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Testing & Validating: 3D Seismic Travel Time Tomography (Detailed Shallow Subsurface Imaging)

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A detailed full 3 dimensional P wave seismic velocity model was constrained by a high-resolution seismic tomography experiment. A regular and dense grid of shots and receivers was use to image a 500x500x200 m volume of the shallow subsurface. 10 GEODE's resulting in a 240 channels recording system and a 250 kg weight drop were used for the acquisition. The recording geometry consisted in 10x20m geophone grid spacing, and a 20x20 m stagered source spacing. A total of 1200 receivers and 676 source points. The study area is located within the Iberian Meseta, in Villar de Cañas (Cuenca, Spain). The lithological/geological target consisted in a Neogen sedimentary sequence formed from bottom to top by a transition from gyspum to silstones. The main objectives consisted in resolving the underground structure: contacts/discontinuities; constrain the 3D geometry of the lithology (possible cavities, faults/fractures). These targets were achieved by mapping the 3D distribution of the physical properties (P-wave velocity). The regularly space dense acquisition grid forced to acquire the survey in different stages and with a variety of weather conditions. Therefore, a careful quality control was required. More than a half million first arrivals were inverted to provide a 3D Vp velocity model that reached depths of 120 m in the areas with the highest ray coverage. An extended borehole campaign, that included borehole geophysical measurements in some wells provided unique tight constraints on the lithology an a validation scheme for the tomographic results. The final image reveals a laterally variable structure consisting of four different lithological units. In this methodological validation test travel-time tomography features a high capacity of imaging in detail the lithological contrasts for complex structures located at very shallow depths.