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Investigating a small-scale archaeological feature in the ancient city of Miletus using shear wave seismics

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The ancient city Miletus is located at the Mediterranean coast of present Turkey. Its former geographical position on a land tongue in the Gulf of Miletus with four bays, which can be used as harbours, made the city a place of great economical interest. During the last decades, several archaeological and geophysical investigations were carried out to reconstruct the cityscape of Miletus.
In 2018, geoelectrical measurements revealed a high-resistive anomaly near the ancient western market place. The aim of the presented study is a more detailed imaging of this anomaly with help of shear wave seismic methods.
For this purpose, a 35.5m long profile was build up across the geoelectric anomaly. An overall of 72 S-geophones was used with a spacing of 0.5m. Shots were struck every 1m by the use of a hammer and a shear wave source.
A "simple" velocity evaluation by the Wiechert-Herglotz method shows shear-wave velocities between 270-380 m/s in the first three meters. This depth gradient of velocities is verified by a refraction tomography using the first breaks of each channel. The tomography also shows a high velocity zone of about 470 m/s in the deepest part of the model.
A Full Waveform Inversion (FWI) was calculated using the refraction tomography as a start model. The inversion model shows three distinct high velocity zones in a, apart of these anomalies, quite homogeneous model. In these zones, velocity reaches values of more than 500 m/s.
The results are in accordance to geoelectrical measurements conducted on the same profile. High velocity zones strongly correlate with areas of higher electrical resistivity. Corings near these velocity and resistivity anomalies show massive layers of limestone starting at a depth of about 1.5m and thus verify the findings of the geophysical investigations.
In conclusion, the shear wave seismic measurements are capable of resolving small-scale features even in shallow depths, especially with help of FWI. Together with the geoelectrics and corings, the results deliver an important contribution for the further interpretation of the buried archaeological feature.