bellaterra, Spain 14 Av. Edouard Belin, 31400 Toulouse, France 193 Bellaterra, Spain

cedirect.com

irect



419 - 441

lance in Jamaica Bay, NY: Evidence for a substantial flux of submarine groundwater

*, John P. Rapaglia, J. Kirk Cochran, Henry J. Bokuniewicz

ciences Research Center, Stony Brook University, Stony Brook, NY, 11794-5000, USA

1 December 2006; received in revised form 29 March 2007; accepted 29 March 2007 Available online 18 April 2007



LETTERS









CONTINENTAL SHELF



Continental Shelf Research 26 (2006) 852-861



Hydrochemistry and isotopic signatures of subpermafrost ground water discharge along the eastern slope of the Lena River Delta (Charkin et al., 2020)



Valen

Tho

Methane transport through submarine groundwater discharge to the North Pacific and **Arctic Ocean and two Alaskan sites** (Lecher et al., 2016)

🐉 fror

Current magnitude and mechanisms of groundwater in the Arctic Case study from Alaska (Dimova et al., 2015)

Discharge Estimation in Semi-Enclosed Basins: The Cas Study of Long Island Sound

Joseph Tamborski^{1,2,3*}, J. Kirk Cochran⁴, Henry Bokuniewicz⁴, Christina Hei Jordi Garcia-Orellana^{5,6}, Valentl Rodellas⁵ and Robert Wilson⁴

Department of Geosciences, Stony Brook University, Stony Brook, NY, United States, ² Department of I Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, MA, United States, ³ Centre for Wa Studies, Dalhousie University, Halifax, NS, Canada, 4 School of Marine and Atmospheric Sciences, Stonj Stony Brook, NY, United States, ⁵ ICTA. Institut de Ciència i Tecnologia Ambientals, Universitat Autònom Bellaterra, Spain, ^e Department de Física, Universitat Autónoma de Barcelona, Bellaterra, Spain

Submarine groundwater discharge at Forsmark, Gulf of Bothnia, provided by Ra isotopes

Lindsav Krall^{*1,2,3}, Giada Trezzi⁴, Jordi Garcia-Orellana⁴, Valenti Rodella⁵, Carl-Magnus Mörth², Per Andersson²

¹The Swedish Nuclear Fuel and Waste Management Company, Sweden ²Department of Geological Science, Stockholm University, Stockholm Sweden ³Department of Geosciences, Swedish Museum of Natural History, Stockholm, Sweden ⁴Institue de Ciència I tecnologia Ambientals, Universitat Autònoma de Barcelona, Spain ^o CEREGE, Aix-Marseille Université, Aix-en-Provence, France

OPEN ACCESS

Check for updates

Available online at www.sciencedirect.con Water Science and Engineering

lance in Jamaica Bay, NY: Evidence for a substantial flux of submarine groundwater

*, John P. Rapaglia, J. Kirk Cochran, Henry J. Bokuniewicz

ciences Research Center, Stony Brook University, Stony Brook, NY, 11794-5000, USA

1 December 2006; received in revised form 29 March 2007; accepted 29 March 2007 Available online 18 April 2007



13/17

LETTERS

Introduction - Radon





Methods - Radon



Durridge



Durridge

Westfal et al., 2017







Summary

RB

Rn mapping to identify spots of SGD. Continuous monitoring along the coastline

Output the four Ra isotopes to quantify SGD. Transects across the coast.

Best to use in combination with other traces



R Norway grants

Thank you!

Working together for a green, competitive and inclusive Europe

Project financed by the Norwegian Financial Mechanism 2014–2021 (85%) and national co-financing (15%) within GRIEG Programme "Submarine Groundwater Discharge in a Changing Arctic Region: Scale and Biogeochemical impact" Project No. 2019/34/H/ST10/00645

> www.eeagrants.org Facebook, Twitter, LinkedIn, Instagram YouTube: EEANorwayGrants Mail: info-fmo@efta.int

Programme Operator:

