Seismic data quality control based on semblance and envelope attribute analysis

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Assessing the quality of seismic data is always an important task for the data obtained after seismic processing. An important preparatory step is the application of suitable criteria and adequate quality control of the processed data. The quality of seismic data is affected by many factors, including geology aspects, seismic acquisition problems, signal processing, and others. To evaluate the quality of the processed post-stack data, the joint behaviour of the envelope (E) and semblance (S) attributes was proposed for consideration. A cross-plot analysis E = f(S) between envelope (E) and semblance (S) was also performed to detect pitfalls and poor-quality records in seismic data. In post-processed seismic data, quality problems may be obscured and not explicitly displayed, and only advanced analysis of wave characteristics can reveal footprints on the record. The developed approach to data quality evaluation was tested on the 3D seismic data of the southern Ural Foreland. The generated envelope (E) and semblance (S) cubes were analyzed for different aspects, with the analysis performed in vertical and horizontal directions. Most importantly, quality was assessed at the level of target horizons, which are located in the lower part of the seismic record. Within the intervals of interest, slices of the envelope and semblance attributes were extracted. A closer look at the obtained slices revealed the existing problems related to the merging of the northern and southern cubes. The border between merged cubes is displayed as footprints. It is also possible to show gaps on traces referring to zero values. The problematic records obtained relate mainly to the southern part of the merged survey and are well highlighted on the semblance attribute slices. The seismic record of the northern part is much less complicated by such pervasive vertical anomalies, except for the marginal zones of minimal folding. For a more detailed identification of the problem areas, a cross-plot analysis E = f(S) between envelope and semlance attributes was performed. With the help of this analysis, three zones of critical values (A, B, C) could be identified. The analysis of the separated zones on the cross-plot E = f(S) helps us to define the areas of the absence and irregularity of the records belonging to the “A” zone, other problem areas of the record corresponding to the “B” zone and the reflections isolated in the “C” zone can be correlated with the regular record. The most representative anomalies of problematic data are identified in the “A” and "B” zones at shallow times of 300–500 ms and are associated with poor recording and other footprints after seismic processing and acquisition. According to the generated time slices E = f(S), existing problems on seismic traces demonstrate their continuation on a smaller scale at times from 500 to 700 ms. The records below 700 ms in the northern sector show much better quality, while there are still recording problems in the southern part; moreover, the pitfalls on the CDPs have a vertical pervasive character. It can be concluded that the seismic survey in the southern sector is plagued with registration problems in many intervals and can obviously be recommended mainly for qualitative estimations and basic structural correlation and is not suitable for quantitative interpretation (seismic inversion, AVO, attributive analysis, etc.).