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UNCLASSIFIED- INFORMATION ON SOVIET BLOC INTERNATIONAL GEOPHYSICAL COOPERATION - 1960

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INFORMATION ON INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM — SOVIET-BLOC ACTIVITIES

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I. GENERAL

Geophysical Studies

The benefits of international cooperation in the investigation of the mysteries of nature were clearly manifested by the International Geophysical Year. Even the biggest optimist did not expect to see scientific cooperation produce such striking results. In the past 3 years science has made a gigantic forward step in the investigation of the Earth. But the processing of the available materials has only begun; it will take many years before their all-embracing significance is revealed.

The greatest of all the achievements made during the IGY was the photographing of the far side of the moon never before seen by man. The observations of the artificial earth satellites produced invaluable information. Take, for example, such an old problem as the determination of the exact size of the flattened parts of the globe. About 300 years ago the brilliant English scientist Newton first suggested that the Earth was not shaped like a sphere since it rotates around its axis.

Under the effect of the centrifugal force which is particularly great near the equator and altogether absent at the poles, the earth sphere was flattened in the shape of a spheriod similar to a tangerine. That suggestion became the object of spirited controversies among the scientists lasting about half a century. To settle the dispute, the French Academy of Sciences sent out two expeditions, one to the equator and another to the north pole. They were to measure the meridian arc, accurate to one degree. If the Earth is shaped like a tangerine, the Polar degree must be longer than the equatorial. The work of the expeditions which lasted 8 years was very difficult and dangerous. But the scientists completed their mission. The results of their investigations confirmed Newton's predictions. Nevertheless, their measurements, just like those of many other scientists who followed them, were not accurate. Only the orbits of the soviet earth satellites and their comparison with those of the American satellites revealed the exact magnitude of the flattened parts of the earth's sphere. And all these calculations were made under the comfortable conditions of the laboratory with the aid of electronic machines.

Studying the orbits of the sputniks, the scientists came to the conclusion that the shape of the Earth is not symmetrical in relation to the equator. If we looked at the image of the earth's surface in a mirror, we would find that the outlines of the northern and southern hemispheres are different from each other. Actually, the Earth is shaped like a "pear" with its narrow end at the north pole and the flat side at the south pole. The surface of the Earth at the north pole is 15 meters higher, and just as much lower at the south pole, that it would have been had the Earth been shaped like correct ellipsoid.

One of the important tasks of the IGY was to find the thickness and structure of the earth's crust. The Hungarian scientists played a particularly active part in this undertaking. It is not easy to establish the lower limits of the earth's crust. Precise geophysical methods make it possible for the scientists to penetrate deeper into the earth's sphere. These methods are based on the study of the fluctuations of the earth's crust brought about by earthquakes and artificial explosions. If the earth were a homogenous body, the seismic waves in it would spread in a straight line and with the same speed. A study of the speed of the spreading waves revealed that the earth's sphere consists of a number of concentric zones of various thicknesses. In the upper layers the earthquake waves spread at a speed of 5.6 kilometers per second. Further down the speed increases by 1 kilometer remaining at the rate to a depth where it suddenly jumps to 8.2 kilometers. This part of the crust is called the Mokhorovitch level (after the Yugoslav scientist who first discovered it), and is believed to be the bottom border line of the earth's crust. Thus to establish the Mokhorovitch level means to determine the thickness of the earth's crust.

(Photo caption: A picture of the far side of the moon)

(Photo caption: The shape of the Earth. The solid line shows the shape of the earth established on the bases of recent data, and the dotted line indicates the theoretical shape)

Investigations have shown that the thickness of the earth's crust on the continents is between 30 and 40 kilometers; in the high mountain areas it goes up to 60 kilometers, and in the oceans it is down to 5 kilometers.

During the geophysical year our scientists made a study of the earth's crust on the European continent. The observations of the 1956 earthquake were carried out with that purpose in mind. Although the accuracy of those data are inadequate, in view of the considerable distance between the observers and the center of the earthquake, they still provide ground for the belief that the average thickness of the earth's crust on the European continent is about 33 kilometers. More accurate measurements, made possible by artificial explosions, were taken at 9 different points in Hungary. The results were surprising. It was found that on the territory of our republic the earth's crust is considerably thinner than the European average, measuring approximately 22-27 kilometers. This is apparently due to the distension of the Earth's surface that had occurred here in the past.

Scientists have recently advanced the idea of drilling the earth's surface where it is thinnest, at the deepest part of the ocean bottom. The implementation of this plan would produce direct

information on the material structure of the crust below the Mokhorovitch level. But this still calls for the solution of several very complicated technical problems.

The Hungarian researchers have made a substantial contribution to the study of the Earth's elasticity. The observations were carried out by the Tigon'ska geophysical observatory with the aid of a very sensitive device, a gravimeter. Observed there also were the fluctuations of the Earth's magnetic field and the earth currents. Much of the work under the IGY program was carried out also by the meteorological institute. In addition to their studies of the atmosphere, our scientists measured the Sun's radiation. The institute had collected all the information on the northern lights to establish a broad information service in the course of the IGY. Its ionosphere-observation station was one of those that produced the basic data on the peculiarly "light days."

We cannot refer to the results of the International Geophysical Year without mentioning the heroic performance of the polar expeditions whose scientists volunteered to endure the hostile elements of nature in the name of science. The point under consideration is the exploration of the southern permafrost zones. The task of the Antarctic explorers was to find out whether the Antarctic is a continent. They established that the Antarctic actually has a continental structure but a certain part of it is made up of a number of islands.

Scientists have for a long time been interested in the causes behind the rising Scandinavian surface. The explanation offered was that during the glacial period the earth's crust was caved in by a layer of ice 2-3 kilometers thick, and when the ice melted it reverted to its original position. It was decided to check the authencity of this assumption in the Antarctic. That latter also contains huge glaciers 2-3 kilometers thick, and sometimes even 4 kilometers. A study of the seismic waves, humidity changes and even direct drilling operations revealed that over a considerable area down there the earth's crust actually sank below sea level.

One of the exploration groups mapped the protruding peaks of the Antarctic mountains. They range approximately from 2,300 to 4,600 meters in height; they are part of single mountain chain system. Preliminary geological investigations indicate that this system of mountains is of a volcanic origin; 90% of them are covered with snow and ice. Tests were made on some of the rock samples taken from the east Antarctic gneiss shield. Their age is about 520 million years. It is interesting to point out that the Rio de Janeiro gneiss (South America) and the Capetown granites (South Africa) go back to about the same era. This circumstance justifies the belief that the continents came into being simultaneously.

Thus these few examples alone reveal the extent to which the International Geophysical Year has advanced the study of the mysteries of our Earth. ("Geophysical Studies," by Eded Laslo, Nauka i Zhytta, No 5, 1960; pages 57-58.)

II. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Soviet Spaceship and Rocket-Carrier Observed Over Moscow -- An Izvestiya Dispatch

The Soviet spaceship has been continuing its speedy flight around the Earth for almost a half-month. This giant is demonstrating to the entire world that the laurels of priority and preeminence are firmly in the possession of our country.

During the first days after the launching, good conditions for observation prevailed in the southern regions of the Soviet Union. In the last few days it has also been possible to observe the spaceship in the vicinity of Moscow, but the continuous cloud cover has unfortunately made it impossible to see the ship. But yesterday Moscow residents were able to observe it for the first time.

Despite the late hour, a great many people were gathered on the astronomical observing area at the planetarium. At 0210 hours the delighted cry "There it is!" was heard. Moving through the sky rapidly in a southwesterly direction was a small bright "star" -- the rocket-carrier. It varied in brightness. During its flight the rocket was continually "tumbling."

At 0231 another small "star" shot over the capital -- this was the spaceship itself. ("Spaceship Over the Capital," by V. Lutskiy, Izvestiya, 28 May 1960)

Soviets Put Models of Space Instruments on Exhibition

The following brief notice recently appeared in Pravda:

After a partial renovation of the exhibition, the doors were opened yesterday to the so-called "Rocket Hall" of the pavilion of the Academy of Sciences of the USSR at the Exhibition of Achievements of the National Economy of the USSR.

Visitors exhibited a lively interest while examining models of Soviet space instruments that have functioned beyond the Earth and a great deal of other material clearly evidencing the outstanding attainments of the Soviet Union in the mastery of space.

For the first time a model of the interplanetary station launched with the third Soviet cosmic rocket on 4 October of last year was set up in the center of the hall. In the upper part of the shining metal body of the station one could see the opened shutters of the television apparatus used to photograph the reverse side of the Moon and transmit its image to the Earth.

Of great interest is the display stand entitled "Means and Methods of Observing Artificial Earth Satellites." In particular, a new instrument is on display which is used in the observation and photographing of satellites. It is supplied with a moving film which gives a bright photograph and a clear image. ("Station for Photographing the Moon," Pravda, 29 May 1960, page 6)

Russians Use Meteorological Rockets in Research in Franz Josef Land

A recent article in Nedelya, the Sunday supplement of the newspaper Izvestiya, reports on Soviet activities in Franz Josef Land.

Mention is made of research work and exploration conducted under the leadership of P. Ya. Mikhalenko. The article indicates that after four years of work every islet, mountain peak and embayment has been fully mapped.

The article is centered on meteorological work by the use of rockets and a photograph illustrates the recovery of a nose cone. Nevertheless, the article emphasizes the human interest angle, not the scientific aspects of this research. ("Rocket Goes Into the Zenith," by B. Kolokolov, Nedelya, No 9, 24-30 April 1960, pages 8-9)

Conference on Problems of the Mathematical Theory of the Motion of Artificial Celestial Bodies

A conference on problems of the mathematical theory of the motion of artificial celestial bodies (satellites and rockets) was held from 22 to 25 December 1959 at the State Astronomic Institute imeni P. K. Shternberg (GAISh), Moscow State University. The conference was organized by the Chair of Celestial Mechanics and Gravimetry of Moscow State University (Professor G. N. Duboshin, Head of the Chair) on commission and under active assistance of GASh and in close contact with the Institute of Theoretical Astronomy of the Academy of Sciences USSR (ITA, Leningrad), The Astronomical Council of the Academy of Sciences USSR, the Mathematics Institute of the Academy of Sciences USSR (MIAN), and other organizations.

A report on the conference appears in Astronomicheskiy Zhurnal, Vol 37, No 2, 1960, in which a brief resume of each of the reports which were read is presented.

More than 100 persons participated in the conference. These were representatives of 30 scientific research institutes and establishments, among which were: GASh, ITA, Astrosovet [Astronomical Council, Academy of Sciences USSR], MIAN, Institute of Mechanics of the Academy of Sciences USSR, Central Scientific Research Institute of Geodesy, Aerial Photography and Cartography (TsNIIGAiK), the Chair of Theoretical Mechanics of Moscow State University, the universities of Leningrad, Kazan, Rostov, Tbilisi, Latvia, and others. Seventeen of the 28 reports heard were read by professors, associates and aspirants of Moscow State University. ("Conference on the Problems of the Mathematical Theory of the Motion of Artificial Celestial Bodies," by Ye. A. Grebenikov; Moscow, Astronomicheskiy Zhurnal, Vol 37, No 2, 1960, pages 362-368)

Czechoslovak Observatory Used as Part of Moscow Tracking Center

The rash of official and semi-official Czechoslovak commentary on the recent launching of the Soviet "space ship," published in the Czechoslovak press, includes information which indicates that at least

one Czechoslovak astronomical observatory is integrated with the Moscow tracking center. A brief item in a series of pronouncements by prominent scientists, identifies Dr. Otto Oburka as the director of the Oblast People's Observatory in Brno, "which is simultaneously the official observation station No 143 of the Moscow center for tracking artificial satellites and rockets."

According to other commentary published, it is apparent that most of the facilities of the Czechoslovak and Slovak academies of science were engaged in observation of the space craft. Identified facilities include the Astronomical Observatory of the Slovak Academy of Sciences, located at Skalnate Pleso in the Tatra Mountains, whose director is listed as Dr. Ludmila Pajduskova-Mrkosova; the Astronomical Observatory of the Czechoslovak Academy of Sciences at Ondrejov, which is stated to be well prepared to record the first optical sightings of the ship as it passes over Czechoslovakia; and the Ionosphere Station at Panska Ves, which apparently monitored the signals of the space ship.

The 18 May 1960 issue of the same source contains a brief item of information which identifies the director of the Popular Astronomical Observatory at Prague-Petrin to be one Frantisek Kadavy and states that the observatory is part of the Czechoslovak Astronautic Society. Kadavy is the occasional author of popular science-type articles in selected Czech periodicals. ("Persuasive Proof of Primacy," unsigned news item, Prague, Obrana Lidu, 17 May 1960, pages 1-2)

III. UPPER ATMOSPHERE

Full Translation of an Article on the Earth's Corona by I. Shklovskiy

Many people believe that interplanetary space is some kind of absolute vacuum. In actuality this is not the case. Interplanetary space is filled with a material medium, although, to be sure, it is extremely rarefied.

The thorough study of the matter found in the uppermost portions of the Earth's atmosphere and in interplanetary space is one of the most urgent problems of modern astronomy and geophysics. It is through the regions of cosmic space adjoining the Earth that the trajectories of interplanetary flights will pass in the none-too-distant future. As it is absolutely necessary for aviation to know all the properties of the air ocean surrounding the Earth, so for astronautics it is necessary to know all the properties of this interplanetary medium. This is especially important to insure reliable radio communications with interplanetary rockets.

There is another but no less important side to this problem. As is well known, streams of solar corpuscles pass through interplanetary space; on entering the upper layers of the Earth's atmosphere they cause considerable perturbations therein. This, in particular, determines

the conditions for terrestrial radio communication on the short waves. Consequently, a study of the factors causing such perturbations, and the possibility of predicting them, is of great practical significance.

An understanding of the immense significance which the Sun exercises on various terrestrial phenomena is possible only by a clarification of the properties of the streams of solar corpuscles and the interplanetary gas medium through which these streams travel. Meanwhile astronomical and geophysical research accomplished over a period of many years from the Earth's surface has not led to a clear understanding of the gaseous medium filling cosmic space, either in the vicinity of the Earth, or at great distances from it.

In the same way, we know little for certain about the nature of the streams of solar corpuscles. Such an abnormal situation is due to the great difficulties with which it is necessary to contend during the solution of this interesting and important problem.

There is every reason to assume that the gas in interplanetary space should for the most part be ionized, that is, consist of particles charged positively (ions) and negatively (electrons). In principle it is possible to observe the interplanetary ionized gas medium because the electrons which form a part of it will scatter the Sun's light. When this happens the light rays experience certain qualitative changes called polarization. On the other hand, interplanetary space is filled with extremely fine hard particles -- specks of dust, which also scatter sunlight. This luminescence can be observed easily toward morning or in the evening in the form of a bright, gradually narrowing zone in the sky. The described phenomenon has been known from time immemorial and is called "Zodiacal light." Quite recently German researchers have discovered a rather considerable polarization of Zodiacal light. Hence they have drawn the conclusion that there is ionized gas in interplanetary space; near the Earth, at a distance on the order of several million kilometers, the number of particles of this gas in a cubic centimeter, according to their measurements, is about 1,000.

This is an extremely tenuous result since the observed polarization of Zodiacal light can arise during scattering on the interplanetary dust particles. Leading Soviet and foreign astronomers, especially Academician V. G. Fesenkov, have devoted their attention to this problem.

The peculiarities of the dissemination of low-frequency pulses of radio radiation connected with lightning discharges is also indicative that there is ionized gas in interplanetary space. Such pulses, disseminating along the lines of force of the Earth's magnetic field, have passed through regions separated from the Earth's surface by a distance of 20 to 30 thousand kilometers, after which they have returned to the Earth's surface. However, the ionized medium through which such pulses pass could be the outermost rarefied layers of the Earth's atmosphere, not the interplanetary gas.

In 1957 American scientists, using rockets, discovered during the night hours an intensive luminescence of the sky at great heights in the ultraviolet line of hydrogen "Lyman-alpha" (such radiation does not reach the Earth's surface, since it is already absorbed at a height of about 70 km). This luminescence of the night sky has been explained by the American scientists by the scattering of solar ultra-violet radiation by interplanetary atoms of hydrogen (non-ionized). Working with this hypothesis, it was possible to estimate the density of the atoms of hydrogen in interplanetary space, and then with the assistance of simple theoretical considerations, compute the density of the ionized interplanetary hydrogen -- the principle component of interplanetary gas. In 1958, however, the author of this article pointed out that the observed ultraviolet luminescence of the night sky can also be explained by the scattering of the ultraviolet radiation of the Sun in an extremely widespread cloud of atoms of hydrogen surrounding the Earth.

The famed English geophysicist Chapman considers that the uppermost layers of the Sun's atmosphere, the so-called "solar corona," extends right up to the Earth's orbit. To use the graphic expression of this scientist "We live in the Sun's corona." If Chapman were right, then in interplanetary space there would be a rather great amount of ionized gas. A completely opposite point of view has also been expressed. For example, the leading German astrophysicist Berman has posed several serious objections to the very possibility of the existence of gas in interplanetary space.

Summing up, it may be stated that the important problem of interplanetary gas and its properties has been completely uncertain up to very recent times. However paradoxical it may seem, astronomers have known far, far better the nature of interstellar gas. In recent times it has become increasingly apparent that only by a direct experiment in cosmic space can we solve the problem of the properties or even the very existence of interplanetary gas.

On all three Soviet cosmic rockets there have been conducted experiments for the study of ionized gas in interplanetary space and in the outermost parts of the Earth's atmosphere. These experiments were conducted by a group of Soviet radio-physicists under the direction of K. I. Gringaus, Doctor of Technical Sciences. Special instruments were devised for this purpose -- three-electrode traps for charged particles. A group of astrophysicists under the direction of the author of this article took part in the processing and interpretation of part of the extremely extensive derived experimental data.

The trap for charged particles has a simple design. Each trap consists of a small metal plate (collector) and two grids, insulated from the body of the rocket. The charged particles, striking against the collector, create an electrical current, negative in the case of electrons and positive in the case of ions. The magnitude of the currents is measured by the use of a special amplifier. A negative voltage -- 200 volts -- is applied to the inner grid (relative to the

body of the rocket). This is necessary for suppression of the photoelectron current arising as a result of the illumination of the collector by that part of the ultraviolet rays of the Sun which does not reach the Earth's surface. Because of this grid all the electrons "torn" from the surface of the collector by the ultraviolet radiation of the Sun are returned back to the collector. A small voltage is applied to the second grid (relative to the body of the rocket) for the sorting of particles by energy.

There were four traps with different potentials of the outer grids on the Soviet cosmic rocket launched on 12 September 1959. These potentials were: +15 volts, 0 volts, -5 volts and -10 volts. The positive current, as already indicated, can only be caused by ions; their energy can be estimated by a comparison of the readings of all the traps. However, if a negative current is simultaneously recorded in all the traps, then this means that it was caused by currents of electrons. In this case the energy of each electron exceeded 200 ev, since only such electrons can pass through the retarding potential attached to the inner grid of the trap.

The magnitudes and directions of the currents in all the traps were transmitted to the Earth by a telemetric system. By using the measured values of the currents in the traps, taking into account all the circumstances of the experiments, it was possible to determine the concentration of the charged particles in the cosmic space surrounding the rocket, that is, the number of such particles in a cubic centimeter.

An immense amount of experimental data was derived as a result of the measurements made on the three Soviet rockets by use of traps. During the time of the flight of the Soviet cosmic rocket in September 1959 about 12,000 measurements of currents in the traps were transmitted to Earth by telemetric means. The processing of this great amount of experimental data required the intense work of a group of Soviet radiophysicists and astrophysicists. It was necessary to carefully take into account the influence of the rotation of the rocket container on the current readings, the electrical potential of the container in dependence on external conditions, and a number of other circumstances as well. It goes without saying that we cannot say anything of a detailed nature here about all these important problems.

Let's dwell on the principal scientific results of investigations by use of the traps. Figure 2 is a graph of the relationship between the concentration of ions and distance. It is calculated in kilometers from the Earth's surface. It is possible to draw two main conclusions on the basis of the data shown in Figure 2 (Figures are not reproduced here).

1. The Earth is surrounded by an extremely extensive and very rarefied atmosphere consisting of ionized gas. With full justification we can call this atmosphere "the Earth's corona" or the "geocorona."

The concentration of ions in the geocorona is on the order of several hundreds of positively charged particles per cubic centimeter. For comparison we can mention that the concentration of ions in the Earth's atmosphere at a height of about 300 km attains one or two million per cubic centimeter. And at the Earth's surface the concentration of atmospheric molecules is expressed by a colossal 20-digit number.

From the character of the change in the concentration of ions with distance from the Earth's surface it may be concluded that the geocorona consists of hydrogen. The geocorona can be traced right up to a distance of twenty-two thousand kilometers from the Earth's surface. There is reason to assume, however, that the extent of the geocorona is variable. It can depend on a number of circumstances, chiefly on the activity of the Sun.

2. In interplanetary space, at distances exceeding 22,000 km from the Earth's surface, no measurable concentration of ionized gas was discovered. Hence, taking into account the accuracy of the experiment, the conclusion may be drawn that if there is ionized gas in interplanetary space, its concentration is less than several dozen ions per cubic centimeter. On the basis of existing indirect data, based on an analysis of currents in the traps, the concentration of interplanetary ionized gas should be still considerably less than this value.

These experiments completely substantiate the idea that a "stationary" ionized gas does not exist in interplanetary space. We emphasize the word "stationary" because from time to time, especially in periods of intense solar activity, interplanetary space is filled with streams of charged particles moving at an immense velocity. Evidently these corpuscles in streams continually "sweep out" (so to speak) the ionized gas from interplanetary space and this is the reason for its absence.

As a result of the experiments with the charged particle traps, the problem of the nature of the interplanetary medium has been substantially clarified. A number of old ideas have had to be abandoned as not being in accordance with reality. At the same time these experiments have enabled us for the first time to demonstrate the presence around our planet of a gaseous, extremely extensive corona-like envelope.

The question naturally arises: why is the Earth surrounded by a very extensive hydrogen corona? Although no theory has yet been fully worked out to explain this interesting phenomena, in general terms the explanation amounts to the following.

There is always water vapor in the lower layers of the Earth's atmosphere. At heights exceeding 100 km the ultraviolet radiation of the Sun decomposes (dissociates) the molecules of water into their constituent atoms of hydrogen and oxygen.

Right up to heights of 140 to 160 km the Earth's atmosphere is well mixed; therefore the relative proportion of hydrogen atoms remains more or less constant. However, at great heights the intermixing of

the atmosphere ceases and the lighter hydrogen atoms, with increasing height, become more numerous. Somewhere at a height of about 1,500-2,000 km the hydrogen in the Earth's atmosphere becomes its principal element. It should be noted that the velocity of the thermal movements of the hydrogen atoms is rather great and for a considerable part of them they exceed the first cosmic velocity. Therefore the atoms of hydrogen situated in the uppermost layers of the atmosphere continually "abandon" it, as if "escaping" into interplanetary space. The hydrogen atoms constantly "slipping away" from the limits of the Earth form the geocorona.

If there were not a constant replenishing by means of evaporation of ocean water, all the hydrogen existing in the Earth's atmosphere rather rapidly would "escape" into interplanetary space. Computations show that for this reason the level of the world ocean has dropped several meters in the course of the geological history of the Earth.

Thus, the first experiments in the direct "probing" of the gaseous medium in cosmic space has already yielded extremely valuable scientific results. In this article we have dealt only with a few of them. In particular we have not dwelt on the problem of the streams of charged solar corpuscles discovered by means of traps at distances of hundreds of thousands of kilometers from the Earth, where its magnetic field is already becoming small. Finally, the processing of the results of the measurements of currents in the traps has enabled us to substantially refine our knowledge of the properties of the radiation belts. The full results of this research accomplished by means of charged particle traps are published in Soviet scientific journals.

There is every reason to assume that the continuing "probing" of cosmic space will yield ample new and valuable scientific results.

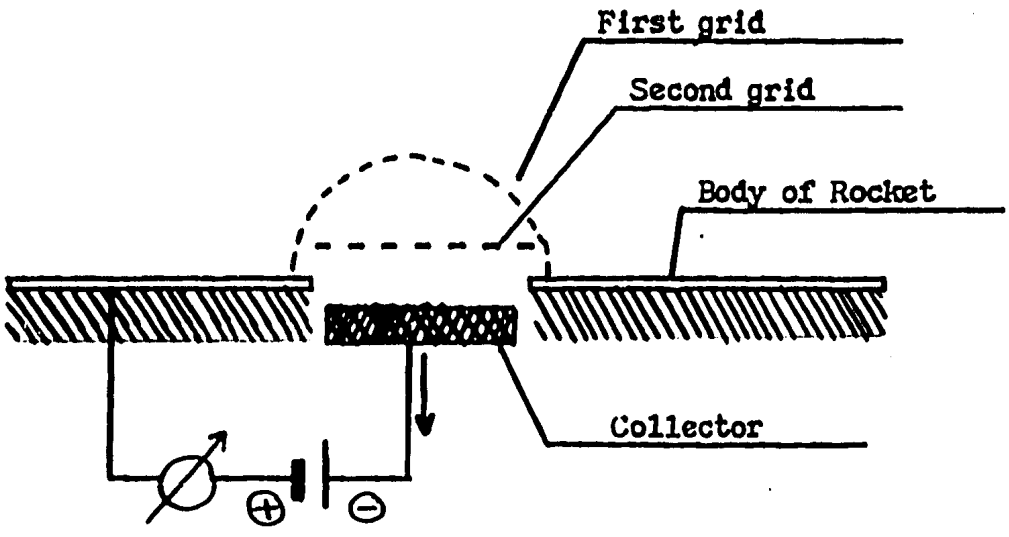

Figure 1. Diagram of charged particle traps

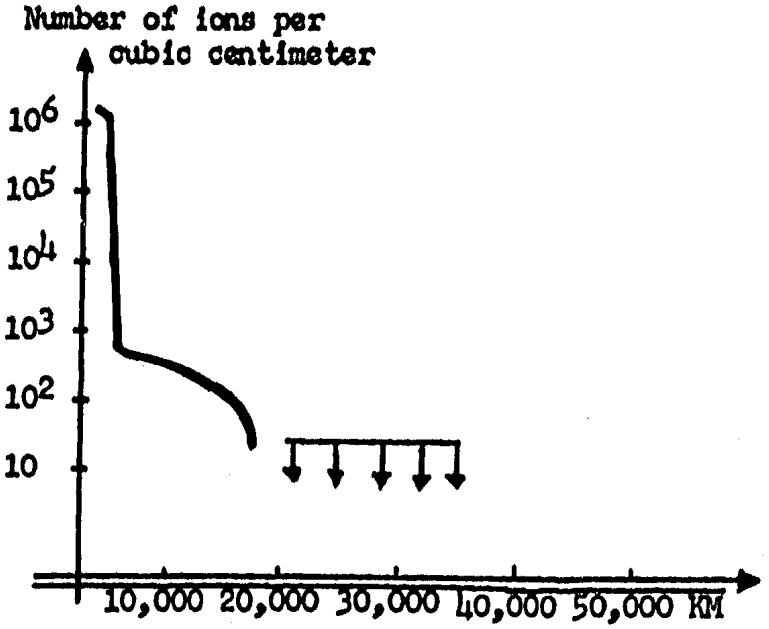

Figure 2. Graph showing the ratio of ion concentration to distance (Computed from the surface of the earth).

("The Earth's Corona," by I. Shklovskiy, Pravda, 25 May 1960, page 6)

Report on Russian Research on the Character of the Atmosphere of Mars

A. V. Kurchakov points out in this article that in a number of papers devoted to the interpretation of photometric observations of Mars the opinion is expressed that the atmosphere of that planet differs in its optical properties from the Earth's in that true absorption plays an important role. The fact is, Kurchakov demonstrates in this 10-page article, that true absorption in the atmosphere of Mars is of no importance. ("On the Optical Properties of the Atmosphere and Surface of the Planet Mars," by A. B. Kurchakov, Vestnik Leningradskogo Universiteta, No 7, Seriya Matematiki, Mekhaniki i Astronomii, No 2, 1960, Pages 154-163)

Emissions of the Solar Corona

High quality and complete non-eclipse observations of the solar corona were collected during the IGY. These made possible comparisons of coronal radiation in λ 5303 and meter waves and also geomagnetic disturbances, which are more detailed than those made previously.

Conclusions:

1. The intensity of the coronal line λ 5303 A has a maximum above sunspots.

2. The best conditions of visibility of coronal details occur a day after their crossing the east limb of the Sun or a day before crossing the west limb.

3. Radio emission during noise storms on meter waves has a narrow directivity (the solid angle is less than 10°), there being a sharp increase in the intensity of λ 5303 A in the same place in the corona.

4. A noise storm on meter waves is usually observed 2-4 days before a geomagnetic storm. ("The Connection Between Optical and Radio Emissions of the Solar Corona," by M. N. Gnevyshev, Main Astronomical Observatory, Academy of Sciences USSR; Moscow, Astronomicheskiy Zhurnal, Vol 37, No 2, Mar-Apr 60, pages 227-234)

Mars Studies at Kharkov Observatory

The possibility of explaining the variations of contrast by transparency in Mars' atmosphere is considered by N. P. Barabashov and I. K. Koval' in the latest issue of Astronomicheskiy Zhurnal. The study is made on the basis of the examination of contrasts on Mars in red, green and blue light. The authors conclude that the observational data on the contrasts in red, green and blue light ($\lambda > 420$ mμ) are determined mainly by energy distribution in the spectrum of the planet's surface. ("Some Results of the Investigation of Contrasts on Mars," by N. P. Barabashov, I. K. Koval', Kharkov Astronomical Observatory; Moscow, Astronomicheskiy Zhurnal, Vol 37, No 2, Mar-Apr 1960, pages 301-305)

Radio Telescope at Lebedev Institute Used in Studies of Venus

The results of observations of the radio emission of Venus on the 8 mm wave are given in an article in Astronomicheskiy Zhurnal, by A. D. Kuz'min and A. Ye. Salomonovich of the Physics Institute imeni P.N. Lebedev, Academy of Sciences USSR.

The 22-meter radio telescope of the Lebedev Institute was used for the studies which were conducted in September-October 1959. The brightness temperature averaged, over the whole disk, was 315° $\pm$ 70° Kelvin, 17 days after inferior conjunction. An increase in brightness temperature with increasing distance from inferior conjunction was detected. The authors make some observations about physical conditions on the planet. ("Radio Emission of Venus on 8 mm," by A. D. Kuz'min and A. Ye. Salomonovich; Moscow, Astronomicheskiy Zhurnal, Vol 37, No 2, Mar-Apr 1960, pages 297-300)

Studies on Cosmic Rays and the Earth's Corpuscular Radiation With Rockets and Satellites

An article describing studies conducted during the flights of the Soviet artificial earth satellites and the cosmic rockets written by S. N. Vernov and A. Ye. Chudakov, Lenin Prize winners for work in this field, appears in the Soviet scientific periodical, Uspekhi Fizicheskikh Nauk, Vol 70, No 4, 1960.

The most interesting result of the measurements with satellites and cosmic rockets conducted in both the USSR and the USA has been the discovery near the Earth of a new radiation, consisting of charged

particles held in a trap created by the Earth's magnetic field. The intensity of this radiation is so great that it can cause demagnetization of the Earth's magnetic field. The new radiation consists of particles circulating around the Earth. It arose only as a result of the presence of the magnetic field. It is for this reason that Vernov and Chudakov have considered it reasonable to call this radiation, terrestrial corpuscular radiation (ZKI).

The article describes in detail, (1) the apparatus used in the radiation measurements; (2) the outer zone of terrestrial corpuscular radiation (ZKI), its location relative to the Earth; (3) the inner zone of high intensity ZKI, its location relative to the Earth, the nature and energy of the particles in the inner zone, and the stability of the intensity in the inner zone; (4) radiation outside the Earth's magnetic field; and (5) an analysis of the obtained data and possible hypotheses on the origin of ZKI.

The article contains 16 figures showing the following: (1) A block diagram of the scintillation counter, (2) A block diagram of the gas-discharge counter and the principal circuit of the typical electronic components, (3) a diagram showing an example of increased intensity in high latitudes encountered by Sputnik II, (4) diagrams of typical recordings of readings of Sputnik III's scintillation counter in high latitudes of the northern hemisphere, (5) a chart indicating the entry and exit of Sputnik III from the outer zone in the low latitudes of the northern hemisphere, (6) a chart showing the entry and exit of Sputnik III from the outer zone in the high latitudes of the southern hemisphere, (7) a diagram showing the trajectory of the first and second cosmic rockets in geomagnetic coordinates, (8) a diagram showing the relationship of intensity to the altitude of the flight of the first cosmic rocket, (9) diagrams showing the magnitude of the ionizing effect in the outer zone in the northern hemisphere and the universal magnetic index for the same time, (10) diagrams showing typical recordings made in the region of South America by Sputnik III, (11) relationship of the intensity of the phosphorescence of the sodium iodide crystal to the time after exposure, (12) a diagram showing the intensity of phosphorescence and the count rate to the orbit location of Sputnik III relative to geographic coordinates, (13) a drawing showing the probable outline of the lower limits of the inner zone in the plane of the geomagnetic equator, (14) diagrams showing examples of recordings made on the entry of Sputnik III into the inner zone while moving from north to south, (15) diagrams of recordings indicating the exit of Sputnik III from the outer zone and the approach to the inner zone in the northern hemisphere, (16) a schematic representation of the motion of a charged particle along a force line of the Earth's magnetic field, (17) a diagram used for the calculation of the number of charged particles formed in one second in a tube with a one cm^2 cross section at the equator, and (18) a diagram used in the calculation of the injection of particles at a point on a given line of force.

The authors present these conclusions: (1) Two separate zones of high intensity radiation exist around the Earth, (2) The outer zone, in the equatorial plane, begins about 20,000 km from the center of the Earth and extends outward up to 60,000 km. The force lines of the geomagnetic field are the limits of the zone. At low altitudes (300-1,500 km) the outer zone is observed within the geomagnetic latitudes of 55-70 degrees. As the distance from the Earth along the force lines increases a sharp increase in the intensity of radiation is noted. This is experimental proof of the existence of a magnetic trap around the Earth for the particles. A maximum of radiation during the flight of the first cosmic rocket on 2 January 1959 was located at a distance of 26,000 km from the center of the Earth on a force line intersecting the Earth's surface at a latitude of 63 degrees. During the flight of the second cosmic rocket on 12 September 1959 the maximum was located at a distance of 17,000 km on a force line at a latitude of 59 degrees. (3) Particles in the inner zone are electrons distinguishable into two groups, the first consists of electrons with energies of several tens of kiloelectron volts. The flux of electrons with energies of more than 20 kev at maximum consists of 10^9 cm^2 sec^1 $sterad^1$. The second group consists of electrons with energies of about 10^6 electron volts. The flow of such electrons at maximum consists of 10^5 cm^2 sec^1 $sterad^1$. (4) The inner zone in the equatorial plane begins at an altitude of 600 km in the western hemisphere and extends outward to a distance of about one earth radius. The boundary of the internal zone is the force line emerging from the Earth at the geomagnetic latitude of 35 degrees. The intensity of radiation in the inner zone held constant for a month, with at least an accuracy of 15%. (5) Particles entering into the composition of the inner zone are protons with an energy of about 10^8 electron volts. The flow consists of 10^2 protons/cm^2/sec^1/$sterad^1$. At the edge of the inner zone, within the geomagnetic latitudes 35-40 degrees, low energy radiation (less than 10^6 ev) was observed which obviously consisted of electrons. This energy can be found also over the entire inner zone. (6) Between the two zones, within the geomagnetic latitudes 40-45 degrees, a region was observed where increased intensity of radiation is practically absent. On the basis of the accuracy of the measurements made it is possible to confirm that the flow of electrons with energies greater than 100 kev in this region at altitudes of 300-700 km is less than 10^{-3} from this same flow in the outer zone. The flow of electrons with an energy greater than 10^8 ev is less than 10^{-3} from this same flow in the inner zone. (7) Outside the Earth's magnetic field the radiation consists of protons and other nuclei. The total flow consists of 2 particles/cm^2/sec^1. The average ionizing capacity of charged high energy particles is 2.5 times greater than the minimum. The flow of protons in interplanetary space with an energy of hv 450 kev is less than 0.1 phot/cm^{-2}/sec^{-1}, and with an energy of hv 45 kev is less than 3 phot/cm^{-2}/sec^{-1}. Thus, hard electromagnetic radiation does not play an essential role in cosmic

space. During the flight of the first and second cosmic rockets, no variations of the above-indicated radiation component exceeding several percent during a period of time averaging 10-20 minutes was detected. (8) Comparison of the experimental data with theoretical deliberations shows that the high energy protons in the inner zone can originate at the expense of the decay of neutrons, being emitted by the Earth's atmosphere. The intensity of radiation in the center of the inner zone at low altitudes is due to ionization losses of protons in the upper atmosphere. In the geomagnetic latitudes higher than 30 degrees and correspondingly at higher altitudes in the plane of the equator the intensity begins to fall sharply because of imperfections of the magnetic trap in these latitudes. This imperfection of the magnetic trap appears to be almost identical for high energy particles and low energy particles (see number 5 above). Therefore, it is unlikely that the imperfection of the magnetic trap was connected with the loss of magnetic moment of the particle. ("Investigation of Cosmic Rays and Terrestrial Corpuscular Radiation During the Flights of Rockets and Satellites," by S. N. Vernov and A. Ye. Chudakov; Moscow, Uspekhi Fizicheskikh Nauk, Vol 70, No 4, 1960, pages 585-619)

First Rumanian Radio Telescope

According to a brief news item in source, the construction of the first Rumanian radio telescope has begun at the astronomical observatory at Iasi. The telescope, which is the work of a group of physicists, composed of Victor Nadolschi, the director of the Observatory and a member of the International Astronomical Union, Virgil Antonescu, a lector, and Dumitru Sandu, assistant, will have a parabolic antenna with a diameter of 6 meters, and is said to be "extremely sensitive."

The first studies attempted using the radio telescope were reported very successful, succeeding in receiving solar emissions. ("First Radio Telescope Made in the Country," (unsigned news dispatch) Rominia Libera, Bucharest, 7 April 1960, page 1)

IV. METEOROLOGY

First Automatic Meteorological Station in Rumania

The first automatic meteorological station in Rumania is reported to be working very well. Every three hours, the installation in Afumati transmits the temperature, pressure, and humidity of the air, as well as the direction and speed of the wind. This station is said to be different from similar stations in the country, but the article does not explain its uniqueness. The operation of this automatic station increases the possibility of setting up similar operations in isolated parts in the world, on the sea and

in very inaccessible areas. This will permit the obtaining of supplementary meteorological information for weather forecasting and navigation. ("Automatic Meteorological Station is Working Well"; Munca, Bucharest, 1 April 1960, page 1)

V. SEISMOLOGY

Report on the Seismicity of the Eastern Carpathians

The following is a translation of the Russian summary of a Ukrainian language article appearing in the Geologichniy Zhurnal of the Academy of Sciences of the Ukrainian SSR.

The precise determination of the sites of the foci of earthquakes is of primary importance in the study of the seismicity of an area. This is not an easy matter. Various authors use different methods to indicate the coordinates of the epicenters of earthquakes of macroseismic origin; these occur with exceptional frequency in the case of deep earthquakes and where the geological structure is complex and in cases where the zone of maximum destruction does not coincide with the epicentral zone. The seismic maps of Montesse de Ballor, Martonne, and others have lost their value to a considerable extent. Even instrumental data do not always insure a precise determination of the coordinates.

We have delimited two regions of seismic activity -- the Vrancha mountains (in Rumania) and the Trans-Carpathians. The first region is the area of deepest (up to 170 km) and most intense earthquakes in Europe. In the vicinity of the Trans-Carpathians almost all earthquake data relate to the category of macroseismic shocks; this forces us to deal with them with a certain amount of caution.

The recurrence of earthquakes is the second index of the seismicity of a region. The most promising research is an investigation of earthquakes from the point of view of the energy balance.

This article studies the earthquakes of the Vrancha region that exceed an intensity of 8. The catalogue of earthquakes was proposed by Popescu; it excludes the earthquake of 22 November 1940 (intensity less than 8) but includes those of 1868, 1880 and 1912. The majority of the earthquakes have an intensity of between 8 and 9 -- an average of 8-1/2. The magnitude of the energy liberated was accordingly assumed as a conventional unit. Five earthquakes are less intense, averaging between 8 and 8-1/2 -- a mean of 8-1/4, consequently each of them is equal to 0.5 conventional units. Plotted on the horizontal axis of the graph (Figure 2) are the dates of the earthquakes, while the total energy liberated is plotted on the vertical axis. The corresponding equation has the form (1), on the basis of which it may be assumed that a destructive earthquake (intensity of 8-1/2) may be expected about 1970. If a

less intense earthquake takes its place in the sequence (with an intensity of 8-1/4), then such an earthquake can occur in 1959. The error in the indicated figures is ±7 years. All these conclusions are approximate, as a result of the inaccuracy in the values for the energy of the earthquakes.

Maps of seismic regionalization are of substantial importance for describing a region. Such a map, compiled by a group of workers at the Geophysical Institute, has many inadequacies. Therefore in the latest version of the scheme of seismic regionalization of the Carpathians area (Figure 3), compiled by the Institute of Physics of the Earth, changes were introduced as a result of our critical remarks, since in 1954 we had already pointed out the undervaluation of the Trans-Carpathian area. It seems to us that the boundary of the zone with an intensity of 5 should coincide with the northeastern end of the Ukrainian crystalline shield.

The maximum seismic activity is observed at the site of the sharp turn in the Carpathians. It may be assumed that deep processes, arising at a depth of 150 to 200 km from the surface, are so strong that they have caused a sharp turn westward in the Carpathian Range and caused a series of tectonic breaks, faults and thrusts which in turn caused the manifestation of seismic phenomena which continue up to the present time. The Vrancha region is the node where three large tectonic faults meet.

In the Trans-Carpathians, the second active region, a group of epicenters that is important in number and intensity is evidently related to the zone of development of extrusive rocks and is associated with lines of young faults. Unfortunately, the depth of these earthquakes remains unclear as do the precise coordinates.

The table gives the results of determination of the thickness of the Earth's crust in the Carpathians region as derived by different authors; from this table it is possible to see an increase in the thickness of the Earth's crust in regions close to the mountains.

("Some Remarks on the Seismicity of the Eastern Carpathians," by S. V. Yevseyev, Geologichniy Zhurnal, Akademiya Nauk Ukrayns'koy RSR, Vol XX, Issue 2, pages 40-50)

Soviet Seismic Stations Observe Chilean Shocks

Soviet newspapers reporting on the disastrous earthquakes which recently occurred in Chile give some information on the detection of the shocks by USSR seismic stations. It is summed up as follows.

The first signal of the disaster was recorded at 1319:02 hours Moscow time in Moscow on 21 May by associates of the Central Seismic Station of the Academy of Sciences USSR "Moskva."

Within a short while from the seismic stations on Heiss Island, Alma-Ata, Simferopol', Pulkovo, Irkutsk, Yuzhno-Sakhalinsk, and others, came confirmation of a strong earthquake somewhere. When the data was processed the earthquake was plotted near the Chilean city of Conception.

The scale force of the earthquake as reported by the instruments was 10. Following this 15 more shocks were recorded by the Central Seismic Station.

On the following day, 22 May, at 1349:53 hours a new, strong shock was recorded. Finally, at 2229:53 hours the strongest shock was recorded.

The earthquake caused tsunami which also reached Soviet shores in the far east. Five meter waves hit the islands of Paramushir and Shamshu. No loss of life was incurred as the inhabitants had withdrawn deep into the interior because of an early tsunami warning which was given in plenty of time by coastal seismic stations. Damage was limited to only moorings and other coastal objects of the fishing combines.

Continued observations at the Central Seismic Station resulted in the detection of a new shock of medium force at 1153:53 hours on 25 May. This shock was the most dreadful experienced in Chile. The destruction on the surface of the Earth corresponded to that of a scale 12 earthquake. The reason given for the difference in force recorded in Moscow and that at the epicenter is that the shock occurred close to the surface of the Earth and only an insignificant zone of its energy was converted into oscillation of the deep layers of the Earth which reached Moscow. ("Earthquakes in Chile"; Moscow, Izvestiya, 28 May 1960, page 4)

Albanian Earthquake Leaves 8 Dead, Many Injured

An earthquake with a scale intensity of 8 occurred in southeastern Albania near the city of Korce on 26 May. Eight persons were reported dead and 100 injured. In the city of Korce, which numbers some 35,000 inhabitants, 20 percent of the buildings were destroyed.

This account appeared in an Izvestiya story reporting the Chilean disaster. ("Earthquakes in Chile"; Moscow, Izvestiya, 28 May 1960, page 4)

VI. OCEANOGRAPHY

A Report From the Bottom of the Sea

The heavy two-motor plane was gliding smoothly above the seacoast. From an altitude of several thousand meters the surface of the land resembles a geographic map. Left behind were Astrakhan' and Gur'yev. Nestled in the rocks below are the stone buildings of the Shevchenko fortress, the old exile place of the freedom-loving Ukrainian bard.

Several years ago I had occasion to investigate this part of the coast. After long trips in the hot rock desert our contingent would stop for a short rest in the shade of the trees that had been planted by the great Taras (Shevchenko) himself. There, too, under the trees is a round stone table which had seen the rustling leaves of his manuscripts, and the glowing water colors...

My thoughts are interrupted by a sudden jolt. The plane made a sharp bank toward right. I look at the navigator's map: the bright red line of our route intersects the Caspian Sea, and ends near its western coast in Baku.

The geological explorations near the coast of the Apsheron peninsular carried out by the Caspian expedition of the aerial observations laboratory of the USSR Academy of Sciences began about 10 years ago. A body of geologists, working under the supervision of Vitaliy Vasil-yevitch Sharkov, candidate of geographical sciences, compiled a geological map of the shallow sections of the sea bottom which had been photographed from the plane. Detailed maps of the Zhiloy and Naftovy Kameni islands as well as the shallow sections of Apsheron, Darwin, etc., were compiled on the basis of aerial photographs.

In these years the sea around the Apsheron coast has changed beyond recognition. The steel structures of a sea oil industry have now risen where the water surface once appeared endless as far as the eye could see. A whole city -- Naftovi Kameni, the pride of industrial Azerbaidzhan -- grew up on the sea! One hundred and twenty kilometers of streets laid out on piles above the water surface, hundreds of derricks and thousands of workers: drillers, seamen, tractor operators and truck drivers. But we, the marine explorers, were primarily interested in the nature of the Caspian Sea bottom, its geological structure and the available oil deposits.

The sea was very calm as its mirror-like surface was cut by the cutter's bow. Several expedition scientists were leaning over a small table on the deck. Spread out on the table were aerial photographs of the sea bottom. It looked like a patched quilt: patches of every possible shade of color are combined into fantastic designs. But this is only a "mute" map. What the scientists want is to study it in its natural form by going down to the bottom of the sea and investigating the soil, vegetation and topographic formation represented by each particular design.

The ship lowers its anchor. The first to set out on his underwater trip is K. Petrov, the expedition's hydrobiologist. In addition to his fins, mask and aqualung, he takes along a camera for underwater photography. A thin nylon (Ukr. word: kapronovyy) cord connects the diver with those aboard ship.

A few sharp jerks on the cord. In the language of the divers it means "I am on the bottom, feeling well."

While watching for these unique reports from the bottom, we of the expedition who had frequently gone down there, are accompanying the divers in our imagination on their trip in the silent world. Where the cliffs descend abruptly into the water, the incoming waves can be seen stirring the bright-green sea plants underneath. Those are the enteromorph which appear to draw a line between the sea and dry land. Other sea plants, thread-like in shape and brownish-green

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in color, are found much deeper in the water. It is among them that the diver is now making his way. His direction is indicated by the bubbles of his exhaled air coming to the surface.

But suddenly the rock bottom comes to an end and an underwater plain begins. As far as the eye can see the bottom is crisscrossed with bars of mullusk shells.

How did these bars originate? Their formation is associated with the continuous influence of the sea waves. What actually happens is that the waves pick up the "drifting" clusters of mullusk shells depositing them in the shoals near the coast and "building up" entire bars.

The underwater pathfinder continues to look around. What a wealth of interesting things and surprises he is apt to come across! The sloping bottom suddenly comes to an abrupt end. It is the side of a terrace, the remnant of the Caspian coast line that was submerged in ancient times. The place where the diver is now standing was dry land several centuries ago, and the sea lever was considerably lower; the waves were then raging at the foot of the precipice. Petrov examines a handful of shells picked up from the bottom. Among the light moilusk shells are a few dark (mityliaster) shells, the youngest inhabitants of the Caspian Sea. Brought over from the Black Sea about 30 years ago, they quickly adapted themselves to local conditions.

(Photo caption: Expedition hydrologist A. Babkov observing underwater currents)

The study of the wave processes and currents is the duty of another member of the expedition, A. Babkov. And while Petrov is busy photographing, the figure of another diver appears in the greenish twilight. Babkov lands on the bottom with his simple apparatus for investigating the bottom currents.

From there on the divers move together. They are kept for long periods of time among the bottom sea weeds. Phlegmatic looking gray fish swim leisurely by, and many large shrimp keep stirring on the bottom. But as soon as you approach them the shrimp take a defensive position by facing the diver and threateningly extending their claws. But there are still more unpleasant encounters. When the ship approaches any of the numerous rock islands, the thin bodies of sea snakes can be seen darting about in the water. They are not harmful but as you suddenly come across them you unwillingly shrink back. There are particularly many snakes on the islands where they are coiled up in every crack of the rocky surface.

Starting for the bottom is the chief of the geological section, Z. Gur'yeva. In her hand is a surveying compass set in crystal glass. Selecting a place near the edge of an underwater cliff, this woman-explorer measures the incline of the rock layers which produce a fold there, and takes samples. The underwater observations will help her elaborate the previous geological maps of the shallow areas and draw the necessary conclusions about the possible oil deposits there.

One of the most interesting characteristics of the southern part of the Caspian Sea are the mud-volcanoes whose existence is associated with the presence of gas and oil in the ground. They do not erupt very often but they don't take a second place to the lava-erupting volcanoes in regard to size.

I witnessed such an eruption from the deck of the expedition ship recently when a fountain of mud and boulder shot up from the depth to a height of a four-story building. A whole island grew up on the water before my eyes; we inspected this "newborn" land in the period between two eruptions and measured it: it had a diameter of close to 100 meters.

Our ship lowers its anchor near the island of Los' which came into being as a result of several eruptions. We reached the island by a small boat and climbed up to its steep edge. A fantastic picture opened before our eyes: its bare surface resembled the lunar landscape. Tiny cones of mud volcanoes, salses, could be seen here and there. Sometimes they hardly project above the terrain, and only after a walk of about several dozen meters on the muddy ground is it possible to find a round, water-filled crater with swirling gas streams shooting up through it. Some of the mud volcanoes are very steep and it is not easy to get to the craters. Every now and then they erupt streams of mud which cascade down to the foot of the volcano. When fire is applied to the crater of a small mud volcano, it kindles up with a bluish flame. This is what used to attract the fire worshippers of the past who built their temples near the natural gas outcrops.

Our task is to investigate the group of underwater mud volcanoes scattered on the sea bottom near the island. Their underwater cones at a depth of over 10 meters can easily be recognized on the photographs recently taken from the expedition's plane.

Sharkov and Petrov are lowered to the bottom. The picture confronting them in the semi-dark underwater kingdom is a surface covered with fragments of sandstone and shale. Here and there jets of gas escape from under the stones with a slight swirl. No fish nor sea plants can be seen around.

Suddenly the pressure in the ears increases which means increasing depth. The divers are down in the volcano crater itself. There is much to be done here: rock samples must be taken, the appearance of the crater memorized and measurements made. Only half an hour later do the divers return to shipboard. Removing their heavy aqualungs, they immediately pick up their log books: everything has to be recorded. And the implication of these observations is remarkable: wherever there are mud volcanoes, there is oil.

(Photo caption: shell bars on the Caspian Sea bottom)

("A Report from the Bottom of the Sea," by B. Koshechkin; Znaniya Ta Pratsya, No 5, 1960; pages 23-24)

VII. ARCTIC AND ANTARCTIC

May Day Celebrated at Main Soviet Antarctic Base

Mirnyy, 3 May (by radio). The lights of a holiday celebration have sparkled for several days at Mirnyy. May Day in Antarctica coincided with the beginning of a severe winter. There is a fierce blizzard and raging winds. The ocean is covered with ice. The giant icebergs rise up like islands.

Winter did not take us by surprise. The expedition's work is continuing. A sledge-tractor train has recently returned to Mirnyy. The train covered about 2,000 km under difficult conditions, with frosts as great as 67 degrees.

A group of geodesists is now working on the ice dome. Along a 50-km traverse they are studying the displacement of the ice cover of the Antarctic continent. Very soon a plane will drop three meteorological stations five hundred kilometers from Mirnyy. One of them will be established on a giant iceberg about 70 km long. ("May Day in Antarctica," by V. Venediktov [Chief Engineer of the Fifth Antarctic Expedition], Leningradskaya Pravda, 4 May 1960, page 4)

Temporary Meteorological Stations Established in Antarctica -- A "Pravda" Report

Winter has come to Antarctica. At the South Geomagnetic Pole, where the Soviet scientific station Vostok is now in operation for its third year, the polar night is in full sway. The men who are passing the winter here recently recorded a frost of 79.7 degrees. Such a low temperature was observed at the Vostok station for the first time at this season of the year.

The twelve Soviet researchers, headed by the experienced polar specialist Vasiliy Sidorov, have done everything necessary for life and work in this severe region of Antarctica. In March planes from Mirnyy delivered food, fuel and miscellaneous supplies and equipment to Vostok. Now aircraft will not appear at the station until the end of the polar night.

The Soviet scientists on the sixth continent have planned an extensive program of detailed study of the circulation of the atmosphere for this year. For this reason a number of temporary meteorological stations has been established in both coastal and interior regions.

At the end of April the first transportable meteorological station "Druzhba" was inaugurated on the western shelf ice. It was set up on the Zavadovskiy ice dome, 300 km from Mirnyy. The meteorogist A. Dergach, the radioman B. Kazadayev and the Czechoslovakian scientist-aerologist O. Kostka have already been making scientific observations at this station for more than three weeks.

A few days ago our polar specialists set up a second transportable meteorological station "Pobeda" on an immense iceberg situated in the southern part of the Indian Ocean, approximately 320

km to the northeast of Mirnyy. The equipment was delivered here aboard two transport planes which were piloted by the polar airmen Aleksandr Pimenov and Anatoliy Barabanov.

The colossal iceberg on which the meteorological station has now been established was discovered in 1957 by Soviet explorers at the time of an aerial ice reconnaissance. Continuing observations of this ice giant showed that it is evidently sitting on a shoal. It is several thousand square kilometers in area. Four Soviet polar specialists are working at the station "Pobeda" -- the meteorologist B. Deryugin, the aerologist M. Kalikhman, the astronomer V. Mal'tsev and the radioman V. Skripko.

Meteorological, actinometric and aerological observations are being made and radiosondes are being sent aloft at these transportable stations. The results of observations are transmitted by radio to Mirnyy, are incorporated into general synoptic summaries, and disseminated throughout the world.

The third transportable scientific station was inaugurated on 20 May on Drigal'skiy Island; this island is situated in the Davis Sea at a distance of about 90 km to the north of Mirnyy. The personnel and the equipment for the station were delivered to the site by planes which were piloted by the airmen A. Pimenov and Yu. Zotov. Three polar specialists remained to work at the transportable station -- the aerologist A. Smirnov, the radioman A. Kutusov and the meteorologist G. Skayb [Russian transliteration] of the German Democratic Republic. ("Everyday Life in Antarctica," unsigned article, Pravda, 27 May 1960, page 6)

Nauka i Zhyttya, No 5, 1960

Under the Banners of Many Countries

...Autumn 1956. In the gothic hall of the Barcelona municipal building, where Columbus once reported on his famous project that led to the discovery of America, members of the national committees of the International Geophysical Year gathered to discuss their preparedness for common observations.

World famous scientists mount the speaker's rostrum one after the other. They discuss the plans to be carried out during the IGY by the countries they represent. Academician Ivan Pavlovitch Bardin, head of the Soviet IGY committee, reports that the Soviet Union intends to launch artificial earth satellites during the IGY in connection with the program of geophysical observations. There is a tense silence in the hall. Some faces betray amazement. At that time, however, not all of them believed in the possibility of such a plan being realized. In 1956, man's invasion of space was still considered a matter of the remote future...

Four years have passed since then. The spectacular successes of Soviet science and technology made it possible to launch 3 satellites and 3 space missiles, thereby initiating the era of conquest of

interplanetary space by man. The achievements in this field represent the most outstanding contribution to world science made by the Soviet people during the common geophysical investigations in the following years. Besides, a number of important observations facilitated the solution of certain mysteries of our planet.

The depth of the World ocean, the permanent icy vastness of the mysterious sixth continent, the highest mountain peaks and endless deserts — all these still inadequately explored areas of the earth were subjected to a many-sided investigation. And how many important and interesting discoveries have already been made in the field of glaciology* (*Glaciology is an independent branch of physical geography dealing with the nature of ice and its role as aphysico-geographical factor) and meteorology, oceanology, astronomy and geodesy! Basic new information was obtained about the earth's magnetic field, the characteristics of the ionosphere and northern lights, cosmic rays and the processes taking place on the sun. Thus it can be said without exaggeration that the IGY represents a sort of qualitative leap into the sphere of geophysical investigation, and a new stage in the study of the earth.

Now that the year of great geophysical investigations, which actually lasted two and a half calendar years, has come to an end, the processing of the voluminous factual materials collected by the scientists has begun. It will take several more years to complete this job. The following example provides an idea of the scope of this work. All the entries on earth currents made by the Soviet stations alone, which must be read and analyzed, amount to almost 1,600 kilometers of written lines!

As a result of these complex observations, many previously held conceptions have been abandoned. New vistas have been revealed by the investigations in every field of geophysics. Various fields of certain sciences were drawn closer together. All this augurs well for a turbulent development of world scientific thought as a whole.

The history of international cooperation has been enriched by the brilliant example of the continuing unified effort on the part of 66 countries of the world directed toward the many-sided investigation of our planet. These countries differ from one another by their political and social systems, and their scientists are of different political persuasions, world outlook and nationalities. But they are all united by the common and noble aim of improving in every way the living conditions of the people on earth. Characteristic in this connection is the statement made by the noted Indian scientist K. R. Ramanatanax at the Assembly of the International Geophysical and Geodetic Society in Toronto. He said: "The IGY is the most graphic example of international scientific cooperation in that it has drawn together the working people of many nations with different ideologies existing at different levels of scientific development."

THE "EARTH-SUN" PROBLEM

As is known, the International Geophysical Year was dedicated primarily to the current study of solar activity. It should be said that this time the investigators were fortunate: in 1957-1959 the sun revealed its greatest activity in the past 200 years. The continuous observations carried out under a single program simultaneously at different points of the globe with the aid of the latest apparatuses made it possible not only to considerably broaden our conceptions of the Sun but in some respects also change them.

Summarizing the investigations in this field, we must dwell first of all on the two zones of charged electrons and protons surrounding our planet as was established by the Soviet and American scientists. These observations are highly valuable since heretofore we did not suspect the existence of such zones. They are of particular importance for the future astronauts as they will help them plan the course of their flights.

(Photo caption: the radiotelescopes used in the observations of solar radiation)

We now know that the inner zone containing considerably more energy than the external zone begins at 35° - 40° latitude in both hemispheres. It originates at an altitude of almost 1,000 kilometers but its particles reach a maximum intensity at about 2,000-3,000 kilometers above the earth's surface.

The other, the external zone, is located far from the earth's surface, over the equator, descending to an altitude of several hundred kilometers at 59°-65° latitude. In this part of the earth polar lights are observable more often than in any other. The major mass of charged particles of the other zone is found at a distance of 20,000-25,000 kilometers above the earth's surface (near the equator). It is interesting to note that the outer belt of this zone is not permanent and can undergo considerable changes, for example from 60,000 to 90,000 kilometers. Obviously, the "matter" filling the outer zone consists of corpuscular streams (streams of charged particles) radiated by the Sun. The Soviet scientists have found that the electric streams flowing in the densest part of the outer zone are responsible for the changes in the magnetic fields at those altitudes.

The investigations made with the aid of rockets and sputniks have also revealed the mysteries of the ionosphere. It was found that above 300 kilometers the density of electrons in the ionosphere diminishes considerably slower than had been thought before. The calculations made with the aid of the sputniks, for example, established that the electron density at an altitude of 3,000 kilometers should be 200-300 per one cubic centimeter. These data on the physical properties of the upper atmosphere are very important: they will, in particular, make reliable radio communication between the future astronauts possible.

Similar new conceptions about the upper layers of the atmosphere compelled us to take a different look at the existing theories on polar lights and ionospheric and magnetic storms. Thus the author of the most popular theory on magnetic storms, the noted English scientist Chapman, is now advancing a new idea according to which the Earth remains within the Sun's atmosphere. He believes that the density of charged particles in the interplanetary space is considerably greater than has been presumed before, and that the temperature constantly rises from about 1,200° at an altitude of 200-300 kilometers to a million degrees, on the Kelvin scale, in the solar corona.

Measurements made on land and by rockets made it possible to establish a so-called current circle, known as the "electric stream," at an altitude of 140 kilometers above the equator area. Flying through such a belt, the rocket recorded a sharp change in the magnetic field which is indicative of the presence of an electric current. The electric currents flowing in a narrow belt of about 500 kilometers bring about the peculiar changes in the magnetic field observable on the earth's surface in the area of the magnetic equator.

(Photo caption: V. S. Kamenev, permanent USSR representative at UNESCO, and V. A. Troits'ka at the international "Earth-Planet" exhibition in Paris, standing before a model of the American artificial earth satellite)

The observations of the various processes on the Sun have resulted in a great deal of new information for the astronomers. Detailed information has been obtained for the first time on the magnetic fields in the active areas of the Sun and the origin of chromospheric flashes.

It is known that severe ionospheric storms, magnetic storms and changes in the intensity of cosmic radiation, etc.,occur about a day after the appearance of spots on the Sun's central meridian. How can these "unsafe" spots which produce such important phenomena for the Earth be differentiated from the "safe" ones. Investigations have produced information to the effect that the corpuscular streams apparently originate from the sun spots which produce an intense radiation at 1-meter wavelength. This is particularly important in connection with radio communication.

(Photo caption: general view of the "North Pole-6" drifting station)

No less interesting are the new facts established during the observations of the magnetic storms. For example, the devices installed in a weather balloon flown to a 30-kilometer altitude showed that the intensity of primary cosmic radiation during magnetic storms can be increased thousands of times. The space in which such intensified

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radiation occurs is very unsafe for future astronauts. A thorough study of this phenomenon is therefore very important.

Finally, another interesting observation. It appears that in some cases the Arctic and Antarctic polar lights originate simultaneously. A definite relationship pattern has been established between the polar lights and the fluctuations of the earth's electromagnetic field which also occur simultaneously in these areas.

WEATHER AND CLIMATE

Meteorological observations were made by tens of thousands of stations during the IGY. The air temperature, humidity, pressure and force of wind were measured several times a day from the Antarctic "cold storage," which spreads its cold throughout the atmosphere, to the Arctic. The investigations carried out with the aid of weather balloons made it possible to raise the "ceiling" of aerological observations. Measurements were taken at altitudes above 30 kilometers by special meteorological rockets.

(Photo caption: The third Soviet Antarctic expedition. A tractor-drawn sled train on the way to the pole in the relatively inaccessible Antarctic)

A comparison of the data obtained simultaneously all over the earth made it possible not only to establish certain definite climatic patterns but also to predict future changes in the climate. Special synoptic maps were compiled on the basis of the observation data. The Soviet scientists were the first to compile them according to the observation data obtained by all the observation stations on the globe. This is what these maps show. The strong western winds blowing in the northern hemisphere during the cold season of the year produce various currents. At an altitude of 30 kilometers these currents travel at a speed of 200-300 kilometers per hour. In May or early in June a so-called summer stratospheric anti-cyclone is formed above the Canadian archipelago. Toward the end of June its center shifts to pole embracing almost the entire northern hemisphere. Eastern winds are observed in the anti-cyclone border zone in northern hemisphere. These are the causes of the sharp changes from cold to warm.

The most interesting observations of various meteorological processes were made in the southern hemisphere, particularly in the Antarctic. This area of the glove has for a long time been a "blank spot" to the explorers. The existence of a belt of constant strong western winds isolating the low and temperate latitudes of the southern hemisphere from the higher ones was hitherto assumed. It is found that this is not so. It has now been established that the inter-latitude changes of the air masses in the southern hemisphere are more intensive than in the northern.

It was also believed that a permanent climatic anti-cyclone existed above the Antarctic. But investigations of the sixth continent showed that cyclones also occur there from time to time. The higher the altitude, the lower the temperature. The lowest temperature recorded in the stratosphere was -93° Centigrade. The absolute minimum temperature records on the Earth, in the area of the "East" and "Soviet" stations, was -87.4° Centigrade. This is the cold pole of our planet.

A study of the relationship pattern between the atmospheres of the northern and southern hemispheres and the measurement of the air masses shifting from one hemisphere to the other are very important for long-range weather predictions. Besides, the new information on the pattern of atmospheric processes taking place at altitudes up to 30-40 kilometers will improve the weather forecasting service for fast and high-flying planes.

(Photo caption: the Diesel-powered ship "Lena" at the Antarctic coast)

Very interesting data have been obtained in the field of physical meteorology. For example, a chemical analysis of atmospheric precipitation revealed that the annual precipitation per hectare in the European part of the USSR includes 3-4 kilograms of nitrogen, 5 kilograms of chlorine, 4-10 kilograms of calcium and 10-20 kilograms of sulfur, etc. Such information is of indubitable interest in agriculture.

It is particularly important to ascertain the contents of ozone in the atmosphere. This gas plays an important part in determining the heat balance of the Earth by engulfing a considerable portion of the solar spectrum. Investigations have established that the ozone content varies with different latitudes. The lowest content is near the equator, and the highest near the poles.

Much attention under the IGY program was devoted to glaciological investigations. Why is it so important to study the ice-covered areas? They are quite sensitive to climatic changes. The layers of snow and ice forming from year to year in this area are a unique chronicle of the climate and its past transformations. That is why the accumulation and losses of snow and ice through the year, as well as the advances and retreats on the glacier front, are the key to the understanding of the climatic patterns of the past and present. As a unique storage place of cold and moisture, the glaciers considerably affect the climate not only of the adjacent areas but of the Earth as a whole. They play an important part in the global humidity circulation and in the circulation of the air and ocean water.

The present ice-formation area is over 15 million square kilometers in size which is close to 10 percent of the entire land area. The moisture contained in the glaciers amounts to about 22 million cubic kilometers while all the surface water of the Earth is estimated

at about 4 million cubic kilometers. It is interesting to point out that if all the available glaciers were melted, the level of the world ocean would rise about 54 meters. This makes it clear why the glaciers affect the water picture of our planet.

Twenty-six countries of the world carried out glaciological investigations during the IGY. The largest volume of work was performed by the USSR and US. It was established in the course of the observations, for example, that the might of many glaciers, including those of the Antarctic, is considerably greater than had been assumed. But the diminishing ice-formation processes observable everywhere indicate that the climate has generally been getting warmer in the past 10-12 years.

The final processing of all the materials will lead to new important conclusions. It is already clear, for example, that the great possibilities of improving navigation and climatic conditions in the Soviet Arctic and north of Canada, by the destruction of the permanent ice cover in the Arctic, are quite realistic. It is even possible that this will not require such complicated engineering installations as a dam across the Bering Strait.

IN THE OCEAN DEPTHS

The world ocean, just like the atmosphere, cannot be divided into isolated areas. Whatever happens in one of its parts will inevitably affect the nature of the processes in the entire body of water of our planet. It is understandable, therefore, that no single country can obtain exhaustive information about the ocean basin without the cooperation of other countries in this field.

Seventy ships and several dozen shore stations carried out oceanographic observations during the IGY. Soviet oceanologists carried out observations in all the oceans. The discovery of new underwater ranges, mountains and valleys were frequently reported in the press. Thus a large mountain range crossing the Arctic basin was discovered in the Arctic and named after Lomonosov. The depths of the Pacific were explored again, especially the well-known Marianna Depression, etc. The greatest depth of the ocean was found to be over 11 kilometers. An investigation of underwater currents revealed that they flow 10-20 times faster than had been assumed before. Only a few years ago it was thought that the deepest parts of the ocean were devoid of any life. Actually, this is not so. During the explorations of the research ship VITYAZ' of the Academy of Sciences USSR new species of life and plants were found at a depth of 6-8 kilometers.

A close study of the relationship between the physical, chemical, biological and geological processes occurring at various latitudes between the Arctic and Antarctic made it possible to establish a geographic zonality of the world ocean and find new whaling and fishing grounds. In the opinion of the Soviet oceanologists, the biological, chemical, mineral and power resources of the oceans are practically unlimited.

Much new information has been obtained on the nature of the tides, the distribution of seismically active areas in both polar zones and the structure of the Earth's magnetic fields in the oceans. It was found, for example, that earthquakes frequently occur in the area of the Lomonosov mountain range. About 130 of them were recorded in 1958 alone. The Antarctic region, on the other hand, is relatively quiet from a seismic point of view.

Areas with different structures of the earth's crust -- oceanic, continental and intermediary -- were discovered in the Pacific Ocean and Asia. This information is very important for the establishment of oil deposits in certain areas and reserves of underground hot water as well as the earthquake danger to construction in the Kurile-Kamchatka zone.

Unique information on the structural characteristics of the Earth's crust and core has been obtained through the use of space rockets. It has been ascertained, for example, that the source of the earth's magnetic anomaly, like that of East Siberia, is distributed not in the Earth's crust but apparently in its core. This conclusion is based on an analysis showing that the size of the magnetic nucleus diminishes with the increasing height above the mentioned anomaly deposits. The fact that the moon has no magnetic field is confirmed by the assumption that the Earth's permanent magnetic field is conditioned by movements within the fluid core of the earth.

A study of the high tides on the earth shows that they have an effect on the slowness of its eternal rotation. Valuable information was obtained by the observatories all over the world by their accurate observations of the latitudes and longitudes. These materials make it possible to establish the causes and patterns of the fluctuations of the Earth's poles and the inconstant speed of its rotation.

The international geophysical investigations are over. The rich materials amassed by this common effort are now being studied by scientists of all countries. The common efforts of different countries in the exploration of various areas of the globe are continuing. Complex geophysical observations, for example, are still carried out in the Antarctic.

A survey of the earth's magnetism with a view to determining the magnetic field structure is expected to be made in all the continents and oceans within the next few years. Dozens of countries will participate in this great international undertaking. Oceanographic observations in the Indian Ocean will be carried out by a joint effort. Finally, there is a great future in the investigation of cosmic space, and the success of this effort will be determined by the general progress of science.

Participating in the recently created International committee on geophysics are four of the largest organizations: the International Geophysical and Geographic Union, the Geographic and Astronomical unions and the International union of pure and applied physics. One of the

major tasks of this Committee is the publication of the results achieved in the scientific observations during the IGY and their practical application.

Many interesting scientific investigations and discoveries still lie ahead. The guarantee of their success lies in the aspiration of the scientists of all countries to place the human mind in the service of the cause of peace and progress. ("Under the Banners of Many Countries," by V. A. Troits'ka, Nauka i Zhytta, No 5, 1960; pages 21-25)

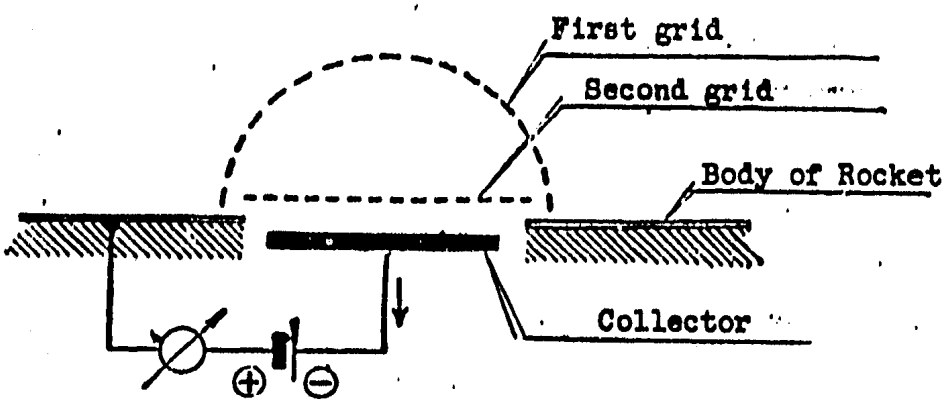

Figure 1. Diagram of charged particle traps

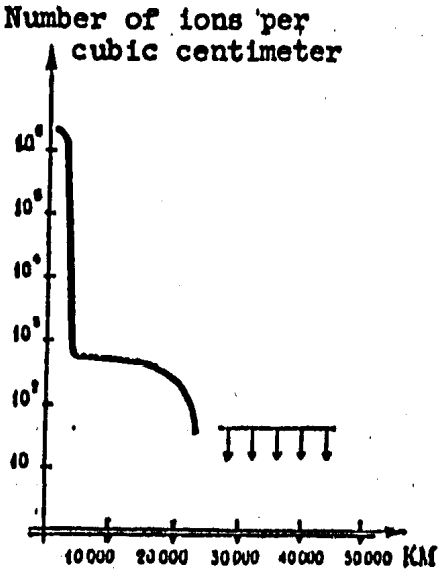

Figure 2. Graph showing the ratio of ion concentration to distance (Computed from the surface of the earth)