

Paleo MSc-exam 9 Nov.2010

1)

- a. give in your own words a definition for Burial Efficiency and Export Productivity (no formula but description !)
- b. Give in your own words a definition for steady state
- c. What general processes are needed to create a pronounced Oxygen Minimum Zone (OMZ) such as found West of Peru or West of Angola ?
- d. Can you mention potential additional factors that contribute to the OMZ in the NW Indian ocean ?

(10 pt.)

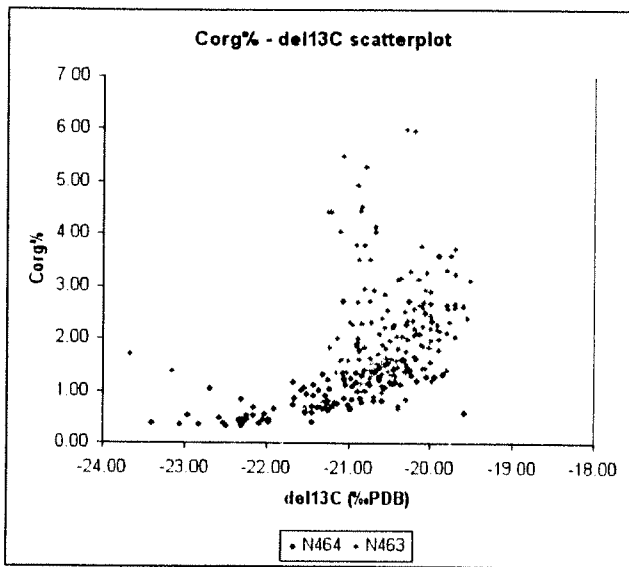


Fig. 1. The $\delta^{13}\text{C}_{\text{org}}$ versus %Corg in NIOP cores 464 and 463.

2)

While taking simple assumptions, during the practicles you determined from this plot (Fig. 1) that the predominant explanation for the large range of $\delta^{13}\text{C}_{\text{org}}$ values in these two cores (from -24 to -19.5‰) was due to terrestrial versus marine contributions. For this you took the $\delta^{13}\text{C}_{\text{org}}$ for terrestrial to be -26, and for marine to be -19.5‰. There are, however, other factors that may lead to the marine $\delta^{13}\text{C}_{\text{org}}$ not to be constant.

- a. What other factors may contribute to the variability in marine $\delta^{13}\text{C}_{\text{org}}$ values; explain briefly
- b. Which of these could contribute to the NW Indian Ocean sites; explain briefly

(7 pt.)

3)

Part of these questions relate to Figure GC-2. The half-decay time for ^{210}Pb is 22.3 yr

- a. Explain the shape of ^{210}Pb in fig. GC-2b (Taranto Gulf core NU04MC)
- b. Explain difference(s) in the shape of ^{210}Pb between the two cores
- c. Determine the average sedimentation rate for the upper 300 mm of core NU04MC (in cm/ky)

- d. Give a brief explanation of Reservoir Age (what is it, what contributes to it, by what processes may it be affected...)
- e. Do we have to take reservoir age into account for question c. ? If so, give an approximate number. In any case: motivate briefly.

18 pt.

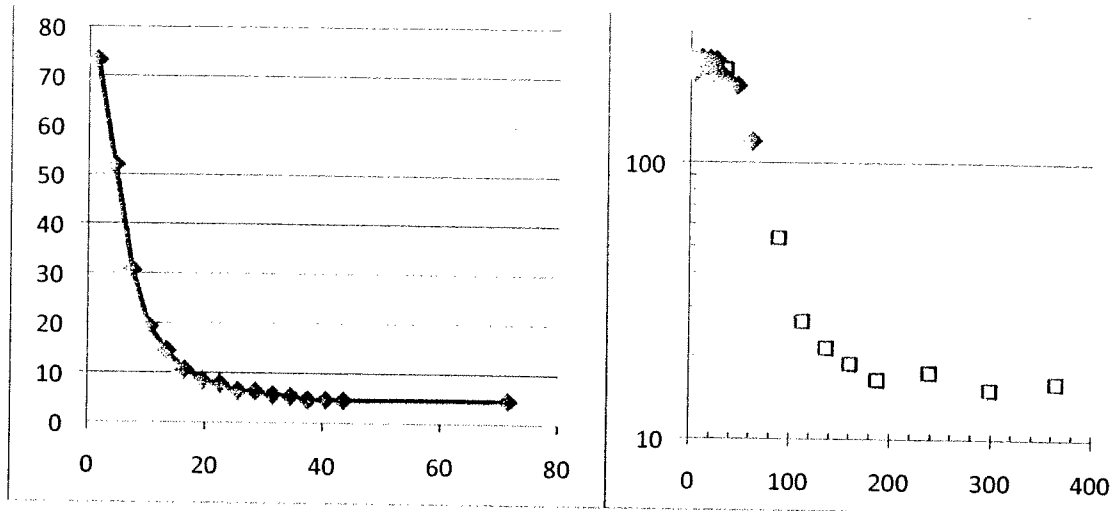


Fig.2a. ^{210}Pb activity (dpm/g) versus depth (mm) in the sediment of deep anoxic basin core NU15MC (data after Jilbert et al.); b. ^{210}Pb activity (dpm/g) versus depth (mm) in the sediment core NU04MC taken in Taranto Gulf (Goudeau, De Lange unpubl.), southern Italy (different symbols refer to two different labs producing the data)

4)

- a. What factors influence the $\delta^{13}\text{C}_{\text{carbonate}}$ for planktonic foraminifera ?; explain briefly, indicating the qualitative effect.
- b. Is there usually a difference (or not) in the $\delta^{13}\text{C}_{\text{carbonate}}$ for planktonic and benthic foraminifera from the same deep-sea core-top sample ?; explain briefly why not, or what qualitative difference you expect and why.

(7 pt.)

5)

In a high-productivity region in the North Pacific, all three biogenic components (i.e. 'soft tissue' : Organic Matter; hard skeletal parts: Carbonate, and Opal) descend to the seafloor that is below the CCD

- a. Explain qualitatively what happens with each of these three components using one or more of the following words, if applicable: primary production, alkalinity, acidity, degradation/dissolution occurring ... (where/when)..., deep water, distinct areas of production, exposure time to ..., distinct areas of preservation, mineralization, under/over-saturated.
- b. Explain qualitatively the effects on alkalinity for the processes of each of the three components in question a.

(8 pt.)

6)

Climate change on millennial time scales has been found to occur globally. Over most of the planet these changes are synchronous. However, a distinct anti-correlation has been observed between the Arctic and the Antarctic.

- a) How has this anti-correlation been established? (i.e. what was measured where, so that we know that these records are anti-phased)
- b) This anti-phased behavior between the northern and southern parts of the oceans has been described by the “seesaw” theory. Please describe the mechanism used in this theory to explain the anti-correlation.
- c) This mechanism has both a weak spot (Achilles heel) and an amplification (Flywheel). Briefly explain the processes involved and how they might regulate the mechanism you described at b.

(12 pt.)

7)

Bottom water oxygenation influences local conditions as well as global biogeochemical cycles. Accurate reconstruction of past bottom water oxygenation is therefore important.

- a) What proxies are available for reconstruction of past bottom water conditions? Also explain the mechanism behind these proxies.
- b) Low oxygen concentrations in the water column potentially result in the loss of fixed nitrogen, which you might already have explained in your answer to the question above. How would this potentially affect global $p\text{CO}_2$?
- c) Which two areas in the global ocean might have played a crucial role in past modifications of the global fixed nitrogen pool?

(12pt.)

8)

Oxygen isotopes provide important paleoceanographic information.

- a) Which stable isotopes of oxygen exist?

In the following questions please explain your answer.

- b) What determines the $d^{18}\text{O}$ of ice?
- c) What determines the $d^{18}\text{O}$ of O_2 trapped in gas bubbles in ice?
- d) What determines the $d^{18}\text{O}$ of the carbonate shells of planktonic foraminifera?
- e) What (primarily) determines the $d^{18}\text{O}$ of the carbonate shells of benthic foraminifera?

(9pt.)

9)

Divalent cations that are present in seawater are incorporated in the calcite produced by foraminifera to build their shell. This is not surprising since foraminifera use seawater to extract the necessary ions for calcification. In their cells, however, they modify the chemical composition of seawater that they take up. One of the most important changes in the composition of this seawater is that one of the elements present in seawater is actively removed by most species of foraminifera.

- a) Which element is this?
- b) Why is specifically this element actively removed?

(6 pt.)

10)

To explain high frequency climate changes often changes in solar activity are inferred. Because changes in solar insolation related to solar activity are only very small an indirect mechanism has been proposed via cloud formation.

a) Explain how solar activity, cloud formation and global climate might be linked. \

Since the production of ^{14}C is modulated by amongst others solar activity this is often studied to reconstruct the impact of solar activity on past climate change.

- b) What other factors affect the production of ^{14}C and its subsequent distribution?
- c) Which other radiogenic isotope is produced similarly to ^{14}C in the higher atmosphere?
- d) How can you take advantage of the different geochemical behavior of this element to unravel the other factor such as described at b?

(12pt.)