Studying the Effect of Receiver Intervals on the Resolution of Seismic Tomograms Using Field Examples

Sherif M. Hanafy, King Fahd University of Petroleum and Minerals, CPG, Dhahran, Saudi Arabia

# Abstract

The resolution of a seismic tomogram is influenced by various parameters determined during data acquisition (such as the number of shots/receivers and their intervals) and inversion (such as the initial velocity model, number of iterations, and accepted error). This study specifically investigates how varying receiver intervals affect the resolution of final traveltime tomograms. We analyzed three seismic profiles recorded in Taif, Saudi Arabia, where igneous and metamorphic rocks characterize the study area. We used three-receiver intervals to record the field data, as shown in Table (1). To understand the subsurface geology of the area, many boreholes were drilled, from which we collected 12 core samples. The collected core samples' depth ranges from the surface to 650 m below the ground surface. The bulk density and the P-wave velocity are measures for these core samples, and these lab measurements are used as ground truth to validate the final tomograms.

***Table 1: The acquisition parameters used to record the field data.***

|  |  |  |  |
| --- | --- | --- | --- |
| **Profile No.** | **No. of Rec.** | **Rec. Interval (m)** | **Profile Length (m)** |
| P1 | 121 | 1 | 120 |
| P2 | 41 | 4 | 160 |
| P3 | 110 | 10 | 1090 |

The first arrival traveltimes of the recorded data are manually picked and then inverted to generate the corresponding traveltime tomograms. Final tomograms indicate that the maximum penetration depth correlates with profile length, where P1 and P2 achieve a maximum depth of 42 m, while P3 reaches 150 m from the surface. The velocities observed in the traveltime tomograms ranged from 1000 m/s to 6500 m/s, aligning with core sample measurements of 2840 m/s to 6420 m/s. These high P-wave values are expected due to the subsurface lithology in the study area. Notably, the contrast in detail among the tomograms is significant, with P1 and P2 revealing intricate local anomalies corresponding to green and felsic schists. In contrast, P3, with the larger receiver interval, provides a broader view of the subsurface geology but lacks the resolution to capture these detailed features. Our result confirms that the difference in tomograms’ resolutions is mainly due to the receiver interval used, and partially due to the number of receivers and the profile length, which highlights the critical role of receiver intervals in enhancing the clarity and detail of seismic tomograms.