

Name

[REDACTED]

Student number

[REDACTED]

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YOU MUST ANSWER ALL PARTS OF ALL SIX QUESTIONS

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QUESTION 1

- a) What are the three main processes that cause melting of the Earth's mantle? Illustrate your answer with a P-T phase diagram.

[5 marks]

- b) Which of these melting processes would lead to the smallest degrees of partial melting and why?

[2 marks]

- Wat zijn de chemische verschillen tussen magma's*  
c) What are the geochemical differences between magmas formed in a subduction zone and those formed in a mid ocean ridge environment? (Tip: You can use trace elements to distinguish between tectonic settings)

[3 marks]

QUESTION 2

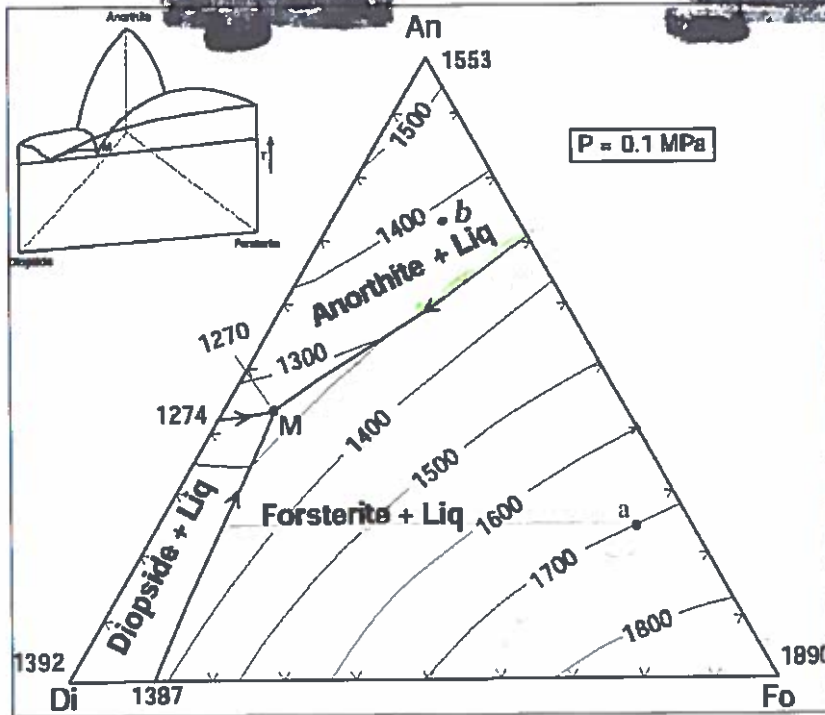
- a) Give the definitions of primary, primitive and parental magmas. In your answer be clear about the differences between these three magma types, and how they might be related to one another by fractional crystallization. Give as much detail as you can.

[6 marks]

- b) Describe what is meant by a magmatic cumulate? What minerals would be concentrated in this type of rock?

[4 marks]

QUESTION 3



A liquid with composition **a** cools to form a fully crystallized rock

(a) What is the name given to **point M** on the figure?

[1 mark]

(b) Which **mineral(s)** or **mineral combinations** will grow as the melt/rock mixture cools from **point a**? If more than **one mineral crystallizes** give the order in which they crystallize. Give the **temperatures** at which **changes** in the crystallization sequence occur

[5 marks]

(c) How **many degrees of freedom** are there when the system **cools to 1300°C**? Use the phase rule

[2 marks]

(c) What are the **relative amounts of Forsterite and liquid (in %)** present when the system cools to **1500°C**?

[2 marks]

(d) A mantle **peridotite** contains **60% Forsterite, 30% diopside and 10% anorthite**. What is the composition of the **first melt to form during partial melting**?

[2 marks]

#### QUESTION 4

Nickel has the following distribution coefficients for Forsterite, Anorthite and Diopside: 14, 0.01 and 2.6 respectively.

(a) For which mineral(s) is Ni a compatible element?

[2 marks]

(b) Which mineral(s) would have to crystallize in order to increase the Ni concentration of the remaining liquid in a magma chamber?

[2 marks]

(c) Suppose that olivine starts to crystallize first, and that after some time plagioclase crystallizes together with the olivine. Show in a variation diagram of  $\text{SiO}_2$  against Ni, how this would change the trend in the compositions of residual liquids.

[3 marks]

(d) During partial melting of the mantle, would you expect Ni to be high or low in concentration in the first fractions of melt that form?

[1 marks]

#### QUESTION 5

How would you recognize rocks that were deposited in a pyroclastic flow in the field? Describe the volcanic stratigraphy, the main textural features of the rocks and the eruptive processes that they can be linked to. Use diagrams to illustrate your answer and use the correct terminology to describe the rocks and their textures.

[10 marks]

#### QUESTION 6

List the five major minerals that would be present in granite, along with the petrographic properties that you would use to identify them in thin section

[10 marks]

