A Hidden Resource: Offshore Aquifers and Submarine Fresh Groundwater

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1. Introduction

Coastal communities worldwide face increasing pressure to manage aging water infrastructure, adapt to a changing climate, and meet growing demands for water supply. Technical and economic limitations on existing water supplies has turned attention to alternative sources of water, including offshore fresh groundwater reserves. In Oregon, little is known about the feasibility of using offshore aquifers as sources of fresh groundwater or as reservoirs for CO_2 sequestration. This study reevaluates historic data from seven "dry" oil and gas exploration wells drilled off the Oregon Coast in the mid-1960s before the area was closed to additional drilling. The research addresses whether offshore aquifers along an active plate margin can be considered a viable option for developing or storing water supplies for growing communities along the Oregon Coast.

2. Offshore Groundwater Use

Post et al. (2013) describes vast meteoric groundwater reserves found below the sea floor on a global scale. Although offshore aquifers are hydrologically connected to onshore groundwater resources, the volume of fresh groundwater observed offshore exceeds the estimated inputs from onshore groundwater. Clark et al. (2009) estimate that these subsea aquifers, located along continental shelves, were filled with freshwater from exposure to the atmosphere during sea-level low stands, in the Last Glacial Maximum, between 19,000 and 26,500 years ago. The volume of freshwater (defined as having total dissolved solids (TDS) < 1 g/L) stored globally in sub-seafloor aquifers was estimated to be 3×10^5 km^3, while brackish water, (TDS < 10 g/L), was estimated to have a volume of 5×10^5 km^3 in offshore reserves (Post et al. 2013). Brackish water could likely be treated through distillation, which could make it a cost-effective alternative to desalination of seawater.

5. References

Clark, P. U., A. S. Dyke, J. D. Shakun, A. E. Carlson, J. Clark, B. Wohlfarth, J. X. Mitrovica, S. W. Hostetler, and A. M. McCabe. 2009. The Last Glacial Maximum. *Science* 325 (5941): 710–14.

Post, V. E., Groen, J., Kooi, H., Person, M., Ge, S., Edmunds, W. M. (2013). Offshore fresh groundwater reserves as a global phenomenon. *Nature* 504, no. 7478: 71–78.

3. Analysis of Offshore Well Data

Given the occurrence of fresh groundwater resources found in offshore regions worldwide, it is possible that similar resources exist off the coast of Oregon. This analysis used data from eight offshore exploration wells drilled in the 1960s, including drilling reports, geologic logs, and borehole geophysical data, to characterize the geology offshore of Oregon. Figure 1, shown below, is an example diagram showing the lithology of one of the exploration wells based on drilling reports. Results from the analysis show a consistent distribution of volcanic formations (Columbia River basalts, volcanics, and tuffaceous materials) throughout the Oregon territorial sea that are suitable for storage of water through ASR, and storage of gases such as carbon dioxide. These formations are also potential water-bearing units. Further exploration of offshore groundwater resources should target volcanic rock aquifers and sedimentary aquifers from the Missoula Floods, particularly interflow zones and deformed fractures where formations are likely to have a higher permeability.

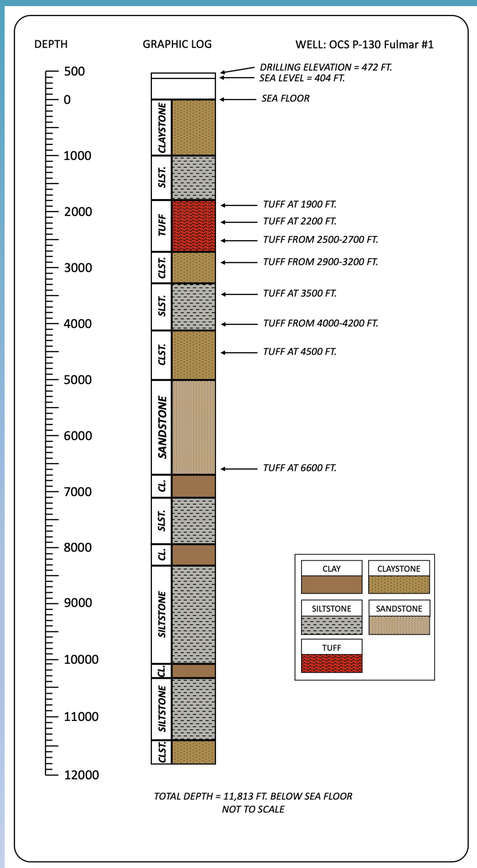
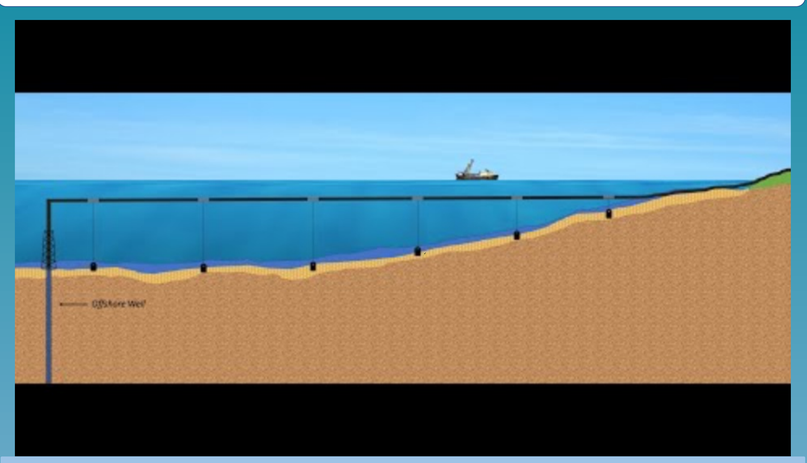


Figure 1. Well diagram showing lithology changes in offshore exploration well.

4. Offshore Space in Oregon

The area offshore of Oregon is currently utilized for a wide variety of activities, including fishing, tourism, commercial transit, renewable energy generation, marine reserves, aquaculture, and fiber optic telecommunications cables. Introducing the use of offshore groundwater wells would increase the demand for space and would thus require integrative planning with existing users of the offshore space. Figure 2 shows the relationships between various actors involved in the Oregon offshore environment.



Video: transporting offshore groundwater

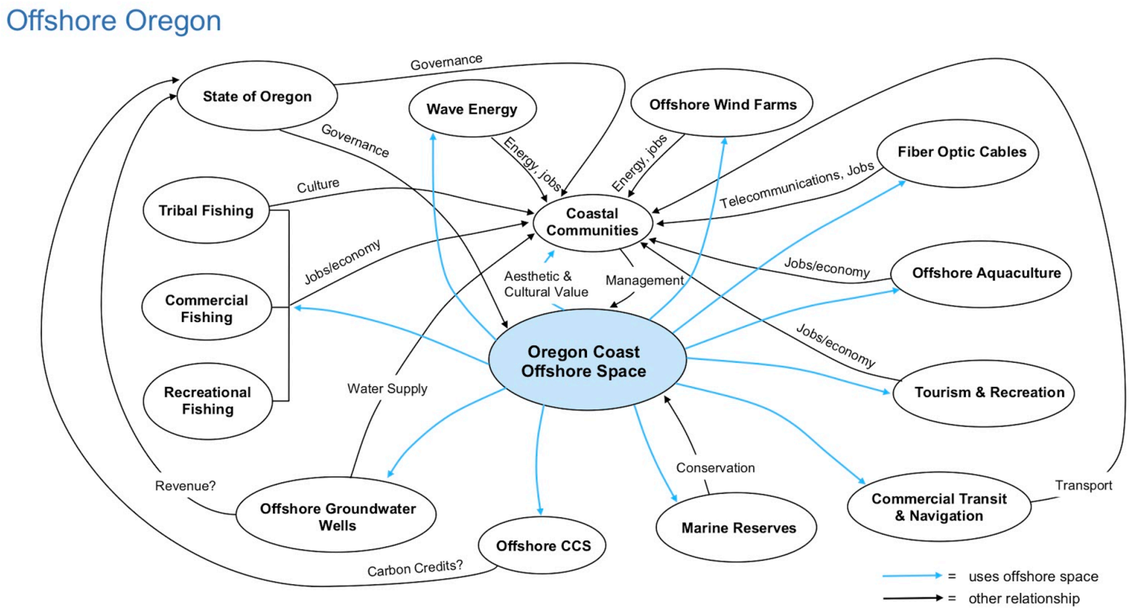


Figure 2. Relationships between space users in the Oregon offshore environment