

# **Understanding the Effect of Near-surface Extreme Velocity Heterogeneities on the Seismic Data in the Arid Environment Through High-fidelity Outcrop-based Models**

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## **Abstract**

A complex interplay between near-surface sub-seismic lithofacies heterogeneities and diagenetic overprint partially causes inferior seismic data quality in the arid environment. Capturing and replicating near-surface geological complexities is the essential first step toward building an optimum acquisition design and processing workflow to address this low-quality data. This study constructs 3D high-fidelity outcrop analog velocity and density models and utilizes them to investigate the effect of extreme near-surface property heterogeneities on the arid seismic data. A 5 km x 5 km x ~120 m facies model at 5 m x 5 m x 30 cm resolution was constructed based on carbonate outcrop analog studies from three separate locations. The facies model includes the intricate meter-scale facies geometry of rudstone channels and stromatoporoid/coral buildup complex constructed by process-based modeling. P-wave, S-wave, and densities at cm-resolution were populated using publicly-available measurements of the analog rocks. These measured properties were then distributed to the facies model. A one-degree homocline was applied to the resulting facies-controlled P-wave, S-wave, and density models to simulate a simple structural dipping. A maximum of 3 m thick low-velocity topsoil layer partially covers the models. Overprinting karsts were distributed to the 3D property models based on open-source satellite image mapping of circular topographic depressions in the area. The karsts have velocities and densities of the topsoil. The final resulting models feature not only a complex juxtaposition between karst, topsoil, and the bedrock but also a complex three-dimensional lithofacies variation inherent within the carbonate rocks. Simulated 2D split spreads from some portions of the models show poor quality shot gathers similar to the typical seismic data from the arid area. The resulting models can be utilized as a sandbox to test acquisition design or processing workflow to improve the data quality in the arid area.