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# Geophysical 3D models of likely seismically triggered large landslides in the SE Carpathians

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The task of characterising deep-seated mass movements in mountainous regions is challenging, especially if age and circumstances of the failure are unknown. In this work, we illustrate the potential of geophysical investigation methods on two old landslide bodies in the SE Carpathians and present integrated results in the form of high resolution 3D models.

The region of Vrancea-Buzau in the SE Carpathian Mountains in Romania is known as seismic region having endured at least four earthquakes of MW > 7.4 during the last two centuries; e.g. “the Great Vrancea Earthquake” in 1802 (Georgescu, 2002) as well as the MW 7.7 quake in 1940. Seismically induced ground failures are common phenomena in the study area, but examples documented by historical documents are generally quite small. Here, we analyse older, much larger and deep-seated landslides and rock falls near mountain ridges for which the type of triggering is not known but is likely to be related to large past earthquakes and probably less connected with climatic factors. The latter can be considered as the cause of by far most of the shallow and flow-like mass movements in that region.

The two slope failures here described developed in Carpathian flysch, i.e. intercalated layers of sandstone and shale, and their morphologies are marked by prominent detachment zones near the mountain crest and hummocky surface structures typical for landslide deposits. The first site presented is the Balta landslide with its geological setting dipping into the slope, which under normal conditions would support slope stability and thus the need of an energetic impact to cause failure, e.g. of seismic nature. The second site, called “Lacul Vulturilor” or “Eagle’s Lake”, is presumably a result of several events. It is marked by soil compressions, probably due to high pressure waves, recent rock falls and the presence of a swamp area as well as two lakes, one of which is water-filled and one ephemeral.

The principal contribution to the here presented geophysical prospection of both sites, and later for the model creation, is the H/V technique. Measurements are performed with a single seismic station, in order to record the ambient noise of the soil. Here, we use the technique to define the depth of loose material overlaying intact substratum and thus to determine the basis of landslide (i.e. the impedance contrasts between two media). In addition, 2D geophysical surveys were performed in form of seismic refraction (SRT) and electrical resistivity tomographies (ERT). The seismic surveys are thereby interpreted in terms of P-wave and surface wave velocity of the subsoil. In order to reproduce the investigated slopes, all processed data were incorporated in the high resolution 3D models. The data illustrates the measured contrasts in form of electrical resistivity, seismic velocity or microseismic frequency response. This information allows the creation of interpolated surfaces and corresponding volumes to characterise the geological structure of the landslide bodies and their substratum.