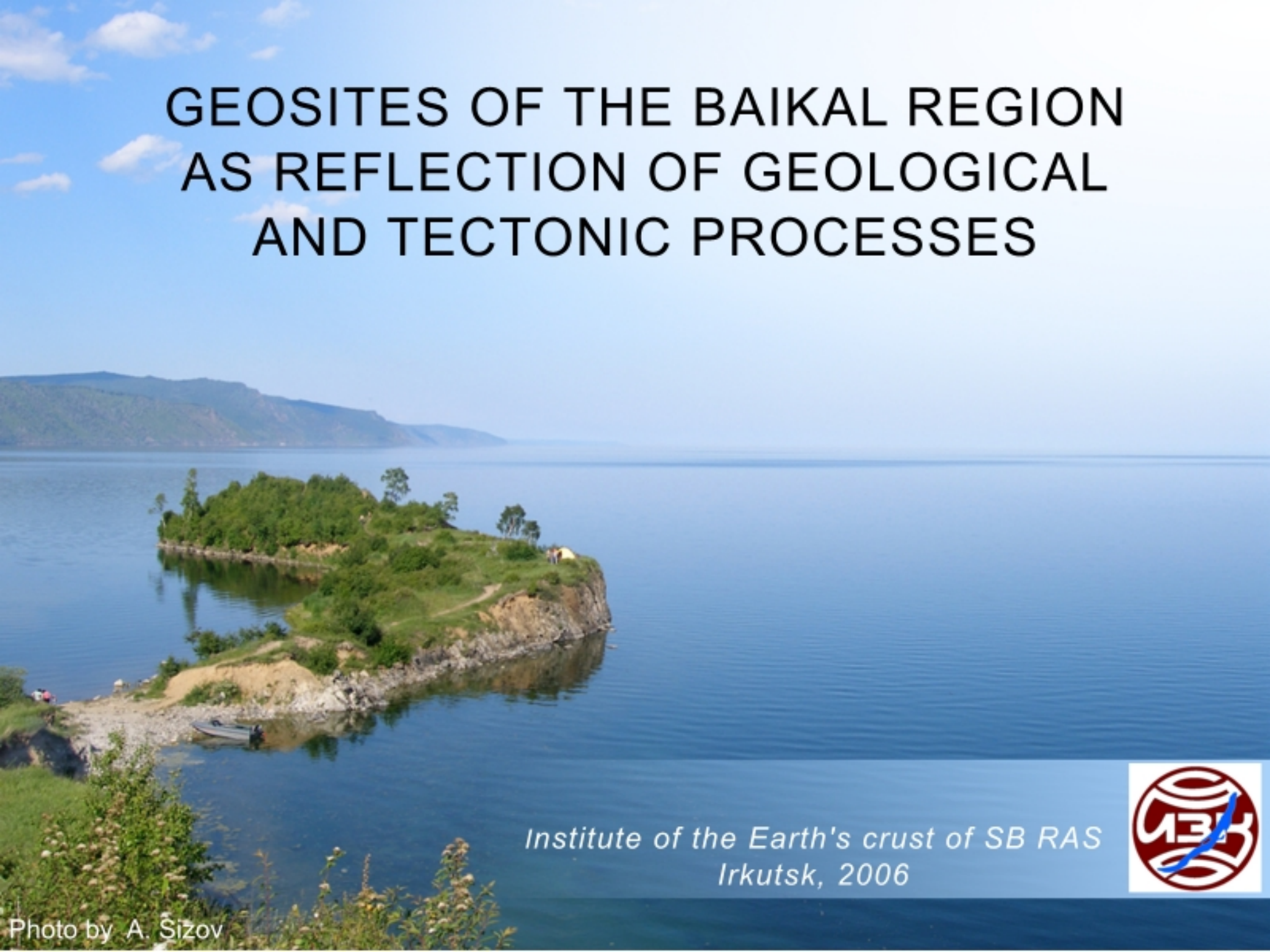
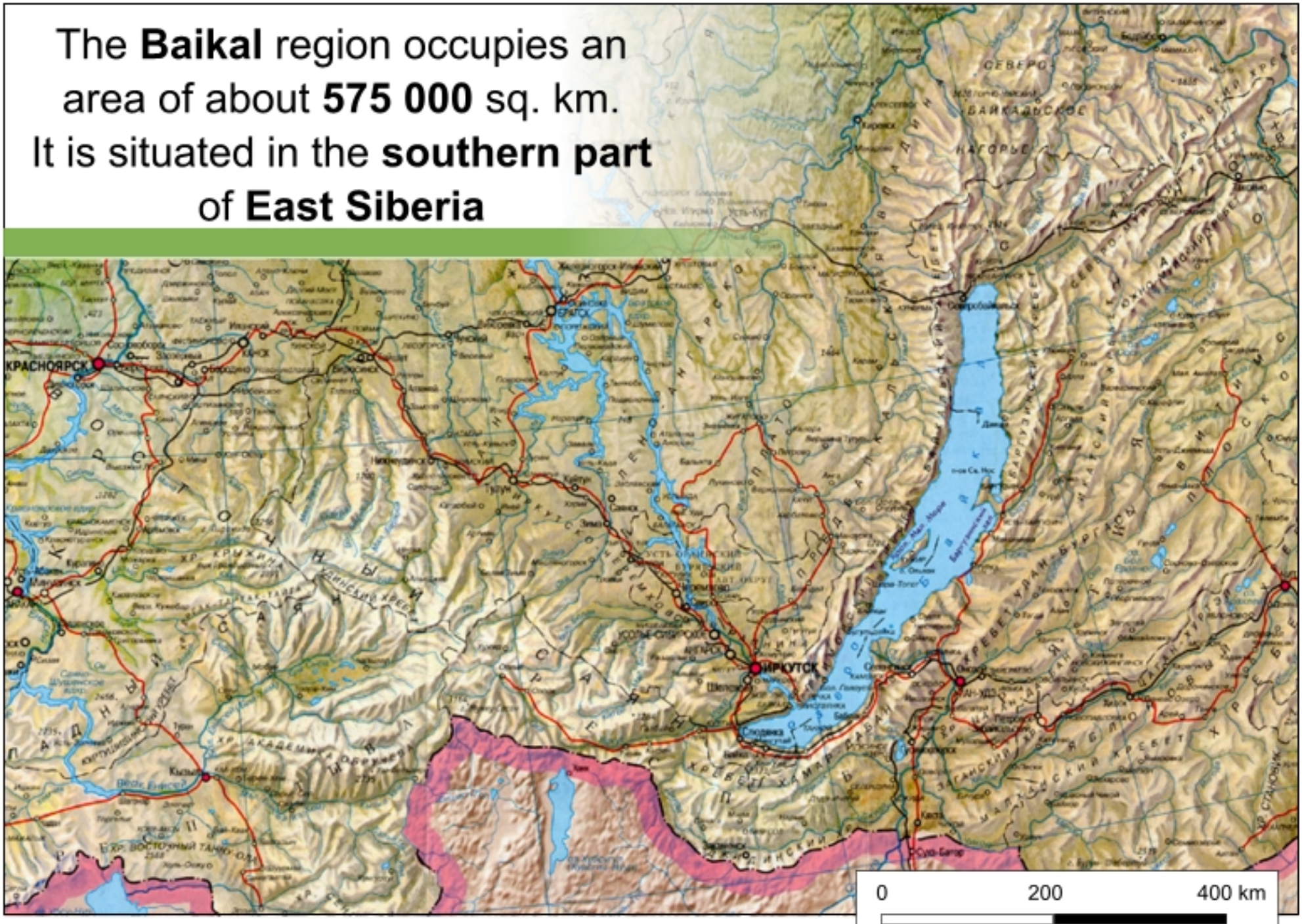
GEOSITES OF THE BAIKAL REGION AS REFLECTION OF GEOLOGICAL AND TECTONIC PROCESSES



Institute of the Earth's crust of SB RAS
Irkutsk, 2006

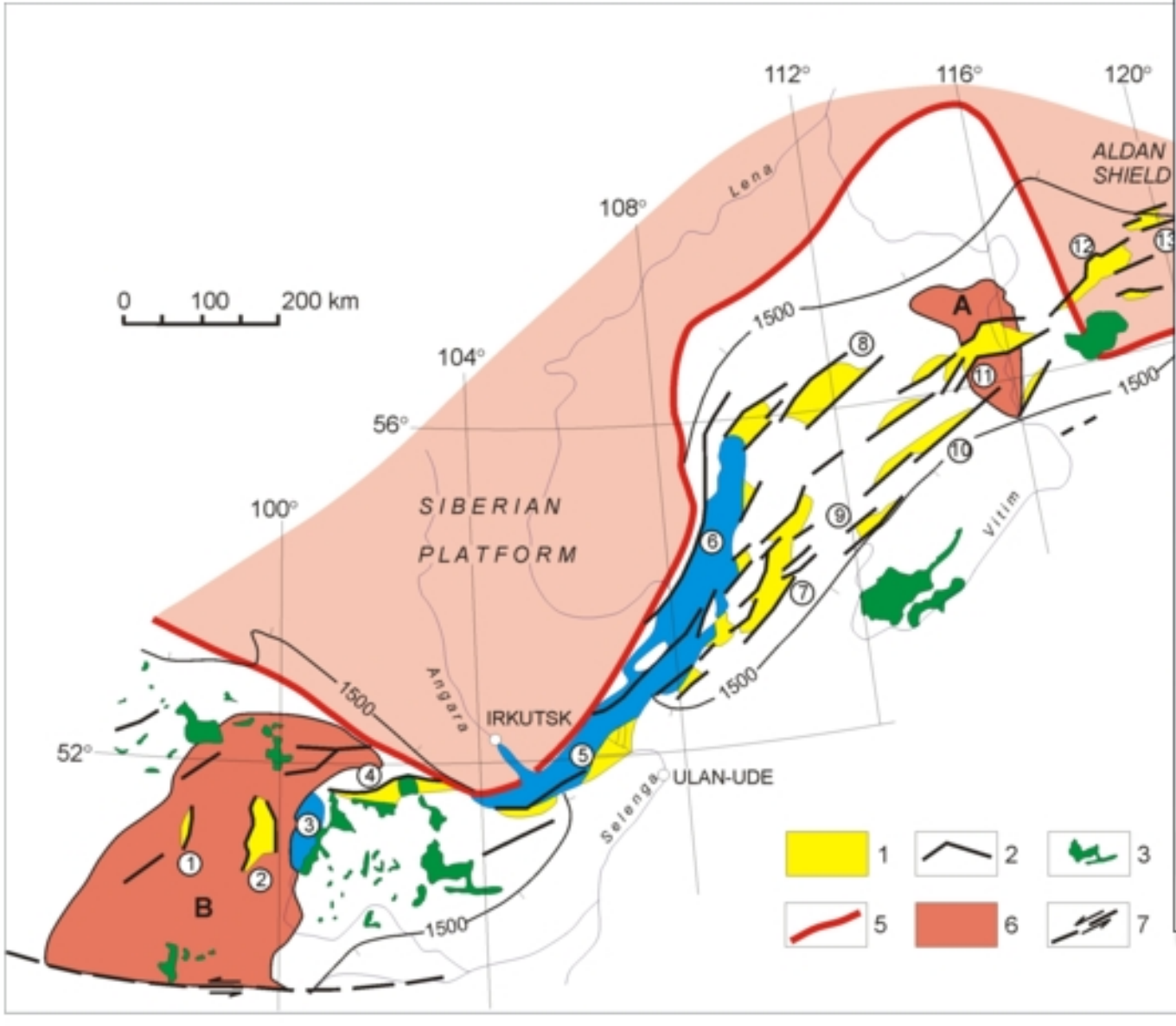
Photo by A. Sizov

The **Baikal** region occupies an area of about **575 000** sq. km. It is situated in the **southern part** of **East Siberia**



THE **BAIKAL** RIFT SYSTEM

(Logachev, 1997)

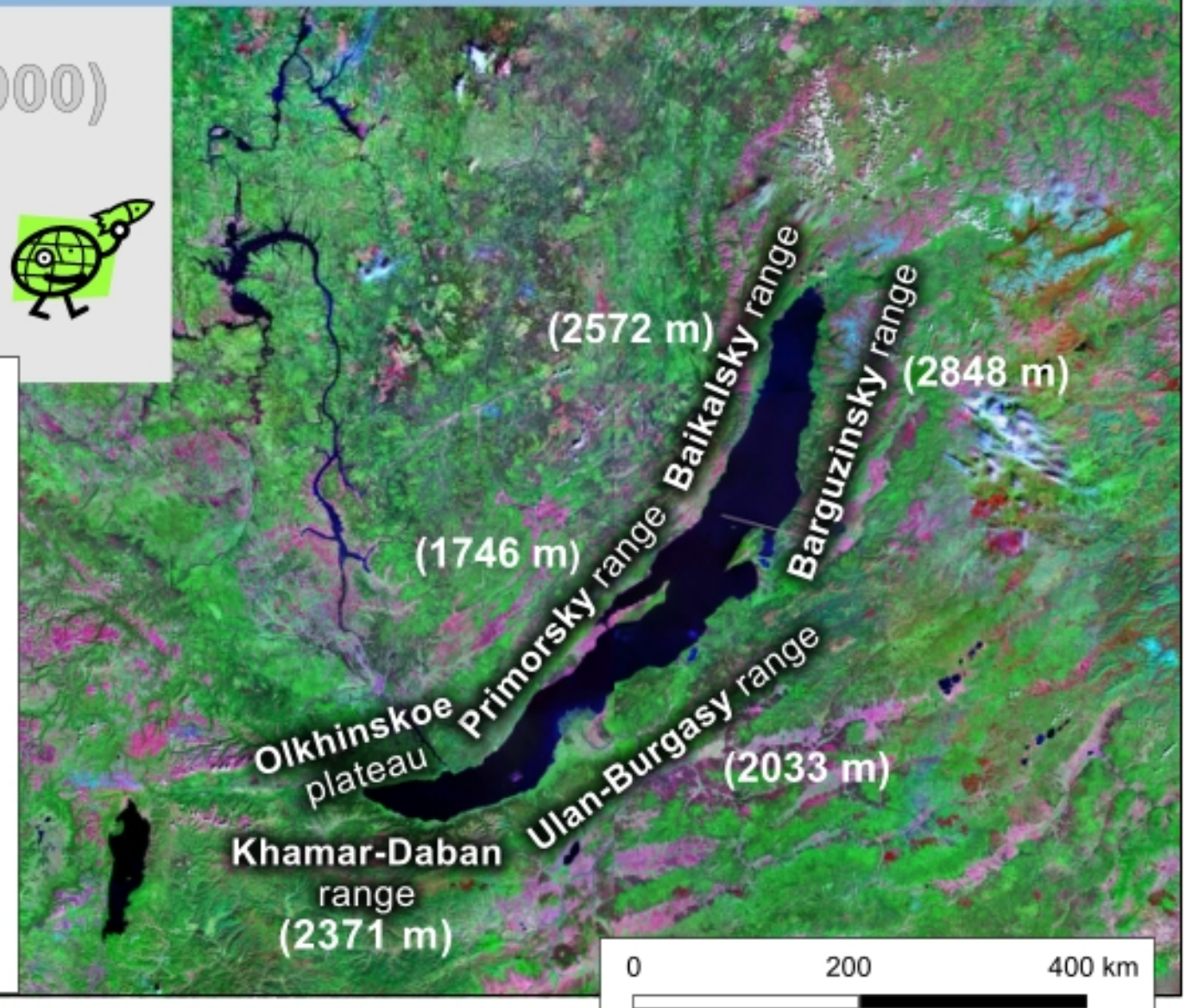


The Baikal rift system is a series of narrow rift basins, mountain ranges and fault zones (within Sayan-Baikal fold-and-thrust belt), which stretches for 1800 km along the active boundary between the Siberian Craton and a mosaic of continental fragments

(Logatchev and Florensov, 1978; Tapponnier and Molnar, 1979; Zonenshain and Savostin, 1981; and other)

The **Baikal Lake** is the central element of this natural system. Some morphometric and orographic characteristics of the lake and its surrounding represented on the slide

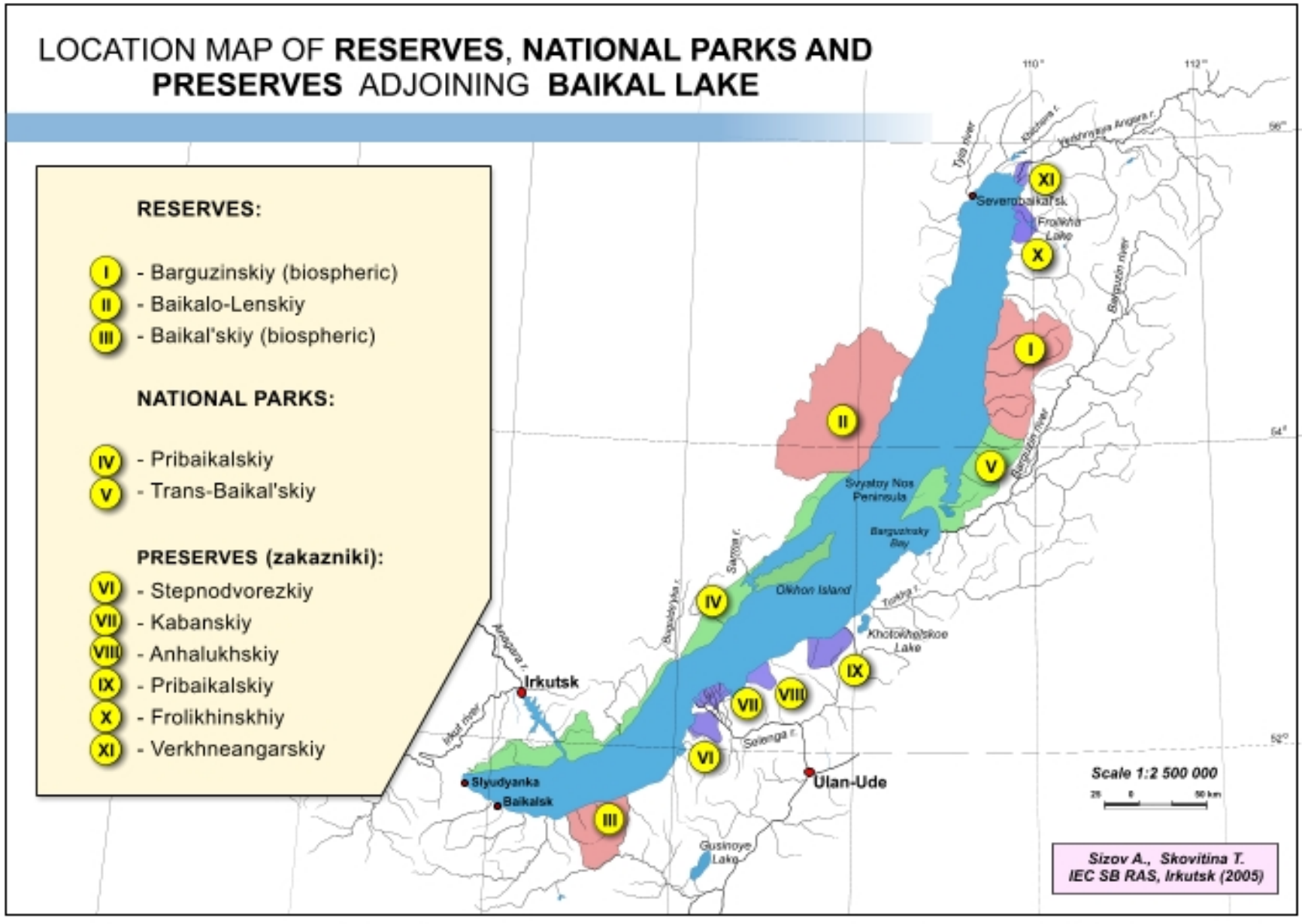
Landsat-7 (2000)
TM image



- The length of Lake Baikal is **635 km**
- Maximal width of Lake is 80 km
- The volume of fresh water is **23 015 km^3**
- Max depth is **1642 m**
- The total thickness of sediments in the Baikal basin is **8-9 km**

Many natural sites and objects of the Baikal region have official status of geosites and on the other hand - nonofficial status of tourist Mecca.

Consequently, the tourism often has an uncontrolled character and is detrimental to the environment, inspite of the activity of the employees of preserves, national parks located on these territories.



Only main reserves, national parks and reserves adjoining the Baikal Lake are shown on this map. In fact, there is much more of them.

We suppose, that a popularization of scientific (geologic, tectonic and geomorphologic) knowledge would play a positive role in elimination of negative effects produced by a "wild" tourism.

The most representative natural sites in the Baikal region are:

- Coastal zone of the Baikal Lake;
- Tunka Valley (Southwestern Pribaikalye);
- Barguzin Valley (Southeastern Trans-Baikal area);
- Okinskoe Plateau (Eastern Sayan)

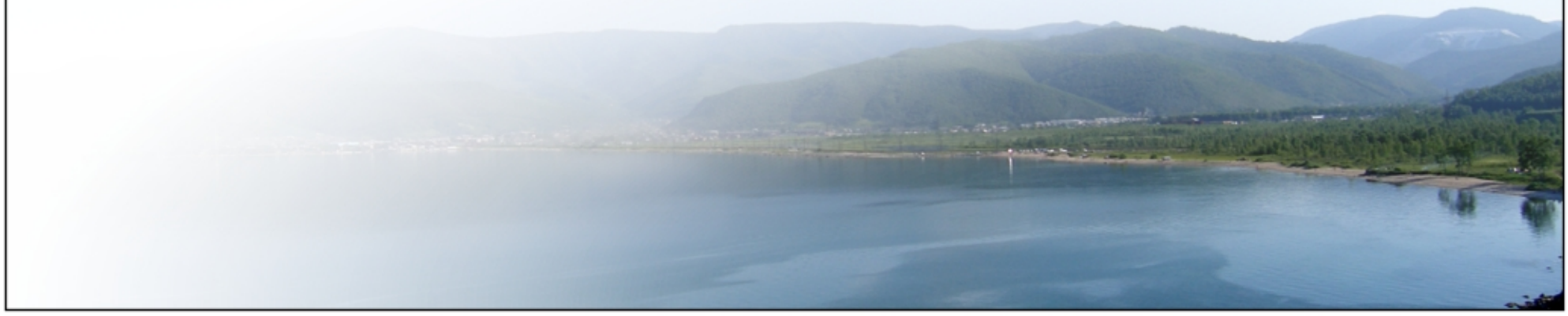
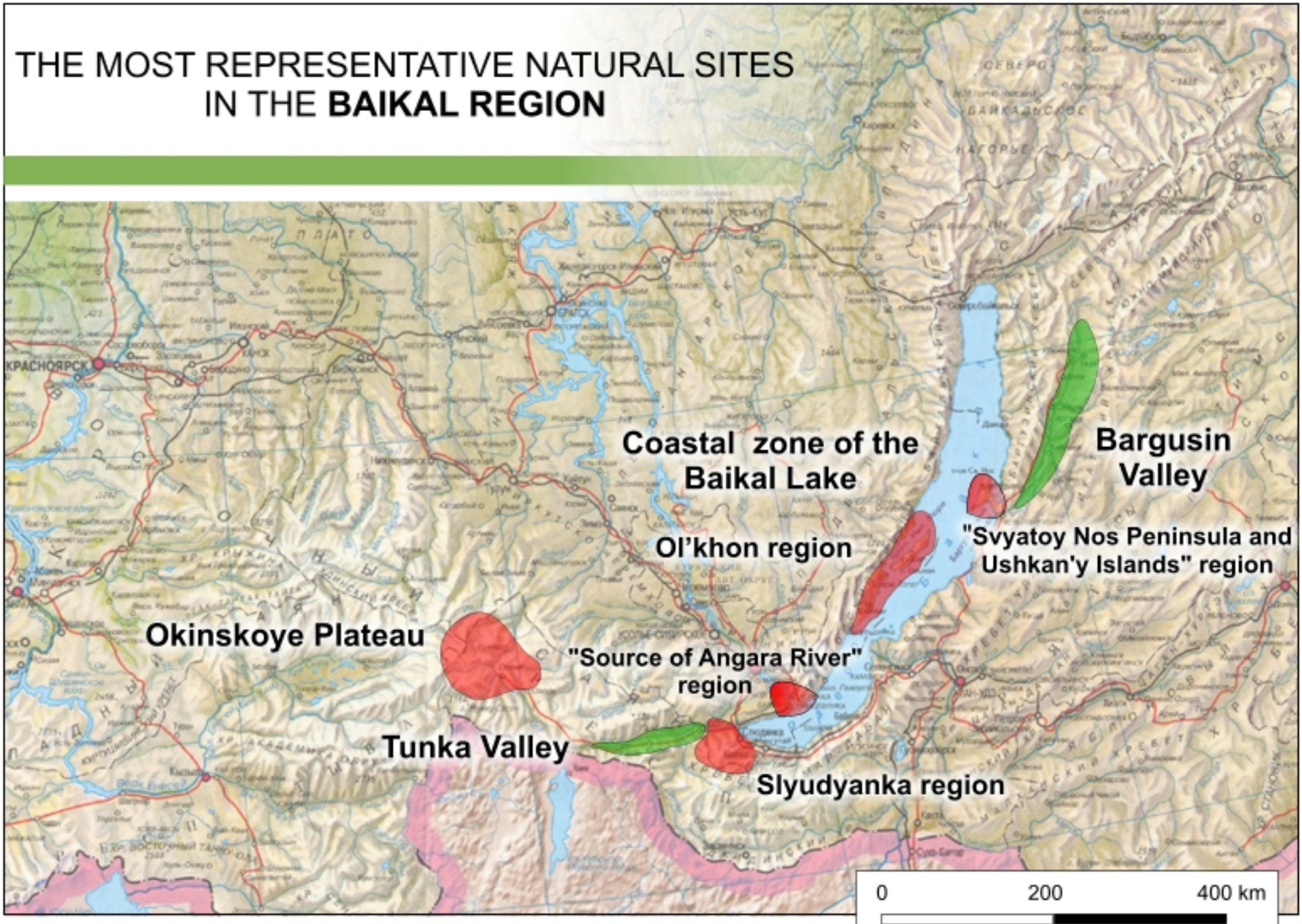


Photo by A. Sizov

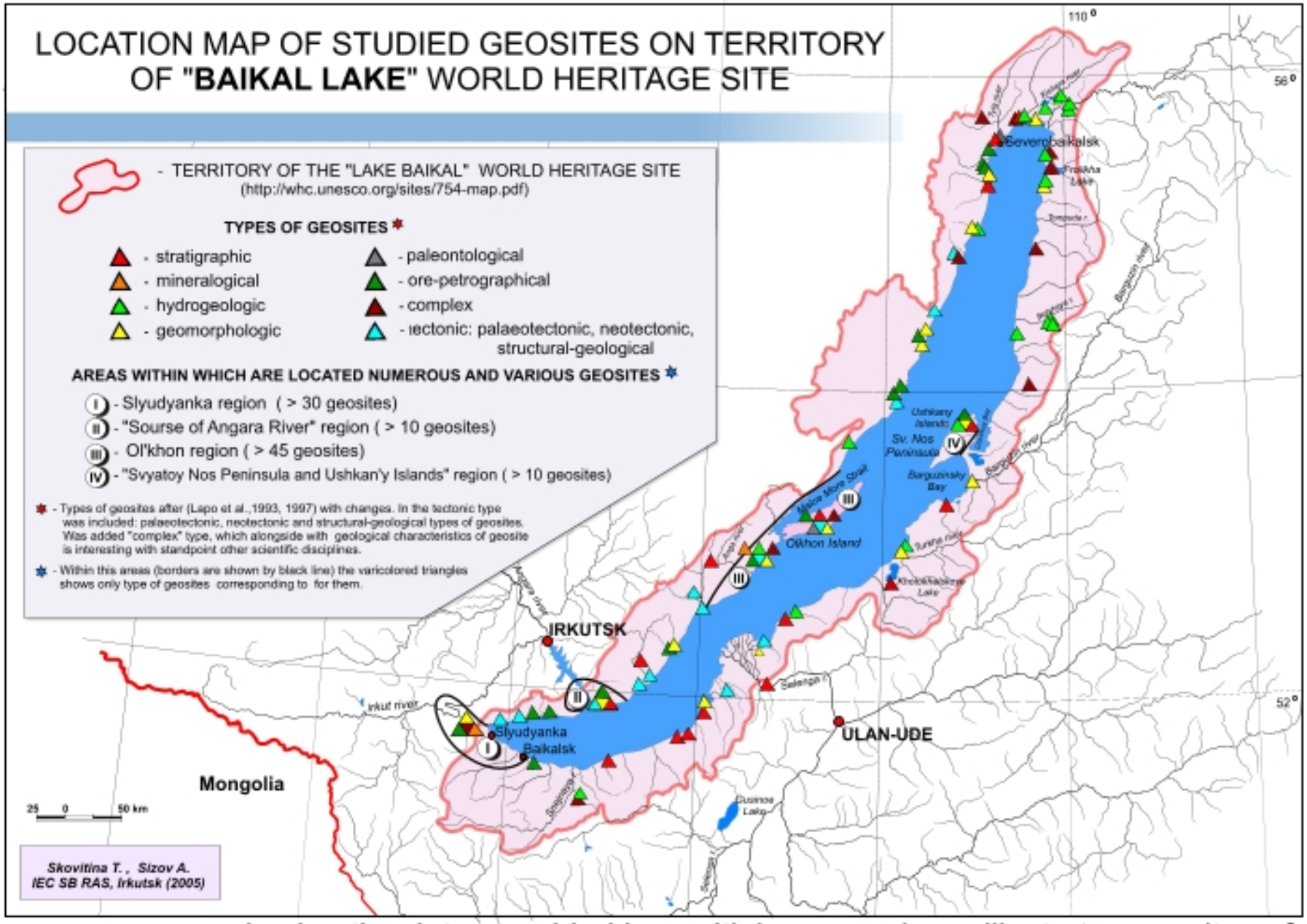
THE MOST REPRESENTATIVE NATURAL SITES IN THE **BAIKAL REGION**



Boundaries of the Lake Baikal World Heritage Site

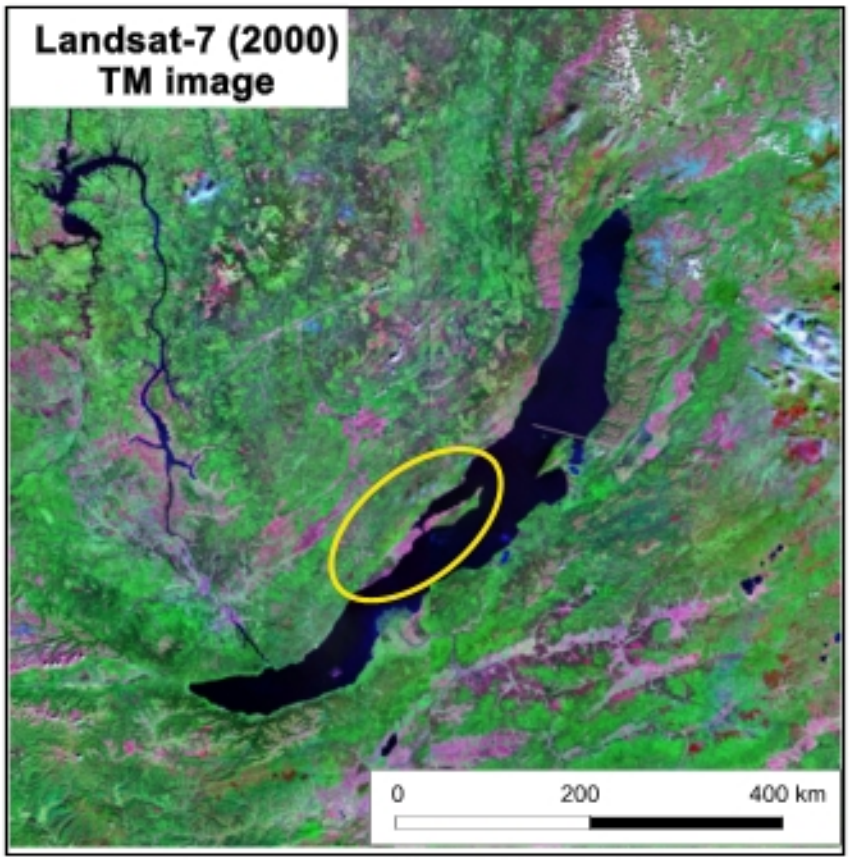
The Lake and its coastal zone were included in the World Heritage List in 1996 yr.

http://whc.unesco.org/sites/754-loc.htm



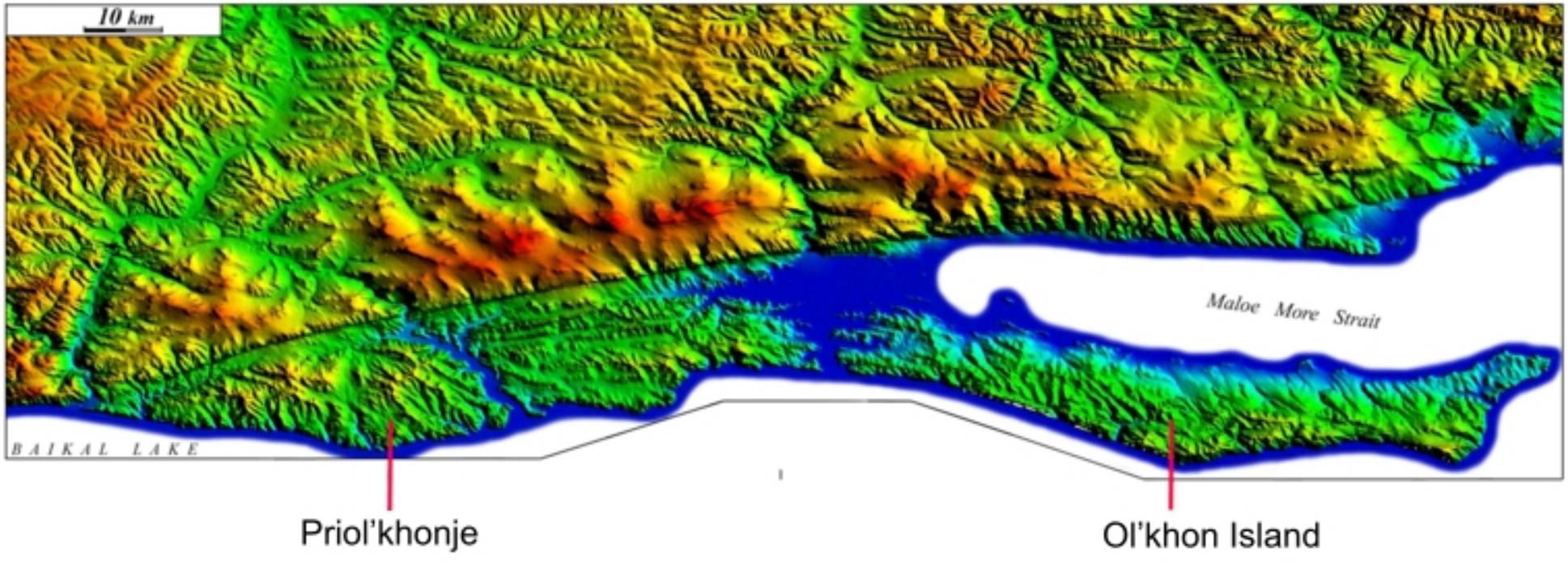
This map, composed using the data, provided by multiple researchers, illustrates geosites of different types, which located along the perimeter of the lake. Four areas here are marked by the continious black line - Slyudyanka region, "Source of Angara river" region, Ol'khon region and "Svyatoy Nos Peninsula and Ushkan'y Ilands" region. Numerous and various geosites are located within their borders. Two of them will receive a more detailed description.

MAPS SHOWING THE **OL'KHON REGION**



OL'KHON REGION

The region includes **Olkhon Island**, which is over **70** km in lengthways and the narrow steppe plateau (the territory known as **Priol'khonje**), that stretches for 100 km and adjoins to **Primorsky** range. Full square area of the region equals 1800 sq. km.



DEM of Ol'khon region (was generated in program "Global Mapper 6.0")

OL'KHON REGION

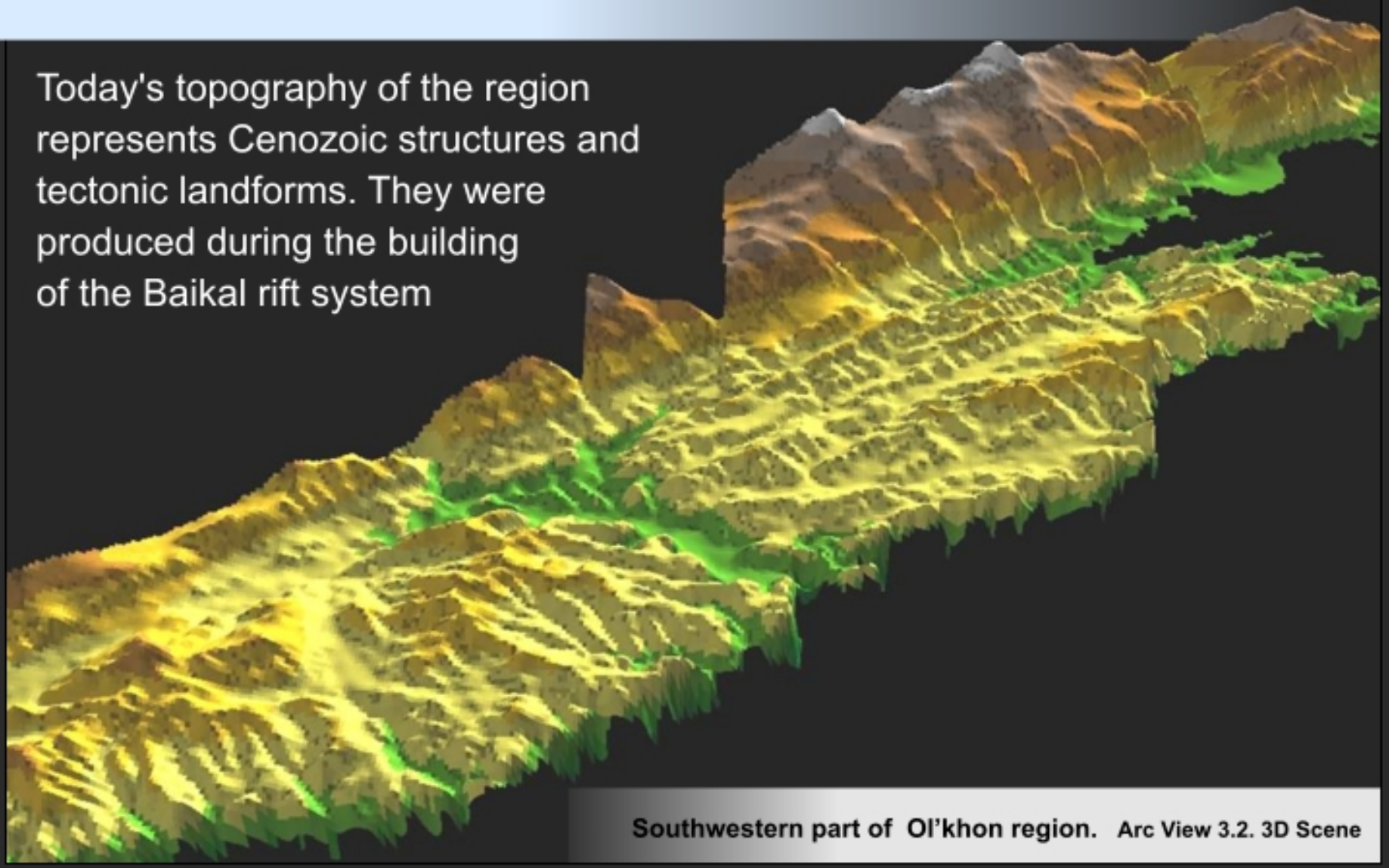
The outstanding features of this region are:

1 - Exceptionally good exposure and a striking variety of rocks (Pz);
2 - Impressive tectonics and a wide range of metamorphic conditions.

Geological Map of the southwestern part of the Ol'khon region (compiled by V.S. Fedorovsky, 2005)

OL'KHON REGION

Today's topography of the region represents Cenozoic structures and tectonic landforms. They were produced during the building of the Baikal rift system



Southwestern part of Ol'khon region. Arc View 3.2. 3D Scene

Basically, they are composed of horsts and grabens and are divided by Cenozoic listric and strike-slip faults, which inherit Early Paleozoic blastomilonite sutures. This is an alternation of narrow, but elongated, horsts and grabens, corresponding with the collisional strike-slip plates of Early Paleozoic crystal base.

OL'KHON REGION

The scarp of Primorsky fault

The scarp of Morskoy fault

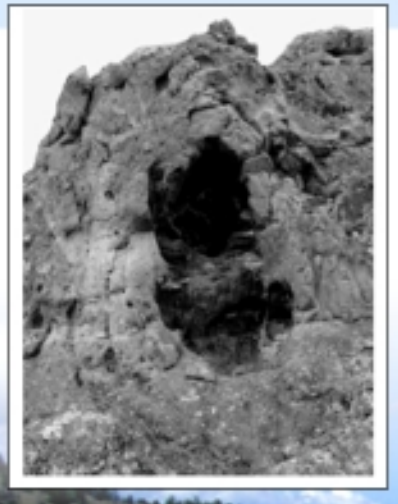
Among the newest rift structures special attention is drawn by scarps of Primorsky and Morskoy normal faults (the Primorsky fault is an inherited structure, it repeats collisional suture of terrain-continent system of Pz).

OL'KHON REGION

At the same time, in the relief we can also observe main Paleozoic structures and rocks, exposed during the long-term denudation, which preceded Cenozoic rifting. For example, very impressive granite dykes of the Nuthei area which look like ancient half-destroyed castles...

OL'KHON REGION

The marble melange



The marble wall

The marble pavement

The marble arch

Beautiful landscapes occur in areas of marble and marble melange propogation

OL'KHON REGION

The weathering forms of the subalkaline gabbroids of the Birkhin massive have quiet unusual shapes.

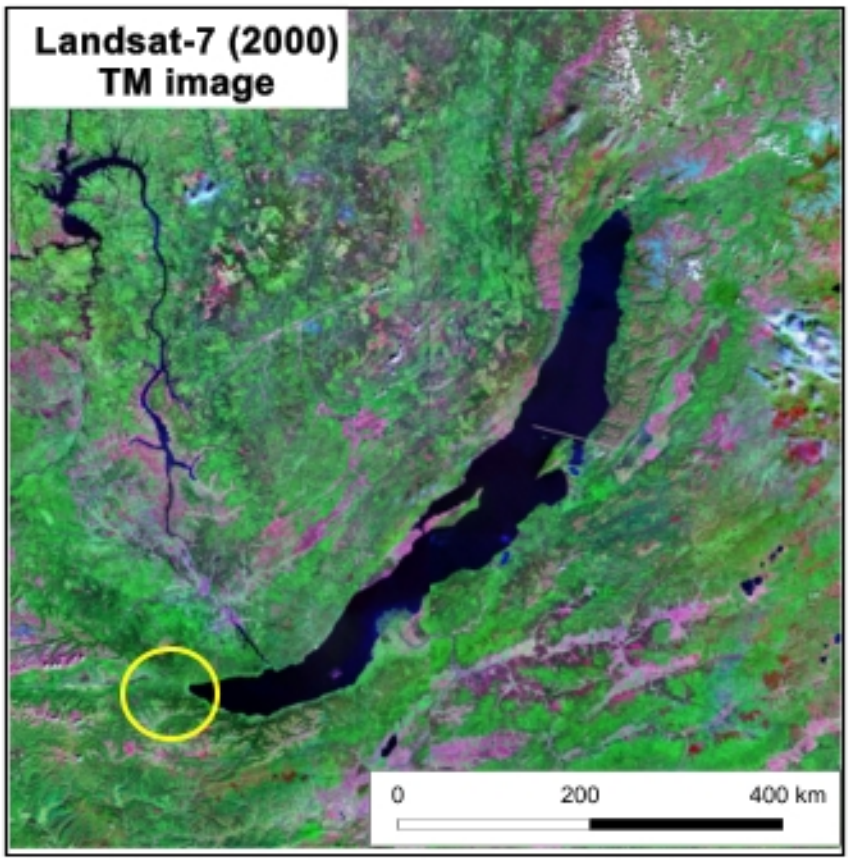

Thousands of huge stone "balls" form a "lunar" landscape...

OL'KHON REGION

Here you can see pencil clivage - an extremly expressive microrelief forms in the gneiss field

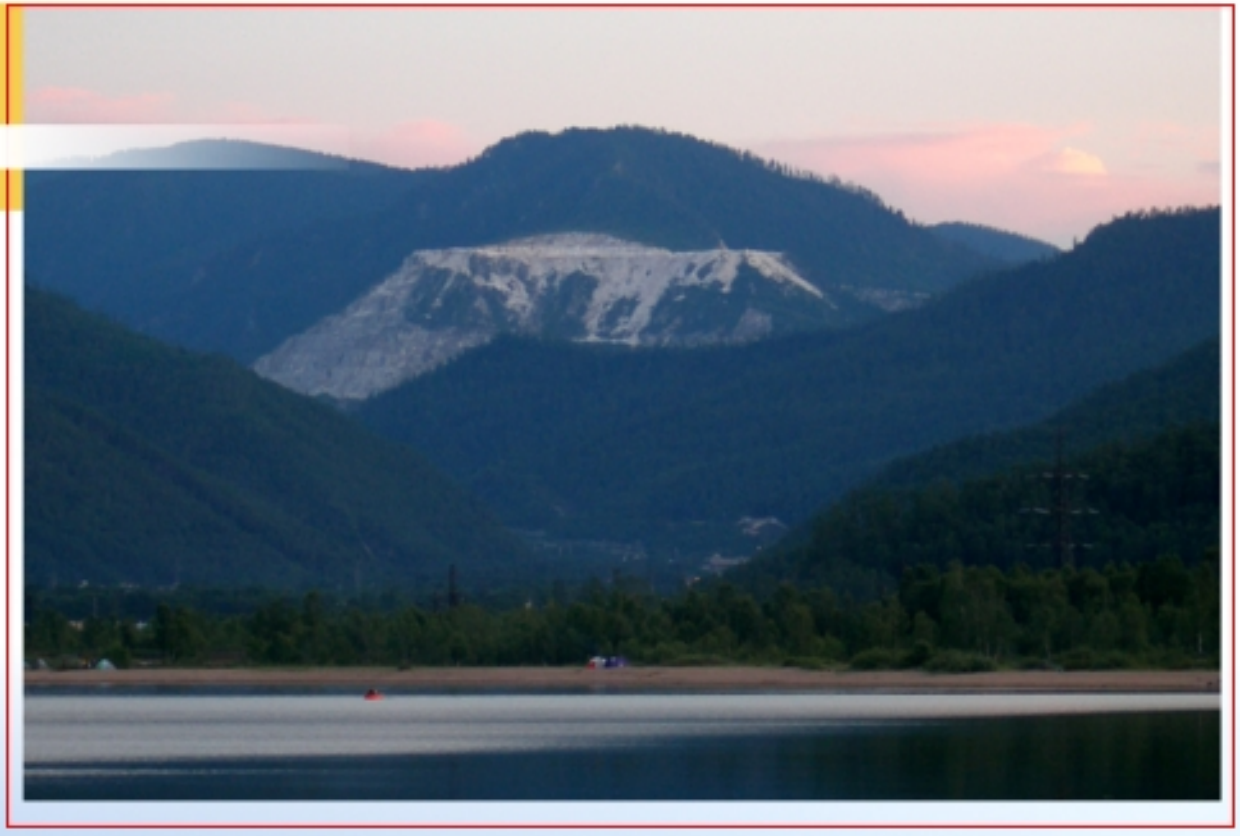
These, and many others features of geology, tectonics and geomorphology of the Ol'khon region allow it to be considered very perspective for the development and carrying out of the geotourist excursions.

MAPS SHOWING THE **SLYUDYANKA REGION**



SLYUDYANKA REGION

is situated at the southern ending of the Baikal Lake



Photos by A. Sizov

SLYUDYANKA REGION

Picturesque mountain landscapes with multiple lakes and waterfalls are typical for this region. However, in the first a place, the Slyudyanka region is famous as well as of one of the oldest petrographic and mineralogic poligones of Russia

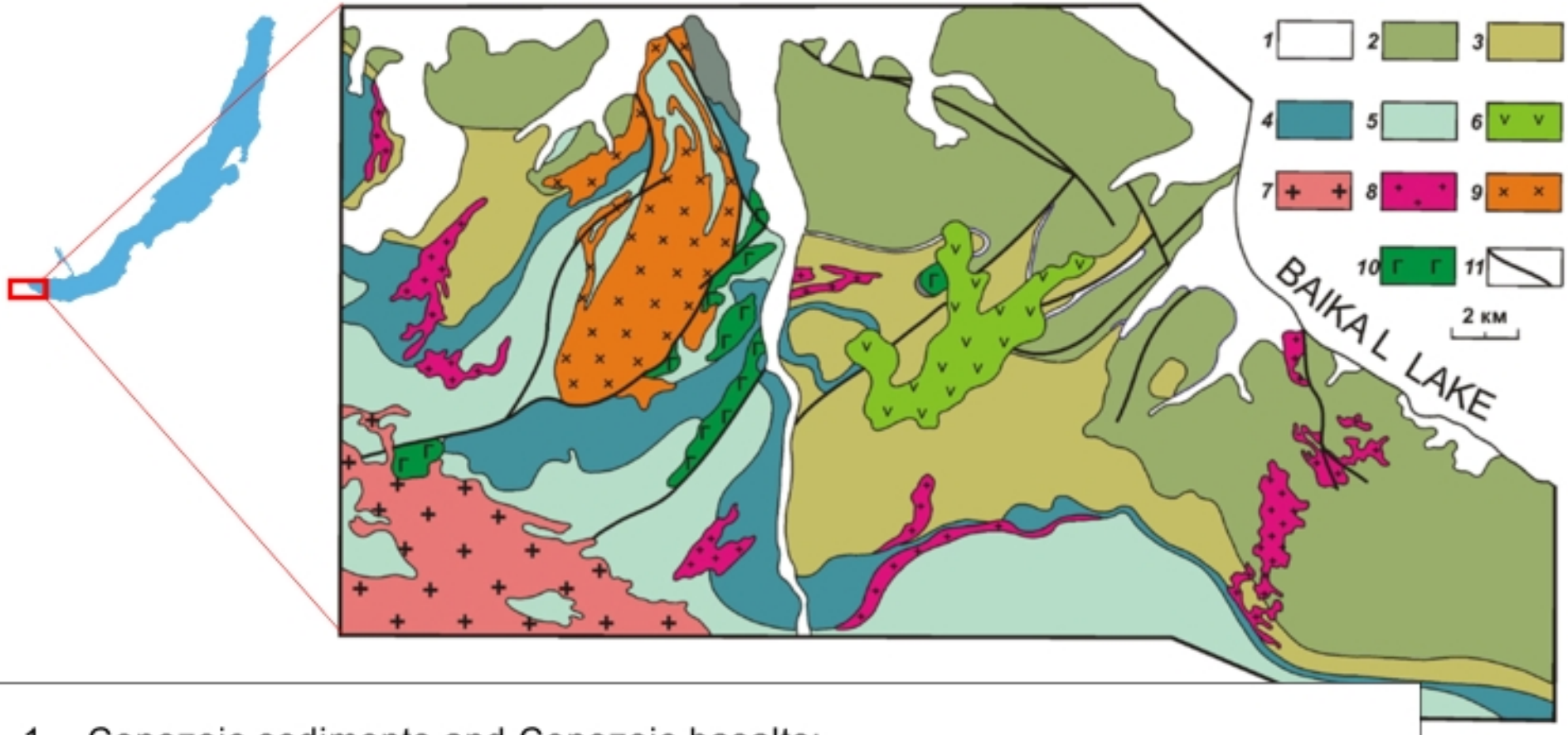
Crystalline (granulite) Slyudyanka complex is considered to be the part of the huge Paleozoic composite Khamar-Daban metamorphic terrain.

At the same time, Slyudyanka crystalline complex is supposed to be a separate unit not only because of its high-grade metamorphism, but also because it differs from the low-medium temperature zones by its more complex evolution, magmatism, endogenic mineralization.

This is the one place, where charnockites, alaskites, rare earth pegmatites, widely spread abissal magnesian scarns with phlogopite and lazurite deposits (Reznitsky et al., 2001).

GEOLOGICAL SCHEME OF THE **SLYUDYANKA REGION**

(Vasil'yev, Vishnyakov, Reznitsky, 1986)

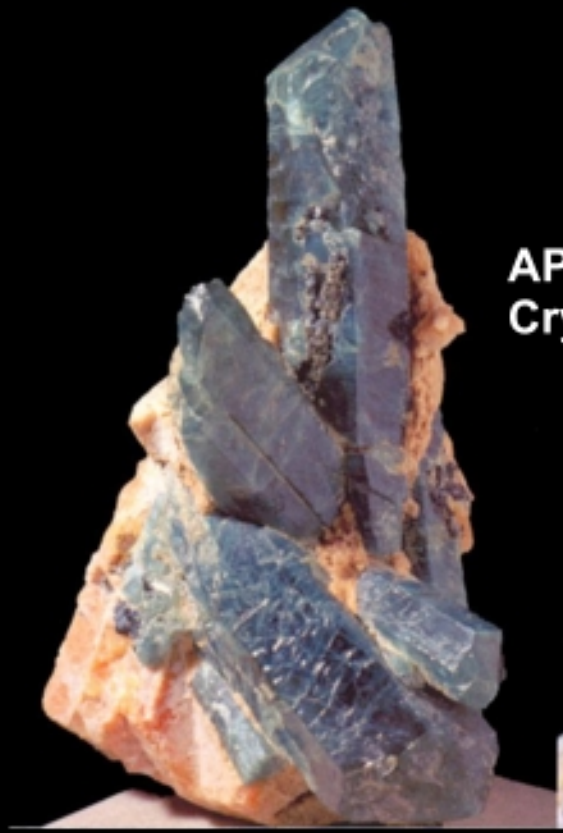


1 – Cenozoic sediments and Cenozoic basalts;
2,3 – khangarul'skaya series: 2 – bezymyanskaya suite, 3 – kharagol'skaya suite;
4-6 – slyudyanskaya series: 4 – pereval'naya suite; 5 – kultukskaya suite;
6 – horizons of biotitic gneisses; granites, syenites; 8 – gabbroid; 9- faults (dislocations).

MINERALS OF **SLYUDYANKA REGION**

BAIKALITE (diopside)
Snakelike intergrowth of crystals of crystals withapatite,phlogopite, calcitepite, calcite

APATITE (fluorapatite)
Intergrowth of crystal in pink calcite



APATITE (fluorapatite)
Crystal in calcite

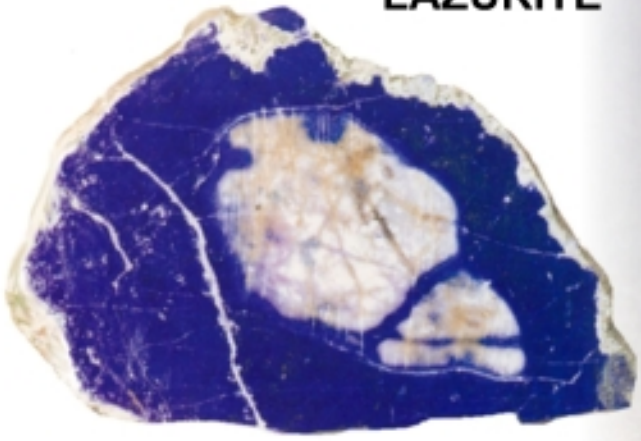
Photos and design by A. Shevelev

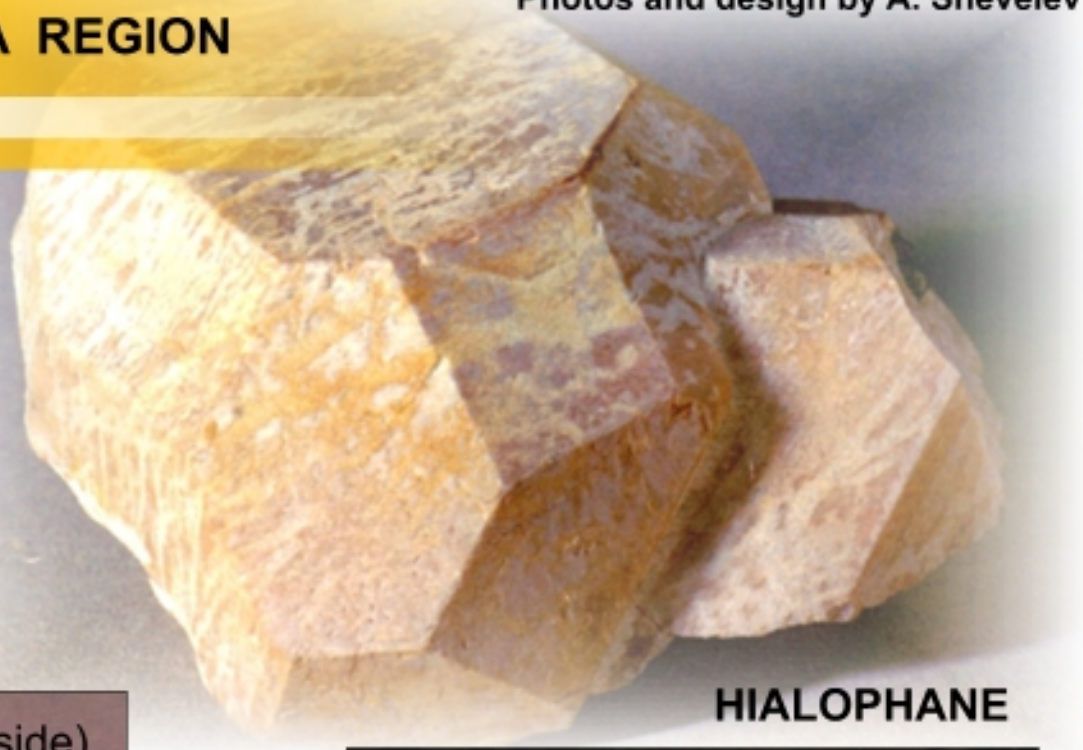
In the first place, the region is famous for its perfect crystal habits and unique sizes of the crystals there

MINERALS OF **SLYUDYANKA REGION**

Photos and design by A. Shevelev

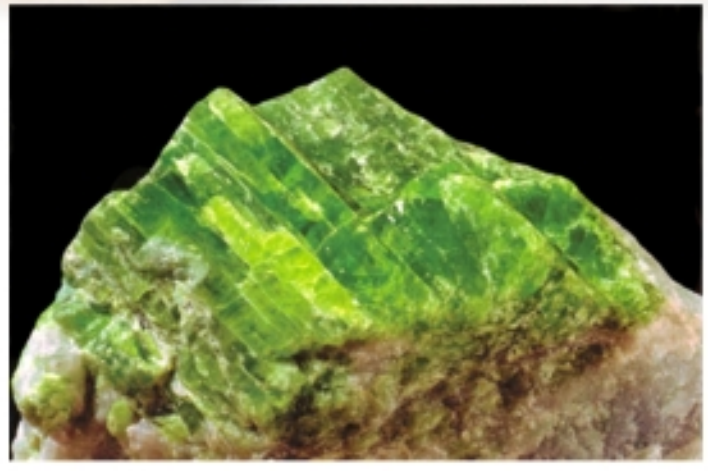
LAZURITE





HIALOPHANE

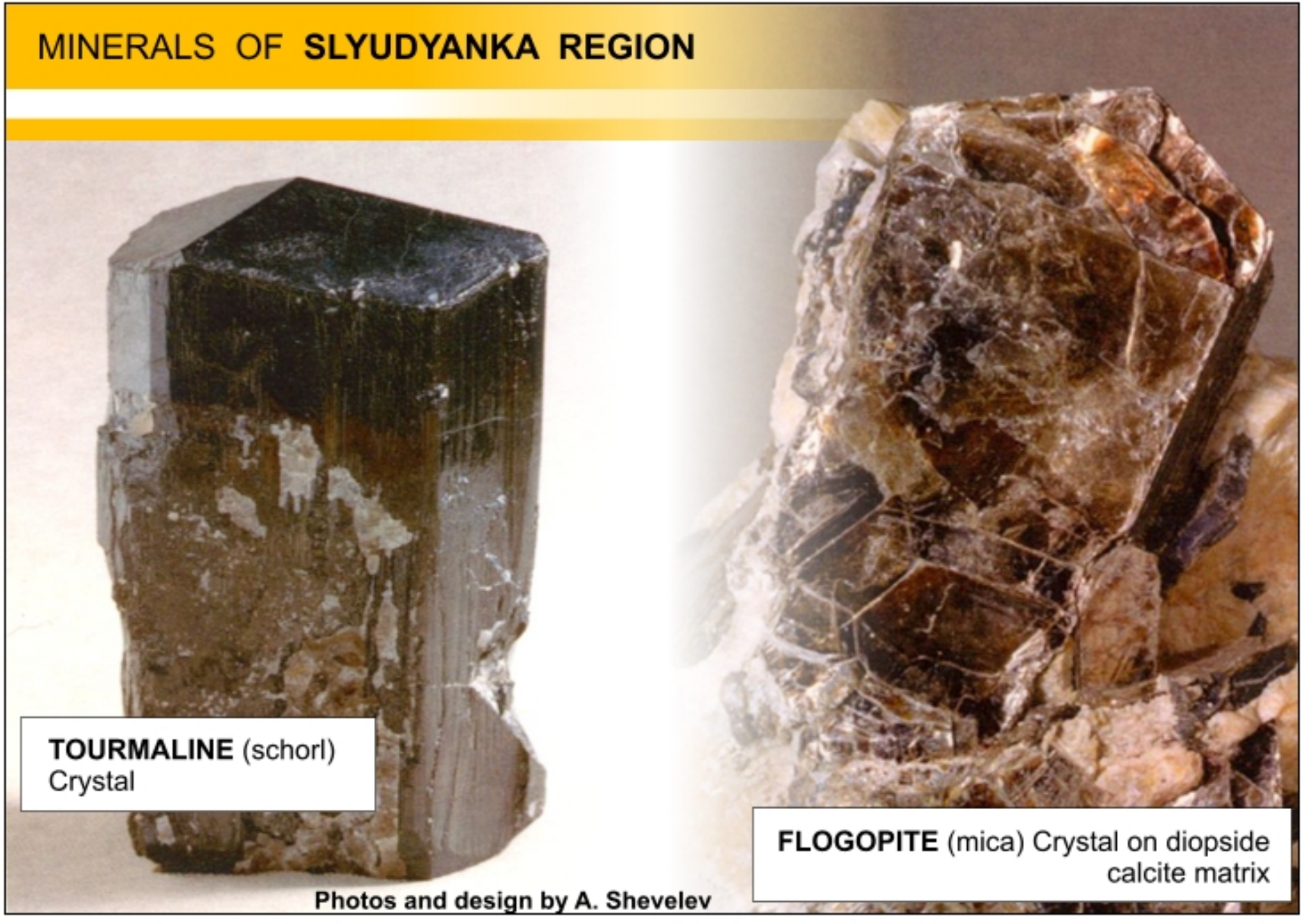
BAIKALITE (diopside)



LAVROVITE (Vanadium-bearaing diopside)

Crystalls of 1.5-2 meters high and 1 meter in diameter were discover while the exploitation of the phlogopite deposits. In addition, crystalls of apatite, scapolite and many others that reached 10 of decimeters in lenth have been found here

MINERALS OF **SLYUDYANKA REGION**



TOURMALINE (schorl) Crystal

FLOGOPITE (mica) Crystal on diopside calcite matrix

Photos and design by A. Shevelev

Large quantities, unique dimensions, perfect facet, morphologic and considerable specific variety of crystalls of the Slyudyanka region provide unique scientific, museum and collection material

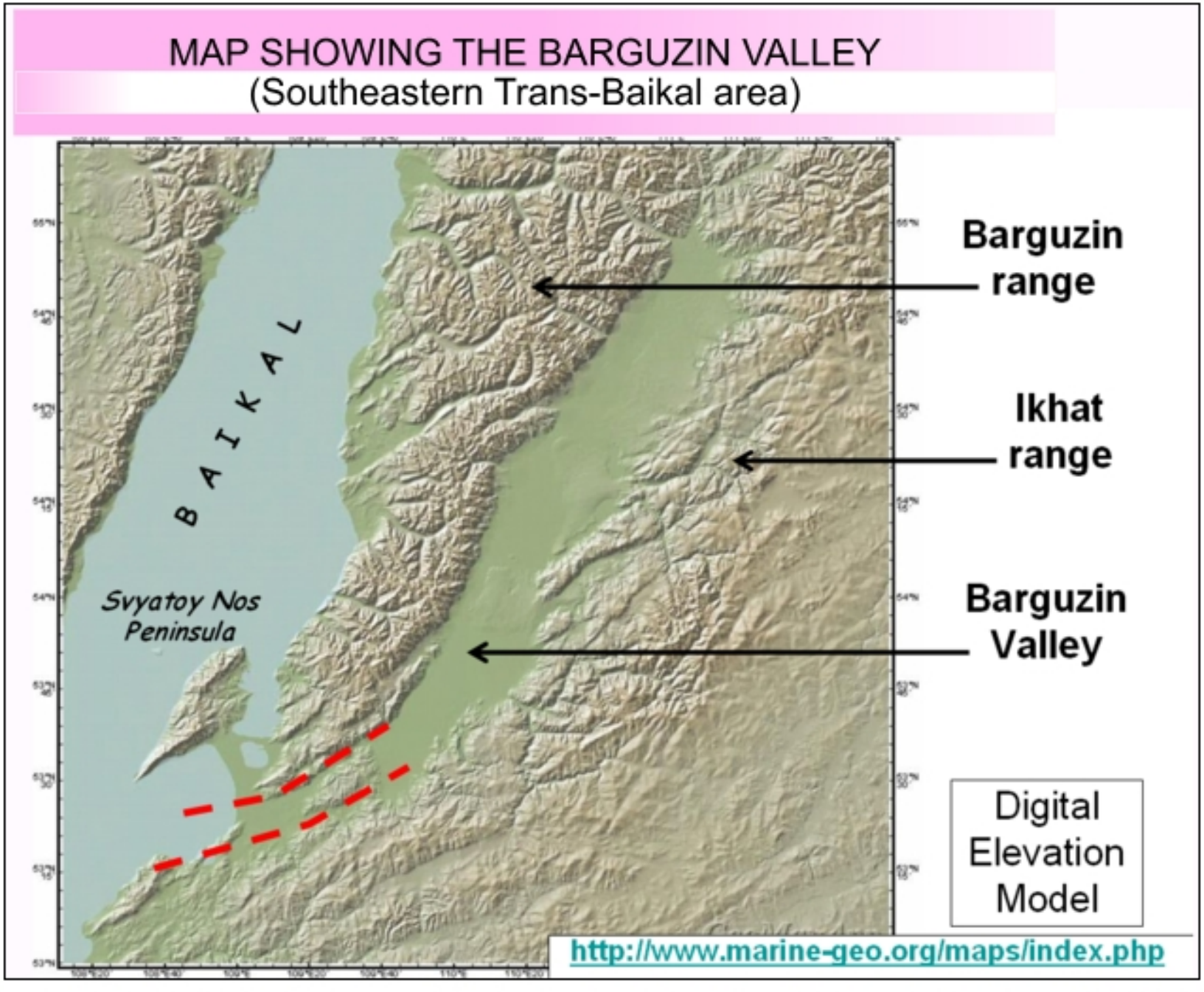
MAPS SHOWING THE TUNKA VALLEY (Southwestern Pribaikalye)

The Tunka rift valley continues the system of basins of the Baikal rift zone from the southern termination of Lake Baikal to the west and extends for 250 km in sub-latitudinal direction. This lateral low of tectonic relief and surrounding ranges - Alpine-type Tunka bald mountains in the north and "Siberian-type" Khamar-Daban in the south -are a part of the Tunka national park (Shchetnikov et al., 2005)

Photos by A. Shchetnikov

TUNKA VALLEY

The unique landscapes of its territory are comparable with the beauty and sights of Lake Baikal. Various geosites are concentrated there (Shchetnikov et al., 2005).
Many of them are a bright reflection of young tectonic and geomorphologic processes, including hazardous types of it.
For instance, strong and catastrophic earthquakes (Holocene age) are represented in relief by precise traces - paleoseismic dislocations...



The Barguzin valley is situated at Southeastern Trans-Baikal area and stretches for more than 200 km with a maximal width of 35 km. It is situated to the east from the Baikal Lake and joins it with two open passes. Barguzin Valley is a receptacle for many geosites.

BARGUZIN VALLEY

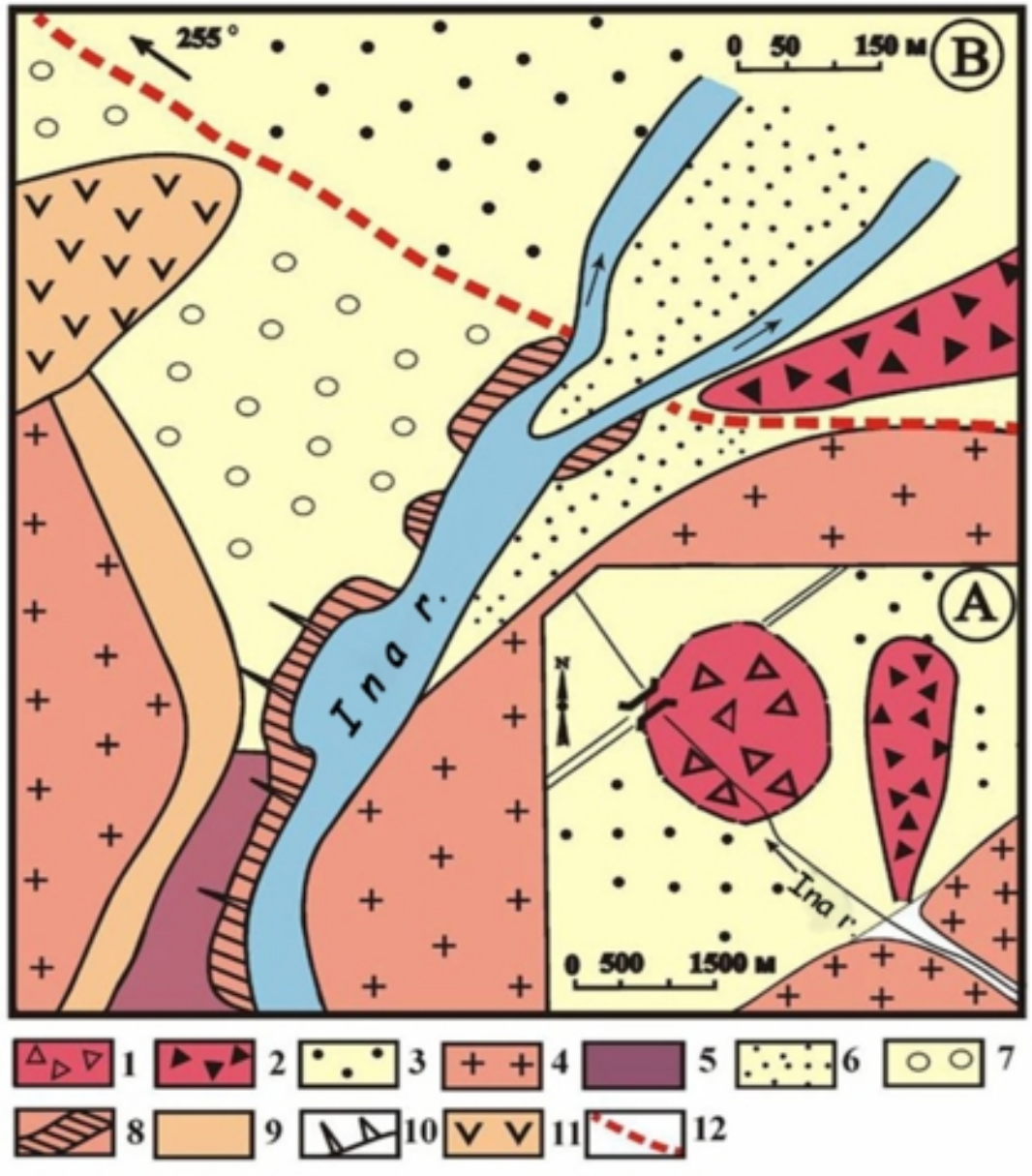
Fancy rocks, located on the slopes near the basement of the Ikatsky range in the Suvo province form a very picturesque group, vividly reminding ruins of a medieval castles

Photos by A. Shchetnikov

BARGUZIN VALLEY

A huge accumulation of coarse-block material is located in the eastern part of the Barguzin valley near the Ina river runout from the Ikat range. This stone's field is situated in the steppe area and is scattered across the area of 10 sq. km. That is why it is easily observe and draw attention at the first place.
Just this field is associated with the stone garden.

Photos by A. Shchetnikov



Geomorphologic scheme of "Ina stone garden"

The second element of the Ina stone garden is an elongated inrush of the coarse-block material near the river Ina's run out from the range, which forms a low elevation on its right shore. The blocks here are overlapped by each other

BARGUZIN VALLEY

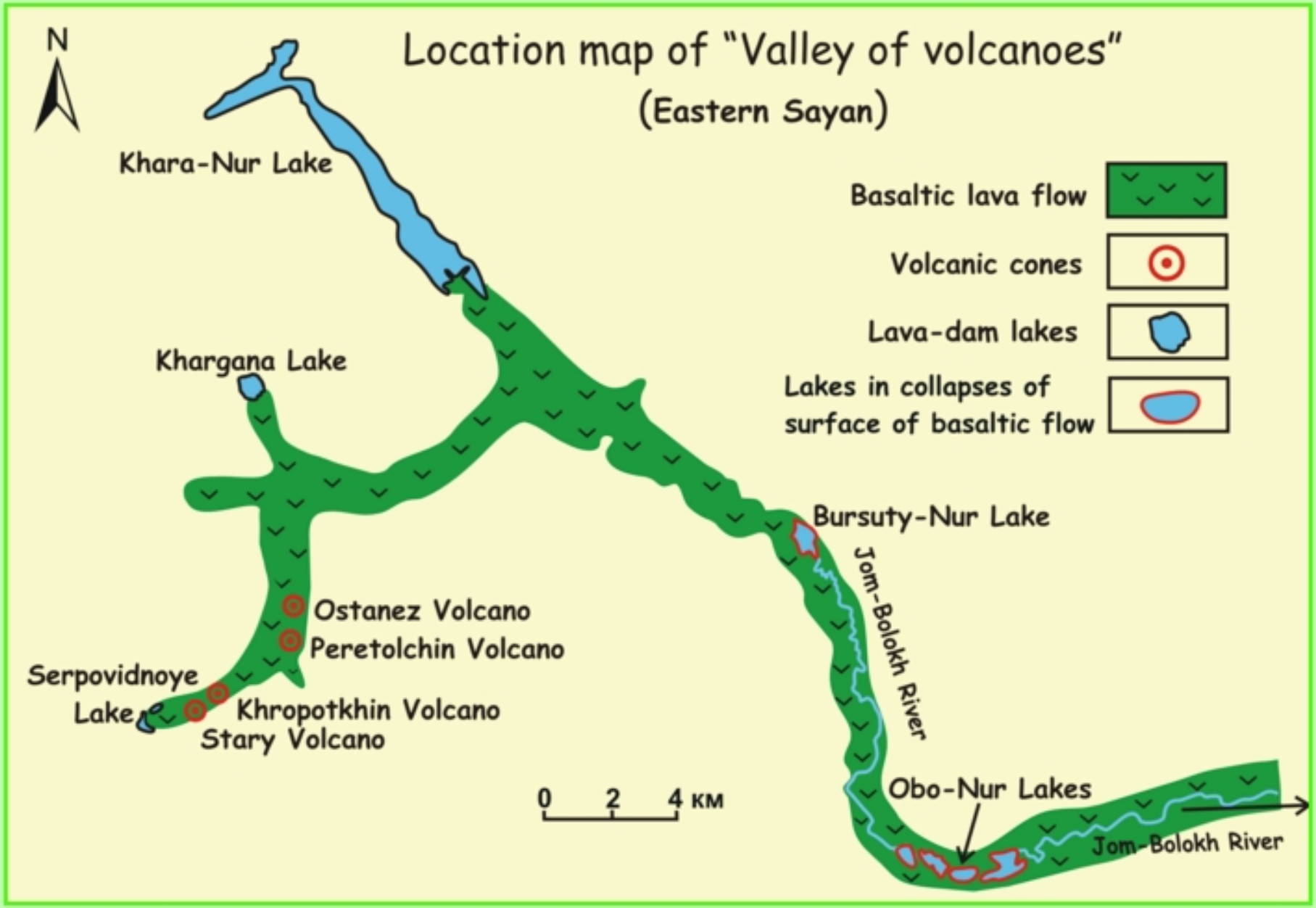
The precise genesis of this site remains unrevealed, though it is clear, that it appeared due to a catastrohic simultaneous outburst of great amount of coarse-block material from the range to the valley, which has no analogues in the mountains of the **East Siberia.**

This makes the **Ina stone garden** is a unique formation, thus draw scientific attention, and positively influences its visitors, in spite of it catastrophic origin.

Photos by A. Shchetnikov

VALLEY OF VOLCANOES
(EASTERN SAYAN)

And at last, here is another natural site of the Baikal region, which cannot leave any visiting tourist indifferent - especially if he is a Geologist or Geomorphologist.
Lava flows, stretching for many kilometers and volcanic cones are considered to be the most effective appearance of the modern volcanic activity. Zhom-Bolock lava flows in the Eastern Sayan belong to the South Baikal volcanic area.
They are the largest in scale trachybasalt outflows in Central Asia (Yarmolyuk et al., 2003)



Zhom-Bolock lava flows stretch for 80 km with the width of 2 km and thickness of 200 m at their head and 10 meters at their termination. Their total volume is rated as 16 cubical kilometers. Lava flows are composed of olivine havaiites and more unfrequently of basanites (Yarmolyuk et. al., 2003)

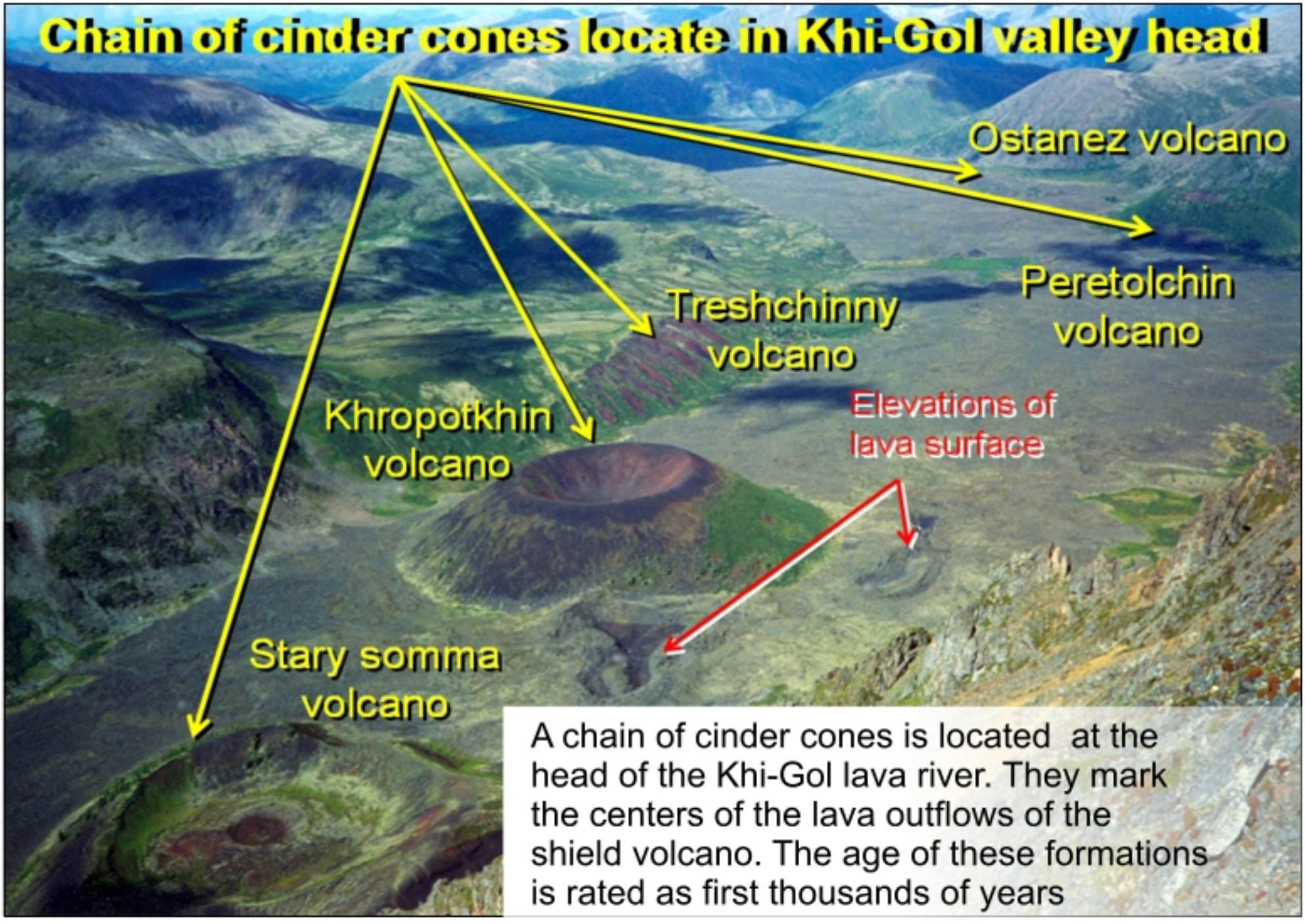
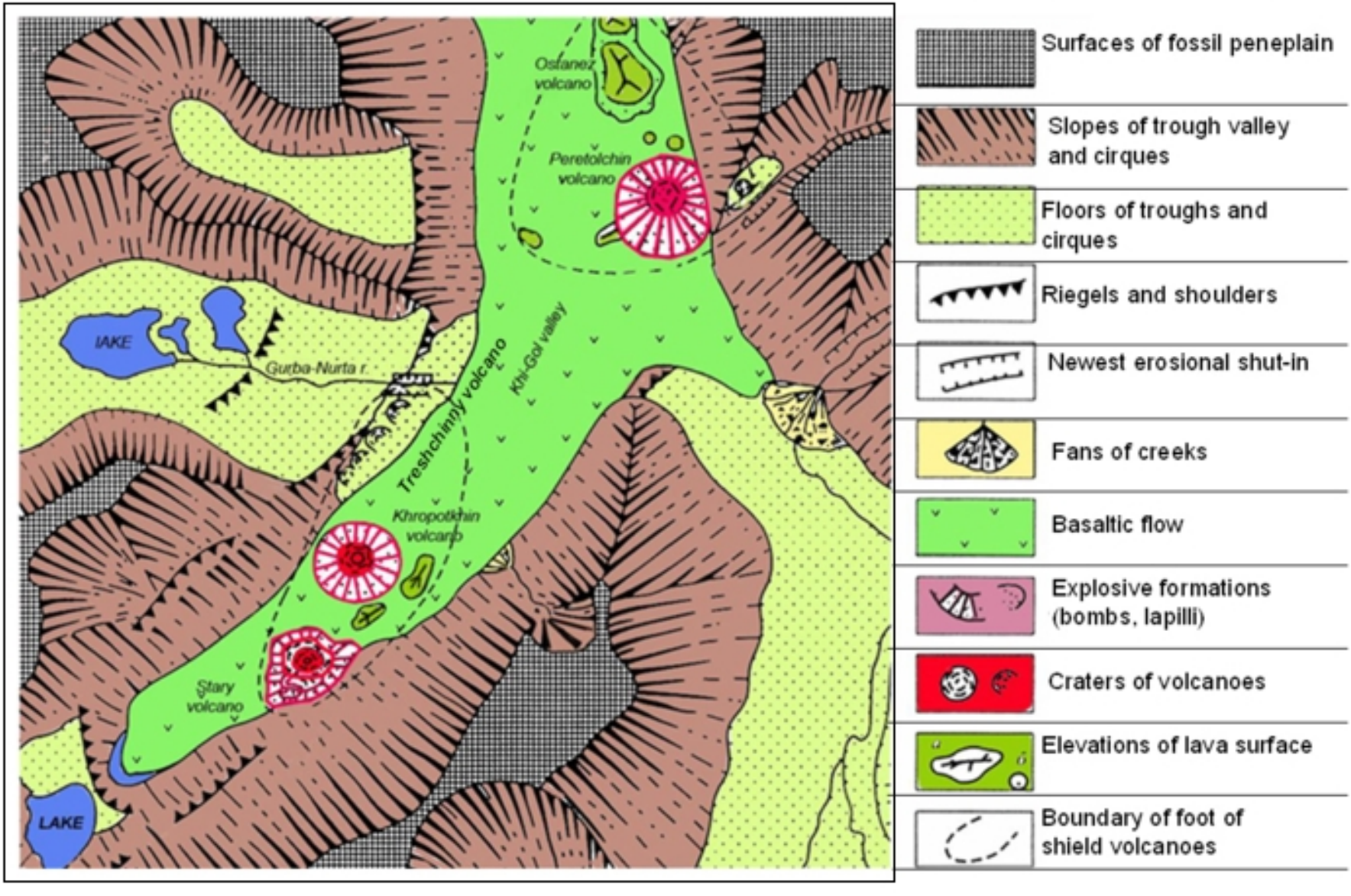


Photo by A. Shchetnikov

VALLEY OF VOLCANOES (EASTERN SAYAN)



Geomorphologic scheme of Khi-Gol valley head

(Yarmolyuk et al., 2003)

VALLEY OF VOLCANOES
(EASTERN SAYAN)

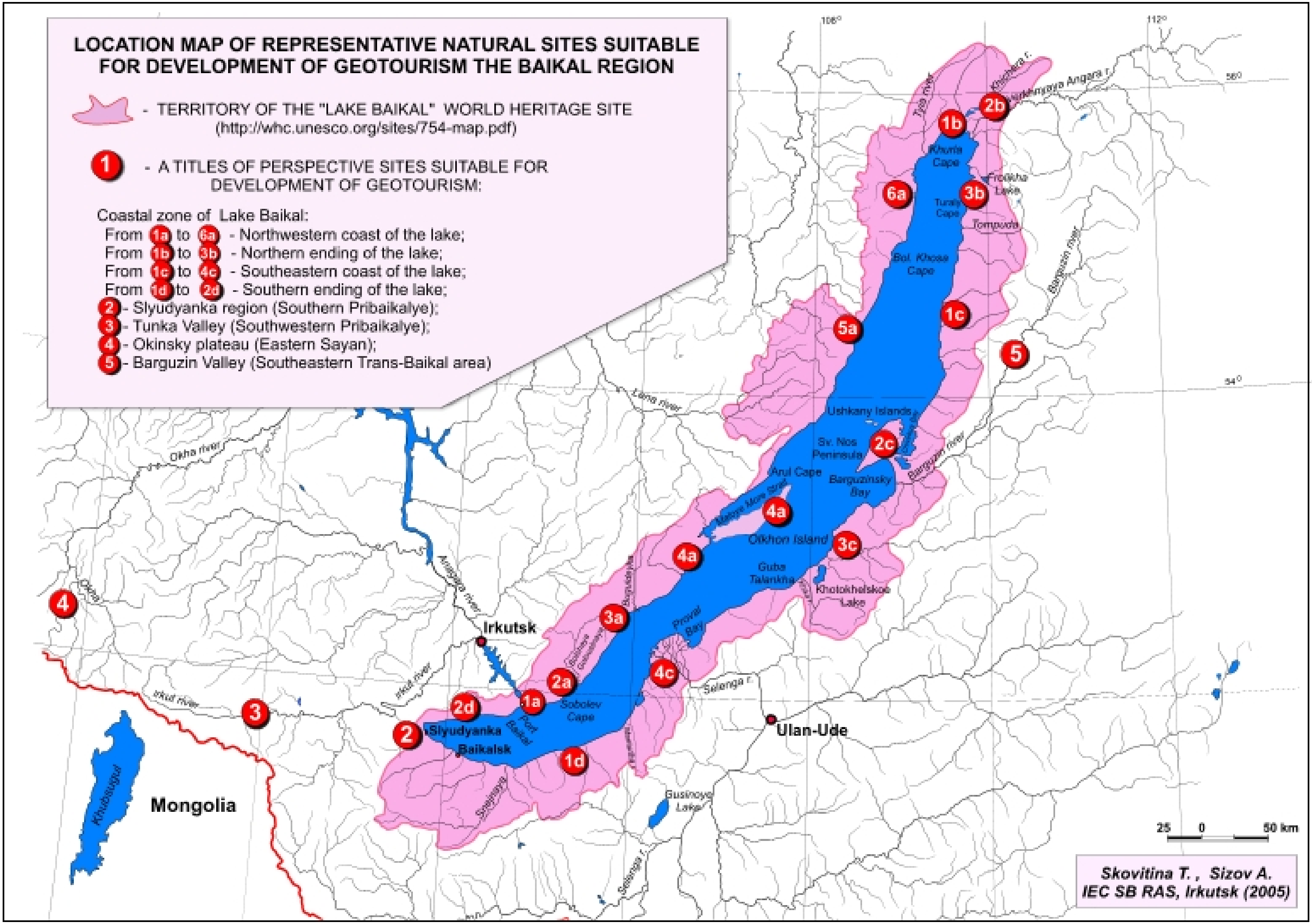
Khara-Nur Lake

Photo by A. Shchetnikov

Zhom-Bolock lava flow-units caused the appearance of a number of lava dam lakes. Khara-Nur Lake is the biggest of them and reaches the area of 33 sq. km. Two small picturesque lakes formed in the Khi-Gol valley head. One of them has a shape similar to the boomerang or sickle.

Concluding, we should propose that a lot of specific phenomenal and paradoxical geofeatures, and the fact, that they appear to be the most picturesque landscapes of the Baikal region, allow us to distinguish the mentioned geo(morpho)sites among the others.

These sites are marked with filled red circles on the map (next slide).


LOCATION MAP OF REPRESENTATIVE NATURAL SITES SUITABLE FOR DEVELOPMENT OF GEOTOURISM THE BAIKAL REGION
- TERRITORY OF THE "LAKE BAIKAL" WORLD HERITAGE SITE (http://whc.unesco.org/sites/754-map.pdf)
1 - A TITLES OF PERSPECTIVE SITES SUITABLE FOR DEVELOPMENT OF GEOTOURISM:
Coastal zone of Lake Baikal:
From 1a to 6a - Northwestern coast of the lake;
From 1b to 3b - Northern ending of the lake;
From 1c to 4c - Southeastern coast of the lake;
From 1d to 2d - Southern ending of the lake;
2 - Slyudyanka region (Southern Pribaikalye);
3 - Tunka Valley (Southwestern Pribaikalye);
4 - Okinsky plateau (Eastern Sayan);
5 - Barguzin Valley (Southeastern Trans-Baikal area)
106°
112°
56°
54°
Khunis Cape
Frolikha Lake
Turaly Cape
Tompuda
Bol. Khoso Cape
Lena river
Ushkany Islands
Sv. Nos Peninsula
Aryl Cape
Barguzinsky Bay
Barguzin river
Maloye More strait
Olkhon Island
Guba Talankha
Khotokhelskoe Lake
Proval Bay
Okha river
Angara river
Irkutsk
Irkut river
Selenga r.
Ulan-Ude
Sobolev Cape
Port Baikal
Slyudyanka
Baikalsk
Gusinoye Lake
Mongolia
Khubsugul
25 0 50 km
Skovitina T., Sizov A.
IEC SB RAS, Irkutsk (2005)

This chapter was designed in frame of the Russian Foundation for Basic Research (## 05-05-64016, 06-05-64360), President's Grant Council (# MK-2797.2005.5), Russian Federation Education and Science Ministry Program "Development of the high school scientific potential of (2006-2008)", Project number/title RNP.2.2.1.1.7334 "Research and educational centre "Baikal".

In this report Tatiana Skovitina used some own images presented at 32nd International Geological Congress (Florence, Italy, 2004), IV International Symposium ProGEO on the Conservation of the Geological Heritage (Braga, Portugal, 2005) and the International Symposium ProGEO-2006 "European conservation politic of geological heritage. Theory and practice" (Kyiv, Ukraine, 2006).

Institute of the Earth's crust of SB RAS.
Irkutsk, 2006