

Saltwater Infiltration

While searching for an ancient Roman road, a graphic demonstration of the impact of salinity change on GPR response was observed

Noggin SmartCart in use along a path near a saltwater marsh area, Christchurch, UK

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Drinking water concerns in coastal areas

GPR systems sense saline groundwater

Overview

In coastal areas, the influx of saltwater into shallow fresh water aquifers can have dire consequences on drinking water supply and create other environmental concerns. The results in this case study derive from an archeological survey in the UK. While searching for an ancient Roman road, a graphic demonstration of the impact of salinity change on GPR response was observed.

Problem

GPR usage is becoming increasingly common in coastal areas. Interest ranges from study of paleo shorelines for major geologic events such as tsunamis to concerns about saline contamination of drinking water to the exploration for heavy mineral deposits in beach sand.

Since saline groundwater limits GPR penetration, the common question is 'How close to the saltwater coast can one work?'

GPR has been used successfully right up to the high water point in coastal areas. Given that saltwater is likely to spread into the ground near the coast, how is this possible?

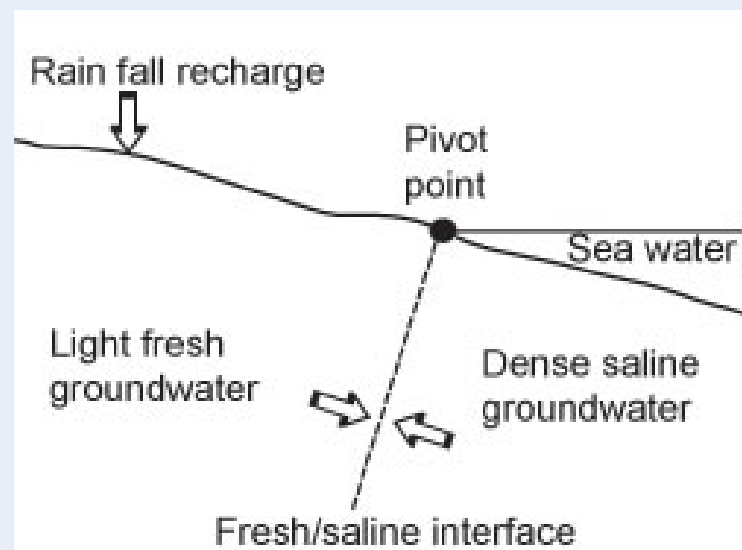
GPR Contribution to Solution

The basic explanation is depicted in the graphical illustration to the right. The hydrogeological regime is driven by the interplay between fresh and saline groundwater. The freshwater is constantly being

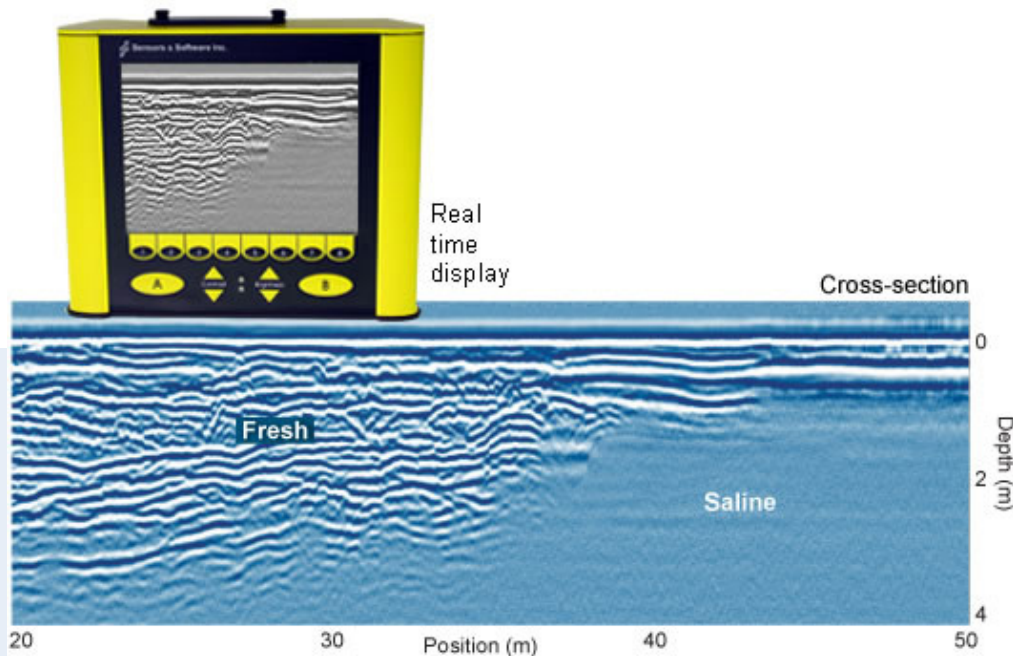
recharged by rainfall so there is a positive pressure head forcing freshwater down and out to the shoreline. A boundary between fresh and saline water occurs and is often abrupt.

In a simplistic way, the black dot in the figure below can be viewed as a hinge point with the fresh-saline groundwater boundary swinging back and forth depending on the relative pressure head as rainfall re-charges the land area and tides vary. Since fresh water tends to be lighter (lower density) than saline water, the fresh water will often ride over the saline water to some degree.

GPR is highly sensitive to the boundary location. While surveying with a Noggin 250 SmartCart on a path near a saltwater marsh area, the path crosses onto a sand spit at the dotted line. The figure below shows how abrupt the transition from fresh water to saline water can be.



Saltwater intrusion simple conceptual model.



Abrupt cut-off in GPR penetration caused by saline groundwater. The saline water is intruding under the land area making a distinct dipping cut-off in the radar signal.

The details of any particular area will be controlled by the local geologic stratigraphy. Some strata will be more permeable than others resulting in a more rapid flux of water one way or the other, so the simple straight-line boundary will always be blurred by the geology.

As the above example shows, the fresh-saline water interface is a dramatic event on a GPR section.

Results & Benefits

GPR systems can sense the presence of saline groundwater. Some key points to note are:

- GPR responses are highly attenuated by the presence of saline groundwater
- Time lapse measurements can indicate the ebb and flow of salt water in shallow aquifers

- Systems such as the Noggin SmartCart configuration can be easily used to map out areas impacted
- An intuitive model for understanding the GPR response in shoreline areas has been presented.

GPR responses vary greatly depending on the target being sought and the host material. GPR response variability can be challenging to new GPR users. When learning about GPR, the best practice is to review several similar case studies to develop an understanding of variability. Check for other insightful information on the resources tab to learn more. Use Contact Us or Ask-the-Expert to reach our Application Specialists who can help you tap into Sensors & Software's vast array of technical information.

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