MINERALIZATION SOUTH OF THE EQUATOR IN RELATION WITH EQUATORIAL FERTILITY

by

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All the cruises of the R.V. Coriolis in the Western Equatorial Pacific have pointed out a nitrite accumulation layer which has been found at the top of the thermocline, in a convergence zone between the Equatorial Current and the South Equatorial Counter Current, near 5°S. A special cruise called EPONITE has been devoted to the study, along the 167°E meridian, of this phenomenon, which is of a particular importance, because of its location just south of the highly fertile equatorial upwelling zone. The nitrite is an intermediary step in the mineralization cycle of the organic nitrogen. But it can also be produced by bacteria or by phytoplankton cells reducing nitrate. The presence of nitrite in a well oxygenated layer raises the question of its origin.

The EPONITE cruise has been carried out, while the tradewinds blew from the east-northeast. These winds, abnormal for the season (August-September 1970), created in the mixed layer : i) north of the Equator, an horizontal divergence which produced an upwelling in the upper layers, ii) south of the Equator, a convergence with a frontal zone which separated the warm, low salinity surface water of the South Equatorial Counter Current, from the colder upwelled equatorial surface water. Underneath, in the lower part of the pycnocline, laid the salinity maximum of the South Pacific Subtropical Water.

A cross section of the nitrate concentration shows a large maximum ($8\,\mu g\text{-at } NO_3\text{-}N/l$) in the thermocline between 7°S and 9°S, limited by the isanosteric surfaces 500 and 400 cl/t. The accumulation layer of the nitrite was present between 4°S and 8°S, with a maximum ($1\text{-}2\,\mu g\text{-at } NO_2\text{-}N/l$) at 520-530 cl/t, between two maxima of the density gradient : the upper gradient is associated to the thermocline, the lower one to the salinity maximum.

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With such a distribution it is difficult to find a vertical relationship between the nitrite maximum and the content of the overlaying waters. The nitrite maximum is below the chlorophyll a maximum, which lies at the bottom of the mixed layer and above the phaeo-pigments maximum. The mixed layer has a very low primary production, and the nitrite maximum is located underneath the first density gradient which acts as a screen between the mixed layer and the nitrite maximum. Furthermore, both sides of the nitrite maximum, the density gradient and the nitrite gradient, are closely related, so that the nitrite seems to mix as a conservative property; if there is a biological or chemical process it is confined to the nitrite maximum layer. Thus the nitrite maximum is formed by another mecanism than the vertical mixing process with the mixed layer.

The continuity of the position of the nitrite maximum with regard to the thermosteric anomaly can be the result of an isentropic meridional flow. The Cromwell theoretical model of the meridional circulation with a northeast tradewind indicates that the rich heavy water upwelled north of the Equator, sinks in the frontal zone south of the Equator and flows southward below the warm homogeneous layer. In its motion the water would carry the nitrite either as nitrite, either as nitrogenous organic matter, away from the equatorial area particularly rich in dissolved and particulate organic matter. The nitrite found near 5°S could thus be only an intermediate step, in time and space, in the mineralization cycle of the nitrogenous organic matter. The nitrate maximum, south of the nitrite one, would be a further step. The spatial limitation of the nitrite maxima concentrations to the 5°S area is due to optima conditions for the nitrite appearance at this place, that is to say, the balance between the ammonia oxydation into the nitrite and the nitrite oxydation into the nitrate.

In case of a switch of the wind to the southeast, the horizontal divergence and upwelling south of the Equator would upwell the nutrients accumulated along the previous convergence zone and support the equatorial fertility. Thus the seasonal swinging of the tradewinds could reinforce the fertilizing effect of the winds on the surface waters of the equatorial region by favouring a lateral subsurface storage of nutrients under various forms and their subsequent vertical transport to the surface. The organic material, which is stored along the convergences north and south of the Equator, can be completely mineralized or can feed zooplankton populations, which grow far from the enriched equatorial area.

It must not be forgotten that all the meridional motions are involved in a main zonal circulation, and it is difficult to state a continuity between the Equator and the convergence zone near 5°S, along a meridian.