Transport Roads & Maritime Services

NSW GOVERNMENT

Test method T226

Petrographic examination of rock in thin section and polished thin section

OCTOBER 2012

Revision Summary

Ed/Rev Number	Clause Number	Description of Revision	Authorisation	Date
		Reformatted and Revision Summary Added	D.Dash	May 1999
		Date on Test Method Revised to Agree with Date on Revision Summary	D.Dash	Feb 2001
Ed 2/ Rev 0	All	Reformatted RMS template	J Friedrich	October 2012

Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test method T226 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T226

Petrographic examination of rock in thin section and polished thin section

1. Scope

This test method sets out the procedure for the petrographic examination of samples of rock by means of optical microscopes, to identify, describe and classify mineral and other constituents of a sample, and to determine relative amounts of any constituents of the sample which may have a bearing on the quality of the material.

2. Definition

Term	Definition
Primary Minerals	(a) Are those minerals, including certain deleterious minerals, which were deposited in the original rock-forming episode.
Deleterious Secondary Minerals	(a) Are those minerals which have been altered or restructured from Primary Minerals by weathering, thermal and chemical agents. These minerals are known to affect the material in which they are contained adversely. Deuteric minerals for the purpose of this test method are classed as Secondary Minerals. Table 1 lists the common deleterious minerals.

3. Apparatus

3.1 Apparatus for the Preparation of Specimens

(a) Rock-cutting saw with a blade at least 180 mm dia

(b) Grinding and thin-section cut-off machine with diamond impregnated lap and approximately 150 mm blade

(c) Polishing wheel with steel lap (optional)

(d) Glass plates 300 mm × 200 mm × 13 mm Glass Plates with bevelled edges.

(e) Carborundum powders 200 grit, 400 grit, 800 grit

(f) Slide warming hot plate capable of maintaining a temperature within the range of 145 to 150°C

(g) Vacuum impregnation equipment (optional)

(h) A thermostatically controlled oven with good air circulation capable of maintaining a temperature within the range of 40 to 50°C

(i) Petrological microscope for checking thin sections during their preparation

(j) Glass micro slides 76 mm x 25 mm (Standard) and 47 mm x 27 mm (Half-Slides)

(k) Microscope glass cover slips 22 mm x 22 mm and 45 mm x 22 mm cover glasses

(l) Epofix Resin or equivalent, embedding and impregnating agent

(m) Epirez Epimount, or equivalent, embedding and impregnating agent

(n) Lakeside No 70C or equivalent, thermostatic setting synthetic resin, this may be substituted for items (l) or (m) when the temperature of setting is not critical

(o) Caedax or equivalent for cementing cover slips

(p) Canada balsam

(q) Xylene

(r) Single edge razor blades, swab sticks, ethyl alcohol for thin section cleaning.

(s) Assorted fine brushes and forceps for handling glassware and specimens

(t) Diamond tip pen for recording on thin sections their identification during preparation

(u) Acid dichromate and acetone for cleaning glassware

(v) Prospector's pick

(w) 75.0 mm, 63.0 mm, 53.0 mm, 37.5 mm, 26.5 mm, 19.0 mm, 9.50 mm, 6.70 mm, 4.75 mm, 2.36 mm, 1.18 mm, 850 μm, 600 μm, 300 μm, 150 μm, and 75 μm AS sieves

(x) Cotton cloth, polishing cloth (Selvyt)

(y) Chrome oxide, polishing compound

(z) Alumina (Linde B), polishing compound

3.2 Apparatus for the Examination of Specimens

(a) A petrological (polarising) microscope - fitted with low, medium and high power objectives; transmitted and incident light capacity; measuring analyser; compensates and retardation plates; revolving vernier read stage; and a Bertrand lens system capable of being centred

(b) An interchangeable binocular phototube, with final magnifications from 40× to 1250× for use with the petrological microscope

(c) Stereoscopic microscope with objectives and eyepiece to give final magnifications from 6× to 60×

(d) Photomicrographic equipment (Optional)

(e) Point counter for the modal analysis of thin sections of mineral aggregate.

(f) Immersion oils with refractive indices of n = 1.515 and n = 1.410 to n = 1.785 in steps of 0.005 as required

(g) Sodium cobaltinitrite for K-Feldspar staining

(h) Hydrofluoric acid for K-Feldspar staining

4. Preparation of Thin Sections and Polished Thin Sections

(a) Microscopic examination of rocks and minerals requires samples to be prepared either as thin-sections for examination in transmitted light, or as polished specimens for examination in reflected light. Polished thin-sections may be prepared when it is necessary to study both transparent and opaque constituents in a single specimen

(b) If the sample is fragile or porous, as is often the case with weathered and some sedimentary rocks, first strengthen it by impregnation with plastic prior to trimming. In this case carry out the immersion procedure under vacuum

(c) Cut a parallel-faced chip (1-3 mm thick) from a massive or impregnated sample. Grind one of the parallel surfaces on 400 and 600 grit carborundum, and cement this surface to a glass slide. Use either Epofix Resin or Epirex Epimount as cements. (Canada Balsam or Lakeside 70°C may be used as a substitute)

(d) When the cement has set, clamp the slide to the vice of the slide cut-off machine and cut a chip away to leave a slide about 60-100 μm thick on the glass slide.

(e) Grind the 60-100 μm thick slide to a uniform thickness of about 30-40 μm on a diamond impregnated lap. Water is usually used as the lubricant but kerosene or ethylene gycol should be used if water-soluble or water-reactive constituents are present.

(f) Carefully thin the slice on a slow speed steel lap or glass plates using 400 grit followed by 600 grit carborundum unit a thickness of 30 μm has been attained. If necessary, final grinding with 800 grit carborundum may be carried out on plate glass. The correct polarization colours at this thickness for quartz and other minerals can be found by inspection of a Michel-Levy Chart.

(g) Attach a glass cover slip to the thin section. Smear the cover slip and glass slide with cementing agent (either Caedax or Canada Balsam) and lower this slip cement-side down onto the section and press gently to expel any bubbles. Press the slip more firmly onto the section, allow the cementing

(h) Polished thin-sections are prepared as described above except that instead of attaching a cover slip upon completion of final grinding, the exposed surface is polished by hand for examination in incident light. Polish initially with chrome oxide on a rotating lap covered with cotton cloth, followed by final polishing by hand, using Alumina (Linde B) on cotton cloth (Selvyt) stretched over plate glass

5. Procedure

(a) Describe each rock type in detail, including grain size, colour, mineralogy, modal composition, micro-texture, microstructure, and the general physical condition. Procedures for mineral identification are set out in Figure 1

(b) Record the presence of any constituents of the sample known to cause adverse effects in its proposed use

6. Calculations

Calculate the modal compositions from data obtained by the point counting procedure.

7. Reporting

7.1 Summary Report

Report the essential information required to identify the material as to its source, proposed use and hand specimen description. Nominate the type of rock from the list in Table 2.

7.2 Detailed Report

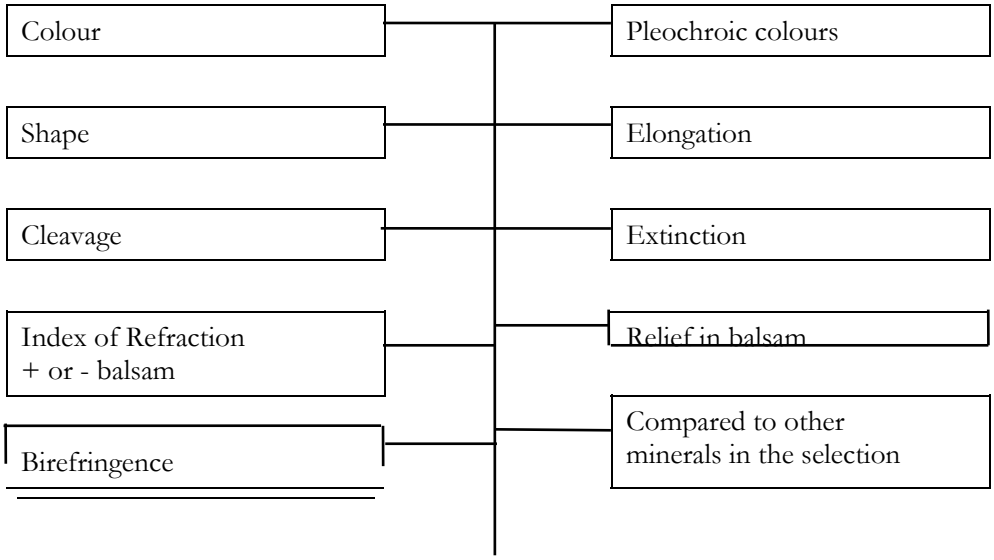
Report the composition and features of the material. Tables and photomicrographs may be used to adequately present information gained from the examination. Recommendations concerning additional petrographic, physical or geological examinations should also be included.

8. Techniques

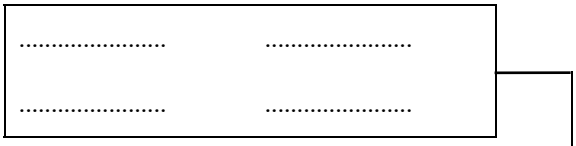
Special techniques may be required when using cements to fix the rock specimen to the glass slide. In such cases the manufacturer's instructions must be followed. Care should be taken when hot-setting cements are used with samples containing temperature reactive constituents, substitution of the cementing agent may be necessary.

Outline for Identification
(Transparent Method)

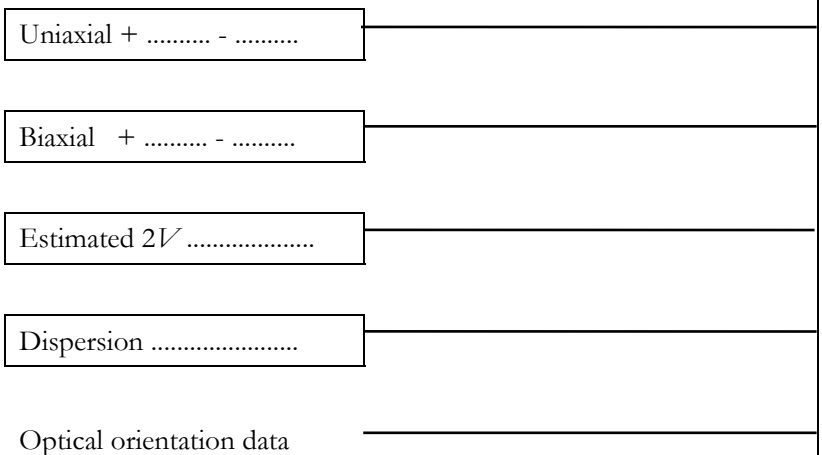
Mineral description



Mineral possibilities



Optical character



Mineral identification

Associated minerals

Conclusion

TABLE 1

Some known Deleterious Primary, Secondary and Deuteric Minerals

Montmorillonite (Smectites)	Montmorillonite Beidellite Nontronite Saponite Hectorite
Mixed-Layer Clays	Chlorite Swelling Chlorite/Vermiculite Montmorillonite
Dicalcium Silicate	
Chalcedony	
Chlorite Group	Swelling Chlorite Chlorite
Mica	Illite Glauconite Others
Kaolinite Group (Kandites)	Kaolinite Dickite Nacrite Halloysite Antigorite Chrysoltile
Vermiculites	
Zeolites	Natrolite Harmotome Chabazite Faujasite Mordenite Heulandite Groups
Iddingsite	
Oxides and Hydroxides of Iron	
Gibbsite Brucite } (Bauxite)	
Pyrite Marcasite Other Sulphides	
Carbonate Barite Fluorite Magnesite	

TABLE 2
Rock Groups

Granite	Gabbro	Quartzite
Microgranite	Dolerite	Hornfels
Rhyolite	Basalt	Arkose
Diorite	Quartz	Greywacke
Microdiorite	Breccia	Concretionary rocks
Andesite	Slate	Limestone
	(including indurated shale)	Chert
Syenite		Conglomerate
Microsyenite	Foliated Rocks	Sandstone
	(Schist, Serpentinite etc)	Siltstone
		Shale
Trachyte		Mudstone

These major rock groups, into which the majority of natural rocks fit, shall be used for classifying rock types. (The rock groups are defined in Appendix 1).

Appendix A: Petrographic examination of rock in thin section and polished thin section

A.1 Definitions of individual major groups

(i) Granite is coarse grained, igneous rock containing more than 10 percent of free quartz with much feldspar and subsidiary ferromagnesian mineral such as Hornblende. Grainsize determination is based on the average of all grains, with a minimum average grainsize diameter of 0.5 mm as the limit.

A distinction between Granites and Granodiorites is made according the nature of the feldspar, the Granites contain orthoclase or alkali feldspar as the dominant constituent whilst the Granodiorites contain an equal amount of plagioclase. However the Granodiorites are included in the Granite group.

Texture should be mainly granitic or pegmatitic.

(ii) Microgranite has a mineral constitution equivalent to the Granites, rocks have been so classified when the average grainsize diameter is less than 0.5 mm but greater than 50 μm ignoring the phenocrysts; but where the phenocrysts constitute more than 30 percent of the rock then it has been classified as Microgranite rather than Rhyolite.

This approximation amounts to an assessment of the average grainsize of all grains including phenocrysts where they are abundant.

Texture may be porphyritic or granitic.

(iii) Rhyolite has the same mineral constitution as the Granites. Separation of the Rhyolites and Microgranites is based on the upper limit of grainsize being less than 0.05 mm for an average assessed on the greater dimension of grains in the groundmass. This assessment should include all minerals and not be confined to quartz or feldspar.

Texture is typically fluidal.

(iv) Diorite has a mineral constitution with less than 10 percent quartz and the feldspar should be plagioclase dominant over coloured silicates, the latter being predominantly amphibole but excluding olivine. Grainsize as for Granite.

Texture is typically granitic.

(v) Microdiorite has a mineral constitution as for Diorites and grainsize as for Microgranites. Texture is porphyritic or granitic in most cases.

(vi) Andesite has the same mineral constitution as the Diorites whilst the distinction from Microdiorites is made on the basis of grainsize of phenocrysts in the same way as the Rhyolites and Microgranites were separated.

(vii) In Syenite the mineral constitution typically is less than 10 percent quartz with an alkali feldspar as the dominant constituent and some subsidiary ferromagnesian silicate, whilst the grainsize is the same as for the granite group (viz, more than 0.5 mm average based on the measurement of the greater diameters).

Texture is typically granitic.

(viii) In Microsyenite the mineral constitution is as for Syenite with grainsize as for Micro-granite.

Texture is typically porphyritic or granitic.

(ix) Trachyte has a mineral constitution similar to Microsyenite but is like Rhyolite in respect of grainsize. It frequently contains sodic amphibole.

Texture is typically fluidal without glass in the fabric.

(x) Gabbro as a group has 40 percent or more of ferromagnesian minerals with calcic plagioclase, the former being typically pyroxene or olivine. The distinction between Gabbro and Diorites has been made principally on the nature of the ferromagnesian silicate. Olivine is typical of Gabbro, Dolerite or Basalt; where olivine is not present the composition of the plagioclase or colour index should be considered.

Texture is typically granitic. Norites, and ultrabasic coarse grained rocks, e.g., Picrite or Peridotite would be included in this blanket group.

(xi) Dolerites are similar in mineralogy to the Gabbro group and like the Microgranites in grainsize.

Texture is typically ophitic.

Lamprophrye and Limburgite are included with the Dolerites.

(xii) The basalt group has similar mineral assemblage and colour index to Gabbro. A distinction between Dolerite and Basalt is based on grainsize and phenocrysts as in the case of Rhyolite and Microgranite.

(xiii) Quartz rock consists substantially of vein quartz.

(xiv) The Breccia group includes both the pyroclastic rocks and fault Breccia, the essential feature being particles of uneven or angular shape in a matrix of finer particles or of igneous origin. Tuffs and agglomerates are included in this group. Nevertheless differentiation has been made when naming such materials on the basis of particle size, an average of 2 mm (excluding matrix) being the maximum size for breccia whilst Tuff has a maximum grainsize of 0.1 mm.

(xv) Slate is a derivative of Shale, Mudstone, tuff or fine-grained sandstone rendered more compact by contact or regional metamorphism. It is characterized and distinguished from shale by the presence of intersection joints. It is sometimes intersected by quartz veins and generally of fissile nature, the degree of fissility depending to some extent on the original rock.

(xvi) Sheared Rocks include the Schists, gneisses and Serpentinites all of which bear obvious sheared structure.

(xvii) Schists are fine-grained, chloritic or micaceous and strongly laminated; Gneiss has an augen structure in a matrix having a grainsize of 0.2 mm average or more.

The name Serpentinite has been applied to any rock in which there is more than 10 percent of the mineral serpentine concentrated in shear planes within the rock.

(xviii) Hornfels is a fine-grained, non-schistose metamorphic rock resulting from contact metamorphism.

(xix) Quartzite is a metamorphic rock consisting principally of quartz in a matrix of finer quartz and clay mineral. Magnetite formed from limonite or haematite is taken as evidence of severe heating.

(xx) Arkose is any arenaceous rock containing irregular to rounded fragments of feldspar or soft rock.

(xxi) Greywacke is an arkose which was formed by the deposition of sediments in comparatively deep water and is generally poorly sorted.

(xxii) Concretionary rocks are chemically formed rock such as travertine or Kunkar. The distinction from Limestone is based on the more or less concretionary structure.

(xxiii) Limestone is a massive or stratified rock composed predominantly of calcium carbonate and generally containing fossils of marine organisms.

(xxiv) Chert is a very compact and homogeneous impure siliceous rock. Hardness is about 7. It may be massive or banded. It sometimes contains remains of siliceous organisms, but is sometimes formed from non-fossiliferous dense sedimentary rocks which have silicified.

Jasper is included in this group.

(xxv) Conglomerate is a cemented clastic rock containing rounded fragments corresponding in their grain sizes to gravel or pebbles.

(xxvi) Sandstone consists of cemented or otherwise compacted detrital sediments composed predominantly of quartz grains, the grades of the latter being those of sand.

(xxvii) Siltstone is a very fine-grained consolidated clastic rock composed predominantly of particles of silt grade.

(xxviii) Shale is a laminated sediment in which the constituent particles are predominantly of the clay grade.

(xxix) Mudstone is an unlaminated sedimentary rock composed substantially of consolidated clay minerals. If organic material is absent the rock is sometimes known as claystone.