Geophysical Research Abstracts
Vol. 16, EGU2014-15839-2, 2014
EGU General Assembly 2014

High resolution seismic reflection/refraction profiling across a large debris flow fan (Vinschgau/Venosta Valley, Italian Alps).

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Fan-shaped deposits are common in formerly glaciated mountains, especially where steep tributary valleys join broad troughs; this being a classic locus where high volumes of mobilized sediment suffer a sudden loss of transport power. A group of exceptionally large alluvial fans occurs in Val Venosta, a major glacial trough in the east-central Alps, Italy. In this work, our attention is focused on the Gadria fan, near Lasa/Laas; it is one of the largest symmetrical fans in the Alps: it deflects the Adige River to the opposite slope foot and dominates Val Venosta as an extraordinary half-barrier. Using a high-frequency vibratory source, we acquired and processed an $\sim$4 km long high-resolution seismic reflection profile across a representative transect of Val Venosta, over the Gadria fan, and across the residential area of the village of Laas. One of our targets was indeed the study of the shallow portion (about 500m deep) of Gadria alluvial fan.

Alluvial fan environments, often present significant challenges for high-resolution seismic exploration. The main factors hindering seismic imaging are: 1) strong lateral velocity contrasts in heterogeneous sediments of the shallow portion of subsurface; 2) unfavorable topographic conditions along the profile and 3) presence of dipping reflectors representing the bedrock. A dense wide-aperture acquisition geometry, allowing nonstandard processing and a meaningful interaction and comparison between refraction and reflection data has been proven capable of overcome most of the above-mentioned limiting factors (Improta & Bruno; 2007 Bruno et al., 2010, 2011, 2013). A dense wide-aperture acquisition geometry allows recording both multi-fold reflection data spanning a large range of offsets and deep penetrating refracted waves, which are suitable for first-arrival travel-time tomography. Tomography contributes information about the subsurface structure and also provides a good control on the near-surface velocity structure that is crucial for improving the quality of static corrections.

Reflection data were processed using both a standard CDP processing and a common-reflection-surface (CRS) processing. The CRS stack is a new alternative to the classical processing sequence of normal moveout, dip moveout and stacking. The method uses a stacking operator that locally describes the response of a reflector in a laterally inhomogeneous medium and does not depend on the interpretation of a stacking velocity model. The application of the CRS stack allowed an improvement of S/N ratio with respect to the CDP stacked sections without introducing significant artifacts. In particular, continuity of both the shallow reflections from the Adige river deposits and the seismic basement is considerably enhanced. Seismic reflection images and V_P tomography velocity modes are in excellent agreement and allow to evaluate: (1) the structure and topographic pattern of the valley bedrock along the entire profile; (2) the thickness of sediment accumulation, and the valley engraving; (3) the seismo-sratigraphic features of the Adige river deposits, which fill the more depressed portion of the valley; (3) the geometry of alluvial fan's deposits. We are confident that our results, tied to well data to be drilled along the profile in the next months, will prove very useful in better understanding the debated genesis of Adige Valley.