

NOBLE GAS TEMPERATURE PROXY FOR CLIMATE CHANGE

IMPACT STATEMENT

Noble gases in groundwater appear to offer a practical approach for quantitatively determining past surface air temperatures over recharge areas for any watershed. The noble gas temperature (NGT) proxy should then permit a paleothermometry of a region over time. This terrestrial proxy when coupled with groundwater age dating offers a timeline of climate changes. Such a history of regional climate changes can thus aid our understanding of the resultant intensification of the water cycle. Therefore, forecasting changes in runoff and shifts in recharge patterns can be improved to model water quality and stream flow modifications. These nascent applications are occurring on the Olympic Peninsula, Washington, in support of the reestablishment of healthy anadromous fisheries.



BACKGROUND:

The NGT proxy is introduced for the Olympic Mountains region as a quantitative assessment of past mean recharge air temperatures. Continental climate archives are stored in aquifers that are ubiquitous and can be integrated into regional syntheses of past climate environments. Aquifers may smooth out short-term meteorological fluctuations but often preserve long term climate change information. In order to retrieve earlier surface air temperatures at recharge areas in watersheds, noble gases (He, Ne, Ar, Kr, and Xe) are measured in groundwater. Fundamentally, the solubility of noble gases is temperature dependent, and thus, the temperature at which recharged water last equilibrated with the atmosphere can be calculated from noble gas concentrations. The advantageous spatial relationship of noble gas and mean air temperature at the recharge location is maintained and is not impacted by recharge altitude, seasonal distribution of precipitation, and vapor source area.

DESCRIPTION:

The Olympic Peninsula offers a prognostic study area for climate change in the Pacific Northwest. The National Risk Management Research Laboratory of the U.S. Environmental Protection Agency's (EPA) Office of Research and Development is leading an interdisciplinary team of hydrologists and chemists from several organizations. Experimental sampling techniques and new analytical tools have been developed to test the application of noble gas paleothermometry for climate change investigations. Collaborative field activities with the U.S. National Park Service (USNPS), the U.S. Forest Service (USFS), Peninsula Community College, and the Washington State Department of Natural Resources (DNR) are guiding sampling of ubiquitous springs in the

Olympic massif. Shared rare gas mass spectrometry, stable isotope analyses, and radioisotope assays are being conducted with Ohio State University, the U.S. Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL), and Purdue University. Collaborative modeling with Environment Canada-Climate Centre, Miami (Ohio) University, and the University of Washington is centered on scaling general circulation models to adapt regional data sources obtained through this project. Assessment of climate change model forecasts, as they relate to shifting recharge and runoff patterns with effects on anadromous fisheries, would be integrated into EPA's Region 10 activities.

RESEARCH PARTNERS:

Collaborators: USNPS; USFS; Washington State DNR; Environment Canada-Climate Centre; Ohio State University; DOE/ORNL; Purdue University; Miami (Ohio) University; Peninsula Community College, University of Washington, EPA/Region 10

EXPECTED OUTCOMES AND IMPACTS:

A timeline of past surface air temperature changes in the watersheds of the Olympic Peninsula will be utilized to forecast trends for recharge and runoff modeling in support of anadromous fisheries.

OUTPUTS:

Expected outputs consist of journal articles and conference proceedings.

RESOURCES:

Sidle WC and Cvetic V (2009). *Holocene noble gas paleothermometry from springs in the Olympic Mountains, Washington*. Presentation at the 2009 Geological Society of America Annual Meeting in Portland, Oregon. <http://www.geosociety.org/meetings/2009/>

National Risk Management Research Laboratory: <http://www.epa.gov/nrmrl/>

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