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ARTICLE

On the Possible Cometary Nature of the Uchur Cosmic Body (Fall 3.08. 1993)

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ABSTRACT

An expeditionary study of the area of the alleged impact event that occurred on 3.08.1993 in the area of the Lower Konkuli River (southeast of the Aldan Highlands, Lurikan Range, Russia) was carried out. According to the materials of remote sensing, the places of collision with the earth of a cosmic body are determined. In the area of the impact of the shock wave on the Earth's surface, peat samples were selected, the micro probe analysis of which showed the presence of a cosmogenic substance in concentrations 6-8 times higher than the background. Silicate and magnetite micro spheres, native iron, moissanite, and carbon micro tubes coated with a film consisting of pure nickel were found. Of particular interest were the findings of specific Ni film micro structures that allow us to make an assumption about the cometary nature of the Uchur cosmic body. Most researchers associate the observed flights of fireballs with the subsequent fall of meteorites. Researchers are trying to find the massive body of the fallen space body. However, often, even after many years of searching, a massive cosmic body cannot be found. This happened when studying the site of the fall of the Tunguska cosmic body. In this case, it remains to be assumed that the cosmic body contained microscopic dust particles. The structure and composition of such particles can only be studied using microscopic research methods. When studying the Uchur cosmic body, the authors concluded that it could be of a cometary nature due to the findings of specific particles—thin films of pure nickel on the surface of plant remains of terrestrial origin. This hypothesis arose from the recent discovery of atomic nickel vapors in comets.

Keywords: Uchur cosmic body; Impact event; Cosmogenic matter; Microtubes; Nickel films; Microstructures; Cometary nature

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1. Introduction

Among the various natural disasters to which modern civilization is subject, a special place is occupied by the dangers associated with the fall of cosmic bodies to the Earth. On the one hand, there is no evidence in the historical and archaeological sciences that any cosmic processes had an impact on the course of the historical process. On the other hand, geologists and geophysicists involved in this topic point to the existence of more than a dozen impact craters that formed on the Earth's surface during the same period and too obvious traces of major climatic anomalies and environmental downturns that have no established connection with Earth processes [1]. Thus, in previous studies [2,3], traces of a catastrophe of presumably impact origin 5000-5500 years ago were found at different objects.

The largest space catastrophe of the 20th century occurred in Russia and is known to the whole world under the name of the Tunguska cosmic body, although no large material traces of the cosmic body that exploded over the Siberian taiga on June 30, 1908 have yet been found [4]. Another major event that also happened on the territory of Russia was the fall of the Sikhote-Alin meteorite on February 12, 1947, which affected an area of about 48 square km, where about 150 impact craters ranging in size from 1 to 27 meters were later identified [5]. In total, about a dozen large fireball explosions and almost 200 falls of cosmic bodies weighing more than 1 kg on Earth were recorded over the 20th century [6]. The last well-known event of this kind was the fall of the Chelyabinsk meteorite on February 15, 2013. The monograph *Methods and means of information-analytical assessment of asteroid and comet hazard* [7] summarizes information about this event and analyzes the actions of the Ministry of Emergency Situations to eliminate its consequences. The book concludes that this event gave rise to an emergency at the federal level, which required the concentration of significant resources to eliminate its consequences. The Chelyabinsk event initiated the inclusion of space (asteroid-comet) hazards in the official list of natural hazards that need forecasting and planning for counteraction, protection and elimination of consequences.

The issues of practical implementation of such planning require, first of all, adequate risk assessments arising from space threats. In turn, the basis for such estimates are estimates of the probability of falling cosmic bodies of one size or another to the Earth. It is most important to obtain such estimates for the current stage of geological history, i.e. for the Holocene (the last 10-12 thousand years). The existing estimates, which are used by the community of astronomers and astrophysicists, are based mainly on observations of comets and asteroids, as well as analysis of craters on the Moon and other bodies of the Solar System [8,9]. However, the most reliable data on the probabilities of cosmic bodies falling to the Earth can be obtained from an analysis of the actual statistics of such falls, provided that ground tracks are reliably recorded and there is reliable evidence of their connection with cosmic bodies [10].

Practical adherence to this recommendation encounters, first of all, the scarcity of information about such falls even at the present stage (the last 50-100 years). Falls of cosmic bodies capable of leaving traces on the earth's surface occur quite rarely, while more than two-thirds of this surface is covered with water. Despite the extensive development of observational astronomy, means of communication and mass communications, far from all cases of falls and air explosions, even over land, become known to scientists and specialists. Such a fall includes the Uchur cosmic body, which fell in a remote area, in the Khabarovsk Territory of Russia. The nature of this fall is still unknown, and such cases are known in history. Suffice it to recall that the fact of the Tunguska explosion became known to the scientific community almost 20 years after the event itself [4]. The introduction into scientific circulation of each potentially dangerous case of the interaction of cosmic bodies with the Earth is extremely important. It requires careful and comprehensive study, since it changes (always increasing) the estimates of the probability of cosmic bodies falling to the Earth at the present stage of its geological history. Awareness of the reality of space hazards requires the development of a system of measures to protect against them and reduce the consequences, based, among other things, on obtaining reliable estimates of the expected frequency of falls [11].

It should be noted that the least studied are the collisions of the earth with objects like the "Tunguska cosmic body". Such space objects can have a very significant impact on regional ecosystems. At the same time, there are still no convincing conclusions about their nature, since it is extremely difficult to obtain data on their mineralogical composition and even state of aggregation. Progress in their research can be made possible by direct fixation and research of the fall of such objects on the earth's surface. An example of such an event, witnessed by one of the authors of this article (V.E. Kirillov), is an air explosion and a possible collision with the Earth of a rather large cosmic body that occurred in the evening between 21 and 22 hours local time (10 and 11 hours UTC) 3 August 1993 in the basin of the river. Lower Konkuli (Aldan Highlands, Lurikan Ridge). The present work is devoted to the study of such an event. The group of geologists working in the river valley, which he headed, left the area of the event a few days before it. During the event itself, the detachment was located 15-20 km southeast of the epicenter and was shielded from the effects of the explosion by the Lurikan ridge with altitudes up to 1800 m. In his book of memoirs, V.E. Kirillov writes: "Suddenly, the soil shook violently; then two fading shocks followed, accompanied by a distant rumble to the north" [12]. According to sensations, the intensity of the first most powerful shock was about 3 points. Sound phenomena in the form of a fading rumble lasting 4-5 seconds followed a few seconds after the seismic shocks.

After 2-3 days, the geologists again found themselves in the Lower Konkuli valley. The age-old forest was so disfigured, as if an atomic bomb had exploded here. Huge trees were "cut down" either at the base or in the middle part, or sticking out in the form of whips without branches. A high barricade of chopped, chipped and broken trees with sharp broken branches sticking out in all directions was formed below. The height of the barricades from the shafts in the zone of severe destruction reached 4 m. Later, even the heavy equipment of the Amur artel explorers could not overcome these barricades. Wade through such rubble, four hundred meters wide, was a real torment. The length of the ellipse of destruction was about one and a half kilometers; at least that follows from route observations. In one place we came across a deer, littered with trunks and already gnawed by a bear. Along the periphery of the ellipse of destruction for several kilometers in the area, some of the trees were uprooted and lay with their tops in one direction—to the southwest [12].

As shown by the results of modeling the damaging effects of cosmic bodies with a diameter in the range of 10-50 m and the study of the impact sites of large meteorites (Tunguska, Chelyabinsk, Sikhote-Alin, etc.), in such cases, the bulk (95.0-99.9%) of a space body entering the Earth's atmosphere is destroyed when moving in the upper layers of the atmosphere due to the ablation process. The mass reaching the lower dense layers of the atmosphere, as a rule, breaks up into fragments ranging in size from a few meters, which fall to the Earth's surface, forming impact craters, to micro particles tens to hundreds of micrometers in size, which form a dust trail that falls along the fall trajectory. At the same time, the dust component contains magnetite micro spheres [13], which are formed in large quantities as a result of ablation, native iron, and, in a smaller amount, nickel (the mechanism of their formation is considered [14]. Therefore, the areas of the fallout of the dust component of a large meteorite turn out to be very large in area and can many times exceed the scattering ellipse of individual specimens of visible size (1-2 mm or more). For example, the total area of scattering of fragments of the Sikhote-Alin meteorite was an ellipse 10 × 2 km in size [15], which is an order of magnitude larger than the size of the crater field with the area of damaged forest (about 1 km^2) and the area of the fallout of visible fragments (about 2.5 km^2).

Micron-sized nickel particles found in the snow cover near the flight path several tens of kilometers from the place of the alleged fall still remain the only material evidence of the fall of the Vitim fireball in 2002 [16]. Magnetite and silicate micro spheres are evidence of the fall of the Tunguska cosmic body in 1908 [13].

Thus, in conditions of inaccessibility of the study area, taking into account the limited time and small size of the research group, the most effective is the search for indicator micro particles in the surface layers of the soil [14]. It is also important that such a search in the field does not require expensive and heavy equipment (deep metal detectors, georadar, etc.). Cosmic particles are especially effectively accumulated and stored in peat deposits, so the main goal of the expeditionary work was to take surface samples of peat in the area of the supposed fall of the Uchur cosmic body (UCB). Subsequently, the samples were studied at the Geophysical Observatory Borok, Branch of the Schmidt Institute of Physics of the Earth, Russian Academy of Sciences, using a technique combining the petromagnetic and micro probe methods with micro mineralogical analysis.

2. Materials and methods

Investigation of the impact area of a meteor explosion. The expedition survey of the impact area of the UCB was performed twice, in July-August 2016 and in August 2017. The detachments were led by an employee of the IVMiMG SB RAS, Ph.D. Amelin I.I. (IVMiMG SB RAS), the detachments included Amelin I.V. (geologist, artel of prospectors “Golden Pole”) and Tynda L.B. (a chemical engineer from Moscow). During the first trip, the group examined the areas to the north and northwest of it and took samples of peat. The length of the routes in the area of the fall of the UCB (p. Lower Konkuli, Unga-Bereyakan, Ayakachan, Synnyar) was 25 km. The list of objects inspected in 2016 is presented in **Table 1** and **Figure 1**.

The second expedition carried out in August 2017 allowed us to increase the area of the studied area, reach the area of forest fallout and slope stability violations, as well as to select additional peat samples.

Using medium-resolution satellite images of the Sentinel-2 spacecraft and the Landsat-8 spacecraft (10 m/pixel and 20 m/pixel, respectively, [lv.eosda.com]), a search was carried out for signs of modern changes in forest vegetation and relief in the upper reaches of the Lower Konkuli River. The most extensive violation of the forest cover was found near the mouth of the stream. Using the revealed violations of the continuity of forest vegetation under the influence of external factors and assuming that the genesis of this area is due to the collision of fragments of the UCB with the Earth, we will call it the cosmogenic impact area. This area has a total area of about 4-5 sq. km and is located in the valley of the Lower Konkuli, between the Vershinny stream and the channel of the river Lower Konkuli. It consists of 6 fragments, between which there are free-standing trees, as well as areas of instability on the left slope of the valley of the river Lower Konkuli. The area of the fragments of the dump is 0.5-1.5 hectares. Under the snow cover, the outlines of fallen tree trunks with a diameter of at least 50 cm are visible. The forest area in the valley of the Lower Konkuli River is represented by trees 25-30 m high and 0.6-1 m in diameter at the base of the trunk (spruce, larch, poplar). The mosaic of forest fallout in the valley of the river Lower Konkuli at the Vershinny stream indicates the fragmentation of the cosmic body before the collision with the Earth.

3. Results

To search for micro particles that were part of the UCB and a possible ablative trace, an analysis of the surface layers of peat in the area of the intended impact was carried out. The micro mineralogical analysis was carried out using a scanning electron microscope “Tescan Vega II” with a prefix for energy dispersion analysis. To determine the background concentration of cosmic matter in the region, the study of the surface layer of peat outside the dust trail of the expected impact event was carried out. The sampling site is the valley of the Aldan River 1.5 km east of the village Chagda, a riding swamp (**Figure 1**, **Table 2**). The upper 15 cm of the sample was analyzed.

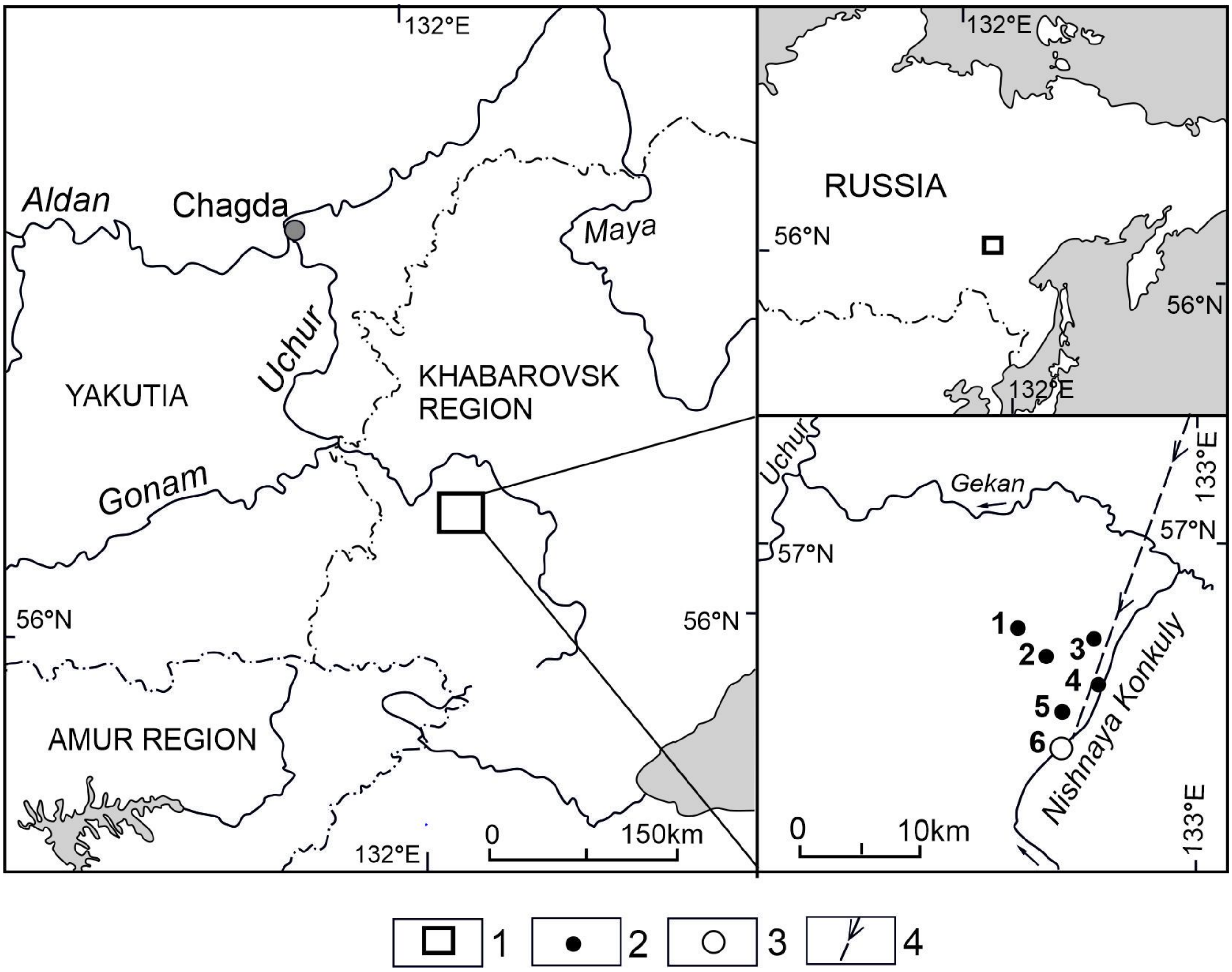


Figure 1. Position of the Uchur cosmic body impact site on the map of Russia and the Far East region and the research site in the Lower Konkuli river basin.

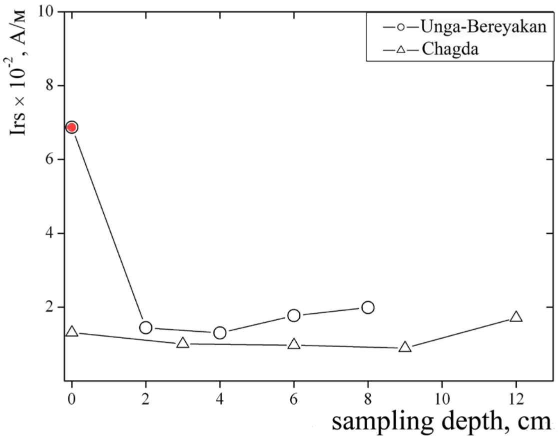


Figure 2. Dependence of saturation remanence (Irs, A/m) on sampling depth, cm.

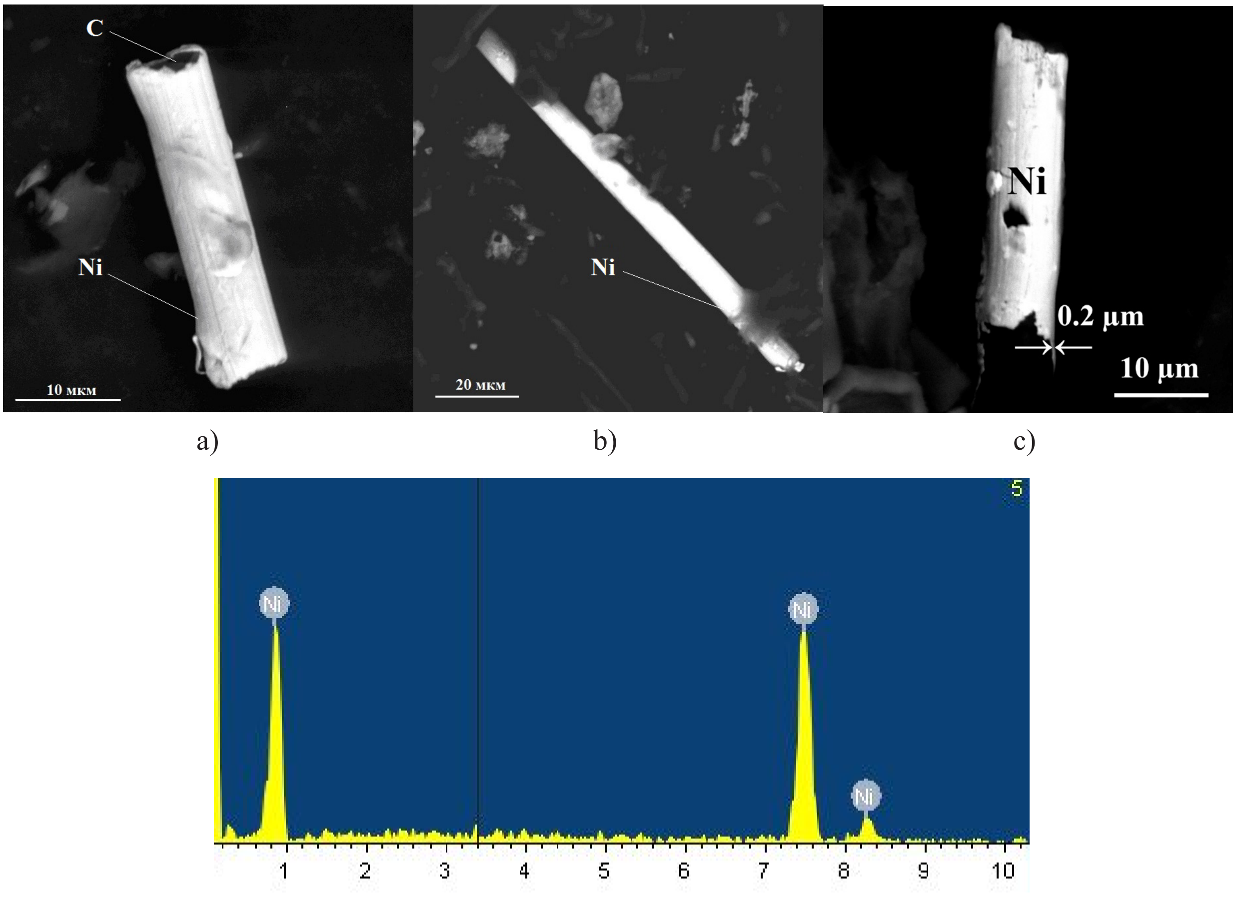
To search for peat samples most enriched with mineral (in this case cosmogenic) matter, we measured their residual saturation magnetization of the Irs. This parameter is determined by the presence and number of "large" (more than 0.1 microns) mineral particles with residual magnetization. The size of the separated and studied particles was 1-20 microns.

The results of the Irs measurements of the studied samples are shown in **Figure 2**. It can be seen that the Irs of the surface layer of peat from the fall area of the UCB significantly exceeds the residual saturation magnetization of the underlying layers (7×10^{-2} A/m versus 1.5-2 $\times10^{-2}$ A/m) both from the fall area and the control sample of the Chagda (by 600-700%!). The assessment of the depth of the "catastrophic layer" with UCB particles in peat was carried out based on the fact that the expected impact event occurred in 1993. The rate of peat formation in this area (middle taiga) approximately coincides with the area of the Tunguska event, for which this value is 0.5 mm/year [17]. The upper 10 cm of the peat part is quite sufficient for analysis (23 years have passed from the moment of the expedition work to the expected impact event, that is, a "catastrophic layer" can be expected at a depth of 1.2-1.3 cm), which is confirmed by the results of the Irs study shown in **Figure 2**.

In the second stage, the layers with the highest Irs of the series and background samples were subjected to micro probe analysis to determine the morphology and chemical composition of micro particles [14]. The micro mineralogical analysis was carried out using a scanning electron microscope "Tescan Vega II" with an EDS attachment. A micro probe study of the particles of the surface layer of the sample from the area of the fall of the UCB ("catastrophic" layer) showed that its distinctive feature is the presence of structures in it that could arise when hot UCB particles collide with organic material (peat). Structures of this shape with no film have been found. (**Figures 3a,b,c**). Inside each structure, there is a charred biogenic fragment. The energy dispersive spectrum (**Figure 3d**) of the film shows that it consists of pure nickel (100% Ni).

1) The site of the fall of the UCB on the map; 2) research sites; 3) possible place of fall of fragments of the UCB; 4) the direction of movement of the UCB.

Comments for research sites: 1) felling of the forest with a pronounced general direction of falling trunks; 2) "burn" of elfin and soil; 3) depressions in the upper reaches of the Unga-Bereyakan; 4) base of the exploration team of the Amur artel, 5) "fresh" signs of the impact of the shock wave on the boulders of the slope; 6) the alleged place of the fall of the UCB.



a) b) c)

d)

Figure 3. Microparticles from the site of the UCB fall: a) Ni tube (film) 0.5 × 6 × 35 microns with biogenic carbon residue inside; b) Ni tube (film) 0.5 × 8 ×100 microns; c) Ni tube (film) 0.2 × 6 × 40 microns; d) The energy dispersive spectrum of the film shows that it consists of pure nickel.

Table 1. Coordinates, dimensions and location of objects in the area of the impact of the UCB found during search routes and remote sensing decryption.

The name of the object	Coordinates of the center of the structure, northern latitude, eastern longitude	Absolute height, m	Area, hectare	Distance from the fall of the forest (1 in Figure 1), km
1. The fallout of the forest with the general e.g. trunks	56.93854° 132.75706°	900-1000	20-30	10-11
2. Falling out of the forest with chaotic e.g. trunks on the Ayakachan River	56.95211° 132.85342°	800-900	100-200	9-10
3. Probable “burn” of the elfin and soil	56.91480° 132.81825°	1050	1-2	7.5
4. Traces of movement of boulders on the slope (chipped outer surface)	56.86249° 132.85127°	950-1100	0.5-1	1.7
5. Epicenter of severe destruction (fallen forest)	56.84773° 132.84257°	860-870	3-4	-

Table 2. Characteristics of the selected peat samples.

Location of the selection coordinates	Coordinates northern latitude, Eastern longitude; absolute height, m	Geometric dimensions (L-W-H), mm	Distance from the intended epicenter, km
Unga-Bereyakan	56.92579° 132.87410°; 850	150 × 60 × 280	9
Chagda	58.73823° 130.64098°; 197	150 × 200 × 300	248

4. Discussion

A key finding in the study of UCB was the detection of thin films (0.1-0.2 microns thick) of metallic nickel and iron on the surface of terrestrial objects—plant residues. It was impossible to explain the formation of such films by terrestrial processes. However, on 31.08.2019, an interstellar comet passing through the Solar System (2I/Borisov) was discovered. Analyzing the observations of comets of the Solar System and the interstellar comet 2I/Borisov, obtained with a Very Large Telescope (VLT drive). At the European Southern Observatory (ESO), astronomers discovered the presence of nickel and iron in their atmospheres, even in those that were far from the Sun.

This was the first detection of heavy metals, usually associated with hot environments, in the gas shells of cold ice wanderers. “It was a big surprise to find iron and nickel atoms in the atmospheres of all comets that we have observed over the past two decades—and there were about twenty of them,” notes Jean Manfroid from the University of Liege (Belgium) [18]. At temperatures exceeding 700 °K, comets also emit metallic vapors, which are formed as a result of the sublimation of metal-rich dust particles. The authors reported spectroscopic observations of atomic Ni vapors in the cold comet 2I/Borisov [19].

5. Conclusions

Usually, researchers in search of traces of impact events focused on the search for massive objects. However, no massive object was found during the study of the UCB. Specific microstructures were found in the form of thin films of pure nickel. Under terrestrial conditions, the formation of such films is impossible. A possible mechanism for the formation of thin nickel films has become clear due to the recent discovery of atomic nickel vapor in cometary atmospheres [18,19]. It is likely that atomic nickel vapor from the comet’s atmosphere formed a thin film of nickel on them when it collided with terrestrial objects.

The authors have shown the possibility of using specific film microstructures to identify both UCB and other cosmic bodies of presumably cometary origin, to which we referred UCB.

Studying the trails of fallen comets is extremely important, as they can carry traces of extraterrestrial life, and could also destroy ancient civilizations.

Author Contributions

Tselmovich V.A.: General work management, sample preparation, microscopic and microprobe measurements.

Amelin I.I.: Organization of expeditionary work in 2016-2017, collection of samples.

Gusiakov V.K.: Substantiation of research, processing of expeditionary results.

Kirillov V.E.: Primary expeditionary work at the site of the fall of the Uchur cosmic body in 1993.

Kurazhkovskii A.Yu.: Magnetic measurements of peat samples.

Conflict of Interest

No conflict of interest.

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