

THE GEOLOGIC EVOLUTION OF THE URAL MOUNTAINS: A SUPPOSED EXPOSURE TO A GIANT IMPACT. G. A. Burba, Vernadsky Institute of Geochemistry and Analytical Chemistry, Russia's Academy of Sciences, 19 Kosygin St., Moscow 119991, Russia e-mail: burba@online.ru

Introduction: The Ural Mountains at the eastern boundary of the European part of Russia mark the natural topographic and geologic border between Europe and Asia. This mountain range has in general the straight linear position N to S approximately along 58–59°E. Such position changes abruptly within the middle segment of the range, between 54 and 59° N, where the mountain chains curves eastward along the semicircular outline. Such change looks to be caused by some obstacle, the lithospheric heterogeneity.

This eastward-looking arc of the Middle Ural Mountains is considered [1–3] as the eastern segment of a large ring structure, which is referred hereafter as Middle-Ural Ring Structure (MURS). The structure is located between 54 and 59°N, 52 and 62°E (Fig. 1). Its approximate outlines could be traced on the map from Perm to Yekaterinburg, then to Chelyabinsk, Ufa, Izhevsk, and further to Perm. The minimal diameter of MURS rim is 400 km and its maximal diameter is about 550 km.

Surface topography: The eastern half of the MURS rim is a part of the Ural Range from the area of Kachkanar Mountain in the North to Yamantau Mountain in the South. NW part of the rim is Okhanskaya Vozvyshennost (Highland) to the North of Kama river. Western part is Sarapulskaya Vozvyshennost. SW part is Bugulminsko-Belebeyevskaya Vozvyshennost (to the South of Belaya river). There are two uplands in the central part of the MURS, both are N to S elongated: Tulvinskaya Vozvyshennost and Sylvinskiy Kryazh (Range). The SE part of the MURS bottom is occupied with Ufimskoye Plateau.

The topographic level of the eastern segment of MURS rim is up to 1000-1500 m above sea level, NW segment – up to 300 m, W segment – up to 200-250 m, SW – up to 300-350 m. The uplands in the central part of the ring structure are up to 400-450 m. Minimal altitude within the MURS is 58 m (in Kama river valley, near Belaya river mouth), and maximal altitude is 1640 m (Yamantau Mountain on the south rim of MURS).

The eastern segment of the MURS rim (Middle Ural Mountains) is the lowest part within the whole Ural mountain range.

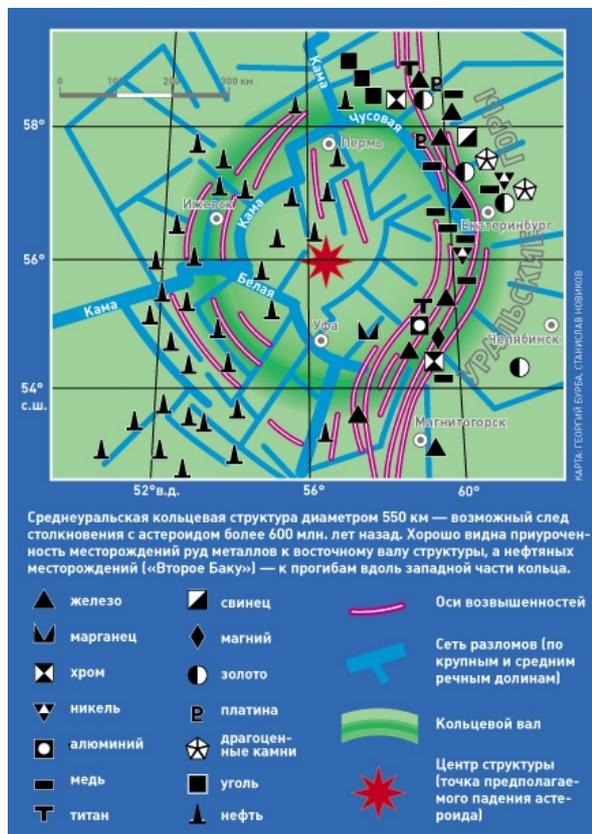


Fig. 1. Middle-Ural Ring Structure with maximal diameter 550 km – a possible footprint of asteroid impact more than 600 mln. years ago. The metal ore deposits are localized within the eastern rim of the structure, and the oil fields (so named “The Second Baku”) are located within depressions along the western part of the ring.

Cities (clockwise from the N): Perm, Yekaterinburg, Chelyabinsk, Magnitogorsk, Ufa, Izhevsk.

Rivers (clockwise from the N): Kama, Chusovaya, Belaya, Kama (twice).

Legend in English:

- | | | |
|-------------|-------------|----------------------|
| - iron | - lead | - axis of heights |
| - manganese | - magnesium | - net of faults |
| - chromite | - gold | (along rivers) |
| - nickel | - platinum | - ringed rim |
| - aluminium | - gems | - structure's center |
| - copper | - coal | (point of the |
| - titanium | - oil | supposed impact) |

River net patterning: The ring of MURS is outlined with a general pattern of the large river valleys of Chusovaya, Belaya, and Kama river (the segment between the mouths of Chusovaya and Belaya, the left tributaries of Kama). Valleys of a smaller (intermediate-sized) river valleys also outline a MURS concentric patterning. The directions of small-sized rivers (being generalized to rectilinear positions) are mainly radial to MURS. So, the concentric-radial (so named 'broken plate') structure takes place within the MURS.

Basement topography: There is an isometric depression in the basement under the MURS. Its depth is down to -8 km. There are two uprisings of the basement with summits located at -3 km depth. These uprisings are located just under the two uprisings in the surface topography within the central area of the MURS. The depth to diameter ratio for the depression of the basement is 1/50.

Paleoenvironment: Paleogeographical maps show the depression of the surface within the outlines of the MURS beginning from the Precambrian time.

Mineral resources: The overwhelming majority of the mineral fields of the Ural Mountains are located within the MURS, to put it more precisely, within the eastern half of its rim [4]. There are ore fields of iron, copper, chromite, nickel, titanium, gold, platinum, and some other metallic mineral resources here. The fields of the well-known Ural gems also are within this area. One could say, that the mining industry of the Ural region is in intimately connection with the MURS. So, MURS makes the industrial power of the Ural.

The geologic depressions within the western rim of the MURS are the areas of the vast oil fields, known as "The Second Baku" (such nickname was assigned to the large region of oil fields, discovered in 1940s along Kama river and at the adjacent areas of Tatarstan, Bashkortostan, Udmurtia, and Permskaya Oblast to compare the oil richness with the world-known Azerbaijani oil fields of Baku at the Caspian Sea).

Interpretation: The whole set of the data provides a possibility to conclude that the MURS have a structure, which looks like a giant impact crater, similar to the craters on the other planets. This crater have a sharp expression in the basement topography, and not so sharp expression in the surface topography. Such smoothed appearance in the surface topography could be connected with a thick layer of sediments, which have filled the crater. Uprisings in the central part of the MURS could be considered as places of the

crater's central mountains, as they are located over the basement uprisings. The mineral fields looks to be in connection with the activity within the presumable ring faults of the structure's rim.

Conclusion: It could be suggested that the geologic evolution of the Middle Ural area took place within the net of faults, which have been originated during the impact event in Precambrian time and stay active during the further periods of geologic history. It looks like that MURS have been a stable obstacle during the formation of the Ural Mountains, so the ranges could not overpass through the MURS and changed their rectilinear propagation to circle the MURS from the east. MURS could be an ancient giant impact crater, which affected the geologic development of the Ural Mountains linear range.

References: [1] Бурба Г.А. (1990) *XXI Всесоюзн. метеоритная конф.*, 29–30. [2] Бурба Г.А. (1990) *12-я Сов.-амер. рабоч. встреча по планетологии*, 12, 26–27. [3] Burba G.A. (1991) *LPS XXII*, 153–154. [4] Burba G.A. (2003) *3rd Internat. Conf. on Large Meteorite Impacts*. Abstr. 4117.