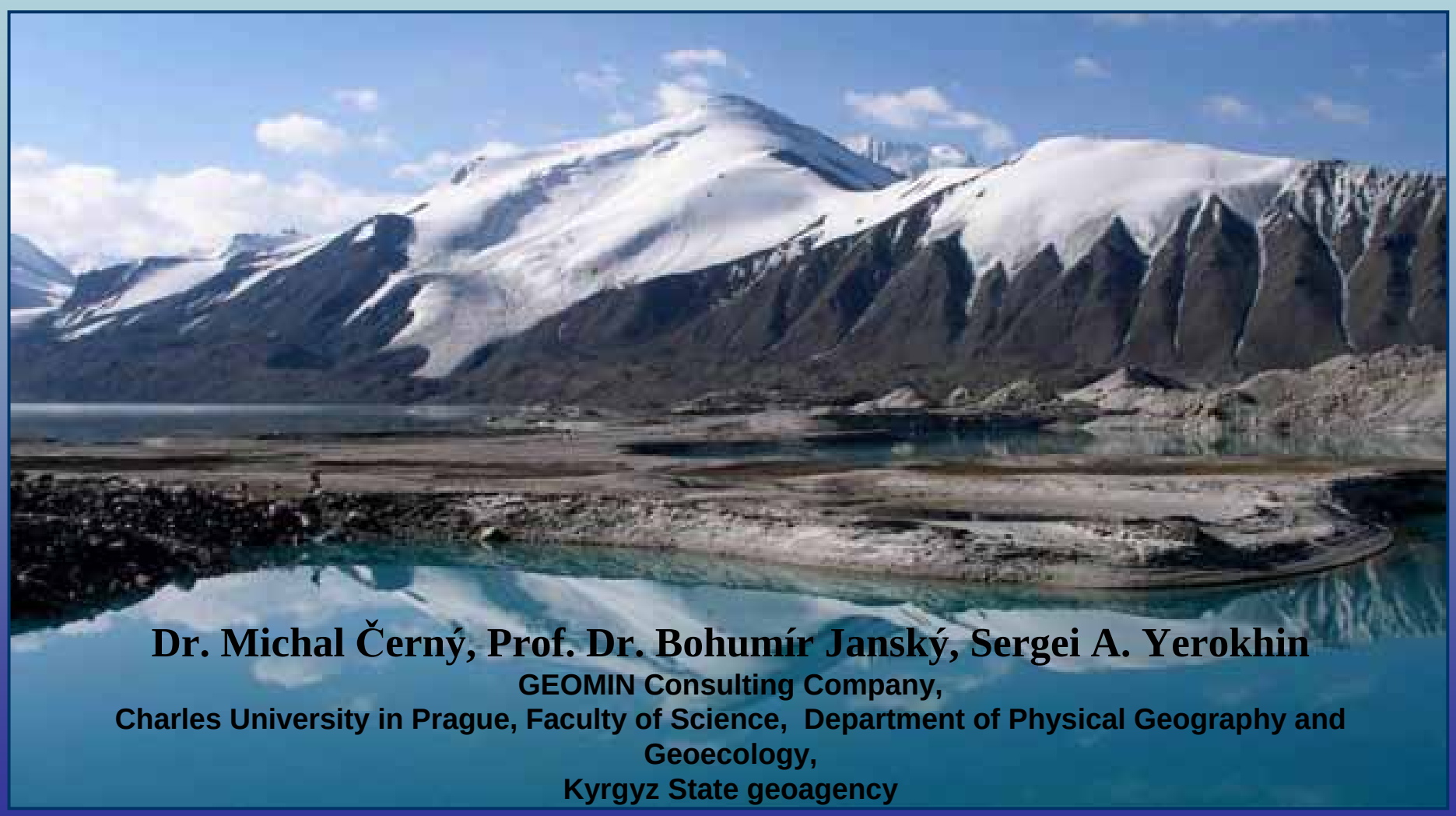
Monitoring of Hazardous Lakes in Kyrgyzstan



Dr. Michal Černý, Prof. Dr. Bohumír Janský, Sergei A. Yerokhin

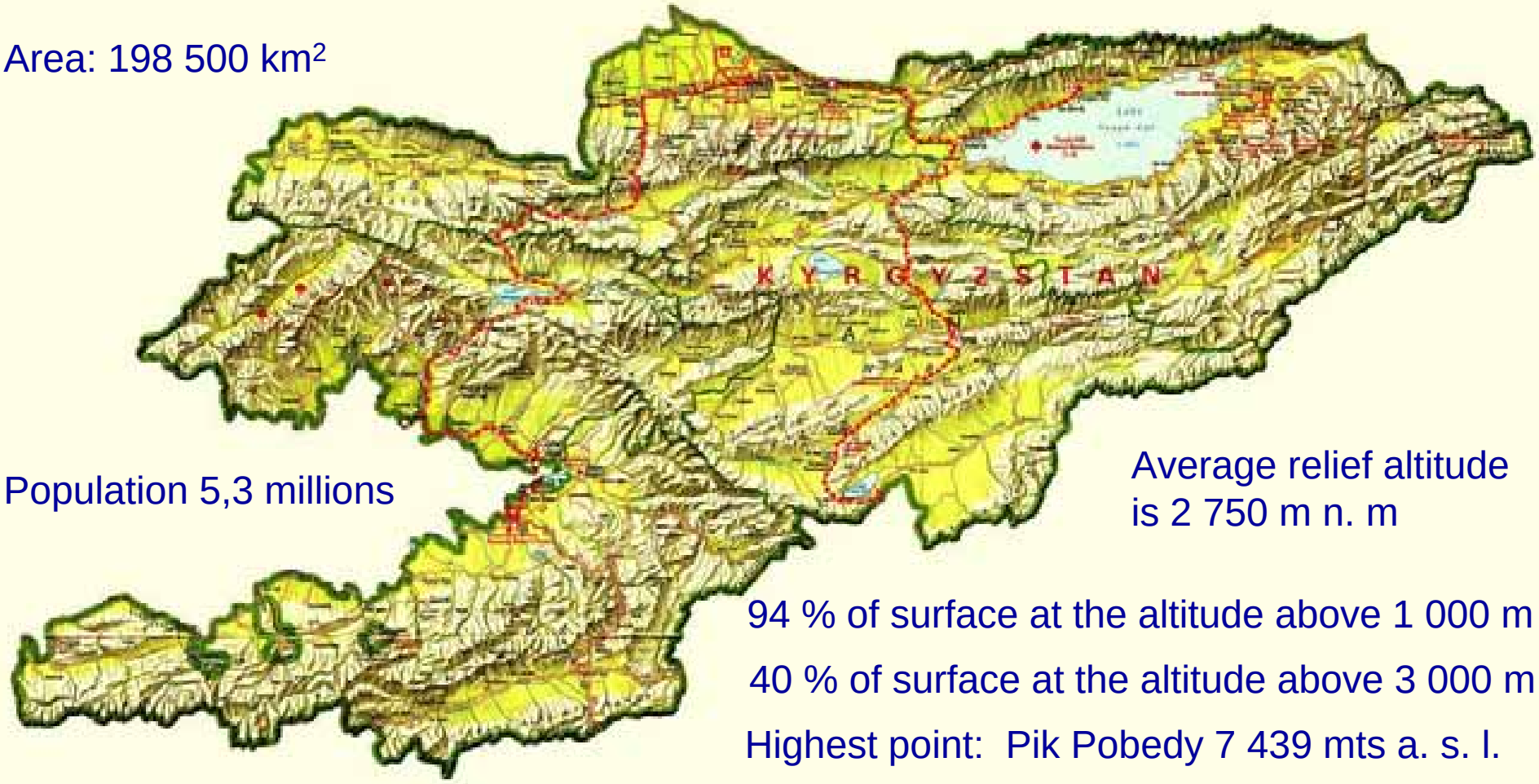
GEOMIN Consulting Company,

Charles University in Prague, Faculty of Science, Department of Physical Geography and Geoecology,

Kyrgyz State geoagency

Kyrgyz Republic

Area: 198 500 km^2



Population 5,3 millions

Average relief altitude is 2 750 m n. m

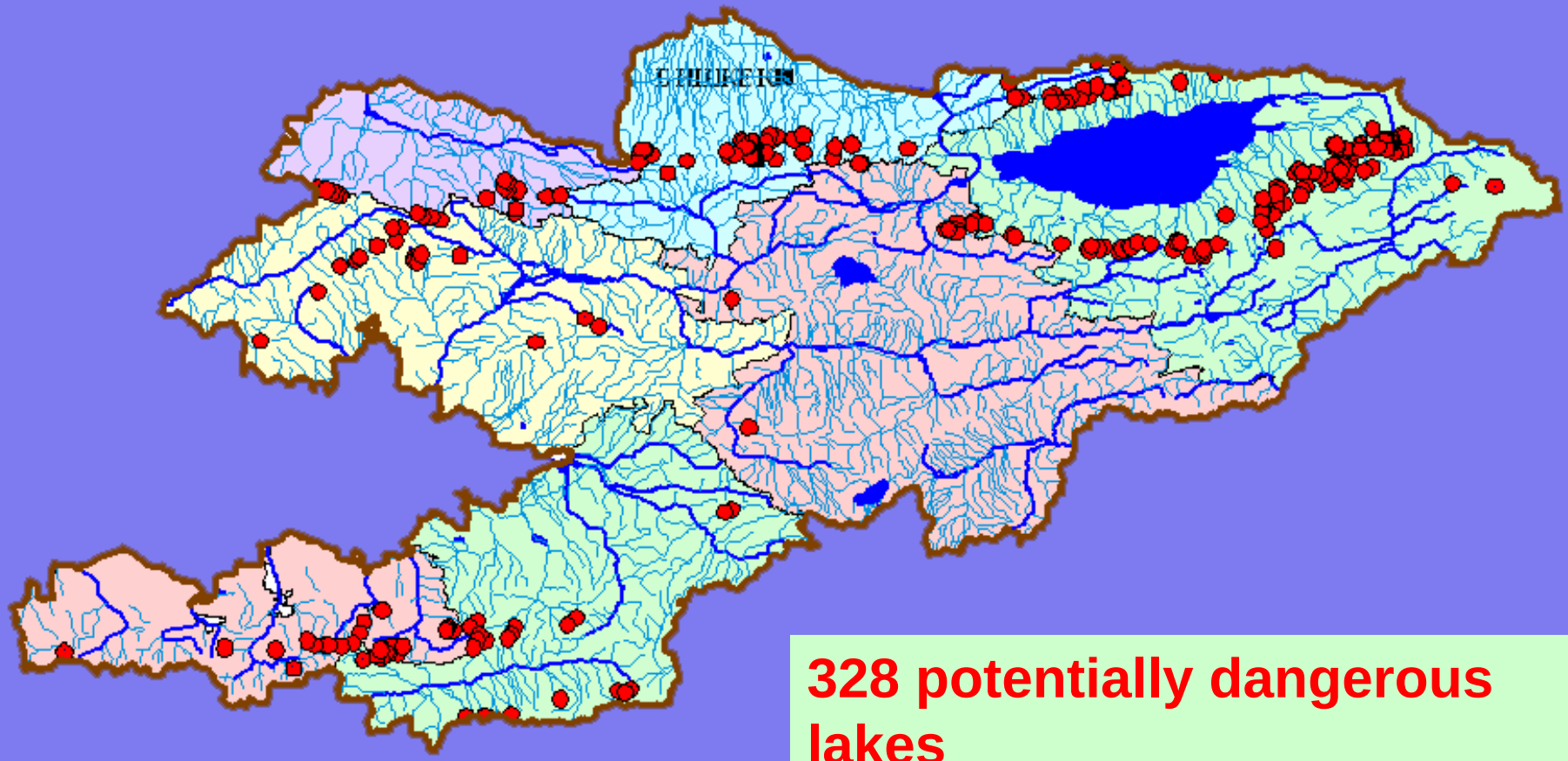
94 % of surface at the altitude above 1 000 m

40 % of surface at the altitude above 3 000 m

Highest point: Pik Pobedy 7 439 mts a. s. l.

The hazardous alpine lakes in Kyrgyzstan

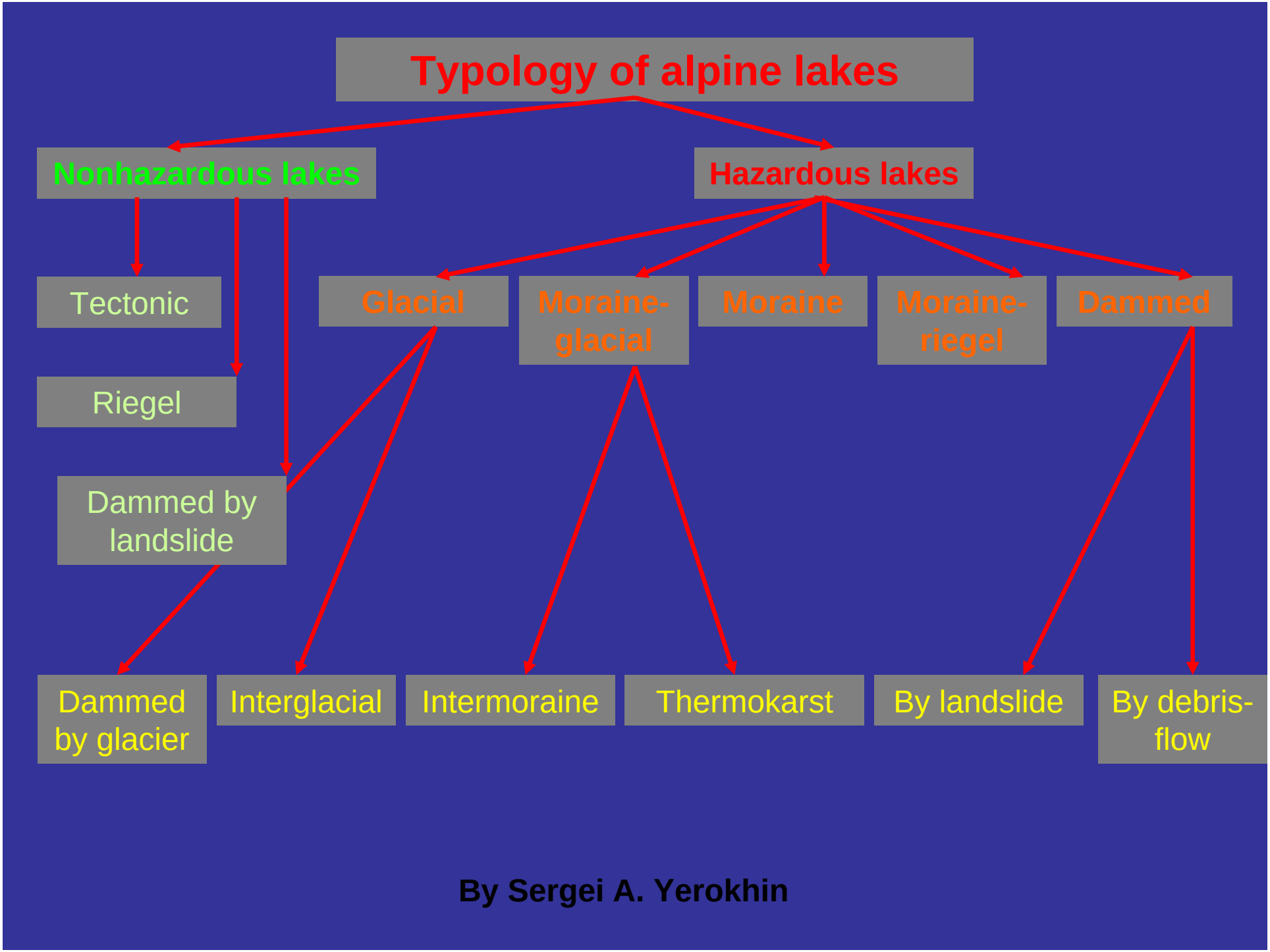
1500 lakes covering more than 1 hectare



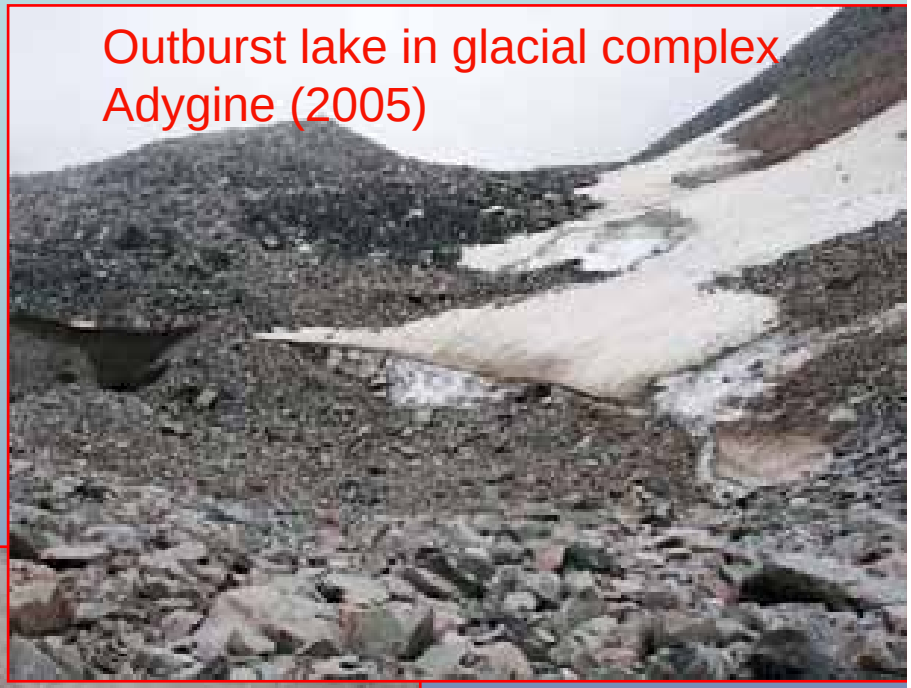
328 potentially dangerous lakes

12 actually dangerous lakes

25 of high potential hazard


Typology of alpine lakes
Nonhazardous lakes
Hazardous lakes
Tectonic
Riegel
Dammed by landslide
Glacial
Moraine-glacial
Moraine
Moraine-riegel
Dammed
Dammed by glacier
Interglacial
Intermoraine
Thermokarst
By landslide
By debris-flow
By Sergei A. Yerokhin

Lakes after outburst

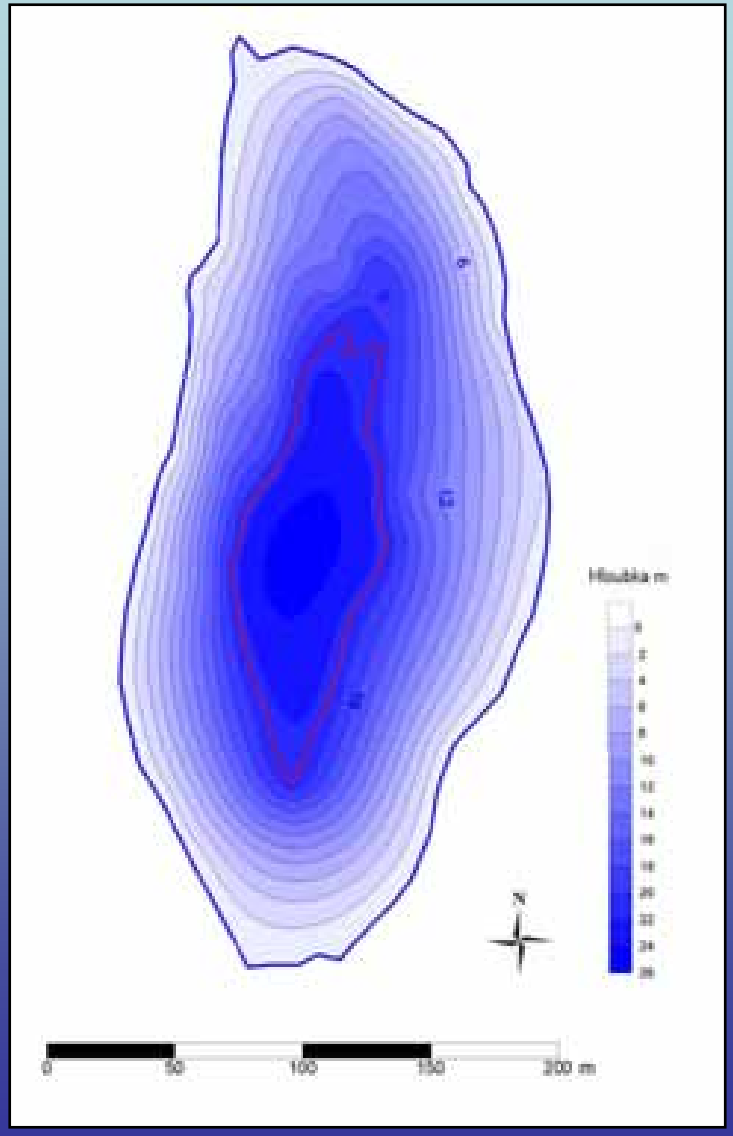


Lakes after outburst

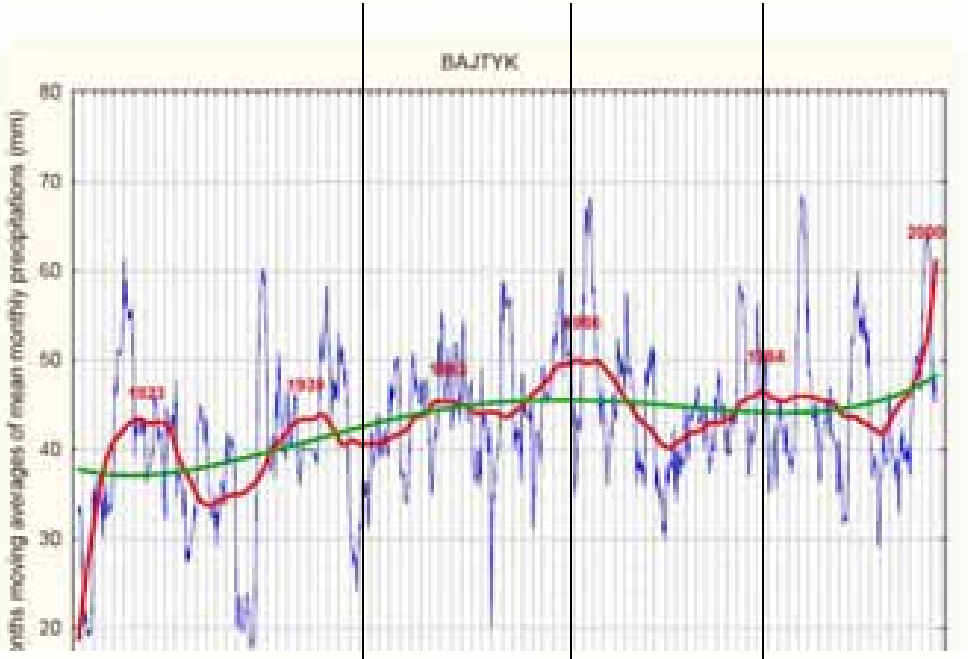
Outburst thermokarst lake in Shakhimardan (1998)

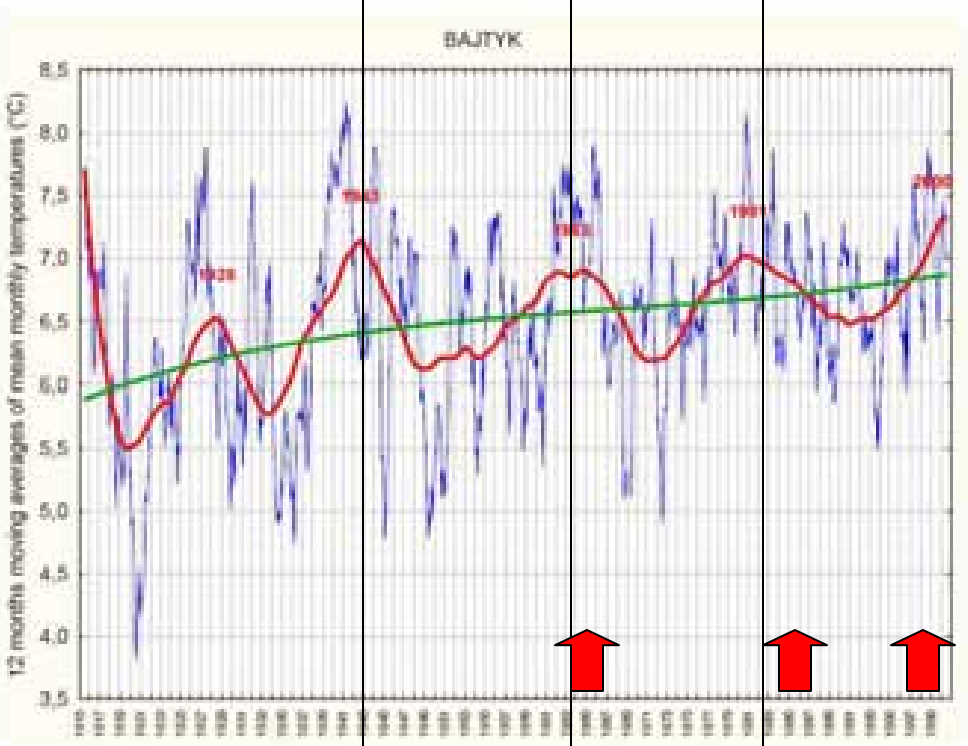
Outburst of Zyndan glacial lake, 24th of July 2008

Outburst of Zyndan glacial lake, 24th of July 2008




MOUNTAIN GLACIERS ARE RETREATING
NUMBER OF GLACIAL LAKES IS GROWING
HAZARD LEVEL IS ICREASING





Development of precipitations and temperature

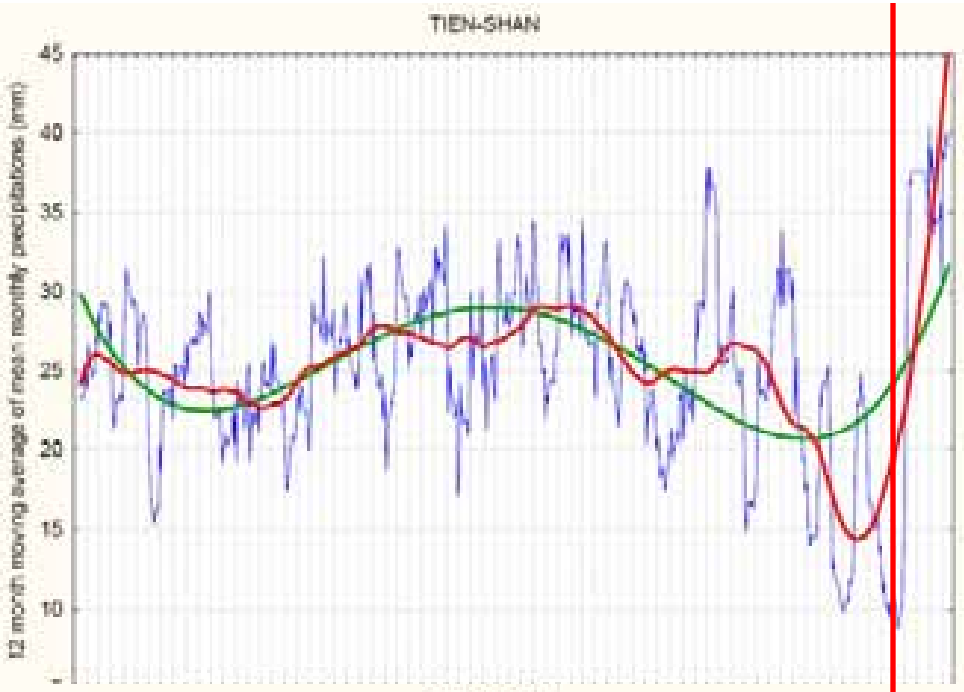
Baytyk station 1 579 mts a.s.l.

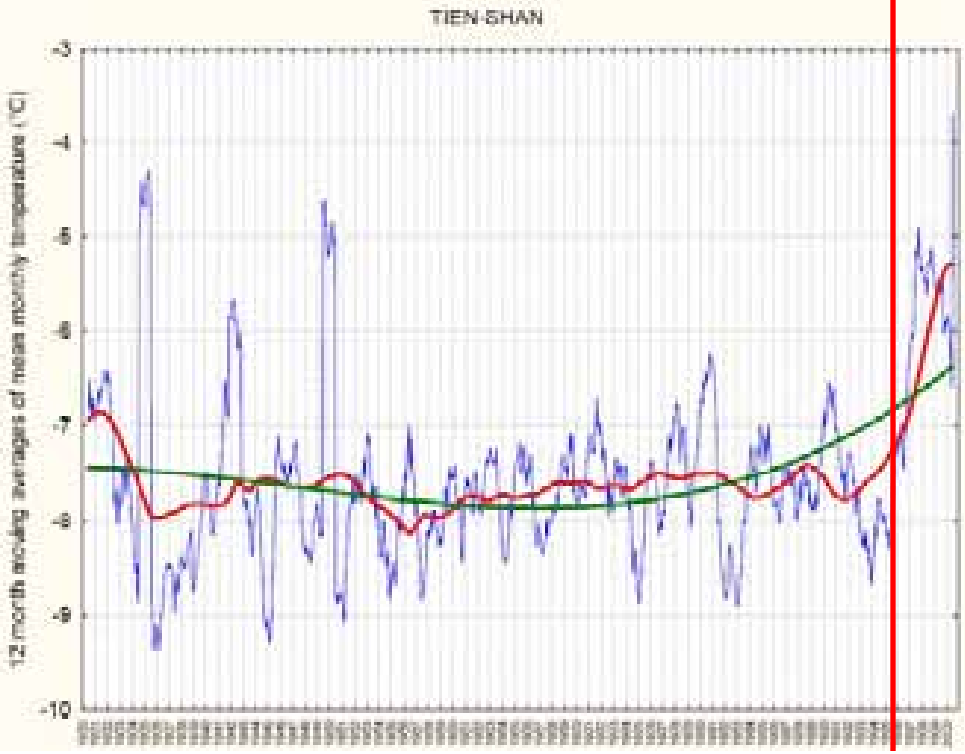
Precipitations:
15 years cycle until 1966,
Change to 20 years cycle.
Steep increase since middle of nineties.

Temperature:
Regular 20 years cycle.

Clear correlation between precipitations and temperature In the middle of sixties and eighties

Highest number of disastrous outbursts in 1965-70, 1983-88, 1997-99





Development of precipitations and temperature

Tien Shan 3 659 mts a.s.l.

Precipitations:
Irregular 15 years cycle until 1990.
Steep ascent since 1996.

Temperature:
Very irregular course with no clear cycle
Steep ascent during last decade.

No correlation between precipitations and temperature

Researched regions in Kyrgyzstan

1 – Kyrgyz Ala-Too ridge, 2 – Kungey Ala-Too ridge, 3 – Ak-Shiyryak ridge, 4 – Babash-Ata ridge, 5 – Talas Ala-Too ridge, 6 – Terskey Ala-Too ridge, 7 – Alay ridge

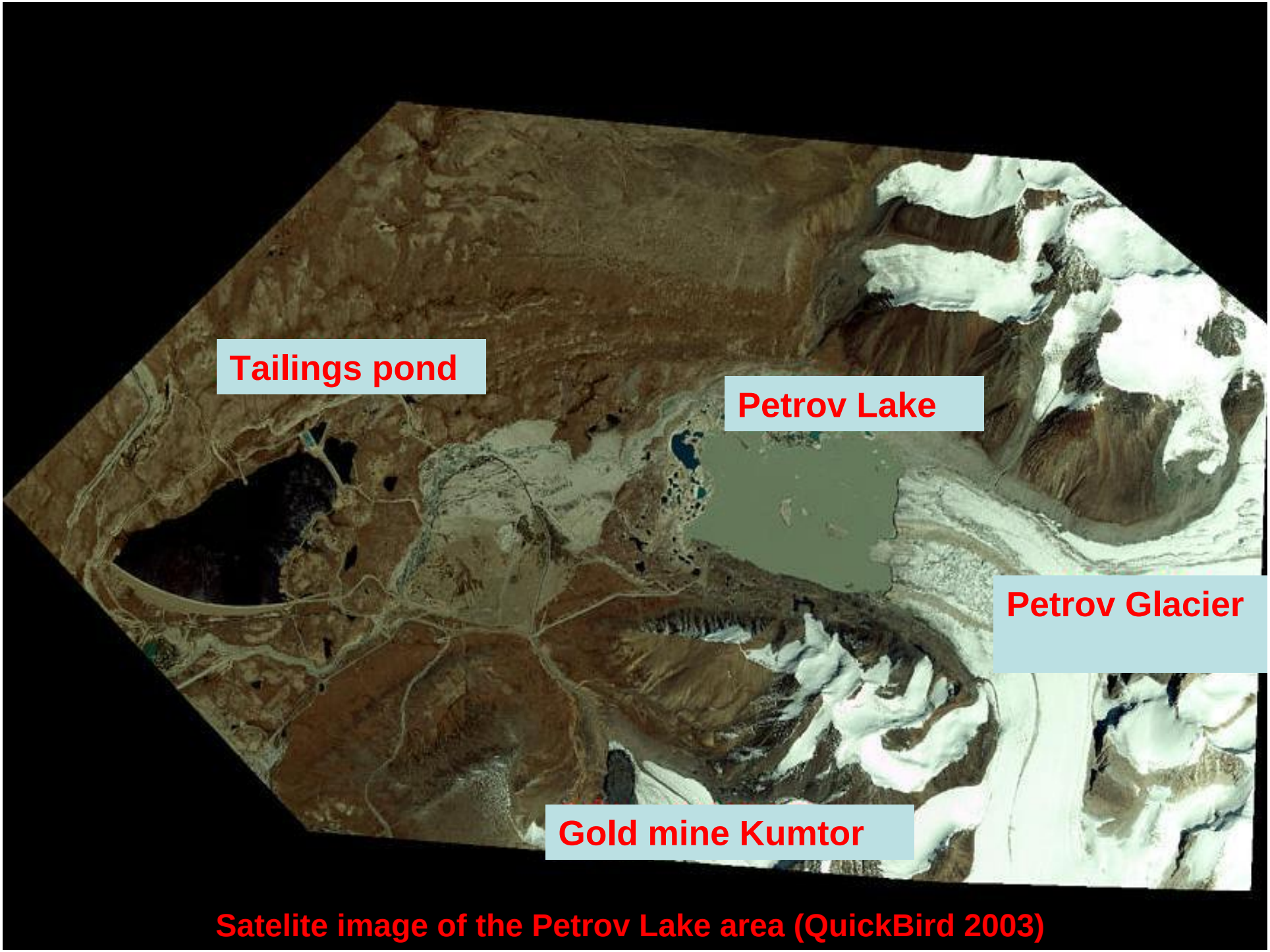
Red line – regions researched by 2004 – 2006 project

Blue line – regions researched by curremt (2007 – 2010) project

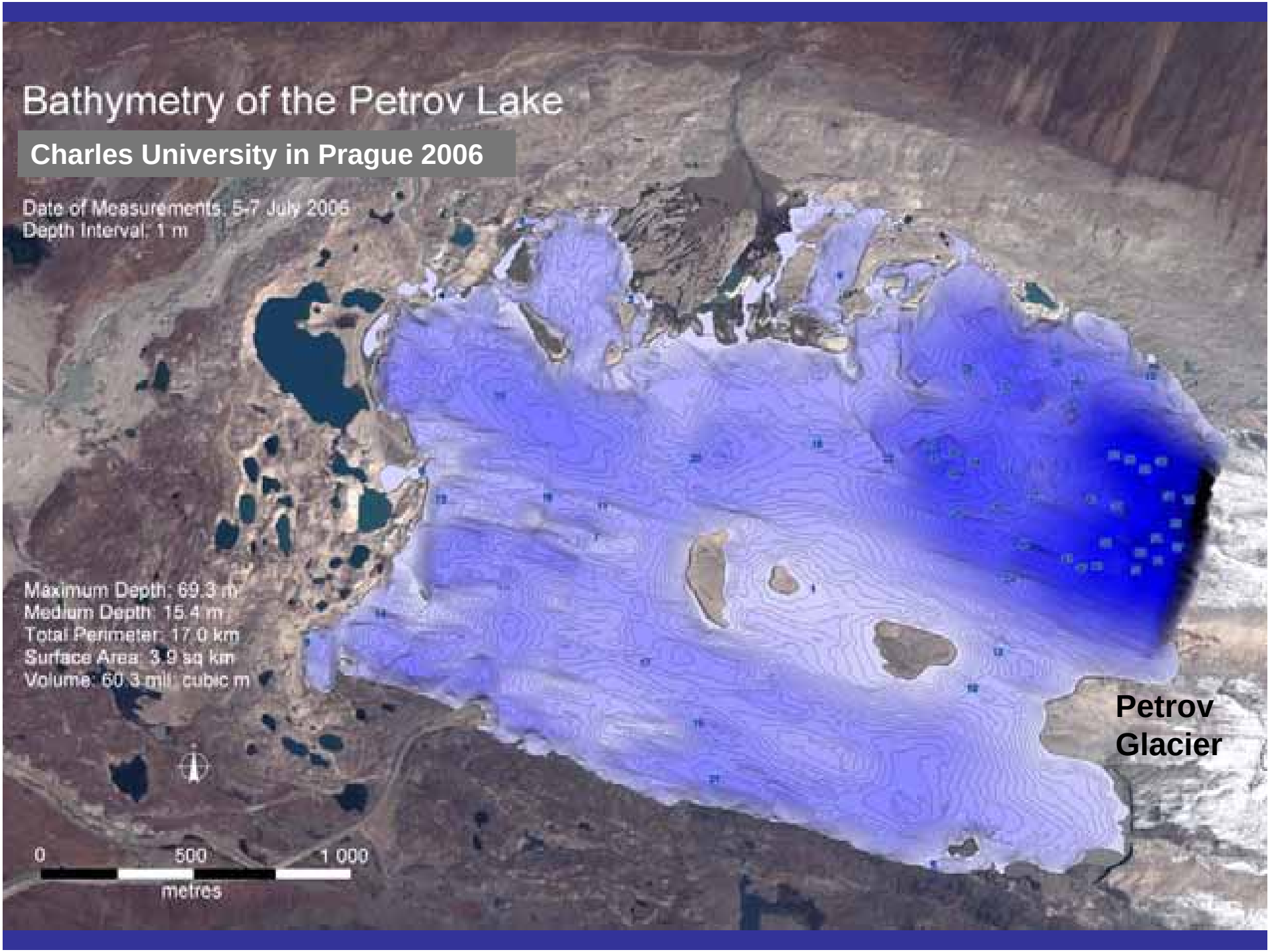
Petrov lake

Petrov lake

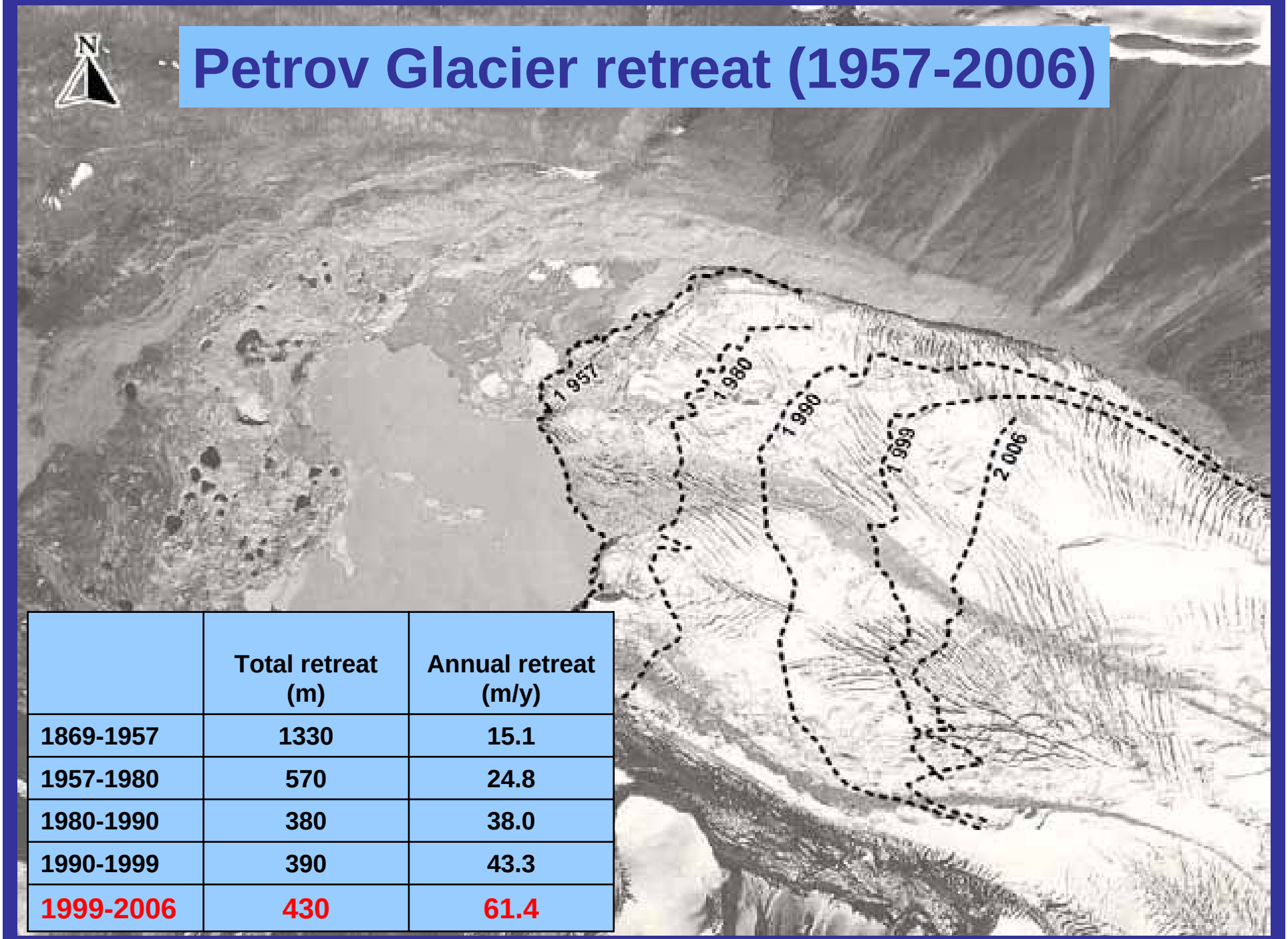

Lake Petrov and the Kumtor mine
Petrov glacier
Petrov lake
Ak-Shiyrlak massive
T A N



Satelite image of the Petrov Lake area (QuickBird 2003)


Bathymetry of the Petrov Lake
Charles University in Prague 2006
Date of Measurements: 5-7 July 2006
Depth Interval: 1 m
Maximum Depth: 69.3 m
Medium Depth: 15.4 m
Total Perimeter: 17.0 km
Surface Area: 3.9 sq km
Volume: 60.3 mil. cubic m
0
500
1 000
metres
Petrov Glacier

Petrov Glacier retreat (1957-2006)

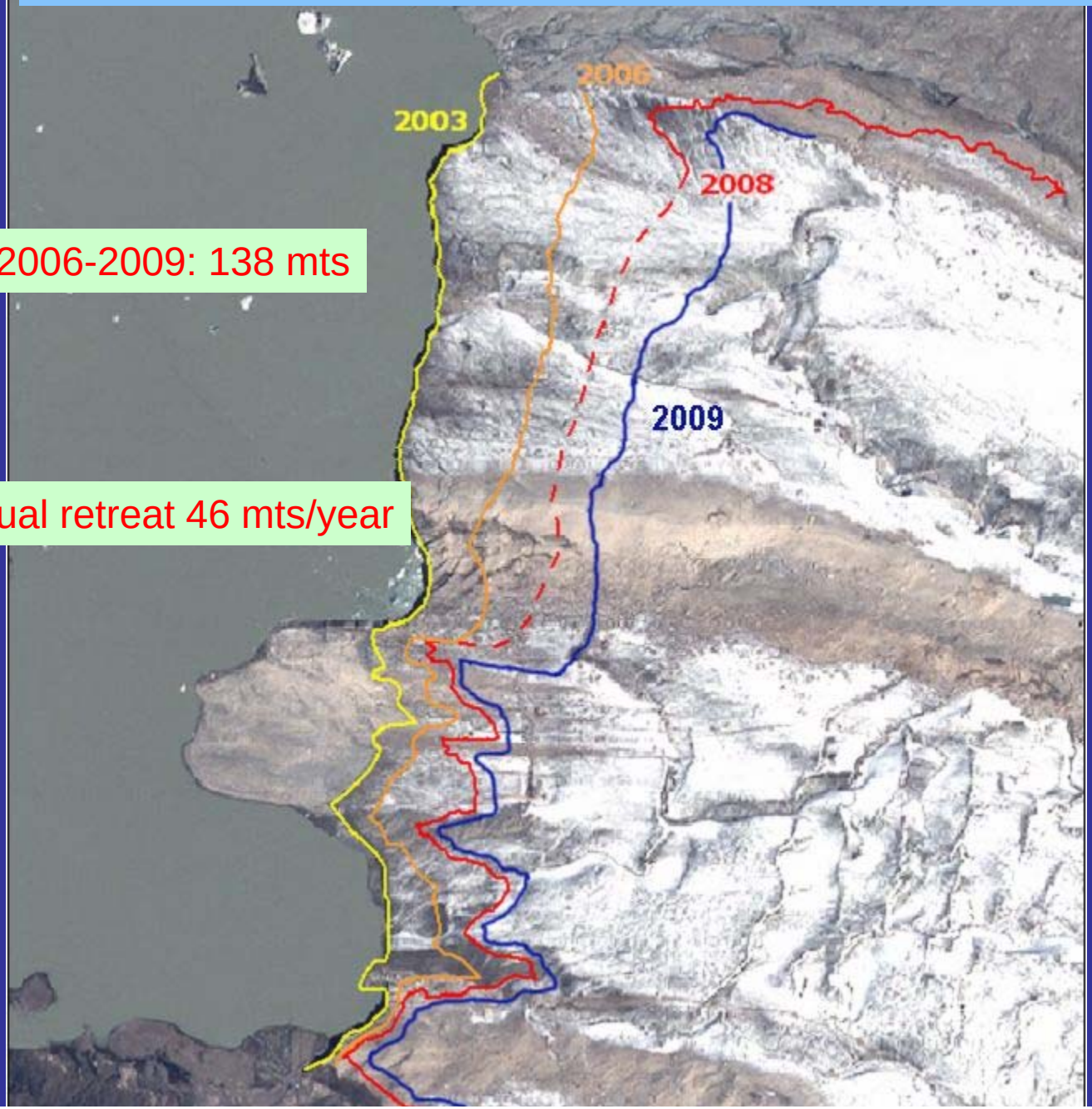


	Total retreat (m)	Annual retreat (m/y)
1869-1957	1330	15.1
1957-1980	570	24.8
1980-1990	380	38.0
1990-1999	390	43.3
1999-2006	430	61.4

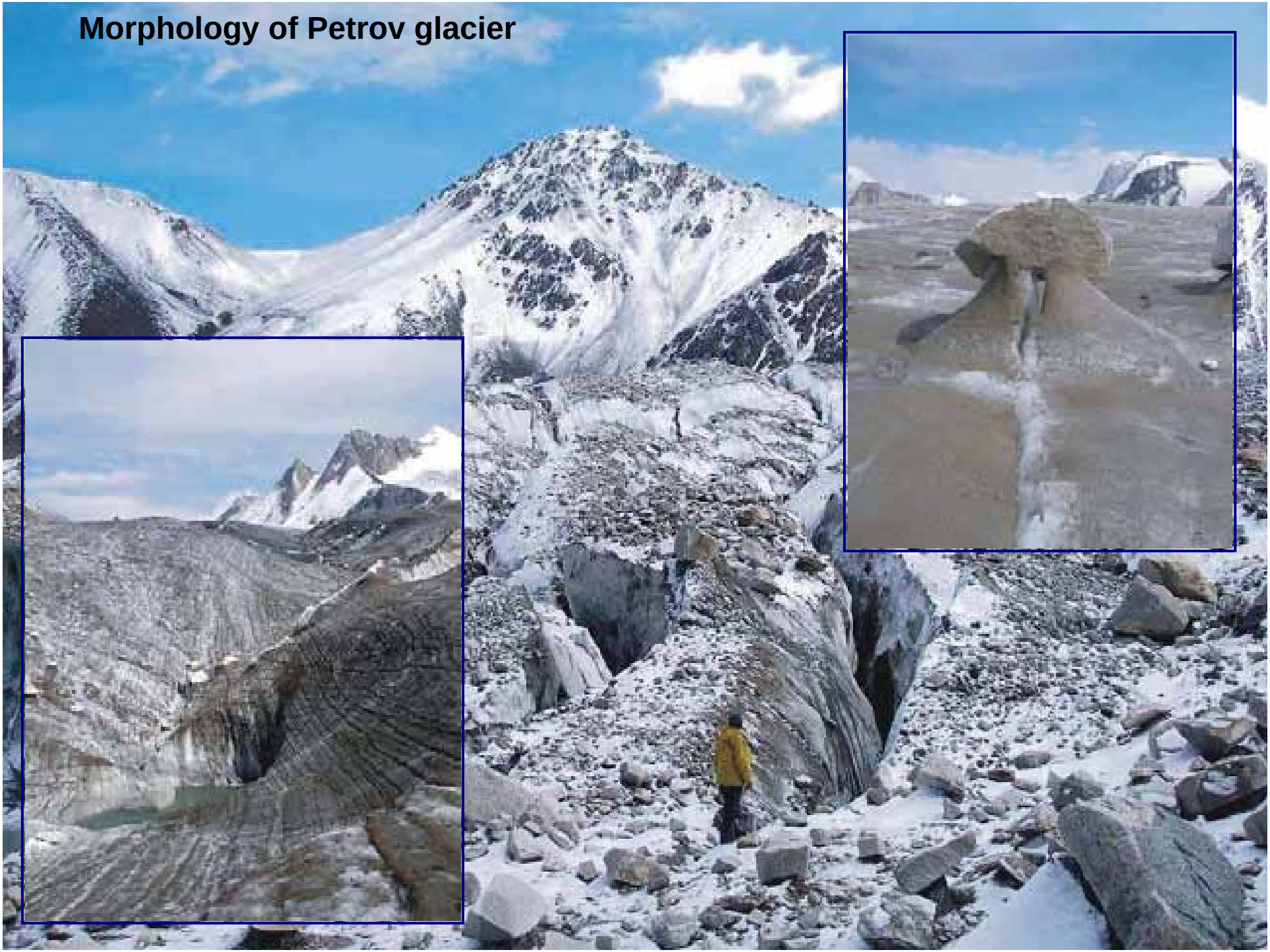
Petrov Glacier retreat (2003-2008)

Total retreat 2006-2009: 138 mts

Average annual retreat 46 mts/year

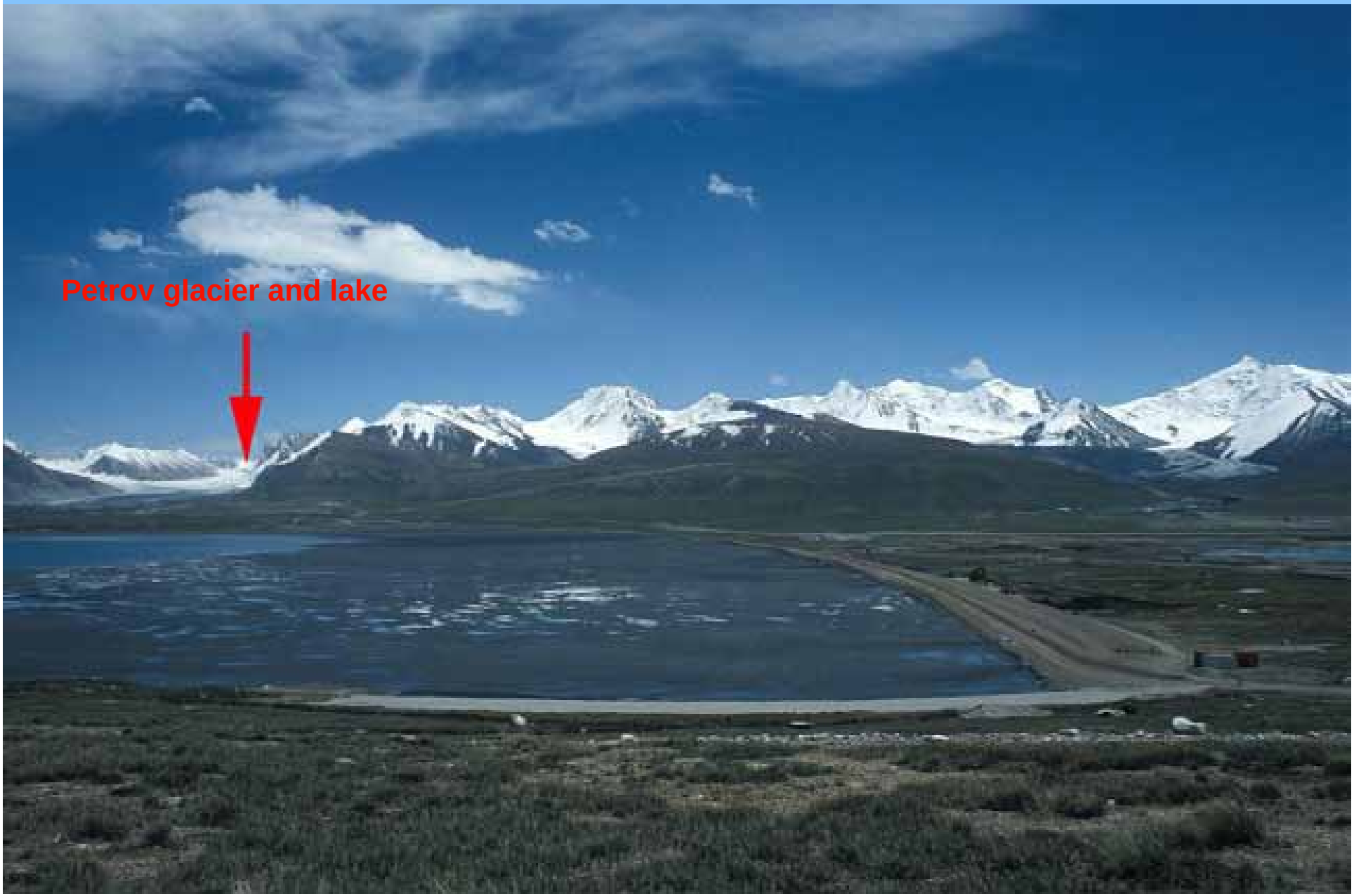


Morphology of Petrov glacier



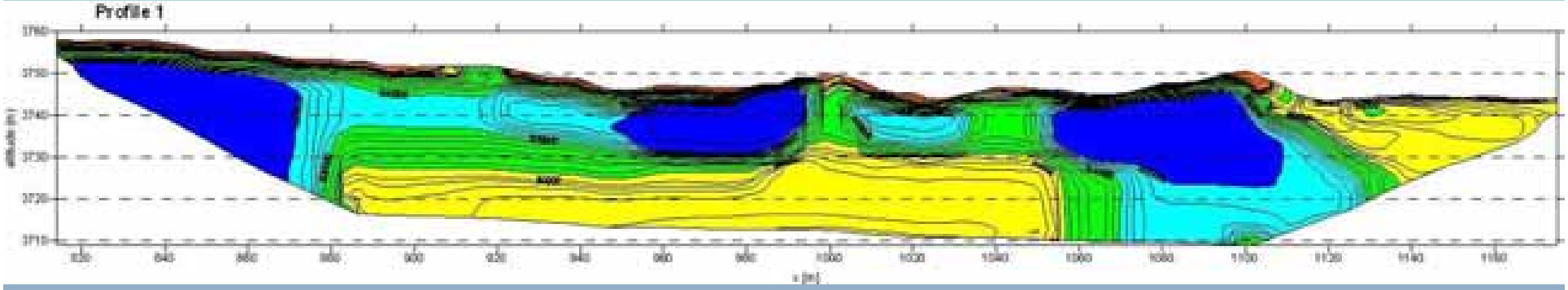
Calving of Petrov glacier

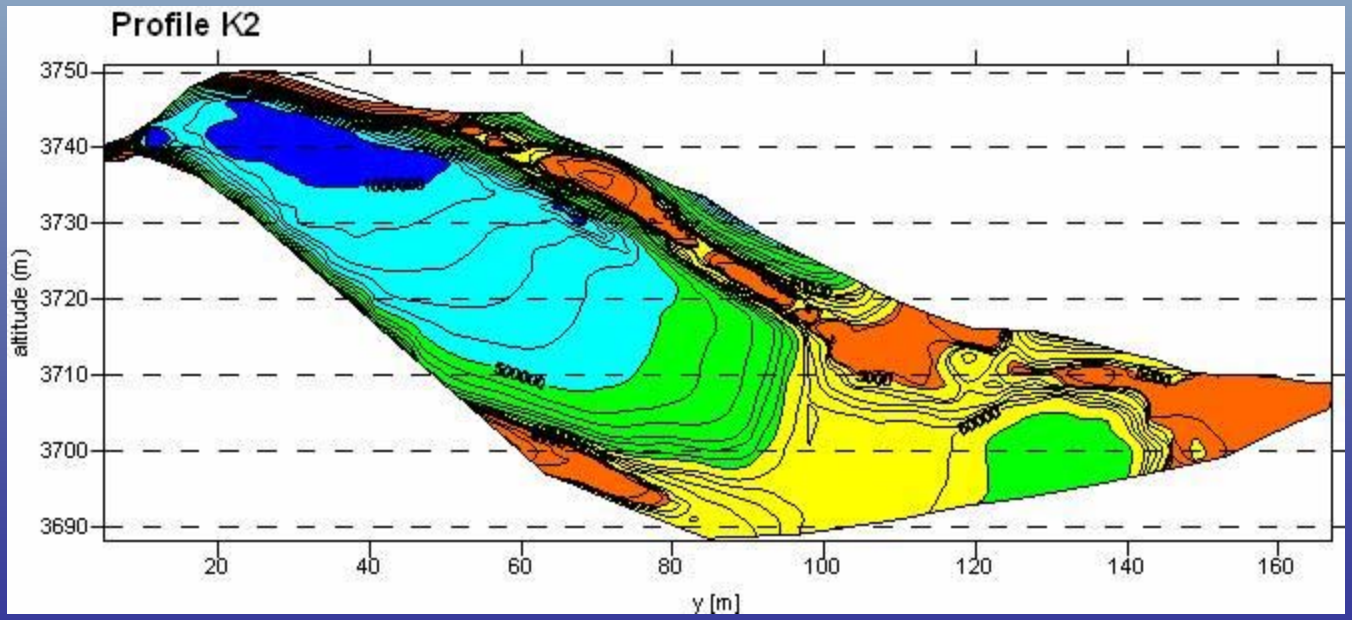
View over tailings pond to the glacier and Petrov lake



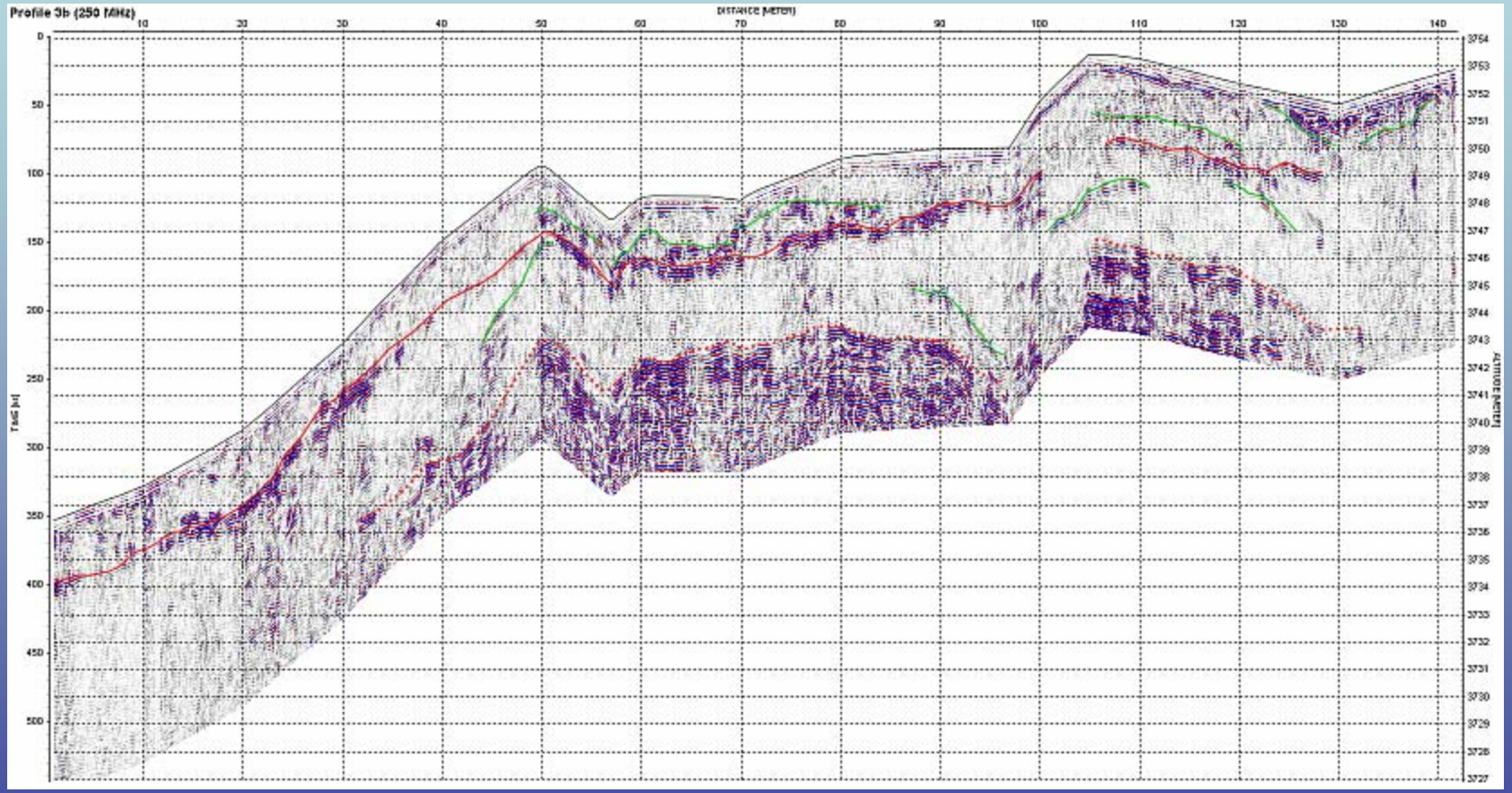
Geophysical survey of Petrov lake dam

Resistivity tomography



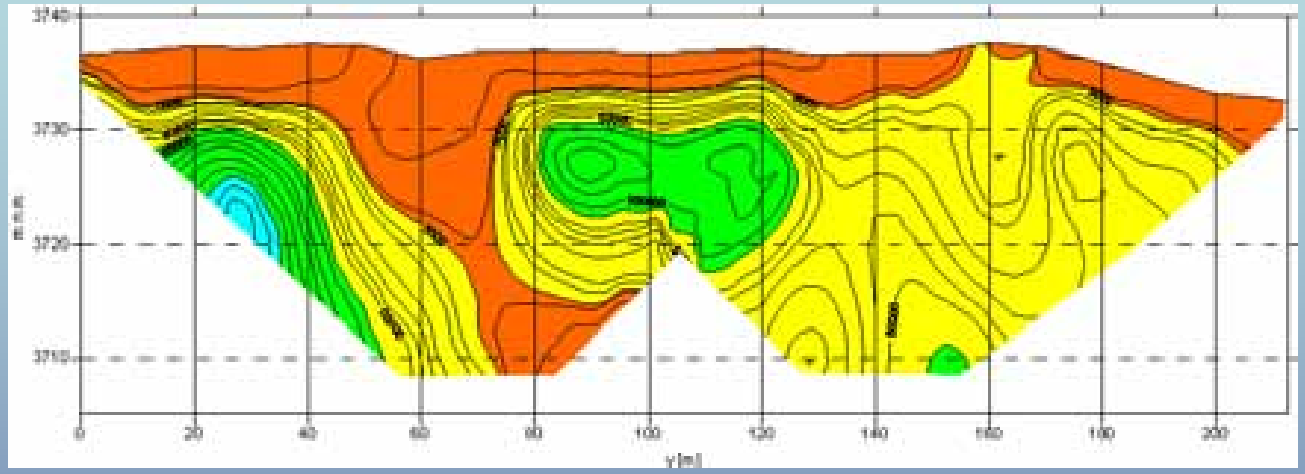


Example of the Ground Penetration Radar cross section of the outflow shore

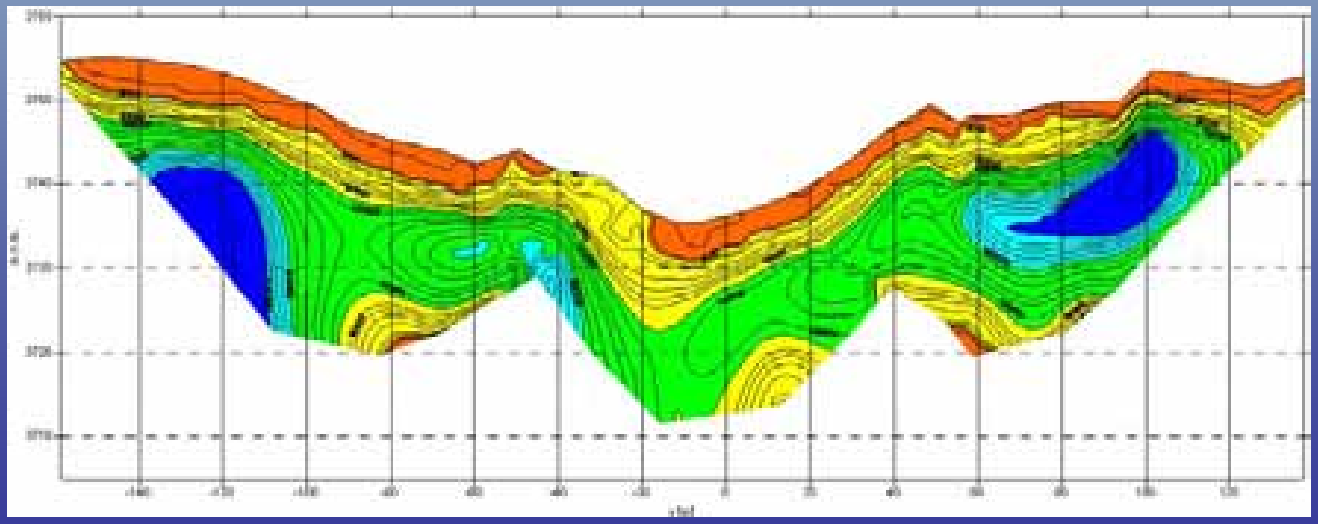


Resistivity tomography of outflow

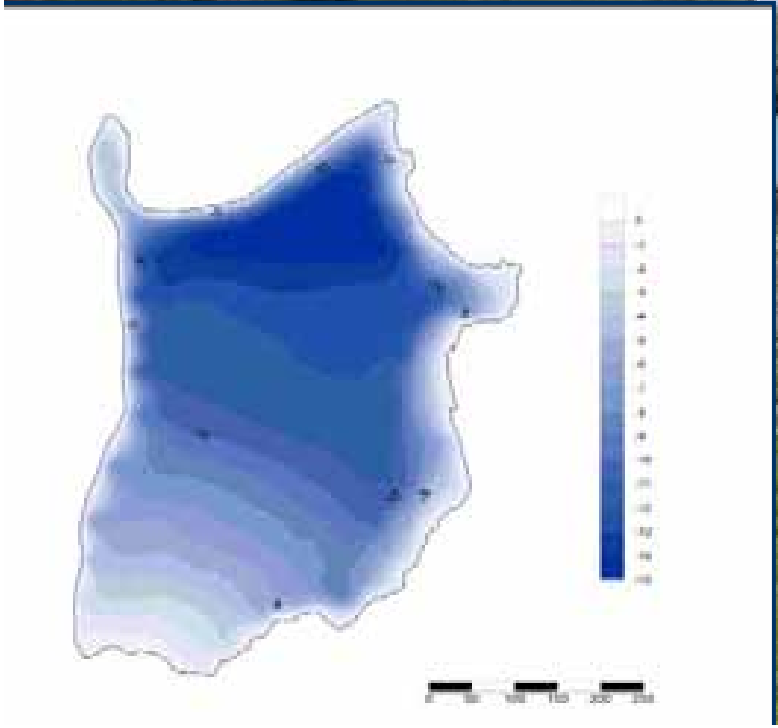
longitudinal section along the outflow



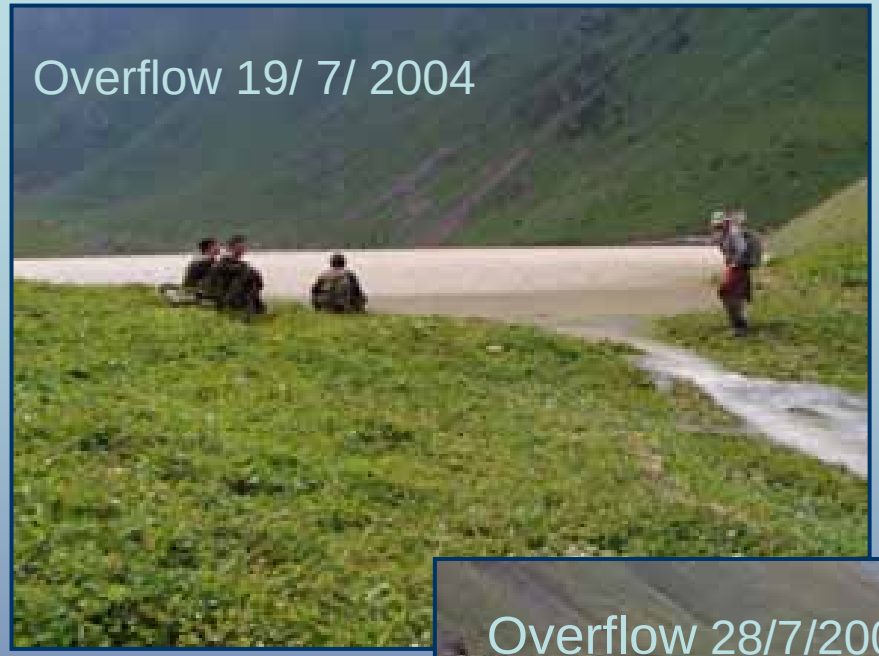
crossection across the outflow



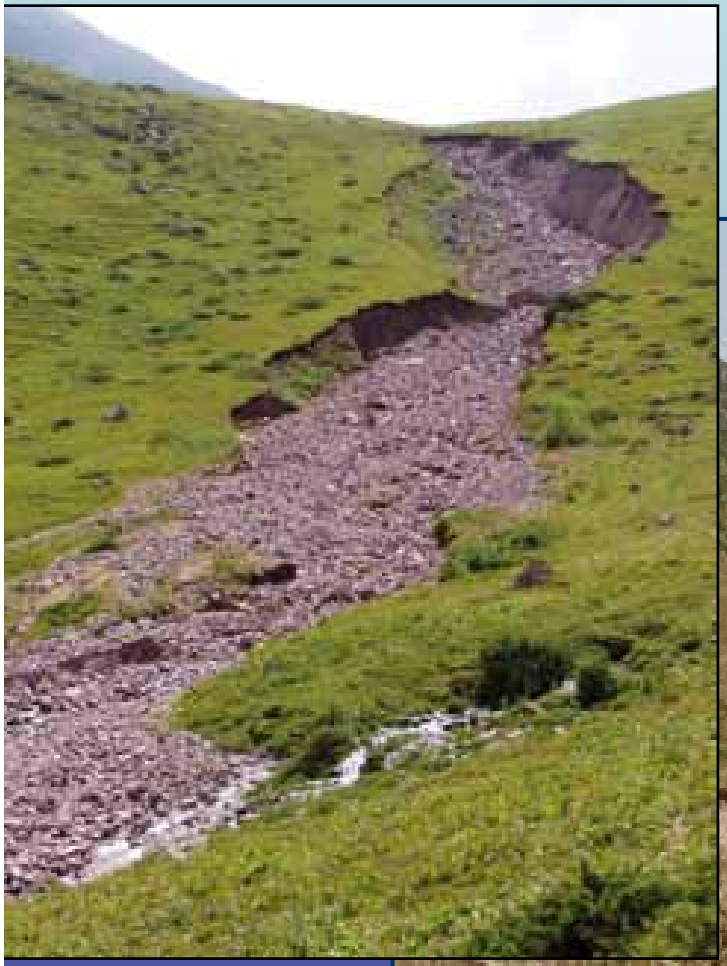
LAKE KOLTOR



Koltor lake – new trouble



Koltor lake – new trouble

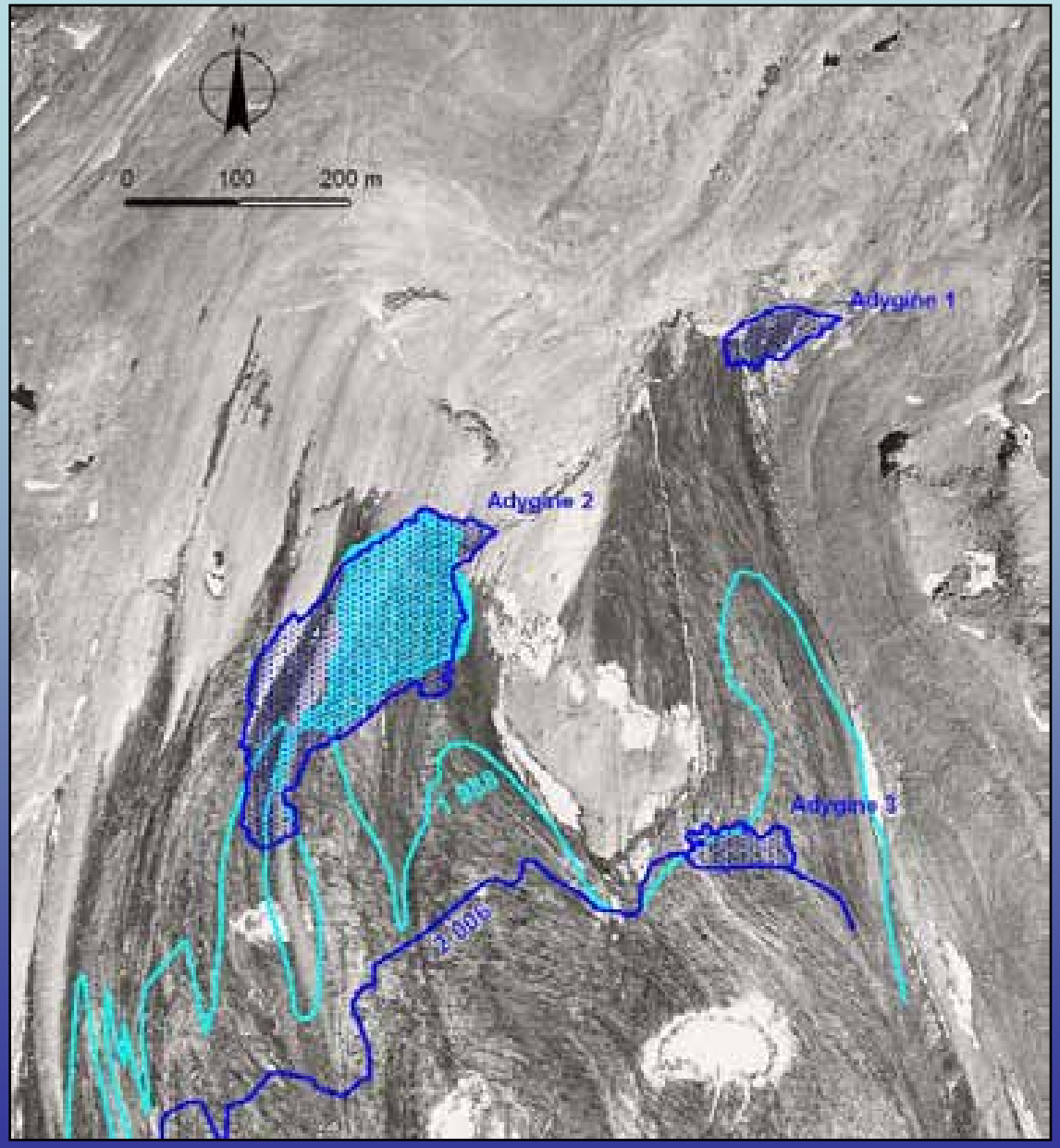


Erosion furrow at outer side of lake dam

Protection of erosional furrow of Koltor lake

Glacial complex Adygine

Development of glacial complex Adygine since 1962



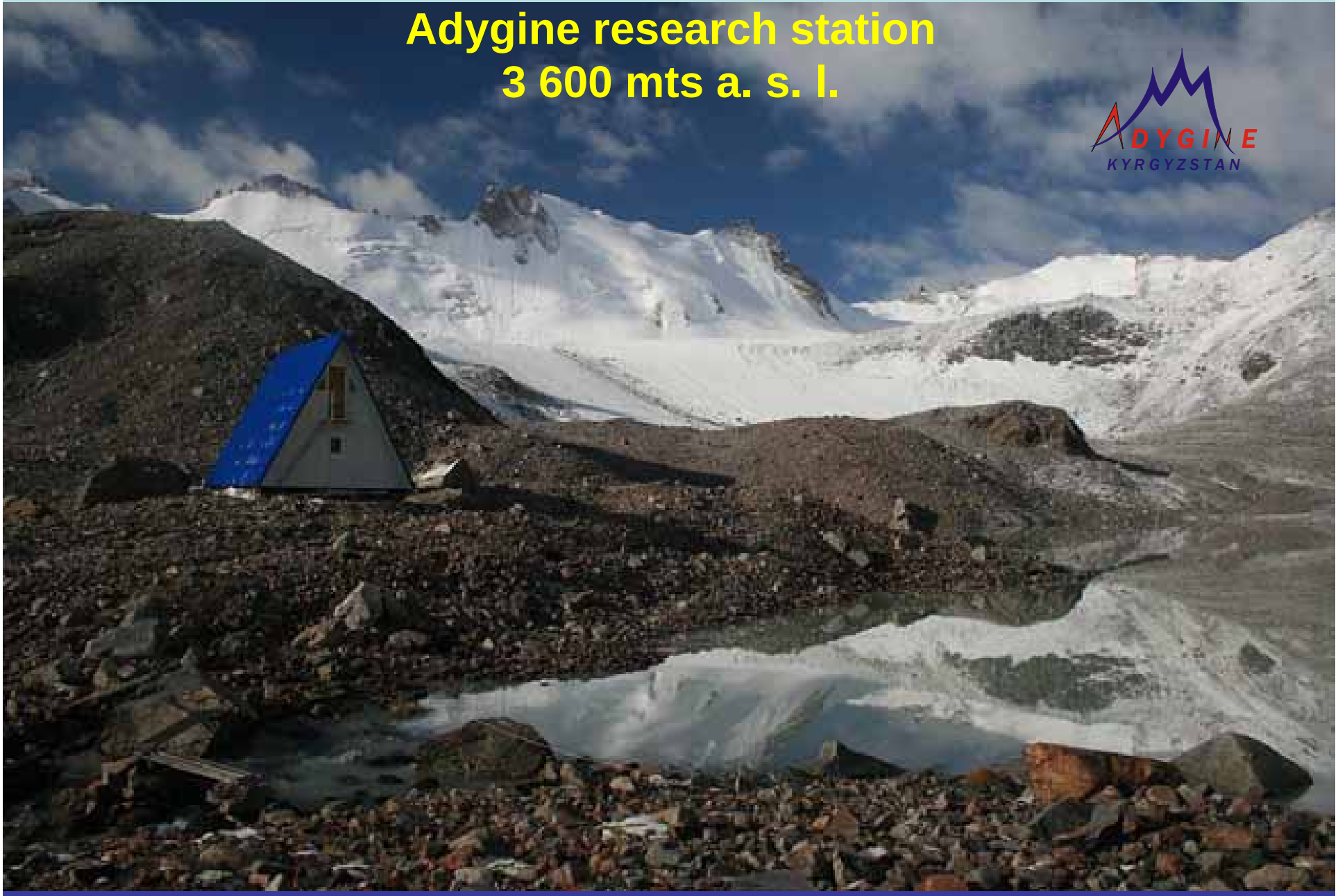
Development of lakes and glacier foreland

Year 1962:
Lower lake doesn´t exist,
upper lake forms narrov belt
behind a rock barrier ,
glacier reaches to the riegel.

Year 1988:
Lower lake begins developing,
upper lake is growing,
glacier retreaded by 200 mts.

Year 2007:
Lower lake is fully developed,
upper lake is behind its maximum
develpment and is step by step
filled by glacial sediments,
glacier have retreated by 250 m.
upwards

Adygine research station
3 600 mts a. s. l.




ADYGINE
KYRGYZSTAN

Research and monitoring station Adygine

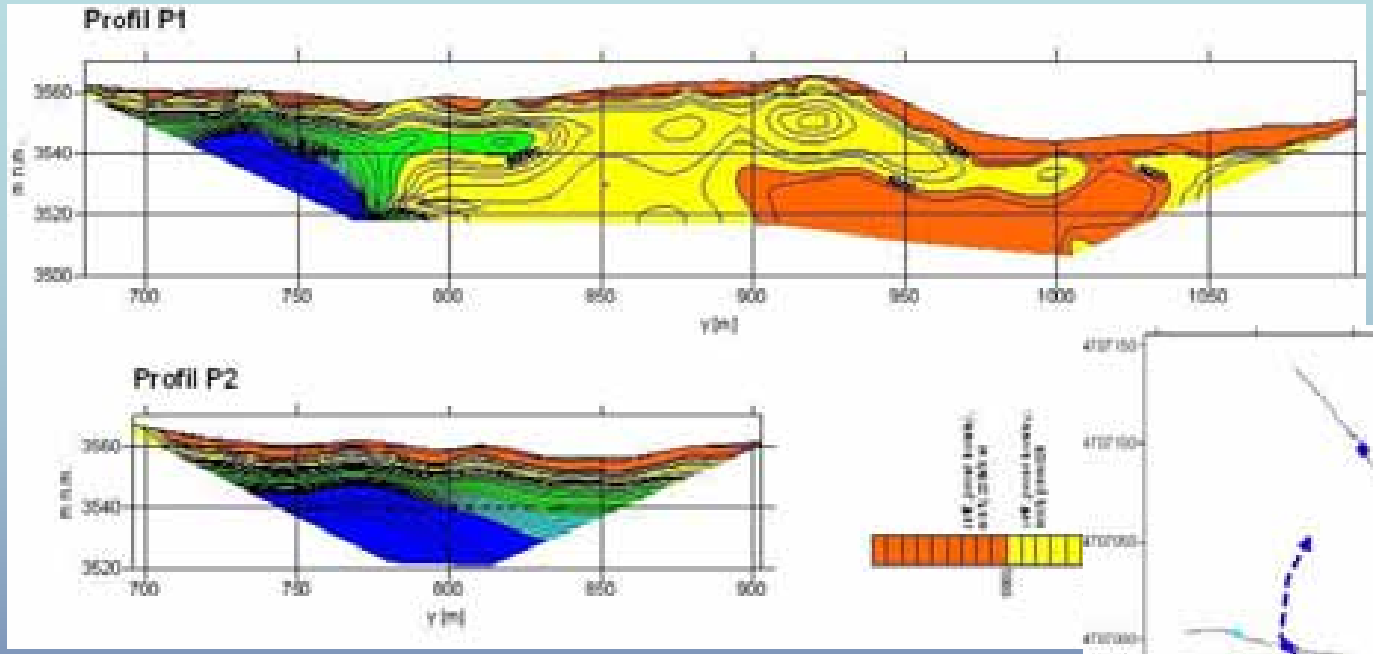
The research programme of the station is aimed at:

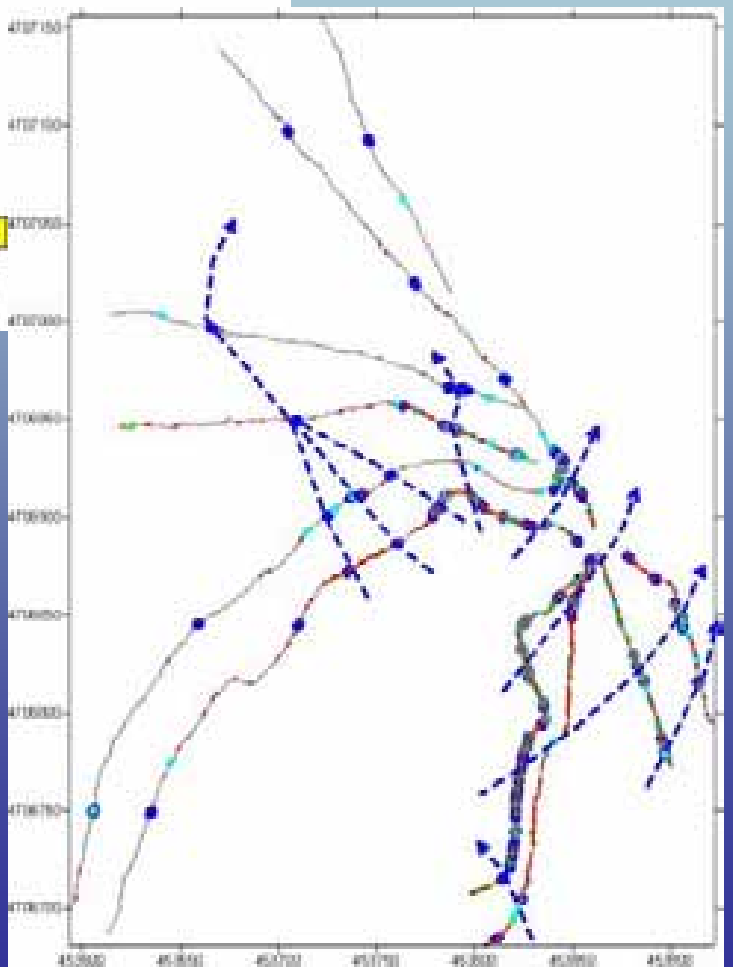
- **Monitoring of hazardous lakes**
- **Meteorological observations**
- **Hydrological measurments**
- **Glaciological research**
- **Other researches (geological, botanical etc.)**

ADYGINE
KYRGYZSTAN



Geophysical survey of Adygine lake dam

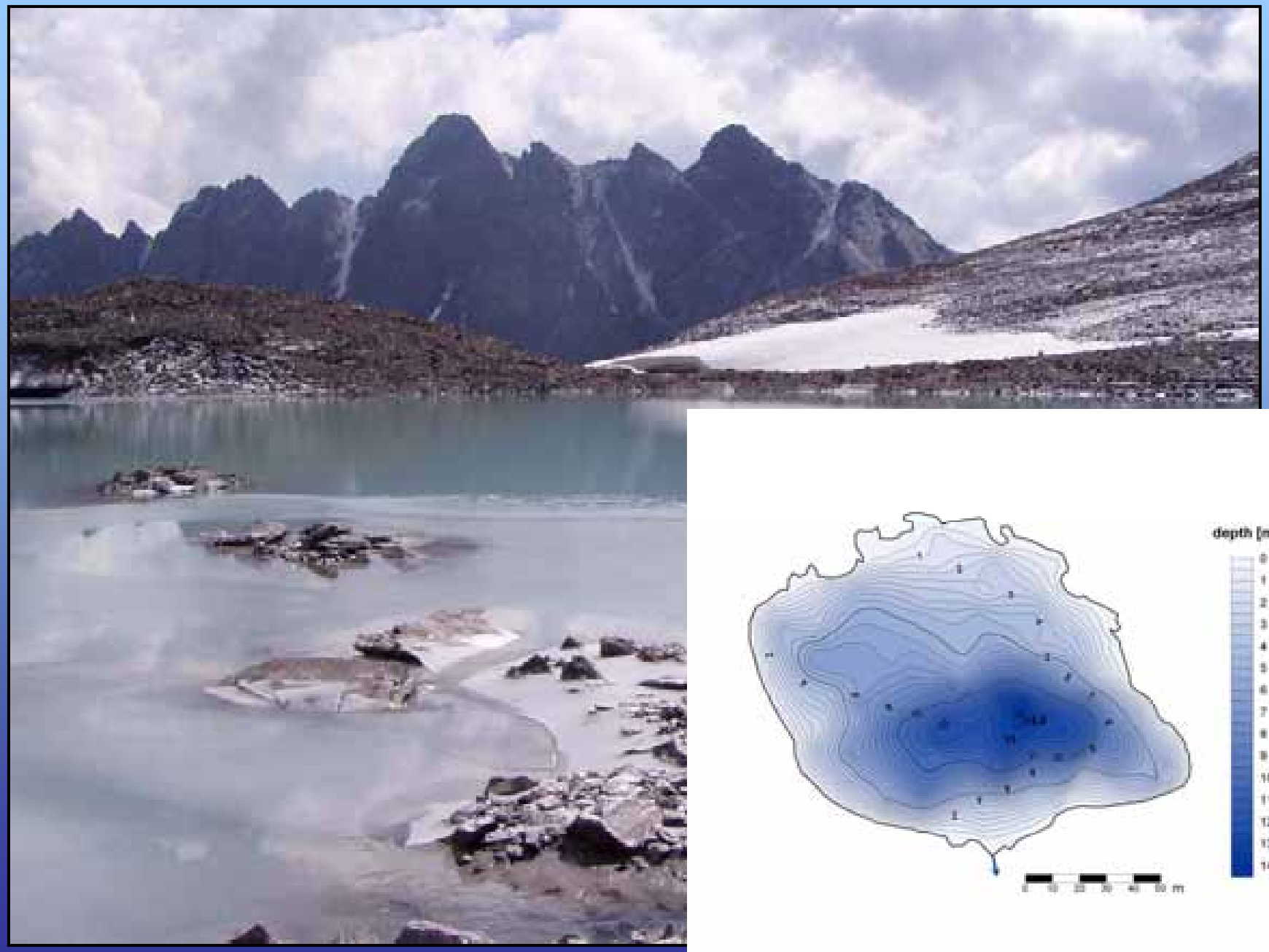




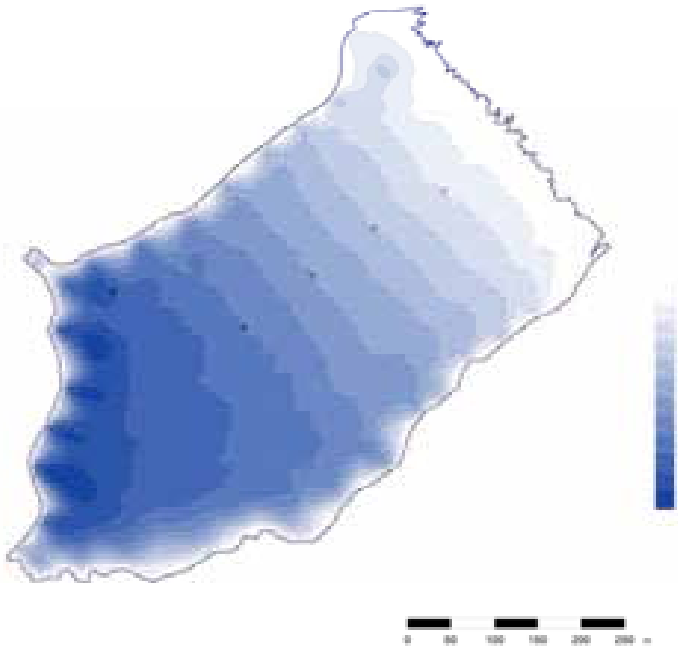
ADYGINE
KYRGYZSTAN

New work in Adygine and Ak-Say

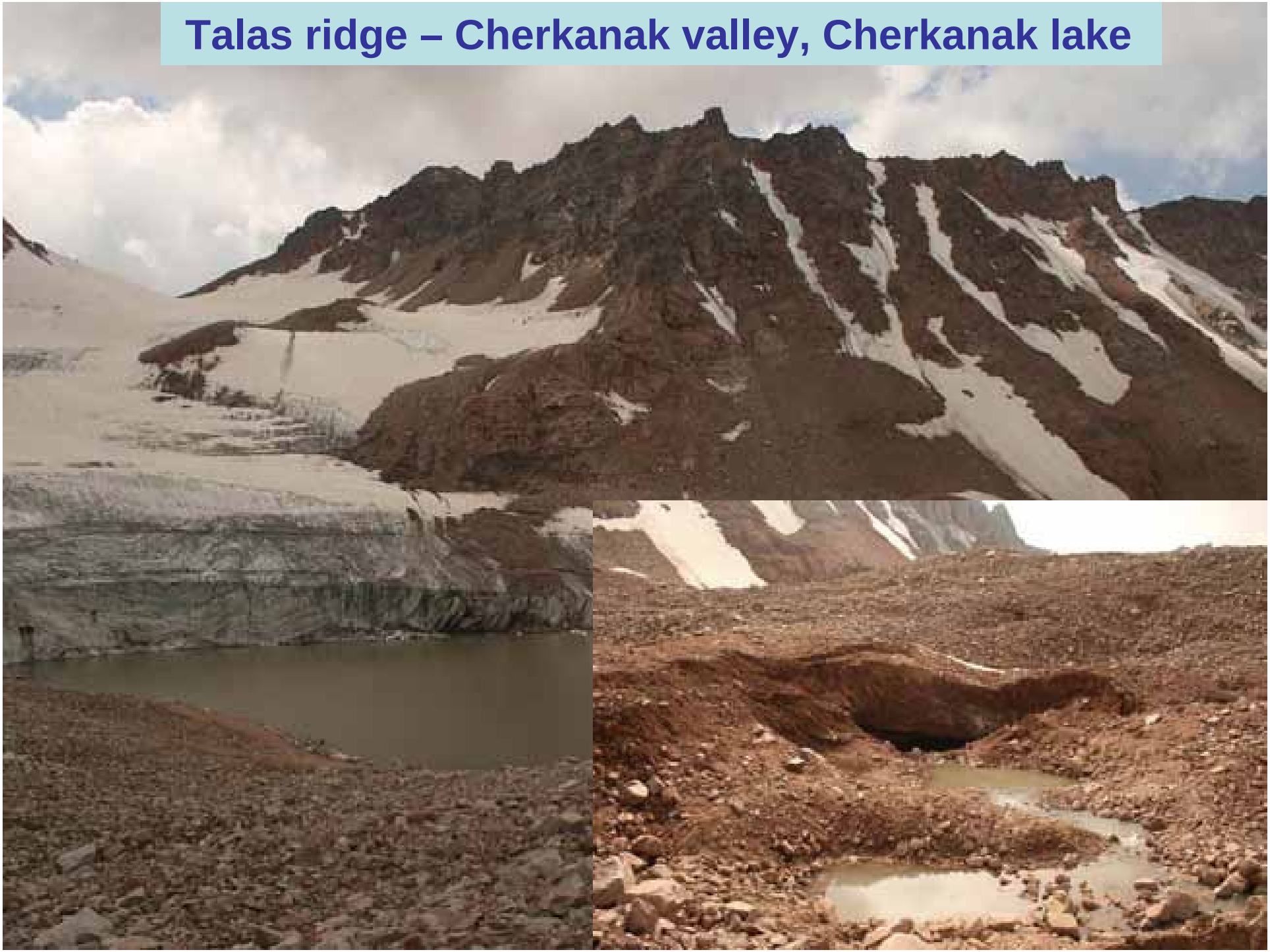
At-Jayloo lake, Kyrgyz range



Issyk-Ata valley
Minjilki lake



Talas ridge – Cherkanak valley, Cherkanak lake



Talas ridge – Cherkanak valley, Djalpaktor lake

GENERAL CONCLUSIONS

Retreat of most of glaciers at the heights of 3 500 – 4 000 mts a. s. sl.

Development of new lakes after frontal part of retreated glacier tongue.

Short life-time of recently appeared lakes, few years or even months.

Negative influence of current climate changes

- increase of evolution dynamics,
- more chaotic development of glacier complexes,
- decreasing of ice core mass inside the moraine,
- higher water outflow from melting glaciers and discharge variability of glacial rivers.

Higer risk level due to more intensive exploitation of mountain valleys

ADAPTATION MEASURES

1. Monitoring, risk level research, risk assessment

- Monitoring on regional scale
- Monitoring of individual objects

2. Population awareness

3. Risk analyses

- Risk analyses of lakes showed actual outburst hazard
- Risk analyses of selected threatened valleys

4. Early warning system

- Preliminary measures
- Warning about already progressing flash-flood or debris flow

5. Technicalities and engineering

- Modifications of lakes dams and overflows
- Modification of the river bed below the lake
- Induced outburst

NEED FOR MULTILATERAL COLLABORATION

1. Monitoring, lake research, risk analyses

A. Long-term monitoring of mountain glacier cover changes and studying of consequent glacial lakes development.

- **Projects based on remote sensing monitoring.**
  - **Long-term project – at least 5 years**

B. Risk analyses of selected lakes and valleys

- **Detailed research aned assessment of the most threatened valleys**
  - **Based on previous investigation**
  - **Medium-term projects, about 2 – 3 years**

2. Early warning system

Implementation of early warning management and Instalation of proper warning tools.

- **Based on previous investigation and risk analyses.**
  - **Short-term to medium-term projects, 1 – 3 years according to scheduled activities.**

3. Engineering solutions

Modifications and constructions in the most thretened localities showed actual outburst hazard.

- **Based on previous detailed investigation or long-term monitoring, coordinated with Ministry of Emergency priorities.**
  - **Short-term to medium-term projects, 1 – 3 years**

The scientists have a hard life…


THANK YOU FOR YOUR ATTENTION