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## The influence of hazardous geological processes on the transport infrastructure within the river valley of Aurgasa (Bashkortostan, Russia)

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### Abstract

The article analyses an example of the impact of hazardous geological processes (landslides, karst) on the highway Ufa-Orenburg region. Activity of hazardous geological phenomena, presumably, is caused by tectonic factors. The article emphasizes that in the designing, construction and reconstruction of transport infrastructure one have to take into account engineering-geological features of the areas.

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*Keywords:* highway, landslide, karst

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### 1. Introduction

Guaranteeing of projecting, construction and safety exploitation of transport infrastructure objects needs fair and reliable information on the development of hazardous geological phenomena influencing technogenous entities. The highway Ufa-Orenburg at the crossing of the river Aurgazy valley (in the vicinity of the N. Kal'chir settlement) has been influenced by the complex natural and technogenic induced determined geological processes impeding its

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exploitation. In the article, the results of investigation of hazardous geological processes and their effect on the highway Ufa-Orenburg part are considered.

## 2. General provisions

At present, the geological risks associated with activity of karsts and landslides refer to specific types of geological impacts on man-made objects [1]. However, in the guidance documents (Standards, Guidelines, and Codes) regulating the practice of site investigations for construction, the study of karsts and landslides phenomena carried out separately [2, 3, 4, 5]. Along with that, the mutual influence of different geological hazards (karst, landslides) is not taken into account. On the other hand, there is a need for a re-examination of dangerous geological processes activation (e.g. the influence of tectonic faults or some other geological criteria re-evaluation). Also, it is not researched the possibility of joint negative impact of the processes mentioned on man-made objects (in particular, on objects of a transport infrastructure). As a result, in the design and construction of transport infrastructure, some mistakes can happen and maintenance of roads is broken.

## 3. Geomorphological conditions and geological setting peculiar features

The territory under investigation is situated within the Aurgazinsky region of the Bashkortostan (Russia). The examined area is located at the right (northern) side of the river Aurgazy valley. The river Aurgazy is in its turn the right tributary of the river Urshak. The river Aurgazy valley at the examined area is characterized by asymmetrical structure: its right side has an erosion character and has a form of a ledge eroded in the "uplifted" surface formed by the bedrock sediments. The left side of the river Aurgazy valley is formed by Quaternary sediments and obviously looks like the accumulative structure. The peculiar feature of the river Aurgazy valley left side is connected with its ruggedness by a network of gullies and ravine cuttings. The level difference between the near water shed surface and river valley bed at the examined area accounts for about 110-130 meters.

The highway Ufa-Orenburg intersects the river Aurgazy valley from the north to the south. Just at the entrance in to the river Aurgazy valley (from the side of its high right bank), the highway is built onto a high embankment gently sloping into a southerly direction. The upper part of the geological cross-section at the territory under investigation is composed of terrigenous-carbonate-sulphate Lower-Permian sediments belonging to the Ufimsky stage ( $P_{1u}$ ). According to the drilling data (obtained from the «Bashkirdortransproject»), these sediments consist of the dusty argillite-like clays and dusty aleurites, light-grey, grey, greyish-brown, reddish-brown hard with inter layers (up to 0,3-0,5 meter thickness) of grey and light-grey marls and gypsums destroyed in separate intervals by karst processes up to rubble and gravel. The general thickness of the Ufimsky sediments revealed by drilling accounts for more than 17 meters. The Ufimsky stage sediments are underlined by the sediments of the Iremsky suite of the Kungursky stage ( $P_{1k}$ ). Within the structure of the Iremsky suite one may outline three carbonate and four sulphate members. The Iremsky suite stratum is opened in the bed part of the river Aurgazy valley and is intensively karst effected [6].

The granulometric composition of the clayey sediments of the lower part of the Ufimsky stage is characterized by the following quantity of particles: clay dimension particles varying from 15-18% up to 26-28%, silts dimension particles varying from 38-44% up to 51-53%, coarse sand dimension particles not exceeding 2%. The Ufimsky stage sediments are characterized by the following physico-mechanical properties: density - from 1,83 g/cm<sup>3</sup> up to 2,04 g/cm<sup>3</sup>, natural water content – from 17% up to 26%, plasticity index – from 13-15 up to 21, cohesion – 0,032-0,044 MPa, angle of internal friction – 18-27°.

At separate parts the Ufimsky stage sediments are deposited in their deposited state, and forming the Holocene stratigraphy-genetical complexes, up to 4-5 meter thick, and up to 6-8 meter thick or even more. The formation of the Holocene sediments is connected firstly with the development of landslide processes. As for these sediments, they are characterized by lowered values of physico-mechanical properties: density - from 1,67 g/cm<sup>3</sup> up to 1,82 g/cm<sup>3</sup>, natural water content – from 31% up to 40%, and plasticity index – 24-25.

The upper part of the Iremsky suite stratum consists of the sulphate member.

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