Bull. Nov. Comp. Center, Math. Model. in Geoph., 23 (2021), 9–17

On the search for new impact structures based on the "orbital" hypothesis*

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Abstract. In this paper, a cosmogenic "orbital" model of formating astroblemes on the Earth's surface is used for the search for new large structures of the impact origin. Because of the only known exact parameter of this model is the distance of 23.25° between the round-the-world turns of a cosmic body, we will use this step in the sub-latitudinal direction to search for the cosmogenic valleys in the surface topography and gravity field.

Keywords: Catalogs and databases of the impact structures, orbital motion.

Introduction

A cosmogenic "orbital" model of formating unnaturally smooth surfaces on the Earth (the furrows and the smooth valleys) was proposed [1] explaining the periodicity of their location by the multiple tangential impact of a large cosmic body ($D \sim 800$ km) captured by the Earth as a satellite making several dozens orbits around the planet before falling and sinking into the Earth's bowels. A similar model of the capture and attachment of another satellite to the Earth was substantiated back in the middle of the last century by L.A. Pukhlyakov Associate Professor of Tomsk Polytechnic University [2] as the most consistent hypothesis explaining the data about the past of our planet known: an increase with a subsequent reduction in the speed of the Earth's rotation (during the approach and attachment of the second satellite), the chronology of the origin of mountains and oceans, folding, continental drift and many others. The cited work examines the stages of both the landings of this hypothetical satellite to the Earth, and its immersion in the deep zones of the Earth in confirmation of the previously stated hypothesis of the immersion of heavy rocks of the cosmogenic origin by O.Yu. Schmidt and E.N. Lyustih [3].

If the model proposed is correct, then during its tangential circumnavigation, not only a cosmic body (CB) will affect the relief of our planet, leveling its surface, but also solid obstacles protruding in the Earth's relief can affect passing of the CB. In particular, when the latter collides with significantly protruding relief forms, its massive part may spall off, which, with its weight, is capable of bending or tilting the edge of the lithospheric

*Supported by Project 0251-2021-0004 of the ICMMG SB RAS state assignment.

plate and sinking into the asthenosphere. A previously identified example of a valley claiming a similar formation mechanism is the potential "Taklamakanskaya (Tarim basin)" astroblem ($D = 300$ km) [4], one of the largest deserts in the world, which, according to geological and geophysical data, is a heavy strong block of the plate edge, behind which (according to S_V-tomography) one of the "channels" of immersion of dense and cold material deep into the asthenosphere is (see the tomographic section along the profile through South Siberia — Takla-Makan — Middle Tibet in [5]).

Recall that the traces calculated in paper [1] of the first day of the proposed flight of a CB, in terms of periodicity are well comparable with the maximums of the anomalies of the total S_V-field (detected by tomographic layers below the base of the lithosphere: $225 \leq H \leq 700$ km). It is not excluded that a periodic en-echelon positive S_V-anomaly along the edge of the Eurasian continent (Figure 1), which is a chain of deep "channels" [5], may have the same formation mechanism (when a part of the CB material cut-off by a high-mountain obstacle breaks through the lithosphere and rushes along the channel deep into the asthenosphere), if an arcuate ridge of alpine folding has passed along the entire edge of the Eurasian continent before the collision.

We do not have accurate information about the starting point of the assumed motion of the CB and the direction of the round-the-world paths, the angle of inclination to the equator adopted is 68.7°, while in calculating the orbits in [1], the accepted angle of motion of the ISS (URL: spacegid.com/media/iss_tracker) was 51.63°. At a steeper inclination angle, the northern inflection point of the CB orbit path reaches the Arctic coastal ocean, and the southern inflection reaches the Antarctic coast. The tracks of the new calculation version, like the tracks of the previous version,

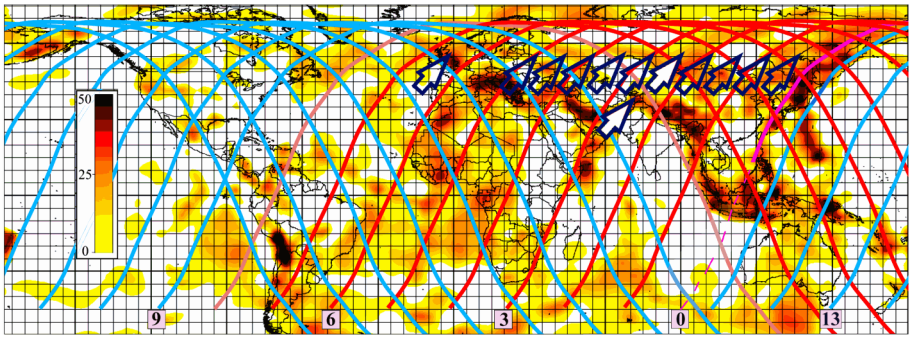

Figure 1. An example of the calculation of round-the-world tracks for the first day of the assumed tangential motion of a CB with an inclination angle of 68.7° to the equator. The zero Track, marked in lilac, is hypothetically confined to the center of the Ω-shaped geophysical megastructure [5]. White and transparent arrows indicate to the position of the valleys discussed in this paper

cross the volcanic zones, valleys of civilizations and, more precisely, zones rich in minerals.

Let us note that now although some of the previously identified in [1] objects are between the traces of the round-the-world turns (for example, the local positive S_V-anomaly at the center of the Pacific coast of South America is now between 7 and 8 turns, see Figure 1), they can correspond to the traces on the second day of the flight, shifting by 12° to the west relative to the orbits of the first day, i.e., practically in the middle track between them. While the CB makes one turn with a linear speed of 7.182 km/s near the Earth's surface, the planet rotates 23°15′ (23.25°). This speed is calculated as follows: if the first cosmic velocity of the CB gravity center at an altitude of 400 km is equal to 7.677 km/s, then at the point of contact with the Earth its speed will be equal to 7.224 km/s, and for the condition of a slow decrease in the CB altitude the speed can be slightly reduced (in our calculations — by 0.58 %). Thus, after one day of the CB flight, the tracks are visually shifted by 12° to the west starting from the 16th turn: $23.25 \times 16 = 372 = (360 + 12)°$.

With smaller obstacles in the Earth's relief and, accordingly, with smaller scales of the mass that broke away from a CB, the conditions of active subsidence of the Earth's crust could form, which created the discussed here valleys, closed among the highlands, confined to the traces of the CB passage.

Since, as is shown above, the only exact parameter of the CB motion that we have in the "orbital" model is the distance between its round-the-world turns, to search for such valleys we will use a step of 23.25° in the sub-latitudinal direction, and when taking into account the turns of two days of the tangential CB flight will the alternating steps of 11.25° and 12°.

1. Valleys of possible cosmogenic-orbital origin

The study of the of the Earth's relief shows a geomorphological similarity of the valleys surrounded by mountain formations. First, the attention is drawn to the visual similarity of the structures of presumable impact origin located in the mountainous areas "Abakanskaya" and "Ferganian Big" [6] marked with white arrows in Figure 1. This similarity is manifested both in the relief and in the gravity anomalies (Figure 2): the exact coincidence of the diameter as 276 km; an elongated axially symmetric shape of the valley with a "trail" extending beyond the crater (with an axis azimuth of 54–60°, possibly directed along the trajectory of the CB flight).

Taking into account the hypothesis of the multi-turn CB decline, let us check the presence of territories similar to the "Abakanskaya" structure (Minusinsk depression) in the latitudinal direction ($\sim$ 54°N) with a step

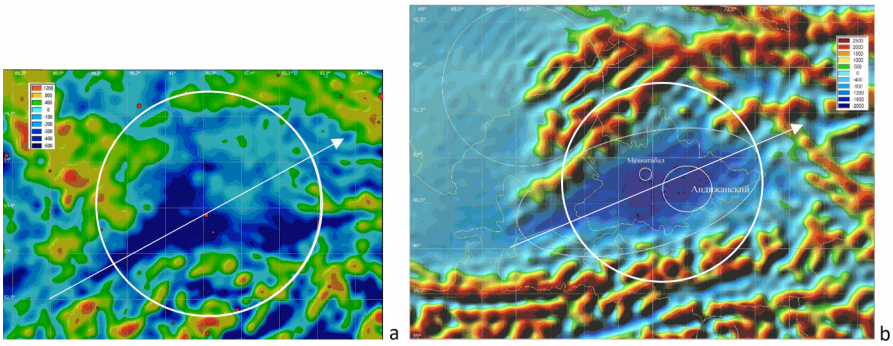

Figure 2. Gravity anomalies corresponding to the "Abakanskaya" (a) and "Ferganian Big" (b) structures ($D = 276$ km) of presumably the orbital-impact origin

of 11.25–12°. In this search, first, let us pay attention to the presence of a depression or a ring structure, as well as to the location of the main river channel (which cuts the valley at the center, similar to the Abakan River) and the direction of its flow. If we find such structures, we will call them by the name of the central river. Let us note that the Minusinsk depression, which includes the "Abakanskaya" structure (or Minusinsk / South-Minusinsk basin [7]), is wider and has a nominal diameter of 420 km that we have adopted. It is such a size of the valley that we will take as a sample when looking for its sub-latitudinal analogs.

The generalized search results are shown in the table and in Figures 3, 4: to the east (Figure 3) and to the west (Figure 4) of the Minusinsk depression (or "Abakan" — by the name of the main river of the structure). They show that common for all the structures found is the presence of a large river at the center of the valley with a direction of their flow to the north (with rare exceptions): the Abakan River and further the Yenisei, the Irkut River and further the Angara, as well as the Zeya, the Amur and the Ishim rivers. In the European part of the Russian Federation, these are the Belaya, the Sura and the Desna rivers. Of these, only the Zeya and the Desna rivers flow to the south.

The valleys (by the name of the rivers) are presumably of orbital-impact origin at a latitude of 54°N with the longitude coordinate Δ in E degrees and the numbers of the corresponding hypothetical CB turn (#)

River	Δ°E	#	River	Δ°E	#
Desna	33.25	5	Abakan	91.00	18
Sura	44.50	20	Angara	103.00	2
Belaya	56.50	4	Vitim	114.25	17
Ishim	67.75	19	Zeya	126.25	1
Kamen-na-Obi	79.75	3	Amur mouth	137.50	16

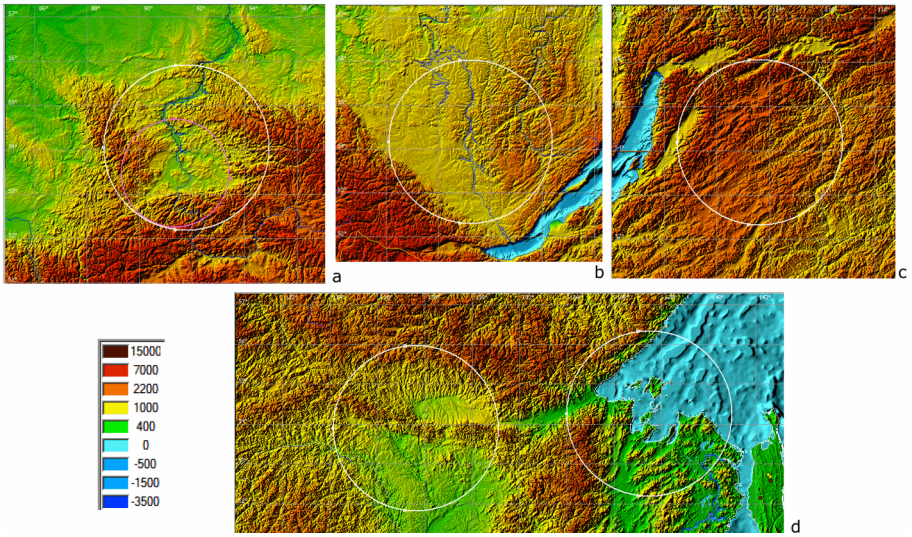

Figure 3. The relief (according to the GIS-ENDDB-program), corresponding to the valleys of the assumed orbital-impact origin: the Abakan (a), the Angara (b), the Vitim (c), the Zeya and the Amur (d). In the color caption: a height above the sea level in meters

The valleys-twins to the east of the "Abakanskaya" structure:

- Angara (Figure 3b) — the Minusinsk Basin. In the catalog [6], it is as the potential impact ring "Zapadno-Pribaikal'skaya" structure (or the "Angarsky nuclear") [8, 9]. At the center of the ring structure, the Angara River flows northward.
- Vitim (Figure 3c) — the Vitim plateau, in the catalog [6] it is as the potential structure "Vitimo-Olekminsky nuclear" [8, 9]. At the center of the ring structure, the Vitim River flows northward.
- Zeya (Figure 3d, left) — the Upper Zeya plain, wider than the ring "Zeya-Gilyui" structure [10] indicated in the catalog [6] as one of a questionable origin. At the center of the plain, the Zeya River flows southward.
- The Amur mouth — the Tugur and the Ulban bays, a wider valley than the questionable impact structure "Tugur" indicated in the catalog [6]. The Amur River flows northward.

To the west of the Abakan Valley, we can also trace a chain of the weakly expressed river valleys with a northward flow direction, with a latitude step between them of 11.25–12°. Unlike the valleys considered above, located in mountainous and foothill regions, they do not find a match in the catalog [6], because they are not expressed in the relief of the territories of the West

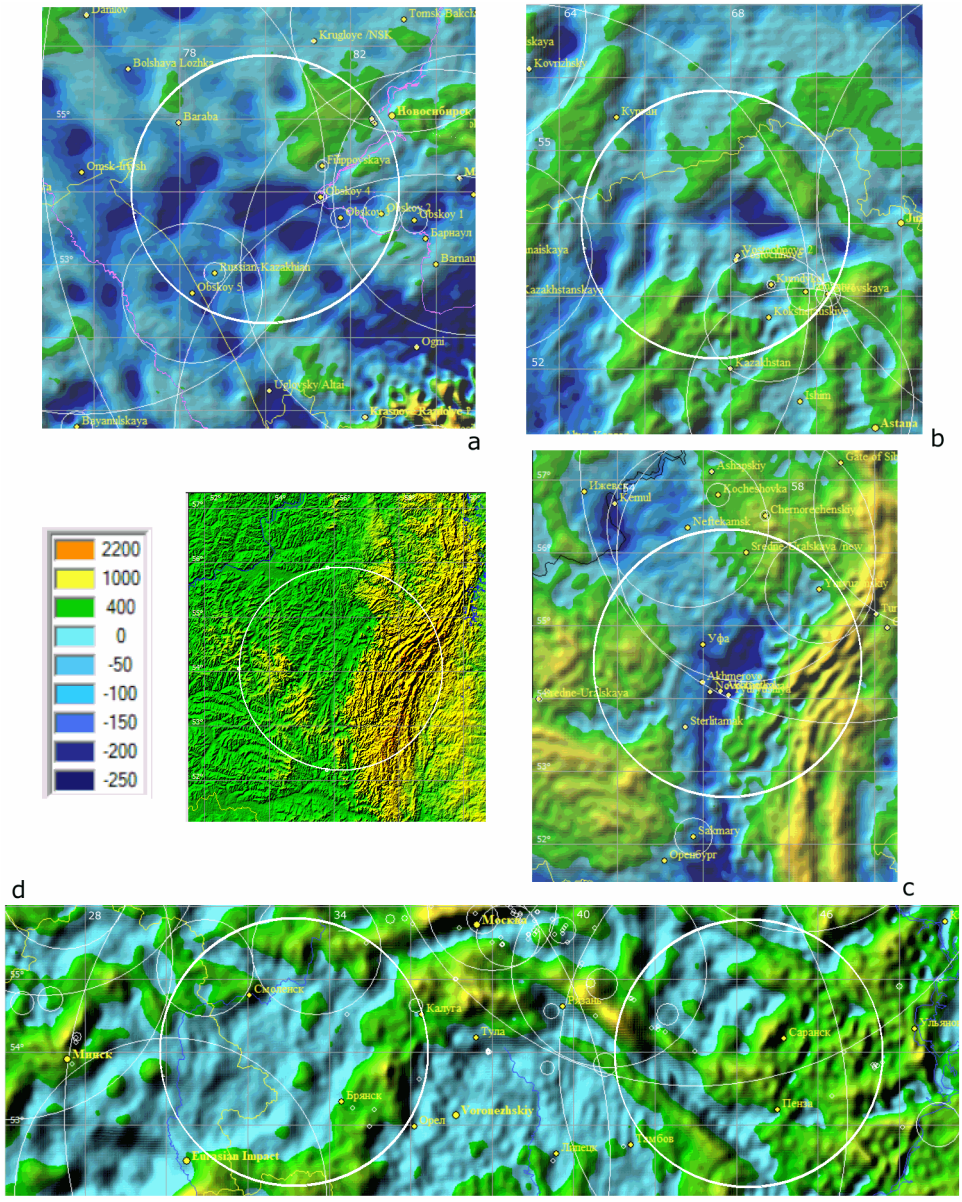

Figure 4. Gravitational anomalies corresponding to the potential impact structures of the "orbital" origin: the Kamen-na-Obi (a), the Ishim (b), the Belaya (the Belaya valley relief is shown on the left) (c), the Desna and the Sura (d). In the color caption: the value of gravitational anomalies in mGal

Siberian and the East European plains (which can be explained by the fact that they do not border on mountain systems, with the exception of the Belaya River valley, bordering the Ural Mountains). However, even valleys not manifested in the relief are accompanied by noticeable anomalies in the gravitational field, so we list them from right to left in the western direction from the Abakan Valley:

- Kamen-na-Obi (Figure 4a) — the Barabinsk lowland (a southern part of the Vasyugan plain). It manifests itself in the form of intense narrowly localized negative anomalies in the gravitational field. The Ob river bed deviates from its main direction to the west towards the Barabinsk lowland, and flows to the north.
- Ishim — the Petropavlovsk region of the Ishim plain (the Northern Kazakhstan). It manifests itself as an intense, narrowly localized negative anomaly in the gravitational field (Figure 4b). It is 2.5° north the proven impact structure "Ishim (Tengiz)" [4,11]. The Ishim River flows northward.
- Belaya — expressed in relief in the shape of the Kamsko-Belskaya plain. It is 2° south of the probable impact structure "Sredne-Uralskaya/new" [12]. It manifests itself as an intense, narrowly localized negative anomaly in the gravitational field (Figure 4c). The Belaya River flows northward.
- Sura is the central part of the East European Plain. It manifests itself as an alternating annular anomaly in the gravitational field (Figure 4d, right). The Sura River flows to the north (in contrast to the Volga River channel located 1° east and flowing to the southward).
- Desna — the Western part of the East European Plain. It manifests itself as an extensive negative anomaly in the gravity field (Figure 4d, left). The Desna River flows southward.

Let us note that the nature of the gravitational anomalies of the latter two structures belonging to the East European Plain differs from the previous ones in a more circular shape.

Further to the west, in the sought for zones, there are structures through which the boundaries between the land and the seas pass, they include not only lowlands, but also uplands, and the nature of its gravitational anomalies is significantly different from the previous ones in lesser expressiveness and the complication by other formations. However, we note that the last of them (Great Britain: 54°N, 2°W) corresponds to the local maximum of the positive S_V-anomaly and, possibly, is associated with the immersion of a large CB fragment into the Earth's interior.

It should be noted that the approach proposed to the search for valleys has been justified in more southern latitudes, where the land is largely

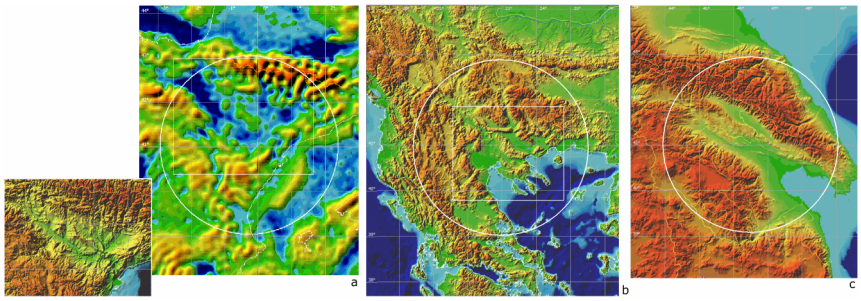

Figure 5. Maps of the areas corresponding to structures assumed as the orbital–impact origin: a) the Ebro (a gravity anomalies), in the inserted picture — the relief of the valley marked in the map with a rectangle, b) the Salonica (a relief) c) the Kura (a relief). See the color caption in Figure 4

indented by the seas. For example, morphologically similar valleys with a latitude difference of 23.25° are the Ebro River Basin (Aragonese Lowland, Spain) at 41°N, 0.25°W, Salonica Plain (Aegean Sea) at 41°N, 23°E, and the Kura-Araks lowland (Caspian Sea) at 41°N, 46.25°E (Figure 5).

Conclusion

The "orbital" hypothesis proposed by F.R. Khazivaliev [1] can serve as a basis for identifying new large structures of the impact origin, presumably associated with the tangential effect of a cosmic body flying around the world. In the areas with mountainous landscapes they are well pronounced in the relief, and in the plain areas they are marked by gravitational anomalies. Further research in this direction and the creation of a database of structures spaced apart from each other at the calculated distances: 23.25°, 12°, 11.25°, will help to clarify other numerical parameters for calculating the paths of a hypothetical CB flight over our planet.

References

[1] Hazivaliev F.R., Mikheeva A.V. The "orbital" hypothesis of cosmogenic impact on the relief and geodynamics of the Earth // Bull. Novosibirsk Comp. Center. Ser. Math. Model. in Geophys. — Novosibirsk, 2019. — Iss. 21. — P. 11–21.

[2] Pukhlyakov L.A. Review of Geotectonic Hypotheses. — Tomsk: TSU Publishing House, 1970 (In Russian).

[3] Schmidt O.Yu. Four lectures on the theory of the origin of the Earth. — Publishing house of the Academy of Sciences of the USSR, 1949. — P. 65–69 (In Russian).

[4] Zeilik B.S. Shock-Explosive Tectonics and a Brief Outline of Plate Tectonics. — Alma-Ata: Gylym, 1991 (In Russian).

[5] Mikheeva A.V. South-Asian megastructure according to the GIS-ENDDB geographic information system // Geoinformatics. — 2018. — No. 4. — P. 2–13 (In Russian).

[6] Mikheeva A.V. Web-site "The complete catalog of the Earth's impact structures. 3251 records" [Electronic resource]. — 2021. — URL: labmpg.sscc.ru/index1.html (application date: 01.12.2021).

[7] Minusinsk Basin // Great Russian Encyclopedia. Vol. 20. — Moscow, 2012 (In Russian).

[8] Katz Ya.G., Poletaev A.I., Sulidi-Kondratyev E.D. Ring Structures of the Face of the Planet. — Moscow: Znanie, 1989 (In Russian).

[9] Bryukhanov A.N. at al. Map of Cosmogeological Objects of Russia. — KRFGIN "Geokart", 1995 (In Russian).

[10] Stepanov V.A., Melnikov A.V., Nosyrev M.Yu. Zeya-Gilyui structure of the central type and its ore content // Dokl. of RAS. — 2005. — Vol. 404, No. 3. — P. 395–399 (In Russian).

[11] Zeilik B.S. Cosmogeological Map of Kazakhstan. — Min. of Energ. and Miner. Res. of RK, 2008 (In Russian).

[12] Mikheeva A.V. Impact craters and linear magnetic anomalies // Proc. of the Int. conf. Near-Earth Astronomy–2007 / Eds: M. and V. Kotlyarov — Nalchik, 2008. — P. 185–190.