Examination Quaternary Geology and Climate Change   GEO3-4303

Wednesday 15 April 2009
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Carefully read the questions and provide complete answers (with explanation)!

1.   Definitions

Briefly indicate the meaning of *5 out of the following 6* items:
a) Lichenometry
b) EMIC model
c) NAO
d) Lysocline
e) Enhanced Greenhouse Effect
f) Isostatic rebound

2.   Time control

a. The ^{14}C method has been widely applied in dating materials containing carbon. What is the approximate half-life of ^{14}C, and which year is 'present' in ages BP?
b. Explain how to establish a ^{14}C calibration curve; mention at least tree types of information that can be used, and indicate the approximate time ranges covered by these methods.
c. Explain how U-Th dating is applied in Quaternary age determination of marine deposits and corals.
d. Which characteristics of the Earth's magnetic field are used as a dating method in Quaternary climate research, and which are the associated time scales?

3.   Climate forcing and control

a. At a certain point in time the following trends in orbital parameters are occurring: Obliquity is increasing, Precession is shifting such that the Earth is at the perihelion in June, and Eccentricity is high. What are the consequences of this situation for I) growth or decay of the N-hemisphere ice sheets, and for II) the intensity of monsoons in Africa? Explain your answer.
b. Explain how variations in solar activity can be reconstructed. How far back in time is this possible?
c. Indicate 2 types of changes that have occurred in the Ocean circulation which have affected the climate in NW Europe. How can these changes be recognised in sediment cores from the Atlantic Ocean?

4.   Ice cores and ocean records

a. Draw the shape of the δ^{18}O curve for the past 150,000 years in the Summit (GISP2/GRIP) ice record from Greenland; indicate (schematically) glacial and interglacial periods, Younger Dryas, Dansgaard-Oeschger events and Bond cycles.
b. δ^{18}O curves can be obtained from ice cores, and from planktonic forams and benthic forams in ocean cores. What is the approximate value range of each of these during glacial and interglacial times?
c. Explain how variations in SST and Ice sheet volume are determined using the δ^{18}O values of the three sources mentioned in b.
d. How can we reconstruct variations in precipitation rate on the Greenland Ice sheet during the past glacial?

5. Future climate

A research team proposes to use a full-coupled Ocean-Atmosphere General Circulation Model (OAGCM) to simulate the climate over the forthcoming century, until the year 2100. For this experiment the model must be driven with climate forcing; and 2) the geographical boundary conditions must be schematised in the model.

a. Which natural external climate forcings will determine the climate during the next century?
b. Which of these can (not) be used in the modeling experiment? Why?
c. Which geographic boundary conditions must be used in the model schematization?
d. Through which 'activities' will mankind influence the climate in the next century?

The team decides to evaluate the effects of 2 SRES scenarios, the A1F and B2.

e. Which of the two will result in a more extreme climate change – why?
f. Mention at least three potential 'ticking time-bombs' within the Earth system that might drastically affect our climate in the next centuries. How will these influence the climate and what will be the effects?