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IMPACT OF HYDROPOWER PLANT WATERS ON THE DESTABILIZATION OF SHORES AND CAUSING LANDSLIDE TO ITS SHORES

Alfred FRASHERI

- *Faculty of Geology and Mining, Polytechnic University of Tirana, Albania*

- Tirana, 2014

1. Introduction

- Albania represents a mountainous country and Albanides are represented geological structures with possibilities of instable slopes and landslide development .

- Based on the geological formations and landslide body mass, can be present following landslide classification in Albania:

- Instable slopes and intensive landslides developed in weathered bedrocks and in overburden bed at the lakeshores of hydropower plants.

  Instable slopes and intensive landslides developed in Oligocene flysch formation.

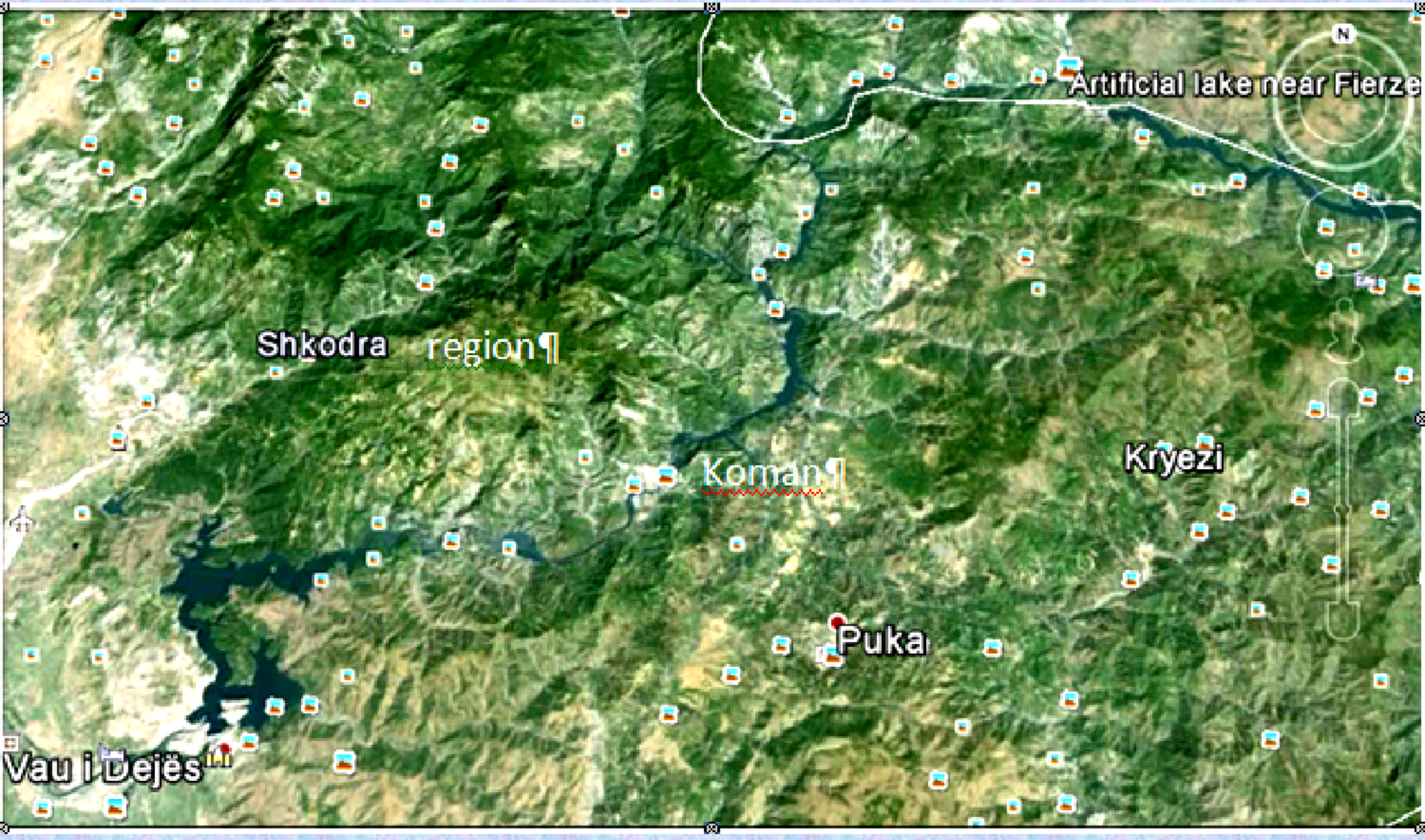
- Instable slopes and landslides developed in Neogene’s molasses formations.

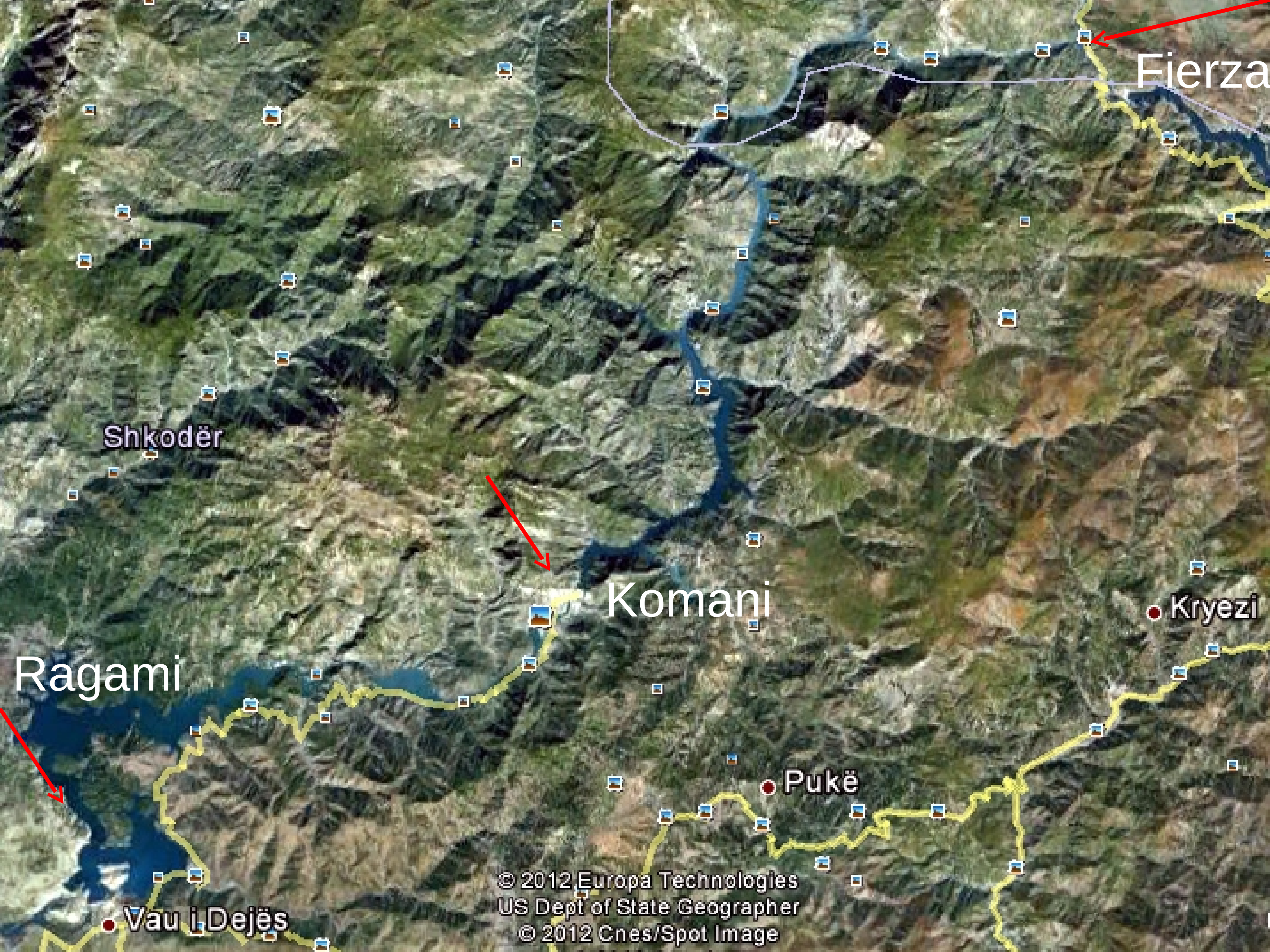
- Landslides developed in loose Quaternary deposits.

- Downfalls in the weathered rocks

- Albania has numerous and biggest dams belonging to the hydroelectric power plant system. These dams are made of concrete and/or rock fill with central clay core. Drini River hydropower plant cascade, at the Northern Albania, is the most biggest. This cascade is composed by Fierza, (1978), Komani (1985) and Vau Dejës (1971) hydro power plant. Fierza Hydroelectric Power Plant at higher river flow, has an installed power of 500 MW.
- The **volume of water** in its artificial lake is 2.7 billion m^3 and **lake depth** averagely 133 m. The dam has a **length on head** of 400 meters and height 167 meters.

DRINI RIVER BASSIN
RAGAMI AND PORAVA LANDSLIDES





Fierza
Shkodër
Komani
Kryezi
Ragami
Pukë
Vau i Dejës
© 2012 Europa Technologies
US Dept of State Geographer
© 2012 Cnes/Spot Image

PORAVA HYDROPOWER PLANT
DRINI BASSIN

SATELLITE VIEV OF PORAVA LANDSLIDES

- **Difference between maximal and minimal levels** of surface water in lake was varied over the years from some meters up to 30 or more meters, depending on the annual meteorological conditions.

The exploitation of hydrotechnical work over the last 27 to 41 years has influenced the modification of their physical- mechanical properties and constructive structure, but also to the lake shore slopes and water reservoirs.

There are observed active **landslides** in the lakeshores. The most biggest is landslide at Porava village, about 2,5 km from the Fierza dam, and Ragami landslide near of Ragami Dam in Vau Dejës. These landslises represent a great geological risk for hydropower plants, and Porava village. Walls of the houses are broken in Porava villages.

PORAVA LANDSLIDE

- In the paper are presented results of the complex geological-geophysical-geodesic investigations in landslides in Albania, and impact of the lake’s water on slope’s soil and bedrocks.

– INTEGRATED GEOLOGICAL-GEOPHYSICAL IN-SITU INVESTIGATION FOR LANDSLIDE PROGNOSIS,

Study and monitoring.

- **In-situ investigations and monitoring for investigation for landslide prognosis, study and monitoring were carried out by integrated engineering geology-geophysics methods:**
- **Geological Mapping**
- **Geomorphological Mapping**
- **Hydrogeological Mapping**
- **Engineering Geological Mapping**

Geophysical Mapping, in-situ investigation and monitoring

Gravity micro survey

Magnetic micro survey

High Frequencies Seismic Tomography and profiling.

Geoelectric Tomography, electric soundings and profiling, etc.

Electrical, radiometric, sonic etc. well logging

Laboratory analysis and determinations
Geodesic observations.

In-situ geophysical investigation and monitoring are programmed to perform in three phases:

1. Surface integrated geological-geophysical survey and installation of geodesic markers.

2. Drilling of shallow boreholes, cross-hole seismic survey and well logging.

3. Periodical geophysical surveys and geodesic observations in boreholes and on the ground surface.

Consequently, geophysical-engineering studies have a complex character:

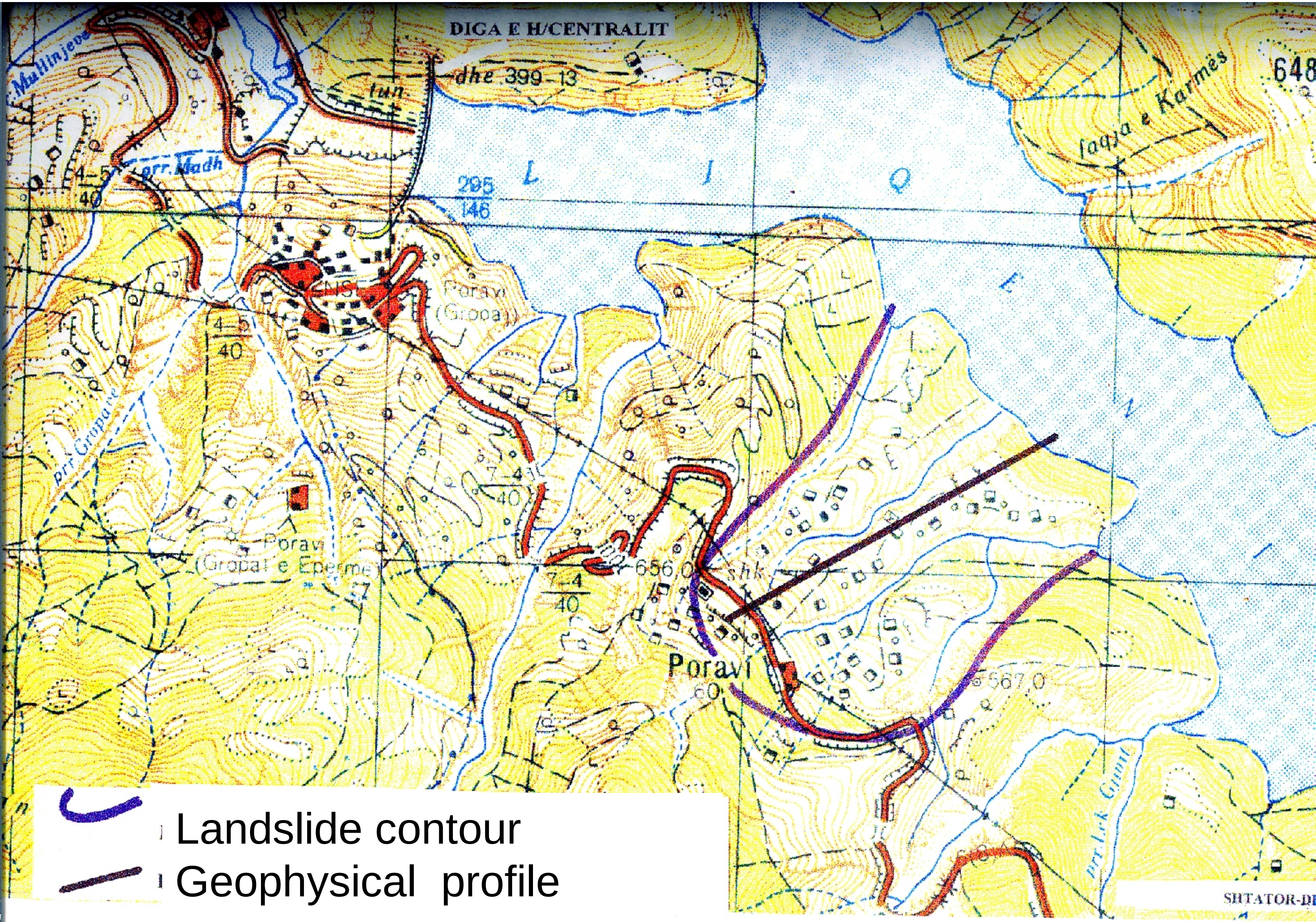
- To prognoses slope instability and landslide development possibility in the future,

- To study the landslide body structure and soil of the landslide area,

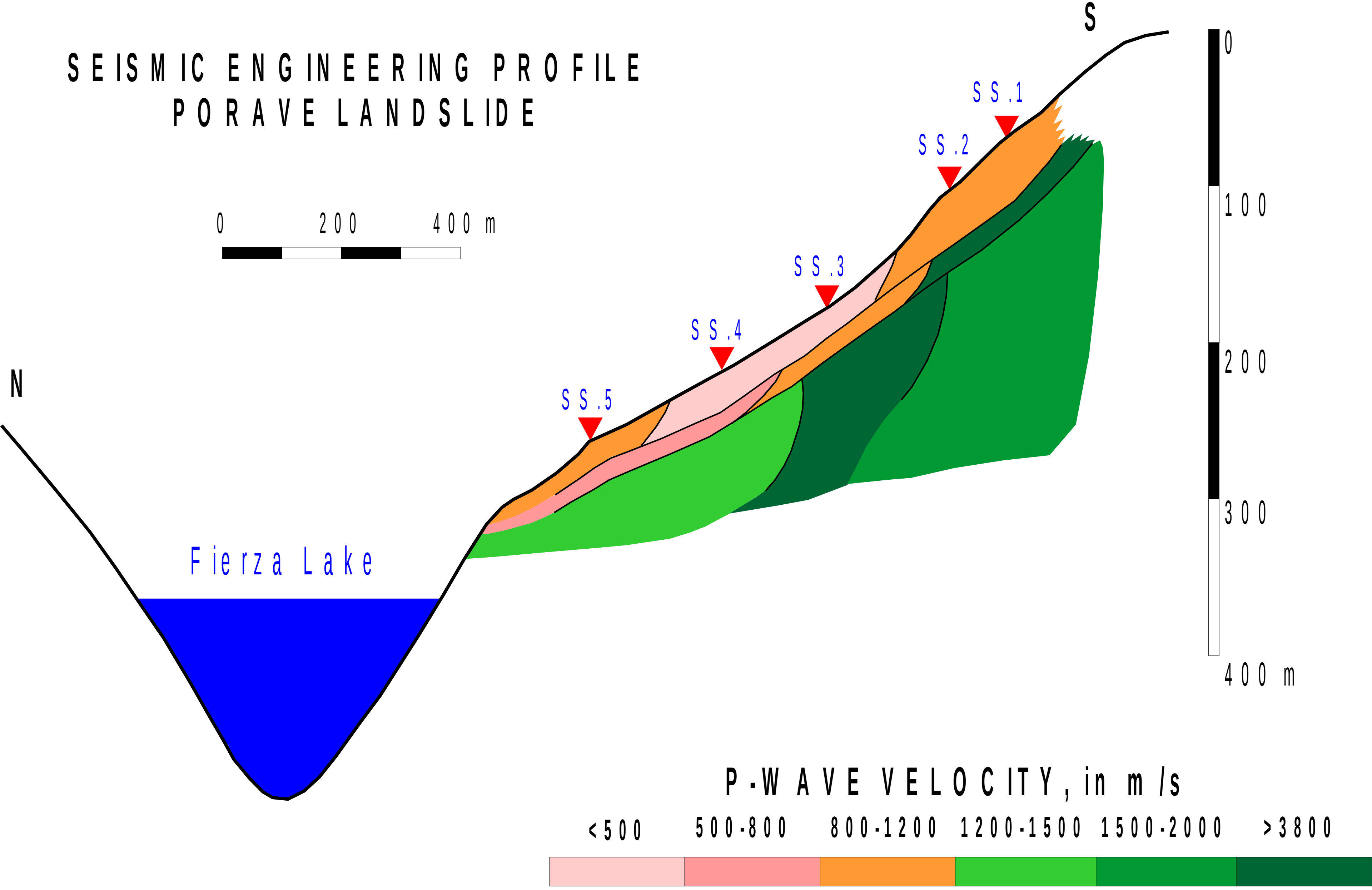
- Evaluation of in-situ physical-mechanical properties of soils and rocks and

- In-situ monitoring of landslide phenomena.

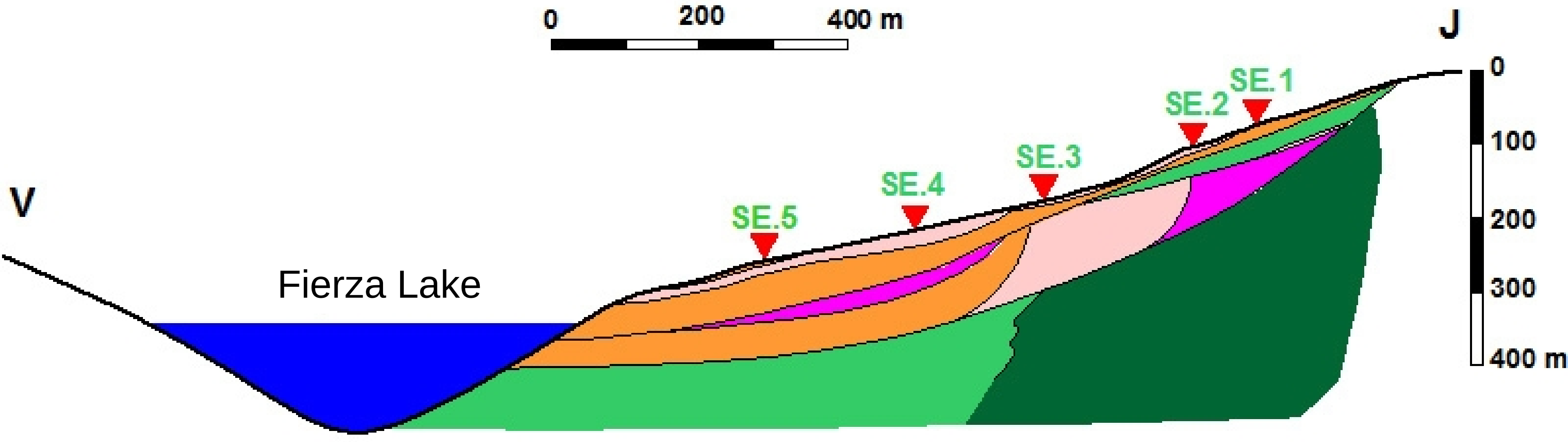
PORAVA LANDSLIDE PLANIMETRY



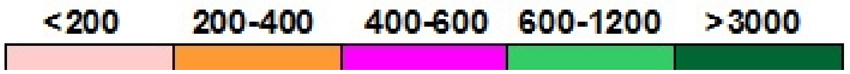
LOW FIERZA WATER LEVEL, SEPTEMBER 2013

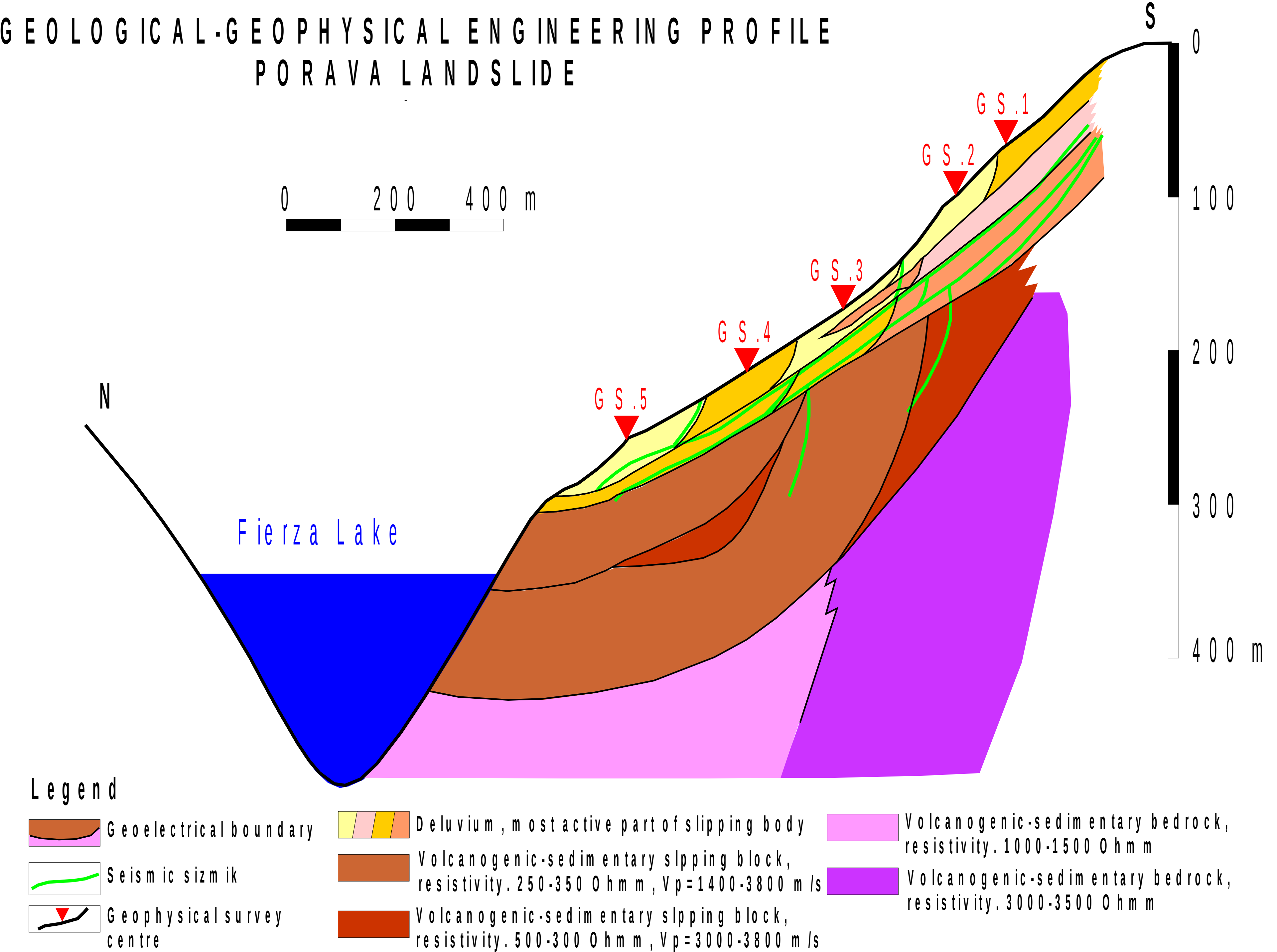

SEISMIC ENGINEERING PROFILE
PORAVE LANDSLIDE
0 200 400 m
N
S
SS.1
SS.2
SS.3
SS.4
SS.5
Fierza Lake
0
100
200
300
400 m
P-WAVE VELOCITY, in m/s
<500
500-800
800-1200
1200-1500
1500-2000
>3800

GEOELECTRICAL ENGINEERING PROFILE
PORAVA LANDSLIDE



Eletric. Specific Resistivity, in Ohmm

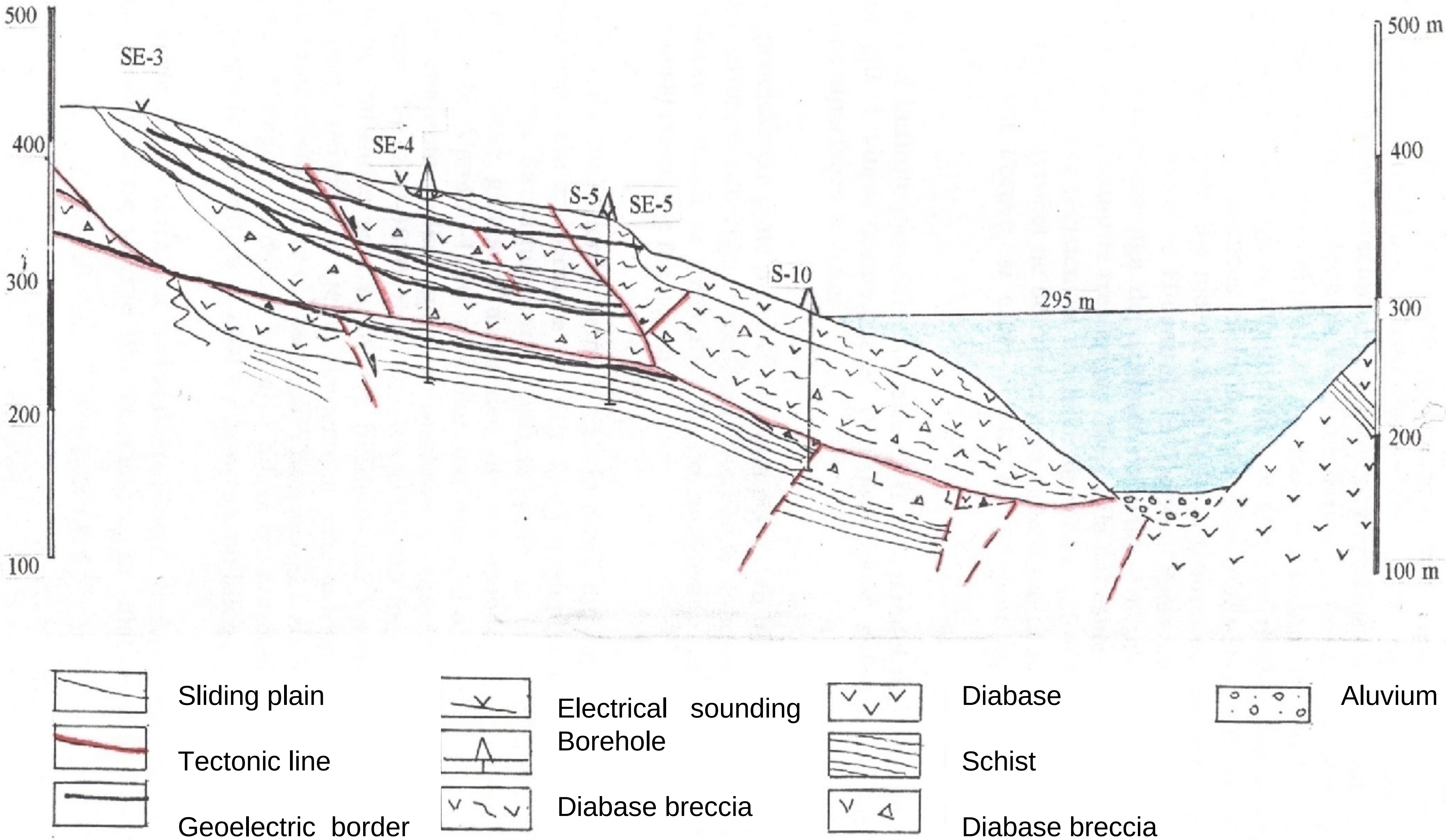




GEOLOGICAL-GEOPHYSICAL ENGINEERING PROFILE
PORAVA LANDSLIDE
0 200 400 m
N
S
0
100
200
300
400 m
GS.1
GS.2
GS.3
GS.4
GS.5
Fierza Lake
Legend
Geoelectrical boundary
Seismic sizmik
Geophysical survey centre
Deluvium, most active part of slipping body
Volcanogenic-sedimentary slpping block, resistivity. 250-350 Ohmm, Vp=1400-3800 m/s
Volcanogenic-sedimentary slpping block, resistivity. 500-300 Ohmm, Vp=3000-3800 m/s
Volcanogenic-sedimentary bedrock, resistivity. 1000-1500 Ohmm
Volcanogenic-sedimentary bedrock, resistivity. 3000-3500 Ohmm

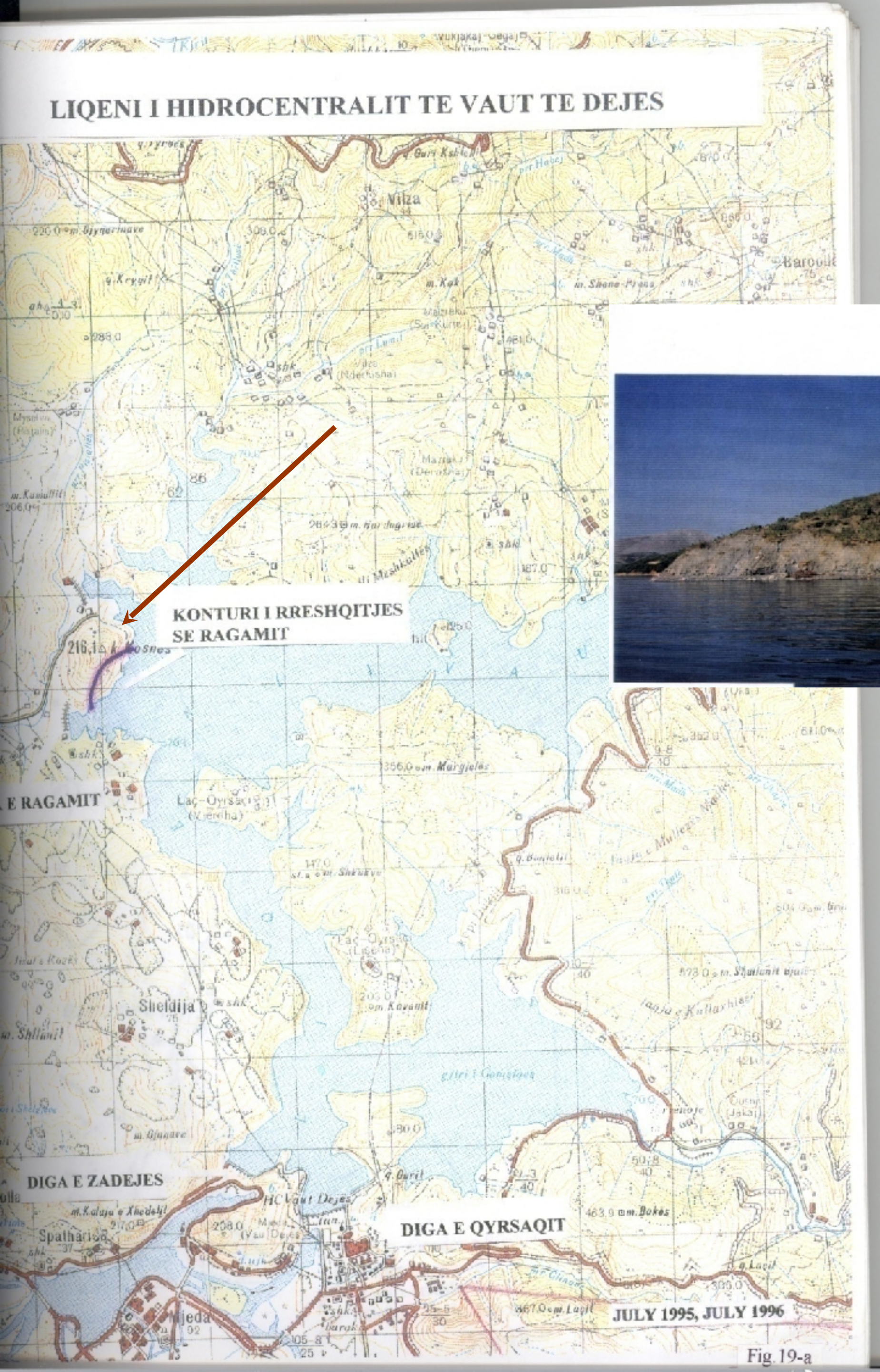
COMPARISON OF THE GEOPHYSICAL AND GEOLOGICAL DATA

(Geological Profile Dhame L. and Dhima N.)

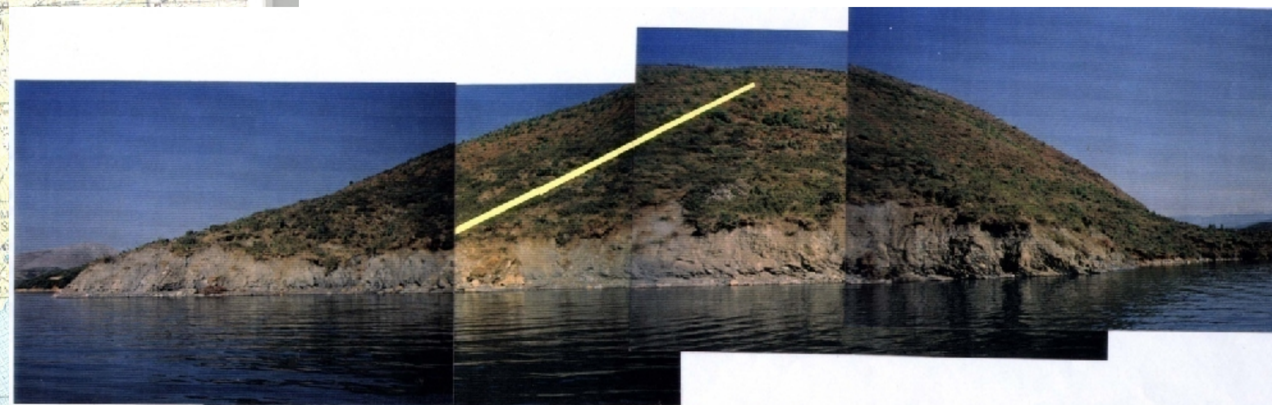


- Results that the Porava landslide is the biggest slide studied till now. The lower plane of this landslide is located about 100 - 160 m deep. It separates the volcanogenic-sedimentary rocks with very low petrophysical characteristics from the volcanogenic-sedimentary deposits untouched by the sliding phenomena. The total volume of the whole sliding body, from some approximate calculation based on these preliminary geophysical data, is estimated to be over 40 million m3.
- The Porava slipping body is heterogeneous and composed of blocks.

PORAVA LANDSLIDE AND BROKEN HOUSES WALLS OF THE VILAGE



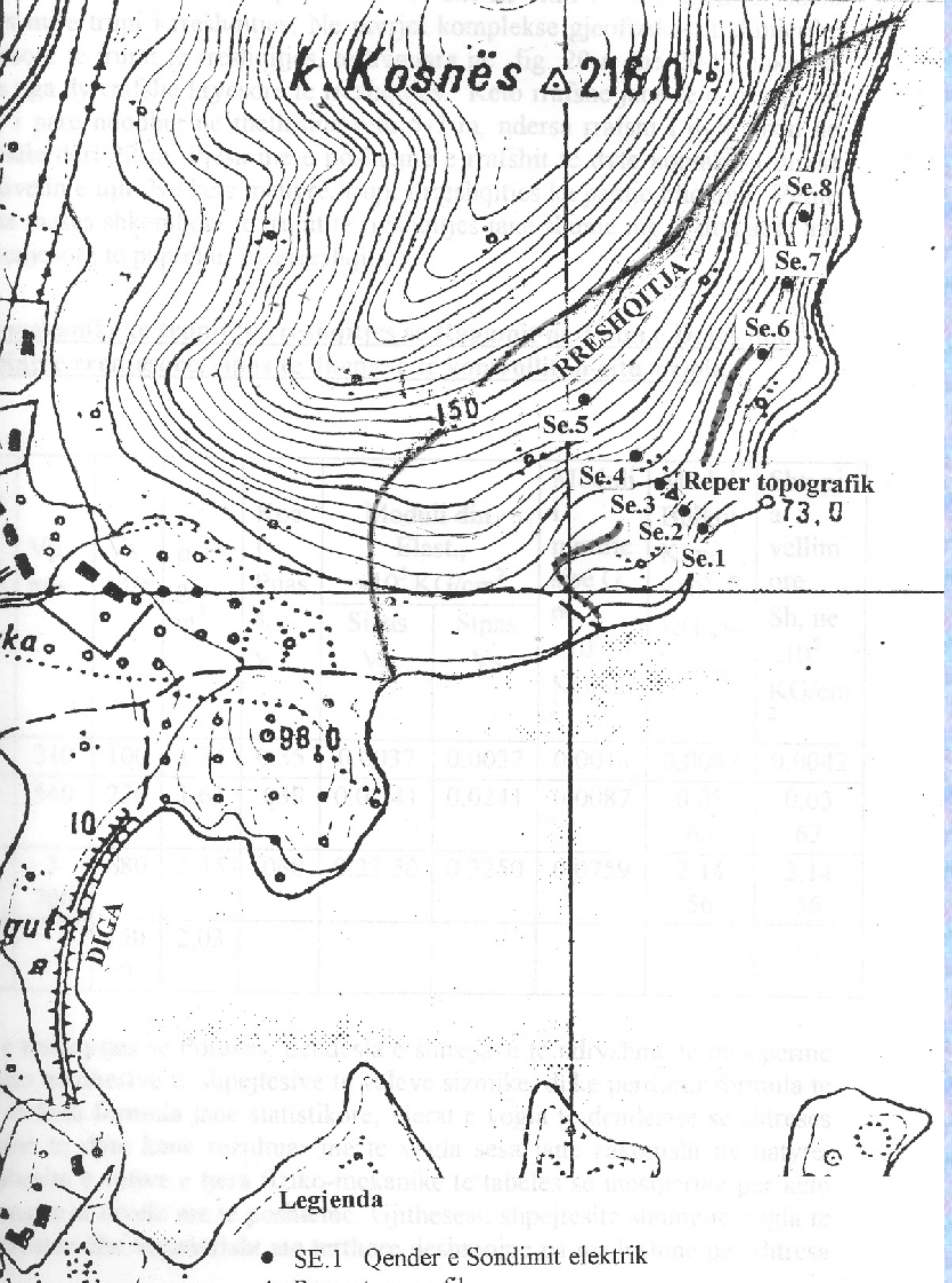
RAGAMIT, VAU I DEJES LANDSLIDE

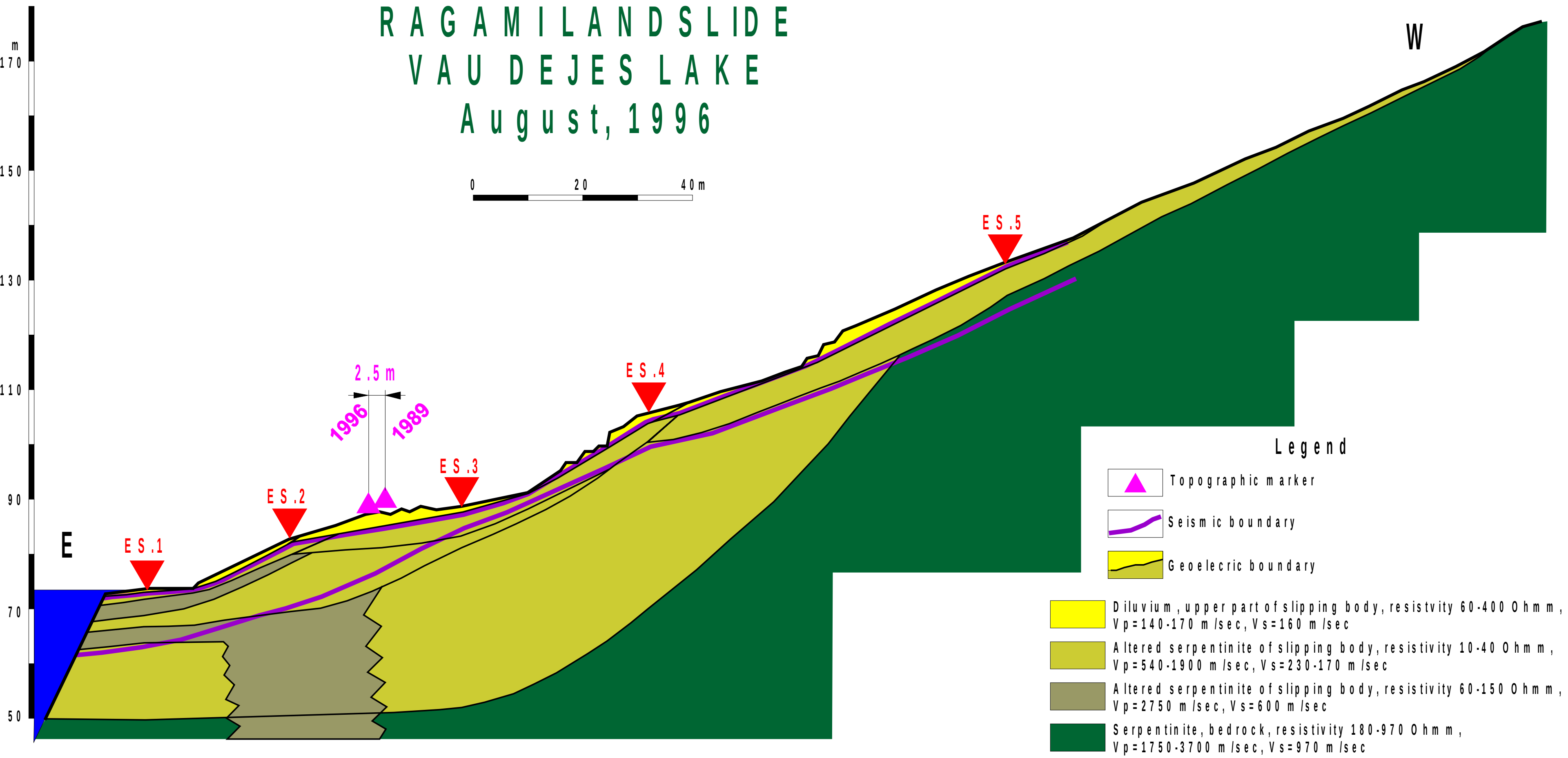


LANDSLIDE FRONT


More...
Map
Satellite
Terrain
RAGAMI LANDSLIDE
Vau i Dejes Lake
1000 ft
200 m
©2008 Google - Imagery ©2008 DigitalGlobe, GeoEye, Map data ©2008 Tele Atlas - Terms of Use

DINAMICS OF THE RAGAMI LANDSLIDE DEVELOPMENT





R A G A M I L A N D S L I D E
V A U D E J E S L A K E
A u g u s t, 1 9 9 6
0
2 0
4 0 m
m
1 7 0
1 5 0
1 3 0
1 1 0
9 0
7 0
5 0
E
W
E S .1
E S .2
E S .3
E S .4
E S .5
2 .5 m
1996
1989
L e g e n d
T o p o g r a p h i c m a r k e r
S e i s m i c b o u n d a r y
G e o e l e c r i c b o u n d a r y
D i l u v i u m , u p p e r p a r t o f s l i p p i n g b o d y , r e s i s t v i t y 6 0 - 4 0 0 O h m m ,
V p = 1 4 0 - 1 7 0 m /s e c , V s = 1 6 0 m /s e c
A l t e r e d s e r p e n t i n i t e o f s l i p p i n g b o d y , r e s i s t i v i t y 1 0 - 4 0 O h m m ,
V p = 5 4 0 - 1 9 0 0 m /s e c , V s = 2 3 0 - 1 7 0 m /s e c
A l t e r e d s e r p e n t i n i t e o f s l i p p i n g b o d y , r e s i s t i v i t y 6 0 - 1 5 0 O h m m ,
V p = 2 7 5 0 m /s e c , V s = 6 0 0 m /s e c
S e r p e n t i n i t e , b e d r o c k , r e s i s t i v i t y 1 8 0 - 9 7 0 O h m m ,
V p = 1 7 5 0 - 3 7 0 0 m /s e c , V s = 9 7 0 m /s e c

GEOELECTRIC LONGITUDINAL PROFILE
RAGAMI LANDSLIDE
VAUT DEJES LAKE
Tirana, December 1998

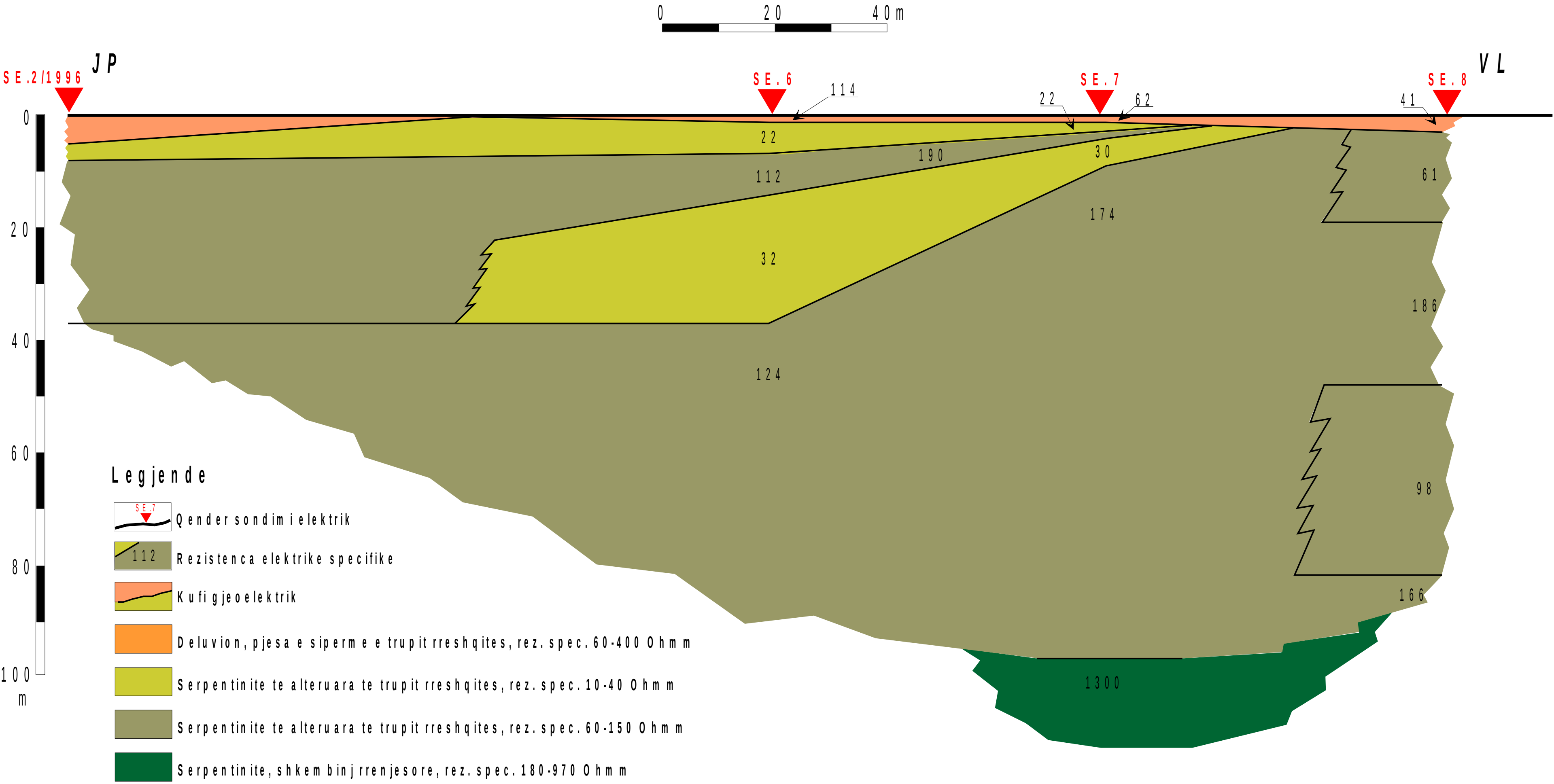
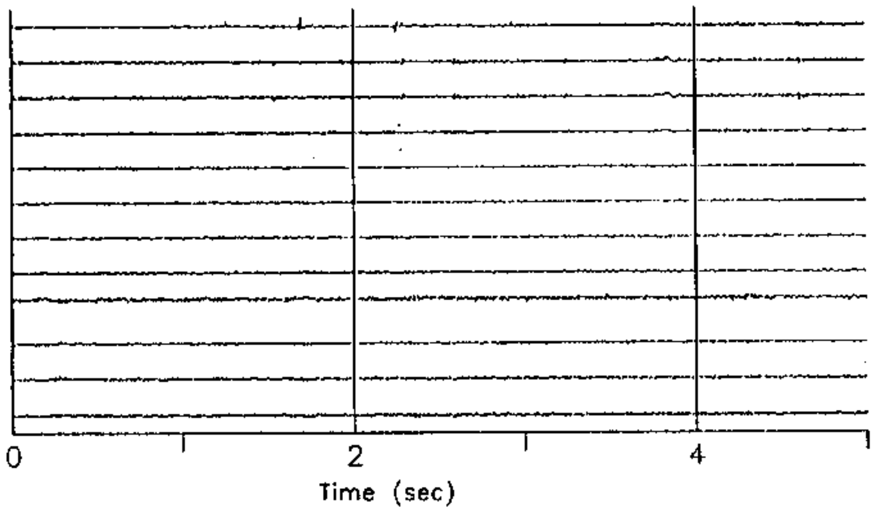
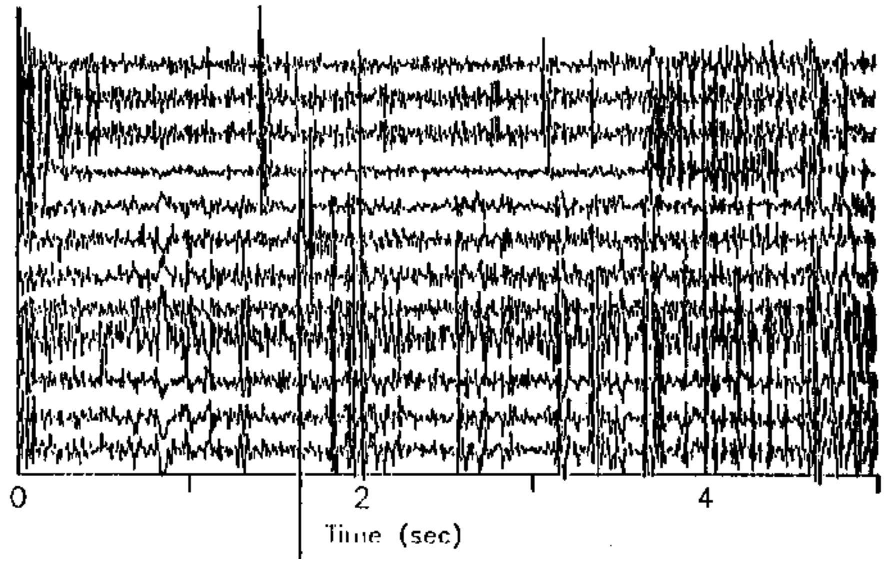


Fig.

Thick and high volume slipping bodies represent the Ragami active landslide in the shore area of the Vau Dejes Lake.



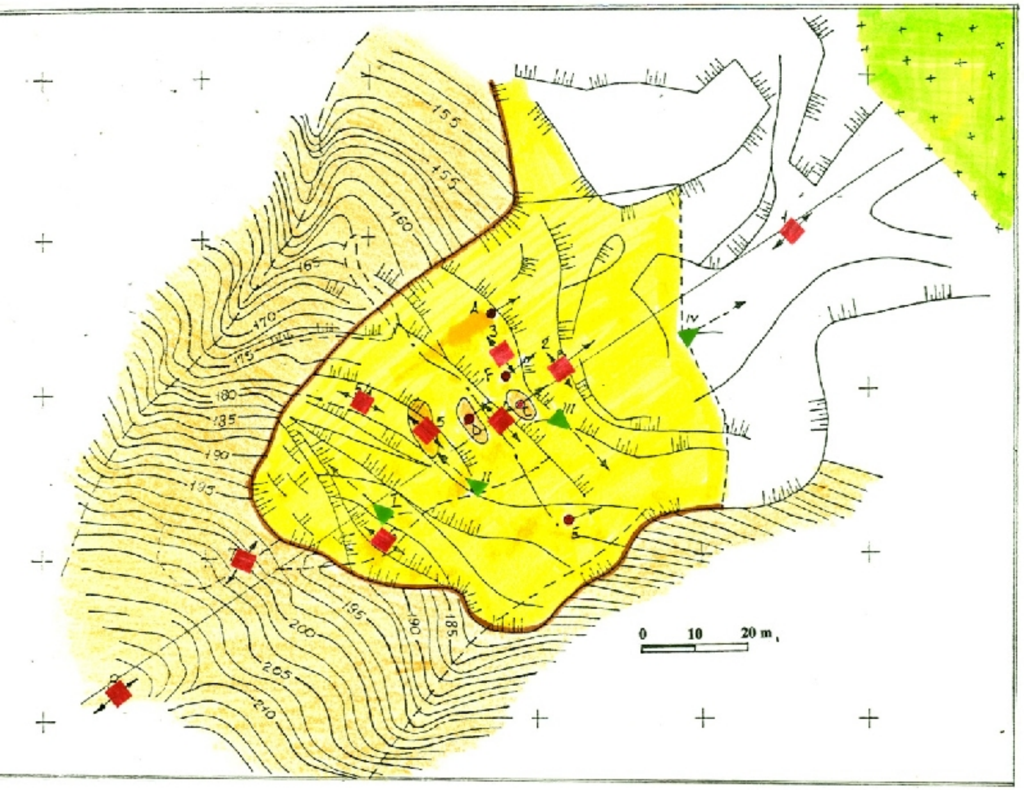
Outside of slipping body



Inside of slipping body

Natural seismic-acoustic activity in the Ragami landslide area

Topographic Sketch of the BENJA LANDSLIDE



LEGJENDE

- Konturi i trupit te rreshqitjes
- Shkembinjte rrenjesore, flish
- Reper gjeodezik
- Qender e sondimit elektrik
- Qender e vrojtimit sizmik
- **Dige**

BENJA LANDSLIDE

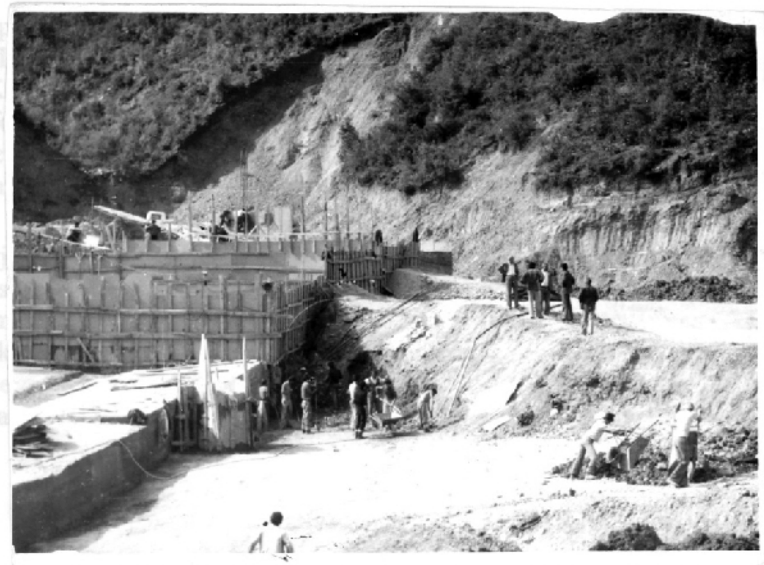
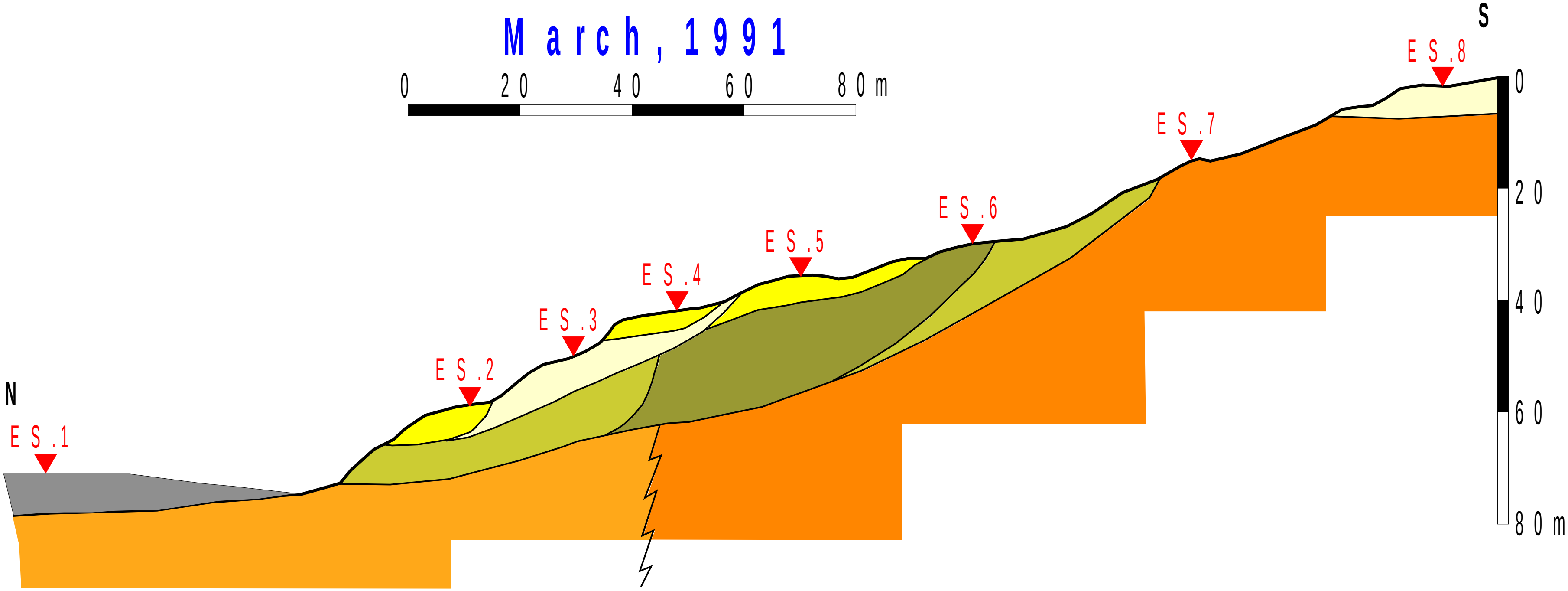


Foto 15. Pamje nga rreshqitja ne vepren hidroteknike te Banjes (Korrik 1987).

BANJA LANDSLIDE
BANJA HYDROTECHNIC WORKS
March, 1991



Legend

- Diluvium, siltstone, resistivity 10-20 Ohmm
- Flysch, slipping block, resistivity 30-40 Ohmm
- Sandy flysch, slipping block, resistivity 60 Ohmm, Vp=1000-3000 m/sec
- Sandy flysch, slipping block, resistivity 60-130 Ohmm, Vp=4500 m/sec
- Flysch, bedrock, resistivity 10-20 Ohmm, Vp=4100 m/sec
- Sandy flysch, bedrock, resistivity 15-60 Ohmm, Vp=5000 m/sec
- Geoelectric boundary
- Dam (in construction)

NORMALIZED SPECTRA OF SEISMOACOUSTICS ACTIVITY BANJA LANDSLIDE

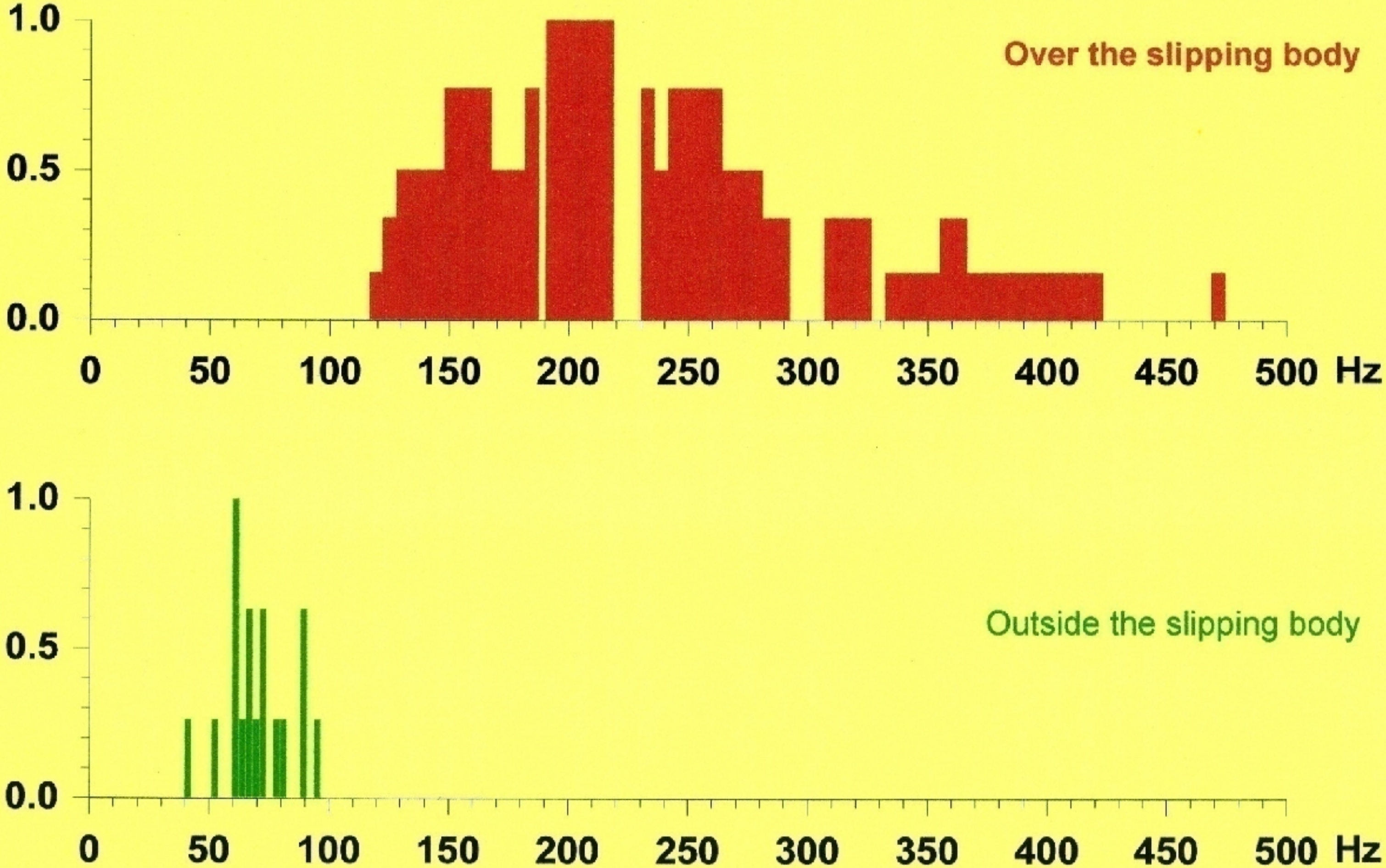
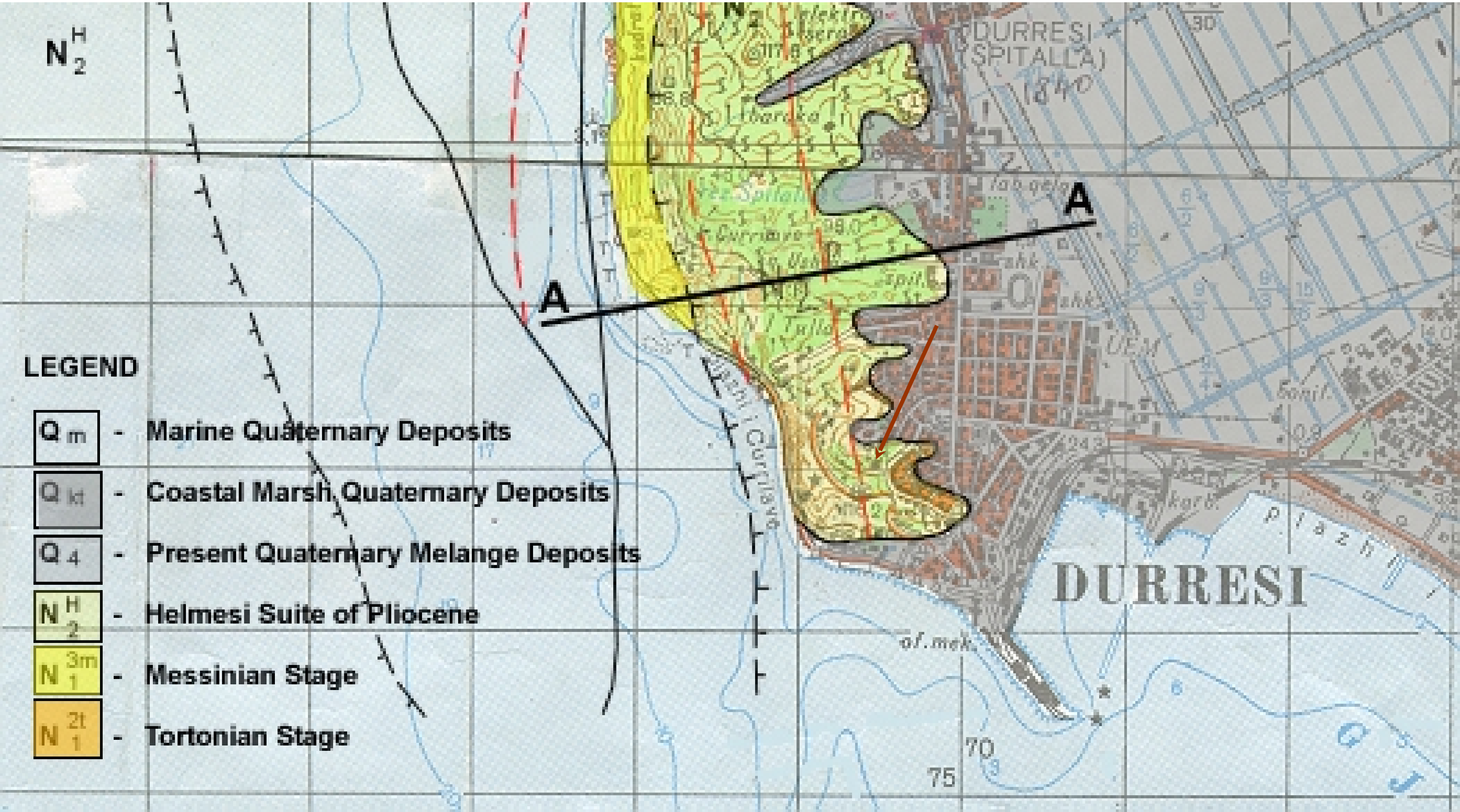


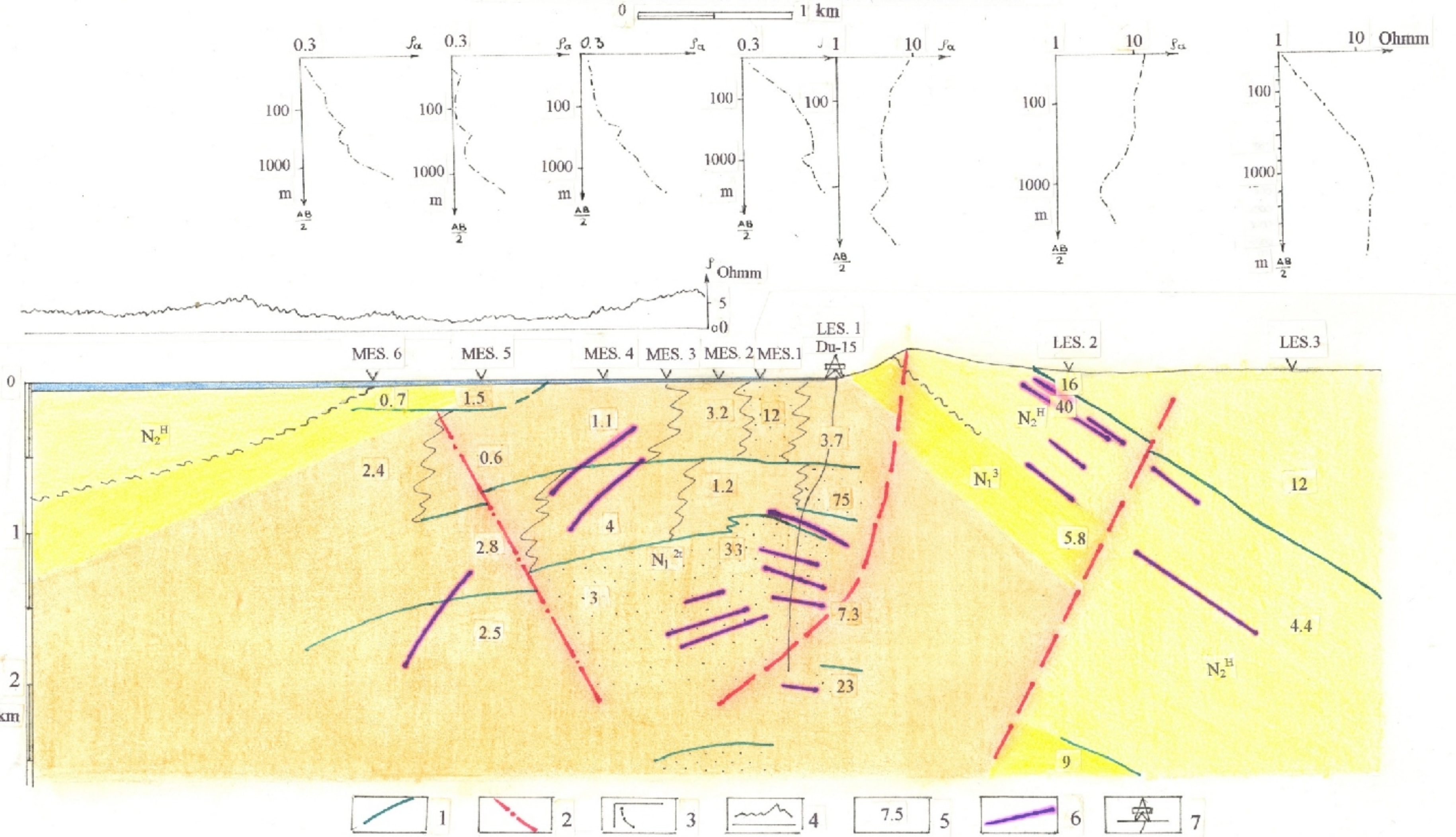
Fig. 15

LANDSLIDE IN THE NEOGENE LITTORAl HILLS, DURRESI CITY

GEOLOGICAL MAP OF THE DURRESI AREA



GEOELECTRICAL MARINE- LAND LINE IN DURRESI REGION



(Accordind to A. Frasheri)

1. Geoelectrical boundary; 2- Tectonic fault according to the geoelectrical data; 3- Electrical sounding curve; 4- Apparent resistivity profile, according to the electrical profiling with array A500M20N,C---→ ∞ ; 5- Digits in the line show the values of the electrical resistivity of the rocks; 6- Seismic horizon; 7- deep well.

VIEW OF DURRESI NEOGENE HILLS LANDSLIDE

CRACKS OF THE KING ZOGU VILLA WALLS

CRACKS OF THE KING ZOGU VILLA WALLS AND ROAD

Conclusions

Geophysical-engineering studies have a triple character:

a)the soil of the landslide area investigation,

b) evaluation of in-situ physical-mechanical properties of soils and rocks, and

c) in-situ monitoring of landslide phenomena dynamics.

- Based on the above analyses can be reached the following conclusions:

In the integrated geophysical-geological profiles are fixed studied landslides bodies. In these profiles were also clearly fixed the sliding plains.

In general, even though the geological conditions in which these slides have been developed are different, the plains have regular configuration, with maximum deepness in the center of the profile.

The extent of the landslide and the position of sliding plains were precisely fixed using the integrated geophysical survey.

- The slipping body, very often, is made of several slipping plains of block like character.

- Especially active today, are the slipping plains located 15 - 20 m deep. The slipping body over this plain is mainly made of deluvial - eluvial sediments, or rocky masses with very weak physical - mechanical characteristics. Their dynamic is causing more damages every day to the houses of the Porava village.

- The block like nature of the sliding bodies brings to the conclusion that in general these bodies can not fall immediately as a whole, in any kind of velocity. Only in particular cases, like in Banja, the fall occurs immediately.

- The structure of the slipping body and its dynamic stands in the foundation of the patterning on the landslide development. Besides the others, the height of the dam is directly defined from this pattern. Accepting the slipping body as a unique mass, has sent to the over heightening of the dam and greater expenses.

THANK YOU

FOR YOUR ATTENTION

!