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INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM--SOVIET-BLOC ACTIVITIES

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Results of Sputnik-III Study of Electron Concentration Reported

The satellite study of electron concentration in the upper atmosphere is described in the July issue of a Soviet journal. A translation of the article follows.

The direct observation of electrons of medium hardness in the upper atmosphere was made in an experiment conducted on the third Soviet artificial satellite, launched 15 May 1958. The somewhat harder component was studied later by other investigators. Analogous experiments were made of rockets in the region of the auroras.

A feature of the experiment described here is that only electrons with energies of the order of 10 kiloelectron volts were recorded. The indicators used did not react to the X-radiation produced by these electrons in the atmosphere and in the satellite itself. Thin fluorescing screens (ZnS, activated by Ag) were used which contained two milligrams of the substance per square centimeter. Thes• screens completely absorbed the electrons noted above, and only a very inconsiderably portion of the X-radiation passing through them. Protons with energies of several tens of kiloelectron-volts did not act on these indicators since aluminum foils (0.4 and 0.8 milligrams per square centimeter) were placed in front of the screens. If the X-rays had also been recorded, the data obtained would have distorted the information concerning the distribution of corpuscle-electrons with latitude and altitude. The upper atmosphere of the Earth, particularly in the zone of maximum recurrence of auroras, is transformed into a source of X-rays under the action of electrons with the energies mentioned above. About half of this radiation passes directly into outer space. The equipment on a high altitude rocket or a satellite will therefore be subjected not only to the X-rays which are produced in their shells but also to the radiation of the whole upper atmosphere. Since X-rays are generated to a more intense degree close to the zone of the maximum recurrence of auroras and this zone becomes visible above the equator at a distance of approximately 2.5 Earth radii, the maximum flux of this radiation above the Equator will be close to this region. In other experiments, the deeply penetrating X-radiation was recorded, along with hard electrons and protons, thus making the interpretation of results vague or not completely unique.

By using aluminum foils of various thickness as absorbers, we were able to estimate the "equivalent" energy of the electrons in addition to estimating the intensity of the flows of, electrons of medium hardness. Indicators were graduated in a parallel flow of monochromatic electrons, which impinged perpendicularly on a fluorescing screen, for a wide range of energies. With a change in the electron energy, there was a change in

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the ratio of the intensities of the radiation recorded by the photoelements for the same fluorescing screens. The flow of nonmonochromatic corpuscles of the upper atmosphere also caused different signals in both indicators. The observed ratio of the signals corresponded to a definite value of the energy of the monochromatic electrons. This energy was called the "equiva' lent" energy of the electrons. The sensitivity of the indicators used for electrons with energies of 10 kiloelectron volts as compared with electrons with energies of 40 kiloelectron volts decreased by a factor of 30 for the thin foil and $3 \cdot 10^3$ for the thick foil. Thus, the equivalent value indicated that the majority of electrons have an energy less than the "equivalent". Within the limits of the scales of the measurements, and as a consequence of certain nonhomogeneities in the thickness of the foil, the indicators used recorded electrons with energies from 10 kiloelectron volts. The characteristic of the amplifiers was made nonlinear and as far as possible was made such as to record the logarithms of the intensity of the radiation of the fluorescing screens. This was accomplished with an accuracy of several tens of one percent. The difference in the logarithms of the currents of the two indicators was first determined and with this, the equivalent energy of the electrons was determined on the basis of the graduated curves. The "equivalent" current of the monochromatic electron flow was found on the basis of the equivalent energy and then its "equivalent" strength, which is the derivative of the "equivalent" energies and currents.

Restricting diaphragms were placed in front of the indicators to insure the recording of corpuscles in a solid angle of 1/4 steradians. To obtain the value of the "equivalent" currents and strengths in steradians, the measured values must be multiplied by 4. However, the electron flows may exhibit considerable anisotropy.

The radio telemetry material which we have at our disposal makes it possible to draw a number of new conclusions which are extremely important from a geophysical point of view. For the first time in the investigation of the upper atmosphere, a direct observation was made of medium hard electrons with an energy of approximately 10 kiloelectron volts.

They were recorded at altitudes of from 470 to 1,880 kilometers above sea-level. The lowest intensity was recorded above the geomagnetic equator at an altitude of around 1,300 kilometers. For an "equivalent" energy of approximately 20 kiloelectron volts, their minimum current was estimated to be approximately 10^{-14} amperes per square centimeter per steradian. At medium and polar latitudes, up to 60 degrees geomagnetic latitude, the current for electrons with an equivalent energy of about 12 kiloelectron volts was ordinarily 5.10^{-11} amperes per square centimeter per steradian during the night time and sometimes more than 10^{-10} amperes per square centimeter per steradian. Isolated higher values of the recorded current were noted even at 4 degrees geomagnetic latitude. It is interesting to note that the appearance of considerable measureable currents was observed in the extraequatorial zone of increased ionization in the F, region, described by Appleton.

In planning the experiment, it was not expected that the intensity of the electron flows would be so great. In many cases, as a result, the apparatus went beyond its scale and it was then impossible to estimate the intensity and "equivalent" energy of the recorded electrons. Both instruments only infrequently went beyond their scale simultaneously. Figure 1 [not reproduced] shows the dependence of the intensity of the electron flow on the equivalent energy in the region from minus 42 to minus 54 degrees geomagnetic latitude in the altitude range from 1,720 to 1,880 kilometers during the night of 15 May 1958 above the southern Pacific Ocean. The values for the equivalent energy of the electrons in kiloelectron volts are laid off along the abscissa and on the ordinate in logarithmic scale are the densities of their "equivalent" currents in amperes per square centimeter, assuming that they correspond to a parallel flow of electrons, i.e., without multiplying the measured values by 4 per steradian. The concentric circles indicate repeating values of equal intensity with the same "equivalent" energy of the particles. With an increase in the "equivalent" energy of electrons, their number quickly decreases.

As the satellite rotates around its two axes, considerable changes occur in the intensity of the electron flows. However, sometimes variations were observed in the intensity and "equivalent" energy of the electrons within a time interval which was much less than the very short period of rotation of the satellite. The quickest observed changes occurred within a time of around 1/2 second. Faster changes were not recorded. The rotation of the satellite changed the position of the entry window of the indicator relative to the direction of the magnetic lines of force.

The "equivalent" energy of electrons in lower latitudes was higher. The maximum recorded value was 40 kiloelectron volts. In the polar regions, only the lowest values around 10 kiloelectron volts were recorded.

It is possible to estimate the solid angle around the magnetic line of force within which the charged corpuscles penetrate the atmosphere below a given altitude. For example, at a geomagnetic latitude of 50 degrees, the span of the critical solid angle to ensure penetration of particles from altitudes of 1,500-2,000 kilometers to the regions below the F-layer of the ionosphere must have a value of around 100 degrees, which is greater than the capture angle of the indicators. In the light of this, it becomes possible to estimate the total flow of fast electrons penetrating the lower layers of the atmosphere. For example, this energy flow for the case of minimum currents is equal to approximately one erg per square centimeter per second. This value is quite sufficient for further ionization and heating of the upper atmosphere. It is close in magnitude to that which Bates and Chapman found necessary to maintain the temperature gradient in the upper atmosphere near 5 degrees per kilometer and which cannot be guaranteed because of the hard electromagnetic radiation of the Sun.

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Since the observed electron flows are more intense in the higher geomagnetic latitudes, one might suspect that they are sources for the heating and expanding of the upper atmosphere which was observed on the basis of the slowing down of artificial Earth satellites. The variations in the intensity of the flows of these electrons, which evidently depends on solar activity, could explain the observed correlation between the degree of slowing down of the satellites and the integral effect of chromosphere bursts.

Electron flows with energies around 10 kiloelectron volts which penetrate the lower layers of the atmosphere and are absorbed in them are so great that they cannot be explained on the basis of cosmic rays. ("Observation of Electrons with Energies Around 10 Kiloelectron-Volts in the Upper Atmosphere With the Aid of the Third Satellite), by V. I. Krasovskiy, I. S. Shklovskiy, Yu. I. Gal'perin, and Ye. M. Svetlitskiy, Institute of Physics of the Atmosphere, Academy of Sciences USSR; Doklady Akademii Nauk SSSR, Vol 127, No 1, 1 Jul 59, pp 78-81)

Moon Satellite Discussed by Shternfel'd

An instrumented (TV, etc.) lunar satellite orbiting only 10 kilometers above the surface of the Moon is suggested by A. Shternfel'd, noted Soviet scientist, as fully possible and the most satisfactory means of mapping lunar details, the latter being necessary for future space ship landings and the establishment of Moon "villages." Shternfel'd's description follows.

It is possible to achieve such an orbit after first bringing a rocket to a point 200 kilometers from the Moon's surface. The rocket can then be transformed into an artificial Moon satellite at this distance by imparting a horizontal velocity to it, whereby the satellite's fall will be equalized by the inertia of its forward motion. This value is 1,590 meters per second, approximately one fifth that of the orbital velocity of a satellite near the Earth's surface.

The mountain peaks on the Moon reach an altitude of approximately 9 kilometers. This means it would be dangerous to drop a satellite lower than 10 kilometers.

For lowering the orbit of a satellite with an altitude of 200 kilometers down to 10 kilometers, its speed must be reduced down to 1,548.5 meters per second, decreasing its orbital velocity by 41.5 meters per second. This is a difficult operation, but if successfully accomplished, the satellite gradually drops closer and closer to the lunar surface.

This drop continues for an hour and 2 minutes. The velocity during this time builds up to 1,719 meters per second. But, if this entire inertial flight is made at a small angle to the horizon then at the lowest point of the calculated elliptical curve, at the periastron, the flight will be strictly horizontal. Then after passing through the point closest the Moon, the satellite will again rise up to an altitude of 200 kilometers. It is necessary to switch the rocket from its eccentric orbit into a circular one at the periastron.

During the rocket's fall, the radial velocity increases by one meter per second every 2-2.5 kilometers and at an altitude of 10 kilometers [sic] already consists of 1,674 meters per second. The speed of a rocket-satellite lowered to such an altitude from a 200-kilometer orbit is equal to 1,719 meters per second. Therefore, it is necessary to slow down the motion of the satellite at periastron by 45 meters per second (1719-1764).

In the smaller orbit, the local day will also be shorter. Here it will last one hour 49 minutes and 20 seconds. During this time, the lunar satellite will cover a distance of 10,983 kilometers, the length of the new orbit.

However, when it completes a full circle, it will not be over the same point on the surface of the Moon as it was before. The Moon, though very slowly, also revolves around its own axis. Therefore, if the satellite travels in a polar orbit, then it will gradually survey the entire surface of the Moon. For this, less than a month would be necessary: after 27 days 8 hours, the length of the lunar month, the satellite, flying at an altitude from 200 down to 10 kilometers over the Moon, will complete from 308 up to 363 revolutions around it, and the Moon itself, one revolution in relation to the stars. Thus, in this course of time, the entire lunar surface will be seen by observers on Earth.

From an altitude of 10 kilometers all the details of the lunar surface with a dimension of 3 meters will be distinguishable with 15-power binoculars (with average vision). People possessing sharp vision can distinguish objects less than half this size. It is obvious that the optical instruments with which artificial satellites of the Moon will be outfitted will have greater resolving capability than binoculars. However the maximum duration of observation for a point on the surface of the Moon from an altitude of 10 kilometers is reduced fivefold; from 18 minutes 37 seconds at an altitude of 200 kilometers down to 3 minutes and 42 seconds. ("Moon of a Large Moon," by A. Shternfel'd; Tekhnika Molodezhi, No 4, Apr 59, p 4)

II. UPPER ATMOSPHERE

Abastuman Radiotelescope

Regular observations on the Sun's radio temperature are conducted at the Abastaman Astrophysical Observatory of the Academy of Sciences of the Georgian SSR under the IGY program. These investigations are conducted with apparatus for detecting the Sun's radio emission by the compensation method. The equipment is described by A. L. Semenov, of the observatory as follows.

The apparatus consists mainly of three units--an antenna feeder system, a radio receiver with an automatic recorder, and power units.

The antenna consists of 32 dipoles located in a single plane and placed over the reflecting screen. All the dipoles are interconnected by an asymetric feeder and the output antenna is tapped in to an RK-6 receiver cable. Attenuation of the signal in the cable for a given length is equal to three decibels. The antenna's design permits it to be aimed at any portion of the sky. The directivity factor of the antenna

$$D = \frac{2}{\int_0^{\pi} F^2(\varphi)\sin\varphi\, d\varphi}$$

was determined graphically for two sections of the antenna's directional diagram, the horizontal and vertical.

Thereafter, according to the formula

$$D = \sqrt{D_g \cdot D_V}$$

a value for D, equal to 80, was found. The width of the antenna's radiation pattern at half-power in the horizontal and verticle planes is equal to 12 and 17 degrees respectively.

The receiving apparatus of the radiotelescope for 209 megacycles is a sensitive superheterodyne with a total band pass of $\Delta f = 1.5$ megacycles and operates according to the compensated circuit. Such circuit give a specific gain in comparison with usual amplifiers in the reception of weak signals having a continuous spectrum. This gain is $Q_k = \sqrt{2f\Delta\tau}$, where $\tau = RC$ is a time constant of the detector. In this instance, $\tau = 4$ seconds, and $Q_k = 3.5X10^3$. The sensitivity according to the incrementation of temperature is

$$\Delta T = \frac{FT_o}{Q_k},$$

where F is the noise factor of the receiver, which in this case is equal to 8 and T_o = 300 degrees Kelvin.

Then

$$\Delta T_\varepsilon = 0.7 \text{ degrees Kelvin}$$

Since the Sun is viewed under an angle of about 40 minutes, which gives a solid angle of $\Delta\Omega = \frac{1}{7,000}$, then the sensitivity according to the temperature of the body with D = 80 will be

$$T_{min} = \frac{4}{\Delta\Omega} \frac{\Delta T_\varepsilon}{D} \approx 800 \text{ degrees Kelvin.}$$

The radiotelescope's power units are highly stable sources of anode and incandescent voltages for all the radio tubes.

From 3-hour averaged data for each day the effective temperature of the radioemission of a quiet Sun was found to be equal to $0.7X10^6$ degrees Kelvin. This value is well within the limits of error of the experiment and agreement is in with data from other sources.

The maximum temperature of a disturbed Sun in the period of observations was equal to $35X10^6$ degrees Kelvin. This means that the maximum increase in the Sun's temperature exceeded the level of the quiet Sun 50 times. ("Measurement of the Radio Noises of the Sun on a Frequency of 209 Megacycles," by A. L. Semenov; Tbilisi, Soobshcheniya Akademii Nauk Gruzinskoy SSR, Vol 22, No 4, Apr 59, pp 413-416)

III. METEOROLOGY

Study on Electrical Properties of Thunderstorm Precipitations

Parallel measurements of the charge and radius of individual rain drops and the density of the current of thunderstorm precipitations were conducted for obtaining additional information on thunderstorm precipitations. The instrument used for this aim has three separate channels with an automatic printer. The channels for measuring the total charge of the precipitations (integrator) and for measuring the charge of the individual drops are constructed on the principle of direct current amplifiers with a carrier frequency.

The instrument used made it possible to fix the radius of drops in the range from 0.47 down to 0.63 millimeter and the charges (both positive and negative) from $2X10^{-3}$ down to $3X9^{-2}$ CGSE. The current of precipitations could be measured within the limits of $3 \cdot 10^{-12}$ amperes per square centimeter. The error in measuring the charge and radius of a drop did not exceed 2 percent, and in measuring the current of precipitations amounted to 7 percent.

The studies showed that a more considerable negative charge enters the Earth during strong thunderstorms than previously supposed. The distribution of the charge according to the drops in thunderstorm precipations is assymetrical because of the presence in part of the drops of large negative charges which are not found for positively charged drops. The charges in drops of thunderstorm precipations near the surface of the Earth have a somewhat smaller value than was observed by R. Gunn (J. Geophys. Res., No 1, 1949, p 54) in thunderstorm clouds, which is explained by the neutralization of part of the charge of the drops during their fall to Earth. In other respects, the measurements obtained confirm corresponding measurements made by Gunn from an airplane (J. Geophys. Res., No 2, 1950, p 55) and ground observations by J. Chalmers (J. Roy. Met. Soc., No 331, 1957, p 77). ("On the Electrical Properties of Thunderstorm Precipations," by V. I. Arabadzhi; Moscow, Doklady Akademii Nauk SSSR, Vol 127, No 2, 1959, pp 298-301)

East German Searchlight for Scatter and Extinction Measurements in the Atmosphere

A group of associates at the Physical-Technical Institute of the German Academy of Sciences in Berlin, Radiation-Sources Area, investigated the feasibility of using a searchlight with a high-voltage mercury arc lamp for measuring the scattering and extinction of light in the atmosphere. They selected a two-kilowatt DC lamp, type HBO 2001 (made

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by VEB Berliner Gluehlampenwerk), which has an average light density of about 45,000 candles per cm^2 and a good average distribution of light density over the anode-cathode axis; the light density values directly in front of the cathode are higher than the average, and below the average value at the anode. The spectrum consists almost entirely of the mercury lines of the arc spectrum with line widths which, at times, can amount to as much as 30 angstroms, because of different factors of line broadening, and has a continuous background of approximately half the total radiated energy.

The total energy radiated in the lines could be about 0.75 kilowatt for a two-kilowatt lamp, and the resonance lines of the mercury, because of considerable reabsorption, do not contribute essentially to the reflection.

The mercury high-voltage light source affords the great advantage of the extraodinarily high intensity of the lines, which, if selective filters with pass widths comparable to the width of the line in question are used, is equivalent to a much higher powered arc.

In the designing of the searchlight, special attention was given to an exact adjustment of the vertically directed beam and to the focusing of the light source.

The light source was arranged axially in the mirror, in the normal position, with the cathode at the top and the anode below. A mirror 60 centimeters in diameter, with a 35-centimeter focal length (usual Zeiss type), mirrored on the back and corrected by the glass body, was used. On the mirror, the light source illuminates a ring-shaped zone which makes up about 65 percent of the entire surface of the mirror. The center zone is excluded by a shading of the anode; this affords the advantage of a better optical quality of the reflection, since in these mirrors, the difference of the focal lengths of the edge zone and of the center field amounts to as much as one millimeter.

In this arrangement, part of the illuminating plasma of the discharge is not used as a light beam, and the parts of the mirror lying directly in front of the anode do not contribute to the illumination. This means that the effective illuminating volume is quite small, 2 x 2 mm^2, but that the light density is greater than average, since the area of greatest density is in front of the cathode.

Practical tests were conducted at the branch station of the institute at Kloster on Hiddensee Island. The beam focusing was very good; the intensity of the laterally scattered light, and thus the maximum altitude, depends strongly on the adjustment, in that the laterally scattered brightness diminishes rapidly with defocusing.

With this relatively small searchlight, heights in excess of 20 kilometers were reached -- with the good visibility conditions which prevail on the island of Hiddensee.

Observations made earlier by J. Wempe (reported by Reeger and Seidentopf in Optik 1 (1946) 15) on the presence of a vapor or cloud layer with its lower edge at a height of 11 kilometers, with otherwise clear sky, were confirmed several times.

Special interest was devoted to photographing the beam in the violet and ultraviolet part of the spectrum and comparing it with the general brightness caused by night glow and moonlight. The intensity of the violet and ultraviolet lines is so great that, when selective filters are used, the increased brightness caused by other factors has no influence at all. This affords the possibility of conducting photographic observations -- independent of a large general brightness. ("A Searchlight With 2-Kilowatt Mercury High-Voltage Lamp for Scattering and Extinction Measurements in the Atmosphere," by C. Jung, et al; Berlin, Experimentelle Technik der Physik, No 3, 1959, pp 139-142)

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IV. SEISMOLOGY

Study on Multiple Reflected Waves

Experimental data on the kinematics of multiple reflected waves registered with the aid of middle frequency (f = 37 cycles) and high-frequency (f = 105 cycles) apparatus are presented. Types of multiple waves are determined. The possibility of improving the scheme of propagating multiple waves with the use of the amplitude of the waves is shown. ("Determining the Types of Multiple Reflected Waves According to Their Kinematic and Dynamic Characteristics," by A. M. Epinat'yeva and N. G. Mikhaylova, Institute of the Physics of the Earth Academy of Sciences USSR; Moscow; Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 7, Jul 59, pp 965-980)

Measurement of Earth's Crust Motions Requires Global Cooperation

On the assumption that both regional and local movements of the earth's crust are of equal importance, this article suggests that objective results can be obtained in the study of the mechanism of these movements only through large-scale geodetic cooperation: by periodic repetition of the precise level determinations in individual countries, by joining together the nets of individual countries, by checking the nets at geologically stable areas, by combining the triangulation nets (particularly between continents and islands), and by a regular repetition of measurements and comparison of results. This would necessitate a close international cooperation such as was realized with such great benefit during the IGY. ("Some Remarks On the Question of the Movements of the Earth's Crust and Their Geodetic Determination," by K. Svoboda, Prague; Berlin, Vermessungstechnik, No 8, Aug 59, pp 221-223)

Coefficient of Reflection of Petroleum-Gas Bearing Strata in Seismic Recordings

On the assumption that one of the reasons for the complexity of seismic data is rock which contains petroleum and gas (the petroleum-gas content influences the density of the rocks, the velocity of elastic waves inside them, and the wave resistance of the rocks and thus influences the coefficient of vibration from the boundaries of a petroleum-gas bearing stratum), this article considers the influence of the petroleum-gas content on the elastic properties of rock under various geological conditions.

All petroleum-gas strata comprise multicomponent nonhomogeneous media and, as far as elastic properties are concerned, represent a system consisting of solid, liquid, and gaseous components; the solid component is made up of grains of rock forming a skeleton of a collector and cemented matter; the liquid and gaseous components are petroleum and gas and water containing an insignificant amount of gas. The petroleum-gas layers also contain a certain amount of combine water, in which there is also some dissolved gas. In nonhomogeneous media, in the absence of external pressure, the velocities of elastic vibrations (the wave lengths of which are immeasurably greater than the dimensions of the nonhomogeneities) are determined by the macroscopic conditions of the nonhomogeneous media. If a porous medium is subjected to external pressure, however, then the velocity is also partially determined by the contacting of the grains. In view of these conditions, the equation of velocity of a longitudinal seismic wave (a_p2) in a petroleum stratum has the form

$$a_p2 = \frac{1}{2}\left[\frac{\left(1 - \frac{1}{3}\,\frac{C\Delta P^{1/3}}{K_m}\right)^2}{\Pi\beta + \frac{1-\Pi}{K_m} - \frac{1}{6}\,\frac{C\Delta P^{1/3}}{K_m^2}} - \frac{2}{3}\,C\,\Delta P^{1/3}\right]^{\frac{1}{2}} \qquad (1)$$

where $\Delta P = P_{\mathfrak{J}} - P$; ρ is the mean density of the porous rock saturated with liquids; Π is the coefficient of porosity of the collector; β is the compressibility of the embedded petroleum; K_m is the modulus of structural compression of the grains of sand of the collector; $P_{\mathfrak{J}}$ is the geodynamic pressure; P is the strata pressure; C is the quantity characterizing the Young modulus and the Poisson coefficient of the grains of sand of the collector. (In the case considered here, it is assumed that the gas is completely dissolved in the petroleum, and the amount of combined water is equal to zero; it is further assumed that the collector represents grains of sand which, in the first approximation, are of spherical form with a hexagonal packing.)

Under natural conditions, the quantity a_p2 in equation (1) cannot be determined uniquely because of the ambiguity of $P_{\mathfrak{J}}$.

Not considering the possible relationship of $P_{\mathfrak{J}}$ and P under various geotectonic conditions, and assuming that, in the general case, $P_0 \leqslant P < P_m$, and also that, as a result of the deformation of the rock, $P_m < P_{\mathfrak{J}}$, there are three possibilities for the limiting value ΔP (P_0 = hydrostatic pressure; P_m = geostatic pressure):

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1) $P_{\mathcal{J}} = P$, where $P_{\mathcal{J}} \leqslant P_m$, $P \geqslant P_0$. Then $\Delta P = 0$, and equation (1) is rewritten in the form

$$a_p 2 = \left[\frac{1}{\rho \left(\Pi \beta + \frac{1 - \Pi}{K_m} \right)} \right]^{\frac{1}{2}} \qquad (2)$$

2) $P_{\mathcal{J}} > P$, where $P_{\mathcal{J}} = P_m$, $P = P_0$. Then $\Delta P = P_m - P_0$, and $a_p 2$ is determined according to equation (1).

3) $P_{\mathcal{J}} \gg P$, where $P > P_0$, $P_{\mathcal{J}} > P_m$. This case corresponds to the highest, and most ambiguous, value of $P_{\mathcal{J}}$.

In the above determination of $a_p 2$ it was assumed that the mechanical admixtures in the porous volume either are completely absent or are found as if in a suspended state and that they are subjected only to the pressure of the all-sided compression and are not in elastic contact with the grains of sand. In reality, however, admixtures located between the grains of sand reduce the elasticity of the contacts which form in accordance with the Hertz theory [H Hertz, Gesammelte Werke, Leipzig 1895, Vol 1, pp 155-173]; thus, in equation (1), the value C should be replaced by $\Delta C = C - C_1$, where C_1 characterizes the macroscopic elasticity of the admixtures, as well as their quantity and their distribution in the pores. In the range where $\Delta C \longrightarrow 0$, equation (1) is rewritten in the form

$$a_p 2 = \left[\frac{1}{\rho \left(\Pi \beta + \frac{1 - \Pi}{K_{m0}} \right)} \right]^{\frac{1}{2}} \qquad (3)$$

Interstitial masses formed by admixtures can be considered zones which connect the elementary volumes of the grains of sand. Under these conditions, K_{m0} represents the distributed elasticity. The velocity $a_p 2$ is determined by equation (3).

Computed for constant parameters of the collector and of the embedded petroleum (The skeleton of the collector, with a porosity of 20 %, is represented by quartz; the compressibility of the petroleum $\beta = 12 \cdot 10^{-11} \text{bar}^{-1}$.), the velocity $a_p 2$ has the following values:

According to equation (1), with H = 3,000 meters, a_p2 = 1,970 m/sec; according to equation (2), a_p2 = 1,300 m/sec; and according to equation (3), a_p2 = 1,330 m/sec.

The velocity computed according to equation (1) differs considerably from that computed according to equations (2) and (3), and, at this point, it is not possible to determine, according to the value of a_p2, any appreciable influence of the embedded petroleum on the elastic properties of the rock. This influence, however, can be characterized by the relationship between the velocity in the petroleum-bearing (a_p2) and in the water-bearing (a_p3) parts of the petroleum-bearing stratum, where all parameters, except those of the fluids which fill the pores of the collector, and the geological conditions of deposition are uniform in the first approximation.

Computed for H = 3,000 meters, the relationship $a_p2/a_p3 = 74 \pm 8$ %; for H = 2,000 meters, $a_p2/a_p3 = 74 \pm 8$ %, and for H = 1,000 meters, $a_p2/a_p3 = 72 \pm 6$ %. (Under these conditions, and for a cubic packing of the grains of sand (of spherical form), a_p2/a_p3 is equal, respectively, to 72 ± 6, 72 ± 6, and 70 ± 4 percent.) The intervals of change of a_p2/a_p3 correspond to the divergences (for $\Delta P \leqslant 0$ and $\Delta P > 0$) of the values of a_p2/a_p3 from the average value and, under certain circumstances, may serve as the limits of accuracy of the characteristic of the influence of the embedded petroleum on the elastic properties of the porous rock under natural conditions.

The coefficient of reflection from a water-petroleum contact of a normally incident longitudinal seismic wave for the above-indicated depths (3,000; 2,000; and 1,000 meters) of the stratum, its parameters, and the compressibility of the petroleum is equal to 17 ± 5, 17 ± 5, and 18 ± 4 %, respectively.

The value of the coefficient of reflection from the surface of a water-petroleum contact is great enough, in many cases, to cause such a reflection to be recorded on seismograms, and is one of the reasons for the periodic appearance and disapperance of isolated vibrations on seismograms.

The value of the relationship a_p2/a_p3 indicates that the coefficients of reflection from the roof and from the foot of a petroleum bed are different and are one of the reasons for the change of form of the seismic recording.

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The oriented values obtained here are considered to be characteristic of the degree of influence of the embedded petroleum on the elasticity of the rock and suggest the feasibility of mapping according to the elastic properties of a petroleum-gas-bearing portion of a stratum in the surrounding formations. ("On the Possiblity of Using Seismic Surveying for the Direct Search For Deposits of Petroleum and Gas," by I. Ya. Ballakh and M. F. Mirchnik, Corresponding Members, Academy of Sciences USSR; Moscow, Doklady Akademii Nauk SSSR, Vol 126, No 6, 1959, pp 1239-1241)

V. OCEANOGRAPHY

Sea-Bottom Studies Aided by Submarine

A description of submarines and underwater devices used for peaceful pursuits by Engr Yu. Kryuchkov, includes a brief mention of the Soviet research surmarine Severyanka. Kryuchkov gives a bit of new information on the ship which is operated by the All Union Scientific Research Institute of the Fishing Industry and Oceanography. The Severyanka, according to Kryuchkov, is equipped with a depth-stabilizing device which enables it to remain at any depth. In addition, it has an exit chamber through which its scientific personnel equipped with diving suits and helmets can leave the submarine while it lies on the bottom of the sea and conduct scientific studies. ("Overboard--The Deep Continent," by Engr Yu. Kryuchkov; Moscow, Tekhnika Molodezhi, No 4, 1959, pp 36-39)

Non-Magnetic Ship Zarya Departs on Second Voyage

The Zarya, Soviet nonmagnetic expeditionary ship, left on its second voyage under the International Geophysical Cooperation program. The schooner left on 20 August on what will be a period of 10-11 months during which it must cover some 30,000 miles. Its itinerary will carry it near the shores of India, Indonesia, Australia, New Zealand, the islands of Samoa and Fiji, and also to Japan and the People's Republic of China.

All the scientific apparatus, magnetometers, the ionospheric station, the neutron monitor, and also the ship and navigation mechanisms and instrument are in perfect condition. The schooner is commanded for the long voyage by Taras Ivanovich Mazhara. ("The Zarya Has Put to Sea"; by B. Bologov, Chief of the Complex Marine Magnetic Expedition, Candidate of Physicomathematical Sciences; Moscow, Izvestiya, 21 Aug 59, p 1)

Vityaz on New Voyage

The Vityaz, scientific research ship of the Institute of Oceanology of the Academy of Sciences USSR, left Vladivostok 31 July on a new voyage. The scientific workers aboard will, in accordance with the International Geophysical Cooperation program, conduct research in the northern part of the Pacific Ocean. Accompanying the Soviet scientists on the voyage were the Chinese oceanologists Ho Chun-shu, Weng Hsueh-ch'un, and Fan Shih-Tz'un. The voyage will last 40 days. ("On a Distant Voyage"; Moscow, Izvestiya, 1 Aug 59, p 2)

Report on Marine Suspensions in North Atlantic

Suspended matter from the surface waters were collected on the first voyage of the Soviet expeditionary ship Mikhail Lomonosov in the northern part of the Atlantic Ocean between Iceland and the shelf of the British Isles according to these profiles: (1) Iceland-Hebrides Islands; (2) along the Icelandic shelf; (3) Reykjanes Ridge-shelf of the British Isles, (4) the Faroe-Scotland Gut.

Microscopic investigations of the suspensions were made. This analysis revealed three basic types and three subtypes of particles. The Atlantic waters are characterized by their great cleanliness during November, the period of the study.

Good separation of suspended matter and the study of their microscopic composition makes it possible to establish the origin of water masses and even of individual currents. The advantage of this method is the need of only small quantities of water, and also the speed in obtaining results which can be used during hydrological investigations directly in the expedition. ("Suspended Matter in the Northern Part of the Altantic Ocean (Between Scotland and Iceland)," by M. V. Klenova, Institute of Oceanology Academy of Sciences USSR; Moscow Doklady Akademii Nauk SSSR, Vol 127, No 2, 1959, pp 435-437)

Study on the Heat Balance of Far Eastern Seas

The results of the calculation of the main component of heat balance for the surfaces of the Bering Okhost, Japan, Yellow, and China seas are presented. It is shown that the heat balance of the surfaces of these seas is negative, and its compensation occurs at the expense of heat transport by branches of currents in the northwestern part of the Pacific Ocean. The distribution of the value of heat balance within the limits of each of these seas makes it possible to plot the course of intrusions of Pacific Ocean waters and also to estimate the mass of these waters. The problems of the yearly variation of the main component of heat balance are also considered. ("Heat Balance of Far Eastern Seas," by A. M. Batalin, Far East State University; Moscow, Izvestiya, Akademii Nauk SSSR, Seriya Geofizicheskaya, No 7, Jul 59, pp 1,003-1,010)

VI. ARCTIC AND ANTARCTIC

Arctic Summer Begins

The short Arctic summer has begun at the Soviet drift stations Severnyy Polyus-6 and Severnyy Polyus-8. Even at midnight, the sun does not disappear below the horizon.

Severnyy Polyus-6 is now drifting 320 kilometers north of Spitsbergen. The air temperature is often as high as 1-2 degrees above freezing point, and the snow is melting rapidly.

Severnyy Polyus-8 is drifting 780 kilometers north-northeast of Ostrov Vrangelya. In this region the weather is colder. The maximum air temperature has never yet been as high as one degree above freezing point.

The program of scientific observations at the stations is being fulfilled according to plan. All polar staff workers are in good health. ("Twenty-four hours of daylight," Moscow, Vodnyy Transport, 23 Jul 59)

Winter Season at Station Lazarev

The Antarctic winter weather in the area of station Lazarev has been relatively mild. The average temperature in June was about minus 18 degrees Centigrade. During the first part of July, the average temperature of the air dropped to minus 24 degrees Centigrade. The sea near the ice shelf, on which the station is located, is getting a cover of young ice. One of the periodic hurricanes broke up the ice and carried the ice fragments out to the west. During June and July, the calving of icebergs from the edge of the ice shelf about 5-15 kilometers northwest of the station, has continued. Ice domes, which are up to 200-300 meters high, have formed on the surface of the ice shelf. The domes are covered with a large number of cracks.

After a 2-month polar night, the sun has appeared again. A period of more intensive scientific observations is now approaching. The station workers are planning to explore the ice shelf in the vicinity of the station. ("The Polar Day is Beginning," Moscow, Vodnyy Transport, 25 Jul 59)

Temperature Drops at Station Vostok

On 23 July, the air temperature at the interior station Vostok was minus 79.5 degrees Centigrade. It is the first time this year that such a low temperature has been recorded at the south geomagnetic pole. In August, even lower temperatures are expected. As it is known, on 25 August 1958, the temperature at the station Vostok was minus 87.4 degrees Centigrade, which was the lowest temperature ever recorded on the earth.

Despite low temperatures and lack of oxygen, the ten Soviet scientists headed by V. S. Ignatov, Candidate of Technical Sciences, are conducting regular scientific observations. ("Minus 79.5 degrees," Moscow, Vodnyy Transport, 28 Jul 59)

Winter Operations at the Station Vostok

The most important stage of the wintering period at the station Vostok has now begun. This is the height of the Antarctic winter, and the polar night is still continuing. The air temperature has dropped to minus 80 degrees Centigrade. During the last few days, the temperature rarely rose above minus 75 degrees. The severe cold complicates all activities at the station. Radiosonde launchings and meteorological observations have become more difficult. Injection of diesel fuel also presents difficulties. Occasionally, the self-recording devices for temperature and humidity measurements break down and the aurora cameras fail to operate. Daily life is a continuous struggle with nature.

The staff members were able to make the self-recording devices operate at a temperature of minus 80 degrees. Until now the temperature limit had been minus 50-60 degrees. The breakdowns of aurora cameras have been reduced to a minmum. Aerological observations have been continued without a single interruption. The small group of Soviet polar scientists is successfully overcoming all difficulties and is striving to improve the quality of scientific research results.

At present, the station staff is spending much time in drilling a deep test hole for glaciological research; tests will be made to determine the temperature regime at various levels of the snow and ice. This will help to solve a number of interesting problems such as the heat balance of the Antarctic ice sheet and the ice age and will aid in determining conditions of glaciation.

The return of the sun to this region of Antarctica is not far off. A broad reddish stripe is already visible near the horizon, like the glow of a distant fire.

Several days ago, a severe geomagnetic storm broke out in Antarctica, which was accompanied by a complete absorption of radio waves in the ionosphere and by brilliant auroras. During a 9-day period, radio contact between Vostok and the stations Mirnyy and Lazarev was completely disrupted.

Despite the severe cold and snowstorms, the scientific staff is successfully conducting research under the program of the IGC-1959. The results obtained in all fields of research are of great scientific and practical interest. All staff members at Vostok are in good health and are looking forward to the end of the winter and the arrival of the first planes from Mirnyy. ("Before Sunrise," Moscow, Izvestiya, 29 Jul 59)

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