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Immersive virtual reality gaming for geoeducation: proof-of-concept for the prehistoric Wildalpen Rock Avalanche, Austria

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Geoeducation involving people of all ages and societal groups represents an important foundation for building more sustainable societies, including a better awareness of hazardous processes such as landslides and related geomorphic phenomena. In the 21st Century, geoeducation stands in tough competition with a multitude of other pieces of information received by post-modern humans. To ensure that messages are appropriately received and remembered, geoeducational resources have to be funny and impressive. As immersive virtual reality (VR) experiences are supportive to this aim and are becoming more broadly affordable, we apply this technique and develop a set of landslide-related geo-gaming applications, which will be installed at the visitor centres of the three Austrian UNESCO Global Geoparks (UGGps), and freely available to all those who have the necessary VR equipment.

We present a first proof-of-concept study for the prehistoric Wildalpen Rock Avalanche, which occurred sometimes between 5900 to 5700 a BP during the autumn or winter period and displaced a rock mass of approx. 900 million m³. The area affected by the prehistoric rock avalanche is located in the Steirische Eisenwurzen UGGp in the province of Styria. Based on topographic reconstruction of the pre-event terrain and the release mass, we simulate the dynamics of the rock avalanche with the open-source mass flow simulation tool r.avaflow 3. This tool is equipped with

- a new, highly automatized, work flow for constructing VR-ready meshes in the open-source software Blender 3 and, on this basis, to generate videos that can be watched in VR with simple anaglyph or 3D glasses; and
- a script to generate animations (sequences) of landslide dynamics in the game development software Unreal Engine 5, based on the meshes produced in Blender 3.

Such sequences can be integrated in immersive VR gaming applications of various levels of complexity. Players can trigger multiple landslides at different pre-defined locations and different times. In our proof-of-concept-study, we present a simple one-player game in which the Wildalpen Rock Avalanche can be triggered by grabbing a magic wand and touching with it the release area of the landslide. After the avalanche has come to rest, a piece of a fir (*Abies alba*), which was

embedded in the rock avalanche sediments, appears at the surface of the deposit. Such tree logs have been used to date the event. The log can be grabbed by the player and, when touched with the magic wand, will tell how it has experienced the rock avalanche and the time after.

Remaining technical challenges include possible effects of flow-type landslides on the players. Unreal Engine 5 is centred on interactions between discrete objects: whereas it would be straightforward to displace a player hit by a falling rock, dragging away a player by a continuously moving flow represented by a sequence of meshes is much more demanding from a game development perspective.

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