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2D to 3D high-resolution seismic data conversion: imaging a shallow water metal bearing mine tailings deposit in Portmán Bay, Spain

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High-resolution (HR) 3D seismic acquisition is expensive and often not available due to a variety of reasons. This work builds an optimized workflow to convert a dense 2D HR seismic grid into a 3D seismic volume. The task has been developed within a broader project, NUREIEVA, which aims at characterizing a metal-rich onshore and shallow marine mine tailings deposit in Portmán Bay, Murcia, Spain, which developed from 1957 to 1990. Hence, in the framework of the NUREIEVA project a very dense set of 2D HR seismic lines was acquired. The geophysical equipment used to capture the submarine extent, thickness and internal structure of the mine tailings deposit was a hull-mounted Kongsberg TOPAS PS18 single-channel parametric source. The seismic grid thus acquired consisted of 1309 2D lines, with an approximate distance between lines of 10 m, covering an area of 7.45 km^2. The parametric source yielded a vertical resolution of 15 cm, which is very high if compared with conventional seismic reflection data.

In order to visualize the internal architecture of the mine tailings deposit in all directions, it is desirable to convert the dense 2D network of lines into a full 3D data volume. Such a data volume is intended to assist reaching faster deposit delimitation and more accurate volumetric calculations. For this purpose, a new optimized 2D to 3D conversion processing flow including a 3D interpolation scheme has been designed. Given the specific characteristics of the input data, a number of challenges had to be addressed, namely: (i) a very high vertical resolution that differs by at least two orders of magnitude from the horizontal resolution; (ii) a large data volume (2 TB), which involves extensive computing time; (iii) the heterogeneity in the acquisition parameters. Because of this, the lines had to be processed previously to the 3D interpolation to homogenize the imaging characteristics and signal content. This new methodology can be now applied for obtaining a 3D volume to any case where a single channel dense 2D seismic grid is available. Furthermore, the new methodology, duly adapted to each particular scenario, represents a low cost alternative to conventional HR 3D seismic and could prevent further seismic shooting in areas when 2D data is already available.