

# RISK ASSESSMENT ON LANDSLIDES PROCESSES OF THE NORTH-EAST OF LAKE SEVAN (ON THE PATTERN OF VILLAGE AVAZAN)

Hasmik Balyan

Department of Physical Geography, Yerevan State University, 1, Alek Manoukian Street, Yerevan, 375025, Armenia – [hbalyan@ysu.am](mailto:hbalyan@ysu.am)

**KEY WORDS:** Landslides, Rejuvenation, Underlava Streams, Interlava Streams

## ABSTRACT:

Especially they are widely spread in the areas of mid and low-mountainous villages where is the rapid strengthening of fluvial-glacial processes and intensive destruction of shapes by river valleys and by gulch ravine net.

Geologic-geomorphologic surveys are the important preliminary stage in the studying of landslide process. Studying landslide zone is located in south-east part of Sevan range which belongs to the system of folded-block ranges of the Small Caucasus.

From the geological point of view, Sevan range is huge and complicated anticlinoria of General Caucasian spread. Slopes, directed to Sevan Lake, are steep enough (20-30 degrees) and have stepped structure, conditioned by young fault disorders. The range slopes are divided by thick river net gulch ravine, most of which have steep V-shape profiles. Landslide processes are highly popular on slopes due to steppe structure of steep slopes that are pliant to sliding of volcanic-sedimentary and heavily smashed rocks.

Rejuvenation of those faults in quaternary period brought to formation to some landslides as well as to the one we study. The latter is located directly under the villages of Avazan. Landslide ranges the slope 500 meters in length and 200 meters width. The head part is cirque-formed with abrupt wall of cracks-estrangements with 2-3.5 meters height. Landslide body has wavy-stepped structure probably conditioned by complicated system of fault-estrangement. There is basin-shape fall next to the foot of slope with mire bottom pointing the exit for ground waters. On the tongue of the landslide there are numerous cracks of different types. In distance of 300 meters from the edge of the village, landslide is getting narrow then it becomes fan-shaped again and by its tongue part catches row of houses on the edge of village.

On the very end of the tongue where the slope cut is, near river Avazan there is a system of diametrical fractures. That shows that the river bed and main part of the village that litter stable rocks due to which landslide tongue moves to river bed.

Although the constant slope cut by the river that has big eroding strength causes threat of continuous move of landslide masses and their take away by river as alluvial fan deposits. Besides described morphologic conditions and rock character addicted to sliding hydro morphologic conditions also stimulate.

Numerous springs on the bottoms of landslide ledges and on the bottom of basins sow that there are many confined waters in the landslides that are lens-shaped between clay rocks.

There is a fault distracts on the slopes of the entire Sevan range directed valley. Faults usually are located as parallels and sometimes they rapidly change their direction of lines. Fault planes of dislocated steps are close to landslides that are especially spread there and where are the exits of serpentinite ultrabasic intrusions. Entering of ground waters into contorted bedding zones stimulates activations of landslides – cleave made serpentinite into type of clay slates that are pliant to sliding.

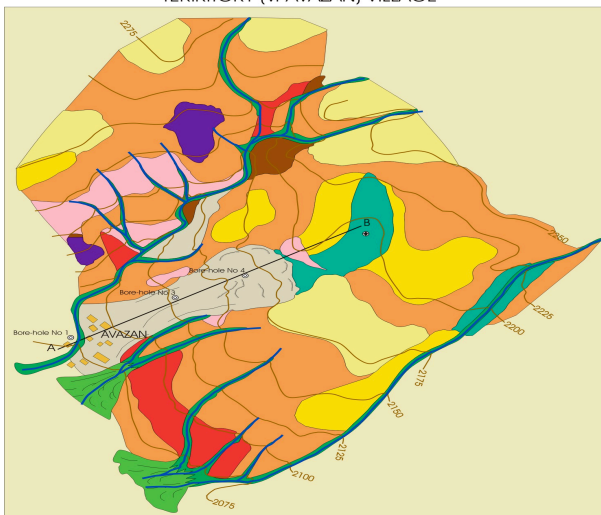
## MANUSCRIPT

Landslides in the RA are regarded as unfavorable natural phenomena that create ecological-geomorphologic hazards and do great harm to the national economy. In most cases these processes, being natural, often tend to be predetermined. Intensive rate of human burden (exploitation of high-mountain meadows and extermination of mountain forests due to energy crisis during the past 10-15 years) as well as changes in hydro-meteorological phenomena and elemental natural processes provoked their greater activity.

Northern and north-eastern parts of the republic are viewed as model regions of intensive development for various types of landslide and other gravity denudation processes, whose activity increases intensive modern neotectonic motions as well as ecologically hazardous exodynamic processes, rejuvenation and activation of which became evident after destructive earthquake of 1988.

Sevan ridge is a huge complicated anticlinorium of Caucasus strike. The slopes of ridge, inverted to Sevan Lake make a range of difficult undulation anticlines, stroke by longitudinal faults. Rejuvenation of these faults in quaternary age brought to formation of a range of landslides, among which the ridge, studied by us, is situated.

LITOLOGY-MORPHOLOGICAL MAP OF LANDSLIDE TERRITORY (V. AVAZAN) VILLAGE



It is also evident, that these fault contacts make favorable conditions for penetration into fault planes subsoil and ground waters. The latter ones transform schist-forming serpentinites into the clay slates, saturated by water. These new growths, having a small dip of resistance to the shear-fault and being under the big loading of the above-stated rock masses, come in movement on fault planes.

On the modern stage the investigation of such hazardous natural-technogenic phenomena has an actual character, and in particular, the determination of risk level and risk management. The latest investigations of the reasons of their appearance and development let us reveal some very important factors, allowing forecasting the further way of their development.

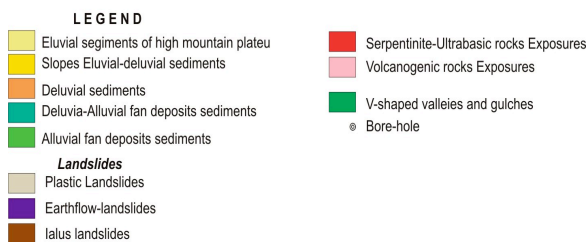
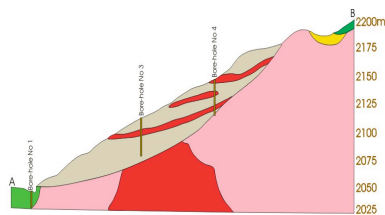
The results of stationary observations over landslide bench marks have a surface character towards ground masses with a minor power. The bench marks don't allow investigating the character and activity of landslide motions on much deeper horizons. Therefore with the purpose of supervision over a body of landslip modern fluctuations of the area of his distribution, the most effective is the remote method of vertical electric sounding, applied by us during the investigation Dilijan landslide, about which it is thoroughly stated in the article (Balyan, 2004).

The natural conditions of volcanic regions open wide opportunities of finding and using the large dynamic water reservoirs, which are concentrated in deep depths of volcanic highlands. About half of territory of the Republic of Armenia is covered with powerful (from 200 to 1 km) cover of lava flow and alternated with them sedimentary formations. The lavas are differed with intensive fissuring and proosity. In consequence of the great part of surface waters penetrates in lava rock mass, concentrating in the ancient buried valleys. In longstanding research process on the territory of the Republic and little Caucasus's

near regions, S.P. Balyan has outlined series of criteria for the revealing buried under the neogene-anthropogenic volcanogenic-sedimentary formations of underlava relief (S.P. Balyan, 1969). It is known that lava flows and lava sheets have buried ancient relief, dismembered by river system. Equalizing the ancient relief, the volcanic eruption products have created modern high mountain plateau and up of them huge volcanic massifs.

The lavas are differed with intensive fissuring and porosity. In consequence of, the great part of surface waters penetrates in lava rock mass, concentrating in ancient buried valleys, the planned picture and direction of which are differed from modern river system.

By paleogeomorphological researches, which were conducted by professor S.P. Balyan still in 1955, were revealed concrete, well-aimed and clear normalities of the shapes and shape development underlava and interlava relief. Namely, there are defined four complexes of the lava flow, essentially differing from each other with square development and water properties. Each complex has definite drainage square, corresponding to the given geological period of time. These contours in the following lava eruption phases are not repeated.



Moreover, the planned picture and direction of paleovalleys are differed from the modern river system. In deep erosion incised valleys are founded groups of powerful springs, discharge of which is calculated by hundred and thousand liters in a second.

The following picture was described by S.P. Balyan: Among the lavas of different cycles of outpourings are placed impermeable burnt scorched day stratum of the ancient rock waste and valley's deposits of interlava river valleys. In lava rock mass they create well-disposed storey each on other interlava streams of different directions. During their opening on the high slopes of volcanic massifs are also formed springs with large and enough firm regime. It is observed the following normality: the more deep is settled down the valley network, the bigger is its catchment square and, consequently, the degree of water output.

Underlava and interlava streams are not ordinary river runoff. It is a complicated complex, passing through fissures and pores of jet streams, which are, depending on the power of lava eruption of the given cycle, forming confined "horizons" of ground waters with the capacity of 100-150 metres (Paleokasakh). If the upper stream storeys are connected with the hydrometeorological regime of the given area, the low ones are differed with exclusive stability of the regulated runoff, which are forming big dynamic reservoirs of volcanic massifs and highlands.

For the realization of the entire capture of paleovalleys' buried streams of high hypsometric notes (marks), and also for the replenishment of the ground waters' reserves at the expense of flood flow, the professor S.P. Balyan proposed on principle new, rational approach for the solution of these problems. With this object has been used the complex paleogeomorphological, hydrological and geophysical research methods, authenticity of which has been already proved on many examples of the revelation buried

valleys in Paleokasakh, Paleoakhuryan and in other regions. So, Paleokasakh's waters capture on high marks, approximately  $4\text{m}^3/\text{sec}$ , will help in the solution of the problems of soil drainage marshed areas, entirely, in reduction of the Ararat plain unconfined ground water's level.

And the second, no less important problem is the replenishment of the ground water's reserves in the buried river basins through the way of conservation spring flood flow for the future water-security improvement in settlements, for irrigation of pastures and for other agricultural problems.

The parameters' definition of the buried valleys by the complex paleogeomorphological, hydrogeological and geophysical methods have allowed S.P.Balyan to mark (mention) the favourable areas of the powerful streams capture with firm regime, which are already possible to direct by the gravity to cities and settlements, which have a very big popular-economic meaning.

This method increases objectivity of the geographical forecast, improves quality of the received field material for the detailed analysis that allows preventing or adjusting them with a view of economic feasibility.