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Fiskare från
bronsåldern

Rock carving
Bronze age
fishermen



MEDDELANDE från
HAVSFISKELABORATORIET LYSEKIL Nr 275
INSTITUTE OF HYDROGRAPHIC RESEARCH
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Some preliminary studies on patchiness in surface water

by

Stig H. Fonselius

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TITELBLAD-RAPPORTER

3 Datum 1981-11-04

4 Ärendebetäckning (Diarienum)

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16 Projektets/Rapportens titel och undertitel

Some preliminary studies on patchiness in surface water

17 Projektledare/Rapportförfattare

Stig H. Fonselius

18 Sammanfattning av projektet/rapporten (ange gärna målsättning, metod, teknik resultat m m) The conception "patchiness" the measurement of chemical patchiness and suitable parameters are discussed. The difficulties of the measurements and requirements for the analysis are described. Two preliminary patchiness studies in the Baltic sea area are described. In the first study a dense grid containing 144 sampling points was run in Kattegatt in March 1980. Samples were drawn at a depth of 4 m by help of the R/V ARGOS and were analyzed for phosphate. The distance between the grid points was 0.1 nautical mile. In addition a series at every meter down to 10 m was taken using a small "Rosette" sampler consisting of 6 small plastic samplers which could be closed simultaneously by help of a messenger. In this way 6 simultaneous samples could be taken at every depth. The results are discussed by help of figures and diagrams. In the second study a larger programme was run on board the ARGOS in the Baltic proper in May 1981. During this study many different parameters were measured and different programmes were carried out during 5 days. Only phosphate results from a grid programme containing 25 grid points are included in the present report. The distance between the grid points was 1 nautical mile and at every point samples were taken at 0, 5 and 10 m. The result is discussed by help of horizontal phosphate distribution maps.

19 Sammanfattningen skriven av
Stig H. Fonselius

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Some preliminary studies on patchiness in surface water

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Abstract

The conception "patchiness", the measurement of chemical patchiness and suitable parameters are discussed. The difficulties of the measurements and requirements for the analysis are described.

Two preliminary patchiness studies in the Baltic sea area are described. In the first study a dense grid containing 144 sampling points was run in Kattegat in March 1980. Samples were drawn at a depth of 4 m by help of the R/V ARGOS and were analyzed for phosphate. The distance between the grid points was 0.1 nautical mile. In addition a series at every meter down to 10 m was taken using a small "Rosette" sampler consisting of 6 small plastic samplers which could be closed simultaneously by help of a messenger. In this way 6 simultaneous samples could be obtained at every depth. The results are discussed by help of figures and diagrams.

In the second study a larger programme was run on board the ARGOS in the Baltic proper in May 1981. During this study many different parameters were measured and different programmes were carried out during 5 days. Only phosphate results from a grid programme containing 25 grid stations are included in the present report. The distance between the grid points was 1 nautical mile and at every point samples were taken at 0, 5 and 10 m. The result is discussed by help of horizontal phosphate distribution maps.

The possibility of an uneven distribution or patchiness of different physical, chemical and biological parameters in the sea is often discussed in the literature, (Steele 1978, Steele and Henderson 1979, Horwood 1978, Grasshoff 1980).

Steele also estimates the different time and space scales for different biological parameters. These are growing with size and trophic level of the organisms. Very few investigations regarding chemical patchiness seem to have been published. Most probably time and space scales for such patchiness are smaller than for biological patchiness.

Chemical patchiness is probably caused by mixing and by biological activity of organisms in the water. Oxygen and carbon dioxide are produced and utilized, nutrients are taken up by organisms, excreted by these and are mineralized through bacteriological oxidation of dead organisms.

Patchiness may be very difficult to study. The analytical method used, has to be reliable, specific and precise in order to minimize "analytical patchiness" caused by spreading of analytical results due to bad reproducibility. The systematic error in patchiness studies not of importance, but random errors will cause an analytical spreading of the results giving the impression of patchiness in the distribution of the measured parameter. Therefore it is important to use analytical methods in which the spreading of the results or the random error preferably is at least one order of magnitude smaller than the expected patchiness.

In marine chemistry the patchiness of the nutrient distribution may be of interest and the analysis of phosphate in sea water is simple to carry out and gives precise results. Therefore phosphate may be a suitable nutrient for studies of chemical patchiness in sea water.

A simple patchiness study was carried out on board the R/V ARGOS in Kattegat 5 March 1980. The ship moved in a grid system according to the track in fig. 1 with a speed of 3 kn starting from the center. At every 0.1 nautical mile a sample was drawn from a tap in the thermosalinograph system, where water is pumped continuously from a depth of 4 m. The phosphate reagents were added immediately and the analysis of the samples were carried out immediately after the finishing of the programme. In this manner a square of 1.1 x 1.1 naut. miles was sampled and 144 samples were obtained. The analysis was carried out according to Koroleff (1976). Koroleff gives the precision of the used phosphate method to be $\pm 15\%$ at a level of $0.2 \mu\text{mol/l}$. Fig. 2 shows the results plotted on the grid map. On the map the very irregular distribution of the phosphate values can be seen. The values vary between 0.09 and $0.29 \mu\text{mol/l}$, which is much more than the precision given by Koroleff. It has to be stressed that it is not possible to get a completely synoptic map when sampling only with

one ship and therefore 3 hours were required for running through the grid system. The sampling was carried out between 14.25 and 17.20 GMT and diurnal changes in the phosphate distribution may have occurred during the day. Salinity and temperature were recorded on the thermosalinograph during the sampling, but no significant correlation between phosphate values and temperature or salinity could be found. In order to test the precision (or micropatchiness) and the depth distribution of phosphate in the surface water, a series of samples were taken at every meter down to 10 m using an ISIS sampler constructed by the late prof. Gundersen. The ISIS sampler takes 6 simultaneous water samples with 6 small plastic samplers arranged in a ring around the hydrographic wire. The diameter of the device is 30 cm and the samplers are closed with a messenger from deck. Each sampler takes 200 ml water. Fig. 3 shows the result of this sampling. In the figure all individual values and the mean value for each depth are shown. The spreading of the values is above the halocline much larger than the precision of the analysis. The halocline was during the sampling situated at around 8 m. At 4 m depth the results were between 0.11 and 0.24 $\mu\text{mol/l}$, quite close to the extremes obtained in the grid, thus indicating the same order of magnitude of patchiness also in a micro scale. For precision see table I. A second patchiness programme was run with the R/V ARGOS in May 1981 in the Baltic proper at the international station BY 32. This time the programme was more extensive including several different studies. Several parameters, both biological, chemical and physical, were measured. The parameters were salinity, temperature, pH, alkalinity, nutrients, heavy metals, primary productivity, chlorophyll, phytoplankton, zooplankton biomass, current measurements, Secci disc, colour index etc. The analysis of most parameters has not at present been finished and I will here limit myself to describing some results of phosphate measurements in a grid programme. According to the plan, the ARGOS would remain at a central station measuring several parameters every hour down to 30 m. The grid should be run by one of the lifeboats of the ARGOS. The lifeboat was directed to the grid points by help of radio and radar from the bridge. The grid was 5 x 5 naut. miles containing 25 grid points. At every grid point samples were taken from 0, 5 and 10 m. The distance between the points was 1 naut. mile. Unfortunately we encountered heavy fog that morning and it was not possible to see the life boat on the radar farther away than 1 naut. mile. The life boat had therefore to be ordered back after finishing the 8 inner points and the remaining 16 points had to be taken with the ARGOS. In that way we lost the planned reference sampling at the central point. The weather was during the whole programme week calm and nice. Figs 4, 5 and 6 show the phosphate distribution at the three sampling levels in the grid. It has to be pointed out that the spring plankton bloom had already begun

and that the phosphate values therefore were quite low. During the afternoon of the grid programme the fog lifted and the clear sunshine may have increased the plankton production. During this time the western and southern part of the outer square was run and we can see that the phosphate values in the zero and 5 m levels there are between 0.04 and 0.05 $\mu\text{mol/l}$. In all the three levels a "patch" with high phosphate values can be seen at approximately the same position. It is rather weak and distorted at the 10 m level. The details of this patch will be closer studied when the results of other parameters have been obtained.

The experiences from these two patchiness studies show that the work has to be carefully planned and that as many reliable parameters as possible have to be used in the programme. Phosphate seems to be a suitable chemical parameter for patchiness studies. The grid should be run as quickly as possible in order to avoid diurnal effects.

In order to test the precision of the analytical technique for phosphate, 10 samples of surface water and 10 samples of water from 60 m were taken from the same sampler and were analyzed in the normal manner. Table I shows the results.

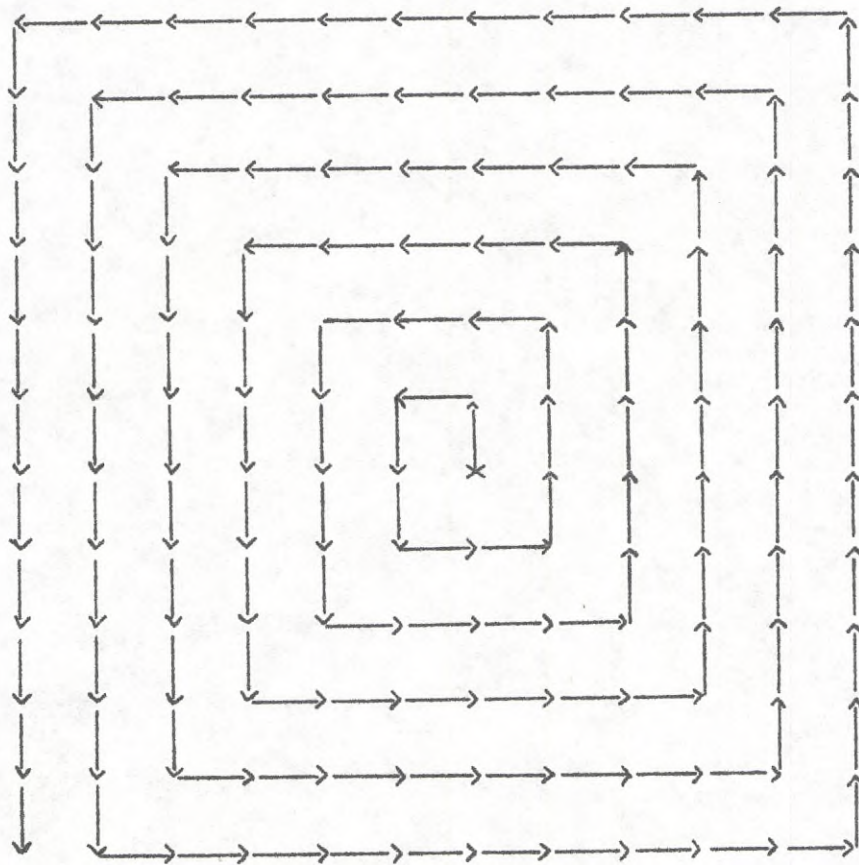
Table I

PO_4	0m $\mu\text{mol/l}$	PO_4	60 m $\mu\text{mol/l}$
	0.07		0.63
	0.07		0.63
	0.07		0.64
	0.07		0.63
	0.08		0.64
	0.08		0.63
	0.07		0.64
	0.07		0.64
	0.07		0.64
	0.08		0.64
mean	0.073		0.636
SD \pm	0.0045		\pm 0.0049

Differences larger than 4 times the standard deviation have been considered significant and therefore isolines with a difference of 0.02 $\mu\text{mol/l}$ were used.

References

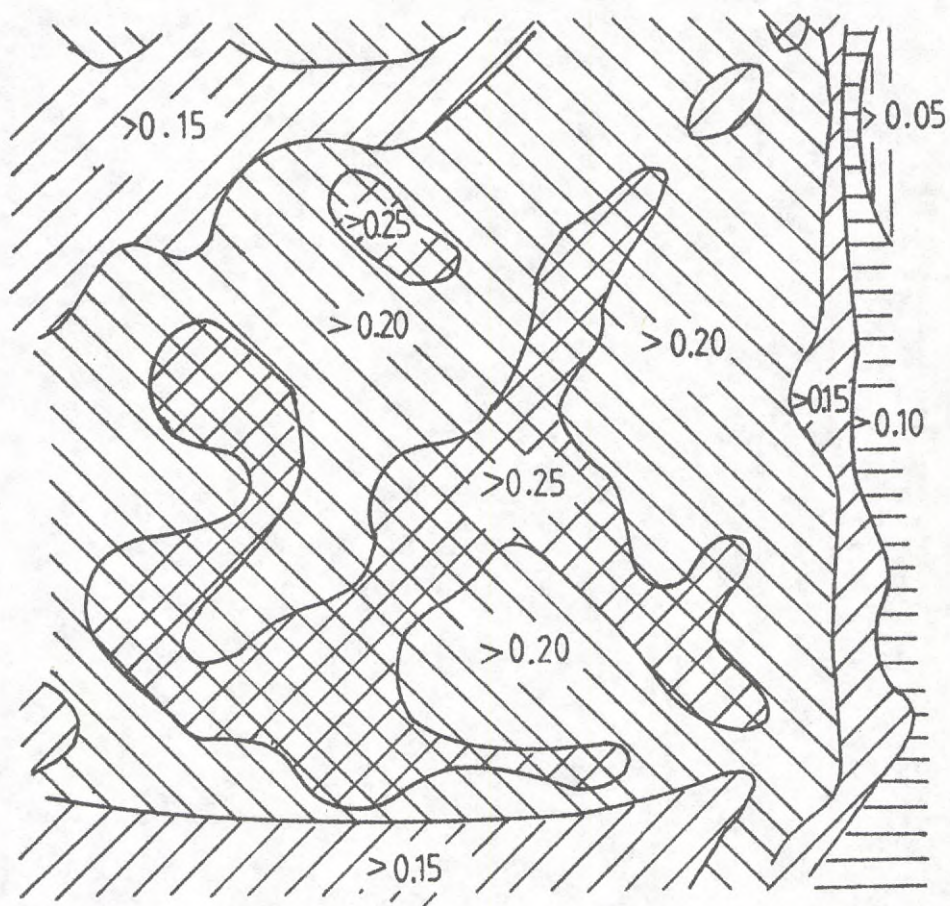
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ARGOS

Patchiness study
Grid with 0.1nm between sampling points
Horizontal patchiness L Middelgrund 80 03 05

Fig . 1



ARGOS

Patchiness study

$\mu\text{mol PO}_4 / \text{l}$ at 4m

Horizontal patchiness L Middelgrund 80 03 05

Fig. 2

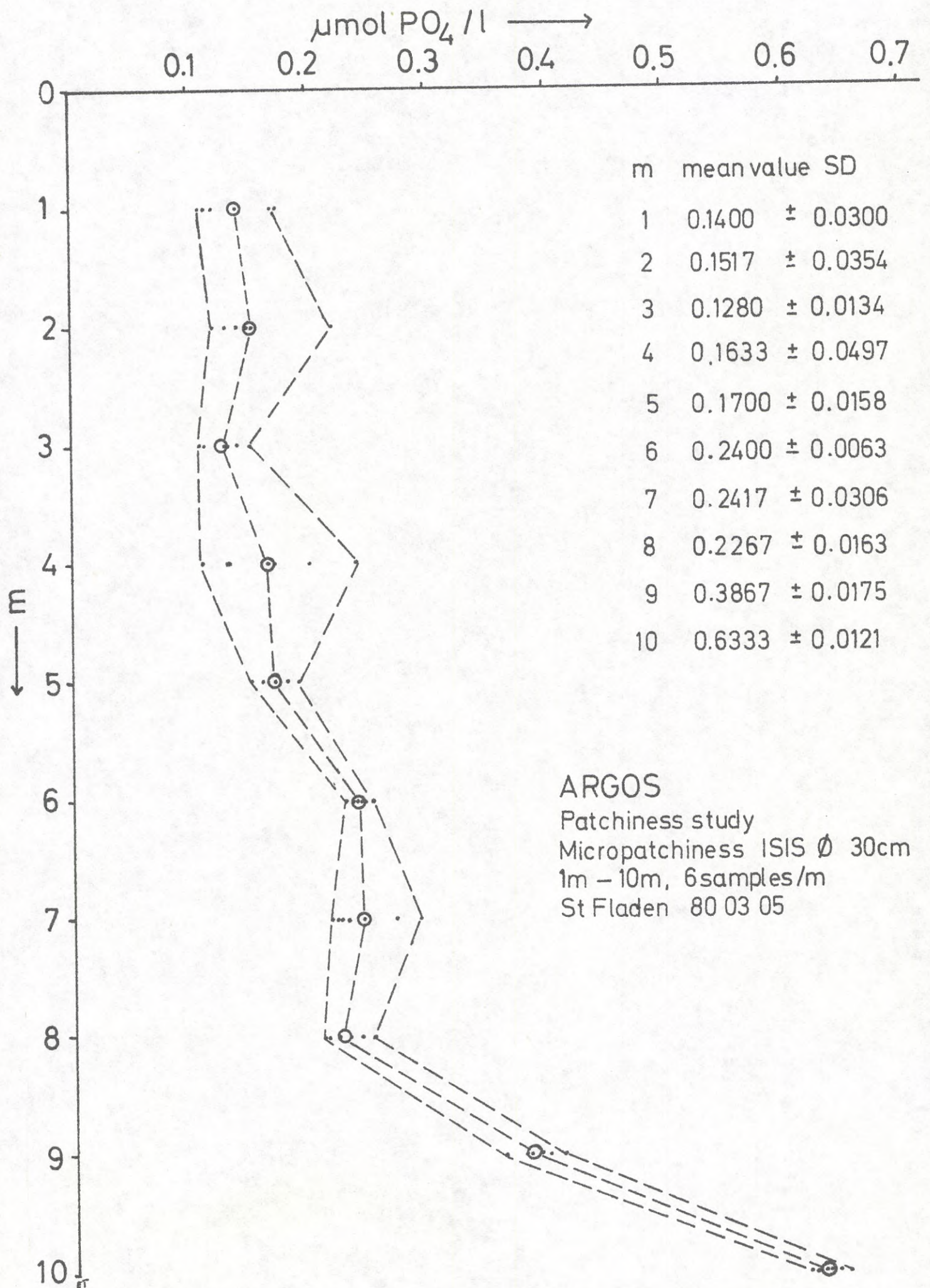
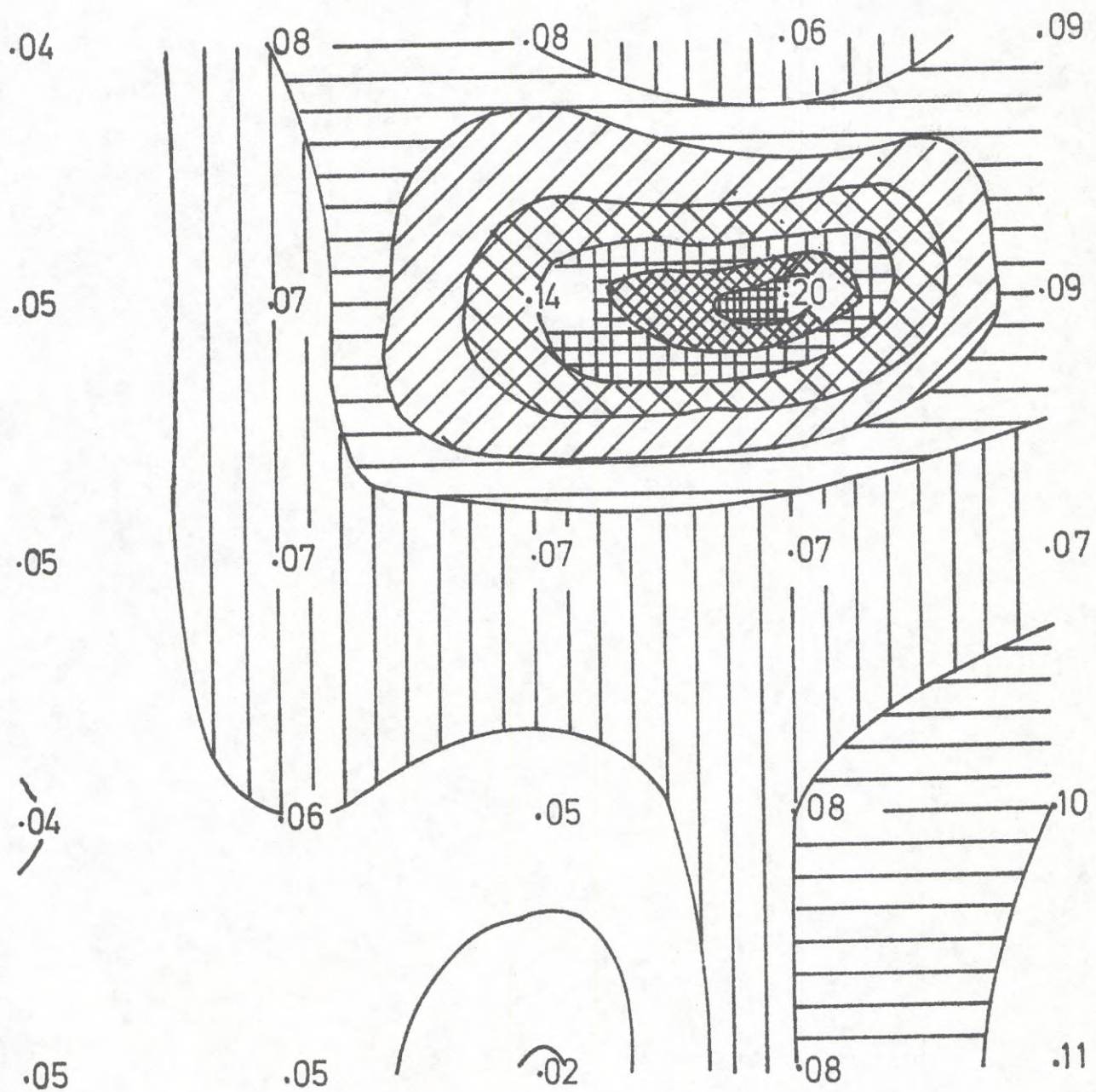
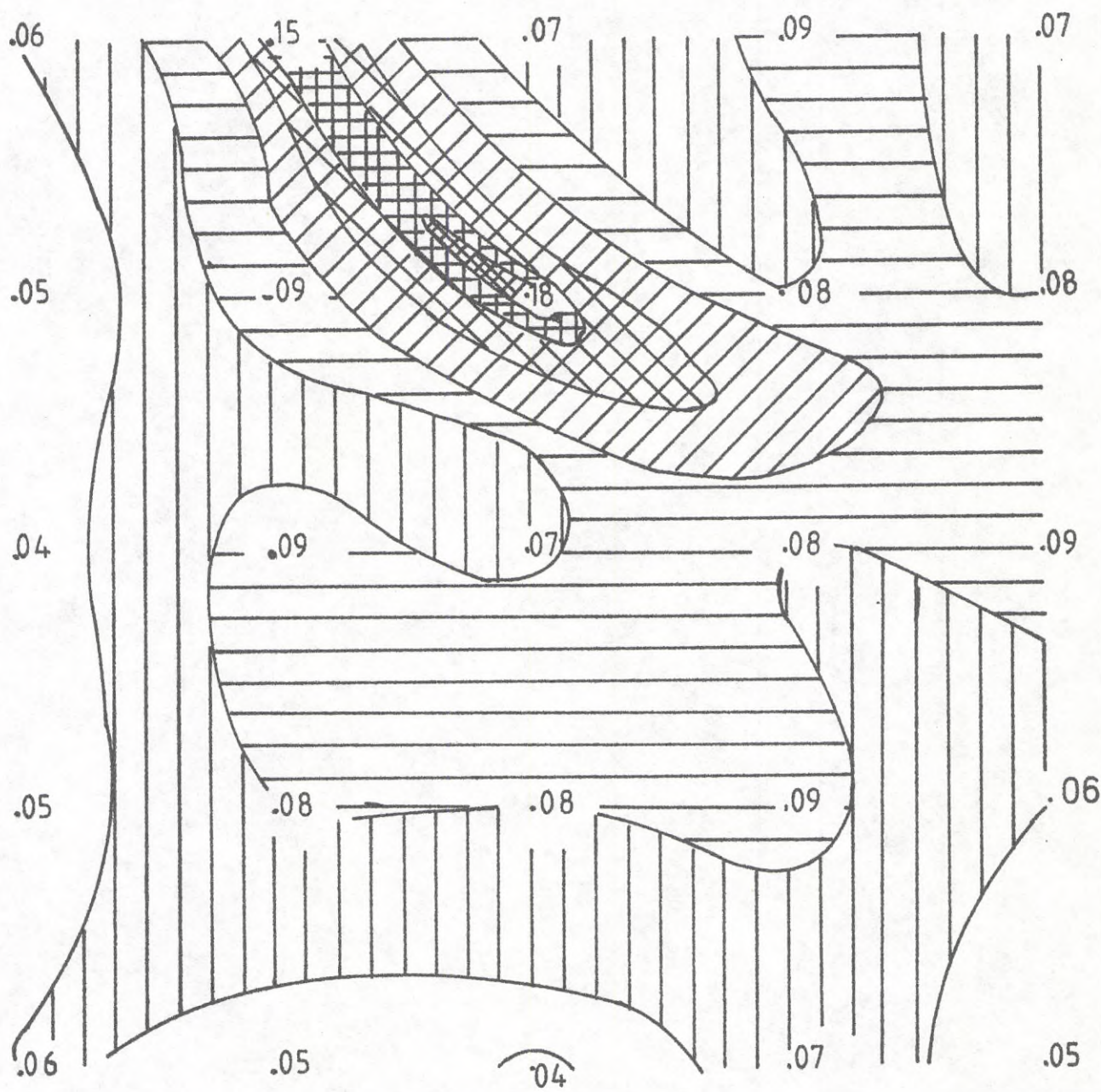


Fig. 3



ARGOS
 Patchiness study
 PO_4 in $\mu\text{mol/l}$ at 0m on BY 32 , 81 05 20
 Fig. 4

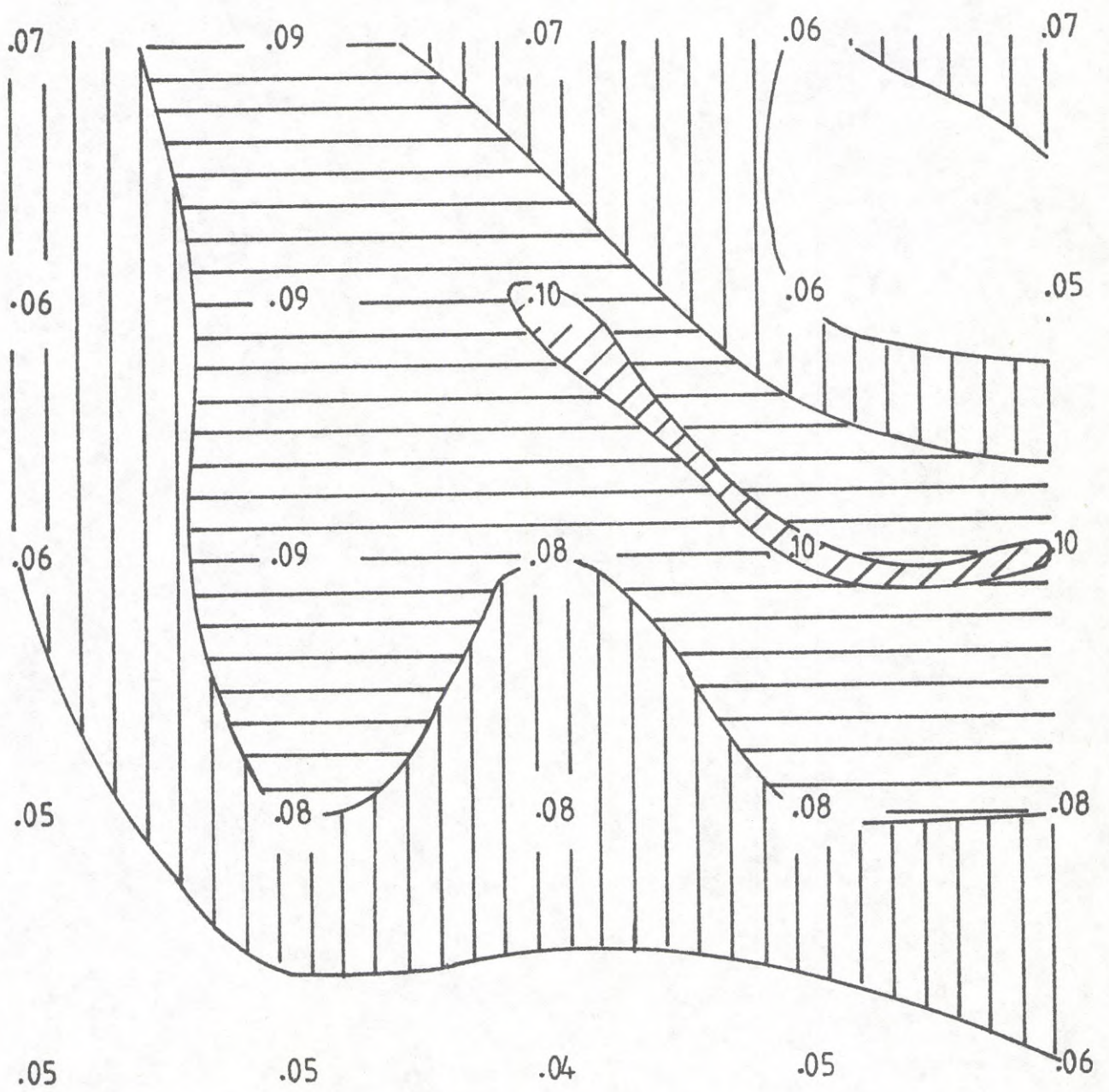


ARGOS

Patchiness study

PO₄ in μmol/l at 5m on BY 32, 810520

Fig. 5



ARGOS

Patchiness study

PO_4 in $\mu\text{mol/l}$ at 10 m on BY 32, 81 05 20

Fig. 6

