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Cosiesmic slope mass movements and its contribution to the Holocene landscape denudation: geological evidences and numerical estimations from SE Altai (Russia).

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Strong earthquakes deform Earth's surface and affect the topography of mountain terrains. They can also induce widespread mass wasting which often cause most of the global damage and most of all casualties related to the earthquakes. Their abundant occurrence and large volumes of displaced material also indicate a great influence of seismically induced landslides on landscape denudation. Estimating earthquake magnitudes and topography changes using instrumental data and historic accounts can give information about regional seismicity during relatively short time period. At the same time the evolution of paleoseismogeological studies clearly demonstrates that in order to properly understand the seismic potential of a region, and to assess the associated topography changes, extensive studies are necessary to take full advantage from the geological evidence of past earthquakes. The key point of this investigation is detailed study of geomorphologically expressed surface displacement of evidently seismic origin.
The Altai neotectonic uplift is the part of Central-Asian collision belt and is a transpressional zone formed due to oblique thrusting. Russian Altai is the northern extension of Mongolian Altai which is known by its high seismicity. As a result SE Altai is the most seismically active part of Russian Altai. This was evidenced by the 2003 Chuya earthquake (MS = 7.3).
Strong Holocene earthquakes left the most enduring imprint on landforms of Russian Altai. Giant landslides have been well preserved in topography here due to arid climate. The leading factor in generation of such landslides is seismic excitation. Our field observations of the ground effects of strong modern and prehistoric earthquakes reveal regional criteria that indicate seismic origin of Altai paleolandslides. Unconsolidated Cenozoic sediments presented in the most active areas at the depression-range transition along fault boundaries of landforms provide geological conditions of landsliding in this active mountain terrain.
Paleoseismogeological study of SE Altai reveal a number of strong Holocene earthquakes (shaking intensity IX - X according MSK-64 scale). These events generated a lot of ruptures and giant landslides. Paleolandslide's close location in the modern earthquake's epicenter zone shows that the source areas of large earthquakes in SE Altai were repeatedly reactivated. Strong prehistoric earthquakes with magnitudes M>6.9 occurred here. Besides, this fact also argues the hypothesis of the identity of historic and Holocene earthquake's mechanisms in a region. Thus unilateral displacement of tectonic blocks along the bounders of the Chuya-Kurai intermountain depressions took place at least from the beginning of the Holocene.
In our researches we mainly focused on the largest earthquake triggered landslides. These giant paleolandslides already in itself evidence to high regional seismicity. Using data from 15 strong modern earthquakes worldwide we have calculated the correlation between earthquake magnitude and the volume of the largest triggered landslide. We have also modified correlation between earthquake magnitude and the total volume of generated landslides. All these allow us to estimate magnitudes of prehistoric earthquakes, calculated the total volume of earthquake triggered landslides, the contribution of landslides caused by aftershocks and the Holocene erosion rate due to seismically induced landslides for SE Altai.