# INVESTIGATION OF HEAR BOTTOM CURRENTS IN MOUSE PIT IN THE VICINITY OF NESTOR AREA

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## INTRODUCTION

The development of NESTOR project requires the detailed knowledge of the hydrological conditions, water transfer at the site of neutrino telescope deployment and cable laying.

This is important because of two reasons:

1) The presence of significant velocities near the bottom at the site of cable laying can cause mass transfer, which respectively can lead to changes in cable position, stress arising and possible cable damage.

2) The knowledge of water movement changing water characteristics around the telescope (temperature, water transparency etc.) is necessary for interpretation the results of neutrino detecting experimental results.

In this publication we'll try to summarized experimental data available at the NESTOR site concerning near bottom current structure.

The current meter data presented here were taken as a part of the NESTOR project during 29 Cruise of the R/V Academician Mstislav Keldysh (October-November 1992).The comparison was made with the results obtained on the 45th Cruise of R/V Dmitry Mendeleev and on the 22th Cruise of R/V Vityaz (1991). The location, measurement levels and other conditions of the experiments are shown in the table 1.

All current measurement sites were situated at the sane hydrological conditions and at the similar geomorphological conditions, that is why the results of the measurements are examined jointly.

THE SITE FOR MEASUREMENTS

The NESTOR site is situated on the bottom of the Ionian Trench near the foot of continental slope 20 miles SW of Pylos and 7 miles south of Sapienza island. The bottom morphology was studied in details with echo-sounder by M.Rudenko and is shown in figures 1 and 2 with the locations of the moorings (no-s 1, 2. 3 for 1992 year, 4

*&* 5 for 1991 and 6 *& 1* for 1989 year).

For the bottom morphology in the vicinity of the sites 1-5 it is important that the abrupt continental slope with depth change from 0 to 3700 m restricts Study area frora the north-eastern side.

Nearly horizontal plain site with the rare outcropping of abyssal hills in the southwest direction gently transforms to the Slope of the most abyssal bottom parts of the Ionian Trench (depth 4400-4500). There were both the bottom station (no.6) with 'Potok' current meter (the 45th Cruise of R/V Dmitry Mendeleev) and surface buoy station of 1991 year (no.5) in this area. The depth maximum (5120 meters ) in the Mediterranean sea (this is the Vavilov Deep which in Greece also known as Inouse pit) was registered 20 miles to the West from this site. It is at this site, the second bottom station of the 1989 year (no.7) was deployed at the depth 5110 meters.

## INSTRUMENTATION AND MOORINGS

CURRENT METERS. During these R/V cruises near bottom currents were measured uith impeller current meters 'Potok' (of various modifications) with vector averaging of velocity being designed and manufactured by Experimental Design Bureau (EDB) of oceanological engineering (Russian Academy of Sciences), Moscow.

Such current meters allow registration in time of zonal (u) and Meridional (v) components of velocity along with temperature data on magnetic type cassette or on some memory board (it depends on device model). Sampling rate varies from 1 to l/128$^{th}$ of hour and is chosen according to the experimental purpose. In our cases it was mainly 1/64, 1/32 or l/16$^{th}$ of hour (see table 1).

The 'Potok's current meter uses a rotor with horizontal axis to measure water speed, a vane and internal compass to measure direction, a temperature sensor.

The velocity sensors have been tested at EDB metrological laboratory. There are certification papers for each sensor. Recording to these papers the stall speed of rotor doesn't exceed 3 cm/s. This value does not mean the start of a rotor movement that actually starts when the speed is about 1 cm/s. It means that the manufacturer guarantees the beginning of linear relationship of rotor counts numbers and current speed from 3 cm/s.

The sensitivity of the registration channel is determined as the value corresponding 1-bit change in the registered code. This value is about 0.5-1 cm/s (Fomin et.al. [1]). The registered code converts to the speed using the expression

$$S = A * R + B$$

where R is the registered code or precisely, the number of revolutions/second averaged during the recording interval and S is the current in cm/s, A and B are constants defined for each sensor in the certification papers. The 'Potok' current meter is the device which integrates the number of rotor revolutions during the recording interval and divides the result by the interval.

The vane and compass have a resolution +5 degrees.

The temperature sensors were made in April 1992 at in the Bureau. They have certification papers containing their parameters. The absolute accuracy according to these papers is 0.05 C.

'Potok' current meters were placed at levels which corresponded to the character scales of future neutrino telescope. The low level of future telescope will be 150 m above button, the high level will be 500 m above bottom. At the site 1 current meter was 70 m above bottom, at the site 2 current meter was 170 m above bottom, at the site 3 two current meters were 170 m and 440 m above bottom respectively.

FEATURES OF THE MOORINGS. In 1992 on the R/V Academician Mstislav Keldysh 29th Cruise underwater moorings were used for delivery of the current meters 'Potok' into near bottom layer.

Fig.3a shows the mooring design for sites 1 and 2. In this case 'Potok' current meter (3) was situated beneath the syntactic float on the 11 mm rope and was linked by means of kapron rope to ADS-6 (2). ADS-6 is an autonomous bottom station used by acoustic measurements group. ADS-6 was used in this mooring as a release. There was used 200 kg anchor (4). The lifting of mooring and surface search were based on using of ADS-6 equipment ( acoustic release, radiobeacon, flashlight ).

Fig.3b shows the mooring designed for the site 3 by V.VU.Ledenev and V.H.Rukol. The first 'Potok' current meter was placed directly above acoustic release and the second was 270 m above the first. The 1 m diameter titanium sphere (4) used as a float was linked by means of 150 m kapron rope to the upper 'Potok' current meter. The anchor was connected to the shackle of acoustic release by 150 m kapron rope. The hydrophysical surface buoy GM-47 was used for visual site determination in next experiments of this cruise.

The applied mooring is known as the mooring with intermediate float [2] which applies for minimization of surface waves influence on results measured.

In 1991 on the $22^{nd}$ voyage of the R/V 'Vityaz' eight current meters were placed on each of two surface buoys (fig.4a). In this case 'Potok' current meters (3) were situated on the steel rope (4). On the surface there was surface buoy (5) and there was an anchor (1) on the bottom. Levels of measurements in the near bottom layer were 200, 300 and 500 m above the bottom.

In 1989 on the $45^{th}$ voyage of the R/V 'Dmitry Mendeleev' current meters were deployed at the level 2,5 m above the bottom by means of seismological self-contained pop-up stations (underwater type of mooring). The main parts of the stations are buoyancy of several syntactic discs, kapron rope, two releases, an anchor, devices for searching the station on the sea surface after its lifting (fig.4b). Detail description of the station can be found in [3].

## PROCESSING AND REPRESENTATION OF THE DATA

Data were translated from solid-state memory to PC hard disk using a reader of EOB construction and PC compatible computer. It was the first experiment in ocean conditions with such model of 'Potok' current meter. The previous model of 'Potok' current meter uses magnetic tape for data storage and after data translation from tape it is necessary to make some recovering of these data because the tape quality (which usually is not excellent) influences the data quality. When the data translated from solid-state memory you have the data in computer as they were measured (rotor counts) that is more reliable than in the case of magnetic tape. The "Potokl" program was used for data translation to PC. For the next step of data processing the characteristics of these data such as number of deployment, location, date and time of measurement start, date and time of measurement end, characteristic constants for this current meter and other necessary information were put into file of characteristics. This file and the data file were used by the program "Potok2" as input files and the file containing the table of velocities, temperature, current and direction and the file containing the statistical results for these data such as maximum and mean current values were made as output files.

In this report, statistics, raw and filtered time-series plots, vector stick plots, progressive vector diagrams, histograms are presented.

## STATISTICS

For velocity component vectors u,v and temperature T as a variable there were calculated:

Average

Variance

Standard error

Skewness

Kurtosls

also

Average current

Average current direction

Mean kinetic energy

Fluctuating kinetic energy

were calculated.

Vector stick plots

Vector stick plots of averaged 15-min data are presented for the deployments 3, 6 and 7.

Time series plots

Various quantities, depending on the data set. are plotted versus time.

Progressive vector diagrams (or virtual displacement of water) were calculated for all data. They have tine interval between dots 15-30 min.

Histograms

Histograms and cumulative histograms of the raw velocity components are computed for all the data.

Using mean value and standard deviation expected frequencies and cumulative frequencies (empirical distribution function) were computed:

where m(x) - number of points where current value is lower than certain value.

For convenience of comparison with normal distribution this function was drawn using usual scaling for probability.

The analysis of possible oscillations polynomial filtration was made [4]. Here we represent example for 440 m level at the site 3. For this method the filter cut frequency is the lower period determined by model applying defined as:

where N is the length of data row
t data time interval
p polynom order.

## HYDROLOGICAL FEATURES

The research area was situated in the Ionian Sea at the distance 20 miles from the Peloponnesus to the Southwest. The Ionian Sea belongs to the northeastern part of the Mediterranean Sea central basin. The main hydrological characteristics as was described in [5,6,7] can be summarized as the following:

As a rule in this region the water structure from the surface to the bottom is considered as a composition of three water structures: the surface layer (from 0 to 100-120 meters) mainly of Atlantic origin, which is characterized by higher temperature and lower salinity; the intermediate layer of Levantine origin, which is characterized by temperature maximums at depths 150-200 meters and low border at depths 600-800 meters, and the abyssal layer. These layers are combined in steady structure due to very little vertical gradients of temperature, salinity and density. The abyssal temperature minimum is at depths 1500-2000 meters. Lower the temperature increases due to adiabatic processes. The abyssal water layer is practically homogeneous through all the layer (2000 m) as concluded from the distribution of potential temperature. The salinity changes in this layer don't exceed 0.1 o/oo usually. The potential density of abyssal water layer also doesn't practically change. U. Krivosheya has noted [8], that the density of abyssal [8] waters doesn't practically change during the year and from year to year. He shows the results of CTD stations (CTD Rosette) performed in 1985, October, 1989, October, 1991, July to depths 3500-5000 m. These results demonstrate extremely little changes in salinity and density in this area. The temperature of abyssal waters (from 3000 m to the bottom) was also without changes. However, the temperature in the upper layer of abyssal water in 1991 was slightly higher then in 1985 and 1989, that associated by author opinion with the intensive transport of more saline warm Crete abyssal waters probably during previous winter.

## NEAR BOTTOM CURRENT MEASUREMENT RESULTS

PRELIMINARY INFORMATION. The pattern of region currents is the combination of the steady current of surface and intermediary waters from the Aegean Sea to the Otranto Straight with the local cyclonic circulations [5]. The average transport in this region has the northwestern direction as derived from geostrophic relation. The nearest sites to this area where the results of current measurement in bottom layer are available are the straights between the Aegean and the Ionian seas [9].

All information concerning currents in the bottom layer of the Ionian Sea is represented by individual experiments of Shirshov Institution: as it was mentioned above,- in 1989 on the R/V Dmitry Mendeleev 45 Cruise synchronous measurements of current and temperature were made by T.Demidova & E.Kontar [10] at the site near the NESTOR research area [10] at 3 m above Vavilov Deep bottom at the depths 5110 and 4500 m respectively (sites 6 & 7 in Fig.l & 2).

In 1991 on the R/V Vityaz 22 Cruise measurements were made in the NESTOR research area by V.Krivosheya with two surface moorings (sites 4 & 5 in Fig. 1 & 2). There were 8 'Potok' current meters on each mooring. In the bottom layer current meters were situated at 200, 300, 500 meters above the bottom.

In 1989 the measurement time was about 60 hours. Mean currents were 1-2 cm/s, maximum velocities were about 5 cm/s (table 1). The behavior of 0.5 hourly averaged speed at 5100 m and 4500 m is shown in Fig.5. Stick plots at 5110 m is presented in fig.6, Histograms for speed and current direction for the site 7 (in fig.7 & 8) demonstrate main statistical features of bottom currents there. Also there were weak fluctuations of direction from 180 to 225 degrees. From revealed principal directions of the current and from diagrams of the virtual displacement of water (fig.9) one can see that at both sites during time of measurement it is in accordance with the direction of isobathes (Fig.l).

Currents obtained from surface moorings in 1991 [8] were about 2-3 cm/s (mean values) with maximum values to 20-22 cm/s at 200-500 m above the bottom. The direction changed quickly during 1-2 hours from NW to SE and inversely. The prevailing current direction is tangential to depth counters (isobathes).

In report [8] the correlation between current velocity and wind velocity is noted. In particular, there were velocities about zero simultaneously with wind absence. The author interprets this correlation as the influence of sea level rising in the region of coastal slope.

Our point of view on the above-mentioned correlation is considering below in 'Discussion of the results'. Here we just mention that it can be due to surface buoy movements influence and that's why it is necessary more carefully treat high velocities obtained in 1991.

THE CURRENTS in NOV.,1992. The results of statistical analysis are shown in Table 2. Presented in this table for each level are averaged u (zonal (latitudinal) velocity component), v (meridional velocity component), standard deviation for u, v, averaged value and standard deviation for speed, averaged value and standard deviation for temperature, average current and its direction measured clockwise from north, average kinetic fluctuation energy.

At the site 1 the deployment had the duration of 6 hours, that is less in comparison with preliminary planned duration. It was due to unexpected ADS-6 release working and earlier mooring rising. There were obtained u, v, T time series containing 200 points (recording frequency was 32 cph). The velocity observed was less then the stall value for current meter during 60% of observation time. During other time were observed velocities about 1 cm/s which is about start threshold value of rotor movement for 'Potok' current meter. Yet these weak currents correspond in phase to semi-diurnal tide maximum value. These currents were registered during 2 hours. The average transfer for this observation interval was estimated as 0.1 cm/s. The direction was difficult to estimate reliably because of extremely low speeds.

At sites 2 and 3 were registered weak currents near the bottom with maximum speed to 5 cm/s (Fig. 10, 11. 12). In all the cases the change in measured speeds from the value lower than start threshold which registered as zero to nonzero values took place with the period practically coinciding with semi-diurnal tide. The average speed magnitude at the site 2 was 0.71 cm/s, at the site 3 - 0.58 cm/s at 170 m above the bottom and 1.79 cm/s at 440 m above the bottom. It is worth noting that these average values are statistically significant for tine interval corresponding to the observation time interval ( the record length from 1000 to more then 2000 points ).

The direction of mean transfer in all the cases is determined by the relief characteristics, mainly by isobathes at the observation level (Fig. 1, 2). The mean transfer during observation time at the site 3 at 440 m above the bottom was three tines greater than at 170 m that can be easily seen in fig.13 with the diagrams of virtual displacement of water for the both levels. The northwestern direction in both cases coincided with the direction of abruptly rising continental slope (Fig.2). The estimated values for month are 15 km and 40 km respectively. The southeastern mean transfer at the site 2 (at 170 m above the bottom) was in accordance with the same topographic feature (strike of the continental slope) and can be explained with the change of LF velocity sign.

It is worth noting that the morphological control of current direction is a characteristic feature of current field near the bottom. Linear polarization of the current is due to the presence of linear-elongated bottom structures.

For more detailed study of current distribution particularities the frequency analysis was made, histograms for u, v components, and current direction were drawn ( Fig.14,15,16). For convenience of comparison with normal distribution this function was drawn using usual scaling for probability.

Examples shown in Fig.14-16 were computed for the averaged data row obtained at the site 3 at 440 m above the bottom ( time interval 2 min ) with 2100 points. It is seen some veering of the empirical distribution from the normal distribution and relative steady current direction.

Though the speeds are weak it was interesting to estimate: these currents contain periodical component or not? The estimation was made using polynomial filtration [4] also for 440 m level at the site 3. Using the relationship as it was given for this method above the nearest value of polynom order equals 16. Filter cut low period (Tmin) 10 hours is defined assuming that it less than possible periodical component (of semi-diurnal tidal origin), length of data row N=1200 and time interval dt=1/32 hour. The computed polynomial approximation for the meridional component at the level 440 m at the Site 3 is shown in fig. 17 in comparison with the velocities observed. It is easily seen semi-diurnal oscillations. In the east component such harmonics are more weak. Obviously, taking into account the weakness of transfer in this area we can suggest the main role of the tidal forces in generation of the near bottom current, In the same time well known weak tidal activity in the Mediterranean reflects in small tidal magnitudes in our conditions.

TEMPERATURE. The temperature time series in the bottom layer both in 1989 and 1992 show the absence of temperature fluctuations at all. The difference in data measured by different devices (2 in 1989 and 4 in 1992) is in the range of its absolute error. The mean value for these 6 measurements is 14+0.2 C.

ATMOSPHERIC PRESSURE AND BOTTOM CURRENT. There were no possibilities for synchronous wind measurement because of the absence of a lag. As a whole the wind changed during experiment time significantly both in value and in direction that particularly revealed in ship drift. We could register the pressure by the barograph during the all cruise. It changed significantly as shown in Fig.18 for time observation at the site 2. One can see a certain correlation between the pressure and of the near bottom speed but analysis of this event will be later.

## DISCUSSION OF THE RESULTS

To date the bottom currents were measured at 7 sites in the vicinity of NESTOR research area. There were deployed 5 bottom stations with 6 current meters used (4 in our cruise and 2 on R/V Dmitry Mendeleev 45$^{th}$ Cruise). On the R/V Vityaz 22 Cruise abyssal layer was studied using 5 current meters on 2 moorings with surface buoys. The observation time was 40-80 hours for bottom stations and 200 hours for moorings with surface buoys.

1. In all the cases weak currents with 0.5-2.5 cm/s mean values for observation time were registered. Maximum current values measured on the bottom stations were 5.3 cm/s at the site 3 at the level 170 m above the bottom and 7.3 cm/s at the site 7 (1989, the bottom of the Vavilov Deep).

2. Practically for all data series were determined current fluctuations with periods near tidal periods.

3. Registered current values are enough to cause motion of the most thin-grain sediment (pelite- and subcolloidal fractions) and keep the dynamical balance in the formation of nepheloid layer [9].

4. The characteristic feature for currents observed is the weakly changing direction (not more than 20-30 degrees from the direction of mean current for bottom stations measurements). In all the cases including the moorings with surface buoys the direction of mean

current (the direction of mean transfer) Is determined by the characteristic relief forms. In the site planning for the neutrino telescope strike of this direction is mainly northwest according to the neighboring abrupt continental slope. The southeast direction in the site 2 (36 hours observation) is also in accordance with that strike. Reverse direction is probably connected to low-frequency fluctuations of synoptic scale. Linear polarization of current field that reveals in reverse of direction and its morphological control is a characteristic feature of current field near the bottom when the stretching forms of relief exist.

5. Morphological control, relative stability of current direction in condition of statistical significance of mean current from one side, and practically closeness of the depression surrounding the NESTOR research area deeper than 3700-4000 m, from another side, show probability of the existence of certain circulation here of topogenic origin at least for the observation tine range.

6. There was no significant temperature variability in measurements with bottom stations.

7. Some features of currents measured by Dr. Krivosheya with surface buoys in 1991 [8] coinside with those obtained with pop-up bottom stations and this enchances reliability of both of them. Those are already discussed NW or SE directions of mean currents and their weak mean speed (1-3 cm/s). It can be noticed as well relatively weak variability of the directions during the observations at the near bottom, levels: for bottom station it is about 20 degrees, for surface one about 40 degrees (site 5, levels 4200 and 4300 m; site 4, level 3720 m).

In the same tine there were sometimes rather high speed at surface stations. It was higher than 10 cm/s for about 2 and 10% of observation time at site 5 and 4, correspondingly, and reached 22 cm/s. It is interesting to note that directions of mean and maximal values differed less than 13 degrees for the both sites. The maximal value for the bottom stations was 7.3 cm/s (at site 7, H=5110 m, h=3 m a.s.b.). The total observation tine with surface buoys was two weeks, with bottom station it was one week. Surely, both of them are short to make definite conclusions about probable speed there near the bottom, and absence of the high velocities for the bottom stations and its presence for surface ones nay be explained by the observation time difference.

However, there are strict limitations of surface buoys use for investigation near bottom layers at high depths and in accordance with them, there should be limitations of use of such data for description of a velocity field features there. To remind what limitations we talk about, we should discuss a question on measurement distortions of current meters Potok due to vertical motion of the wire-rope.

## ON THE OVERREADING OF CURRENT-METERS ON SURFACE BUOYS.

Surface moorings (SM) always characterized with periodic orbital notions due to sea waves of varies periods and intensity. Along with this, current meters being attached at the buoy-rope of SM have quasi-periodic vertical component of motion and even in quiet surface conditions the magnitude of vertical notion is about 2-3 m with period 10-15 s and, consequently, with vertical speed about 0.5 m/s which can be compared with and even higher than horizontal current speed. In storms the magnitude of vertical motions increase by several times. There is change of the period that time also.

Numeric modeling of the buoy-rope motion due to orbital movements of a surface anchored buoy [Kalvatis, 1973 and so on] and ocean and lab experiments [Saunders, 1976, N.Maximenko, in press and so on] show that transversal buoy-rope movements attenuate in upper 100 200 m whereas longitudinal ones propagate to the greatest depths without noticed changes.

In the same time, investigation of design and mechanical features of current meters Potok carried out in the Design Bureau of P.P.Shirshov oceanology Institute [ Fomin et al. 1986, Maximenko, in press] show that the Potok's rotor can measure a horizontal component along its axes with high accuracy up to great (about 75 degrees) angles between the rotor axes and velocity vector of the flow. The unique balance of the apparatus provides maintenance of vertical position of the housing in horizontal flow of any intensity. However, the sane scheme of the balance under conditions of vertical motions of the buoy-rope leads to declination of the meter housing in so way that the rotor begins to measure a velocity component V being always higher than real horizontal speed v that should be measured. It can be told that the rotor determining speed by length of path which it runs in liquid, under conditions of vertical buoy rope movements runs in water longer way for a time unit and, consequently, show higher values of the speed.

It is seen also from theoretical and laboratory studies that, besides of this uncontrolled apparent overreading, variable intensity of surface waving results in apparent unstationarity of the current measured with the meters oven if the real flow is stationary. The unstationarity is reduced to high variability of the speed with rather stable its direction.

The main conclusion the authors make from their theoretical, lab and experimental study of surface wave influence on reading of current, meters attached to the surface mooring wire-rope is demand of very careful interpretation of the data registered at high depth especially under condition of variable weather when the correction of the data cannot be done at all. Particular importance of a probability of uncontrolled overreading and apparent unstationarity arise in bottom boundary layer investigation (BBL) at abyssal depths when absolute speed usually is not high. This circumstance forced ALL west oceanographers studying BBL to use SOLELY subsurface moorings (usually they are pop-up bottom stations) for deployment of current meters in there in spite of much more complicated technology and of many time higher cost of the work. We refer here, for example, to the some well known projects and scientists: HEBBLE (Scripps Institution, HHOl. FSU). MANOP (Scripps. US Geological Survey). POEM (Phys. Oceanography of the Eastern Mediterranean, UNESCO. IOC. ICSEM. Greek National Center for Marine Research) [see publications of G.Weatherly, Hollister, Sounders, McCave, Hayes, Papageorgiou, Lascaratos and many others]. In our country study of abyssal BBL are carried out primarily with bottom stations - by GOIN (A.V.Sokov) and IO RAN (S.L.Solovyev – seismicity, E.A.Kontar, T.A.Demidova - hydrophysics and so on). Currents in BBL with the bottom stations were already studied by IO RAN on 37$^{th}$ (1986). 41$^{st}$ (1988) and 45$^{th}$ (1989) cruises of R/V "Dm.Mendeleev", 49$^{th}$ cruise of R/V "Ak.Kurchatov" (1988). 24$^{th}$ (1991), 26$^{th}$ (1991) and 29$^{th}$ (1992) cruises of R/V "Ak.Mstislav Keldysh".

For the reason described above we have to pay more attention to revealed correlation between near bottom surface buoys currents and winds and to significant changes of the speed with relatively weak difference of the directions of the mean and the maximal values. The correlation can be the result of surface condition influence on the current meters reading.

8. Current measurements using bottom stations made in different years definitely show the existence of time intervals with the steady hydrodynamic conditions in the site of future telescope at distances from bottom coinciding with telescope character sizes. The scale of these time intervals is not more than the observation time.

Taking into account the temperature stability it results in very weak vertical mass exchange and weak variability of dissolved matter and particularly, oxygen. The time independent vertical distribution of hydrological characteristics (by CTD data) deeper than 3000 m analysis of hydrodynamic data jointly with the bottom photographies and bottom sediment probes near the site of measurements allow to assume that these conclusion on calm near bottom condition can be extended for longer time intervals.

At the sane time there are some results which could be treated as the existence of currents with large speed values:

1) The high speeds up to 22 cm/s obtained with surface buoys possibly reflect the real enhancement of near bottom current. We can not tell only the part of surface wave influence in these figures.

2) Measured by V.G.Krivosheya temperature increase in the abyssal layer above the 3000 m ( CTD in 1931 versus 1989 and 1985) could be explain (by the author opinion) with the transfer of warm intermediary water from the Aegean Sea during the previous winter that would results in auxiliary currents arising.

2) The presence on the West slope of the research area (the depth 3300-3500 m) hard crust of uppermost sediment consisting on shell remains, cemented by thin grain material shows the lack of conditions for sedimentation now there. This fact may be due to washing the modern sediments out by currents.

3) Also this fact may be considered as the result of repeated slipping down of semi liquid sediments from the steep slopes due to gravitation (so called "gravitational flows"). This is probable because of extremely steep slopes with the angles, which are many times greater than it is necessary for such process, and also because of relative seismic non-stability of this area and the nearness of this area to the coast. Currents (even with low velocities) make the links in sediment layer on the slopes weaker and thus make slipping down possible.

4) From another point of view, the slipping of sediments down the steep slope like avalanche will cause short-time but abrupt change of near-bottom layer dynamics and an appearance of short-time accelerations in currents which can results in specific traces on the bottom. Such traces in bottom microrelief can be seen on the "photograph of the bottom made to the south from the Vavilov Deep by S.K.Kolchugin.

Really, time of the observation was too short. So, for more reliable conclusions it is necessary to study the season change of current dynamics, sediments transfer, water transparency and also seismicity and microseismicity of the bottom for more long time. For this purpose it is necessary to deploy in some places with character bottom relief a set of bottom stations equipped with 'Potok' current meters, nephelometer, sedimentary traps and seismographs for a month during different seasons. Also it is necessary simultaneously make CTD, bottom photography and relief studying, carry out registration of atmospheric processes (wind and pressure). Monitoring of currents, temperature, transparency and bottom microseismicity as well as both surface and near bottom pressure must be also included in the work list of functioning telescope for the control of changes of media characteristic.

Also it is necessary to say that after deploying telescope and cable the upper sediment layer with weak internal links will be partially destroyed and there will arise nepheloid layers of technogenic origin. As it is known from literature such palls can exist for a long time after arising and can be transferred to long distances making the transparency worse. This factor must be taken into account especially during first NESTOR experiments after telescope deployment.

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## REFERENCES

1. Fomin L.M. et all. The measurement of ocean currents, (in russian) Moscow. Nauka. 1989, 197pp.
2. L.Sombardier. Surface current trackers of the World's Oceans, Oceanus. v.33.no.2, 1992, 6-8.
3. Soloviev S.L. et all. Seismological self-contained pop-up bottom station. Fizika Zemli(in russian), 1988, 9, 75-85.
4. Butyrev V., Gordeev N. et all. Statistical methods of information processing applying to the study of hydrophysical fields in the ocean. Oceanological researches, vol.42, 1990,103-122 (in Russian).

5. The hydrology of the Mediterranean Sea (in russian), Leningrad, Hydrometeoizdat, 1976, 376 pp.
6. Ovchinnikov I.M. The main features of water circulation in the Mediterranean Sea. In "Hydrological and hydrochemical studies in the Mediterranean and black seas" (in russian). Moscow. Shirshov Inst., 1979, pp.73-80.
7. Krivosheya V.G., Soloviev S.I,. Seismological, geophysical and hydrophysical researches in the Mediterranean Sea and Atlantic Ocean. Oceanology, 1991, 3, pp. 525-527.
8. Krivosheya V.G., The report of the R/V Vityaz 22 cruise (in russian), 1991, P.P.Shirshov Oceanology Inst.. Moscow.
9. Lascaratos A., Christianidis S., 1987, Water outflow through the straits of Antikythira (SW Aegean), EGS, XII General Ass., Strasburg, April 1987, Terra cognita. v.7, no 2-3, p.544.
10. Demidova T.A. and Kontar E.A., On near-bottom currents in the Mediterranean Sea, Gen.ass.EGU, Vienna, 1991
11. Kennet. J.P., Marine Geology, v.2. Prentice-Hall, Englewood Cliffs, 1982.
12. N.Maximenco. in press.
13. P.M.Saunders, 1976.
14. G.Kalvatis, 1973.

## LIST OF FIGURES

Figure 1: Location of 'Potok' current meters in the near-bottom layer of the Ionian Trench. Location of moorings: 1,2,3 – 1992, 4,5 - 1991, 6,7 - 1989. Pointers show the direction of the mean current vector. The dashed line restricts the study area in 1992 shown in fig.2.

Figure 2: The batimetry of NESTOR area (results of 29 R/V Acad. Keldysh). The directions denoted as '170' and '440' in site 3 correspond to measurement levels.

Figure 3: The design of moorings with underwater buoys: a -ADS-6, b - moorings with a surface buoy, 1992.

Figure 4: The design (a) of the mooring with surface buoy (1991) and (b) of the pop-up bottom station (1989).

Figure 5: 0.5 hourly averaged speed for sites 6 & 7.

Figure 6: 0.5 hourly averaged current vectors for site 7

## LIST OF TABLES

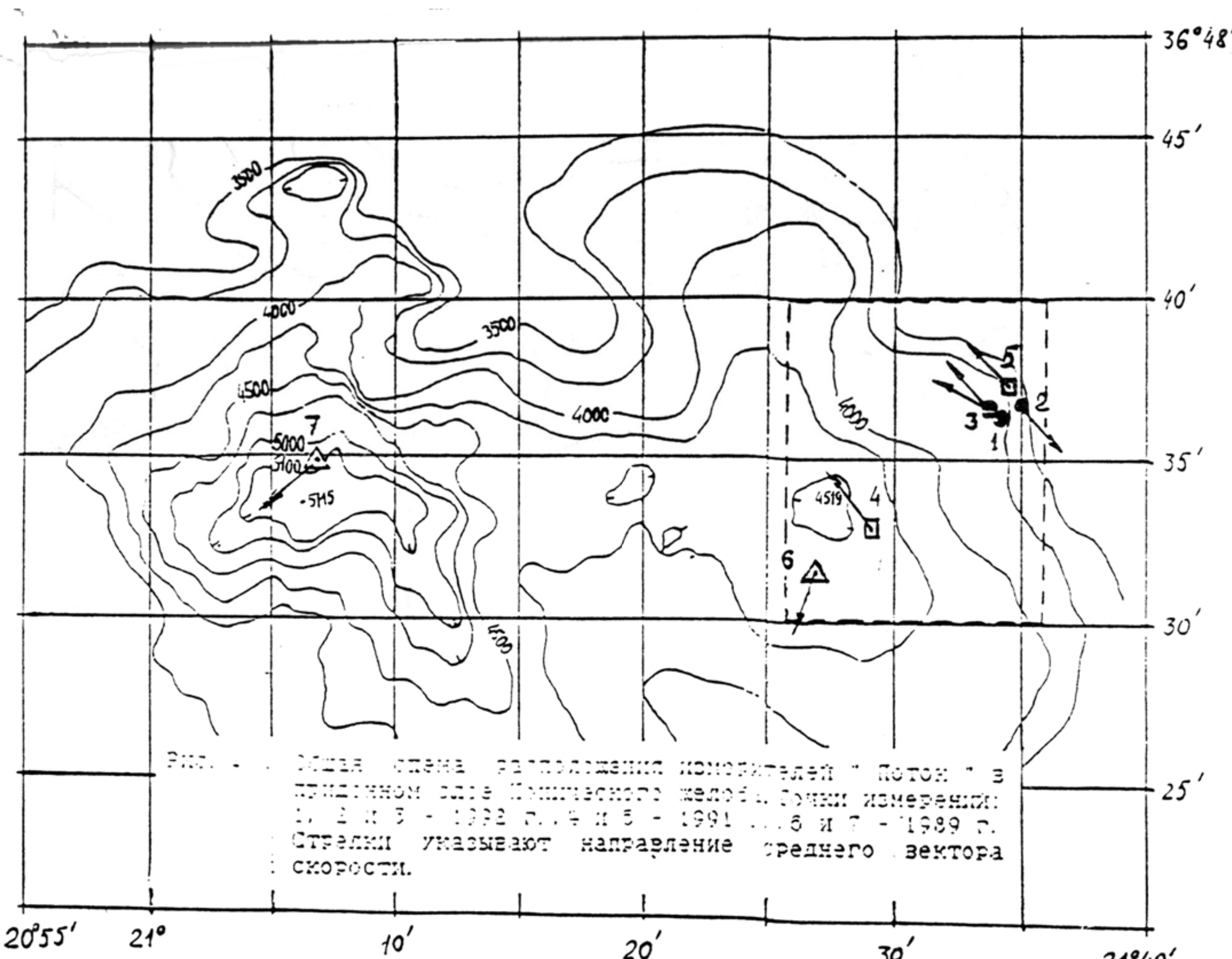



Рис. 1. Общая схема расположения измерителей " Поток " в придонном слое Эллинского желоба. Точки измерений: 1, 2 и 3 - 1992 г., 4 и 5 - 1991 г., 6 и 7 - 1989 г. Стрелки указывают направление среднего вектора скорости.

Fig. 1

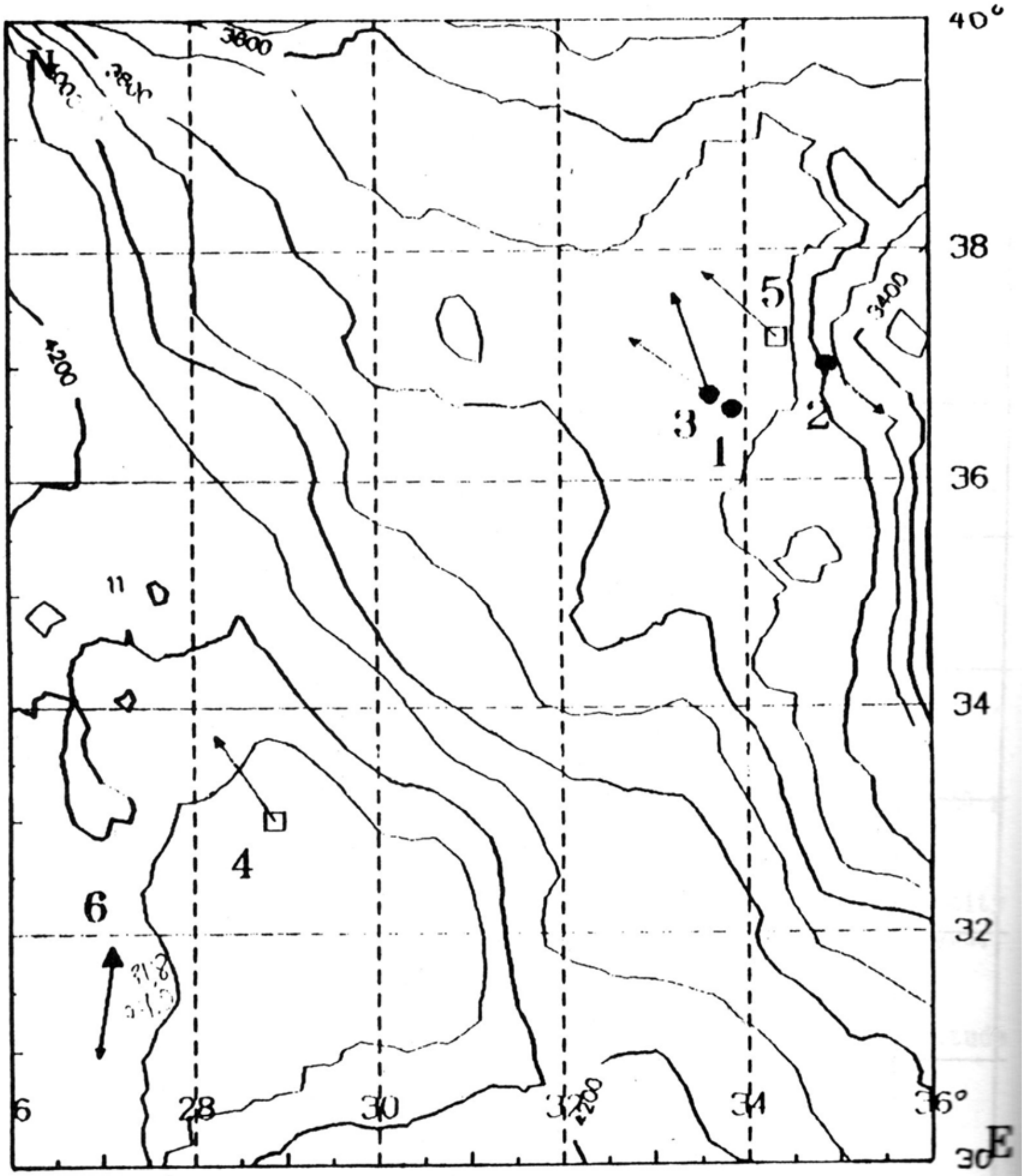



Fig. 2

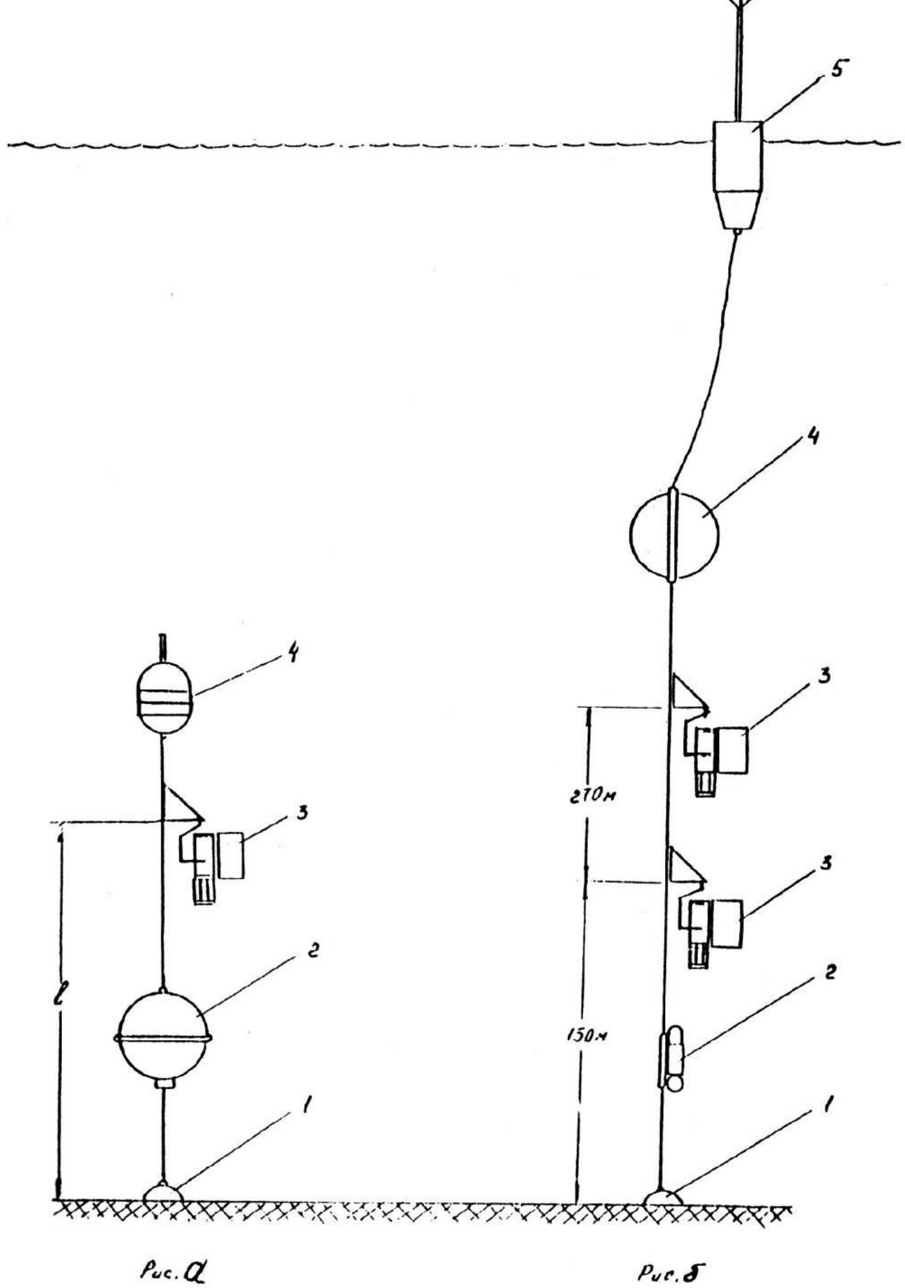



Fig. 3

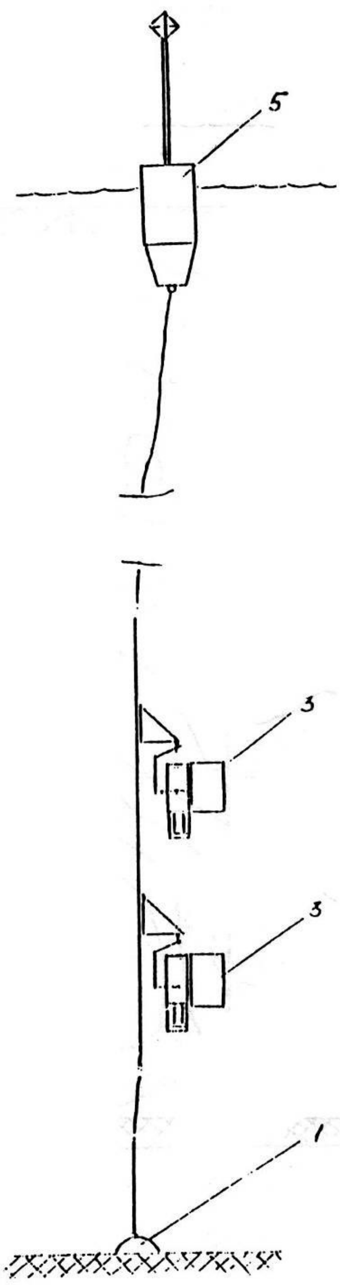
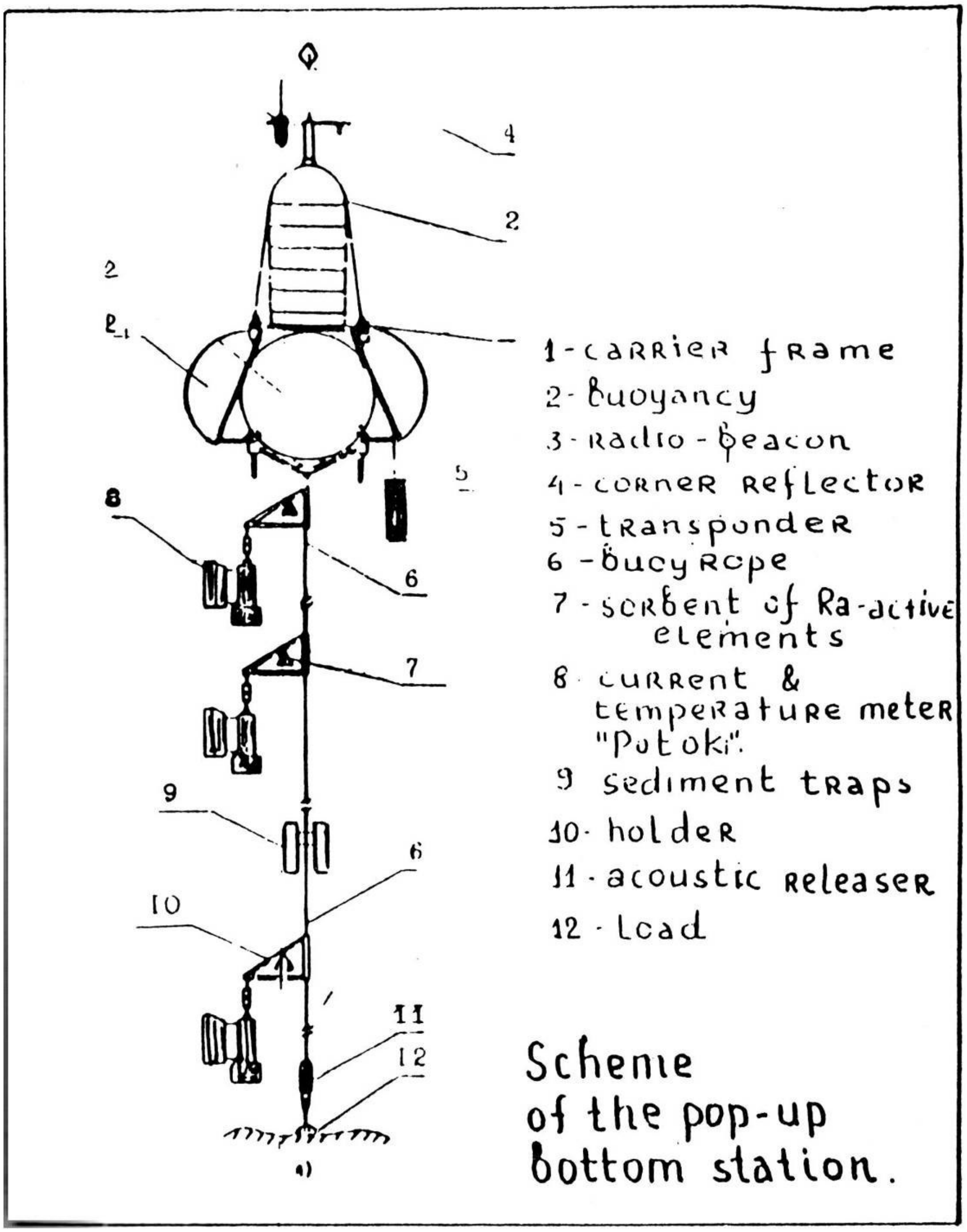



Fig. 4a



1 - carrier frame
2 - buoyancy
3 - radio - beacon
4 - corner reflector
5 - transponder
6 - buoy rope
7 - sorbent of Ra-active elements
8 - current & temperature meter "Potoki".
9 sediment traps
10 - holder
11 - acoustic releaser
12 - Load
Scheme of the pop-up bottom station.


Fig. 4b

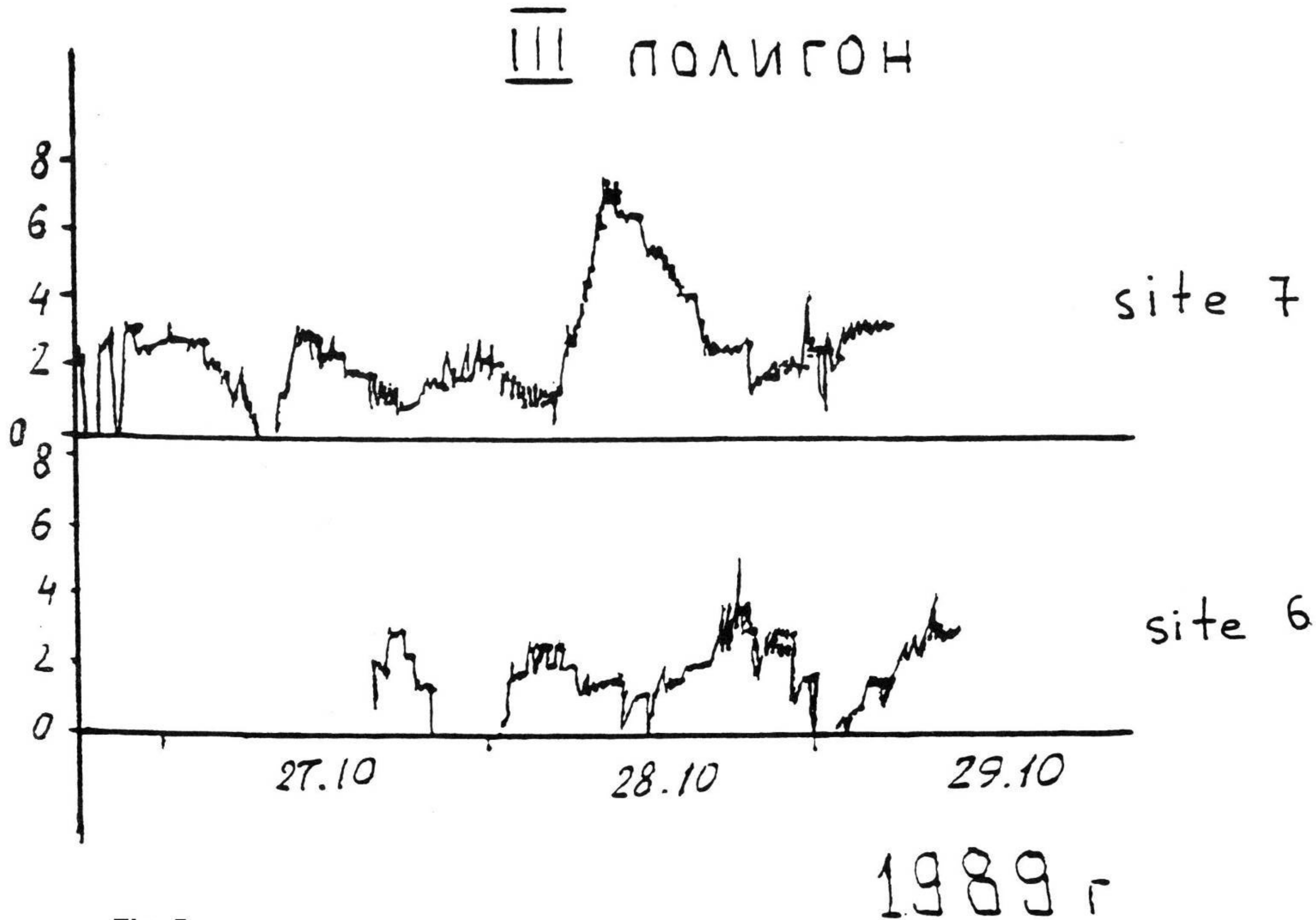
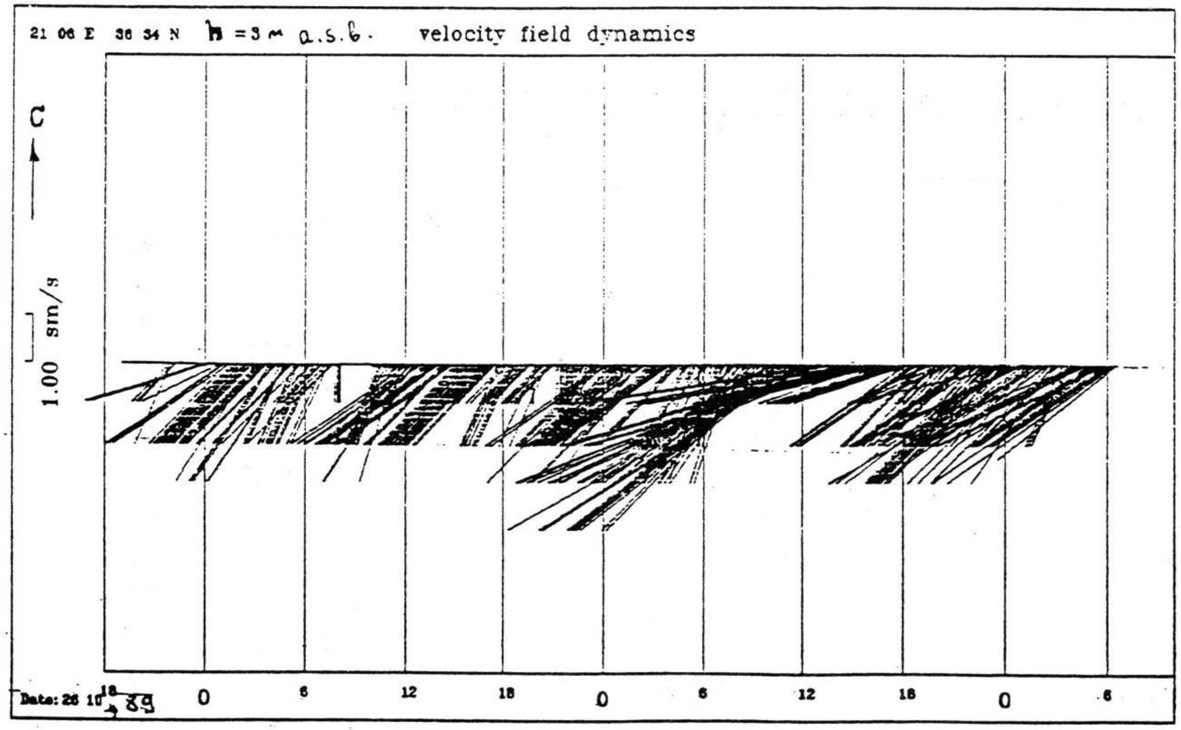



Fig. 5

Fig. 6 Осредненные за полчаса векторы скорости в точке 7. H = 5110 м, h = 3 м над дном.



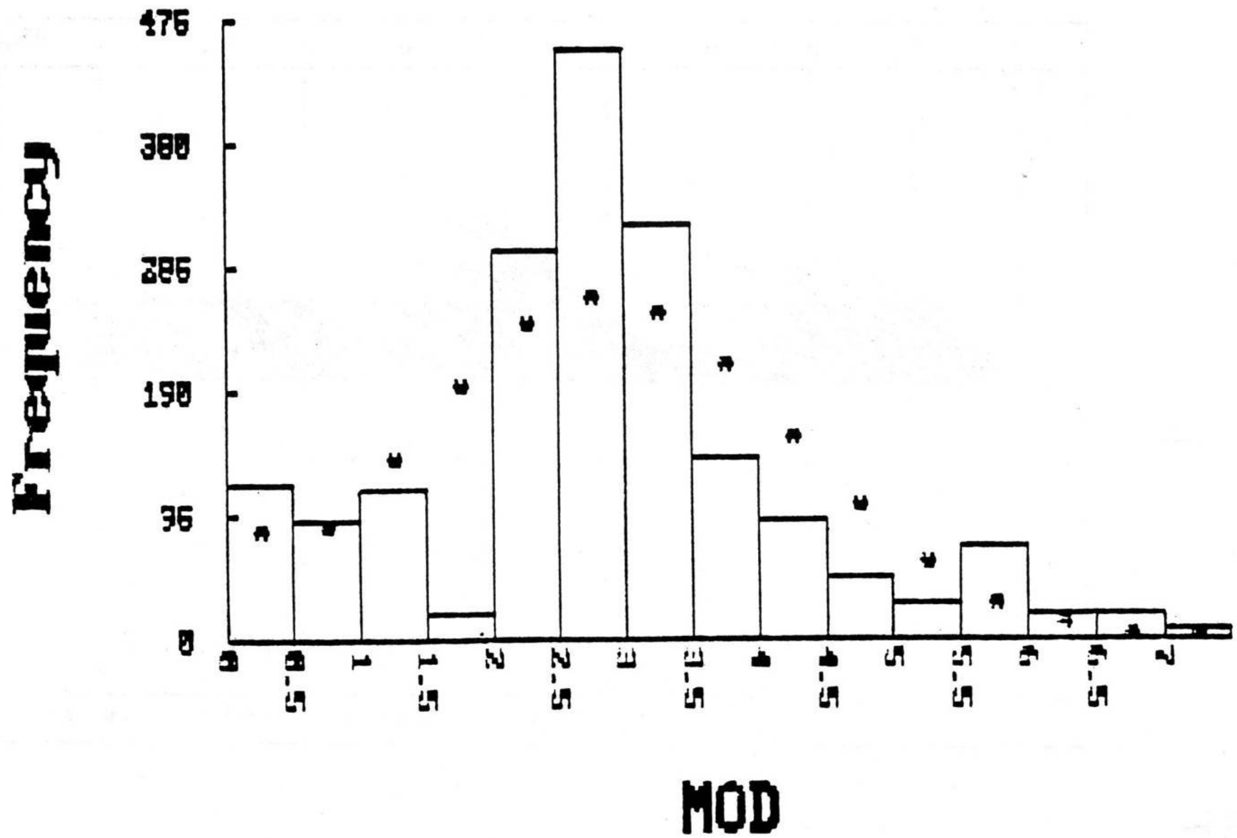



Fig. 7 Гистограмма распределения модуля скорости для т. 7.
(горизонт 3 м от дна)

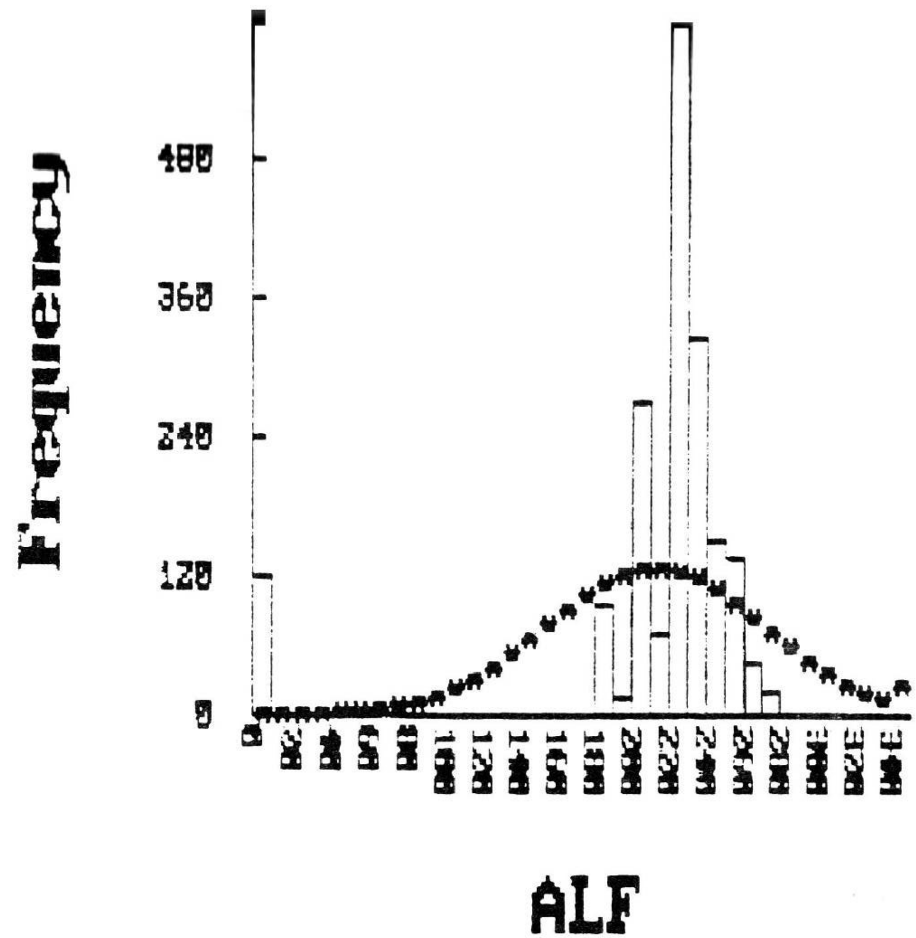



Fig. 8 Гистограмма распределения направление течения для т. 7
(горизонт 3 м от дна)

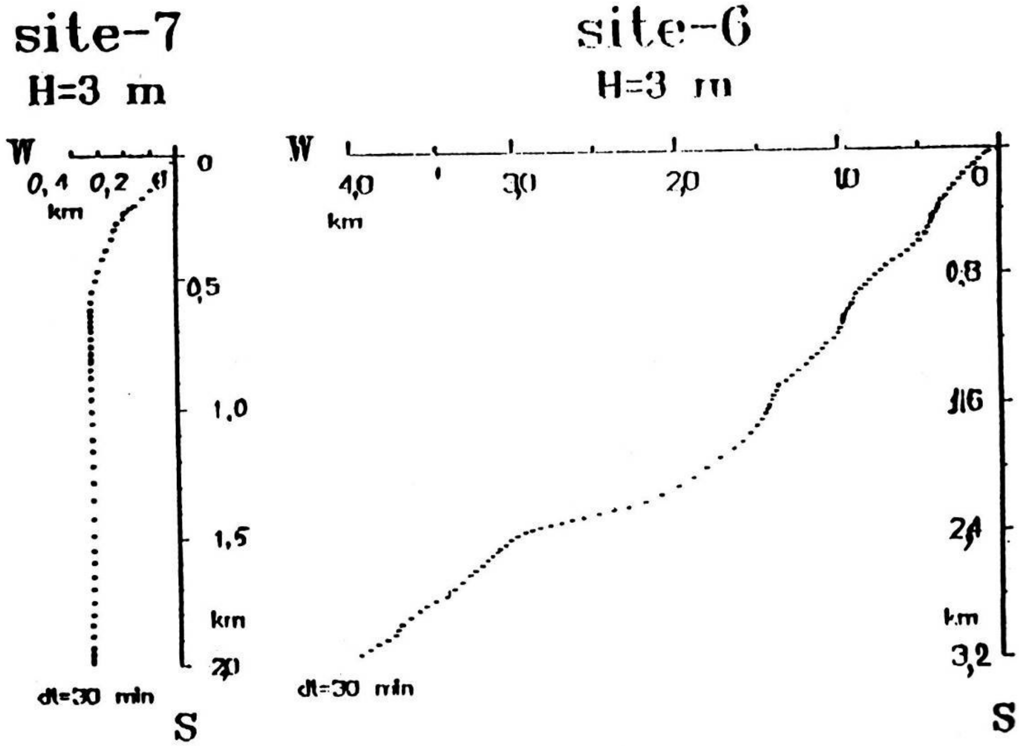



**Fig. 9** Прогрессивные векторные диаграммы для точек 6 и 7.

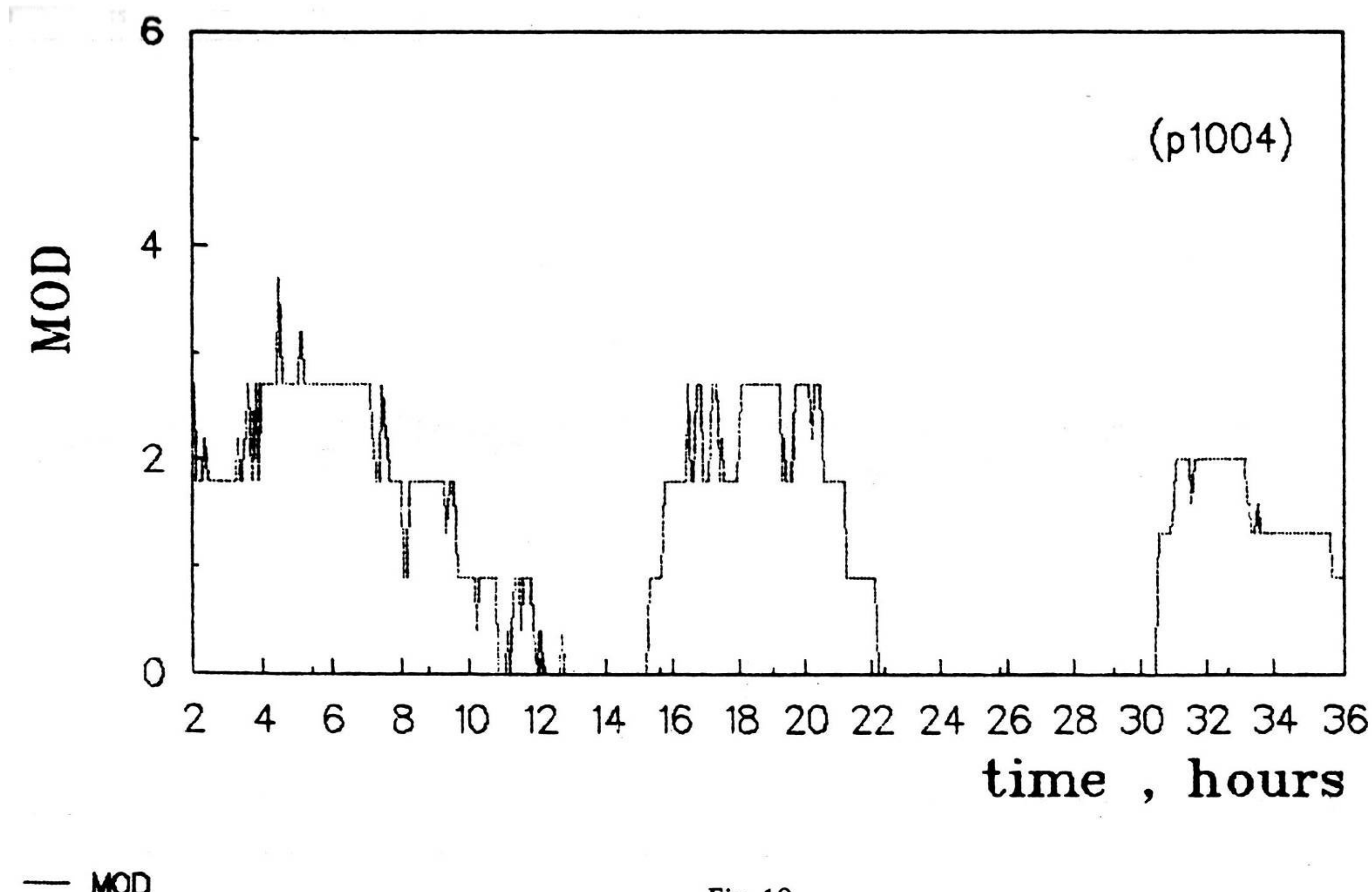
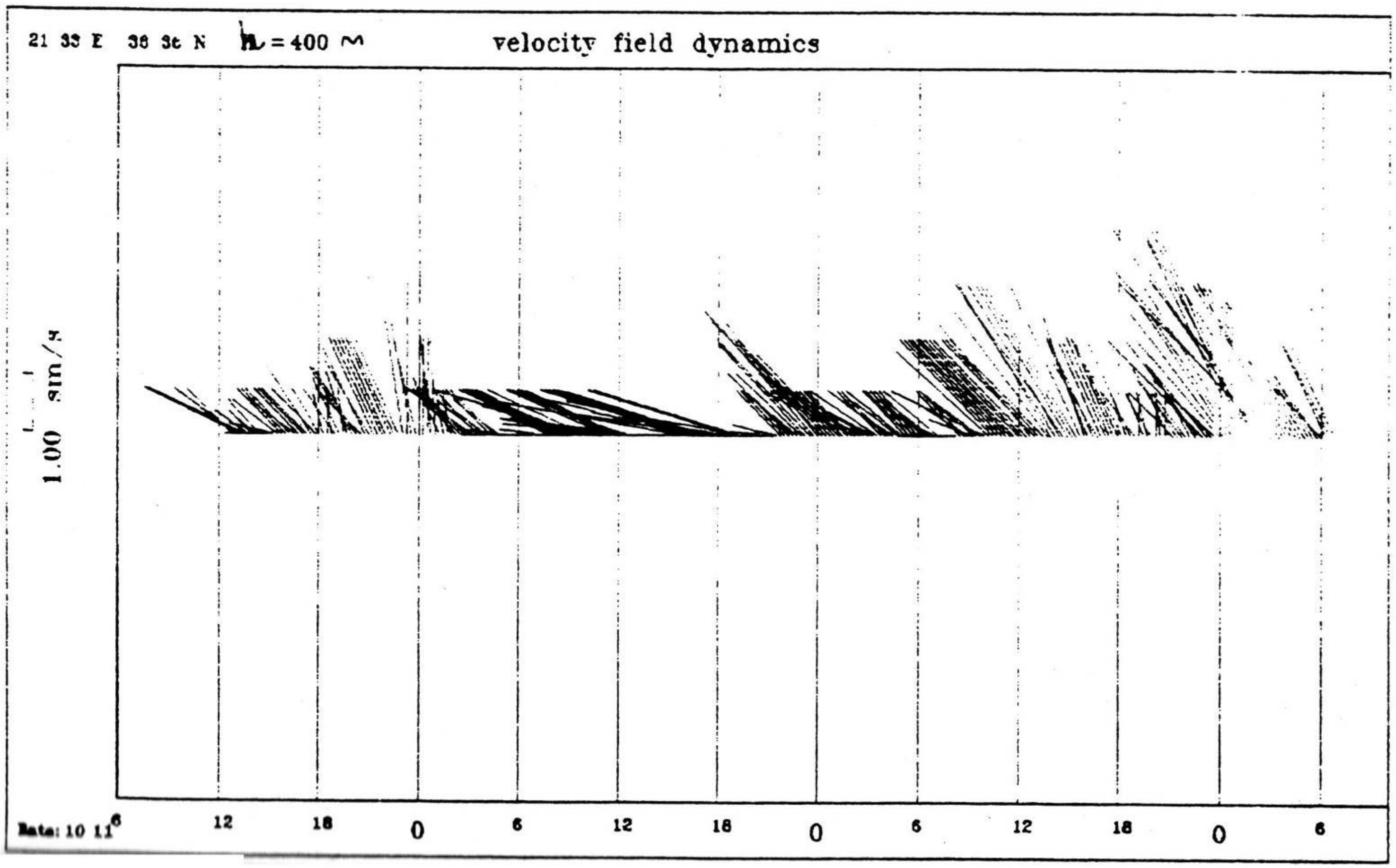
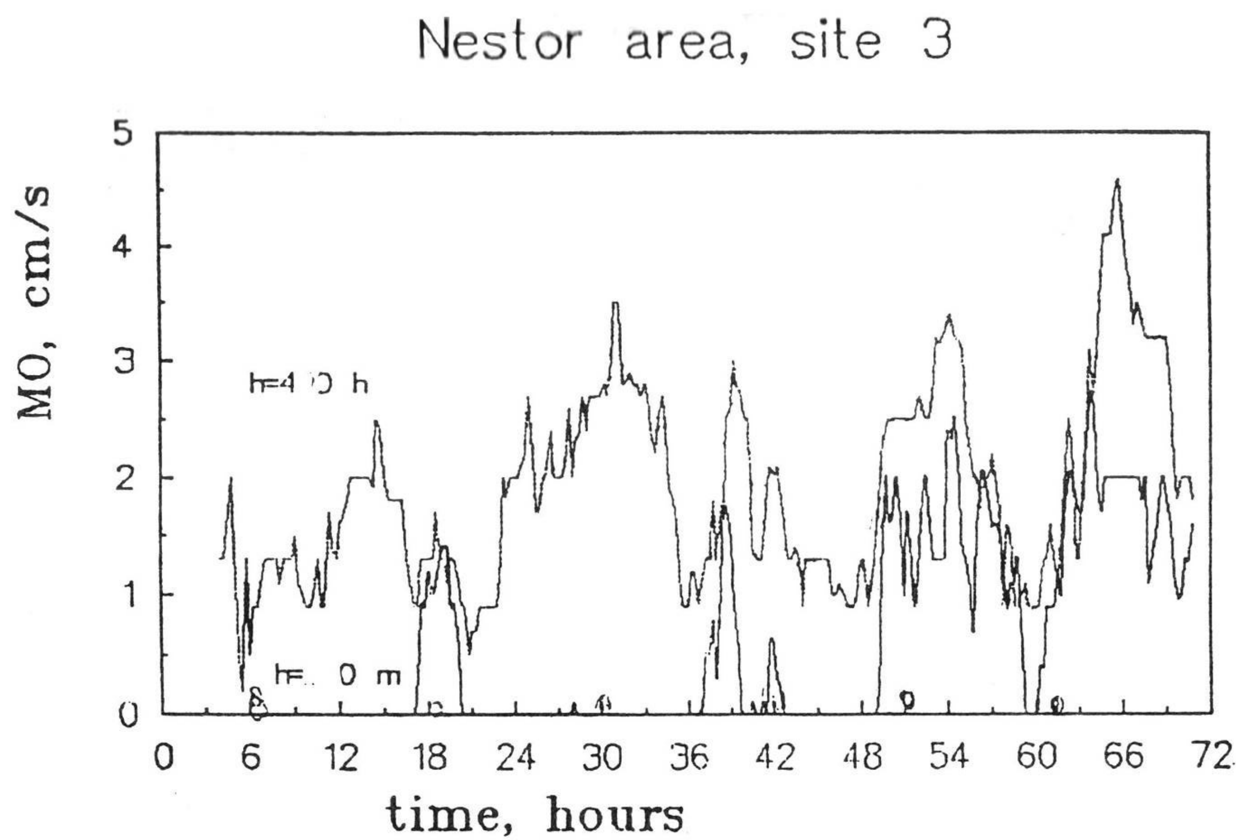

MOD
6
4
2
0
(p1004)
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
time , hours
— MOD

Fig. 10

Fig. 11



21 33 E 38 3c N h = 400 m
velocity field dynamics
1.00 sm/s
Data: 10 11
6
12
18
0
6
12
18
0
6
12
18
0
6




MO1
— MO2

Fig. 12 Модули скорости для точке 3.
(горизонты 170 и 440 м )

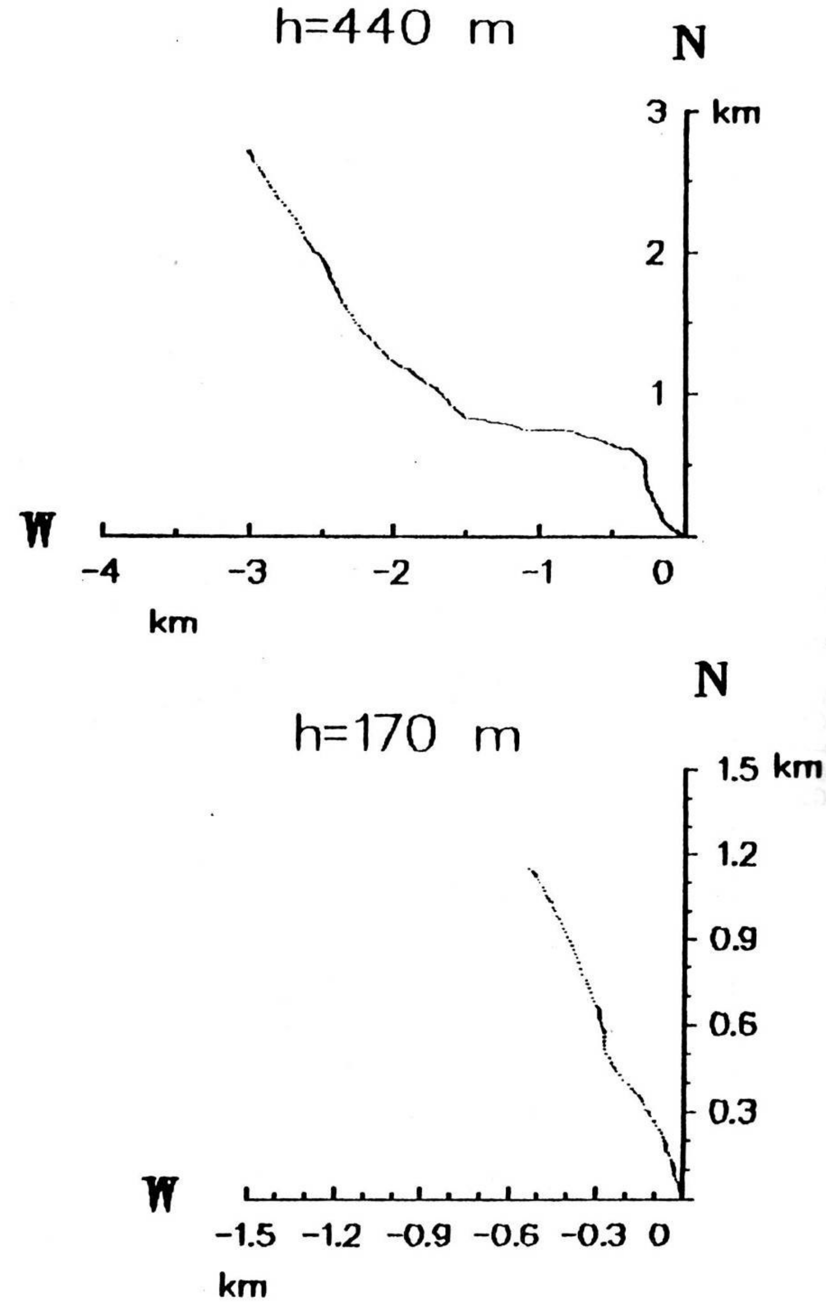

h=440 m
N
3
km
2
1
W
-4
-3
-2
-1
0
km
N
h=170 m
1.5 km
1.2
0.9
0.6
0.3
W
-1.5
-1.2
-0.9
-0.6
-0.3
0
km

Fig. 13

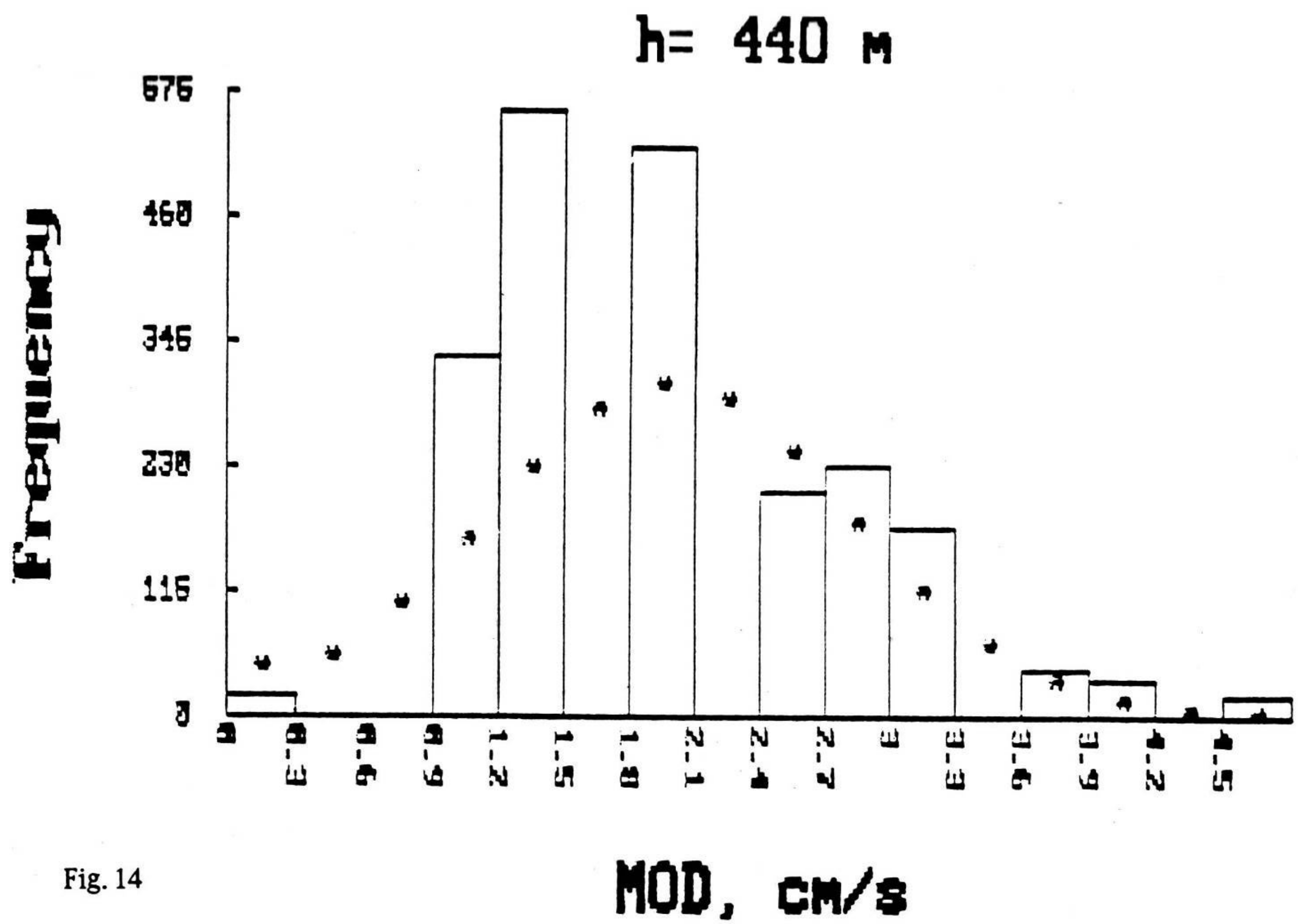



Fig. 14

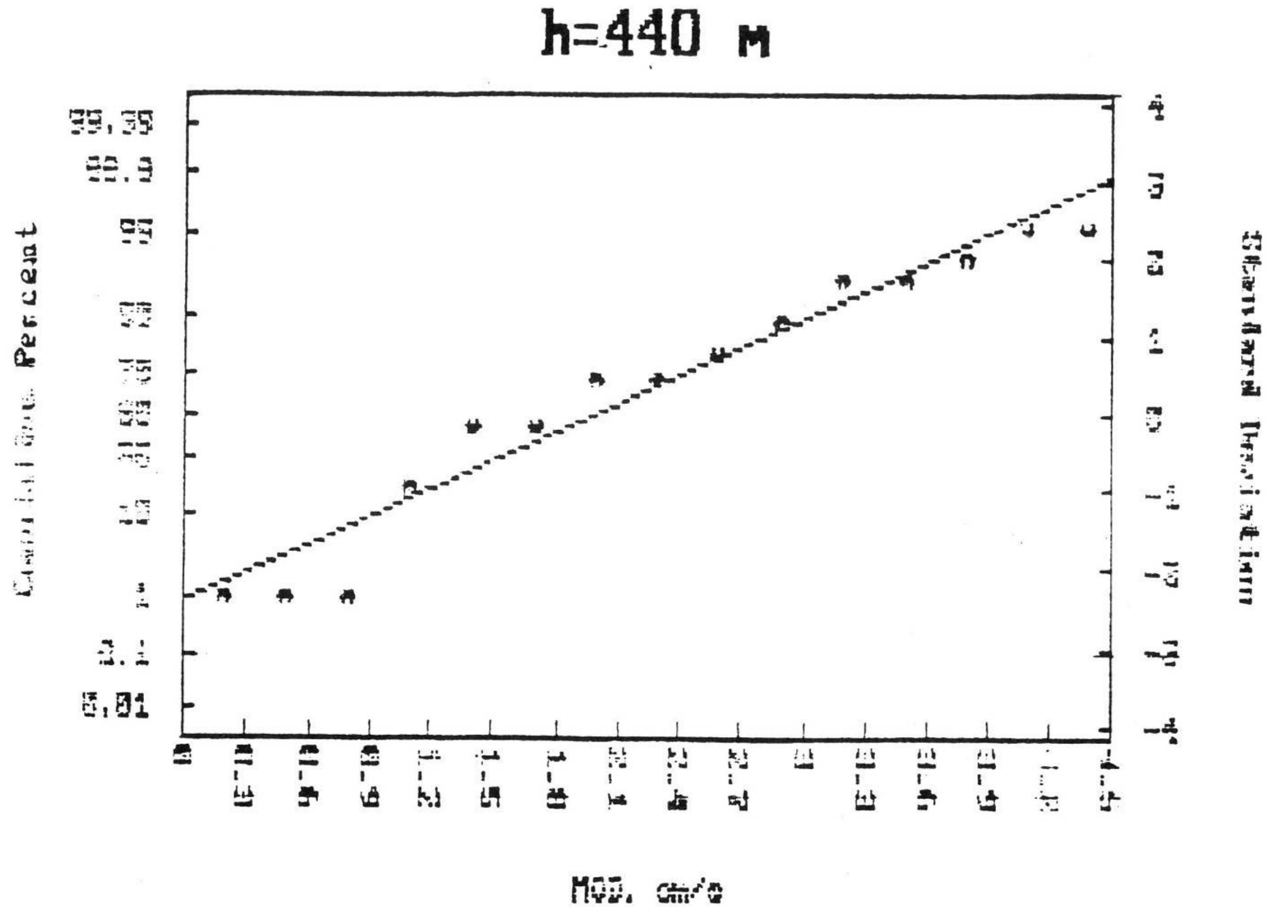



Fig. 15 Куммулятивные частоты встречаемости в вероятностном масштабе для точки 3. (горизонт 440 м от дна)

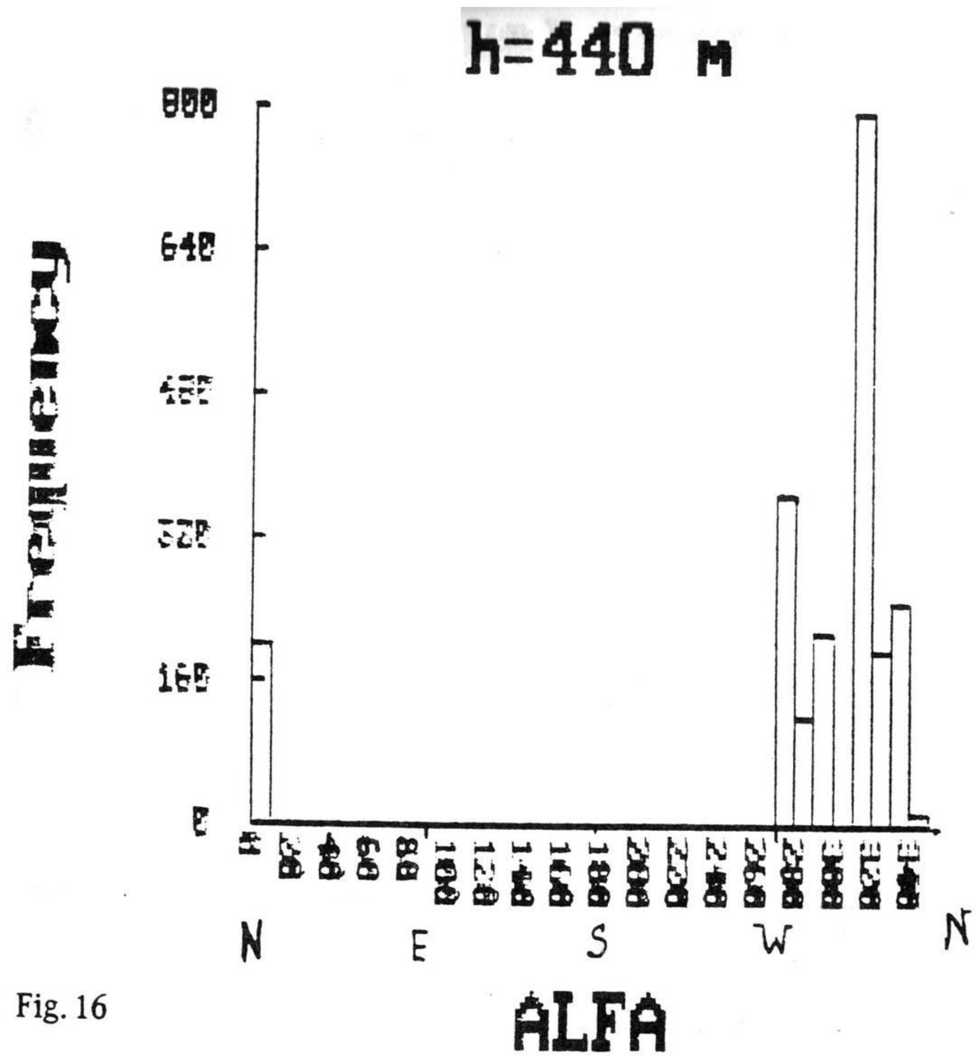
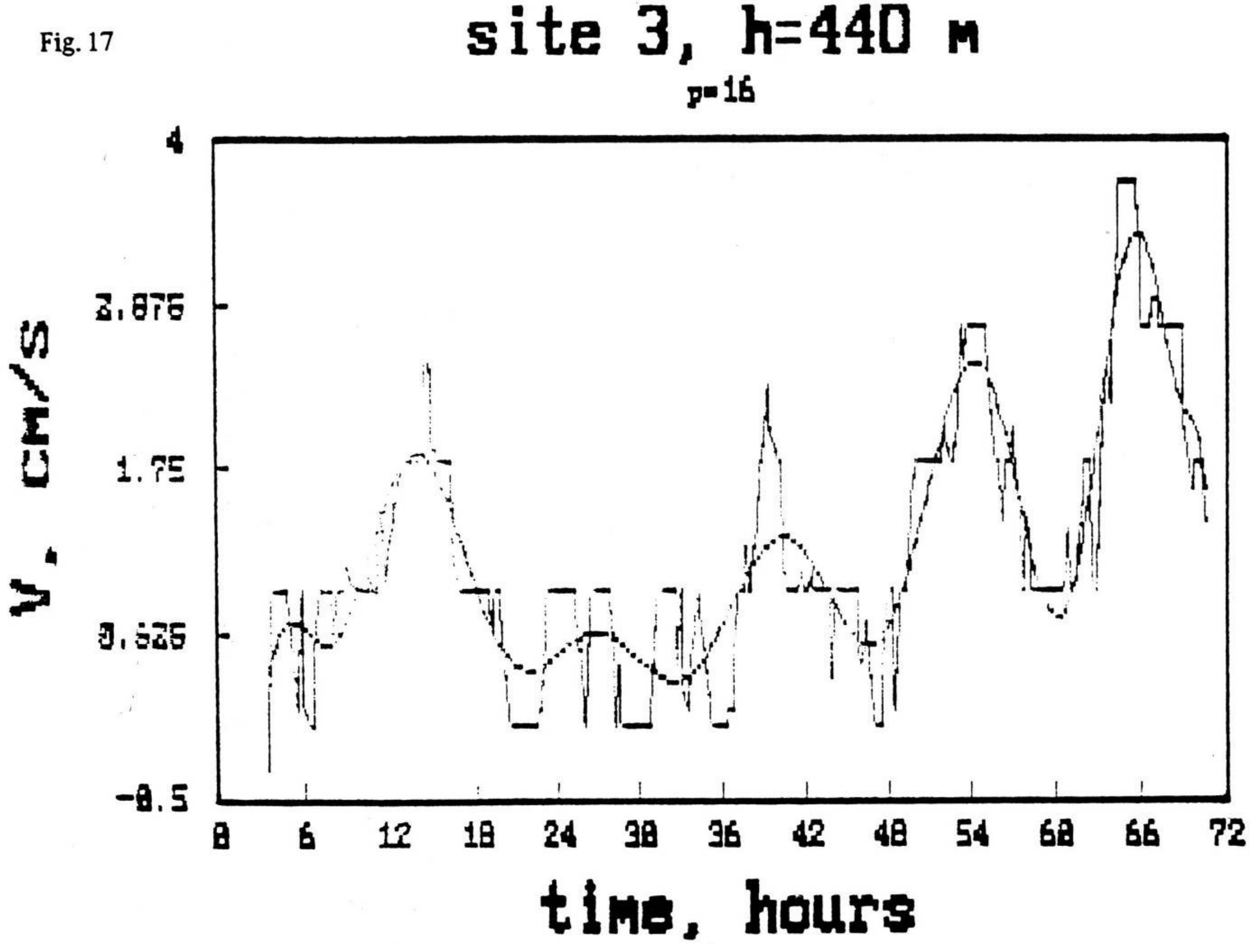



Fig. 16

Fig. 17



site 3, h=440 м
p=16
4
2.876
1.75
0.626
-0.5
V, cm/s
0
6
12
18
24
30
36
42
48
54
60
66
72
time, hours

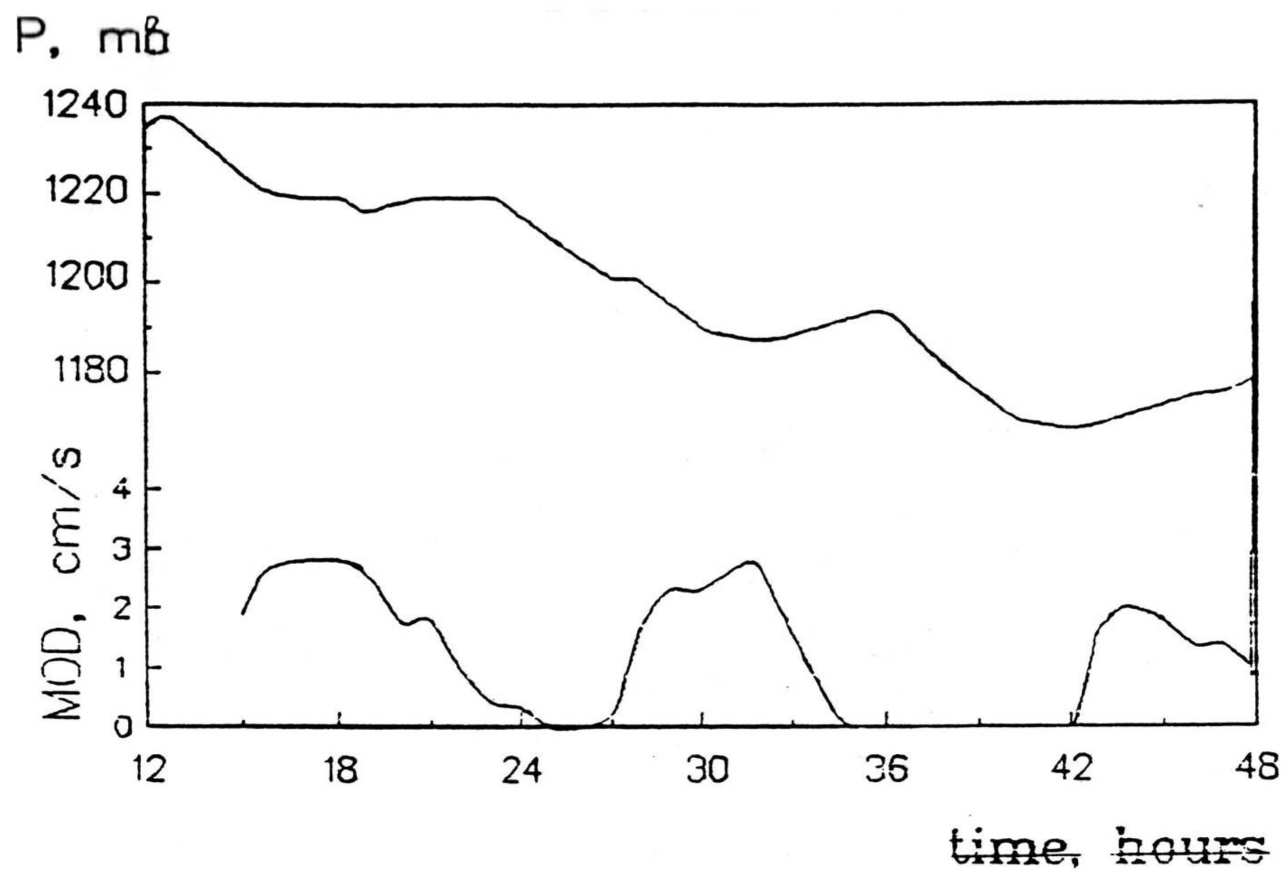



Fig. 18 Изменение атмосферного давления и течения в т. 2 (1992)