M.Geo.239 “Fluids in the crust”

MSC course, Geoscience Master, Georg-August-Universität Göttingen

Winter semester 2018-2019

Instructor: Elco Luijendijk, room 122 in the structural geology department, +49-(0)551 39 14269, eluijen@gwdg.de

Office hours: Preferably afternoons (13:00-17:00)

Course contents

Module LV1: Lectures, 2 SWS

This module introduces fluid flow in the crust and the interaction of fluids with geological processes such as heat flow and deformation. The lecture part of the course (LV1) first introduces the basic physics of crustal fluid flow, heat flow and deformation. We will subsequently study fluid flow systems at a range of scales and settings, including the potential of fluid flow through the lower crust, regional flow in sedimentary basins and orogens and localized hydrothermal systems in faults. The course includes a critical review of case studies from the recent scientific literature.

Module LV2: Exercises, 3 SWS

LV2 consists of exercises where we will learn to set up and evaluate simple numerical models of fluid and heat flow in excel and Python. We will learn to use hydrogeological datasets such as pressure and temperature data to constrain these models. As a final part of the exercises we will combine models and data for a case study of choice on crustal fluid flow.

Grading

The overall grade for M.Geo.239 consist of 50% of the grade for the exam (module LV1) and 50% of the grade for the exercises (module LV2). For the exercise module each of the exercises will count equal towards your grade.

Rationale and aims

This course was designed to provide you with broad knowledge on the role of fluids in geological processes, which is relevant to many other parts of geosciences in your msc. curriculum. This course was designed to also teach core scientific concepts such as how to critically evaluate model studies and compare models and geoscience datasets. In addition, this course provides key background information and skills for future research or industry work on topics such as geothermal energy, oil & gas exploration and radioactive waste storage. And finally, the course was also designed to make you with the scripting language Python. Scripting languages like Python or Matlab have emerged as key tools in research or industry work.

Learning outcomes

After completing this course you will

1) Have learned what factors control fluid flow in the crust and how fluid flow systems evolve over geological timescales
2) Have learned how fluid flow affects geological processes, such heat flow and deformation.
3) Have the ability to construct simple models of fluid and heat flow in excel or Python
4) Be able to use hydrogeological data to evaluate conceptual or numerical models of fluid and heat flow
5) Have learned to critically evaluate scientific literature and model studies of fluid and heat flow

Reading material

1) Selected chapters from Ingebritsen, Sanford & Neuzil (2006) Groundwater in geological processes. A copy of this book is available in the library. Copies of the relevant chapters will be available on stud.ip

2) Selected scientific papers on fluid and heat flow in the crust. See the lecture schedule for more details. Copies of the papers will also be made available on stud.ip

Reading material

You will receive a set of practice questions for the exam as a handout and as a pdf on stud.ip. There are approx. 3 to 4 questions for each lecture. We do not have a lot of time to go through these questions during the lecture hours. However, I strongly recommend that you go through the exam practice questions on your own. Doing so will make the exam much easier and more importantly you will learn much more from the course and will be able to do simple calculations to study fluid & heat flow processes in your future research or industry career. I am available for helping out with the questions in the afternoons (13:00-17:00), at office 122 in the structural geology department.

Important dates

First exam: ***Monday 4 Feb 2019, 13:15-14:45***, room MN01

Second exam: ***Friday 12 April 2019, 13:15-14:45,*** room 131

Deadlines for handing in exercises: **see exercise schedule below**. Deadline for the last exercise is **15 February 2019**

Schedule

Lectures (LV1)

Lecture no	Date	Theme	Lecture title	Reading material
1	17. Oct. 2018	Introduction	Introduction and overview of fluids in the crust	
2	24. Oct. 2018	Fluid flow basics	Where can we find fluids? Fluid volumes in the crust and mantle	Cathles (1990)
3	31. Oct. 2018	Fluid flow basics	Diffusion laws and fluid flow basics	Ingebritsen (2006) section 1.1 and 1.3
4	7. Nov. 2018	Fluid flow basics	Permeability	Ingebritsen and Gleeson (2015), Ingrebritsen (2006) section 1.2 and 1.3
5	14. Nov. 2018	Fluid & heat flow	Crustal heat flow	Ingebritsen (2006) section 8.1
6	21. Nov. 2018	Fluid & heat flow	Physics of fluid flow, heat and solute transport	Ingrebritsen (2006) section 1.4 and 1.5
7	28. Nov. 2018	Driving forces	What drives crustal fluid flow? Topography-driven flow	Garven (1995)
8	5. Dec. 2018	Driving forces	Convection	
9	12. Dec. 2018	Driving forces	Compaction-driven flow	Ingebritsen (2006) section 11.1
10	19. Dec. 2018	Fluid flow & deformation	Faults	
11	9. Jan. 2019	Fluid & heat flow	Oceanic hydrothermal systems	Ingebritsen (2006) section 13.1-13.5
12	16. Jan. 2019	Fluid & heat flow	Continental hydrothermal systems	
13	23. Jan. 2019	*to be announced*	*to be announced*	
14	30. Jan. 2019		Review of course material and exam preparation	

Exercises (LV2)

Exercise session no	Date	Exercise	Deadlines
1	19. Oct. 2018	Exercise 1: Making your own groundwater model in excel	
2	26. Oct. 2018	Exercise 1, continued	
3	2. Nov. 2018	Introduction to Python and exercise 2a: Model groundwater flow using Python	
4	9. Nov. 2018	Exercise 2a, continued	
5	16. Nov. 2018	Exercise 2a, continued	***hand in exercise 1***
6	23. Nov. 2018	Exercise 2a, continued	
7	30. Nov. 2018	Exercise 2b: Model crustal heat flow	
8	7. Dec. 2018	Exercise 2b, continued	***hand in exercise 2a***
9	14. Dec. 2018	Exercise 2b, continued	
10	21. Dec. 2018	Exercise 3: Model a 2D heat and fluid flow problem of choice	
11	11. Jan. 2019	Exercise 3, continued	***hand in exercise 2b***
12	18. Jan. 2019	Exercise 3, continued	
13	25. Jan. 2019	Exercise 3, continued	
14	1. Feb. 2019	Exercise 3, continued	
	15. Feb. 2019		***hand in exercise 3***

Note, the schedules may still change. Any updates will be posted on stud.ip