Tectonophysics GEO4-1409, intermediate test November 30, 2017 13:30-16:00

1. *Switch off your smartphone and put it out of sight*
2. *Head- or earphones are not allowed*
3. *Graphical calculator is allowed*
4. *Answer every question (and just the question)*
5. *You are allowed to leave the room after one hour after the test has started (late comers will be allowed in during the first hour).*

Assignment 1. Messinian Salinity Crisis

Water loss of the Mediterranean Sea by evaporation is (predominantly) compensated by inflow of Atlantic seawater through the Gibraltar Strait. During the Late Miocene *Messinian Salinity Crisis* the Mediterranean basin somehow lost its connectivity with the global oceans, which resulted in a significant lowering of the Mediterranean sea level.

(a) Explain briefly (in words) why this sea level lowering resulted in a flexural response.

(b) Why did the flexural response become a problem for refilling of the Mediterranean basin at the beginning of the Pliocene?

(c) Discuss a mechanism for opening of the Gibraltar Strait that agrees with the regional setting.

Assignment 2. Continental heat budget

What are the main physical ingredients that determine the geotherm in a continent (structure your discussion into boundary conditions, material properties, and tectomagmatic history)? Make sure to indicate why they are important.

Assignment 3. Support of long-wavelength surface loads

(a) Solve the flexure equation

$$P\frac{\mathrm{d}^2 w}{\mathrm{d}x^2}+q=\frac{\mathrm{d}^2}{\mathrm{d}x^2}\left(D\frac{\mathrm{d}^2 w}{\mathrm{d}x^2}\right)+\rho_a g w \tag{1}$$

assuming a uniform elastic plate, zero horizontal in-plane force, for the following surface load:

$$q(x)=H\rho_c g\cos kx \tag{2}$$

where H is the height of the load, ρ_c the mass density, and k the wavenumber. Assume that the solution has the form

$$w(x)=A\cos kx \tag{3}$$

You found the solution when you demonstrated that

$$A = \frac{H\rho_c}{\rho_a + Dk^4/g} \tag{4}$$

(b) Use a carefully constructed figure with columns to demonstrate that the subsidence below long-wavelength surface loads is equal to the subsidence due to Airy isostasy.

Assignment 4. Flexure of a uniform viscoelastic plate

The flexural response of a uniform viscoelastic plate to a periodic surface load (equation (2)) is given by the following equation:

$$w(x,t) = \frac{\rho_c H \cos kx}{\rho_a}\left[1 + (\alpha - 1)\exp\left(-\frac{\alpha t}{\tau}\right)\right] \tag{5}$$

where

$$\alpha = \left(\frac{Dk^4}{\rho_a g} + 1\right)^{-1} \tag{6}$$

(a) Determine $w(x, t \ll \tau)$ and compare the result with equations (4)&(5). Explain!

Relaxation occurs at a rate determined by parameters τ and α.

(b) What is the meaning of τ?

(c) Two loads of the same amplitude have different wavelengths. Which of the two loads stops moving first?

(d) Find an expression for the final subsidence. Explain as clearly as possible that this is the expected result.

Succes!