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Characteristics of saltwater wedge under the chalk cliffs of Sainte-Marguerite-sur-Mer (Normandy, France) using optical and geophysical methods.

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Abstract:

Saltwater wedge is a natural phenomenon defined as the displacement and retention of saltwater in a freshwater aquifer. This saline intrusion can modify the content of dissolved elements in coastal freshwater aquifers, which can have consequences for water use (drinking or agricultural), on the ecology, the environment, the erosion of coasts, and the stability of coastal structures.

This study focuses on the integration and coupled interpretation of various geophysical and optical data obtained on the ground and by drone to evaluate the intrusion of seawater in a coastal chalk cliff in Sainte-Marguerite-sur-Mer in Normandy, France. The objective is to characterize the freshwater-saltwater interface and describe the internal structure of the formation. To do so, the combination of geophysical (Electrical Resistivity Imaging, ERI), aerial (visible and thermal infrared photogrammetry, IRT), and geotechnical (piezometers) methods was adopted.

The ten ERI profiles (transverse and longitudinal to the cliff) allowed for the mapping of the electrical resistivity distribution. The novel contribution of this study was the highlighting of a marine intrusion under the chalk cliffs visualized using transverse ERI profiles implanted directly on the steep dip of the cliff. The use of a 30m deep piezometer positioned on the plateau of the cliff and intersecting the ERI profiles made it possible to constrain the resistivity values to the measured salinity values. The presence of this saltwater wedge was characterized by low resistivity values. The top of the cliff and the parts close to the outcrop showed significant resistivities, indicating a high level of potential damage (cracks in the outcrop, underground cavities*).* This allowed for the identification of a zone (about 10m before the main scarp) vulnerable to the risk of collapse.

It has been shown that the difference in groundwater density leads to unstable conditions. We propose that the denser saline water covering the less dense freshwater creates a haline convection of the brackish waters at the base of the cliff and at the level of the rocky shore platform. The IRT was used to identify the wet areas of the cliff and the resurgences of the water table on the platform. Finally, all the data were grouped to propose a conceptual model of saline intrusion under the coastal cliffs.