
UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2005/2006

April/Mei 2006

EBS 232/3 – Mineralogi Optik

Masa : 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan.

Kertas soalan ini mengandungi TUJUH soalan.

Jawab LIMA soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.

Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.

Semua jawapan hendaklah dijawab dalam Bahasa Malaysia.

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BAHAGIAN A: Sila Jawab soalan-soalan berikut:

1. [a] Dalam kajian petrologi, batuan igneous dikenalpasti dan dikelaskan dengan merujuk kepada pelbagai teknik seperti komposisi mineral, indeks warna dan tekstur. Salah satu teknik pengelasan batuan igneus adalah berdasarkan kepada sistem QAPF. Jelaskan bagaimana pengelasan batuan igneus dikelas dan dinamakan dengan kaedah ini?

[b] Pemerhatian petrografi mendapati sampel **A** dan **B** batuan igneus berikut berkomposisi seperti pada Jadual A.

Tentukan jenis (nama) batuan berasaskan maklumat kandungan mineralogi di atas (*Jadual A*) dengan gambarajah pengelasan QAPF.

[c] Apa pula nama batuan **A** dan **B** ini sekiranya berbutir halus (ekstrusif).

Jadual A

Mineral (%)	A	B
Kuarza	25	25
Jumlah felspar: ((Plag + Alkali Feldspar)	74	70
Plagioklas (P) (daripada keseluruhan jumlah felspar)	5	90
Mineral aksesori (Mafik) - M	Biotit < 1	Augit < 5
Tekstur (Saiz butiran)	Berbutir kasar	Berbutir kasar

(20 markah)

...3/-

2. Ahli mineralogi kerap mengelaskan mineral berasaskan kepada sifat-sifat optik mineral dan mendapati ia merupakan diagnostik sifat-sifat atau jalan ringkas yang dapat mempercepatkan proses pengecaman mineral. Dengan ilustrasi bersesuaian tunjukkan jujukan sifat-sifat penting (*key properties*) dalam proses pengecaman mineral (cartalir) di bawah mikroskop pengutub.

[a] Secara ringkas terangkan perkara berikut:

- (i) Bagaimana arah istemewa pengutub ditentukan?
- (ii) Bagaimana kaedah penyediaan keratan nipis disediakan dan seterusnya diperiksa di bawah mikroskop pengutub?

(20 markah)

BAHAGIAN B: Jawab hanya TIGA (3) soalan berikut:

3. Takrif atau perelaskan secara ringkas akan maksud **empat (4)** daripada perkara-perkara berikut:

[a] Pepadaman selari dan pepadaman lamella (sertakan contoh).

[b] Holokristalin dan holohialin (dalam petrografi igneus).

[c] Sokongan matrik (batuan sedimen).

[d] Isotropisma and *Birefractance* (mikroskopi bijih).

[e] *Neomineralisation* and metasomatisma (dalam batuan jelmaan).

(20 markah)

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4. Jawab mana-mana **EMPAT (4)** soalan berikut:

- [a] Selain tekstur, batuan metamorf juga dikenalpasti dan dikelaskan berasaskan kepada tiga kriteria lain seumpama komposisi kimia. Jelaskan cara-cara pengelasan tersebut.
- [b] Takrifkan *idiomorphic* dan *xenomorphic* iaitu sebutan-sebutan yang kerap kali diguna untuk menerangkan morfologi hablur yang terjadi pada batuan jelmaan/metamorf.
- [c] Jelaskan maksud "pleokroisma balikan" dan "balikan dalaman" (dalam kajian mikroskopi bijih)
- [d] Nyatakan jenis-jenis pepadaman mineral tak isotrop. Terangkan bagaimana sudut pepadaman mineral ditentukan.
- [e] Secara ringkas, perjelaskan perhubungan di antara 'biasan bergu' halaju dan indek biasan, iaitu bila satu alur cahaya memasuki hablur tak isotrop (*anisotrop*).

(20 markah)

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5. Sila jawab **EMPAT (4)** soalan berikut:

- [a] Bagi kes hablur mineral yang keratan nipisnya dibuat dalam keadaan paksi optiknya benar-benar terorientasi pugak terhadap pentas mikroskop pengutub, terangkan bagaimanakah perlakuan mineral ini terhadap sifat-sifat optik berikut kepada sinar yang terkutub dalam arah Timur-Barat yang memasukinya? Gunakan gambarajah bersesuaian bagi menyokong hujah anda.
- (i) Anisotropisma.
 - (ii) Sifat indek biasan dan halaju cahaya.
 - (iii) Dwirefringen.
- [b] Nyatakan faktor-faktor yang lazim mengawal tahap atau darjah perencatan, Δ dua sinar yang melewati menerusi hablur tak isotrop pada suatu keratan nipis. Kedua cahaya ini bergerak pada kelajuan yang berbeza kecuali sekira keduanya bergerak selari berbanding paksi optik.
- [c] Apakah nilai *dwirefringen* serta *perbezaan fasa* bagi suatu keratan hablur (berketebalan 30 mikron) yang mempunyai indeks biasan maksimum 1.553, bagi cahaya yang bergetar selari dengan paksi-c hablur dan nilai minimum 1.544 bagi alur cahaya bergetar seranjang dengan paksi-c. Apakah warna gangguan (*carta Michel Levy*) yang bersepadanan dengan nilai-nilai berkenaan?

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- [d] Jelaskan perkaitan di antara *balikan duaan*, *halaju* dan indek biasan apabila sinar cahaya satah terkutub memasuki kepingan mineral tak isotrop selain daripada keratan basal.
- [e] Bincang secara ringkas dua komponen fizikal (partikal) utama yang lazim membentuk kebanyakan batuan sedimen yang kerap dikenali sebagai gersik (*detrital*) dan bukan-gersik (*non-detrital*).
6. Jawab mana-mana **EMPAT (4)** soalan berikut:
- [a] Apakah perbezaan antara mineral **ekapaksi** dan **dwipaksi**. Seterusnya apakah yang terjadi kepada cahaya yang bergerak selari dengan paksi optik atau seranjang terhadap muka suatu hablur?
- [b] Takrifkan maksud "padatan-butiran" (grain-packing) dalam kajian petrografi batuan sedimen.
- [c] Takrifkan maksud "foliasi" dalam kajian batuan sedimen dan "syis" dalam kajian petrografi batuan metamorf.
- [d] Apakah perbezaan antara **warna gangguan** dan **gambarajah gangguan** suatu mineral yang diperiksa di bawah mikroskop terkutub?
- [e] Tentukan jenis atau nama spesimen batuan igneus berikut yang bertanda **A** hingga **E** sebagaimana cerap dibawah mikroskop petrografik seperti diberikan pada **Jadual B**?

JADUAL B

Spesimen	Warna/tekstur	Komposisi (Anggaran)	Fetor unggul lain
A	Berwarna cerah/berbutir kasar	Q=40% Plag=30% Jumlah felspar	Butiran anhedral kuarza yang dikelilingi oleh biotit dan sedikit muskovit.
B	Pertengahan berbutir halus	Q <15% Plag=90-100% jumlah feldspar (An<50)	Trobosan; kaya plagioklas subhedral, Kelihatan dalam suatu matrik berbutir halus plagioklas, klinopiroksin bahan vulkanik bergelas.
C	Gelap, padat dan homogen	Mudah terpecah kepada bentuk <i>chonchoidal</i>	Holohialin
D	Gelap, ultramafik, berbutir kasar	M=90-100 Plag. <5%	Keseluruhan batuan terdiri daripada hablur ketidaksama butiran dan dwirefringen tinggi olivin, sedikit klorit dan mineral legap lain.
E	Gelap, berbutir kasar	Q <15% Plag=70% jumlah feldspar	Kandungan bilah plagioklas kalsik yang tinggi (An>50). Kejadian olivin yang lumrah dengan sedikit augit.

(20 markah)

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7. Jawab mana-mana **TIGA (3)** soalan berikut:

- [a] Nyatakan jenis batuan serta gred/fasis yang setara bagi spesimen batuan-batuan metamorf berikut (**A-D**) berdasarkan kepada pemerhatian yang telah dibuat terhadap keratan nipis batuan berkenaan sebagaimana diberikan dalam JADUAL C.
- [b] Secara umum, apakah sifat-sifat unggul yang membezakan batuan-batuan sedimen dan metamorf berikut:
- (i) Batu pasir
 - (ii) Konglomerat
 - (iii) Batu Kapur
 - (iv) Syis
- [c] Secara umum, nyatakan sifat-sifat optik lazim dan fetur-fetur unggul *kuarza* dan *kalsit* bila diperiksa di bawah mikroskop pengutub.

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JADUAL C

Spesimen	Warna/tekstur	Mineralogi	Fetut-fetut unggul lain
A1	Cerah, jalur pemisahan/segregasi lapisan mineral gelap dan cerah yang nyata, berbutir kasar.	Terutamanya kuarza, plagioklas, muskovit dan biotit. Mengandungi hablur kianit .	Agak masif dan ira yang tidak sempurna/lemah.
A2	Mika dan empingan mineral lain menyusun membentuk suatu satah	Dicirikan oleh kandungan mika (muskovit) yang tinggi dan berubah-ubah serta klorit. Sejumlah kecil kuarza, felspar dan anhedral garnet.	Kejadian klorit yang agak banyak
A3	Kelabu cerah, pembentukan ira yang baik oleh susunan selari emping mika dan klorit.	Pada prinsipnya kuarza berbutir halus, klorit, serisit dan mineral mika lain yang berkait rapat dengan lempung. Besi oksida	Empingan individu mika tidak kelihatan secara megaskopik. Kilauan mutiara pada permukaan ira yang kasar
A4	Warna cerah, berbutir kasar/retakan(ira) rombohedra. Tekstur saling mengunci	Keseluruhannya kalsit dengan sedikit butiran kuarza halus dan pirit.	Nilai dwirefringen sangat tinggi (akibatkan tampak berkilau). Ira dan kembaran adalah lazim. Kembaran lamella.

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[d] Kenalpasti apakah jenis mineral-mineral bijih berikut, ((i) – (iii)) sebagaimana dicerap dibawah cahaya balikan mikroskop pengutub berdasarkan kepada keterangan-keterangan yang diberikan seperti berikut:

- (i) Warna Putih kekuningan, dwibalikan : tidak terdapat; Anisotropi : Kerap kali lemah, balikan dalaman (IR) : tidak terdapat. Mineral sulfida terbanyak terjadi sebagai kiub-kiub euhedral.
- (ii) Warna, dwibalikan dan ploekroisme : tersangat kuat; dwibalikan : daripada kelabu keperangan hingga hitam kekelabuan; Anisotropisma : tersangat kuat – kuning batang jerami ke perang; balikan dalam : tidak terdapat.
- (iii) Warna: biru nila (indigo blue) dengan pucat keungguan (violet tint) hingga putih kebiruan; dwibalikan/pleokroisme : ungu hingga merah ungu; Anisotropi : melampau, merah-oren hingga keperangan. Mineral kuprum.

(20 markah)

TRANSLATION

UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session of 2005/2006

April/May 2006

EBS 232/3 – Optical Mineralogy

Time : 3 hours

Please ensure that this paper consists of TEN printed pages before you proceed with the examination.

This paper contains 7 questions.

Answer any FIVE questions. If a candidate answer more than five questions, only the first five answered will be examined and awarded marks.

Answer to any question must start on a new page.

All questions must be answered in Bahasa Malaysia.

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SECTION A: Please answer the following question.

1. [a] In petrographic study, igneous rocks identified and classified with reference to various technique such as on the basis of their mineralogical composition, color index and texture. One of the techniques is known as QAPF system. Describe on how these rocks can be classified and named in accordance to QAPF system. Petrographic examination indicated sample A and B (*Table A*) of igneous rocks comprises.
- [b] Determines the type (name) of these rocks, based on the mineralogical composition information given and please indicate on QAPF diagram.
- [c] What is the equivalent rock names for A and B should their texture are fine-grained (extrusive).

Table A

<i>Mineral (%)</i>	A	B
Quartz	25	25
Total feldspar: (Plag + Alkali Feldspar)	74	70
Plagioclase (of total feldspar)	10	90
Accessory mineral (Mafic) - M	Biotite < 1	Augite < 5
Texture (grain-size)	Coarse-grained	Coarse-grained

(20 marks)

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2. [a] Mineralogist often classify minerals according to the mineral's optical properties and often find diagnostic properties or shot cuts that help speed-up mineral identification effort. With appropriate illustrations show the systematic approach and all the key properties which leading to the mineral (flow chat) identification under polarizing microscope.
- [b] Briefly discuss the following:
- (i) How the special direction of polarizer is determined?
 - (ii) How polished section of opaque mineral is prepared and subsequently examined under ore microscopy microscope?
- (20 marks)

SECTION B: Answer any THREE (3) of the following questions:

3. Briefly define or elaborates only 4 (four) of the following:
- [a] Symmetry extinction and lamellae extinction.
 - [b] Holocrystalline and holohialine (in igneous petrography).
 - [c] Matrix (sedimentary rock).
 - [d] Isotropism and Bireflactance (ore microscopy).
 - [e] Neomineralisation and metasomatism (in metamorphic rock).
- (20 marks)

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4. Attempts only **four (4)** of the following:

- [a] Apart from texture, metamorphic rocks are also identified and classified on the basis of other three major criteria such as chemical composition. State and discuss such criteria with appropriate examples of the relevant rock types.
- [b] Define *idiomorphic* and *xenomorphic* that of the term frequently used to describe crystal morphology in metamorphic rock.
- [c] Reflected pleochroism and internal reflection (in ore microscopy).
- [d] Briefly, how extinction angle of a mineral grain is determined? Please state types of extinction often displayed by anisotropic minerals.
- [e] Describe briefly the relationship of *double refraction*, *velocities* and *refractive indices* when a narrow beam of light enters an isotropic crystal.

(20 marks)

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5. Attempts only **four (4)** of the following:

- [a] In the case, where the mineral crystal is mounted on thin section such that its optic axis oriented exactly perpendicular to the microscope stage, explain the following optical properties on how this mineral will behave upon entering light polarized in an E-W direction? Use appropriate diagram to support your answer.
- (i) Anisotropism.
 - (ii) Extinction.
 - (iii) Birefringence.
- [b] State factors that often oversee the degree of retardation, Δ of the two rays that pass through anisotropic crystal in thin section? They are travel at different velocities unless there traveling parallel to optic axis.
- [c] What are the values of birefringence and phase difference for a crystal section (thickness of 30 micron) with a maximum refractive indices of 1.553, for light vibrating parallel to the c-axis and a minimum value 1.540. This is corresponding to what interference colour or order (in Michel Levy Chart)?
- [d] Describe briefly the relationship of *double refraction*, *velocities* and refractive indices when a narrow beam of plane polarized light entering an anisotropic mineral other than basal section.
- [e] Discuss briefly the two major physical components (particles) which generally made up most of the sedimentary rocks which are often known as ***detrital*** and ***non-detrital***.

(20 marks)

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6. Attempts the following:

- [a] What are the different between **uniaxial** and **biaxial mineral** and what happen to the light that travels parallel to the optic axis or perpendicular to crystal face of a crystal?
- [b] Defines 'grain packing' in petrographic study of detrital sedimentary rock.
- [c] Defines foliation in petrographical study of sedimentary rock and 'schist' in metamorphic rocks.
- [d] What are the different between interference color and interference figure of a mineral which are examined under polarizing microscope?
- [e] Determine the most possible types of the following igneous rock specimens, designated as **A** to **E**, as examined under petrographic microscope, as provided in Table B.

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Table B

Specimen	Color/texture	Composition (estimated)	Other Distinguishing features
A	Light color/coarse grained	Q=40% Plg=30% of total feldspar	Undulatory anhedral quartz surrounded by biotite and traces of muscovite.
B	Intermediate, fine-grained	Q=15% Plag. 90-100 of total feldspar (An<50%)	Dyke, zone plagioclase, numerous zone, subhedral plag. Appears in a fine-grained matrix of volcanic glass plagioclase, clinopyroxene.
C	Dark, compact and homogenous	Easily splintered into conchoidal fracture	Holohyaline
D	Dark, ultramafic, coarse-grained	M= 90-100 No essential feldspar	Consist almost entirely of inequigranular, high birefringence olivine crystal, and small amount of chlorite and opaque.
E	Dark, Coarse-grained	Q < 5% Plg = 80% of total feldspar (An>50%)	Contain high calcic plagioclase (An>50) laths with numerous occurrences of olivine and minor augite.

(20 marks)

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7. Attempts any **three (3)** of the following questions?

[a] Indicates the correct **rock types**, and grade or **facies** of the following metamorphic rock specimens, designated as **A-D**, based on the observation made on these thin sections of these specimens as given in **Table B**.

[b] Generally, what are the properties and distinguished features amongst the following sedimentary and metamorphic rocks:

- (i) Sandstone
- (ii) Conglomerate
- (iii) Limestone
- (iv) Schist

[c] Generally, state the common and distinguished optical properties or features between "quartz" and "calcite" when inspected under polarizing microscope?

Table B

Specimen	Color/texture	Mineralogy	Other Distinguishing features
A1	Light, distinct banded of segregated dark and light layer, coarse-grained	Principally quartz, plagioclase, muscovite with biotite. Contain crystals of kyanite.	Somewhat massive, Less perfect cleavage.
A2	Mica and other flaky mineral aligned themselves to form planer	Invariably characterized by a highly content of mica (muscovite) and chlorite, Minor quartz and feldspar, Anhedral garnet	A considerable occurrence of green chlorite
A3	Light-gray, Well-developed cleavage due to parallelism of mica and chlorite flakes.	Principally very fine quartz, chlorite sericite and other mica closely related to clay. Iron oxide.	Individual mica flakes are not megascopically visible. Silky sheen of coarser cleavage surface.
A4	Light color/coarse grained/rhombohedral fracture	Predominantly calcite with tiny amount of quartz and pyrite	Very high birefringence, (cause twinkling) Cleavages and twinning are common and lamellae twinning

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

- (i) Color : Yellowish white, bireflectance : not present, Anisotropy : often weakly anisotropic, Internal reflection (IR) : not present. -The most abundant sulfide occurs as euhedral cubes.
- (ii) Color, bireflectance and pleochroisme : very strong, bireflectance from brownish gray to grayish black, Anisotropy : very strong, straw yellow to brown, Internal reflection : not present.
- (iii) Color : indingo blue with violet tint to bluish white, B/P purple to violet red, A : extreme, red-orange to brownish. Copper mineral.

(20marks)

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