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Attribute classification for generating GPR facies models

Jens Tronicke and Niklas Allroggen
Institute of Earth and Environmental Sciences, University of Potsdam, Germany (jens@geo.uni-potsdam.de)

Ground-penetrating radar (GPR) is an established geophysical tool to explore near-surface sedimentary environments. It has been successfully used, for example, to reconstruct past depositional environments, to investigate sedimentary processes, to aid hydrogeological investigations, and to assist in hydrocarbon reservoir analog studies. Interpreting such 2D/3D GPR data, usually relies on concepts known as GPR facies analysis, in which GPR facies are defined as units composed of characteristic reflection patterns (in terms of reflection amplitude, continuity, geometry, and internal configuration). The resulting facies models are then interpreted in terms of depositional processes, sedimentary environments, litho-, and hydrofacies. Typically, such GPR facies analyses are implemented in a manual workflow being laborious and rather inefficient especially for 3D data sets. In addition, such a subjective strategy bears the potential of inconsistency because the outcome depends on the expertise and experience of the interpreter.
In this presentation, we investigate the feasibility of delineating GPR facies in an objective and largely automated manner. Our proposed workflow relies on a three-step procedure. First, we calculate a variety of geometrical and physical attributes from processed 2D and 3D GPR data sets. Then, we analyze and evaluate this attribute data base (e.g., using statistical tools such as principal component analysis) to reduce its dimensionality and to avoid redundant information, respectively. Finally, we integrate the reduced data base using tools such as composite imaging, cluster analysis, and neural networks. Using field examples that have been acquired across different depositional environments, we demonstrate that the resulting 2D/3D facies models ease and improve the interpretation of GPR data. We conclude that our interpretation strategy allows to generate GPR facies models in a consistent and largely automated manner and might be helpful in variety near-surface applications.