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# ***JPRS Report***

# **Science & Technology**

***USSR: Earth Sciences***

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SCIENCE & TECHNOLOGY  
USSR: EARTH SCIENCES

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## THE GLOBAL MECHANISM OF STORMS

Leningrad TASS in Russian 0800 GMT 27 Dec 86

[Text] Leningrad, 27 December. Soviet geophysicists have established the electrical capacity of the giant natural spherical condenser, which happens to be our own planet. They have calculated that the difference of potentials between the positively charged ionosphere and the negatively charged rock surface measures 250-300 thousand volts. This charge could be neutralized in a matter of minutes if the losses were not constantly replaced due to the storm activities of the clouds.

The scientists at the Main Geophysical Observatory "Aleksandr Voyeykov" in Leningrad reached this conclusion after conducting experiments on a computer with a mathematical model of global storm conditions. This model is based on many years of observation in the air, on sea and on land. Geophysicists have calculated that each second 1,800 storms rage simultaneously above the earth, with the total current of 900 A. Besides, the storms are subject to a uniform global "timetable." It was possible to determine that their maximum activity falls in the time period from 1800 to 1900 gmt, but the flashes of lightning illuminate the globe least frequently from 0300 to 0400.

Scientists have noticed that the total area of the world ocean surface illuminated by the sun undergoes changes during a 24-hour period according to exactly the same sequence. It was concluded that the origin of storms is associated with the uneven 24-hour warm-up of the ocean surface. The fluctuation of evaporation, electrostatic charging of the very small particles of water vapor and the activity of clouds above the ocean serve as a storm discharge mechanism.

The study of the stormy atmosphere is necessary for the solution of such problems as the improvement of wireless communication, transmission of electric power over long distances and others. Using calculations and modeling, geophysicists managed to solve the problem of unexpected explosions in tankers during the washing of cargo compartments. It turned out, that water dust in large-capacity tanks is capable of creating its own kind of ministorm clouds, the charges on which cause sparking of the vapor saturated with oil and petroleum.

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CSO: 1865/151

WHAT CLIMATE IS TYPICAL FOR THE EARTH

Moscow PRIRODA in Russian No 10, Oct 86 pp 34-45

[Article by N.M. Chumakov, doctor of geological and mineralogical sciences, senior scientific specialist, Geology Institute, USSR Academy of Sciences]

[Abstract] This article discusses characteristics of climatic zonality over the earth during the course of terrestrial evolution. The climatic characteristics presented are based on studies of paleoclimatic indicators, certain sea-floor sediments, rocks and organisms which were formed or lived under certain climatic conditions. Maps illustrate the climate of the present day, the arrangement of the continents and corresponding climate zones of the geological past, and the rocks and other climatic indicators used to determine climates in previous geological eras. The earth is presently experiencing a period of glaciation, apparently a slight warming era between two glacial maxima. However, much warmer weather with little or no glaciation is perhaps more typical of the long-term history of the earth. Subtropical beaches have extended in the past and doubtless will extend again in the future to Greenland, though unfortunately this situation will not recur anytime soon. Figures 10.

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NATURAL AND ANTHROPOGENIC CLIMATIC CHANGES

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 10, Oct 86 pp 30-39

[Article by K.Ya. Kondratyev, academician]

[Abstract] Academician K.Ya. Kondratyev has summarized the level of knowledge concerning natural and anthropogenic climatic changes in a single article. The review covers the full range of physical factors involved in the formation of climate and its changes, the need for further development of the theory of climate and clarification of its contribution to study of current

changes, both natural and anthropogenic, and the necessity for anthropogenic factors to be taken into account in climatic predictions. A better understanding of changes in climate requires a study of the earth's paleoclimate, the climates of other planets and the specifics of the climate of large industrial centers. There must be, and is, a special emphasis on changes in atmospheric chemical composition. The anthropogenic influences on climate are so numerous and diverse with respect to spatial and temporal scales that this subject itself is of enormous proportions. The evaluation of possible changes in climate related to the increasing content of CO<sub>2</sub> in the atmosphere itself is a small part of this. In any case, at present no reliable predictions of climatic changes in the next 50-100 years as a result of anthropogenic effects can be made with any certainty. The interrelationship between the biosphere and climate has been poorly understood, ideas are changing rapidly, and intensive research in this direction is required. The current emphasis on research in the field of ocean-atmosphere interaction is fully justified and must be continued. The greenhouse effect is still poorly understood and this, like so many other aspects of climate, requires much additional research. There are complex interrelationships among the different climate-forming factors which greatly complicate the picture. The effect of a possible global nuclear war on climate is still another important field of research. The review ends with a summarization of those problems which are being studied under the world climate Research Program. References 11: 8 Russian, 3 Western.

5303/9835  
CSO: 1865/125

DRILLING FROM BATHYSCAPE YIELDS BOTTOM SAMPLES

Moscow DOMESTIC SERVICE in Russian 0500 gmt 9 Jan 87

[Text] The research vessel "Vityaz" has returned from its latest expedition. At its port of registry, Kaliningrad, our correspondent interviewed one of the participants in the voyage, Professor Yemilyanov of the Oceanology Institute, USSR Academy of Sciences. We studied the underwater ridge of a volcano in the East Atlantic, he said. For the first time, with the aid of the Argos deep-sea submersible we not only filmed and photographed the bottom, but also used this bathyscape for the first time as a sort of drilling rig. The drilling enabled us to collect unique samples of earth from the ocean bottom, with an extremely interesting geological structure. Further study of these samples will be carried out on shore. The expedition was carried out in accordance with an international program. Scientists from Britain, Italy and Bulgaria were on board the vessel, and carried out research.

/9835

CSO: 1865/256

RADAR GUIDES SHIPS, MEASURES ICE, MONITORS STORMS FROM SPACE

Moscow TASS in English 000 gmt 28 Dec 86

[Text] A radar system has gone into operation for remote sensing of the earth's surface from space. It was developed in the Ukraine. The system will help guide ships in Arctic seas during the polar night. The radar can determine the thickness of ice and clear water areas and monitor the direction and strength of storms.

/9835

CSO: 1865/153

RESEARCH VESSEL 'GEOFIZIK' STUDIES DEPTHS UNDER OCEAN FOR 'LITHOS' PROJECT

Murmansk TASS in Russian 1510 gmt 6 Jan 87

[Text] Murmansk, 6 January. Soviet geologists on board the research vessel "Geofizik" today began studying the structures of the depths of the earth beneath the ocean bed between the Bahamas and the Canary Islands. The expedition, which is being carried out within the framework of the "Lithos" international project for studying the Earth's lithosphere, will facilitate the study of the problem of continental drift, which interests scientists, and will also add to scientific data on the origin of minerals. Geologists and geophysicists from other countries are taking part in this work together with Soviet specialists.

/9835

CSO: 1865/150-E

## RESCUE OF SHIPS IN BALTIC

Moscow TASS in Russian 1607 gmt 18 Dec 86

[Text] "The wide use of ice breakers has had a great economic effect, having paved the way to free access for merchant ships to frozen ports, said Vladimir Bogorodskiy, Chief of the Directorate of the Northern Sea Route, commenting on the results of the conference. Leningrad alone receives over a thousand ships from various countries during the winter period. The mooring stations at Vyborg, Tallinn, Riga and the ports of Finland and northern Sweden continue to operate.

Our cooperation in the escorting of ice breakers is businesslike and friendly. An inestimable role is played in this, among other things, by a constant exchange of meteorological information and operational maps of the ice situation on the busier sea routes from the Gulf of Bothnia to the straits of Denmark. And now the West German participants in the treaty have pledged to provide operational information about the situation in the Mecklenburg Bight and the Kiel Fjord.

A protocol on the results of the Leningrad meeting was signed, in which is planned the further deepening of interaction between the ice breaker services of the countries of the Baltic basin and the use of modern means of communication, including satellite information."

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CSO: 1865/150-E

NII-SHELF INSTITUTE DEVELOPS ALL-WEATHER DRILLING PLATFORM

Moscow TASS in English 2304 gmt 28 Dec 86

[Text] Scientists and experts of the NII-Shelf Institute have developed the country's first ice-withstanding stationary platforms, which are intended for drilling and extraction of oil and gas at sea. The combined design of the all-weather installation makes it possible to quickly turn the platforms from the drilling version into the production one. As compared with traditional ones, they use less metal and construction time has been considerably reduced.

/9835

CSO: 1865/150-E

CORRESPONDENT SUGGESTS 2ND TITANIC EXPEDITION HAD MILITARY PURPOSE

Moscow INTERNATIONAL SERVICE in English 2300 gmt 8 Jan 87

[Excerpts] We have a question today from [a caller in] New Jersey. He would like to know what we in this country think about the discovery of the Titanic. So it's back to our science correspondent Boris Belitskiy.

(Belitskiy) [Passage omitted] There was a great deal of interest when the wreck was found in 1985. I think the Soviet media had nothing but praise for this memorable accomplishment.

(Question) Now what about [the] second expedition to the wreck to explore it inside?

(Belitskiy) Well this was a rather different matter and was bound to evoke mixed feelings.

(Question) Well you probably mean because some people saw it as desecrating a grave at sea?

(Belitskiy) Not only that, you see it soon became known that this expedition was financed largely by the Pentagon, which put up 3,000,000 dollars for it. And, according to the NEW YORK TIMES, the Pentagon hoped that the expedition would further its plans of testing a prototype system for detecting sonars on the ocean floor and in the long term for choosing sites there for installing missiles. In other words the Pentagon didn't shrink from intruding into a mass grave at sea in order to turn it into a test site for its offensive arms systems. Now, naturally, this raises the important question of what are the ocean depths to be, a scene of scientific exploration or yet another arena of an unbridled arms race? As far as the Soviet Union is concerned, it's most emphatically in favor of keeping the seabed and the ocean floor an area of peaceful exploration only.

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CSO: 1865/256

TSUNAMI RESEARCH RANGE ESTABLISHED IN PACIFIC

Moscow DOMESTIC SERVICE in Russian 0700 gmt 22 Jan 87

[Summary] Specialists from the Far Eastern Scientific Research Institute of the USSR State Committee for Hydrometeorology have established a tsunami research range in the southwestern part of the Pacific. A unified and automated tsunami warning system, which will form part of an international early-warning service, will commence operations during the current Five-Year Plan.

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CSO: 1865/202-E

UDC 551.465.52

SEMINAR ON MATHEMATICAL MODELING OF GEOPHYSICAL CURRENTS

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86 pp 1040-1044

[Article by V.A. Ryabchenko]

[Abstract] A permanent seminar on mathematical modeling of geophysical currents has been organized in the Section on Science of the Earth and Universe, M. Gorkiy Science House, USSR Academy of Sciences, Leningrad. The purpose of the seminar is to exchange ideas and experience in the field of mathematical modeling of geophysical phenomena, including processes occurring in the ocean, atmosphere, cryosphere and upper mantle. The theme of the seminar includes modeling of turbulent currents in the boundary layers of the atmosphere and ocean, circulation of the ocean and atmosphere, tidal movement in the ocean and crust, storm surges and floods, as well as methods of computational mathematics. The work of the seminar is headed by a board consisting of eight meteorologists and oceanographers, chaired by Doctor of Physical and Mathematical Sciences, Professor Yu.V. Nikolayev; Deputy Chairman--Doctor of Physical and Mathematical Sciences, Professor B.A. Kagan; Scientific Secretary--Candidate of Physical and Mathematical Sciences V.A. Ryabchenko. Subjects discussed at the first eight sessions of the seminar are reviewed, including: methodological problems in mathematical modeling of geophysical currents; numerical modeling of the boundary layer above waves; modeling of global climate; synoptic disturbances and large-scale circulation of the ocean; formation of the microstructure of temperature and salinity fields in the upper layer of the ocean; a two-layer model of circulation in the ocean with detailed description of the effects of the upper quasihomogeneous layer; numerical experiments for estimating the thermal influence of the ocean on high-latitude climate; and reproduction of climatic circulation in closed water bodies.

6508/9835

CSO: 1865/203

## INTERACTION OF SHEAR LAYERS AND INVERSION STRUCTURE FORMATION IN BOTTOM STRATIFIED CURRENT

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 6 Sep 84, after revision 16 Jul 85) pp 920-930

[Article by B.I. Samolyubov, Moscow State University imeni M.V. Lomonosov]

[Abstract] In order to study the physics of mass transfer in a bottom stratified current, expeditions of the Department of Physics, Moscow State University, undertook a cycle of studies in an artificial water body in the USSR between 1973 and 1982, including frequent surveys of the vertical distribution of concentration of suspended matter, temperature and speed, recording of speed pulsations, sampling of water, synchronous measurement of these parameters by sensors along the axis of the current, parallel profile surveys and regular taking of samples from fixed levels. This article analyzes the results of the expeditions of 1981-1982, plus some materials collected in 1979-1980. The studied stratified bottom current is formed when a flow of glacial origin enters a fresh-water basin. The major factor influencing the vertical structure of the current was found to be the second mode of an internal wave resulting from pulsations of pressure in the area of current formation. The wave process of eddy formation generated at the boundaries and in the core of the current is accompanied by appearance of turbidity clouds and temperature inversions. The two-stage mass transfer involved in vortex-wave interaction of the shear layers causes the inversion structure to rise into the mixing layer at the top of the current. The transporting capacity of the vortex-wave component of mass transfer amounted to 20-70%. The registered velocity field disturbances can cause bottom erosion, vortex-wave lifting of large sediment fractions, multiple-mode suspension particle size distributions and an increase in the transport distance of sediments by the current. Figures 4; references 25: 13 Russian, 12 Western.

6508/9835  
CSO: 1865/203

## FILTRATION OF WAVES BY SHEARING CURRENT IN SHALLOW WATERS

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 22 Jun 84) pp 907-913

[Article by Yu.I. Dreyzis, I.G. Kantarzhi and Ye.N. Pelinovskiy, All-Union Scientific Research Institute of Transport Construction (Central Scientific Research Institute of Transport Construction), Sochi; Applied Physics Institute, USSR Academy of Sciences, Gorkiy]

[Abstract] A study was made of the refraction of waves by a shearing current in the direction perpendicular to the velocity vector. This problem is related to currents along the shore in a littoral zone, tidal estuary or reservoir through which a current flows. It is assumed that the scale of the current is large in comparison with the waves. Caustic effects arising at relatively low current velocities are considered and it is shown that the refraction of the frequency-direction wave spectrum by the current causes filtration of the spectrum in direction, which does not occur in deep water. Wave action characteristics after passage of the current are studied. When practical problems are solved considering the refraction of obliquely approaching waves by a shearing current and in hydraulic modeling, one should be cautious in replacing the wave spectrum by a calculated quasi-monochromatic wave, as is frequently done today. When caustic wave reflection is present in this case, this replacement may result in significant errors in determining wave parameters. Figures 3; references 8: 5 Russian, 3 Western.

6508/9835  
CSO: 1865/203

## RECEIVER DEVICE (STRING) WITHOUT LOAD-SUPPORTING CABLE FOR MARINE SEISMIC RESEARCH

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 30 Mar 84, after revision 4 Jan 85) p 1039

[Article by L.I. Kogan, I.N. Yelnikov, P.M. Zakharov, V.A. Badayev and I.A. Sheremet, Southern Division, Oceanology Institute, USSR Academy of Sciences, Gelendzhik; Scientific Research and Planning Institute of Ocean Geophysics, Yuzhmorgeologiya Production Association, Gelendzhik]

[Abstract] A receiver has been developed for multichannel seismic profiling, which can be used in studying the structure of the crust beneath bodies of water and prospecting for minerals as a research vessel moves at a speed up

to 11 knots. This is achieved by increasing the noise tolerance, strength and reliability of the receiver. The loads resulting from towing the device are uniformly distributed among all the current-carrying conductors by attaching the conductors to connecting collars through a cone filled with epoxy resin to form a monolithic unit capable of withstanding the loads. This eliminates the load-carrying cable, which is a major source of vibration noise in other instruments. Figure 1; references: 3 Russian.

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CSO: 1865/203

UDC 551.465.15

#### IMPURITY JET COLLAPSE PROCESS IN STRATIFIED SEA

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 5 Dec 84, after revision 17 Jan 86) pp 902-906

[Article by K.A. Korotenko, Oceanology Institute, USSR Academy of Sciences, Moscow]

[Abstract] Results of a special experiment involving a stationary source of dye, used to study the collapse phenomenon in a stratified sea, are discussed. The experiment was carried out during investigation of turbulent diffusion processes along the Bulgarian littoral zone of the Black Sea, with dye poured out onto the surface of the sea from a stationary platform about 800 m from the shore where the water was 18 m deep. The density of the dye was such that it rapidly sank. Dye concentration in the jet and water temperature were measured from a small boat. The dye jet, propagating through the warm surface layer of the sea, rose to a certain steady level with increasing distance from the source, the thickness of the jet decreasing significantly in this process. The contributions of the turbulent diffusion and collapse processes to the formation of the field of dye concentration in the jet are estimated theoretically and it is shown that in the initial stage jet propagation collapse is dominant in the redistribution process. The field of density and temperature of the stratified layer in which the jet propagated was found to have a fine structure, consisting of a number of small layers with different temperature gradients. Figures 4; references 7: 3 Russian, 4 Western.

6508/9835  
CSO: 1865/203

## SIGNIFICANCE OF INFUSORIA IN ANTARCTIC PLANKTON COMMUNITIES

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 15 Oct 84) pp 982-988

[Article by V.A. Sushin, E.Z. Samyshev and A.I. Gaydamak, Azov-Black Sea Scientific Research Institute of Sea Fishing and Oceanography, Kerch]

[Abstract] Comprehensive studies of Antarctic plankton communities made in 1983-1984 involved a group of protozoan plankton. Based on analysis of materials obtained at that time, the authors undertook a quantitative estimation of the significance of this group in the conversion of energy in the Antarctic plankton community. Plankton was collected in the Western Atlantic sector of the Antarctic in February-March 1984 and in the Central Indian Ocean sector in December 1983 and February 1984. The primary and bacterial production were measured by the radiocarbon method. The main mass of Infusoria in both regions was represented by Strombidium and Tintinnidae, among which Cymatocylis spp and Epiplocylis spp predominated. The distribution of Infusoria was quite uneven. The concentration of Infusoria in the Indian Ocean sector was 50% greater than in the Atlantic sector, 18.3 and 16.2 mg/m<sup>3</sup> in the photic layer in December and February. The regions studied were basically similar in taxonomic and dimensional composition of Infusoria to the Pacific sector of the Antarctic. The specific share of Infusoria in the transformation of energy in plankton communities in both areas was identically high: although the biomass of protozoans was 4-4.4% of the biomass of zooplankton, they represented 43-51% of the total consumption of zooplankton, 47-56% of its assimilation and 54-64% of its production. Microheterotrophs accounted for 95 and 85% of the consumption of energy by all heterotrophs in the Atlantic and Indian Ocean sectors. Figures 4; references 22: 21 Russian, 1 Western.

6508/9835  
CSO: 1865/203

UDC 551.46.077/551.462

## EXPERIENCE IN CONDUCTING SEA BED STUDIES USING TOWED APPARATUS

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 26 Mar 84) pp 1022-1027

[Article by E.L. Onishchenko and S.V. Zhavoronkov, Oceanology Institute imeni P.P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] The Oceanology Institute has developed a number of towed devices, including the "Zvuk-4" and "Zvuk-4m," the most widely used in marine research. The "Zvuk-4" is intended for geological inspection of the

bottom surface, carries two side-looking sonars, an acoustical profilograph, an echo sounder with a resolution of 0.1 m and a camera. The "Zvuk-4m" is similar, but intended for inspection of bottom surfaces with smaller local outcroppings of solid material, for which purpose it carries a television camera and light in addition to the camera as carried on the "Zvuk-4." Photographs can be taken on command from the operator, based on observation through the television camera, or automatically along the surveyed path. The experience gained in utilizing these devices on the research vessels "Akademik Kurchatov", "Akvanavt" and "Vityaz" is discussed. Sample bottom photographs are presented. It was found that presentation of photographic and acoustical information in the form of "mosaics", in which photographs and sonograms are arranged in accordance with their geographic position on the bottom, is most convenient for interpretation. Figure 1; references: 3 Russian.

6508/9835  
CSO: 1865/203

UDC 550.361

#### METHOD FOR CALCULATING TEMPERATURE GRADIENT IN OCEANIC GEOTHERMAL RESEARCH OCEAN

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 21 May 84, after revision 30 Nov 84) pp 1018-1021

[Article by G.D. Yeregin, Sakhlín Complex Scientific Research Institute, Far Eastern Scientific Center, USSR Academy of Sciences]

[Abstract] One temperature measurement method is to place a thermometer which itself has a certain temperature in the medium whose temperature is to be measured. After a certain time has passed, it is assumed that the thermometer has reached the temperature of the medium and the temperature reading is taken as the temperature of the medium. This article uses a heat conductivity equation to derive an equation to determine the temperature gradient for geothermal studies based on analysis of a cylindrical area containing the material being studied and the thermometer. The equation can be used to calculate the temperature of the probe as a function of time based on observation of the initial variation in temperature after the thermometer is placed in the medium whose temperature is to be measured. Figures 2; references: 3 Russian.

6508/9835  
CSO: 1865/203

## SELF-CONTAINED TRANSPARENCY METER

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 22 Feb 84, after revision 16 Jan 86) pp 1028-1032

[Article by G.S. Karabashev, A.F. Kuleshov and S.A. Khanayev, Atlantic Division, Oceanology Institute, imeni P.P. Shirshov, USSR Academy of Sciences, Kaliningrad]

[Abstract] The authors have developed a self-contained transparency meter suitable for high-speed ocean soundings. The measurement base of the instrument is 246 cm; there is a triple prism end reflector to simplify the design. The radiation source beam divergence is 20; and photosensor angle of view is 30', eliminating the influence of multiple scattering. As the device operates, readings are stored in an EPROM unit. The light source is an OPZ-0.75 incandescent bulb and the photosensor is an FEU-85 photomultiplier. The device has been tested down to a depth of 4,000 m. Figures 2; references 4: 3 Russian, 1 Western.

6508/9835  
CSO: 1865/203

UDC 550.834(536.66)

SELF-CONTAINED DIGITAL TEMPERATURE PROBE FOR GEOTHERMAL STUDIES AT SEA  
(ATsTM-1)

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 27 Nov 84) pp 1033-1038

[Article by V.I. Artemenko, V.G. Selyaninov, L.A. Smirnova and V.N. Strygin, Scientific Research and Planning Institute of Geophysical Methods of Ocean Prospecting, Gelendzhik]

[Abstract] The ATsTM-1 instrument is a digital single-channel thermal gradient meter, based on registry of difference signals corresponding to the gradient measured in the bottom layer of the water and the gradient measured in the bottom sediment. The device automatically operates in a cycle of one measurement per minute for 64 minutes, optionally with a delayed start time to allow the instrument to be lowered to the depth of interest. After the 64-minute program, the memory unit of the device contains 64 temperature difference values. After it is returned to the ship, the device is connected to a printer which prints out the 64 readings. Figures 4; references 5: 4 Russian, 1 Western.

6508/9835  
CSO: 1865/203

## MARGINAL GLACIAL FORMATIONS ON OCEAN BED

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 19 Jan 84, after revision 12 Nov 84) pp 967-975

[Article by G.G. Matishov, Murmansk Marine Biology Institute, Dalniye Zelentsy]

[Abstract] Ancient continental ice, moving over the shelf plains of the ocean in the polar and temperate latitudes, produced a system of deep marginal and transverse trenches. The most significant forms of glacial shelf relief are the underwater morainal ridges, narrow, symmetrical ridges 25-100 m in height, extending in arcs along the shelf for many miles. Marginal morainal ridges are found primarily along the littoral edge of monoclinic elevations, structural and basaltic plateaus. The structure of such ridges is examined in the examples of Labrador and Barents shelves. The specifics of these marginal glacial formations indicate major stages or epochs in the development of the glacial cover of the shelf. During the stage of maximum development the continental ice covered the littoral shelf, filling the marginal trenches and extending far out onto the stratal accumulative plains. In many regions the glaciers reached the outer edge of the shelf and between banks, the glaciers extended into the zone of the continental slope. Glacier-accumulative forms were generated under these conditions both during the advance of the ancient ice cover and during its degradation. The deglaciation process was accompanied by oscillations and isolation of large dead ice fields. Figures 3; references 19: 8 Russian, 11 Western.

6508/9835  
CSO: 1865/203

MODELING OF SYNOPTIC VARIABILITY OF LARGE-SCALE OCEAN CIRCULATION  
(EXEMPLIFIED BY NORTH ATLANTIC)

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 8 Jul 85, after revision 6 Jan 86) pp 885-891

[Article by D.G. Seidov, A.D. Marushkevich and D.A. Nechayev, Oceanology Institute imeni P.P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] Previous studies have numerically modeled large-scale ocean circulation with allowance for synoptic-scale meanders, rings and eddies. However, highly idealized models were used, with computations made for rectangular areas, ignoring bottom relief and basin geometry. In the latest series of eddy-resolving experiments, two grids were used to calculate

the evolution of hydrophysical fields: One was for computing integral eddies, the other, coarser grid, for computing temperature field evolution. Water density was assumed to vary only with temperature. A series of diagnostic and prognostic experiments was performed. The effects found in the diagnostic calculations were seen more strongly in the prognostic experiments in which a relationship existed between the baroclinic and barotropic modes of motion. The temperature field at the beginning of the prognostic experiment was assigned from a temperature atlas, the heat flux through the surface was assumed proportional to the temperature difference between the effective atmospheric temperature and the water surface temperature. The calculations confirmed previous computations, indicating that synoptic eddies are maintained by the effect of negative viscosity of the gradient of large-scale hydrophysical fields. The major zone of circulation is the frontal zone of the Gulf Stream. A series of maps of anomalies at intervals of 6 days shows a continuous chain of strongly interacting eddies, moving from northeast to southwest at 10 to 50 cm/s or more. The eddies, 200-300 km in diameter, are centered south of the Gulf Stream. Figures 2; references 16: 9 Russian, 7 Western.

6508/9835  
CSO: 1865/203

UDC 551.463.613

#### FORMATION OF INTRATHERMOCLINE EDDIES IN CANARY UPWELLING REGION

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 10 Apr 85, after revision 25 Oct 85) pp 892-895

[Article by A.G. Kostyanoy and V.B. Rodionov, Oceanology Institute, Academy of Sciences, Moscow]

[Abstract] The 40th cruise of the research vessel "Akademik Kurchatov" included complex hydrophysical, hydrochemical and hydrobiological research in the region of the Canary upwelling. Two synoptic temperature and salinity surveys of the ocean surface and six hydrologic latitudinal sections between 21°08' and 22°20'N, limited by the meridians 17° and 18°W, were executed on 12 and 22 October 1984, each section including 4 to 6 bathometric stations. The results indicate that there were no clear upwelling events on those dates. On 22 October there was a cold spot about 20 km in diameter. A hydrologic section 5 km south of its center revealed unusual temperature, salinity and related density distribution, the curves of these factors for various depths forming "lens" shapes. Surface hydrooptic measurements confirmed the genetic relationship of the anomaly with upwelling water rich in biogenic elements. The appearance of such cold spots in upwelling areas may be related to the formation not only of cyclones, but also of subsurface anti-cyclonic eddies, their gradual disappearance with the combined effect of surface warming and dissipation of the eddies. Figures 2; references 12: 4 Russian, 8 Western.

6508/9835  
CSO: 1865/203

UDC 551.466

PROPAGATION OF LONG NONLINEAR WAVES ON SURFACE OF LIQUID OF VARIABLE DEPTH

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 12, Dec 86 (manuscript received 23 May 85) pp 1317-1321

[Article by Yu.A. Yegorov and I.A. Molotkov, Leningrad State University  
imeni A.A. Zhdanov]

[Abstract] An equation is derived for long, nonlinear waves on the surface  
of a liquid of variable depth. The evolution of a single-soliton impulse is  
studied asymptotically. The evolution of waves on shelves of various slopes  
is studied numerically. Figures 3; references 8: 5 Russian, 3 Western.

6508/9835  
CSO: 1865/200

UDC 551.583

CHANGES IN CLIMATE DURING 20th and 21st CENTURIES (A REVIEW)

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 12, Dec 86 (manuscript received 26 May 86) pp 1235-1252

[Article by G.S. Golitsyn, Atmospheric Physics Institute, USSR Academy  
of Sciences]

[Abstract] This review of the Soviet and Western literature is based largely  
on a United Nations Conference held in Austria 9-15 Oct 1985, entitled  
"Estimating the Role of Carbon Dioxide Gas and Other Greenhouse Gases in  
Changes of the Climate and Related Results," which was preceded by two  
years work under the leadership of the International Meteorological Institute  
of Stockholm University, producing an "international estimate of the role of  
carbon dioxide and other radiation-active components in variations of the  
climate and related effects." Papers presented at the conference discussed  
the CO<sub>2</sub> cycle and CO<sub>2</sub> concentrations in the past, including an estimate of  
the change in CO<sub>2</sub> concentration over the past 250 years; the significance of  
other radiation-active gases in the atmosphere; changes in the climate of  
the Earth over time; changes in sea level; the influence of changes in the  
atmospheric composition and climate on the ecosystem, agriculture and  
forests. The announcement of the conference is reproduced in an appendix.  
Figures 5; references 58: 27 Russian, 31 Western.

6508/9835  
CSO: 1865/200

FLOW MEANDERING CURRENT AROUND BOTTOM RELIEF

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 12, Dec 86 (manuscript received 31 Oct 85, after revision  
7 Jan 86) pp 1300-1308

[Article by V.N. Zyryanov, Water Problems Institute, USSR Academy of Sciences]

[Abstract] A study was made of the behavior and parameters of a meandering zonal current and specifics of flow of a meandering easterly zonal current around meridional and zonal ridges, as well as submerged banks. It was found that a meandering zonal current leads to new vortical formations above submerged bottom relief elements. Figures 3; references 10: 8 Russian, 2 Western.

6508/9835  
CSO: 1865/200

CALCULATION OF MOMENTUM AND ENERGY FLOWS TOWARD DEVELOPING WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 12, Dec 86 (manuscript received 3 May 85, after revision  
20 Sep 85) pp 1309-1316

[Article by V.K. Makin and D.V. Chalikov, Oceanology Institute,  
USSR Academy of Sciences]

[Abstract] Expressions describing the dynamic interaction of winds and waves were formulated from the equations of motion of a fluid above an arbitrarily moving surface by numerical solution of the two-dimensional nonlinear Reynolds equations, derived in a special curved system of coordinates related to the wave profile. A dimensionless form of the equations is used, selecting the horizontal velocity at the upper boundary of the boundary layer as the dimensionless velocity. The energy and momentum flow spectra resulting from the velocity fields are positive at the surface, changing their sign rapidly and growing at higher levels, then diminishing rapidly. The energy flow spectrum is small and attenuates rapidly due to turbulence. Figures 3; references 11: 6 Russian, 5 Western.

6508/9835  
CSO: 1865/200

## STATISTICAL PREDICTABILITY OF MEAN MONTHLY OCEAN SURFACE TEMPERATURES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 11, Nov 86 (manuscript received 29 Aug 84; after revision  
24 Jul 85) pp 1177-1185

[Article by A.G. Ostrovskiy and L.I. Piterbarg, Oceanology Institute,  
USSR Academy of Sciences]

[Abstract] This article discusses the possibility of predicting ocean surface temperatures a month in advance, assuming that the norm of main multiannual seasonal value of ocean surface temperature is well known for each point in the area in question, so that the discussion is reduced to the problem of predicting deviations from the norm. Initial information used is the field of mean monthly values of surface temperature anomalies during previous months. An estimate is made of the gain in predictability resulting from consideration of three-dimensional relationships in the ocean surface temperature field. The minimum possible relative prediction error is estimated for fixed scales of three-dimensional averaging of initial data and assigned measurement error levels. It is noted that improvement of measurement accuracy and spatial resolution by decreasing grid-interval size can improve the quality of predictions generated by the model. Figures 4; references 14: 18 Russian, 6 Western.

6508/9835

CSO: 1865/167

## STRUCTURE OF TWO-PHASE MEDIUM FORMED BY BREAKING OF WIND WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 11, Nov 86 (manuscript received 6 Sep 84) pp 1186-1193

[Article by V.S. Bezzabotnov, R.S. Bortkovskiy and D.F. Timanovskiy,  
Leningrad Hydrometeorological Institute; Main Geophysical Observatory]

[Abstract] Cameras on floats were used to take photographs vertically downward onto the water surface and horizontally 10 cm beneath the water surface as wind waves broke past the cameras in the Kuroshio zone. Photographs were taken as a breaking wave passed and at intervals of 1 second for 2 to 6 seconds after passage of the wave crest. Bar charts are presented showing distribution of bubble diameters at the surface and at 10-cm depth. The distribution of bubble concentration by bubble size and volumetric air content at 10-cm depth as a function of wind speed is also graphed. A significant difference in the distribution of bubble diameters

is found between bubbles in the crest and bubbles in the wake of a wave which has passed. Smaller diameters are much more prevalent in the crest. At 10-cm depth, the structure of the two-phase medium depends on the intensity of the breaking wave and speed of movement of particles within the wave. Mean bubble diameters are related to wind speed. Data obtained previously in the Baltic and Caspian Seas differed significantly from these Pacific Ocean data, confirming the influence of salinity on the intensity of foam formation previously observed under laboratory conditions. Figures 6; references 15: 9 Russian, 6 Western.

6508/9835  
CSO: 1865/167

#### YACHTS USED IN ELECTROMAGNETIC RESEARCH IN BLACK SEA

Moscow ZEMLYA I VSELENNAYA in Russian No 5, Sep-Oct 86

[Article by M.S. Zhdanov, doctor of physical and mathematical sciences, O.A. Kovalenko, candidate of physical and mathematical sciences, and S.M. Korotayev, candidate of physical and mathematical sciences]

[Abstract] In late 1980 it was decided that a yacht would be used in carrying out electromagnetic research in the western part of the Black Sea. The vessel selected was the yacht "A. Grin," with a displacement of 11 tons. The first such expedition was undertaken in July 1981 and was for collecting data to be used in constructing a geoelectric model of the transition zone from the continent to the abyssal part of the Black Sea. Two methods were used, ensuring cross-checking of data: magnetotelluric sounding and magneto-hydrodynamic profiling. In 1982 research was continued in the southwestern area and a new method was added: electrovariation profiling. In the spring of 1984 IZMIRAN (Terrestrial Magnetism, Ionosphere and Radio Wave Propagation Institute) acquired its own yacht, the "Viktoriya," intended specially for electromagnetic research at sea. This vessel, with a displacement of 7 tons, carries a 7-man crew. In research along the Bulgarian shelf and continental slope Russian and Bulgarian specialists discovered a geothermal anomaly over the Prisklonyy fault. It was postulated that this anomaly might be caused by a flow of ground water along the fault. Several years ago IZMIRAN specialists reasoned that a filtration effect exists which is measurable even with very small filtration rates of about 0.001 mm/s. One of the first research tasks of the "Viktoriya" was the checking of the filtration concept in the Prisklonyy fault. The cruise began in August 1984 and the postulated filtration anomaly of the electric field was soon detected. The filtration rate was found to be 0.01 mm/s. In addition, indirect confirmation was obtained that the crust in the western part of the Black Sea has experienced recent crustal subsidence. The use of all three methods mentioned above has continued. The "Viktoriya" is not the only such vessel in use in the USSR: the "Svetlana" is being used by the Pacific Ocean Oceanological Institute; the "Sprey" is owned by the Water Problems Institute; and Odessa State University will soon acquire such a ship. Figures 4.

5303/9835  
CSO: 1865/164

## MICROAREA STUDY OF MAGNETIC SUSCEPTIBILITY OF ROCKS

Moscow RAZVEDKA I OKHRANA NEDR in Russian No 10, Oct 86 pp 48-49

[Article by O.S. Kornev, Marine Geology and Geophysics Institute, Far Eastern Scientific Center]

[Abstract] Traditional methods for determining the magnetic susceptibility of rocks have many deficiencies. Accordingly, an improved method is proposed for studying the pattern of distribution of ferromagnetics in rocks. The method involves measurement of the magnetic susceptibility of a geological body in small (about 1-0,5 m<sup>2</sup>) areas with subsequent construction of maps (plans) of equal values of this parameter. The areas are selected on even surfaces arising along joints or during marine, fluvial or glacial abrasion. Microarea measurements of magnetic susceptibility were made within the limits of granitoid complexes using a kappameter. The measurements revealed that such areas need not exceed 1 m<sup>2</sup>, with 0.25 m<sup>2</sup> being adequate in certain formations. The method can be used in geophysical and geological research. The method gives reliable parameters of magnetic susceptibility of rocks within a particular body, virtually excluding the randomness factor associated with the taking of samples in a thin network of measurements in the field. The method can also serve as a supplementary source of information in studying the internal structure of geological bodies, in ascertaining whether isolated blocks or shows belong to one part of an intrusion or another and in discriminating magmatic formations amidst complexes of differing age. Since sedimentary rocks are also easily differentiated on the basis of the distribution of ferromagnetics, they can also be differentiated on the basis of the morphology of the field of magnetic susceptibility. This can be used as an additional criterion of the stratification of monotonic strata. The simplicity of the new measurement method makes it easy to obtain results directly in the field. References: 3 Russian.

5303/9835

CSO: 1865/112

UDC 556.3:[550.8.012:528](084.3)

## METHODS FOR MAPPING GEOTHERMAL FIELD IN ACTIVE WATER EXCHANGE ZONE

Moscow RAZVEDKA I OKHRANA NEDR in Russian No 10, Oct 86 pp 49-54

[Article by N.M. Frolov, All-Union Scientific Research Institute of Hydrogeology and Engineering Geology]

[Abstract] A fundamentally new method has been proposed for mapping the geothermal field in the zone of active water exchange. It involves scaling of measured temperatures to the level plane and on this plane compilation of

a geoisotherm map on a transparent base by interpolation and its subsequent matching with a hypsometric map, making it possible with a limited number of experimental data to obtain an unlimited number of computation points with relief taken into account. The hypsogeothermal gradient plays a key role in this method. An a priori value is assigned to this gradient. A more precise method is also proposed for determining the hypsogeothermal gradient for each specific region, based on measurement of mean multiyear soil temperatures or single measurements of rock temperature at identical depths, but with different elevations of the temperature measurement points above sea level. The hypsogeothermal gradient is computed as the ratio of the temperatures measured at two points to the difference in the elevations of these points. Since even the latter method does not always make possible a reliable determination of the hypsometric gradient, an even more precise procedure is recommended. An example is given to illustrate the method. Using the new procedures for determining the geothermal gradient it is possible to compile more precise maps of the geothermal field, regardless of the complexity of conditions. A formula is derived which can serve as an algorithm for a curve plotter, making it possible to assign map compilation work to an electronic computer. Figures 3; references: 4 Russian.

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CSO: 11865/112

UDC 551.462.64:553.64(265/266)

#### SOME CHARACTERISTICS OF PHOSPHATIZATION ON PACIFIC OCEAN SEAMOUNTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOLOGICHESKAYA in Russian  
No 10, Oct 86 (manuscript received 29 Apr 85) pp 111-121

[Article by V.N. Svalnov and V.V. Matveyenkov, Oceanology Institute, USSR Academy of Sciences, Moscow]

[Abstract] There is no unanimity of opinion concerning the origin of the phosphorites on Pacific Ocean seamounts. This may be attributable to attempts to isolate a single mechanism of phosphatization, which is improbable considering the complex pelagic conditions of the ocean and its long history of development. The mineralogical composition of phosphatized formations from several such seamounts was investigated. It is postulated that these formations are a result of the vein-metasomatic phosphatization of rocks at the expense of the phosphorus in sea bottom water and sea mineralized solutions, the products of post-volcanic activity in regions of extensive development of alkaline and subalkaline magmatism. The phosphatized rocks were collected during cruises of the "Vityaz" and "Dmitriy Mendeleev" in the neighborhood of the Marcus-Necker seamounts and in the northern part of the Kapingamarangi Plateau. The samples were recovered by trawlings and dredgings and from a submersible. The observations in each area are described in detail. Analyses of the collected material and underwater photographs clearly suggest that the main source of phosphorus on guyots

and seamounts was submarine volcanoes in the final stage of their development. The vein-metasomatic phosphatization resulted from postmagmatic emanations of volcanoes consisting of alkaline and subalkaline basalts. In the Marcus-Necker area there were two types of phosphatization--shallow-water Cretaceous and abyssal Eocene, whereas in the Kapingamarangi Plateau area there was abyssal Late Miocene phosphatization. The phosphatization stages were accompanied by the zeolitization of rocks and the formation of ferromanganese encrustations. Figures 4; references 20: 13 Russian, 7 Western.

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UDC 561:581.33.551.763.1(261/264)

PALYNOLOGICAL STUDY OF LOWER CRETACEOUS DEPOSITS IN CENTRAL ATLANTIC OCEAN

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOLOGICHESKAYA in Russian  
No 10, Oct 86 (manuscript received 2 Jul 85) pp 82-92

[Article by I.Z. Kotova, Geology Institute, USSR Academy of Sciences,  
Moscow]

[Abstract] Specialists at the Geology Institute are continuing research on palynocomplexes from Mesozoic deposits penetrated by deep drilling in the Atlantic Ocean. This research is being done for studying the stratigraphic position of palynocomplexes, clarifying their latitudinal distribution and more precise determination of the boundaries of phytogeographic provinces and regions in the Mesozoic. This article gives the results of study of palynocomplexes of Lower Cretaceous deposits penetrated by boreholes drilled in the central Atlantic in the Deep Drilling Project. These holes were situated in two adjacent regions (European-Sinian and Equatorial), regarded as interesting with respect to the sequence of palynocomplexes, breakdown and correlation of Cretaceous deposits or paleogeography. DDP samples were used; the samples were from holes 398D, 391C, 416A, 370 and 397A. Five different palynocomplexes were defined and the change in their composition with transition from the European-Sinian region to the Equatorial region was determined. These five palynocomplexes (described in detail) are: Berriasian-Hauterivian; Berremian; Aptian; Albian; Upper Albian-Lower Cenomanian. These data indicate that the boundary between the two regions passed to the south of the Blake Plateau. The age of the palynocomplexes in some cases was validated by nannoplankton, foraminifera and ammonites. The similarity and difference of the complexes of the same age from these regions are outlined. Figures 1; references 24: 2 Russian, 22 Western.

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CSO: 1865/107

## MEASURING PROBABILISTIC DISTRIBUTION OF SEA SURFACE CURVATURE RADII

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 10, Oct 86 (manuscript received 12 Feb 85, after revision  
10 Jun 85) pp 1115-1117

[Article by I.B. Yesipov, K.A. Naugolnykh, V.N. Nosov and S.Yu. Pashin,  
Acoustics Institute, USSR Academy of Sciences]

[Abstract] J. Wu (J. OPT. SOC AMERICA, Vol 61, No 7, pp 852-858, 1970)  
made what has been the most thorough study of the probabilistic distribution  
of curvature radii of a water surface as a function of wind speed, but that  
research was limited to a laboratory experiment. Accordingly, an experiment  
was carried out both in the laboratory and in situ. The optical measurement  
method described by Wu was used in this work. Optical sounding of the wave-  
covered water surface was by a thin light ray with a circular cross section.  
The intensity of an individual light pulse registered by a photodetector upon  
reflection of the light beam from a mirror point is unambiguously related to  
surface curvature at the reflection point, making it possible to determine  
curvature radius. Measurement reliability was increased by using light ray  
scanning of large water surface areas. The optical sounder was mounted on  
the deck of a scientific research ship at a distance 5 m from the water  
surface and scanning was across the direction of ship movement. The light  
source was a He-Ne laser with a power 4 mW. The laser ray scanning angle,  
reckoned from the vertical, was  $\pm 0.15$  rad. The scanning rate was 6 rad/s  
and the spot on the sea surface measured  $\sim 1$  cm. The experiment indicated that  
it is not only possible to make remote measurements of the radius of curvature  
of the wave-covered water surface, but also to register the variability of  
the radii of curvature of the surface waves with a change in wind speed,  
surface currents and displacement of the thermocline. Figures 5;  
references 8: 5 Russian, 3 Western.

5303/9835

CSO: 1865/130

## INFLUENCE OF AEROSOL EXTINCTION AND VARIATIONS OF METEOROLOGICAL PARAMETERS ON ACCURACY IN DETERMINING OCEAN SURFACE TEMPERATURE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22, No 10, Oct 86 (manuscript received 2 Jan 85, after revision 9 Dec 85) pp 1109-1112

[Article by S.V. Afonin, A.G. Gendrin and V.V. Fomin, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences]

[Abstract] The problem of determining ocean surface temperature has been solved by a new method involving the numerical modeling of the mechanisms of extinction and transfer of radiation in the atmosphere. The following radiation model was used. Continuum water vapor absorption is taken into account using line wing theory formulas. Selective absorption by the lines of atmospheric gases is taken into account using the formulas for Lorenz, Voigt and generalized contours of spectral lines and also transformation of contour shape with height. Numerical integration is carried out for a stipulated spectral range using an adaptive integration procedure. The atmosphere is nonuniform in altitude and is broken down into 30 layers with a thickness of 1 km, in each of which pressure, temperature, humidity, concentrations of atmospheric gases and coefficients of extinction and absorption by aerosol are stipulated. The range 10.5-12.5  $\mu\text{m}$  was selected for studying the influence of temperature and humidity variations on the accuracy in determining ocean surface temperature. In this range computations were made of the intensity of outgoing thermal radiation for spectral intervals from 800 to 960  $\text{cm}^{-1}$  and a resolution 10  $\text{cm}^{-1}$ . A summer tropical model with an ocean surface temperature  $T_s = 300$  K and an emissivity equal to 1 was selected as a meteorological model. The meteorological and radiation models were used in computing the corrections  $\Delta T = T_s - T_r$ , where  $T_r$  is the radiation temperature obtained from the Planck formulas for the intensity of outgoing long-wave radiation.  $T_r$  was computed for a series of distorted profiles and the  $\delta T$  value, equal to the difference of the radiation temperatures obtained for the initial and distorted profiles, was computed. The  $\delta T$  value reflects the influence of variations of meteorological parameters on  $T_r$  and the accuracy in determining ocean surface temperature. The results are given in a series of graphs. It is concluded that the neglecting of aerosol extinction, even in a slightly turbid atmosphere, in the case of high values of the coefficient of molecular extinction, may result in substantial errors in determining ocean surface temperature and does not make it possible to achieve an accuracy of  $\pm 1$  K. Figures 4; references 5: 4 Russian, 1 Western.

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CSO: 1865/130

## EVOLUTION AND STRUCTURE OF INTRATHERMOCLINE EDDY

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 10, Oct 86 (manuscript received 28 Jan 85, after revision  
21 Jun 85) pp 1098-1105

[Article by A.G. Kostyanoy and G.I. Shapiro, Oceanology Institute, USSR  
Academy of Sciences]

[Abstract] In the ocean, in addition to synoptic eddies, there are highly baroclinic eddy formations which are concentrated in a relatively thin layer in the main oceanic thermocline or pycnocline. These surface eddy currents, intrathermocline eddies, have orbital velocities attaining 30 cm/s, a kinetic energy of 5-7 J/m<sup>3</sup> and a vertical extent from several tens to several hundreds of meters. In the density field the intrathermocline eddies are manifested in the form of near-circular isolated anomalies. The evolution and structure of an intrathermocline eddy lens were analyzed analytically and numerically in the approximation of a three-layer viscous rotating fluid with small Kibel numbers. The evolution of the density field and the three-dimensional velocity field in the eddy lens and in the surrounding fluid were computed. Formulas were derived showing that the dimensionless dependence of the lens radius on time is universal and is not sensitive to details in the initial density and velocity distributions. Experiments were carried out in a rotating apparatus. Two different methods were used for generating eddy lenses. The dependence of the radius of the eddy lens on time, its initial volume, density drop and Coriolis parameter was experimentally determined. The results of computations and experiments are in good qualitative agreement and have a satisfactory quantitative agreement in a wide range of change in the parameters determining the problem. Figures 6; references 19: 10 Russian, 9 Western.

5303/9835  
CSO: 1865/130

## EVOLUTION OF MEAN PARAMETERS OF GRAVITY WAVES ON CURRENT VARYING ALONG DIRECTION OF PROPAGATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 10, Oct 86 (manuscript received 10 Jun 85) pp 1089-1097

[Article by I.V. Lavrenov and V.V. Ryvkin, State Oceanographic Institute]

[Abstract] A new method is proposed for determining the mean parameters of gravity waves on a current varying along the direction of propagation. The

approach is based on a spectral representation of the wave field (real wind waves contain spectral components corresponding to different components of the wave vector). The geometrical optics approximation is used in obtaining a solution which takes into account both direct and return waves and which can be used in describing the change in the spatial two-dimensional spectrum of surface gravity waves on a horizontally nonuniform current which changes along the direction of propagation. After numerical integration of the solution it becomes possible, in dimensionless form, to construct nomograms characterizing the evolution of mean height, length and period of waves on the current. The theoretical results are compared with in situ observations, revealing a very satisfactory agreement. The results in certain respects differ from the classical study of M.S. Longuet-Higgins and R.W. Stewart (J. FLUID. MECH., No 10, pp 529-569, 1961). The conclusions are supported by in situ experimental data. Figures 4; references 8: 6 Russian, 2 Western.

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#### RADIATION REGIME OF GULF STREAM ENERGY ACTIVE REGION DURING WINTER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22, No 10, Oct 86 (manuscript received 30 Jan 86) pp 1082-1088

[Article by L.I. Koprova, Oceanology Institute, USSR Academy of Sciences]

[Abstract] The radiation regime of the Gulf Stream energy-active region was studied on the 5th cruise of the "Vityaz" during the period January-March 1984 in the area 35-41°N, 60-65°W, an area whose radiation regime has been poorly studied because it is characterized by severe storms which are unfavorable for actinometric measurements. Solar altitude is low, days are short, clouds are common, wind speeds are high and there is a great water-air temperature difference. During the periods 1-9 January, 18 January-2 February and 17 February-5 March 1984, during the light hours of day, continuous measurements were made of total (Q) and reflected (R) solar radiation and hourly measurements of direct solar radiation on perpendicular (S) and horizontal (Sl) surfaces. Scattered radiation (D), the long-wave balance (Bl) and the total radiation balance (B) were computed using hourly meteorological observations and measurements of the radiation temperature of the ocean surface made using an IR radiometer. The following are discussed in detail: statistical characteristics of radiation fluxes; influence of cloud cover on radiation; variability of ocean surface albedo; atmospheric transparency. It was found that the radiation balance values in the Gulf Stream zone are small. Since the heat expenditures on evaporation and turbulent exchange are very great, the total heat balance of the ocean surface in this energy-active zone is negative during winter. Figures 3; references: 5 Russian.

5303/9835  
CSO: 1865/130

## EXPERIMENTAL STUDY OF GENERATION OF CAPILLARY-GRAVITY RIPPLES BY HIGHLY NONLINEAR WAVES AT SURFACE OF DEEP FLUID

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22, No 10, Oct 86 (manuscript received 28 Feb 85, after revision 22 May 85) pp 1072-1081

[Article by S.A. Yermakov, K.D. Ruvinskiy, S.G. Salashin and G.I. Freydmann, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] A laboratory study was made of the generation of capillary-gravity ripples (CGR) by steep short surface waves (SSW). Some quantitative aspects of this phenomenon were investigated for the first time. Measurements were made of the dependence of steepness, wave length and frequency of ripples on the crest of a SSW on the amplitude and frequency of the latter. The attenuation of strong SSW was also measured and it is shown that it is related for the most part to the generation of ripples. The experiments were carried out in a flume measuring  $6 \times 0.3 \times 0.4$  m. The waves were generated at the water surface by a wave generator making it possible to change their frequency in the range 2-7 Hz (corresponding to a range of SSW length  $\lambda_s = 35-4$  cm). The experiments indicated that ripples begin to be generated with a steepness of SSW  $2a_s/\lambda_s^0 > 0.02$ . With a further increase in the amplitude of waves the steepness of the ripples on their crests increases rapidly up to values  $\theta_r \approx 0.4$  ( $\theta$  is steepness) with maximum attained SSW steepness  $2a_s/\lambda_s^0 \approx 0.1$ . There is also a rapid increase in the decrement of SSW associated with the generation of ripples to values by an order of magnitude exceeding the value in a linear approximation. A rapid increase in the decrement results in a stabilization of the amplitude of SSW generated by the wind. The wave length of the ripples on the crests of strong SSW virtually does not change with a change in their amplitude and frequency and is equal to about 0.5 cm. Under natural conditions, at least when there is a weak wind, when the generation of CGR is associated for the most part with their generation on SSW crests, not direct generation in the wind field, the spectrum of slopes of CGR must have a maximum at  $\lambda_r \approx 0.5$  cm; this must be taken into account when developing methods for remote sounding of the ocean surface. The nonlinear attenuation of SSW as a result of the generation of CGR on their crests may exert an influence on the processes of self-modulation of SSW and the processes of their interaction with internal waves and can also cause a dependence of the attenuation (or increase) in surface waves in the decimeter and meter ranges on the characteristics of the short-wave part of wind waves. Such studies are important because the process of generation of CGR on the crests of SSW can exert a considerable influence on many phenomena at the ocean surface. Figures 7; references 16: 9 Russian, 7 Western.

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CSO: 1865/130

## BLACK SEA SUBMARINE CANYONS

Kiev GEOLOGICHESKIY ZHURNAL in Russian Vol 46, No 6, Nov-Dec 86  
(manuscript received 27 May 86) pp 72-79

[Article by V.I. Melnik, Geological Sciences Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] The importance of study of submarine canyons in the Black Sea long remained unappreciated and there were few or no data published on this subject until the late 1970's. Few depth measurements had been made which could be used in studying the morphology and morphometry of these canyons. Serious study did not begin until after 1977, with work being done from such research ships as the "Mikhail Lomonosov" and "Okean." Since then an enormous volume of work has been done in studying the morphology and bottom sediments of these canyons with about 50,000 km of echo soundings; 1,000 cores of bottom sediments have been obtained and up to 50 dredgings have been carried out. These have made it possible to map the distribution and types of sediments in different morphological elements of canyons and the "divides" separating them. Soundings were made with distances between runs of 250 m and 2 km, depending on circumstances. Some canyons were studied using submersibles. The literature itself contains little information on the distribution, morphology and even location of the canyons, other than for the southeastern margin of the sea. There has been no complete map of these formations, but this gap has now been filled by preparation of such a map, which accompanies the text. This map shows about 150 canyons on the continental slope. The canyons have been classified as four types. Problems which still remain unsolved are discussed. Figures 3; references: 25 Russian.

5303/9835  
CSO: 1865/181

## ROLE OF RIVER RUNOFF AND VARIABILITY OF LIGHT EXTINCTION INDEX SPECTRA IN WATERS OF WESTERN PART OF ATLANTIC OCEAN TROPICAL ZONE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 292, No 1, Jan 87  
(manuscript received 20 Sep 85) pp 206-208

[Article by G.S. Karabashev and A.F. Kuleshov, Atlantic Division, Oceanology Institute imeni P.P. Shirshov, USSR Academy of Sciences, Kaliningrad]

[Abstract] A.S. Monin, et al. (DAN, Vol 273, No 6, pp 1482-1486, 1983) recently studied the hydrooptical influence of the Amazon on ocean areas up

up to 400 km from the mouth. Observations on the 40th cruise of the "Akademik Kurchatov" have made it possible to trace the influence of the Amazon on ocean optical properties at considerably greater distances from the mouth. Observations were made at points lying at coordinates 09°28.7'N, 54°41'W and 13°55'N, 52°19'W using a shipboard spectral transparency meter with a 1-m base and a spectral range 310-610 nm. The spectral curve of the extinction index of a collimated light beam was plotted for the water samples taken. The spectrum of the extinction index of impurities was ascertained. The changes in this index were not monotonic with increasing distance from the shore. The composition of the admixtures determining the spectral variation of the extinction index of sea water changed in such a way that the rate of increase of the extinction index decreased with salinity with a decrease in wavelength. The observations confirmed the conclusion drawn by Monin, et al. that there is a rapid settling of fluvial suspended matter from the upper layer of the ocean with north-westward movement of freshened waters from the Amazon mouth. (The observations were made at distances 1,000-1,200 km from the mouth, rather than 0-400 km in the first study.) At a considerable distance from the mouth the hydrooptical influence of the river on the ocean is difficult to detect in visible light but is clearly visible in the UV range. Figure 1; references 5: 4 Russian, 1 Western.

5303/9835  
CSO: 1865/230

UDC 551.35

MODEL OF DEPENDENCE OF ERROR IN GEOMETRICAL REPRESENTATION OF FERROMANGANESE NODULE DEPOSITS ON CONDITIONS FOR EXECUTING GEOLOGICAL PROSPECTING WORK

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 292, No 1, Jan 87  
(manuscript received 20 Sep 85) pp 164-167

[Article by I.N. Goryainov, I.S. Gramberg, corresponding member, USSR Academy of Sciences, and M.Kh. Melamud, All-Union Scientific Research Institute of Geology and Mineral Resources of the World Ocean, Leningrad]

[Abstract] The error in geometrical representation reflects the degree of correspondence between the true position and configuration of the contours of geological features and their cartographic rendition. Such errors can result in a change in the system for the working of deposits and an increase in expenditures on the output of a unit of ore mass. The occurrence and magnitude of the error in geometrical representation are analyzed as applicable to deposits of ferromanganese nodules present on the ocean floor. a formula has been derived for computing the dependence of the error in geometrical representation on the parameters of the sampling net. An important factor governing the magnitude of this error is the accuracy in horizontal referencing of Fe-Mn bodies on the ocean floor (this error can attain tens or hundreds of meters). Mathematical procedures are proposed

for determining and compensating for these errors. A special formula is derived for taking into account the ore-free zones within the outline of ore-rich deposits. A final formula is presented which makes it possible to ascertain the overall error in representation which takes all pertinent sources of error into account. Figures 3; references: 1 Russian.

5303/9835  
CSO: 1865/230

UDC 534.231

#### STATISTICAL PROPERTIES OF FIELD OF OCEANIC ACOUSTIC NOISE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 291, No 4, Dec 86  
(manuscript received 6 May 86) pp 982-984

[Article by V.P. Dzyuba, V.I. Ilichev, academician, and V.A. Shchurov, Pacific Ocean Oceanological Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Vladivostok]

[Abstract] The field of underwater acoustic noise is a superposition of independent isotropic and anisotropic components. The isotropic component is defined as that field component whose averaged flux through a unit oriented surface is equal to zero. The anisotropic field component is related to the spatial transfer of acoustic energy and its averaged flux through a unit surface is not equal to zero. Steady dynamic processes are the source of the isotropic component, whereas close and distant shipping and localized dynamic processes in the ocean are the source of the anisotropic component. It is demonstrated that separate study of these components makes it possible to obtain more reliable information on the hydrophysical parameters and the dependence of the level of acoustic noise on wind speed. The statistical properties of the isotropic and anisotropic fields were analyzed. The analysis revealed that for an isotropic field the  $\eta$  value is grouped near 2, whereas for an anisotropic field  $\eta$  is grouped in the neighborhood of unity ( $\eta$  is the ratio of the dispersion of energy density to the power flux density). If the field is a superposition of isotropic and anisotropic fields commensurable in intensity, the  $\eta$  value falls in the interval  $1 < \eta < 2$ . In the frequency band from 300 and 500-550 Hz the main field energy is associated with a propagating signal and therefore the field is anisotropic; in the frequency band 300-500 and above 500 Hz the field has a significant isotropic component. The  $\eta$  values computed from the total power flux in the band 20-1000 Hz for the acoustic noise of 10 different regions of the ocean are given. The formulas presented and the calculations made on their basis therefore show that the degree of isotropicity is dependent on frequency and is related to the energy density-power flux density dispersions ratio, whereas in an isotropic field the acoustic pressure and oscillatory velocity are Gaussian and statistically independent. Figures 3; references 4: 3 Russian, 1 Western.

5303/9835  
CSO: 1865/171

## AZIMUTHAL DEPENDENCE OF FREQUENCY SPECTRA OF SOUND SCATTERED BY OCEAN SURFACE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 291, No 4, Dec 86  
(manuscript received 29 Jul 85) pp 979-981

[Article by I.B. Andreyeva, A.V. Volkova and Ye.A. Kopyl, Acoustics  
Institute imeni akademik N.N. Andreyev, Moscow]

[Abstract] Data are given on in situ measurements of the frequency spectra of acoustic signals in the ocean backscattered by the wave-covered surface. The results indicate the inapplicability of a linear hydrodynamic model to decimeter surface regularities and this gives rise to a number of hypotheses concerning the nature of their movement. The spectra of scattered signals were measured from a drifting ship. Wind speed was about 8 m/s, sound frequency was 3 KHz, glancing angles were 2-13°. Under such conditions there is a Raman scattering on the resonance component of surface irregularities. The study revealed that the short-period ( $\lambda \approx 0,25$  m) components of the spatial spectrum of ocean surface irregularities do not conform to the laws following from linear hydrodynamic theory in that irregularities of resonance dimensions exist in any azimuthal direction but on the average move only in the direction of the wind. Assuming that the frequency shift is caused by the Doppler effect, the rate of movement of the resonance irregularities is close to 0.75 m/s, whereas the scatter of frequency values observed for any  $\varphi$  values ( $\varphi$  is the angle formed by the incidence-scattering plane and the wind direction) would correspond to velocity variations up to  $\pm 0,5$  m/s. A possible explanation of the observed effect is that small irregularities (ripples) are generated by the wind primarily on the crests of long waves; they are transported downwind by their orbital motion and attenuate upon entering the trough between crests. Figures 3; references 5: 3 Russian, 2 Western.

5303/9835  
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## OBSERVATION OF 'ANOMALOUS' RAMAN LIGHT SCATTERING SPECTRA ACCOMPANYING WATER-ICE PHASE TRANSITION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 291, No 4, Dec 86  
(manuscript received 27 Mar 86) pp 836-839

[Article by S.M. Glushkov, I.M. Panchishin and V.V. Fadeyev, Moscow State  
University imeni M.V. Lomonosov]

[Abstract] The article gives the first results of a study of the behavior of the Raman scattering bands of water at 3000-3800  $\text{cm}^{-1}$  accompanying the

water-ice phase transition. Since "anomalous" (for a temperature  $0^{\circ}\text{C}$ ) Raman scattering spectra were discovered, it seemed desirable to give a detailed description of the instrumentation and method. The experimental apparatus was essentially a Raman scattering spectrometer with registry of the scattered radiation at an angle  $90^{\circ}$  to the direction of the exciting light beam (the source was an argon laser). The radiation discriminated using the dispersion prism (wavelength 488 nm) was focused by a lens with  $f = 13$  cm at the center of a cell. The scattered radiation was transmitted through a filter and collected by a lens on the entrance slit of a polychromator of an OSA optical spectrum analyzer. The spectrum was registered in 500 channels; the polychromator dispersion was 0.13 nm per channel. The spectra were processed using a microcomputer connected to the OSA. The data were registered on magnetic disks and reproduced on a curve plotter. A sample with a volume of 25 ml was placed in a thermostated cell with a coolant. The studies were made using three water samples: distillate, doubly distilled water and bidistillate after distillation with potassium permanganate and sulfuric acid. "Anomalous" Raman scattering spectra were stably registered for all three samples, for different degrees of supercooling of water and with different rates of decrease in water temperature and for different rates of heat transfer in the crystallization process. The main contribution to change in the form of Raman scattering spectra accompanying a phase transition is from the change in state of polarization in the volume of the sample. This affords new possibilities in a study of the nature of solid phase nuclei and the dynamics of its growth and the use of Raman scattering spectra in the sounding of water bodies containing both the solid and liquid phases. Figures 4; references 8: 3 Russian, 5 Western.

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UDC 551.51

#### EDDY DYNAMICS AND SOUTHERN HEMISPHERE ATMOSPHERIC ENERGETICS AT CLIMATIC SCALES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 291, No 4, Dec 86  
(manuscript received 25 Sep 85) pp 817-822

[Article by V.F. Romanov and V.Ye. Lagun, Arctic and Antarctic Scientific Research Institute, Leningrad]

[Abstract] A description of the mechanisms of the influence of the properties of atmospheric eddy dynamics on climatic conditions is one of the key problems in the theory of climate. Atmospheric eddies of synoptic spatial ( $L_S$ ) and time ( $T_S$ ) scales are turbulent relative to mean movements of climatic scales. They are responsible for large-scale exchange and to a great extent determine energy exchange with the ocean and land surface. They are highly important in the energy supply of mean global circulation, directly determining climatic conditions. During periods  $T_C$  synoptic eddies (SE) are generated,

move, attain maximum development, become stationary and are filled in individual regions. The strongest energy exchange between the atmosphere and ocean is usually concentrated in these same regions. It is these "energy-active" regions which to a great extent determine the formation of weather and climatic conditions. With these factors taken into account, the authors clarify the mechanisms of formation of anomalies with active energy exchange during periods  $T_c$ , attributing it to the influence of the synoptic eddies concentrating here which stimulate energy exchange. This is done with emphasis on the southern hemisphere, where such processes, in general, have been poorly studied. The climatic eddies, forming in climatic fields in regions of high concentration of synoptic eddies, are investigated, especially the parameters of their energetics. It is shown that these parameters are consistent with the energy regime of the synoptic eddies (there is a similarity in the spatial structure, dynamics and energetics of synoptic eddies and seasonal climatic eddies in the case of climatic scales). There is a two-phase character of the dynamics of atmospheric movements at the scales  $T_c$ ,  $L_c$ . Figures 2; references 15: 13 Russian, 2 Western.

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UDC 553.065

#### PRESENT-DAY HYDROTHERMAL PROCESS IN RELATION TO CRUSTAL ENERGETICS

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 10, Oct 86 pp 3-10

[Article by V.A. Ilin, Geology Institute, USSR Academy of Sciences]

[Abstract] The problem of the Earth's energetics is formulated. The structure of energetics of present-day hydrothermal systems is outlined using a method developed by the author and their energy potential is compared with other geological processes responsible for formation of the Earth's crust. The energy effect of hydrothermal transformation of rocks was computed for five hydrothermal systems. It was found that the total specific thermal effect varies considerably from system to system; the younger the system, the greater is the heat absorption in its deeper layers; an increase in temperature in the deeper layers leads to the same effect. A study was made of the different mechanisms of energy transformation both within and at the surface of hydrothermal systems. A logical scheme of development of the hydrothermal system with time was prepared (Fig. 1). The block diagram of the hydrothermal process shows the interrelationships among exogenous and endogenous sources of matter and energy. There is no single source of the energy responsible for the genesis of hydrothermal systems. A research method is proposed for studying present-day hydrothermal systems which makes it possible to evaluate those processes which cannot be measured directly (such as expenditures on magma formation and the mobilization of waters). The interrelationship between the hydrothermal process and other

geological processes was studied as well. The proposed method (which includes an empirical formula) makes it possible to predict the possibility of commercial exploitation of any particular system. In the course of formation of the crust an energy of about  $6.7 \cdot 10^{18}$  J/year was absorbed due to hydrothermal changes of rocks. Figures 2; references: 11 Russian.

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CSO: 1865/114

## TERRESTRIAL GEOPHYSICS

### DISCOVERY OF HELIUM THE SAME AGE AS THE PLANET CONTRIBUTES TO VOLCANOLOGY

Leningrad TASS in Russian 1055 GMT 20 Dec 86

[Text] Leningrad, 20 December. The birth of our planet was not accompanied by such high temperatures as many people have previously thought. The depths of the earth heated up only later due to radioactive decomposition and tremendous pressures. Scientists of the Physical-Technical Institute of the USSR Academy of Sciences in Leningrad are backed up in this conviction by the discovery of "preserved" light isotopes of helium of space origin in the earth's crust.

As is known, helium was first discovered in the composition of solar particles; there are only minute amounts on our planet, explained Professor Boris Mamyryn from the Physical-Technical Institute. And if this element is encountered in the earth's atmosphere then it is mainly in the form of the "heavy" isotope helium-4. It was thought that there was virtually no "light" helium in the earth's crust and that this applied even more so to the depths of the earth.

The Leningrad physicists created a unique instrument capable of discovering and quantifying even atoms of substances in samples of rocks, water and air. Using this to seek "light" helium led to the discovery of a very rare natural phenomenon: it turned out that the depths of the planet contain thousands of times more of it than the crust. Moreover, samples taken from superdeep wells and volcanoes on continents, in the oceans and on distant islands displayed the same content of helium-3. The scientists are convinced that they have managed to find "solar" helium which 4,600 million years ago permeated the primary dust cloud which formed our planet.

The physicists' discovery has formed the basis of a new science, the isotope geochemistry of helium, which is now being widely used in various spheres of the earth sciences. Thus, the content of "light" helium can be used to forecast volcanic eruptions; if the thermal waters of the slopes of volcanoes register an increased content of helium-3, that means that large masses of hot magma have risen from the depths into the seat of the volcano.

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SEISMIC DATA MATHEMATICIAN DENIED EXIT VISA

Paris AFP in English 1120 gmt 10 Dec 86

[Text] Moscow, 10 Dec--Soviet authorities have denied mathematician Viktor Fulmakht permission to emigrate citing security reasons because he worked on Soviet nuclear test work in 1971 and 1972, Mr. Fulmakht said Wednesday.

He said he wrote to Soviet leader Mikhail Gorbachev in September requesting that a 1979 request for an exit visa be reconsidered because the 1985 Soviet ban on nuclear tests had introduced a new element to the case.

The mathematician said that six weeks later immigration authorities again rejected his request saying that his case would not be re-examined.

Mr. Fulmakht said that in 1971 and 1972 he had developed computer programs for the Soviet Geology Ministry to handle seismic data registered during underground nuclear tests.

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CSO: 1865/151-E

## OIL FOUND AT LESSER DEPTHS AND PRESSURES

Moscow Domestic Service in Russian 1330 GMT 25 Dec 86

[Text] A scientific discovery by Academicians Trofimuk and Cherskiy, Doctor of Geological and Mineralogical Sciences Tseroy and Candidate of Chemical Sciences Tseroka was today registered at the USSR Committee for Inventions and Discoveries. It widens the theoretical concept of the transformation of organic substances into hydrocarbons.

It used to be considered that oil and gas were formed of organic substances buried millions of years ago in sedimentary rock strata at depths of over 2 km, that this process occurred at definite pressures and temperatures of over 70-80°C. But from time to time geologists have found deposits of liquid fuel at lesser depths and at lower temperatures of rock-containing oil.

The Siberian scientists have proved that oil can be formed in the sedimentary stratum of the earth's crust even at plus 20 degrees and less pressures than had been envisaged.

The results of the scientific discovery make it possible to make a more expedient search for hydrocarbon raw material. The tectonic and seismic activity of the earth's interior becomes a new criterion for the assessment of prospects of regions being oil- and gas-bearing. Taking this criterion into consideration, sedimentary rocks up to 1 1/2 km thick may also be rich in liquid and gaseous fuel. These used to be considered unpromising.

No less important is another practical conclusion from the fundamental work. The author of the discovery considers that in the future it will be possible to build enterprises to produce oil and natural gas from brown coal, peat and other organic substances. This method of obtaining petroleum products may be more advantageous than the processing of hard coal into liquid synthetic fuel.

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CSO: 1865/153

## SEISMIC FOCUS IS KEY TO SEISMIC DANGER PROBLEM

Moscow NOVOSTI NAUKI I TEKHNIKI in English No 15, 3 Oct 86

[Article by Nikolai Shebalin, D. Sc. (Phys.-Math.), Head of the Strong Earthquakes Laboratory, Earth Physics Institute, USSR Academy of Sciences]

[Text] Earthquakes continue to be a terrible threat to humankind. Scientists often fail to predict them and protection against them is often ineffective. The reason for this is our inadequate knowledge of the formation and operation of sources of disastrous tremors--seismic foci.

A few years ago, many seismologists were sure that in the near future effective and universal methods of earthquake forecasting would be found. Now this confidence has nearly everywhere given way to deep scepticism: scientific, technical and socio-economic problems emerging in connection with the attempts to set up a service forecasting the time, place and magnitude of earthquakes thus far have not been solved. The best thing we can do now is to improve methods of forecasting the place and magnitude of future earthquakes (but not the time). This is seismic regionalization. In regions which are most thoroughly studied we can also detect--against the background of seismic regionalization maps--sections where in the next three to ten years strong underground tremors are probable. This work is known as long-term seismological forecasting. It helps to plan construction work more correctly; to abstain from building complex-technology enterprises, for instance, nuclear power stations or chemical plants, to restructure in proper time residential houses, schools, hospitals, etc. with proper account for possible tremors. The methods of erecting such buildings have been worked out quite well in many countries. However, calculations of expected seismic effects are not always accurate. That is why buildings are constructed with a large safety margin, which leads to over-expenditure of metal and cement and to a considerable rise in construction costs.

Are there any ways of breaking the deadlock in earthquake forecasting? How will it be possible to improve preliminary calculations (which actually are also forecasts) of the expected seismic effects of future earthquakes? Until recently, in earthquake forecasting and in methods of calculating seismic effects on structures, the situation was somewhat strange. Various phenomena at the earth's surface within the region under study were mainly analyzed, and no attention was given to the mechanism of the formation of these phenomena and their physical link with the source--the seismic focus.

As far as forecasting is concerned, these were forerunners--sudden anomalous changes of various physical parameters and chemical characteristics of the earth's interior in regions of observations. In aseismic construction these were records of strong earthquakes at the earth's surface--accelerograms. The records of forerunners and accelerograms were studied in detail. They were measured, processed, correlated and synthesized. Their spectra were plotted. But no one paid due attention to seismic foci and their origin.

Now we can say with confidence that key information for earthquake forecasting and for forecasting seismic effects on buildings is contained in the specific features of seismic foci. It is only by studying the relationship between seismic foci and the medium around them, their structure, regular features, formation and development that one can construct models of the formation of forerunners and models of seismic radiation. This is what we lack for solving the major tasks in combating earthquakes.

Seismic foci can be studied by different methods. For instance, it is possible to use records of remote seismic stations. From them one can determine rather easily--even from the other side of the globe--the position (coordinates and depth) of a seismic focus and its magnitude (the intensity of the focus on the Richter scale--one should not confuse it with the magnitude of an earthquake at the surface on the Mercalli scale or the Medvedev-Schponheuer-Karnick scale). It is even possible to determine the position of the plane of rupture in the focus, the direction of the shift in it and its seismic moment (the product of the area of the rupture and the average shift along this rupture). But this is not all: to discern the details of the focus and processes taking place in it, one must observe an earthquake at distances not more than 10-20 km from the rupture in the focus. How can one find himself near the seismic focus if we are unable to determine the exact place and time of its formation? For this it would be necessary to set up a dense network of seismic stations and observing stations: one every 20-30 kilometers. In this case it would be necessary to have several hundred observing stations in the Caucasus and several thousands of such stations in Central Asia and in Kazakhstan. It should be taken into account that the cost of seismic stations and observing stations is high and that their operation in deserts in summer or in highlands in winter is not very reliable.

We use another method in our studies. Large earthquakes often commence not as a single event but as pairs or as triple events in the same place or almost in the same place, with short time intervals (several days or weeks) between individual shocks. If one sets up a small compact network of stations in the epicenter immediately after a strong shock, one can hope to record a new strong shock there. This is what we do. In fifteen years, researchers of the Earth Physics Institute have made eight trips to epicentral zones of strong earthquakes and in two cases adequately recorded the second strong shock. The study of the second Gazli earthquake on 17 May 1976 was especially successful--the force 10 quake was excellently recorded directly at the epicenter.

In 1983, another unique opportunity presented itself: the focus of a relatively weak earthquake outcropped. It came to the earth's surface in the form of a meandering fissure more than 20 kilometers long and several millimeters wide, with the longitudinal shift of the opposite edges of the fissure by 15 to 25 cm.

What new things have we learned today about seismic foci? The main part of the focus is the revived fissure in the earth's depths. The cleft does not get wider due to the pressure of the earth's rock mass. Its edges only shift by several centimeters or meters relative to one another depending on the size of the fissure itself. The size of the fissures varies from hundreds of meters to hundreds of kilometers. This basically determines the magnitude of earthquake foci on the Richter scale and their seismic moment. Earthquake foci with a main fissure of about a kilometer have a magnitude of about force 4 on the Richter scale. Such foci at the earth's surface manifest themselves depending on how deep-seated they are in the earth's rock mass. At a depth of 50 km they practically are not determined, while at a depth of 5 km the shocks can reach force 6 in the epicenter. But if a fissure reaches 30-50 km in length and 10-20 km vertically, it is already difficult for it to hide in the earth's thin crust. (Usually the crust's thickness does not exceed 30-50 km and in the oceans it is still thinner.) The magnitude of the focus with such a fissure reaches force 7 on the Richter scale while the magnitude of oscillations in the epicenter exceeds force 9.

Much depends on the way the fissure in the focus opens. If the old focus which repeatedly operated for millions of years starts acting, the movement along the smoothed fissure takes place rather easily. The movement becomes sluggish and with a low frequency. The focus turns out to be large, and its dangerous hard short-period radiation gets weak. But if over many years geological processes have led to the formation of ledges on this fissure, even a smooth fissure cannot move without destroying these "locks". When at the moment of an earthquake these ledges are crushed and crumbled, intensive short-period oscillations are generated, leading to a sharp increase in the destructive effect of the focus.

"Young" foci with recently formed fissures are still more dangerous: their surface is uneven and meandering, and the radiation of such foci is very abundant in dangerous short-period oscillations. In the course of an earthquake such a focus often opens step by step and not immediately. The fissure opens by leaps from one large ledge to another. The entire process can be seen in the records of oscillations if they are specially processed for removing the distorting effect of a recorder and for restoring the true movement of the soil near the focus. Today our methods enable us to measure residual, step-like movements of the soil by seismic methods and to compare them with the results of repeated geodetic measurements. Studies of interrupted movements in earthquake foci, with due account of the specific geological situation, enables us to better plot synthetic accelerograms--recordings of future earthquakes.

When, from studying individual foci of earthquakes we started studying their combinations, we were in for a lot of surprises. It turned out that as far as foci with different magnitudes are concerned, one can estimate the size of the region of their preparation and see that seismic foci behave almost as different sections in a caste society: large foci ignore small foci which come into existence in their vicinity; small foci weakly react to the preparation of enormous volumes of the earth's crust for the formation of the foci of seismic catastrophes. Families of earthquake foci behave differently in different geological conditions. In young heated plastic zones of the modern folded mountain building of the Alpine type, earthquake foci appear in clusters. Seismic cycles are not clearly distinct here and the role of the plastic flow of matter is great. On the contrary, in ancient congealed regions systems of blocks and fissures exist for tens of millions of years. Blocks constantly move here, earthquake foci emerge in strips along their boundaries, and at the time of their emergence, periods of the repetition of seismic cycles are clearly noticeable. Apparently the mechanism of the formation of the forerunners of earthquakes differs in these regions, and the future earthquake forecasting system will no doubt take these differences into account. It is no accident that long-term seismic forecasting methods develop more successfully precisely in block tectonic regions, for instance in China and Tajikistan.

The work described above certainly does not cover all the studies of earthquakes conducted in the Soviet Union. Studies of the seismic regime and of the stressed state of the earth's depths and the laboratory modeling of foci gradually expand the knowledge we need for combating seismic danger. We know exactly that the prime source of all disasters caused by quakes is the seismic focus. It is only by observing the emergence and development of this focus that we can hope to solve the problems of earthquake forecasting and aseismic construction which are so important for human society.

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SOVIET SCIENTISTS SIMULATE ROCK-FORMATION PROCESSES

Leningrad TASS in English 20 Jan 87

[Text] Leningrad, 20 January. Soviet scientists have simulated in laboratory conditions rock- and mineral-formation processes taking place in the Earth's deep layers.

The scientists have developed a unique apparatus complex which helps obtain the pressure and temperature adequately at a depth of 100 kilometers.

The complex makes it possible to study substance matter of such zones in the Earth's crust which earlier could be judged only by indirect data obtained with the help of geophysical instruments.

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## HOW DID HYDROCARBONS COME ABOUT?

Moscow NOVOSTI NAUKI I TEKHNIKI in English No 23 (106) 5 Dec 86

[Article by Georgi Afanasyev, APN]

[Text] There have been two conflicting views on the origin of oil for over two centuries now, neither of which, however, can explain that process from the beginning to the end. In the meantime, the oil explorers need a clear-cut and exhaustive theory explaining the conditions under which oil is formed and, consequently, in which geological structures it must be looked for. A new comprehensive hypothesis of a Soviet scientist, according to which oil forms as a result of the interplay of both biological and nonbiological factors, may well become just such a theory.

\* \* \*

Just like the French Academy of Sciences does not accept for consideration any perpetuum mobile projects, so is the problem of the origin of oil never examined at major international oil congresses in recent years. But the "two-hundred-year war" between the proponents of the "organic" and "non-organic" theories is not subsiding in the scientific world. The latest flare-up in that war was caused by Professor Thomas Gold of Cornell University in the US who was the initiator of the newly started exploration drilling near the Siljan lake 200 kilometers north of Stockholm. David Osborn from the Boston magazine ATLANTIC even writes in this connection that in the case of success of that drilling our notions about the origin of oil may collapse, referring to the organic theory.

Professor Viktor Gavrilov of the Moscow Institute of Oil and Gas thinks that such a confirmation of the nonorganic theory is not yet the proof that it is the only valid one. Indeed, the existing organic theory has been confirmed many times, has been instrumental in the discovery of practically all known oil-fields and yet there are still "dark areas" in that theory which remains incomplete until they are explained. In the same manner there are areas which defy explanation by the proponents of the nonorganic theory, which means that in this sense it is no better than the organic theory.

By the way, deposits of hydrocarbons in boundary and other rock of magmatic origin which makes up the continental platform (or what is being looked for at Siljan) have already been found in other places, These include the

Oimasha deposit on the Mangyshlak peninsula in the Caspian Sea (USSR), the Aujila oil-fields in Libya and about 200 other deposits.

In this manner, says Gavrilov, today we have two mutually exclusive concepts, each of which is confirmed by practice. This means that neither of them can be wrong and that each of them is valid to some extent. In other words, the proponents of the organic and inorganic theories describe two sides of the same coin.

There is a view that organic theory is purely empirical and appeared as a result of the generalization of known facts. The aforementioned David Osborn, for instance, quotes the words of one of the leading American oil explorers M. Halbooty: The conclusion about the biogenic origin of oil and gas has appeared because we needed a theory. We have found those fossil remains in sedimentary rock and come to the conclusion that where once chemical reactions had taken place, creating oil and gas, millions of living creatures had been buried earlier.

Now, this is not exactly how it really was. Both hypotheses had appeared long before the start of practical oil exploration. The organic theory was first voiced by the great Russian scientist Mikhail Lomonosov in the mid-18th century, and the inorganic by the German naturalist Alexander Humboldt in the beginning of the 19th century. In the beginning, neither was used in practice for what were perfectly good reasons: first, there was no real need for them since in those fabulous days oil often seeped up to the surface of its own accord and leaked from mountain sides; and second, the first oil merchangs were not particularly versed in theory.

The organic theory has been thoroughly analyzed and tried out since its original conception. Suffice it to say that there are dozens of variants of that theory today. Even so, it still contains a whole number of "obscure points". For example, during the recent eruption of the Tolbachik volcano in Kamchatka amino acids were found in its ashes, which are regular components of oil. How did they get there? Or take another example. While developing a procedure for discovering underwater volcanoes by tell-tale eruption gases, experts from the Institute of Oceanology of the USSR Academy of Sciences found out that the most reliable indicator was the elementary hydrocarbon methane. Organic compound were even found in diamonds which are indisputably magmatic formations.

At the same time, while studying the composition of oil, proponents of the organic theory ascertained that it contains the same molecules which are found in living organisms: remnants of amino acids, fats and so on. These molecules are so complex and the number of their types is so large that chance combinations of atoms must be simply ruled out: it is virtually impossible that totally identical molecules should form in different ways in oil and living organisms. This means that oil is certainly directly related to those living organisms.

As for the inorganic theory, Gavrilov thinks that it is attractive purely psychologically. His principal conclusion is that oil formation in

subterranean depths continues to the present day, which means that new deposits keep forming all around and that like solar power and hydraulic resources oil should be treated as a renewable source of energy.

But if this were so, Gavrilov continues, then all fissures in the Earth's crust would serve as oil ducts by which "inorganic hydrocarbons" forming within the mantle would rise to the surface. Such fissures do exist. Take, for example, the so-called rift zones in the ocean where the crevices reach down to the upper layers of the mantle. In such rift zones there are gas seepages containing a certain percentage of methane, although it is much lower than it should be according to the inorganic theory.

Another fact is that according to this theory seas of oil must lap across the surface of Venus. It is known with certainty that there are no such seas there. So today, the proponents of this theory like, say, Gold, are speaking about methane seas on the Jupiter's satellite Titan. Well, we have already lived to see Soviet interplanetary stations landing on Venus. Let's now wait till they reach Titan.

Gavrilov is positive that the origin of oil can only be explained from the positions of modern geophysics and the theory of global plate tectonics. This theory also known as the "theory of the continental drift" postulates, among other things, that there are plates in some parts of the globe which sort of "dive" under other plates, enter the mantle and dissolve there. Organic substances get into the mantle in the process and eventually turn into hydrocarbons there.

In this manner, for carbon to become part of oil or gas, it must necessarily pass through the biosphere, insists Gavrilov. To prove his point, he cites the fact that the largest deposits of hydrocarbons are found in Meso-Cenozoic sediments which formed when organic life was developing on the planet.

The most important point, though, is that the combined theory gives clear recommendations to the drillers to sink new wells in the zones of continental plate overlaps. The validity of these recommendations has been proven by practice. In the US, for example, drillers working in the foothills of the Appalachian and Rocky Mountains have discovered oil and gas deposits whose reserves are estimated at six billion tons of oil equivalent. Similar work is going on in the Soviet Union.

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CSO: 1865/150-E

## LOOKOUT FOR OIL IN CRYSTALLINE ROCK

Moscow NOVOSTI NAUKI I TEKHNIKI in English No 23 (106) 5 Dec 86

[Article by Igor Vladimirov]

[Text] Only a short while ago it was generally believed that oil and natural gas could only be extracted from fossilized organic matter (the remains of animals and plants) spread thinly in sedimentary rock like clay, limestone and sandstone. Yet the analysis of drilling operations on land and the seabed has proved there are over 300 oil and gas fields in different parts of the world whose reserves are contained in the crystalline bed under the sedimentary mantle. It has been found that oil and gas formations in the crystalline bed often resemble in shape those of the upper sedimentary mantle, although in some instances they are present in the bed only. Fields of this type include Mountainview in the United States, Lubny and Kosteljany in Czechoslovakia, Neulengbach in Austria, Yellei-Igai in the USSR, etc. In some instances oil and gas can be found in the upper layers of the bed, while in the other 300 to 1,500 meters deeper. The presence of oil and gas in crystalline rock has been reported in vast areas--2,500 km<sup>2</sup> in Amal-Aujila - Naphora (Libya), 20,000 km<sup>2</sup> in Hugoton Panhandle (USA), 42,000 km<sup>2</sup> in the Orinoco oil belt (Venezuela), 77,000 in the West Canadian basin and 2.5 million km<sup>2</sup> in Western Siberia.

The findings disprove the organic theory, because plants and microorganisms that lived a long time ago could only survive on the Earth's surface or near it, to be later buried in sedimentary rock.

Geological analysis of many fields, including those in the Soviet Union, shows that oil could not get there from the sedimentary mantle. One theory--that it flowed through cracks--has been confirmed by the presence of helium, gas that only comes near oil, if it rises from great depths. The Hugoton Panhandle field in the United States contains, apart from oil and gas, some 10 billion cubic meters of helium.

That hydrocarbons may rise from the mantle has been also indicated by gas leaks through cracks on the ocean floor. Massive leaks of hydrogen and methane, as well as suspension at 400°C, have been observed in places where the oceanic crust, with thin sediments or no sediments at all, is but several kilometers thick. One such place is the East Pacific Rise. Massive flows of methane have been found near a crack on the Caribbean seabed. A powerful methane leak occurs in the Philippine Sea to the west

of the Mariana Islands. Hydrogen and heavy hydrocarbons have been found in benthic waters over the Palau Trench in the Pacific.

Research into oil and gas bearing formations has proved that the deeper the underground waters the more gases they contain. Already scientists have been pondering over a possibility to produce gas dissolved in water on a commercial basis.

Great depths are noted for high pressures and temperatures. Can oil and gas remain intact under such conditions? Thermodynamic estimates and experiments by Soviet scientists indicate that either pressure or temperature, or both, far from provoking thermal destruction of hydrocarbons, invoke their augmentation. In the sedimentary mantle, with its low pressure, hydrocarbons oxidize and decompose under the impact of bacteria, so that deposits get rid of their light, hydrogen-rich components.

Pyotr Kropotkin, associate member of the Soviet Academy of Sciences, says petroleum deposits are of nonorganic origin. He says that at great depths, where temperatures and pressures are much higher than on the surface, waters are oxygen-poor or have no oxygen at all, but they are admittedly rich in hydrogen, the fact that indicates that there may be many hydrides there.

On the basis of their chemical properties, fluids and gases contained in the earth's crust and upper mantle can be divided into two groups forming two separate layers or geospheres. The upper layer spreads several kilometers deep and can be called the oxysphere, or one with oxidizing or neutral environment in the fluid-gas phase.

Still deeper, at about 150 kilometers down the line, there lies the reducing sphere with a regenerating environment rich in hydrogen, methane and other hydrocarbons, as well as water, carbon oxide, etc. The reducing sphere surrounds the earth, with gaps admittedly occurring only in volcano belts. It consists in a great amount of reducing gases leaking through cracks into the upper layers where they are trapped in sedimentary rock; it can offer a favorable environment for the formation of gas, condensate and petroleum.

Some scientists say the earth's degasification led to the emergence of oceans. What they mean is degasification triggered by mild tectonic processes, also known as the "planet's breathing" in scientific parlance. The "breathing" produces leaks of nitrogen and methane, often accompanied by helium. Also called the "cooling degasification", it is seen as conducive to the emergence of oil and gas deposits.

This indicates that the lower layers of the sedimentary mantle and the upper interstices of the crystalline bed may be much richer in oil and gas than originally believed. To put it in simpler terms, oil and gas are to be found at great depths. Abnormal formation pressure prevents the hardening of rock that can be a hydrocarbon collector at a depth of five to ten kilometers. It also prevents oil and condensate from being reduced to other substances, in spite of temperatures ranging between 60 and 170°C.

Geologists may well be advised to look for oil and gas in abyssal cracks through which hydrocarbons flow upwards. In several instances the method has proven successful. But oil and gas can also ascend via "vertical pipelines" rising from the mantle some 100 to 200 km deep. In Soviet Yakutia and South Africa there are diamond diatremes with oil-soaked rock. Analogous phenomena have been observed in Swabia and Scotland, in the Uzon volcano on the Kamchatka Peninsula, on Mount Etna, etc.

Other indications have been provided by studies of a superdeep well drilled on the Kola Peninsula. Like other wells going through the crystalline bed (for example, those on the Ukrainian shield), it contained hard scattered bitumen at all drilling intervals. This can be interpreted as indicating vertical movement of hydrocarbons.

Increasingly scientists arrive at a conclusion that hydrocarbon reserves should be looked for in hard rock, something that has been traditionally regarded as a waste of time.

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CSO: 1865/150-E

## FORECASTERS OF EARTHQUAKES

Moscow NOVOSTI NAUKI I TEKHNIKI in English No 23 (106) 5 Dec 86

[Article by Lyudmila Maximova]

[Text] A bioseismological proving ground has been set up in the Soviet Union. It is attached to the Institute of Seismology of the Kazakh Academy of Sciences. For the first time scientists will stage a systematic extensive experiment of using birds, ants, mountain rodents, including marmots, which can dig holes in the Earth's interior to a depth of 50 meters, for the purposes of earthquake forecasting.

It was known long ago that animals feel approaching earthquakes. For instance, in the year 328 B.C. all weasels and moles left their holes and ran away a few days before the destruction of the Greek city of Helicos by an earthquake. People of ancient Mesopotamia, Japan and China highly respected animals--harbingers of earthquakes.

But over the past few decades reports about animals--forecasters of earthquakes--have become ever-fewer due to the advent of supersensitive instruments recording underground signals. However, so far such instruments cannot warn us reliably about the imminent disaster.

Facts about animals' reaction shortly before a tremor have been recorded, studied and published in scientific literature of Japan, Italy, China and the Soviet Union. The USSR's national program on earthquake forecasting (it is a part of the UN program) also includes a section dealing with the study of animals' anomalous behavior for the purposes of earthquake forecasting.

Biologists say that animals' anomalous behavior is really a normal and typical reaction to a source of anxiety. They differentiate two types of reactions in animals' behavior. The first type is a change in the general emotional reactivity as a result of an indefinite anxiety. Animals' anxiety in such cases finds its expression in increased motor activity, trembling, howling or bellowing. The second type of the reaction is purposeful behavior linked with the imminent danger. Animals flee from sheds, migrate from the habitat, etc. The two types of reactions singled out by the scientists after the studies of reports about animals' behavior

before earthquakes may be of use for determining the intensity, remoteness or commencement of future tremors.

Today we know only 70 animal species which can be used for predicting earthquakes. Other 1,499,930 species have not displayed such capacity perhaps because we have not paid sufficient attention to them. But on the list of animals--"earthquake forecasters"--the most active ones can be singled out. Most cases of anomalous behavior before earthquakes have been recorded among dogs, cattle, rats and mice. But specialists do not think that these animals are the most clever or sensitive. The fact is that these animals surround man and, therefore, they become objects of observations more frequently.

Seismologists believe that animals' unusual behavior can indicate the imminence of an earthquake of force 4 and stronger. Not all animals belonging to the same species react to the approaching quake. Most animals (except reptiles and fishes) rarely feel the approaching event earlier than 24 hours before its commencement. The frequency of unusual phenomena in animals' behavior sharply increases two or three hours before the event and then a few minutes and a few seconds before it. In some cases the larger the magnitude (energy characteristic) of the imminent tremor the higher the intensity of animals' reaction and the earlier the appearance of these biosigns.

But do animals always react to the imminent earthquake and does their anomalous behavior always precede seismic events? Seismologists put this question in the following way: are errors of the type "missing the target" and "a false alarm" inherent of the bioforerunner?

Scientists do not regard the behavior of animals before an earthquake a faultless and reliable sign. On the territory of the Soviet Union over the past 200 years this sign worked only before 30 strong quakes (out of hundreds of such events). But not a single of many dozens of signs studied in detail enables one to make a 100 percent forecast. They all are aggravated by errors of both types. Quake forecasting is difficult precisely because the Earth's interior sends signals of false alarms or camouflages the preparation for underground storms. That is why it is unjust to accuse animals of making mistakes in quake forecasting.

However, the main question for researchers is: with what physical phenomena in the future zone of the seismic focus can animals' anomalous behavior be linked? In the first place, this is the microseismic activity of the Earth's crust, changes in air pressure and in gravitation, oscillations in the level of subsoil waters, infrasounds and ultrasounds, variations of electromagnetic fields and the release of gases from the Earth's interior. These are geophysical phenomena.

This list should be expanded and complemented by zoologists. Scientists think that animals' reaction to the effect of the environment is of a protective character and appears as a result of long evolution when only those animals

survived countless cataclysms which could react in due time and save themselves. For example, sounds caused by an approaching quake cannot be heard by man but they are heard by animals and are easily recorded by special instruments--geophones.

Soviet specialists conduct experiments which will help elucidate the reaction of different animals to electromagnetic waves, electric fields, smells of gases and other indispensable signs of earthquakes. At the same time, scientists want to find animals' natural "instruments"--organs detecting anomalies of the geophysical situation.

Biologists have accumulated extensive experimental data on the impact of various electromagnetic fields, including fields of weak intensity, on living organisms. As far as mammals are concerned, electromagnetic waves with frequencies close to the brain's biorhythms or in the range of geomagnetic pulsations, that is, 0.01-20 Hz, have the strongest effect. These experiments were carried out when artificial field sources of a sufficiently simple shape were used, but biophysicists maintain that even weak natural electromagnetic fields can have a sizeable effect on animals.

In the course of the studies geophysicists have found out that anomalies of electromagnetic radiation before earthquakes can be spread over large distances and presage earthquakes several weeks before the event, although they mostly emerge 24 hours, several hours or several minutes before the event like anomalies in the behavior of most animals. Soviet scientists believe that this direction of the search for the general cause holds out great promise.

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DETERMINATION OF MEAN VELOCITY FROM SECOND DERIVATIVES OF HEAD TRAVEL-TIME CURVES

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 11, Nov 86  
(manuscript received 2 Apr 85) pp 112-118

[Article by L.G. Kiseleva, Geology and Geophysics Institute, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] Previous studies by the author have suggested a method for determining velocity in a covering medium using the second derivatives of travel-time curves. The method is applicable to the processing of head wave travel-time curves for waves propagating through homogenous media with curved refracting boundaries observed on a horizontal line. A priori information on the parameters of the studied model is not required in this method. In this article the method is supplemented by an iterational algorithm for estimating mean velocity. Model examples are used to analyze the accuracy in estimating velocity parameters as a function of curvature of the refracting boundary. Figures 4; references: 5 Russian.

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CSO: 1865/305

UDC 550.837

SPECIFICS OF CONSTANT CURRENT FIELD ON LINE OF INTERSECTION OF INTERFACES OF HOMOGENOUS ANISOTROPIC MEDIA

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 11, Nov 86  
(manuscript received 6 Mar 85) pp 118-129

[Article by V.Ye. Gluzberg, Z.G. Degay and V.A. Shafarenko, TsentrKazgeologiya, Karaganda]

[Abstract] A fundamental system of solutions is obtained for an equation for electric potential in a cylindrical area whose axis is formed by the

intersection of interfaces of homogenous media. The general solution in the neighborhood of this axis is shown to be an exponential function with an exponent which is the root of a certain characteristic determinant with a minimum real part. This exponent may be complex in an anisotropic case. The equipotential line passing through the axis in this case consists of two logarithmic spirals. Special cases of great practical importance are discussed. Figures 4; references: 5 Russian.

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APPROXIMATE EQUATIONS FOR ELASTIC WAVE VELOCITIES IN HOMOGENEOUS ANISOTROPIC MEDIA

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 11, Nov 86  
(manuscript received 29 Mar 85) pp 95-104

[Article by I.R. Obolentseva, Geology and Geophysics Institute, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] Formulas are derived for propagation of elastic waves in any direction in space in media with orthorhombic and hexagonal symmetry. The equations are derived on the basis of the assumption that waves of 3 types have the same polarization in an anisotropic medium as P, SV and SH waves in an isotropic medium. This assumption directly makes the equations applicable for solution of inverse problems due to similarity of polarization of observed waves to the polarization of P, SV and SH waves in an isotropic medium. Estimates are given indicating that these conditions prevail in situations of practical importance. References 8: 4 Russian. 4 Western.

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CSO: 1865/305

USE OF KINEMATICALLY EQUIVALENT CONTINUATIONS OF WAVE FIELD FOR ISOLATING INTERFERING WAVES

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 11, Nov 86  
(manuscript received 14 Aug 85) pp 83-95

[Article by S.V. Goldin and V.M. Vingalov, Geology and Geophysics Institute, Siberian Department, USSR Academy of Sciences, Novosibirsk; Western Siberian All-Union Scientific Research Institute of Geophysics, Tyumen]

[Abstract] The idea of separating interfering waves by the wave continuation method was suggested in 1973. Its essence is as follows: if two waves in a field  $u_0(t, N)$  recorded on a surface  $z = 0$  interfere with each other, but have different apparent velocities  $v_1$  and  $v_2$ , then with any direct or inverse kinematically equivalent continuation and any velocity of the continuation  $v_0 = \text{const}$  they will begin to diverge and the interference zone will decrease. This article analyzes the possibility of applying the method at a certain fictitious level to separate interfering waves and suppress wave noise. Conditions under which the method can be applied are defined and it is shown that the continuation velocity can be selected independently of the true velocity in the medium, depending only on the apparent velocities of the interfering waves. Figures 5; references: 7 Russian.

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UDC 550.347.64(571.56)

DEEP SEISMIC RESEARCH ALONG TAS-YURYAKH-ALMAZNYI-MALYKAY PROFILE (WESTERN YAKUTIA)

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 11, Nov 86  
(manuscript received 14 Feb 85) pp 72-78

[Article by V.D. Suvorov, A.B. Kreynin, I.V. Podvarkova, V.S. Seleznev, V.M. Solovev, V.F. Uarov and S.D. Chernyy, Geology Institute, Yakutsk Affiliate, Siberian Department, USSR Academy of Sciences; Yakutskgeologiya Geological Production Association, Yakutsk; NOMVE, Novosibirsk]

[Abstract] The seismic cross section of the earth's crust and upper mantle was studied along a profile intersecting the Mirnyy kimberlite field in a sublatitudinal direction, a part of continuing research on crustal structure in Western Yakutia. This 400-km section was studied for collecting additional information on structural features of the crust and upper mantle and clarifying results of area studies carried out earlier. Recorders were placed at intervals of 5-8 km and shots set off at intervals of 15-20 km.

The maximum distance between shot and recorder was 480 km. The deep structure in the neighborhood of kimberlite magmatism was found to be quite heterogeneous. The data emphasize the effectiveness of large area systems of observation, indicating the possibility of reliable isolation and tracking of anomalous boundary velocity in plan along the M surface with transverse distances of at least 20-30 km. A number of new characteristics of the crust and upper mantle were determined, supplementing the seismic data already available and confirming the heterogeneity of deep structure. Figures 5; references: 8 Russian.

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UDC 550.837.82(571.56)

APPARENT RESISTIVITY AND CONDUCTIVITY CURVES FOR SOUNDINGS BY NEAR-ZONE  
FIELD GENERATION METHOD

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 10, Oct 86  
(manuscript received 4 Feb 85) pp 115-121

[Article by B.I. Rabinovich and I.V. Yeremina, Siberian Scientific Research  
Institute of Geology, Geophysics and Mineral Raw Materials, Novosibirsk]

[Abstract] A study was made of the possibility of constructing apparent resistivity and apparent longitudinal conductivity curves for magnetic field components and their time derivatives. The magnetic field components of the electric dipole are found to be monotonic functions of  $\tau/r$  with the greatest values as  $t \rightarrow 0$  (dc magnetic field). Boundaries appearing in the cross section at a certain depth  $h$  are manifested on sounding curves beginning at  $\tau/h \geq 4$ . In soundings calculated for two-layer cross sections with an insulating base, the influence of the base is apparent only where  $t/h \geq 4$  as a field increase in the early stages, with a decrease in later stages of formation. Apparent resistivity curves can be calculated by primitive equations only for the magnetic field components; longitudinal conductivity cannot be computed for the full range of E-M field decay time. Figures 3; references: 5 Russian.

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CSO: 1865/307

## SOME RESULTS OF PREDICTING OIL AND GAS CONTENT BASED ON SEISMIC PROSPECTING DATA IN TOMSK OBLAST

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 10, Oct 86  
(manuscript received 5 Feb 85) pp 109-114

[Article by Ye.S. Shlyakhter, V.V. Dudin and V.L. Berilko, Siberian Scientific Research Institute of Geology, Geophysics and Mineral Raw Materials, Novosibirsk; Tomsk Geophysical Trust]

[Abstract] A study is made of the results of automatic prediction, applied to an area in Tomsk Oblast. The software base used was the SEISPAK and INTERSEIS system for the BESM-6 computer, including simple modernized recognition algorithms based on similarity measure functions, having two significant advantages: the structure of the similarity measure function used to isolate objects which are similar to standard objects is such that it takes on characteristic values when the object being studied is similar in physical characteristics to at least one of the standards; the algorithm generates up to 8 different transforms of the initial fields based on the mean frequency field component, gradient and other characteristics by the application of two-dimensional linear and nonlinear filters. The studies revealed one promising area recommended for use in deep drilling. Other objects with less promise will be further analyzed after drilling of the primary area and analysis of geological materials from holes drilled in area. Figures 3; references: 7 Russian.

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UDC 550.834(470.5)

## JOINT USE OF LONGITUDINAL AND TRANSVERSE WAVES IN DEEP SEISMIC SOUNDING

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 10, Oct 86  
(manuscript received 25 Jan 85) pp 94-99

[Article by N.I. Khalevin, A.L. Aleynikov, Ye.N. Kolupayeva, A.M. Tiunova and F.F. Yunusov, Geology Institute, Ural Scientific Center, USSR, Sverdlovsk]

[Abstract] Methods for studying the Earth's crystalline crust using longitudinal and transverse seismic waves are outlined. Refracted or penetrating waves are emphasized. Initial information for the construction of seismic cross sections consists of the arrival times of longitudinal and transverse refracted waves. The geophysical effectiveness of the method for studying the upper part of the crust is illustrated. The method of joint use of waves of different polarizations allows reliable

determination of the physical properties and estimation of the composition of crustal rock by correlating the results obtained from analysis of refracted and reflected waves. The observed acoustical rigidity gradient can be used in correlating individual reflecting elements and in discriminating reflecting boundaries, allowing an increase in reliability of the seismic cross section and structural-petrological interpretation of data. Figures 1; references: 13 Russian.

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#### PROCESSING MULTICHANNEL SEISMOGRAM PHASE SPECTRA

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 10, Oct 86  
(manuscript received 22 Jan 85) pp 99-109

[Article by G.M. Mitrofanov, Geology and Geophysics Institute, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] Continuing previous studies carried out at the author's institute, this article presents practical recommendations for joint processing of the phase components of spectra in multichannel seismograms. The results can also be used in processing instantaneous phases and frequencies. This study of the types of phase component discontinuities in the signal spectrum explains the behavior of phase spectra computed for actual cross sections, leading to recommendations for joint processing of phase spectra. Simple procedures are suggested to increase the accuracy in determining phase spectrum. Figures 3; references 13: 11 Russian, 2 Western.

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UDC 550.837.6

#### EFFECTIVE TRAJECTORIES IN ELECTROMAGNETIC METHODS WITH ARTIFICIAL FIELD EXCITATION, FREQUENCY REGION. THEORETICAL PROBLEMS

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 8, No 6, Nov-Dec 86  
(manuscript received 16 Jan 86) pp 49-55

[Article by V.N. Shuman, Geophysics Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] A simple hydromagnetic model of energy propagation, fully characterizing the real scalar function  $L(x,y,z)$ , which is the solution of

the eikonal equation, is associated with geometrical optics. Geometric rays can be defined as trajectories orthogonal to the wave surface  $L(x,y,z)$ , the direction of which coincides at each point in an isotropic medium with the direction of the averaged Poynting vector. The model is characterized by clarity, universality and effectiveness in the solution of various problems. One extension of the general method of geometrical optics for media with absorption is based on the introduction of complex rays which are formally defined as complex solutions of Hamiltonian equations of the characteristics. Another approach is discussed for applying geometrical representations to the theory of electromagnetic sounding with artificial field excitation in a frequency area, based on separation of the observed response into several components with various properties, allowing interpretation by means of effective trajectories. This approach is more limited than the previous approach and is essentially oriented toward investigation of special degenerate cases. Figures 2; references 11: 9 Russian, 2 Western.

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#### ENGINEERING-METHODIC SYSTEM OF MULTIPLE-IMPULSE SEISMIC PROSPECTING METHOD

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 8, No 6, Nov-Dec 86  
(manuscript received 26 Dec 84) pp 71-78

[Article by V.I. Roman, V.F. Kanevskiy, P.T. Sirotenko and P.A. Korolyuk, Kiev Geophysical Observatory, Ukrainian Geological Prospecting Scientific Research Institute; Geophysics Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] Information is presented on work related to the creation of an engineering-methodic system for continuous multiple-impulse seismic prospecting. Utilization of series-produced digital seismic stations in practice has provided the hardware needed to develop the elements of this system, including multiple-impulse sources of both longitudinal and shear waves, control systems, field research methods, algorithms, software and hardware for conversion of multiple-impulse records into pulse seismograms. The most effective pulse sequence types for the system are defined and requirements for the basic system elements are noted. The hardware base is now essentially ready for the development of multiple-impulse seismic prospecting systems suitable for use in field seismic research. References 14: 12 Russian, 2 Western.

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## DIRECT AND INVERSE PROBLEMS OF GRAVIMETRY FOR SEGMENT OF ELLIPTICAL CYLINDER OF POLYNOMIAL DENSITY

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 8, No 6, Nov-Dec 86  
(manuscript received 10 Nov 84) pp 56-60

[Article by P.I. Balk and T.V. Balk, Earth's Crust Institute, Siberian Department, USSR Academy of Sciences, Irkutsk]

[Abstract] In algorithms based on the concept of equivalent interpretation models, problems of geological content of the model classes of field sources are considered secondary. Approximating and computational properties of models are considered of primary importance. This explains the increasing interest in models with a polynomial density change rule, in which the direct problem is solved in explicit form, the set of model distributions is dense in the space of continuous functions, while the field subset is reduced to simple problems of linear and quadratic programming. The problem of increasing the stability of the results of interpretation cannot be solved in a single model class. An effective means is to reduce the parametric dimensionality of the approximation structure by utilizing a broader set of varied model classes. This article describes a model of sources with polynomial density and a carrier in the form of an elliptical cylindrical segment in order to supplement the set. The numerical experiments demonstrate the stability of the solution of both direct and inverse linear problems where  $n \leq 4$  and the characteristic assignment of field measurement points. References: 5 Russian.

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CSO: 1865/308

## HETEROGENEOUS SEISMIC WAVES AND POSSIBILITIES FOR THEIR PRACTICAL UTILIZATION

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 4: GEOLOGIYA in Russian No 6, Nov-Dec 86 (manuscript received 5 Aug 83) pp 19-33

[Article by A.V. Kalinin, B.L. Pivovarov and I.D. Tsvankin]

[Abstract] Heterogeneous waves take in all components of a wave field formed due to excitation of heterogeneous plane waves with the exception of ordinary surface waves. This article presents a quantitative study of the kinematic and dynamic characteristics of heterogeneous seismic waves formed in media with 1 or 2 interfaces. The interrelationship of heterogeneous and ordinary homogeneous waves is analyzed and methods are suggested for using heterogeneous waves to determine the structure of media. The full system of heterogeneous waves formed at the interface between liquid and solid

media is studied and it is shown that as the source of the waves moves farther from the interface, several types of heterogeneous waves are formed at the point where the source is approximately one-half wavelength or less from the interface. The most complete system of heterogeneous waves is formed when the velocities of P and S waves near the source are greater than the velocities near the receiver. Heterogeneous head waves developing in a three-layer medium are discriminated for the first time and the conditions for their existence are determined. A modification of the methods of reflected and refracted waves, based on the use of heterogeneous waves, is proposed. Figures 8; references 17: 11 Russian, 6 Western.

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UDC 550.837.21.001.57

METHOD OF CALCULATING ELECTROMAGNETIC FIELD IN QUASI-THREE-DIMENSIONAL  
HORIZONTALLY HETEROGENEOUS MEDIUM

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 4: GEOLOGIYA in Russian  
No 6, Nov-Dec 86 (manuscript received 14 May 85) pp 66-70

[Article by N.A. Lebedeva]

[Abstract] An algorithm is suggested for computation of the electromagnetic field in a quasi-three-dimensional model containing both surface and deep heterogeneities. The method suggested for calculation of the electromagnetic field is applicable to models approximating geoelectric anomalies with smooth, twice differentiable functions. The method can be used to study models containing surface heterogeneities simulating irregularities in the relief of the crystalline basement and deep heterogeneities related to rising and descent of a magnetically conducting substance. The models allow analysis of the joint influence of surface and deep heterogeneities for determining the role played by the interaction of excess current induced at various depths. References: 6 Russian.

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## GEOCRYOLOGIC CONDITIONS IN CENTRAL YAKUTIA

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 4: GEOLOGIYA in Russian No 6, Nov-Dec 86 (manuscript received 18 Dec 85) pp 54-65

[Article by T.N. Kaplina, K.A. Kondratyeva and N.I. Trush]

[Abstract] The central Yakutian plain is promising for future development. A significant factor in this development is its geocryological conditions, the variety and great differences among which are related to changes in the zonality and continentality of heat exchange of the surface from north to south and west to east and the regional heat exchange factors over the history of formation of the permafrost rock masses. Joint analysis of the geocryological conditions of the region is utilized to determine the space-time factors in its formation, including the cryolithogenous characteristics of the Neogene-Quaternary deposits, rock temperature conditions and the structure and thickness of permafrost, which have left their impression on the present-day state of geocryological conditions in the region. A geocryological map at a scale of 1:2,500,000 has been constructed and can be used in estimating the stability of geocryological conditions for purposes of planning of development and preservation of the environment. A fragment of the map is presented. Figures 1; references: 15 Russian.

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## APPLICATION OF SPATIAL DERIVATIVES METHOD IN DEEP ELECTROMAGNETIC STUDIES WITH CONTROLLED FIELD SOURCES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12, Dec 86 (manuscript received 23 May 84) pp 39-43

[Article by M.V. Fiskina (deceased), B.Sh. Zinger and E.B. Faynberg, Terrestrial Magnetism and Radio Wave Propagation Institute, USSR Academy of Sciences]

[Abstract] Controlled electromagnetic fields sources represent a new and effective means for investigation of the earth. Since as magnetic fields propagate horizontally from a source over a distance comparable to the depth to which they penetrate in the earth the surface heterogeneities distort the field, it becomes impossible to use traditional methods of interpretation of observation results based on a simple model in which conductivity changes only with depth. Methods are therefore of interest which allow comparatively simple determination of preliminary information concerning the normal geoelectric cross section. This article gives

estimates defining the three-dimensional area in which the impedance of the geoelectrical cross section can be found by the spatial derivatives method. The method is relatively stable with respect to complication of the structure of a secondary field source, as well as the presence of lateral geoelectric heterogeneities. References: 7 Russian.

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CSO: 1865/302

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#### AVERAGING MAGNETOTELLURIC SOUNDING CURVES FOR ELIMINATING LOCAL DISTORTIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12, Dec 86  
(manuscript received 1 Mar 83) pp 81-83

[Article by G.P. Nechayeva, Moscow State University imeni M.V. Lomonosov]

[Abstract] An averaging method has been suggested to eliminate distortions caused by changes in total longitudinal conductivity of the upper portion of a geoelectric cross section. The studied territory is divided into zones with approximately identical shape of the low-frequency portions of the magnetotelluric sounding curves, making possible averaging of conformal sounding curves within the limits of each zone on the assumption that their distortions are random and log-normally distributed. This averaging eliminates or reduces the influence of local distortions. Two averaging procedures are used: averaging of effective sounding curves and averaging of oriented sounding curves, taking into account the direction of the measurement lines. This article uses experimental materials from a past study to demonstrate that by averaging oriented sounding curves, both local and regional distortions can be eliminated, significantly increasing the accuracy of geoelectric constructions. The example, studies from the Transbaykal region on the upper Angara-Barguzin interfluvium, indicates that when the second averaging method is used in regions with quasilinear tectonics, preference should be given to quasi-longitudinal sounding curves, selecting the averaging area with allowance for the geological, tectonic and geoelectric characteristics of the territory. Figures 2; references: 2 Russian.

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## POSSIBILITY OF USING DEEP MAGNETOTELLURIC STUDIES ON KOLA PENINSULA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12,  
Dec 86 (manuscript received 15 Jan 85) pp 75-80

[Article by N.P. Vladimirov and Yu.I. Kuksa, Earth Physics Institute  
imeni O.Yu. Shmidt, USSR Academy of Sciences; Nuclear Energy Institute  
imeni I.V. Kurchatov]

[Abstract] Deep magnetotelluric soundings were made at 10 points in an area of high-resistance rock on the Kola Peninsula. This article reinterprets the experimental data from those sites where the geoelectric cross sections have been studied with different polarizations of the electric field in order to estimate the prospects for the implementation of further work over the Baltic shield. The magnetotelluric sounding points were located in the Murmansk block and Kola zone of Karelides with granitoids and gneisses in the upper portions of the cross sections. The results of a reinterpretation of the experimental material indicate the possibility of using deep magnetotelluric soundings on the Kola Peninsula. The effectiveness of the work can be increased by considering the possible influence of horizontal heterogeneities on the results. The range of variations in natural electromagnetic fields should be expanded in the future in the direction of higher frequencies, allowing reliable correlation of magnetotelluric sounding curves with known cross-sectional parameters. Figures 2; references 16: 15 Russian, 1 Western.

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## CHECKING RESULTS OF PREDICTION OF LOCATIONS OF STRONG EARTHQUAKES (1974-1984)

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12, Dec 86  
(manuscript received 11 Nov 85) pp 72-74

[Article by Sh.A. Guberman and I.M. Rotbayn, Institute of Applied Mathematics  
imeni Keldysh, USSR Academy of Sciences; Earth Physics Institute imeni O.Yu.  
Shmidt]

[Abstract] Earthquake predictions were published in 1969-1974 for a number of seismically active regions of the earth based on pattern recognition methods using a variety of geological and geomorphological data. The results were published in the form of maps of possible locations of future strong earthquakes. This article reports on a check of these predictions over the period from the time of publication through 1984. The hypothesis

that strong earthquakes occur near intersections of faults and/or near known epicenters was confirmed. Predicted locations of future strong earthquakes were confirmed in a number of world regions. The procedures used to construct the earthquake prediction maps can be used to perform the same task in other regions. A sample of 15-25 cases was found to be sufficient for reliable predictions. References: 16 Russian.

6508/9835  
CSO: 1865/302

UDC 534.222

#### CONDUCTIVITY OF GRANULAR AND VESICULAR MEDIA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12, Dec 86 (manuscript received 5 Jul 83) pp 44-52

[Article by V.I. Selyakov, Moscow Physical Engineering Institute]

[Abstract] Percolation models of conductivity of heterogeneous media generally assume some degree of homogeneity of the conducting elements. This article studies a model allowing description of the conductivity of a heterogeneous medium in which the conducting channels are distributed according to their conductivity. An infinite granular medium with cyclical symmetrical placement of centers of grains of identical diameter and a medium with spherical pores of identical diameter, the centers of which are randomly distributed in space, are studied. Formulas are derived allowing determination of the conductivity is known, as it sometimes is in vesicular media. In other cases, it must be determined experimentally. The equations are derived assuming no cross-current between parallel conducting chains. The model allows determination of the conductivity of the media considering the structure of the pore space and its variation with external factors such as pressure and temperature if the distribution of conducting channels by conductivity and the variation of this function in response to external factors are known. The model can be applied to jointed media. Figures 3; references: 8 Russian.

6508/9835  
CSO: 1865/302

## FIELD OF POINT CURRENT SOURCE IN MEDIUM WITH CYLINDRICAL HETEROGENEITIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12, Dec 86  
(manuscript received 22 Apr 85) pp 53-61

[Article by V.T. Ivanov, A.K. Kozyrin, and G.Ya. Kildibekova, Department of Physics and Mathematics, Bashkir Affiliate, USSR Academy of Sciences]

[Abstract] The electric field of a point dc source was studied in an unlimited space containing cylindrical heterogeneities. Equations were derived which can be solved by automated numerical methods, using a combined algorithm for computation of the electric field based on a combination of integral transforms and integral equations. The method allows numerical calculation of the electric field throughout the space with any position of the point source. Using the mutuality principle, the problem can be solved outside the cylindrical inclusions with the point source located within an inclusion. The influence of various parameters on impedance curves is analyzed. Figures 4; references: 11 Russian.

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CSO: 1865/302

## INTERPRETATION OF DEEP MAGNETOTELLURIC SOUNDINGS. I. INFLUENCE OF SURFACE CONDUCTIVITY

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12, Dec 86  
(manuscript received 14 Jun 85) pp 24-38

[Article by M.N. Berdichevskiy, L.L. Vamyan and V.I. Dmitniyev, Moscow State University imeni M.V. Lomonosov; Oceanology Institute, USSR Academy of Sciences]

[Abstract] The three major questions arising in interpretation of deep magnetotelluric (MT) soundings are: how to separate deep and near-surface effects; how to separate crustal and asthenospheric conducting zones against the background of a monotonic increase in conductivity with depth; and when is a one-dimensional interpretation of MT curves reflecting deep conducting zones admissible? All these questions have been analyzed in previous studies by the same authors. In this article, they present and summarize their views on the principles of interpretation of deep magnetotelluric soundings. A method is suggested for considering and eliminating near-surface effects by distortion analysis, film modeling, statistical smoothing, reduction of MT curves to the crystalline basement surface and correction using standard impedance values. Examples of practical applications are presented. The importance of joint application of all suggested methods is emphasized.

Distortion-theory analysis, statistical studies, numerical modeling and correction by means of standard impedance values are all necessary stages in eliminating the influence of near-surface heterogeneities. Figures 12; references 35: 29 Russian, 6 Western.

6508/9835  
CSO: 1865/302

UDC 550.84:553.98:546.791

SPECIFICS OF URANIUM DISTRIBUTION IN PETROLEUMS OF SUBSALT DEPOSITS IN SOUTHEASTERN PART OF CASPIAN DEPRESSION

Moscow EKSPRESS-INFORMATSIYA. SERIYA: GEOLOGIYA, METODY POISKOV I RAZVEDKI MESTOROZHDENIY NEFTI I GAZA in Russian No 9, Sep 86 pp 1-10

[Article by L.V. Shestoperova and O.S. Turkov, "Guryeyneftegazgeologiya" Geological Production Association, and Ye.S. Glotova, All-Union Nuclear Geology and Geophysics Scientific Research Institute]

[Abstract] A study was made of the uranium content of petroleum in the subsalt deposits of the southeastern part of the Caspian depression. The considerable material which has been accumulated has revealed a number of regularities in the behavior of this element in petroleum. The general uranium content in unmodified petroleum is  $8-12 \cdot 10^{-8}\%$ . It was demonstrated that the uranium content of petroleum is governed by many geological processes (oxidation, loss of light fractions during the reformation of pools and extraction of uranium from uranium-bearing bitumens by light hydrocarbons in the migration process). A table gives the uranium content and composition of petroleum of Paleozoic deposits in the southeastern and eastern marginal zones of the Caspian depression; the most important parameters are given for a series of holes. An analysis of these cases made it possible to define the relationships between uranium content, physicochemical properties and composition of petroleum. In general there is a direct dependence between the uranium content and petroleum density and the content of tar and asphaltenes. Mathematical statistics were used in ascertaining the degree of correlation among these parameters. It was found that in the studied area the uranium concentration is determined for the most part by the petroleum oxidation process. More than 41% of the uranium is concentrated in tars and 31% in asphaltenes. Such information (together with other materials) is valuable in retrieving the history of formation of the pools. Figures 1.

5303/9835  
CSO: 1865/317

## FACTORS IN VARIABILITY OF VERTICAL GEOCHEMICAL ZONALITY OF GOLD ORE DEPOSITS

Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR: SERIYA GEOLOGICHESKAYA  
in Russian No 1, Jan-Feb 87 pp 65-72

[Article by M.S. Rafailovich, Kazakh Institute of Mineral Raw Materials,  
Geology Ministry, Kazakh SSR, Alma-Ata]

[Abstract] Gold deposits forming in a wide range of depths, temperatures and pressures are characterized by a nonuniform vertical geochemical zonality (VGZ). Data on the mineralogical composition and zonality of 70 ore deposits in the USSR were generalized for determining the principal factors responsible for their geochemical variability and constructing VGZ diagrams of different types of ores. The work method involved evaluation of the position of gold and its satellites in zonality series of each of these deposits, grouping of deposits by commercial types, similarity of conditions for the formation and ordering of elements in ores and contact zones and an analysis of the factors responsible for the variability of VGZ. The variability of the VGZ of gold deposits is governed by both external and internal factors. The external factors include the geological and geochemical characteristics of deposits, such as depth of formation, magmatism associated with mineralization and composition of gold-producing associations, whereas the internal factors include the physicochemical and thermodynamic properties of elements and minerals which are gold indicators, such as atomic radius, ionic density and isobaric potential. The geological-geochemical factors and VGZ, as indicated by the materials presented here, are closely interrelated. It is further shown that highly important criteria for evaluating gold ore deposits are the depth of their formation and the position of gold in VGZ schemes. With an increase in depth the position of the gold in the VGZ schemes changes. There are three productive associations which form the basis for a generalized VGZ series: gold-copper-rare metal (gold I, copper, bismuth, tungsten, molybdenum), gold-arsenic (gold II, arsenic) and gold-polymetallic (gold III, silver, lead, zinc, arsenic, antimony). Figures 3; references: 10 Russian.

5303/9835  
CSO: 1865/232

## USE OF CALCAREOUS AND CALCAREOUS-BITUMINOUS MUDS IN DRILLING HOLES FOR THERMAL WATERS

Moscow RAZVEDKA I OKHRANA NEDR in Russian No 10, Oct 86 pp 32-34

[Article by N.Ya. Melentyev, G.V. Matsak and V.A. Korobeynikov, "Sevkavgeologiya" Geological Production Association]

[Abstract] Geological structure varies so greatly in the Northern Caucasus that deep holes can be drilled for the exploitation of thermal waters only after special predrilling studies and specific equipment and muds must be employed depending on the particular circumstances. Many difficulties arise because under the influence of high deep temperatures clay muds become thick, lose stability, are difficult to pump and are not easily processed by reagents. In an example cited, such difficulties arose in drilling a hole with a planned depth of 3,200 m drilled for hydrogeological purposes. Problems appeared at a depth of 1,700 m where the temperature was 85°C. The drilling tool began to stick and the mud had to be modified. The clay mud was given a calcareous component for imparting a definite heat resistance and stability, thereby reducing swelling. The mud did not become so dense so quickly, its heat resistance increased with an increase in temperature to 95° and the drilling tool could move freely. In similar work use has been made of calcareous-bituminous muds which constitute a hydrophobic colloidal system in which the dispersion medium is a hydrocarbon phase consisting of diesel fuel, highly oxidized bitumen and the surfactant sulfonol in which lime particles, barite and water are dispersed. Such muds are particularly useful in drilling deep and superdeep holes when the geological section contains unstable deposits and anomalously high and low stratum pressures. They have a high thermal resistance (up to 200-220°C). In the Northern Caucasus, for example, this is the only type of mud ensuring damage-free drilling of a hole to the planned depth in salt deposits of the Upper Jurassic.

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CSO: 1865/112

## IMPROVING PROCEDURES FOR DRILLING BOREHOLES IN PROSPECTING OF PLACER DEPOSITS

Moscow RAZVEDKA I OKHRANA NEDR in Russian No 10, Oct 86 pp 29-32

[Article by V.P. Krendelev, V.M. Minakov and V.A. Orlov, Central Scientific Research Institute of Geological Prospecting]

[Abstract] Holes with a diameter of 219 mm are usually used when exploring mineral placer deposits. However, research has shown that the minimum diameter of holes for evaluating gold placers must not be less than 500 mm. A reliable evaluation of deposits requires large samples and use of drilling tools and procedures ensuring careful removal of such samples. Drilling equipment must be adaptable for ensuring penetration of unconsolidated, thawed and permafrost deposits. No existing equipment can ensure efficient drilling in such a broad range of rocks and therefore several methods must be used for obtaining acceptable indices, assuming a high quality of sampling. Since exploration of placer deposits is usually in regions with a severe climate, complex relief, swampiness and wooded terrain, usually without roads, high requirements are imposed on equipment with respect to mobility, transportability and compactness. This dictated development of special drilling equipment and special work procedures. A table gives the new types of rigs developed for such work, 1 of the rotary drilling type, 1 of the percussion-cable type, and 4 which represent a combination of these types. Each of these drilling variants is discussed briefly. Some of these are said to be equivalent to or superior to foreign equipment. Those variants which incorporate the advantages of both rotary and percussion-cable methods ensure increased work productivity and an improved quality of sampling. However, 75% of the equipment used in the exploration of placers is of the percussion-cable type.

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UDC 55:347.778(0.47.6)

## SCIENTIFIC ADVANCES IN GEOLOGY CERTIFIED AS DISCOVERIES IN 1984-1985

Moscow SOVETSKAYA GEOLOGIYA in Russian No 10, Oct 86 pp 113-117

[Article by I.B. Ivanov, USSR Academy of Sciences, V.V. Pototskiy, State Committee for Inventions and Discoveries, and V.G. Tyminskiy, "Aerogeologiya" Geological Production Association]

[Abstract] During 1984-1985 four scientific discoveries were officially certified by the State Committee for Inventions and Discoveries and the USSR Academy of Sciences. The first was the phenomenon of formation of modern phosphorites in upwelling zones on ocean shelves (Baturin effect),

described by G.N. Baturin, et al. This phenomenon is attributable to the biogenic concentration of phosphorus, its precipitation, mineralization and formation of phosphate concretions. There is now a reliable and full picture of the generation, development and finalization of the phosphorite ore process, beginning with the circulation of phosphorus in ocean waters, ranging through its assimilation by living matter and precipitation to the bottom in the form of organic detritus, and ending with the formation of phosphorite concretions in the sediments. The second discovery was the law of transformation of layered silicate minerals under hydrothermal conditions, described by V.A. Frank-Kamenetskiy, et al. For the first time it was possible to define regular sequences of series of layered silicates under hydrothermal conditions and to study the mechanism of structural inheritance of their transformations, this laying a new scientific direction oriented on detection of the main genetic relationships among minerals. The third discovery was the law of the relationship between the magnitude (energy) of tectonic crustal continental earthquakes and the extent and types of seismogenic geological structures (Gubin seismotectonic law), described by I.Ye. Gubin. This has led to new points of view in seismology. Concepts concerning the uncertainty of conditions for the generation of strong earthquakes have given way to concepts that there is order in the occurrence of these events, reflecting a system of cause-and-effect relationships between geological and seismic phenomena. This law has become the basis of the genetic method for predicting earthquakes. The fourth discovery is the phenomenon of geochemical differentiation and the concentration of rare analogue-elements and aluminum, described by A.A. Beus, et al. There has been a fundamental change in concepts concerning the geochemistry of the pairs Ta-Nb, Zr-Hf, Ce-Y, Si-Al of late- and post-magmatic processes associated with granitoids, including their differentiation and concentration in natural processes. It has fundamentally changed concepts concerning the scales and conditions for mineralogical-geochemical differentiation of analogue-minerals.

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UDC 561:556.3(571.56)

THEORY AND PRACTICE OF PALYNOLOGICAL RESEARCH IN HYDROGEOLOGY (IN EXAMPLE OF YAKUTIA)

Moscow SOVETSKAYA GEOLOGIYA in Russian No 10, Oct 86 pp 105-113

[Article by N.M. Frolov and O.N. Sheshina, All-Union Scientific Research Institute of Hydrogeology and Engineering Geology]

[Abstract] The authors have formulated a system of fundamental ideas in palynohydrogeology which can be regarded as a basis for use of palynology in hydrogeology. The first axiom is that microphytoplankton cannot be more ancient than primary algae ( $Ar_2$ ) and spores and pollen cannot be more ancient

than land vegetation. The second axiom is that spores and pollen can enter rocks directly when the latter are at the earth's surface or enter with infiltration waters after their downward percolation. The first palynohydrogeological law is that if the age of the spores and pollen is older than the age of the collector, they entered the latter at a later time from an adjacent, more ancient system which constituted the source region. The third axiom is that infiltration, a definite size of through fissures and an adequate rate of movement of ground water are required for entry of spores and pollen into the earth's deep layers. The second palynological law is that if with an increase in depth there are individual peaks in the content of spores and pollen of a definite size and at lower levels only groups of lesser sizes are observed, the section consists of rocks with permeability decreasing with depth and the peaks themselves indicate the position of interfaces of layers with different permeability. The fourth axiom is that in the course of evolution the number of biocomplexes and the productivity of spores and pollen increased. Each of these laws and axioms has one or more corollaries. The applicability of these laws, axioms and corollaries is illustrated in specific examples. It is demonstrated that the use of deduction and induction methods is highly effective. On such a basis the results of experimental work can be interpreted with greater certainty. Figures 2; references 14: 10 Western, 4 Russian.

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UDC 550.813:528.94

#### MORPHOSTRUCTURAL ANALYSIS IN LARGE-SCALE GEOLOGICAL MAPPING

Moscow SOVETSKAYA GEOLOGIYA in Russian No 10, Oct 86 pp 69-74

[Article by L.A. Sazonov and A.P. Lopatin, "Krasnoyarskgeologiya" Geological Production Association]

[Abstract] Morphostructural analysis has been used extensively in small- and medium-scale structural and metallogenetic research in folded and platform regions, including those with a quite thick sedimentary cover. The founders of the morphological analysis method were themselves responsible for the long-prevailing opinion that the method was ill-suited for large-scale mapping. Research by the authors in several Siberian ore fields strongly suggests that morphostructural analysis can be extremely useful in detailed mapping. This is illustrated in a number of specific examples. Working principles are outlined. In the compilation of large-scale geological maps the morphological analysis method makes possible a more complete definition of disjunctive tectonics, clarification of interrelationships of different systems of tectonic dislocations and drawing of geological boundaries more precisely. In some cases it is possible to identify geological bodies, such as intrusions, dikes and strengthened or weakened zones of metasomatic changes differing with respect to resistance to

weathering. The method is highly effective for revealing the structural geology of an area. The cost is low and work input is insignificant in comparison with alternative methods. The analysis of topographic maps does not require expensive equipment. Only simple skills are required for identifying endogenous and exogenous relief elements. Morphological analysis does have definite shortcomings, for example, being unsuitable for regions of occurrence of ancient metamorphic strata with manifestations of intensive plastic deformations. However, it is well-suited as a prefield method in large-scale geological surveying and exploration. Figures 3; references: 11 Russian.

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CSO: 1865/116

UDC 563.14;551.781(4/5-17)

IMPORTANCE OF PALEOGENE RADIOLARIANS IN NORTHERN EURASIA FOR GLOBAL ZONAL CORRELATION OF MARINE PALEOGENE DEPOSITS

Moscow SOVETSKAYA GEOLOGIYA in Russian No 10, Oct 86 pp 54-61

[Article by R.Kh. Lipman, All-Union Geological Scientific Research Institute]

[Abstract] In a study of the geographical distribution of Paleogene radiolarians on the continents and in abyssal bottom sediments the author found patterns associated with changes in physiographic conditions, the history of geological development of sea basins and the evolution of radiolarians. An analysis of the vertical and horizontal distribution of radiolarians over enormous expanses in sections in different regions of Northern Eurasia revealed an identical sequence of radiolarian complexes with similar or close and locally identical taxonomic composition. A two-page table gives a comparison of zonal divisions of the Paleogene in Northern Eurasia and oceanic depressions with respect to radiolarians, foraminifera and nannoplankton. These data are analyzed in great detail. The number of zonal subdivisions in the Paleogene (based on radiolarians) is less than the number of suites, horizons and stages. This justifies the inclusion of radiolarian zones in stratification correlation schemes. In a further study of Paleogene zonal stratigraphy on the basis of radiolarians it will probably be possible to define radiolarian zones as zones in the general stratigraphic scale or in a supplementary zonal stratigraphic scale because identical species of Paleogene radiolarians have been discovered at the same stratigraphic levels on the Eurasian continent, in northern Eurasia (in the USSR from the Carpathians to Kamchatka), in Japan, in America, in Paleogene bottom sediments of the Atlantic, Pacific and Indian Oceans and in the Antarctic basin. Radiolarians have great importance for the global zonal correlation of Paleogene marine sediments. References 15: 11 Russian, 4 Western.

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CSO: 1865/116

## TIMELY ASPECTS OF TECHNOLOGICAL MINERALOGY

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 11, Nov 86 pp 122-123

[Article by A.P. Gorbatova, Moscow Mining Institute]

[Abstract] The Commission on Technological Mineralogy of the All-Russian Mineralogical Society was established in 1983 and is dedicated to publishing, scientific and instructional work. A series of monographs entitled "Technological Mineralogy of the Most Important Types of Deposits" (TEKHOLOGICHESKAYA MINERALOGIYA GLAVNEYSHIKH TIPOV MESTOROZHDENIY) is to be published beginning in 1987. A "Dictionary-Reference Manual on Technological Mineralogy" (SLOVARSPRAVOCHNIK PO TEKHOLOGICHESKOY MINERALOGII) was prepared for publication in 1986. The Third-All-Union Conference on the "Role of Technological Mineralogy in the Development of the Mineral-Raw Material Base of the Country" was held in Chelyabinsk during the period 19-21 March 1986. It was attended by 240 scientists representing 131 organizations. There were 18 reports and 148 graphic displays. The following subjects were covered: present status, objectives and prospects for the development of technological mineralogy, combined use of raw material and development of waste-free technologies, mineralogical criteria for technological evaluation of the quality of raw material, purposeful modification of technological properties of minerals, methods employed in technological mineralogy, evaluation of economic effect from introduction of latest advances in the field, and others. The conferees noted a whole series of shortcomings in the field, such as inadequate research work, lack of coordination among workers, users and planning organizations and limited practical application of research results. Various recommendations for further research were proposed. Such conferences should be held once each three to five years with special conferences on specific forms of raw material or methods being held in intervening years.

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UDC 550.38

## THIRD ALL-UNION CONGRESS ON GEOMAGNETISM

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 11, Nov 86 pp 121-122

[Article by S.Yu. Brodskaya, Scientific Council on Geomagnetism]

[Abstract] The Third All-Union Congress on Geomagnetism was held at Yalta during the period 3-8 February 1986. It was attended by 350 delegates,

including representatives from Poland, GDR, Czechoslovakia, Romania and Bulgaria. Summaries of 405 reports were presented. The congress dealt with the following subjects: theory of the geomagnetic field and its secular variations; study of the present-day geomagnetic field; anomalous field of continents and oceans, their mathematical models and physical nature; electromagnetic induction of mantle; construction of magnetostratigraphic scale; global and regional geotectonics; fine structure and paleostrength of geomagnetic field; physical principles of paleomagnetism; magnetism of minerals, solution of geological problems by methods of magnetism of rocks; development of instrumentation. There has been considerable progress in study of the earth's magnetic field. MAGSAT data have been used in analyzing methods for constructing maps of the normal field and secular variation of the magnetic field for use in highly precise airborne magnetometer surveys. Important results have been obtained in study of the anomalous magnetic field. The principal parameters of earthquakes (time, place, intensity) were successfully predicted for the first time by the magnetometric method. Much research has been done on the processes involved in the formation of different types of rock magnetization, including the nature and properties of chemical remanent magnetization.

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ESTIMATING PROPAGATION VELOCITY OF OSCILLATIONS IN INTRASTRATAL INHOMOGENEITIES  
BY ITERATIVE SOLUTION OF DIRECT KINEMATIC PROBLEM

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 11, Nov 86 pp 99-102

[Article by A.G. Averbukh, Yu.B. Okunev and Yu.I. Akopov, Central  
Geological Expedition, Ministry of the Petroleum Industry]

[Abstract] In the study of interval velocities of seismic wave propagation it is necessary that the horizontal size of the geological body be quite large in comparison with the length of the travel-time curve. In many cases, however, velocities must be estimated within the limits of section inhomogeneities whose extent is short and therefore they are manifested only in the form of local anomalies of effective velocities. For such cases the authors propose a kinematic model of the studied medium based on a comparison of the real effective velocities with values computed by solving the direct kinematic problem. The procedure begins with formulation of a hypothesis concerning the geological nature of the inhomogeneity and construction of an initial variant of a deep model corresponding to the real seismic section. Then the pertinent parameters, such as stratum velocity and configuration, are varied in order to achieve a correspondence between model and real anomalies of effective velocities. The initial model must contain the boundaries of the significant drop in interval velocities, the

boundaries enveloping the velocity inhomogeneities and boundaries situated below the inhomogeneities. The computation formulas and procedures for using this model are presented. A group of programs has been prepared for performing these operations. An example of use of this method is presented. Figures 2.

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UDC 622.243.272

INFLUENCE OF TECHNICAL AND ENGINEERING FACTORS ON DEGREE OF CURVATURE OF GEOLOGICAL PROSPECTING HOLES

Moscow IZVESTIYA, VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 11, Nov 86 pp 79-84

[Article by N.A. Buglov and I.N. Strabykin, Irkutsk Polytechnic Institute]

[Abstract] A very serious problem in the drilling of prospecting holes is the curvature of the drill column, which results in unproductive time loss. This had dictated search for new technical solutions for stabilizing the direction of small-diameter boreholes for increasing fieldwork efficiency. The physical and technical factors responsible for this column distortion problem are reviewed. A series of tests was carried out in an iron ore deposit in Irkutsk Oblast with variance of all significant parameters, such as pipe length and drilling speed, but with standard diamond bits being used in all cases. It was found that drilling in alternating uniform and anisotropic rock formations at high speeds imposes severe requirements on choice of makeup of the bottom of the drill column. When endeavoring to stabilize the direction of holes standard drill columns are less effective than trihedral pipes, assuming an identical length of pipes and drilling regime parameters. The effectiveness of use of trihedral pipes in comparison with other columns for lessening the degree of curvature of holes with a diameter of 59 mm is determined by the length of the column assembly and drilling regime parameters. Trihedral pipes with an overall length of 4.0 m make it possible to drill at high speeds with a minimum degree of hole curvature. In constructing the bottom of the drill column there is a need for using pipes of limited length with the maximum possible cross-sectional moment of inertia and with minimum flexure in the hole. Figures 4; references: 11 Russian.

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CSO: 1865/127

STRUCTURAL CONDITIONS FOR LOCALIZATION OF MINERALIZATION IN NEAR-SURFACE  
GOLD-SILVER DEPOSIT

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 11, Nov 86 pp 49-52

[Article by G.V. Moralev, graduate student, Moscow State University  
imeni M.V. Lomonosov]

[Abstract] Near-surface gold-silver deposits, an important source of noble metals, are usually located in volcanic-plutonic zones forming on the active continental margins. These deposits have an extremely nonuniform distribution of useful components caused by a considerable number of factors, among which an important role is played by structural factors. Study of the structural conditions for the localization of mineralization in the ore bodies of gold-silver deposits are important in the exploration and exploitation of deposits. The near-surface deposit which was studied is situated in a Late Hercynian volcanic-plutonic zone in a large complex of granodiorites of the Late Carboniferous. The deposit is a series of quartz-carbonate veins in a major fault which is 13 km in length. Along the fault there is an elongated intrusive mass of granites of Early Permian age, penetrated by granodiorites. The study revealed that gently and steeply dipping faults, transverse relative to ore bodies, are pre-ore and exert a considerable influence on the localization of enriched segments of veins. The most important enriched sectors are localized in the central parts of vein segments bounded by transverse steeply dipping faults where early gold-silver and late silver-polymetallic productive associations are closely integrated. A specific feature of the structural control of mineralization is the presence of enriched sectors in veins directly under low-amplitude gently sloping pre-ore dislocations. Figures 4.

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CSO: 1865/127

GOLD IN POTASSIC FELDSPARS FROM INTRUSIVE AND METASOMATIC FORMATIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOLOGICHESKAYA in Russian  
No 10, Oct 86 (manuscript received 14 May 85) pp 93-101

[Article by N.L. Shilin, S.S. Kumeyev and A.V. Koloskov, Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry Institute, USSR Academy of Sciences, Moscow; Volcanology Institute, Far Eastern Scientific Institute, USSR Academy of Sciences, Petropavlovsk-Kamchatskiy]

[Abstract] There is an unquestionable geochemical relationship between gold and potassium. This is particularly characteristic for the gold ore deposits

of gold-silver formations of the near-surface type, in which the gold in the ores is closely associated with adularia. Among the magmatic formations, rocks with increased potassium contents are characterized by high background gold concentrations. An attempt has been made to clarify the patterns of distribution of gold in potassic feldspars from rocks of different genesis. The minerals were sampled from various unmodified magmatic rocks and metasomatic formations from two volcanic zones in the USSR. Emphasis was on study of the crystallochemical characteristics of the investigated feldspars and their relationship to gold content. It was found that with transition from intrusive rocks to hydrothermal-metasomatic and then to ore formations containing feldspar the quantity of gold in the feldspar increases regularly. With a decrease in ordering there is an increase in content of the orthoclase component and gold in the feldspar. In the course of evolution of magma melts in magma chambers the gold together with the potassium are accumulated in the final stages. Gold-bearing ore-forming gas-hydrothermal solutions could be formed in the concluding stages of evolution of deep magma chambers. Figures 3; references: 12 Russian.

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CSO: 1865/107

UDC 552.11

PROBLEMS IN INTERPRETING PRESSURE AND TEMPERATURE ESTIMATES BASED ON  
MINERALOGICAL AND GEOTHERMOBAROMETERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOLOGICHESKAYA in Russian  
No 10, Oct 86 (manuscript received 22 Apr 85) pp 19-28

[Article by O.V. Aychenko, Far Eastern Geology Institute, Far Eastern  
Scientific Center, USSR Academy of Sciences, Vladivostok]

[Abstract] Research on high-temperature metamorphic rocks has shown that granulitic rocks of different mineral facies cannot be distinguished on the basis of the garnet-biotite geothermometer. In actuality, the distribution of FeO and MgO between garnet and biotite in what are known to be high-temperature rocks belonging to the cordierite-hypersthene, hypersthene-sillimanite and spinel-quartz mineral facies, in many cases corresponding to exceedingly low temperatures. Accordingly, a study was made of calibration of the garnet-biotite geo(thermo)barometer and such related problems as evaluation of the conditions for formation of an orthopyroxene-sillimanite association and the general problem of retrograde metamorphism of aluminiferous rocks, since it has been established that there are regressive trends in change in P-T parameters in the course of evolution of metamorphism of granulite complexes. Data are presented showing that the value of the coefficient of distribution of FeO and MgO between garnet and biotite in high-temperature granulite complexes in most cases reflects successive regressive stages in metamorphism. This explains the low-temperature position of the observed high-temperature mineral facies. P-T evaluations of the stability

of enstatite + sillimanite associations in such complexes as the Chogarskaya and Sutamskaya facies in the Aldan shield are close and correspond to temperatures 830-940°C at P = 8.3-9.5 kbar. A distinguishing feature of the regressive metamorphism manifested in high-temperature granulite complexes is the limited mobility of the components and a metastable existence of the relict mineral associations. The cation exchange of FeO and MgO, at least between garnet and biotite, in such a case evidently occurs more readily than the reaction with the components Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub> and TiO<sub>2</sub>, resulting in stabilization of "aluminiferous" equilibria at higher P-T levels in comparison with "ferromagnesian" equilibria. Figures 18: 10 Russian, 8 Western.

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CSO: 1865/107

UDC 549.516

#### CRYSTALLOCHEMICAL SYSTEMATIZATION OF MANGANESE MINERALS WITH TUNNEL STRUCTURES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOLOGICHESKAYA in Russian  
No 10, Oct 86 (manuscript received 18 Feb 86) pp 3-18

[Article by F.V. Chukhrov, A.I. Gorshkov and V.A. Drits, Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry Institute, USSR Academy of Sciences, Moscow]

[Abstract] During recent years there have been many publications devoted to fundamentally new and important crystallochemical properties of minerals with tunnel structures. With respect to the structure of manganese minerals, the literature fails to reflect the entire diversity of tunnel structures which may exist in nature. Accordingly, the authors have analyzed the structure of known manganese minerals from a unified point of view and propose a rational crystallochemical systematization of tunnel structures which makes it possible to predict the existence of new manganese minerals. Four groups of Mn oxides are discriminated in this new systematization: pyrolusite, hollandite, todorokite and ramsdellite. The systematization is embodied in a two-page table. Not only does this systematization include all known manganese oxides with tunnel structures, but also three new modifications of todorokite defined by the authors (and described in this article). The systematization makes it possible to predict the possible existence of new minerals. Formulas are derived which can be used in computing the parameters of the unit cells of all new (hypothetical) minerals and their crystallochemical formulas are given. Figures 7: references 16: 3 Russian, 13 Western.

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## INORGANIC DIRECTION OF PETROLEUM AND GAS GEOLOGY IN UKRAINE

Kiev GEOLOGICHESKIY ZHURNAL in Russian Vol 46, No 6, Nov-Dec 86  
(manuscript received received 26 May 86) pp 105-113

[Article by V.A. Krayushkin, Geological Sciences Institute, Ukrainian Academy of Sciences]

[Abstract] Specialists at the Geological Sciences Institute, Ukrainian Academy of Sciences, are formulating a theory of the abiogenic origin of petroleum and gas and the conditions for formation of their commercially exploitable deposits at depths of 15 km or more in the sedimentary layers, strata of volcanic origin and crystalline crust. The concept of an inorganic origin of these hydrocarbons is gaining increasing acceptance. The literature on this subject has increased greatly during recent years, and an effort is made in this review to summarize the high points of these discoveries. The deposits evidently of inorganic origin have been discovered throughout the world; details concerning the most important of these are given. There are many such deposits in the USSR with petroleum and gas at depths of 4.6-7.5 km (such as in Cis-Caucasia, Cis-Carpathia, Dnepr, Caspian and Urals areas). Twenty-five such deposits with commercial reserves of petroleum, gas and condensate have already been discovered in the Ukrainian SSR at depths of 4.6-6 km. The 1-Shevchenkovo hole in the Carpathians, which has reached a depth of 7,526 m, has yielded samples of liquid petroleum from a depth of 7,011-7,022 m. Throughout the world more than a thousand such deposits are being worked at depths of 4.6-8.1 km with total initial extractable reserves of 5.2 billion tons of petroleum and 17 trillion cubic meters of gas. But there are also hydrocarbons of an inorganic origin at shallow depths in the USSR, United States, Saudi Arabia and elsewhere (examples are discussed). The theory of an abiogenic nature of all these petroleum and gas deposits is becoming better defined and the real existence of these deposits is accounting for a great increase in the world's reserves of these hydrocarbon resources. Figures 2; references 26: 16 Russian, 10 Western.

5303/9835

CSO: 1865/181

## PLATINUM GOLD IN PLACERS ASSOCIATED WITH ROCKS OF ARCHEAN GRANULITE COMPLEX

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 291, No 4, Dec 86  
(manuscript received 5 May 86) pp 960-963

[Article by F.P. Krendelev, corresponding member, USSR Academy of Sciences, A.D. Genkin, I.P. Laputina and G.I. Tugovik, Chita Institute of Natural Resources, Siberian Department, USSR Academy of Sciences; Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry Institute, USSR Academy of Sciences, Moscow; Amur Complex Scientific Research Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Blagoveshchensk, Amur Oblast]

[Abstract] Gold-platinum mineralization is associated with the structural eluvium of rocks of the Archean granulite complex. The conditions for the formation of platinum gold in such formations are described and the chemical composition of platinum gold and electrum and associated minerals is discussed. Among the magmatic rocks of the granulite complex there are intrusions of basic and ultrabasic composition, metamorphosed and dislocated, together with the crystalline schists surrounding them. There is a pre-dominance of gabbroids, in a study of the mineralogical composition of whose structural eluvium gold-platinum mineralization was detected. X-ray spectral and structural analyses were made. The intergrowths in which platinum gold or electrum are found have a zonal structure. Gold, silver, platinum and copper were present in all the mineral samples studied, although in different quantities. Representative cases are described. The spatial coincidence of gold and platinum in a single placer and the joint presence of these metals in platinum gold and electrum indicate that they have a common origin in source rocks. The positioning of the described minerals in their zonal groupings suggests the following sequence of their formation: native gold (electrum)→platinum gold (electrum)→native platinum. Figures 1; references 7: 3 Russian, 4 Western.

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CSO: 1865/171

## SOLITON PROPERTIES OF TELESEISMIC WAVES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 291, No 4, Dec 86  
(manuscript received 24 Oct 85) pp 814-816

[Article by N.G. Gamburtseva, A.V. Nikolayev, O.B. Khavroshkin and  
V.V. Tsyplakov, Earth Physics Institute imeni O.Yu. Shmidt, USSR Academy  
of Sciences, Moscow]

[Abstract] The first arrivals of teleseismic P-waves were analyzed (their amplitude at the source was determined by source intensity). The travel times of the first longitudinal wave from powerful shots, whose intensity varied by 1.5-2 orders of magnitude, were measured. Depending on source intensity the shock wave lifetime varied, but its contribution to the change in travel time was far beyond instrument resolution. Registry stations were situated at epicentral distances 200, 600 and 3,000 km. The signal-to-noise ratio for minimum shot intensities at a distance 3,000 km always exceeded 3; in no case was the first phase omitted. The analysis revealed soliton properties of these teleseismic waves, properties which can be explained by several physical models. For example, for a linear and dispersionless medium and a broad-band source radiation spectrum there almost always will be seismic P-waves with frequencies satisfying the requirements on the active modes of a soliton. The absence of dispersion for P-waves causes joint propagation of waves at all frequencies in the wave packet from the source, including the active modes (the packet will contain a soliton component). Since a soliton is characterized by anomalously low attenuation and decay into active modes after loss of energy below the threshold level or under the influence of a high-frequency seismic field, in this case the soliton properties of the teleseismic waves are discriminated with greater contrast with increasing distance from the source. Such effects should exist not only for ground, but for any fissured medium, including for the deep parts of the crust and upper mantle where there are micro- and macrofissures and porosity caused by physicochemical processes. Such a nonlinear dispersive medium favors the formation of soliton properties of teleseismic waves in the upper part of the crust and mantle, especially in fault and seismically active zones. Figures 1; references 15: 13 Russian, 2 Western.

5303/9835

CSO: 1865/171

## NEUTRINO GEOPHYSICS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 9, Sep 86  
(manuscript received 5 Mar 86) pp 81-89

[Article by V.A. Tsarev and V.A. Chechin, Physics Institute  
imeni P.N. Lebedev, USSR Academy of Sciences]

[Abstract] After a general review of the physics of neutrinos, their possible geophysical applications are considered. The joint use of neutrino and antineutrino beams, for example, can yield averaged information on the mineralogical composition of internal regions of the earth. In geodesy neutrino beams afford a possibility for precise geodetic measurements at a global scale. The distance between points situated on the earth's surface or on the ocean floor can be determined by measurement of the flight time of neutrinos between these points. In studying the earth's crust the muon method can be used if in a homogeneous medium on the beam path there is a deposit containing matter different in its atomic composition from the surrounding medium. The time required for detecting a deposit is from several minutes to several hours, depending on depth and type of accelerator used. The apparatus for registering muons is simple and compact and can be transported in trucks. In the radio method the radio emission generated by neutrino beams can in principle be used for the introscopy of rocks, but for any practical application the intensities and energies of the neutrino beams would have to be considerably greater than now possible. A thermoacoustic signal generated in rocks by a neutrino beam can be used in geological research, affording considerable advantages over traditional seismic prospecting, but the main shortcoming is the weakness of the thermoacoustic signal and therefore it cannot be used until effective means are found for increasing the signal-to-noise ratio. The acoustic response of the earth's crust to a neutrino beam may be highly useful for geological exploration of hydrocarbon deposits, studying stressed zones in the earth and predicting earthquakes. Decays of radioactive elements result in the emission of low-energy neutrinos whose registry can provide highly important information on the internal structure and dynamics of the earth inaccessible when using other methods. These are but a few examples of the possible applications of neutrino geophysical research. Presently existing and planned accelerators of the next generation are not optimal for the mentioned work in neutrino geophysics. Specialized accelerators might be developed based on the laser acceleration mechanism. The economic feasibility of the practical aspects of neutrino geophysics for exploring mineral deposits remains to be demonstrated. Figures 4; references 22: 19 Russian, 3 Western.

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CSO: 1865/177

## STATE OF DOMAIN STRUCTURE OF MINERALS CARRYING REMANENT MAGNETIZATION OF VOLCANIC ROCKS OF SAATLY DEEP HOLE (3,540-8,126 m)

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA NAUK O ZEMLE  
in Russian No 4, Jul-Aug 86 pp 89-94

[Article by V.I. Bagin and Z.A. Novruzov]

[Abstract] Magnetic studies of volcanic rocks penetrated by the Saatly hole in the depth range 3,540-8,126 m revealed that their magnetic properties are governed primarily by ferromagnetite and titanomagnetite with a low titanium content. Crystallization conditions and modification of ferromagnetic minerals have imposed an imprint on their magnetic domain structure. The state of magnetic domain structure determines the properties of natural remanent magnetization (one of the main indicators of conditions for formation and change of ferrimagnetic minerals). Only indirect methods were used, based on the characteristics of one magnetic parameter or another for different states of the magnetic domain structure of ferrimagnetic grains:  $I_{rs}/I_s$  ratio;  $Q_n$  factor; Lowrie-Fuller test; thermodynamic test. These four criteria were used in identifying the state of the magnetic domain structure of ferrimagnetic grains in the bedrocks of the section penetrated by the Saatly hole. However, not one of the tests was a perfect "fit." A judgment concerning the state of the magnetic domain structure was based on consistency of the results of identification using 2 or 3 criteria. A composite table shows that in the overwhelming majority of cases the grains of magnetic minerals constitute an ensemble of multidomain particles. In the upper part of the studied section it was common to observe a pseudo-one-domain state. In the lower part of the section the rocks contain only multidomain grains of ferrimagnetic minerals. The ferrimagnetic fraction of volcanites from the Saatly hole is represented for the most part by multi-domain grains. In the lower part of the section pseudo-one-domain grains are registered far less frequently than in the upper part, and beginning with 7,300 m and deeper they are entirely absent. References 15: 9 Russian, 6 Western.

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RESULTS OF SCIENTIFIC GEOLOGICAL RESEARCH AT HIGHER EDUCATIONAL INSTITUTIONS  
OF RUSSIAN SOVIET FEDERATIVE SOCIALIST REPUBLIC DURING ELEVENTH FIVE-YEAR  
PLAN

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 10, Oct 86 pp 104-108

[Article by Staff of Main Council on Geology and Mineral Deposits  
Prospecting, Ministry of Higher and Intermediate Specialized Education,  
RSFSR (Russian Soviet Federative Socialist Republic)]

[Abstract] During the Eleventh Five-Year Plan scientific research work in the field of geology and mineral prospecting was carried out at 50 higher educational institutions in the RSFSR. An effort has been made to concentrate attention on the most timely problems in various branches of geological science and engineering. There has been a considerable expansion of regional research directed to environmental protection. Much theoretical work has been done on the deep structure of the crust on the basis of analysis of data from geophysical research and superdeep drilling. Geological-geophysical and mineralogical-geochemical modeling of geological bodies has assumed a greater role in research. Much effort has been concentrated on the development, testing and introduction of new instruments and equipment for geophysical and mineralogical-geochemical work. Research at higher educational institutions in the republic still suffers from spreading out of resources on too many research projects and the inadequate instrumentation and equipment available in many laboratories and on many field expeditions. In many cases this research is poorly coordinated with related research being carried out by government agencies and in the institutes of the USSR Academy of Sciences, as well as with other educational institutions (the latter seldom pool their efforts). Students are inadequately represented in the research effort. [This review briefly discusses significant research projects underway or completed at different institutions.]

5303/9835

CSO: 1865/114

## ANALYSIS OF OPERATION OF UNBALANCED DRILLING TOOL ASSEMBLY

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 10, Oct 86 pp 79-84

[Article by V.V. Neskromnykh and I.N. Strabykin, Irkutsk Polytechnic  
Institute]

[Abstract] High-frequency drilling procedures are being improved by the development of highly balanced drilling columns, a reduction in the radial gap and a decrease in friction between the string and hole walls, measures favoring true rotation of the string about its proper axis. However, even statically balanced strings are dynamically unbalanced due to the high degree of their deformation under the influence of axial and especially centrifugal forces. The loss of stability of the string at the contact with the hole is analyzed in detail. It is proposed, however, that the forces responsible for hole curvature be neutralized and string operating conditions be improved by purposeful imbalance of the string, by a displacement of the string cross section center of gravity relative to its geometrical center. This displacement should be distributed along the length of the drilling tool assembly. The phenomenon of dynamic self-centering is involved, requiring an analysis of the differential equations for small oscillations of statically and dynamically unbalanced assemblies. The conditions for operation of unbalanced strings can be improved by using the phase shift between the vectors of frictional and centrifugal forces, incorporating this in string design. Figures 5; references: 5 Russian.

5303/9835  
CSO: 1865/114

UDC 622.243.27:658.562.012.7.003.121

## ANALYSIS OF WORK QUALITY IN ARTIFICIAL CURVATURE OF HOLES

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 10, Oct 86 pp 71-78

[Article by R.B. Zakiyev and Yu.S. Kostin, Transbaykal Scientific Research  
Institute]

[Abstract] Artificial curvature of holes is the most difficult, time-consuming and costly type of work in directional drilling. The accuracy of curvature is essentially dependent on the technological system for artificial curvature of holes and the competence of its use. Analysis of such work and formulation of measures for improving work quality requires the defining of indices which take into account all aspects of the technological process. Although indices were proposed earlier, and are

still in use, they fall short of providing all the guidance needed in evaluating work quality. This has been remedied due to work done at the Transbaykal Scientific Research Institute. Supplementary indices are proposed which make possible analysis of operation of individual system elements. This has become possible by use of the methods of applied statistics, the theory of planning of an experiment, correlation and regression analyses and computation methods based on a priori information on the accuracy parameters of certain hole curvature operations. The method involves detailed inclinometry of curvature intervals and hole progress at an interval of 0.5-1.0 m, construction of a detailed vector diagram of spatial curvature and a graph of change in total angle. Natural curvature is a factor which must be taken into account: different holes drilled in the same deposit have different natural curvature. The proposed system of indices fully reflects the nature of artificial curvature work and makes possible an objective evaluation of work quality. Figures 2; references: 10 Russian.

5303/9835  
CSO: 1865/114

UDC 550.835

#### NONDESTRUCTIVE METHOD OF CHEMICAL ANALYSIS FOR SUPERDEEP DRILL CORES

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA  
in Russian No 1, Jan 87 pp 76-83

[Article by S.N. Galyamin, V.L. Guma, A.M. Demidov and V.V. Miller, All-Union Scientific Research Institute of Nuclear Geology and Geophysics]

[Abstract] This method of rock chemical analysis uses fast neutrons from a  $^{252}\text{Cf}$  neutron source to excite gamma rays in rock samples, whose only preparation has been sawing to size. The gamma rays characteristic of various rock-forming chemical elements and trace elements are recorded by a Ge(Li) detector and the spectra processed by a microcomputer. This method is especially suited to rapid nondestructive chemical analyses of unique samples, such as drill cores from superdeep drill holes. Advantages of fast neutron irradiation are: 1) better gamma ray yield for light elements, resulting in satisfactory detection limits; 2) the fast neutrons are slowed by the rock, resulting in gamma rays from reactions with lower-energy neutrons, including thermal; and 3) the gamma ray spectra from inelastic scattering have been studied in detail. The results are found to be superior in accuracy and completeness (they sum to 100%) compared to those obtained using thermal neutron excitation. Gamma ray lines and important items in the data reduction are described for the elements C, Na, O, Mg, Al, Si, P, S, K and Fe. Figures 4; references: 3 Russian.

/9835  
CSO: 1865/315-E

UDC 551.521.31:535.5

INFLUENCE OF ORIENTATION OF ASPHERICAL PARTICLES ON CHARACTERISTICS OF  
RESULTING SCATTERING OF POLARIZED RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 12, Dec 86 (manuscript received 17 Jul 85; after revision  
25 Nov 85) pp 1287-1292

[Article by L.I. Podkamen, S.G. Guminetskiy and A.D. Arkhelyuk]

[Abstract] The article continues earlier published research giving results of a model experiment for evaluating the influence of orientation of aspherical particles on their light-scattering matrix and individual characteristics of polarized light scattered by the particles. Measurements were made using a Stokes goniometer in laser radiation at 633 nm. The model system of oriented isotropically absorbing particles involved particles of gamma iron oxide oriented in a magnetic field and applied to a transparent glass substrate in a thin layer. The particles were rod shaped, 2.5  $\mu\text{m}$  in length, 0.5  $\mu\text{m}$  in diameter. The degree of orientation of the particles was 0.86. It was found that orientation of the anisotropic medium resulted in a significant variation in characteristics of the scattered medium in both natural and polarized radiation as a function of angle of preferential orientation of particles in the medium. The polarization characteristics were determined both by the orientation and by the form of polarization of the beam, expanding the possibilities for utilizing polarized radiation to solve the inverse problem of the optics of light-scattering media. Figures 3; references: 7 Russian.

6508/9835  
CSO: 1865/200

## ATTENUATION AND SCATTERING OF RADIATION ON CIRCULAR ICE CYLINDERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 12, Dec 86 (manuscript received 29 Aug 85) pp 1293-1299

[Article by A.G. Petrushin, Experimental Meteorology Institute]

[Abstract] A study was made of the mean scattering cosine and attenuation and scattering effectiveness factors of infrared radiation by circular ice cylinders of infinite length with arbitrary orientation in the horizontal plane with a change in direction of propagation of the incident radiation. In the case of arbitrary orientation of the ice cylinders in a certain plane regardless of the direction of the incident radiation with wavelength between 8 and 11  $\mu\text{m}$  and radius of the cylinder over 10  $\mu\text{m}$ ,  $\langle \cos \theta(\mu', x) \rangle \approx 0.96 \pm 0.02$ . With  $\lambda > 11 \mu\text{m}$ , the mean scattering cosine decreases somewhat to  $0.92 \pm 0.02$ . For smaller ice cylinders,  $< 10 \mu\text{m}$  in diameter,  $\langle \cos \theta(\mu', x) \rangle$  changes significantly with a change in cylinder diameter,  $\mu'$  and wavelength. In all the ranges of diameter and wavelength studied, the attenuation and scattering are sensitive to changes in these parameters. Figures 3; references 9: 4 Russian, 5 Western.

6508/9835

CSO: 1865/200

UDC 534.222.1:551.463.256:551.596.1

## WAVEGUIDE PROPAGATION OF HIGH-FREQUENCY SOUND FIELD IN STRATIFIED MOVING MEDIUM NEAR IMPEDANCE SURFACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 11, Nov 86 (manuscript received 6 Dec 85) pp 1204-1212

[Article by V.Ye. Ostashev, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] A theoretical analysis is presented of the waveguide portion of a high frequency sound field produced by a point monochromatic source located above a flat surface with finite impedance. Wind speed and temperature profiles are arbitrary, their characteristic vertical scales assumed to be greater than the length of the sound wave. A solution derived for a single specific stratification of temperature and wind speed is used in numerical analysis of waveguide propagation of sound in the lower layer of the atmosphere. Figures 2; references 8: 7 Russian, 1 Western.

6508/9835

CSO: 1865/167

UDC 551.583:551.465.7:551.510.4

MODELING OF UNSTEADY REACTION OF OCEAN-ATMOSPHERE SYSTEM TO INCREASING  
ATMOSPHERIC CO<sub>2</sub> CONCENTRATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 11, Nov 86 (manuscript received 24 Sep 85) pp 1131-1141

[Article by B.A. Kagan, V.A. Ryabchenko and A.S. Safray, Oceanology  
Institute, USSR Academy of Sciences]

[Abstract] The purpose of this work was to reproduce the time variability of the climatic ocean-atmosphere system between the beginning of the industrial revolution and the end of the 19th Century within the framework of an improved version of a seasonal thermodynamic model suggested in a previous work by the same authors and not described in this article. The ocean-atmosphere system of the northern hemisphere is represented as 5 interconnected boxes, 3 for the ocean and 2 for the atmosphere, representing different depth layers of the ocean and latitude-limited areas of the atmosphere. The model was improved over the previous version in that the areas of sea ice were not fixed, an evolutionary equation for the mass of ice, snow and meltwater was added, and the possibility of separate study of the evolution of the carbon and thermodynamic cycles was not assumed. Internal oscillations were detected in the interaction between the areas of water covered by ice and the areas of deep cold water. These oscillations should maintain the sea ice through the end of the next century. Figures 2; references 25: 19 Russian, 6 Western.

6508/9835

CSO: 1865/167

UDC 551.521:551.576

THREE-DIMENSIONAL NUMERICAL MODEL OF MESOSCALE PROCESSES OVER ENERGY-ACTIVE  
ZONES OF OCEAN WITH INTERACTION OF CLOUD COVER AND RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 11, Nov 86 (manuscript received 8 Oct 85) pp 1142-1153

[Article by K.Ya. Kondratyev and V.I. Khvorostyanov, Limnological Institute,  
USSR Academy of Sciences; Central Aerological Observatory]

[Abstract] A three-dimensional nonsteady medium-scale numerical model of the planetary boundary layer was developed, including the interaction of dynamic, radiation and microphysical processes during development of low-level cloud cover, in order to provide a more detailed study of cloud cover dynamics and its influence on radiation conditions in energy-active zones of the ocean. The model includes 5 main blocks: 1) dynamics of the planetary boundary layer; 2) hydrothermodynamics and microphysics of clouds;

3) long-wave radiation; 4) solar radiation; and 5) exchange with the underlying surface (plus several supplementary blocks). Numerical experiments with the model indicate that the factors favoring formation and long-term persistence of low-level clouds, decreasing the heat content of the ocean in the Newfoundland energy-active zone and subsequent cooling in Europe are: 1) a decrease in the temperature of the Labrador Current and an increase in the temperature of the Gulf Stream; 2) meandering of the Gulf Stream to the left, bringing it closer to the Labrador Current; and 3) long-term persistence of large-scale baric formations with isobars transverse to the currents. The models indicate that low clouds and fog are important in the chain of feedback interactions between the atmosphere and the ocean in this area, representing one of the main factors responsible for a decrease in the heat content of the oceanic thermocline, increasing the dispersion of the radiation balance in the energy-active zone. Figures 8; references 16: 15 Russian, 1 Western.

6508/9835

CSO: 1865/167

UDC 551.510.42:551.521.31:551.571.3

#### INFLUENCE OF HUMIDITY ON FORMATION OF OPTICAL PROPERTIES OF ATMOSPHERIC AEROSOL

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22, No 10, Oct 86 (manuscript received 10 Jun 85, after revision 17 Oct 85) pp 1065-1071

[Article by K.A. Tavartkiladze, Geography Institute, Georgian Academy of Sciences]

[Abstract] A study was made of the role of variability of atmospheric moisture content in formation of a statistical model of the significant characteristics of atmospheric aerosol. Specifically, an effort was undertaken to ascertain the influence of relative humidity and water vapor elasticity ( $f$  and  $e$ ) in the surface air layer on the structure of the spectral aerosol optical thickness  $\tau(\lambda)$ . The instrumentation used in determining spectral transparency, the method for determining  $\tau(\lambda)$  and the method for evaluating the measurement error and for making computations were outlined by the author earlier in SOOBSHCH. AN GSSR, Vol 72, No 1, pp 85-88, 1973. It was found that in the range of change of water vapor elasticity in the surface air layer 5-25 mbar and relative humidity 45-75% the norms of the spectral aerosol optical thickness in the spectral interval 0.37-0.82  $\mu\text{m}$  should be used as a priori information in studying terrestrial features using artificial earth satellite data. In this range of surface air layer moisture content the norms of spectral aerosol optical thickness can be scaled for the actual water vapor elasticity of the surface air layer over a feature. Using water vapor elasticity and relative humidity of the surface air layer it is possible to approximate the spectral variation of aerosol optical thickness in the spectral interval 0.37-0.82  $\mu\text{m}$  if its

measured value is available for one wavelength within this spectral interval. This sort of approximation for continental aerosol (when there are no weak selective aerosol absorption bands in the spectral interval 0.6-0.8  $\mu\text{m}$ ) can be accomplished with an accuracy not less than 95%. If absorption bands appear (as in a mixed continental and marine aerosol) the accuracy of the approximation is reduced to 80%. Figures 3; references 20: 15 Russian, 5 Western.

5303/9835  
CSO: 1865/130

UDC 551.510.42:551.501.816

#### LIDAR STUDY OF ATMOSPHERIC AEROSOL INHOMOGENEITIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22, No 10, Oct 86 (manuscript received 29 Jul 85, after revision 18 Sep 85) pp 1060-1064

[Article by Yu.S. Balin, M.S. Belenkiy, V.L. Mironov, I.V. Samokhvalov, N.V. Safonova and I.A. Razenkoy, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences]

[Abstract] Applicability of the hypothesis of a conservative passive admixture and its corresponding power-law spectral model for a statistical description of fluctuations of the atmospheric aerosol concentration was investigated. It is shown that the approach used by a number of authors in solving this problem is in actuality invalid. No method for computing the fluctuating parameters of lidar signals based on correlation analysis can provide an unambiguous solution of the applicability of any hypothesis or model for describing the spectrum of fluctuations of aerosol concentration. However, a successful solution is obtained by the spectral decomposition method. This method also affords a possibility for solving the inverse problem: retrieval of the spectrum of concentrations on the basis of lidar measurement data. Data are presented confirming applicability of the hypothesis of a conservative passive admixture and the Kolmogorov spectral model for describing the statistical properties of random aerosol inhomogeneities since the spectra of concentration fluctuations and the backscattering coefficient in the inertial interval of wave numbers conform to the Kolmogorov-Obukhov power law. Figures 1; references 12: 11 Russian, 1 Western.

5303/9835  
CSO: 1865/130

STATISTICAL CHARACTERISTICS OF INTENSITY FLUCTUATIONS OF OPTICAL BEAMS IN  
TURBULENT ATMOSPHERE IN RAIN

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 10, Oct 86 (manuscript received 1 Feb 86, after revision  
21 Jan 86) pp 1050-1059

[Article by G.Ya. Patrushev and A.I. Petrov, Atmospheric Optics Institute,  
Siberian Department, USSR Academy of Sciences]

[Abstract] The literature contains reports on many theoretical and experimental studies devoted to various characteristics of fluctuations in the intensity of optical waves propagating in precipitation, often with recourse to approximate methods and assumptions, making it difficult to assess their applicability for the real atmosphere. In order to clarify the validity of previous research, synchronous measurements were made of the statistical characteristics of intensity fluctuations on three closely spaced paths (which differed considerably in length) on which conditions prevailed for multiple scattering and strong intensity fluctuations on the long paths, whereas opposite conditions prevailed on the short path (the paths measured 0.2, 2.5 and 5 km). The experimental apparatus and program are described. The dependence of intensity fluctuations on optical thickness was determined. The characteristics of these fluctuations, obtained in collimated and divergent beams propagating in a turbulent atmosphere during rains of different intensities, made it possible to trace the nature of change of these intensity fluctuations, their time spectra and probability density relative to the optical thickness prevailing along the path. Figures 6; references 22: 15 Russian, 7 Western.

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CSO: 1865/130

MICROPHYSICAL INTERPRETATION OF SINGLE-PARAMETER MODEL OF POLARIZATION-  
SCATTERING PHASE FUNCTIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 22, No 10, Oct 86 (manuscript received 24 Jun 85, after revision  
4 Nov 85) pp 1042-1049

[Article by V.V. Veretennikov, M.V. Kabanov and M.V. Panchenko,  
Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences]

[Abstract] The article gives the results of interpretation of a statistical model of polarization-scattering phase functions of haze in the coastal region. This made it possible to determine the dependence of the parameters

of microstructure and the complex refractive index of haze on the meteorological range of visibility. The data from a microphysical interpretation were used for retrieval of the polarization and spectral characteristics of light scattering of haze and their variability under conditions of changing atmospheric turbidity. This made it possible to estimate the contribution of particles of the submicron fraction to the absorption of infrared radiation. The study was based on a single-parameter model for the polarization-scattering phase functions of haze in the coastal region. The model describes the angular dependence of these functions at a wavelength  $\lambda = 0.546 \mu\text{m}$  in a wide range of change in the range of visibility from 5 to 50 km. The model makes it possible to avoid time-consuming computations involved in the inversion and interpretation of a great number of individual records of experimental data. The tabulated data clearly show that an increase in turbidity in the visible spectral region can be accompanied by an increase in absorption in the IR range which must be taken into account when making different kinds of radiation computations. These results give a quite full idea concerning the quantitative relationships for microstructural parameters and the optical properties of haze in the coastal region in the spectral interval  $0.48\text{-}0.84 \mu\text{m}$  as a function of the degree of atmospheric turbidity obtained on the basis of solution of inverse problems for the single-parameter model used. Figures 4; references 12: 10 Russian, 2 Western.

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UDC 551.521.3;551.510.42:551.509.68

SPECTRAL STRUCTURE OF SOLAR RADIATION AEROSOL ATTENUATION IN TRANSPARENCY WINDOW 8-13  $\mu\text{m}$

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22, No 10, Oct 86 (manuscript received 4 Jul 85, after revision 18 Sep 85) pp 1034-1041

[Article by A.Kh. Shukurov, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] Variations in the optical density of a vertical column of the atmosphere  $\tau_\lambda$  in intervals of the transparency microwindows in the spectral range 8-13  $\mu\text{m}$  were analyzed using data from measurements made under continental and marine conditions. In this range the two most important atmospheric components are water vapor and aerosol. The  $\tau_\lambda$  data were obtained at observation points located in the Moscow area, in the equatorial zone of the Atlantic Ocean and in the Gissar valley in Tajikistan (these can be regarded as characteristic for the temperate latitudes, marine and arid zones). The instrumentation and measurement methods used in determining  $\tau_\lambda$  were described by the author in IZV. AN SSSR: FAO, Vol 12, No 3, pp 264-271, 1976. The study demonstrated the possibility of empirical separation

separation and allowance for the contributions of water vapor and aerosol to the vertical optical density of the atmosphere in the field of its main transparency window 8-13  $\mu\text{m}$ . An empirical expression was derived for computing the optical density of water vapor in the microwindows of the range 8-13  $\mu\text{m}$  for  $W < 3.5$  cm. The article gives examples of the spectral dependence of aerosol optical density under conditions of considerable turbidity of the continental and marine atmosphere, including for the smoke-filled atmosphere resulting from major peat and forest fires in the Moscow area in August 1972. Figures 3; references 21: 17 Russian, 4 Western.

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CSO: 1865/130

UDC 551.524.72:551.547.5:551.593.1

DETERMINING ATMOSPHERIC TEMPERATURE AND PRESSURE PROFILES FROM MEASUREMENTS OF ASTRONOMICAL REFRACTION NEAR HORIZON

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22, No 10, Oct 86 (manuscript received 15 Jul 85, after revision 28 Oct 85) pp 1026-1033

[Article by N.A. Vasilenko, K.P. Gaykovich and M.I. Sumin, Radiophysics Scientific Research Institute]

[Abstract] The results of retrieval of the vertical profiles of atmospheric parameters are given on the basis of measurements of the optical refraction of celestial bodies from the earth's surface at positive angles of elevation. The study is based on the results of simultaneous astronomical and aerological observations made in October 1968 and 1972. The measurement region was a slightly hilly semi-desert with a clayey-rocky underlying surface. The retrieval was based on solution of the corresponding inverse problem relative to the refractive index. The A.N. Tikhonov and statistical regularization methods were used. The results of processing of the experimental data, especially comparison of measured refraction and refraction computed on the basis of aerological data, as well as comparison of the profiles of atmospheric parameters retrieved by two different methods and probe profiles, show that the accuracy of measurements of refraction, the accuracy in computing the nucleus of the integral equation and the degree of correspondence of the real atmosphere to a spherically symmetric approximation under experimental conditions meet the requirements formulated by K.P. Gaykovich, et al. in IZV. AN SSSR: FAO, Vol 22, No 9, 1986 for successful retrieval of atmospheric parameters. The accuracy of retrieval is comparable to the best theoretical evaluations of the accuracy of retrieval by the surface microwave radiometry method. Temperature inversions are retrieved well. This is evidence of the effectiveness of the algorithms developed for retrieval of atmospheric parameters, especially on the basis of the statistical regularization method. It is shown that the use of refractometric measurements for remote sounding of the atmosphere is highly promising. Figures 4; references 7: 6 Russian, 1 Western.

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CSO: 1865/130

AINOVY ISLANDS EXPEDITION STUDIES CALF-PHOCA

Murmansk TASS 23 Dec 86

[Text] Murmansk, 22 December. A Soviet expedition has completed the work it conducted for a month and a half on the Ainovy Islands Preserve in the Barents Sea. The subject of the studies was the calf-phoca, or tevyak, which is in the Red Book of the USSR.

The Ainovy Islands, which are part of the Kandalaksha State Preserve, are described as an "oasis beyond the polar circle" for their rich and diverse vegetation, quite unusual for the polar latitudes. Prevailing among the plants there are large umbellates--chervil and angelica

The two flat islands rising a little above the level of water are, as a matter of fact, the USSR's only habitat of the calf-phoca. The population of the latter has almost completely disappeared in the gulfs of Finland and Riga.

The members of the expedition almost daily watched the behavior of the seals in the period of their propagation and made interesting discoveries. It is known that the Greenland seal produces and feeds its posterity on drifting ice, while the common seal--on fast shore ice. The calf-phoca propagates in the coastal zone, not in a herd, but monogamously. The scholars have drawn the conclusion that the population of the calf-phoca in the area of the seven islands including, the Ainovy Isles, far from declining, is, on the contrary, growing. Biologists have counted nearly 300 adult specimens on the lay place of the Bolshoi Ainovy Island.

The Tevyak can stay under water two-three times as long as the other pinnipedia. It can dive down to a great depth when hunting fish. The animal is fond of snow bathing and moving speedily by means of flippers. It often creeps for a distance of 200-300 meters from the shore deep into the island.

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CSO: 1865/151-E

## 'OZONE HOLE' OVER THE ANTARCTIC

Moscow TASS 23 Jan 87

[Text] Moscow, 23 January. The "ozone hole" over the Antarctic has an undoubted influence on climate and weather in the world. Dr. Yevgeni Borisenkov, Director of the USSR Main Geophysical Observatory, writes today in the newspaper IZVESTIYA. Absorbing solar radiation, ozone causes air heating in the stratosphere. Such heat processes are upset in the "hole", and atmospheric circulation is changing; hence, instability of climate and winds. Weathermen in their future forecasts will surely take this phenomenon into account.

"The 'hole' developed in the ozone layer located at a distance of 20-25 kilometers from the Earth's surface," the scientist said. Oxygen's "relative" occurs at various levels in the atmosphere but its greater part is in the stratosphere where ozone, absorbing ultraviolet solar radiation, protects living organisms from harmful effects.

Ozone concentration changes seasonally and latitudinally, increasing from winter to summertime and during warm times--from the equator to the poles. However, satellite measurements amazed specialists: ozone concentration in the "hole" is several dozen per cent lower than the ordinary level. Lower ozone concentration in the stratosphere increases possibility of penetration of hard ultraviolet solar radiation and its pernicious influence on the flora and fauna.

Though the "hole" occupies a relatively large area--over one million square kilometers, it appears only in October. During Antarctic spring, such atmospheric phenomena are not registered in the northern hemisphere. "Incidentally, this is one of the riddles of the discovered phenomenon," noted Dr. Borisenkov.

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CSO: 1865/202-E

POLAR WORKERS ESTABLISH ANTARCTIC BASE

Moscow TASS in English 1937 GMT 31 Dec 86

[Text] Leningrad, 31 December--Soviet polar workers have decided to establish another Antarctic seasonal base, Druzhnaya-3, in Queen Maud Land, near the bases of Japan and West Germany. According to a radiogram of heads of the 32nd Soviet Antarctic Expedition, the "Professor Vize" research vessel and the "Kapitan Kondratyev" electrically-driven motorship met today near the Cape of Norway. They started a joint cruise among the icebergs of the Weddell Sea to the area where it is planned to establish the new Soviet research base.

The establishment of the Druzhnaya-3 polar station became a necessity after the breaking last autumn of the Filchner Ice Shelf where the Druzhnaya-1 base had been located for 10 years. During all those years it was the center of Soviet geological and geophysical studies in a vast area of West Antarctica. The settlement consisting of several prefabricated houses and laboratories found itself on a floating island. The ships will approach it and will try to remove from there the most valuable equipment.

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UDC 574.475

CALCULATION OF PRODUCTION OF MASSIVE HERBIVOROUS COPEPODS IN CENTRAL ARCTIC BASIN

Moscow OKEANOLOGIYA in Russian Vol 26, No 6, Nov-Dec 86  
(manuscript received 7 Feb 85) pp 994-997

[Article by K.N. Kosobokova, Oceanology Institute imeni P.P. Shirshov,  
USSR Academy of Sciences, Moscow]

[Abstract] An attempt was made to calculate the annual production of two of the most massive representatives of zooplankton - *Calanus glacialis* and *C. hyperboreus*, amounting to 53-57% of the biomass of mesoplankton in the layer from the bottom to the surface, and up to 90% in the upper 200-meter layer of the polar regions in the Arctic Basin. Calculations were based on tables compiled by processing zooplankton screen samples collected by North Pole drift stations in 1954-1956 at latitudes 76-80°N. The total annual production of the two species was 5.6 g/m<sup>2</sup> in 1954-1955, 1.7 g/m<sup>2</sup> in 1955-1956, indicating that the level of production of the dominant herbivorous copepods in the central Arctic Basin was several times lower than that of communities of the same and similar species in more southerly latitudes. The low production is apparently related to the extreme environmental conditions, including low temperature, polar night and constant ice cover, the brevity of the growing season, low level of primary production and low biomass of phytoplankton. The low temperature and paucity of food resources led to a reduced growth rate of crustaceans, lengthening of the life cycle in comparison with boreal regions and reduced productivity. References 23: 15 Russian, 8 Western.

6508/9835  
CSO: 1865/203

## JET STREAMS IN EARTH'S ATMOSPHERE

Moscow PRIRODA in Russian No 10, Oct 86 pp 70-75

[Article by I.I. Tsigelnitskiy, candidate of geographic sciences, junior scientific specialist, Arctic and Antarctic Scientific Research Institute, USSR State Committee on Hydrometeorology and Environmental Control: "Rivers in the Air"]

[Abstract] Like the great ocean currents, jet streams flow at various altitudes in the atmosphere. There are several such currents moving through the atmosphere of each hemisphere at any time. The jet streams not only control weather, but also largely determine the routes followed by long-distance commercial aircraft, which take advantage of the high-speed, high-altitude air currents to save fuel and time. Air currents also form at lower altitudes and on smaller scales. At weather fronts and in small-scale streams, wind speeds may reach 60 meters per second, with the wind speed at the center of such a small-scale current 2 to 3 times greater than that at the surface. This may result in hurricane-force winds at an altitude of 300 m, with light breezes at the surface where weather instruments are usually located. Around Antarctica, these unstable winds are particularly powerful, generating wind shear 2 to 3 times greater than that in which modern aircraft can be safely landed. Figures 5.

6508/9835  
CSO: 1865/215

UDC 550.834(26)

## EXPERIENCE IN USING COMBINATION OF GEOLOGICAL AND GEOPHYSICAL METHODS IN DETERMINING REFLECTION COEFFICIENTS OF BOTTOM SEDIMENTS ON ARCTIC SHELF

Moscow EKSPRESS-INFORMATSIYA: MORSKAYA GEOLOGIYA I GEOFIZIKA in Russian No 9, Sep 86 pp 1-8

[Article by B.A. Bondarenko, Zh.M. Bulatova, Ye.A. Volkova, Ye.A. Denesyuk, Ye.F. Dubrov and A.N. Nikitin, "Rudgeofizika" Scientific Production Association, USSR Ministry of Geology]

[Abstract] Geological mapping of the arctic shelf must be accomplished by a combination of geological and geophysical methods, with acoustic sounding (seismic profiling) playing a key role. When combined with direct geological methods, such as drilling and sampling, it is possible to perform stratigraphic and lithological referencing of reflecting acoustic boundaries. The acoustic sounding equipment is supplemented by devices for registering reflectivity of bottom sediments. The elastic oscillations are generated by a multi-electrode electrohydraulic source. The bottom signals are registered, amplified and sent to shipboard processors and recorders. The acoustic-geological section and diagrams of the current and averaged amplitude and energy

coefficients of bottom reflection are recorded (as well as other reflection parameters). Good records can be registered when waves are up to class 5 and the rate of the ship's movement is up to 8 knots. Work for plotting maps of distribution of bottom sediments is done in a rectangular grid with a distance of 2 km between the main profiles oriented across the general strike of the shoreline. (Bottom samples are taken by dredge and corers as a cross-check.) A radio navigation system is used for geodetic referencing. As an example of the results of such work Fig. 1 shows a comparison of the results of such a survey and data from geological sampling; Fig. 2 illustrates an acoustic-geological section and a diagram of the reflection coefficient along a profile intersecting late glacial and Holocene marine deposits. The use of such a combined method results in a considerable reduction in the use of direct geological methods. The high productivity of the combined method and the great detail of the results make it possible to recommend it for the purposes of geological mapping, exploration for minerals and engineering work in sea areas. Figures 3.

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CSO: 1865/169

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