
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2010/2011

April/May 2011

EBS 242/3 – Petrography & Ore Microscopy *[Petrografi & Mikroskopi Bijih]*

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains ELEVEN printed pages and THREE pages APPENDIX before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEBELAS muka surat yang bercetak dan TIGA muka surat LAMPIRAN sebelum anda memulakan peperiksaan ini.]

This paper consists of TWO questions from PART A and FOUR questions from PART B.

[Kertas soalan ini mengandungi DUA soalan dari BAHAGIAN A dan EMPAT soalan dari BAHAGIAN B.]

Instruction: Answer ALL questions from PART A and THREE questions from PART B. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.

[Arahan: Jawab SEMUA soalan dari BAHAGIAN A dan TIGA soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]

The answers to all questions must start on a new page.

[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.

[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

In the event of any discrepancies, the English version must be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

PART A / BAHAGIAN A

1. Please define or describe the following:
- (a) Birefringence and Becke Lines (in optical mineralogy)
 - (b) Holocrystalline and holohialine (in igneous petrography)
 - (c) Neomineralisation and metasomatism (in metamorphic rock)
 - (d) Isotropism and Bireflectance (in ore microscopy)
 - (e) Reflected pleochroisme and internal reflection (in ore microscopy)

Takrif atau terangkan mengenai perkara-perkara berikut:

- (a) *Dwirefringens dan garis Becke (mineralogi optik)*
- (b) *Holohablur dan holohialin (petrografi batuan igneus)*
- (c) *Neo permineralan dan metasomatisma (Batuan metamorf)*
- (d) *Isotrop dan Dwibalikan (Mikroskopi bijih)*
- (e) *Pleokroisme pantulan dan pantulan dalaman (Mikroskopi bijih)*

(20 marks/markah)

2. [a] Figure in Appendix 1 shows thin sections of the common rock forming minerals and rock classes found in the earth crust. Discuss about the optical properties of the following minerals and igneous rocks subsequently determine the most possible types of the given specimens

Rajah dalam Lampiran 1 menunjukkan keratan nipis bagi kumpulan utama mineral pembentuk batuan dan batuan yang biasa dijumpai di kerak bumi. Bincang ciri-ciri mineralogi optik bagi mineral dan batuan granit yang disenarai seterusnya kenalpasti nama bagi setiap contoh yang diberikan.

(10 marks/markah)

- [b] Figure 1(b) shows the classification charts or diagrams of the common rock classes or categories (Rock A) in the earth crust. Discuss and elaborate about the classification scheme.

Rajah 1(b) yang diberikan menunjukkan skema pengelasan atau kategori bagi batuan pembentukan kerak bumi (Batuan A). Bincang dan perelaskan skema pengelasan ini.

Rock A
 Batuan A

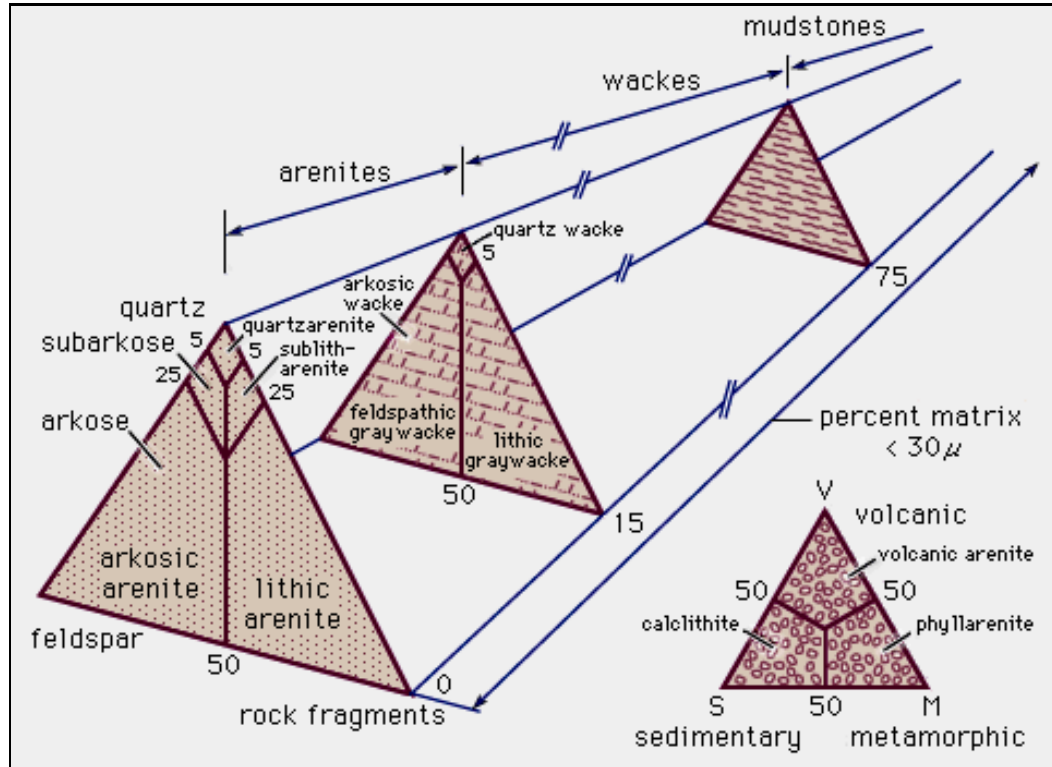


Figure 1(b) / Rajah 1(b)

(10 marks/markah)

PART B / BAHAGIAN B

3. Please answer any two (2) of the following questions:
- [a] How thin section of a mineral is prepared and subsequently examined under polarizing microscope?
 - [b] The anisotropy shown by non-cubic crystals in their physical properties can also be shown by their absorption – this phenomenon is called pleochroism and is a useful distinguishing property. Define and how such property is determined under polarizing microscope.
 - [c] Optical mineralogy is a study of the interaction of light with minerals, most commonly limited to visible light and usually further limited to the non-opaque minerals. With appropriate illustrations show the polarization process of an ordinary light transmitting through a polarizing microscope.

Sila jawab mana-mana dua (2) soalan berikut:

- [a] Bagaimana keratan nipis bagi satu mineral itu disediakan dan seterusnya dikaji menggunakan mikroskop terkutub?*
- [b] Sifat tak isotrop satu mineral bukan kiub yang ditunjukkan melalui sifat fizikal juga dapat dilihat melalui sifat serapannya – fenomena ini disebut sebagai pleokroisme dan sifat yang penting di dalam mengenali sesuatu mineral. Beri keterangan mengenai ciri ini dan bagaimana ia dikenalpasti di bawah mikroskop terkutub.*
- [c] Mineralogi optik adalah pengkajian berkaitan hubungan antara cahaya dan mineral, yang kebiasaannya terhad kepada cahaya yang boleh dilihat dan lebih terhad kepada mineral tidak legap. Dengan menggunakan carta yang sesuai, tunjukkan proses pengutuban cahaya apabila ia menembusi mikroskop terkutub.*

(20 marks/markah)

4. Please answer the following questions.

[a] Identify the most possible type of the following metallic ore minerals which is being observed under reflected light microscope based on the given arguments:

- (i) **Colour:** Yellowish white, **Bireflectance:** not present, **Anisotropy:** often weakly anisotropic, **Internal reflection (IR):** not present. The most abundant sulphide occurs as euhedral cubes.
- (ii) **Colour, bireflectance and pleochroism:** very strong, bireflectance from brownish gray to greyish black, **Anisotropy:** very strong, straw yellow to brown, **Internal reflection (IR):** not present.
- (iii) **Colour:** indigo blue with violet tint to bluish white, B/P purple to violet red, **Anisotropy:** extreme, red-orange to brownish.

[b] Please discuss the following:

- (i) How hardness is measured in petrographic study of ore minerals?
- (ii) What is reflectivity? How the reflectivity of a mineral is determined in ore petrographic study?

4. Sila jawab soalan berikut:

[a] Berdasarkan ciri-ciri yang diberikan, kenalpastikan mineral bijih yang dikaji menggunakan mikroskop cahaya balikan:

- (i) **Warna:** Kuning keputihan, **Dwibalikan:** tidak kelihatan, **Tak isotropik:** biasanya lemah, **Pantulan Dalaman:** tidak kelihatan. Kebanyakan sulfat wujud sebagai kiub euhedron.
- (ii) **Warna, Dwibalikan dan Pleokroisme:** sangat kuat, dwibalikan dari perang kekelabuan ke kelabu kehitaman, **Tak isotropik:** sangat kuat, jalur kuning kepada perang, **Pantulan Dalaman:** tidak kelihatan.
- (iii) **Warna:** biru nila dengan tompok violet ke biru keputihan, **Tak isotropik:** sangat jelas, merah-jingga keperangan.

[b] Sila beri keterangan atau penjelasan mengenai perkara berikut:

- (i) Bagaimanakah kekerasan satu mineral diukur di dalam petrografi mineral bijih?
- (ii) Apakah itu balikan? Bagaimanakah sifat balikan dikenalpasti di dalam petrografi mineral bijih?

(20 marks/markah)

5. Please answer any two (2) of the following questions.
- [a] Explain the following:
- (i) What is the different between ***uniaxial*** and ***biaxial mineral***.
 - (ii) The relationship between *double refraction*, *velocities* and *refractive indices* when a narrow beam of light entering an isotropic crystal.
- [b] What determines the retardation of mineral crystal and its governing factors? Please determine the birefringence of mineral augite with R.I. values for $n_s = 1.724$ and $n_f = 1.700$ respectively for a standard thin section.
- [c] Please explain the following:
- (i) Extinction angle properties of a mineral grain.
 - (ii) The method used to study the extinction angle of a mineral under the polarised microscope with appropriate example of minerals.

5. Sila jawab mana-mana dua (2) soalan berikut.

[a] Berikan keterangan mengenai perkara berikut:

- (i) Apakah perbezaan di antara mineral ekapaksi dan dwipaksi.
- (ii) Perhubungan di antara bias duaaxial, kelajuan dan indeks biasan apabila cahaya menembusi kristal isotropik.

[b] Apakah yang menentukan nilai pembantutan hablur mineral dan faktor kebergantungannya? Sila tentukan nilai dwibalikan mineral augit yang mempunyai I.B. masing-masing $n_s = 1.724$ dan $n_f = 1.700$ untuk keratan nipis piawai.

[c] Sila beri keterangan atau penjelasan mengenai perkara berikut:

- (i) Ciri-ciri sudut padaman bagi satu mineral.
- (ii) Kaedah yang digunakan bagi mengetahui sudut padaman bagi satu mineral di bawah mikroskop terkutub beserta contoh mineral yang sesuai.

(20 marks/markah)

6. Answer the following question:

- [a] Based on the IUGS classification system (Appendix 2), determine the class/type and the name of these igneous rocks according to their respective composition and textures as given in the following Table A.

Table A

Features	Igneous A	Igneous B	Igneous C
Composition	Q: > 23% AP: < 9% Plg: > 66% Acc: Muscovite (< 2%)	Q: 10% AP: 15% Plg: 70% Acc: Biotite, olivine (> 5%)	Q: 22% AP: < 12% Plg: > 65% Acc: Augite (> 2%)
Texture	Medium to coarse grained	Aphanetic	Medium to coarse grained
Distinguished features	Granular	Euhedral, plagioclase normally andesine as phenocryst, Porphyritic	Granular

Notes: Q: Quartz; AP: Alkali feldspar; Plg: Plagioclase and Acc: Accessory mineral

- [b] Briefly discuss the differences between the properties of the following rocks (composition, texture, grain size and other distinguished features):
- (i) Obsidian and granite.
 - (ii) Basalt and granite.
 - (iii) Conglomerate and limestone.

6. Jawab soalan-soalan berikut:

[a] Berdasarkan kepada sistem pengelasan IUGS, tentukan kelas/jenis serta nama batuan-batuan igneus yang mempunyai tekstur dan komposisi seperti berikut sebagaimana diberikan dalam Jadual A.

Jadual A

<i>Fetur</i>	<i>Igneus A</i>	<i>Igneus B</i>	<i>Igneus C</i>
Komposisi	Q: > 23% AP: < 9% Plg: > 66% Acc: Muscovit (< 2%)	Q: 10% AP: 15% Plg: 70% Acc: Biotit, olivin (>5%)	Q: 22% AP: < 12% Plg: > 65% Acc: Augit (> 2%)
Tekstur	Berbutir sederhana hingga kasar	Berbutir halus	Berbutir sederhana hingga kasar
Fetut-fetut unggul	Berbutir	Euhedron, Fenokris Plagioklas adalah andesin sebagai fenokris Porfiritik	Berbutir

Nota: Q: Kuarza; AP: Alkali felspar; Plg: Plagioklas dan Acc: Mineral aksesori

[b] Secara ringkas, bincangkan sifat-sifat perbezaan utama di antara pasangan batuan berikut (komposisi, tekstur, saiz butiran dan fetut-fetut unggul lain):

- (i) Obsidian dan granit.
- (ii) Basalt dan granit.
- (iii) Konglomerat dan batu kapur.

(20 marks/markah)

APPENDIX 1 / LAMPIRAN 1

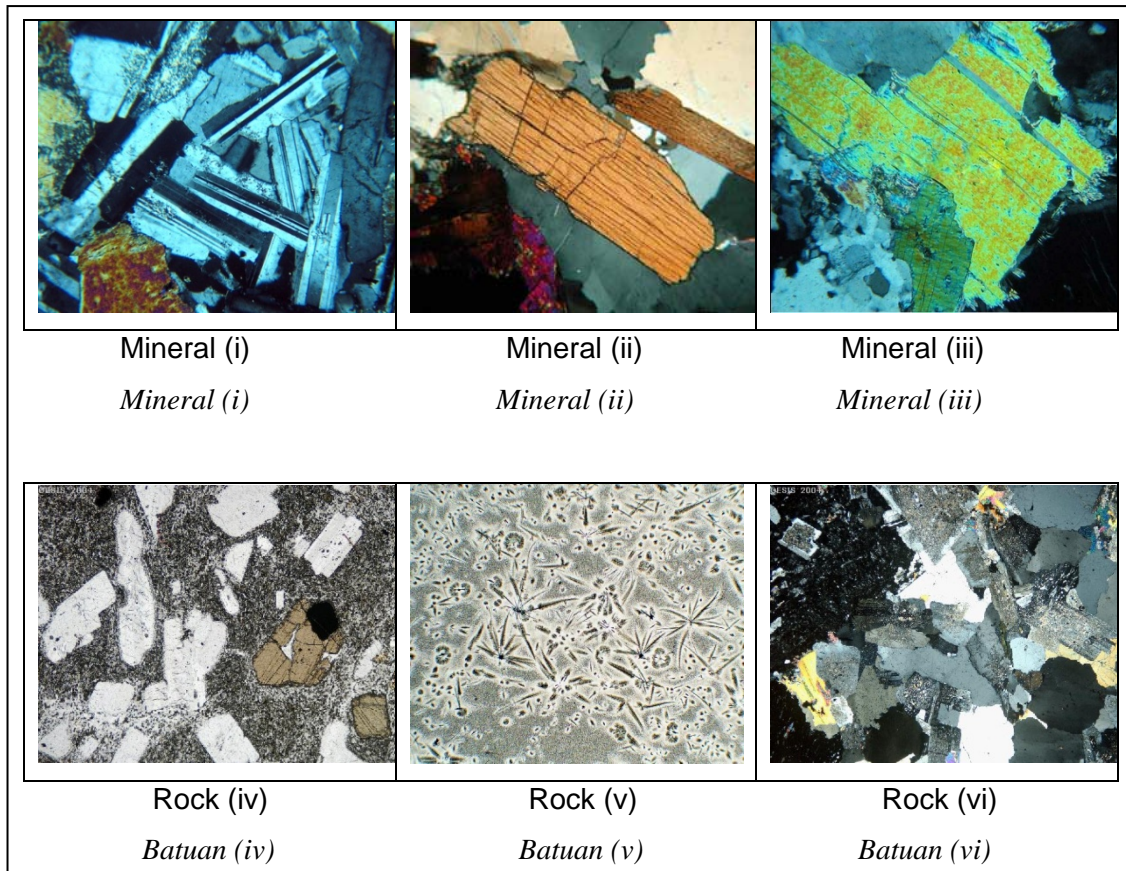


Figure 1(a) / *Rajah 1(a)*

APPENDIX 2 / LAMPIRAN 2

