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Investigations on alluvial deposits through borehole stratigraphy, radiocarbon dating and passive seismic technique (Carnic Alps, NE Italy)

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Alluvial sediment investigations provide fundamental tools to infer the processes that control geomorphological evolution of mountain environments. By analyzing sediment stratigraphy in depth, it is possible to retrieve the source, the geology, the time of deposition, the relative distance travelled by material as well as to distinguish among different type of transport (i.e., gravitational, fluvial or glacial).

In this work, we present a combination of log stratigraphy, radiocarbon dating and geophysical surveys carried out on the valley floor of the But River (Carnic Alps, North East Italy). The But River basin drains an area of 326 km^2 with a range in elevation from 2769 to 323 m a.s.l.; the bedrock mainly consists of carbonates and quartz arenites with minor inclusions of effusive rocks. After Pleistocene the gravitational deposits from mountain slopes have impounded the But River several times. In particular, we analyzed a sector of the upper portion of the But valley close to the confluence of the Moscardo Torrent, frequently affected by debris flows.

A borehole was drilled in the But River floodplain, at the intersection with the Moscardo Torrent alluvial fan, down to a depth of 80 m. The analysis of the core samples allowed discerning three sedimentary levels rich in clay and organic materials, which testify the presence of small dam lakes, originated from the Moscardo debris-flow deposits. Three samples of wood and plant debris were collected from 13, 14 and 23 m of depth, respectively. They were analyzed through radiocarbon dating in order to determine the age of the lakes and, thus, to infer the activity of the debris flows building the Moscardo cone. The calibrated ages of the 3 samples are close to the younger limit of the radiocarbon method indicating a fast aggradation of the valley floor, starting from a period ranging between 1450 - 1632 AD. Historical maps and documents confirm the presence of the lakes until 19th century and they permit to assess their extent and the maximum depths.

Two passive seismic campaigns were carried out near the borehole site and along the But valley at different elevations. The aim was to investigate the depth of the buried bedrock and therefore to indirectly characterize the thickness of alluvial deposits. We calibrated the fundamental frequency of each site by constraining average shear velocity of the alluvial sediments close to the borehole site with known stratigraphy. Eight HVSR (Horizontal to Vertical Spectral Ratio, Nakamura, 1989) were carried out, and thus a first sketch of the buried valley floor along a longitudinal profile of about 5 km was depicted. The values of the derived bedrock depth allow to quantify the differences in thickness between the alluvial deposits and the Moscardo Torrent fan deposits. This information helps to address the contribution of the debris-flow processes in damming the upper But River during the last five centuries.

The results confirm the role of debris-flow deposits from the Moscardo Torrent in shaping the morphology of the valley floor of But River and show suitability of an integrated approach, encompassing log stratigraphy, geophysical surveys and analysis of historical documents, for gaining insights on the evolution of alpine valleys.

Reference

Nakamura, Y., 1989. A method for dynamic characteristic estimation of subsurface using microtremor on the ground surface. Quarterly Report of Railway Technical Research Institute, 30(1): 25-33.