

UNIVERSITEIT VAN PRETORIA / UNIVERSITY OF PRETORIA
DEPARTEMENT PLANTPRODUKSIE EN GRONDKUNDE /
DEPARTMENT OF PLANT PRODUCTION AND SOIL SCIENCE

GKD 250

Introductory Soil Science / Inleidende Grondkunde

March / Maart 2009

Time / Tyd: 60 min

Total / Totaal: 40

Question 1 / Vraag 1

Define isomorphous substitution with special reference to the different types of isomorphous substitution that can occur. / *Definieer isomorfiëse substitusie met spesifieke verwysing na die verskillende tipes isomorfiëse substitusie wat kan voorkom.* (6)

Marks were given, adding up to a maximum of six, to any of the following facts regarding isomorphous substitution:

The substitution, or replacement, of silicon (Si^{4+}) in the tetrahedral sheet (1 mark) or aluminium (Al^{3+}) in the octahedral sheet (1 mark) by other cations with similar size but with the same or lower valency. (1 mark)

Three different types of isomorphous substitution exist namely

1. **Tetrahedral substitution** where only Si^{4+} is substituted for Al^{3+} in the tetrahedral layers; (1 mark);
2. **Octahedral substitution** where Al^{3+} is substituted for Fe^{2+} or Mg^{2+} in the octahedral layers; (1 mark);
3. **Tetrahedral & octahedral substitution** where Al^{3+} is substituted for Fe^{2+} or Mg^{2+} in the octahedral layers; (1 mark).

Question 2 / Vraag 2

Briefly explain the role of permanent negative charged clay particles on soil fertility. /
Verduidelik die rol van permanent negatief gelaaide kleideeltjies in grondvrugbaarheid.

(4)

Marks were given, adding up to a maximum of four, to any of the following facts regarding the role of negative charge development and soil fertility:

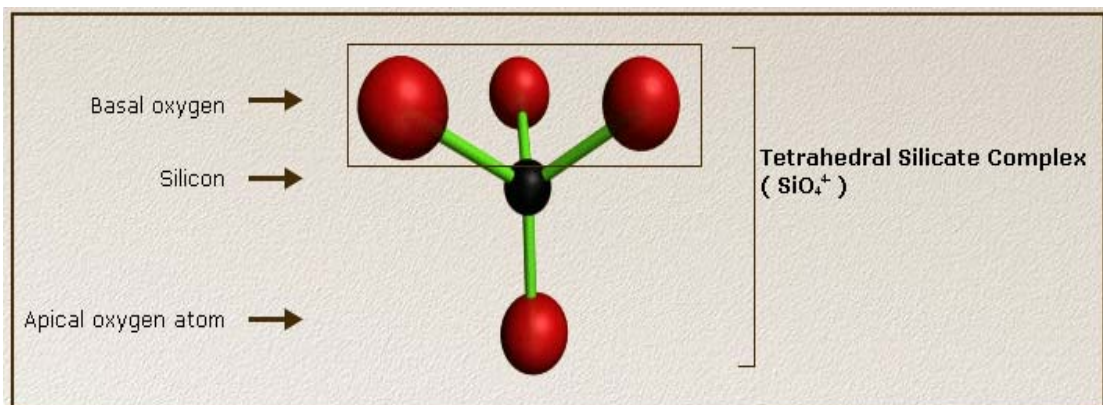
Mark allocation:

Isomorphous substitution results in the development of permanent negative charge on 2:1 clay minerals **(1 mark)**. The development of negative charge enables clay minerals to attract and adsorb cations that are essential plant nutrients **(1 mark)**, for example, Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Potassium (K^+) **(1 mark)**. These cations are commonly referred to as exchangeable cations **(1 mark)**.

Exchangeable cations are plant available **(1 mark)** and not easily leached (removal of cations by water percolating through the soil) from the soil **(1 mark)**.

Sketch a silicon tetrahedron. / Teken a silicon tetrahedron.

(4)



Mark allocation:

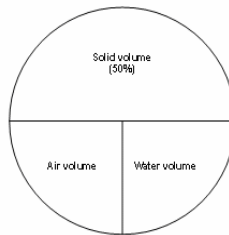
1. Correct coordination number (CN = 4) **(1 mark)**;
2. Show the correct location of Si and OH groups **(2 mark)**;
3. Correct structure showing coordinative environment **(1 mark)**.

Question 4 / Vraag 4

Illustrate and briefly explain the ideal volume composition of soil as a growth medium. / *Illustreer en bespreek kortliks die ideale volume samestelling vir grond as 'n groeimedium.* (6)

Mark allocation:

3 marks were given for the correct illustration showing the volume distribution **as well as the percentages of the different phases.**



No additional marks were given when the same information, given in the illustration, was just repeated. Marks were further given, adding up to a total of six, to any of the following:

- The air volume represents the macro pore volume or porosity of the soil **(1 mark);**
- Adequate macro pore volume is essential for aeration and gaseous exchange **(1 mark);**
- The water volume represents the micro pore volume or porosity of the soil **(1 mark);**
- Adequate micro pore volume is essential for water holding capacity **(1 mark);**
- Increasing the volume of the solids will result in a less desirable medium because of the decrease in overall pore volume **(1 mark).**

Question 5 / Vraag 5

You received the following sand, silt and clay analyses of four soils: / *Jy het die volgende sand, slik en klei analyses ontvang van vier gronde:*

Use the texture triangle and determine the textural class of each soil. / *Gebruik die tekstuur diagram en bepaal die tekstuurklas van elke grond.* (10)

- a) Sand 10%, Clay / Klei 50 % and Silt / Slik 40%;

clay / silty clay (2 mark)

- b) Sand 50%, Clay / Klei 30 % and Silt / Slik 20%;

sandy clay loam (2 mark)

- c) Sand 40%, Clay / Klei 40 % and Silt / Slik 20%;

clay / clay loam (2 mark)

- d) Sand 15%, Clay / Klei 60 % and Silt / Slik 20%;

Don't add up to 100 % (1 mark) but cannot be anything else than a clay (1 mark)

- e) Sand 80%, Clay / Klei 10 % and Silt / Slik 10%.

loamy sand / sandy loam (2 mark)

One mark was also given for any arguments in order to further define the textural class of soils a, b, c and e.

Question 6 / Vraag 6

6.1. Soil biodiversity is: / *Grond biodiversiteit is:*

- a) The amount of organisms in the soil / *Hoeveelheid organismes in die grond;*
b) The amount of heterotrophic organisms in the soil / *Die hoeveelheid heterotrofiese organismes in die grond;*

- c) The functional diversity of the organisms in the soil / *Die funksionele diversiteit van die organismes in die grond;*

- d) The amount of autotrophic organisms in the soil / *Die hoeveelheid outotrofiese organismes in die grond;* (2)

6.2. The following organisms is the most abundant in numbers: / *Die volgende organismes is die meeste in getalle:*

- a) Fungi;

- b) Bacteria / *Bakterieë;*

- c) Earthworms / *Erdwurms;*

- d) Actinomycetes.

(2)

6.3. The second trophic level is occupied by: / *Die tweede trofiese vlak bestaan uit:*

- a) Autotrophic organisms / *Outotrofiese organismes;*
b) Heterotrophic organisms / *Heterotrofiese organismes;*

d) Primary feeders / *Primêre voeders*.

c) Chemolithoautotrophic organisms / *Chemolithoautotrofiese organismes*;

(2)

6.4. White rot fungi are: / *Wit verrottings fungi is:*

a) Strictly aerobic organisms / *Uitsluitlik aerobiese organismes*;

b) Responsible for lignin breakdown / *Verantwoordelik vir die afbraak van lignien*;

c) Chemolithoautotrophic organisms / *Chemolithoautotrofiese organismes*;

d) Primary feeders / *Primêre voeders*.

(2)

6.5. *Nitrobacter* bacteria are: / *Nitrobacter* bakterieë is:

- a) Strictly aerobic organisms / *Uitsluitlik aerobiese organismes*;
- b) Responsible for lignin breakdown / *Verantwoordelik vir die afbraak van lignien*;
- c) Heterotrophic organisms / *Heterotrofiese organismes*;
- c) Chemolithoautotrophic organisms / *Chemolithoautotrofiese organismes*;
- d) Responsible for oxidation of ammonium to nitrate / *Verantwoordelik vir die oksidasie van ammonium na nitraat*

(2)

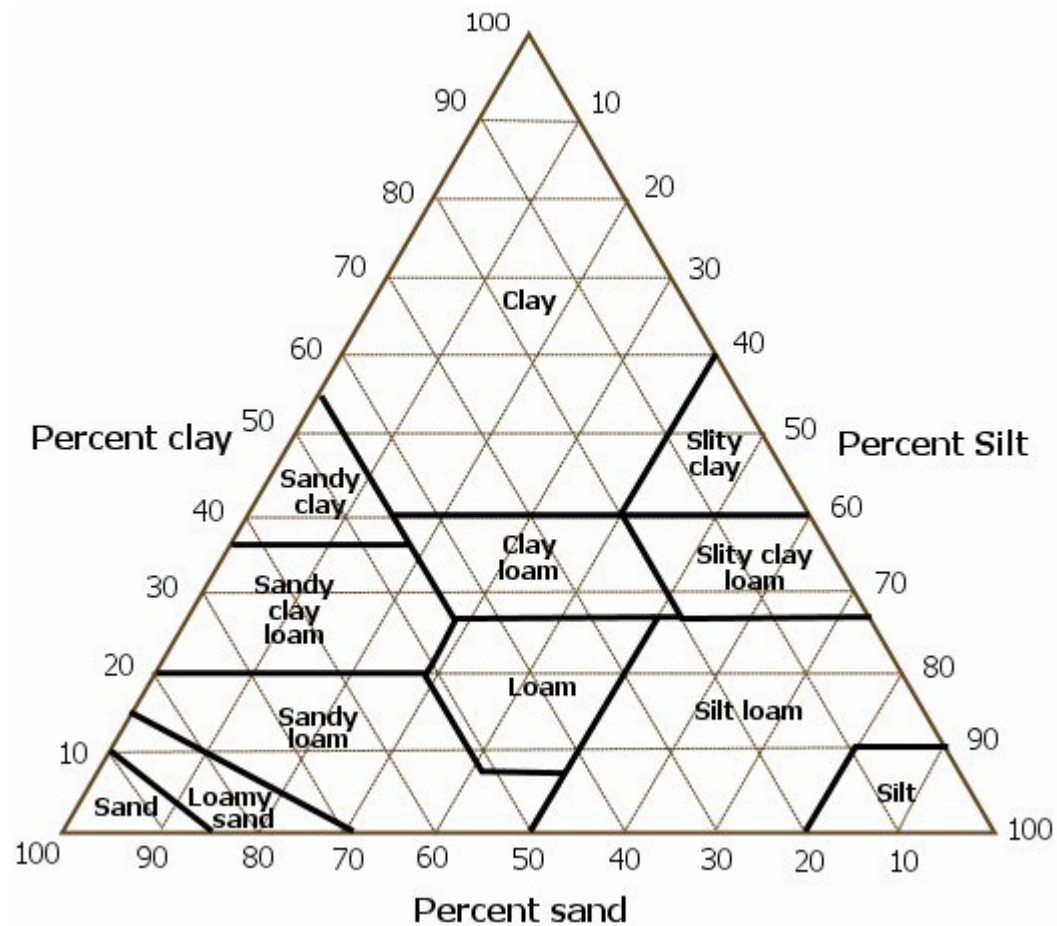


Figure 1 Texture Triangle. *Tekstuur driehoek.*