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The relief of the Azau Valley, Caucasus Mountains, as a product of volcanic activity and glacier oscillation during the last millennium

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The paper reports on a study reconstructing the order of volcanic events and glacier oscillation in the Azau Valley, the Central Caucasus Mts, during the last 1,100 years, when the valley's current landform was formed. The Azau Valley runs eastwards from between the Mt. Elbrus massif and the main ridge of the Caucasus. The valley has a high-mountain relief; its bottom is at 2100-3200 m a.s.l. and it has slopes of different height. The southern slope raises to more than 3000 m a.s.l., while the Mt. Elbrus' volcanic cone on the northwestern side reaches 5643 m a.s.l. Glaciers cover the volcano, the upper section of the valley and its tributary valleys, including large parts of the slopes. The period analysed here begins at the time of the latest lava flow went down the southern face of the Elbrus and blocked the valley. This event is regarded as a direct geomorphological effect of volcanic phenomena in the valley, while more indirect effects include numerous terrain forms produced at that time. Some of them have been nearly entirely eroded away, but most have survived to this day. Until the 18th century, the greatest scale of transformation of the local landform was caused by jökulhlaup floods resulting from sections of the Mt. Elbrus ice cap melting periodically. They produced a number of landforms, including: deep V-shaped incisions into U-shaped glacial valleys, large accumulation fans, braided channels hanging high above the main channel (currently dry), undercut paraglacial fans at the base of the granite slope and eroded-out or fossilised terminal moraines. The effect of the glacial oscillation on the relief of the Azau Valley was only investigated within approximately the last 300 years, i.e. since their maximum glacier reach during the Little Ice Age. Direct geomorphological effects of Mt. Elbrus' volcanic activity affected just a 2-kilometre reach of the valley, while the indirect effects stretched along the entire length of the valley downstream from the lava flow. During at least the last 200 years, since Mt. Elbrus has been dormant, rapid erosion of the lateral moraines, serving as the main source of material for debris flows, processes linked with glacial recession drove the changes to the Azau Valley relief. In this high-mountain cascade system where waste rock material is transferred from the slope system into the valley system and onwards along the valley bottom waste material is exported by the hanging side valleys and imported by the main valley. Eight reaches were identified along the main valley that differed in landform and its rate of change. The study is based on the author's fieldwork and on the analysis of maps and photographs from the last 140 years, as well as of satellite images and literature (mostly by Russian authors).