

A SYSTEMATIC NOMENCLATURE FOR METAMORPHIC ROCKS

RECOMMENDATIONS BY THE SUBCOMMISSION ON THE SYSTEMATICS OF METAMORPHIC ROCKS

1. OBJECTIVES OF THE SCMR

Currently there is no generally accepted systematic scheme for metamorphic terminology. In addition, the usage of some common terms in metamorphic petrology has developed differently in different countries and a range of specialised rock names exists at local level. The SCMR aims to provide systematic schemes for terminology and to produce definitions of terms that are widely acceptable and suitable for international use.

2. SCOPE OF THE SCMR

The SCMR considered all branches of metamorphic rock terminology. This was taken to include terms which were not considered elsewhere by the CSP, specifically: (i) rocks that are quenched melts produced by, or closely associated with metamorphic processes; (ii) a number of structural terms and processes closely associated with metamorphic processes; (iii) terms dealing with the products and processes of impactites.

3. STRUCTURE OF THE SCMR

Chairman: Douglas Fettes (Edinburgh, UK), [until 2000: Rolf Schmid (Zürich, CH)]
Past and Present Members: P. Arkai (Hungary), K. Brodie (UK), I. Bryhni (Norway), E. Callegari (Italy), R.G. Coleman (USA), J.M.V. Coutinho (Brazil), E. Davis (Greece), J. Desmons (France), A. Dudek (Czech Rep.), D.J. Fettes (UK), R. Gorbatschev (Sweden), B. Harte (UK), M. Hashimoto (Japan), L.S. Hollister (USA), S. Karamata (Yugoslavia), H-G Kräutner (Germany), J.G. Liou (USA), H.-J. Meyer-Marsilius (CH), M. Peinado (Spain), N.N. Pertsev (Russia), O.M. Rosen (Russia), F.P. Sassi (Italy), S.K. Sen (India), R. Schmid (CH), Q-H Shen (China), J. Siivola (Finland), W. Smulikowski (Poland), D. Stöffler (Germany), M.E. Teruggi (Argentina), P. Thompson (USA), W. Wimmenauer (Germany), S-T Xu (China).
 The SCMR started operating in 1985. The Subcommittee consisted initially of 33 members, distributed in 11 Study Groups devoted to special topics, and a Working Group of more than 100 Earth scientists spread worldwide. The main consultative work of the Subcommittee was done by correspondence and during annual meetings. Also, questionnaires were sent to members of the Working Group to improve prepared definitions and test international acceptance. This main discussion and consultative phase of the Subcommittee's task is now complete and emphasis is currently placed on publication of its recommendations. The Subcommittee's work was conducted in English and all its recommendations and definitions are designed only for English language usage. Transposition into other languages may follow.

5. PUBLICATION OF THE RESULTS OF THE SCMR

The results to date are available on the SCMR website www.bgs.ac.uk/SCMR. It is intended that all the papers and the Glossary described above will be published in 2005 as a special volume:
 "A CLASSIFICATION OF METAMORPHIC ROCKS AND GLOSSARY OF TERMS. RECOMMENDATIONS OF THE INTERNATIONAL UNION OF GEOLOGICAL SCIENCES, SUBCOMMISSION ON THE SYSTEMATICS OF METAMORPHIC ROCKS".

6. HOW TO NAME A METAMORPHIC ROCK

The SCMR has erected a scheme for naming metamorphic rocks in a simple and systematic way. The basis of this scheme, the scheme and explanatory notes are contained in the SCMR paper 'How to name a metamorphic rock'. A synopsis of the paper is given below; the full text is available on the SCMR website: www.bgs.ac.uk/SCMR

6.1 Principles of nomenclature

A nomenclature scheme consists of defined terms and the rules governing their use. In erecting a nomenclature scheme the SCMR was guided by the following underlying principles.

- The scheme must provide a consistent set of names to cover the spectrum of rock types and their characteristics without any terminology gaps.
- The scheme must ensure that all users can apply the same criteria to give any rock or its characteristic features the same name. These names should be understood uniquely and without ambiguity.

In any system of nomenclature a number of characteristic features are used to divide rocks into groups, and the criteria for such divisions are fundamental to the terminology. The SCMR decided that the above principles would only be fulfilled if the criteria for division were defined **using only one type of characteristic feature**. At a given stage of division a set of rock groups may be recognised in a classification scheme, and these will be given **root names**. Such names form a fundamental element of the classification.

6.2 Potential bases for the classification of metamorphic rocks

The major features of metamorphic rocks that can be widely used for classification are: (a) the minerals present; (b) the structure of the rock; (c) the nature of the rock prior to metamorphism; (d) the genetic conditions of metamorphism (usually in terms of pressure and temperature, with or without deformation); (e) the chemical composition of the rock. After discussion of the above features the SCMR decided that the most comprehensive and applicable nomenclature scheme should be based on the following two principles:

- Metamorphic rocks should be named, in the first instance, on **directly observable features, preferably at the mesoscopic scale, but where necessary at the microscopic scale**.
 - Genetic terms should not be the basis of primary definition of rock types**.
- The directly observable features of all rocks are their mineral content and structure. These have been the basis for common rock names in the past and, following the principles given above, are the primary basis for the metamorphic rock names recommended by the SCMR.

6.3 Previous terminology largely based on mineralogical and structural characteristics

Compound names: Petrologists have traditionally coped with the variety and complexity of mineral content and structure, by using a series of compound hyphenated names (for example, quartz-mica schist, lawsonite-glaucophane schist) in describing metamorphic rocks. The final or root word in such names may be based on structural, mineralogical or protolith characteristics (for example, garnet-mica-quartz schist, garnet-biotite amphibolite, garnet-pyroxene metabasic rock, respectively), and the mineralogical prefixes provide further information on the mineral content of the rock being described. These compound terms have provided for great flexibility of description and naming of metamorphic rocks. However, their widespread usage has not usually been systematic. A major recommendation of the SCMR is that they are now used in a systematic way to provide a wide-ranging system of nomenclature for metamorphic rocks in general.

Specific rock names and name sets: The existing terminology for metamorphic rocks includes many names based on specific mineralogical and/or structural and/or other criteria. These have been called specific names by the SCMR. Such names usually have very precise connotations, but have not been developed in a systematic way to embrace the whole range of metamorphic rocks. Some of these specific names have become extremely widely used for common rock types (e.g.: amphibolite, quartzite, marble, slate).

As such, these specific terms are a fundamental part of metamorphic nomenclature. However, they have not been developed into a general systematic framework that embraces the whole range of metamorphic rocks. Despite this lack of systematisation, SCMR recognised that the specific terms are an integral part of metamorphic terminology.

Protolith names: Metamorphic rock names based on protoliths are very useful and largely consist of prefixing the name of the protolith with 'meta' or 'meta-'. Protolith terms may be used in compound names and carry mineralogical prefixes (for example, biotite metasandstone, garnet metabasalt) or structural prefixes or qualifiers (for example, schistose garnet metabasalt).

Protolith-based names are clearly useful in cases where the characteristics of the metamorphic rock largely reflect those of the protolith and the nature of the protolith can be fully determined, i.e. usually in rocks of low metamorphic grade and/or those that have been only weakly deformed.

It follows that, although protolith terminology for metamorphic rocks is clearly very useful and straightforward and the SCMR recommends its continued usage, it does not provide a basis for a comprehensive and mainly descriptive terminology.

6.4 Systematic classification scheme using root names

The existing terminologies referred to above clearly provide a means for naming metamorphic rocks. HOWEVER, NONE OF THEM IN THEIR PRESENT FORM PROVIDE FOR A SYSTEMATIC CLASSIFICATION OF COMMON METAMORPHIC ROCKS USING A SIMPLE SET OF CRITERIA.

In order to tackle this problem the SCMR proposes a standard procedure for applying compound hyphenated names. *Standardisation of root terms on the basis of mineral content is impossible without a huge array of root names, but standardisation on the basis of structural terms using a single criterion can be achieved quite simply.*

USE OF THE TERMS SCHIST, GNEISS AND GRANOFELS

Following widespread usage in the English language, three terms cover the principal varieties of structure found in metamorphic rocks, particularly as seen in hand specimen. These three terms are schist, gneiss and granofels. The SCMR proposes that these terms are used as the fundamental root terms in the adoption of a systematic terminology. Essentially the terms reflect the degree of fissility or schistosity shown by the rock. Their definitions derive from the recommended SCMR definition of **schistosity**. Thus, if the schistosity is well developed, the rock has a schistose structure and is termed a **schist**. If it is poorly developed, the rock has a gneissose structure and is termed a **gneiss**, and if schistosity is effectively absent the rock has a granofelsic structure and is termed a **granofels**.

GENERAL PROCEDURE FOR NAMING A ROCK USING STRUCTURAL ROOT TERMS

In the system advocated by the SCMR the above fundamental or root terms (based on structure alone) are placed at the end of compound hyphenated names of the type described previously. The considerable diversity of mineralogical names found in metamorphic rocks can then be conveyed by the use of mineral names as prefixes to the root structural term (for example, staurolite-mica-quartz schist, plagioclase-pyroxene granofels, garnet-hornblende-plagioclase gneiss), the mineral names being arranged in order of increasing modal abundance.

Thus any metamorphic rock may be named by using one of the three terms to convey the basic structure, whereas the mineralogical features are given by prefixing the structural term with the names of the appropriate mineral constituents.

6.5 Categories of rock terms: existing and proposed

In parallel with adopting the structural root name system as a comprehensive nomenclature, the SCMR has examined and categorised all the rock terms used in metamorphic nomenclature. Three classes of terms are recognised, namely: 'recommended terms', 'restricted terms' and 'unnecessary terms'. 'Recommended terms' are those that are required for an internationally applicable nomenclature; 'restricted terms' are those that are only used locally or rarely and require further definition if used; and 'unnecessary terms' are those that are no longer required. The **recommended rock names** are the basis of the SCMR nomenclature scheme. They comprise the systematic **root names** and a comprehensive range of **recommended specific names**.

THE RECOMMENDED SPECIFIC NAMES

The recommended specific names range from particularly well-established terms for common rock types (for example, amphibolite, marble, eclogite) to terms that describe relatively uncommon rock types or features of rocks (for example, arterite, mesocataclasite). The latter are most likely to be used to give information when the context of the rock is known, whereas the former names may provide concise and widely acceptable alternatives to the structural root names (for example, marble in place of calcite granofels). Examples of well-established specific names, which may commonly be given preference over the equivalent structural root names are given below. *The list is not intended to be exhaustive. It includes: Amphibolite, Greenschist, Phyllite, Calc-silicate rock, Hornfels, Quartzite, Cataclasite, Marble, Serpentinite, Eclogite, Migmatite, Skarn, Granulite, Mylonite, Slate.*

A full list of relevant specific names is given in the series of SCMR papers dealing with the various fields of metamorphism (migmatites, high P/T rocks, metacarbonate and related rocks, etc.).

4. RESULTS OF THE SCMR

The SCMR is presenting its results as a series of twelve papers and a glossary of terms.

The Papers

The first paper deals with the basis of the nomenclature scheme and sets out the scheme for naming a metamorphic rock. The subsequent papers deal with different specialist areas of metamorphic terminology. The full list is:

- HOW TO NAME A METAMORPHIC ROCK.** Schmid, Fettes, Harte, Davis Desmons, Meyer-Marsilius and Siivola.
- TYPES, GRADE, AND FACIES OF METAMORPHISM.** Smulikowski, Desmons, Harte, Sassi and Schmid.
- STRUCTURAL TERMS INCLUDING FAULT ROCKS.** Brodie, Fettes, Harte and Schmid.
- HIGH P/T METAMORPHIC ROCKS.** Desmons and Smulikowski.
- VERY-LOW GRADE TO LOW-GRADE METAMORPHIC ROCKS.** Arkai, Sassi and Desmons.
- MIGMATITES.** Wimmenauer and Bryhni.
- METACARBONATE AND RELATED ROCKS.** Rosen, Fettes and Desmons.
- AMPHIBOLITE AND GRANULITE.** Coutinho, Kräutner, Sassi, Schmid and Sen.
- METASOMATIC ROCKS.** Pertsev and Callegari.
- CONTACT METAMORPHIC ROCKS.** Callegari and Pertsev.
- IMPACTITES.** Stöffler and Grieve.
- MINERAL ABBREVIATIONS.** Schmid and Siivola.

Papers shown in **red** are now published on the website as recommendations, those in **blue** are published as provisional recommendations and are available for comment, the other papers are at an advanced stage of publication.

The Glossary

During the course of its work the SCMR has sought to compile a comprehensive glossary of all metamorphic rock terms, structural terms and a few process related terms, which will hopefully be of international usefulness. The list currently contains c.1100 entries. Each entry gives the approved SCMR definition, the first usage whenever possible, the etymology and the categorisation of the terms as 'recommended', 'restricted' or 'unnecessary'. 'Recommended terms' are those that are required for an internationally applicable nomenclature; 'restricted terms' are those that are only used locally or rarely and require further definition if used; and 'unnecessary terms' are those that are no longer required.

6.6 Option for naming a rock

The procedure for giving a systematic name to any metamorphic rock, based on structural root terms, is given in the lower part of **TABLE 1** starting with **step 3**. This process does not encompass the use of specific rock names, protolith names etc, which form an important aspect of the overall nomenclature scheme and which is outlined in the upper part of the flowchart, **starting at step 1**. Specific names (or a protolith name) may provide a more concise, refined and detailed terminology than is available with the systematic structural root terms.

It follows that a single metamorphic rock may have up to three correct names, that is, a protolith-based name, a non-systematic/specific name and a systematic/structural root name (for example, metabasalt, amphibolite, hornblende-plagioclase gneiss or limestone, marble, calcite granofels). Choosing which name to use depends partly on the information available to the user and partly on which aspect the user may wish to emphasise.

It is an underlying principle of the SCMR recommendations that the systematic nomenclature scheme exists in parallel with the use of non-systematic names (specific names, protolith-based names, etc). Guidance on when to use systematic or non-systematic names is given below.

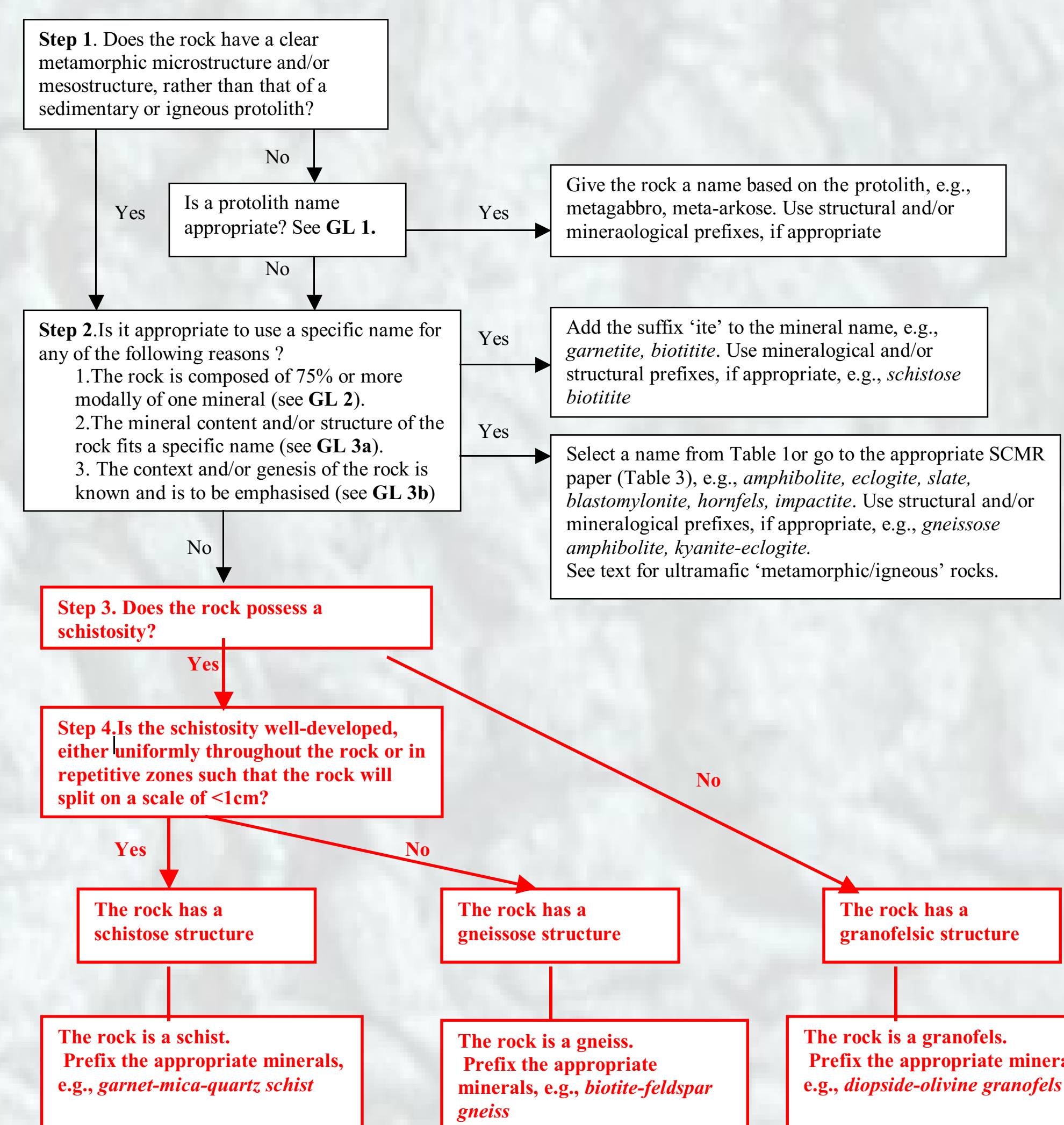


TABLE 1 - Flowchart for Naming a Metamorphic Rock. The upper part of this chart outlines the procedure for deriving a non-systematic name; the lower part outlines the procedure for deriving a systematic structural root name (use lower red part only to go directly to a structural root name)

6.7 General procedure for naming a rock set out in Table 1

The general procedure for naming a rock is given in **TABLE 1**. At several points of Table 1 the user has a choice. The first two steps relate to the use of non-systematic names (specific names, protolith-based names and names using the suffix 'ite'), the next two steps relate to the choice of the correct systematic name. At each of the first two steps the default position will direct the user towards the systematic structural root name, so that if the user is uncertain about any choice, they will always end up with a structural root name. Alternatively, of course, the user may proceed directly to the procedure for deriving the structural root name. In making the choices with the comprehensive flowchart some **simple guidelines** are given, namely:

GL 1. If the rock features are dominated by those of the protolith or the protolith may be determined by the context of the rock then a protolith name may be applied. Protolith-based names are particularly recommended for weakly metamorphosed rocks, especially where the use of a structural root name would be considered contrary to established practice. For example, with a metamorphosed sandstone the name 'biotite-quartz-feldspar metasandstone' should take precedence over 'biotite-quartz-feldspar gneiss (or granofels)'.
GL 2. If the rock contains ≈75% modally of one mineral then it may be named by adding the suffix 'ite' to the dominant mineral (for example, biotinite, epidotite, glaucophanite).

GL 3a. If the rock fits the definition of one of the well-known and commonly used specific names then it is generally appropriate to use that specific term. There is no absolute rule on when to use or not to use a specific name. However a specific name will generally take preference over the equivalent systematic/structural root name if the specific name is well established or understood or if it is more concise or gives greater detail than the systematic alternative (for example marble rather than calcite granofels, amphibolite rather than hornblende-plagioclase granofels, slate and phyllite as types of schist). Conversely, a systematic name is more appropriate where there is no specific name or a possible specific name is little used, ambiguous or poorly defined.

GL 3b. If the context or genesis (that is, the metamorphic processes forming the rock) of the rock is known and particularly if it is desirable to emphasise this or give additional or detailed information about the context or genesis of the rock then the appropriate specific name should be used (for example, nebulite, blastomylonite, tektite, hornfels). In this case the names should conform to those in the relevant SCMR paper.

The specific and protolith names may carry mineralogical and/or structural prefixes or qualifiers (for example, garnet amphibolite, schistose marble, pyroxene-biotite amphibolite with gneissose structure).

Amphibolite is a gneissose or granofelsic metamorphic rock mainly consisting of green, brown or black amphibole and plagioclase (including albite), which combined form = 75% of the rock and both of which are present as major constituents. The amphibole forms more than = 50% of the total mafic constituents and is present in an amount of = 30%. Other common minerals include quartz, clinopyroxene, garnet, epidote-group minerals, biotite, titanite and scapolite.

Metamorphism: a process involving changes in the mineral content/composition and/or microstructure of a rock, dominantly in the solid state. The process is mainly due to an adjustment of the rock to physical conditions that differ from those under which the rock originally formed and that also differ from the physical conditions normally occurring at the surface of the Earth and in the zone of diagenesis. The process may coexist with partial melting and may also involve changes in the bulk chemical composition of the rock.

Impact metamorphism is a type of metamorphism of local extent caused by the impact of a planetary body (projectile or impactor) on a planetary surface (target). It includes melting and vaporisation of the target rocks.

Epizone: zone of low-grade metamorphic rocks characterized by illite Kübler index (KI) mean values less than 0.25 °2ε CuK (after Kübler, 1967, 1968, 1984). Note: the term epizone was originally proposed by Grubenmann (1904) to indicate shallow depth of metamorphism. At present, however, this term is mainly used in the context of illite Kübler index investigations.

Migmatite: A composite silicate rock, pervasively heterogeneous on a meso- to megascopic scale. It typically consists of darker and lighter parts. The darker parts usually exhibit features of metamorphic rocks while the lighter parts are of plutonic appearance (see also leucosome, melanosome, mesosome, neosome, paleosome). Wherever minerals other than silicates and quartz are substantially involved, it should be explicitly mentioned.

Gneissose structure: A type of structure characterised by a schistosity which is either poorly developed throughout the rock or, if well developed, occurs in broadly shaped zones, such that the rock will split on a scale of more than one cm. Mineralogical or lithological layering is commonly present.

6.8 Examples of diagrams recommended for defining terms and nomenclature

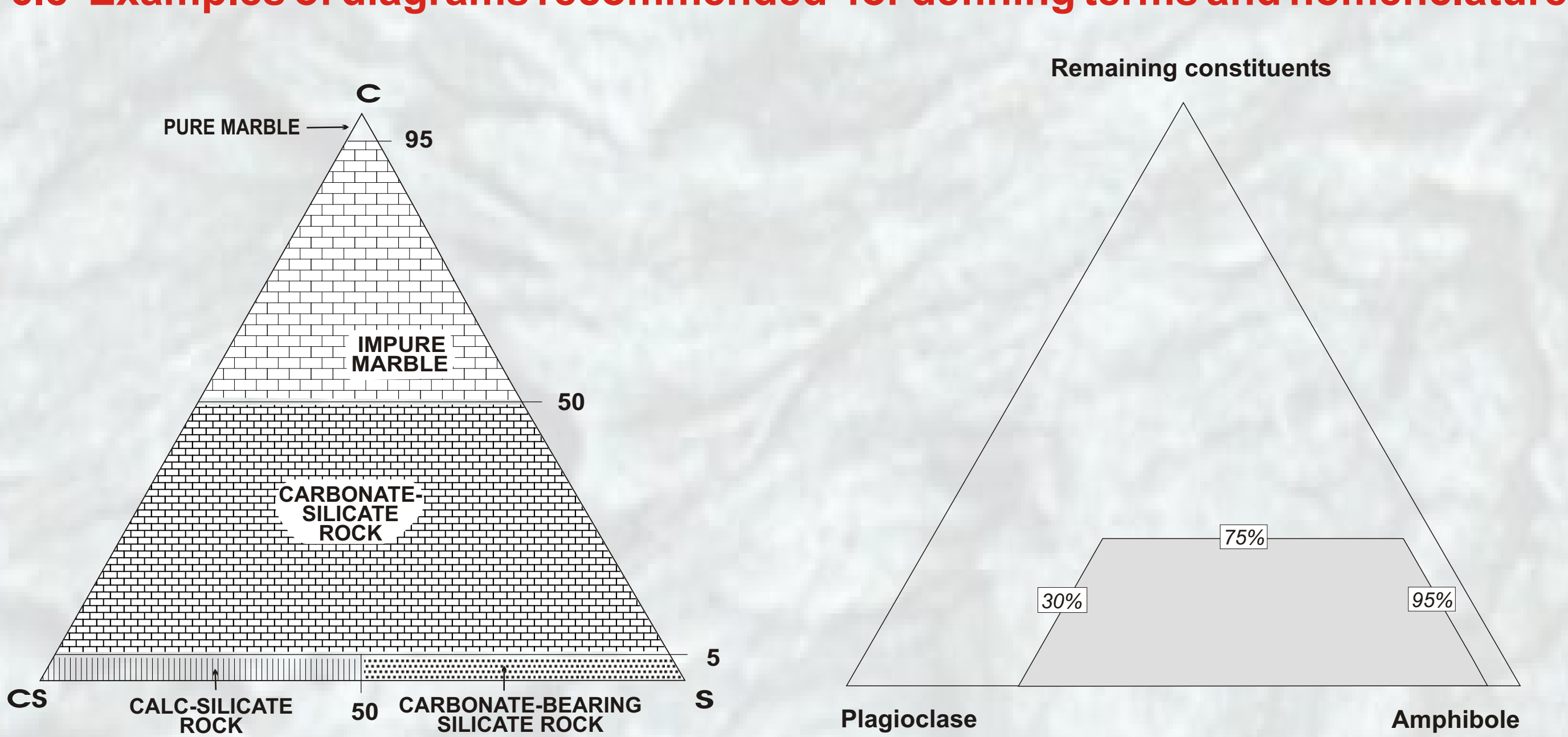


FIG. 1 - Descriptive diagram for metacarbonate and related rocks. C, Carbonate minerals: calcite, dolomite and aragonite. CS, Ca-rich silicate minerals. S, Ca-poor silicate minerals: all other silicate minerals.

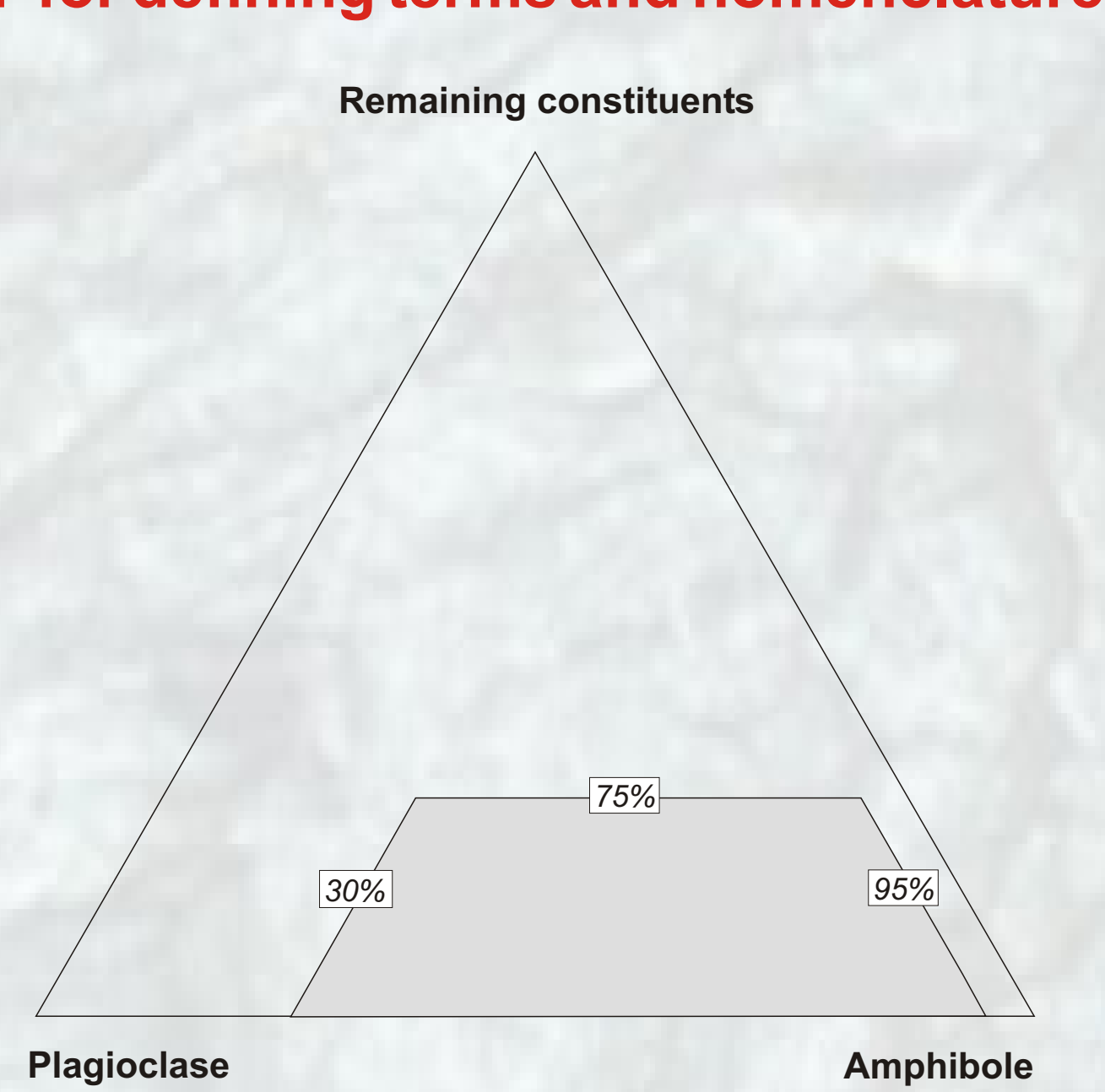


FIG. 2 - Amphibolite field according to SCMR definition.

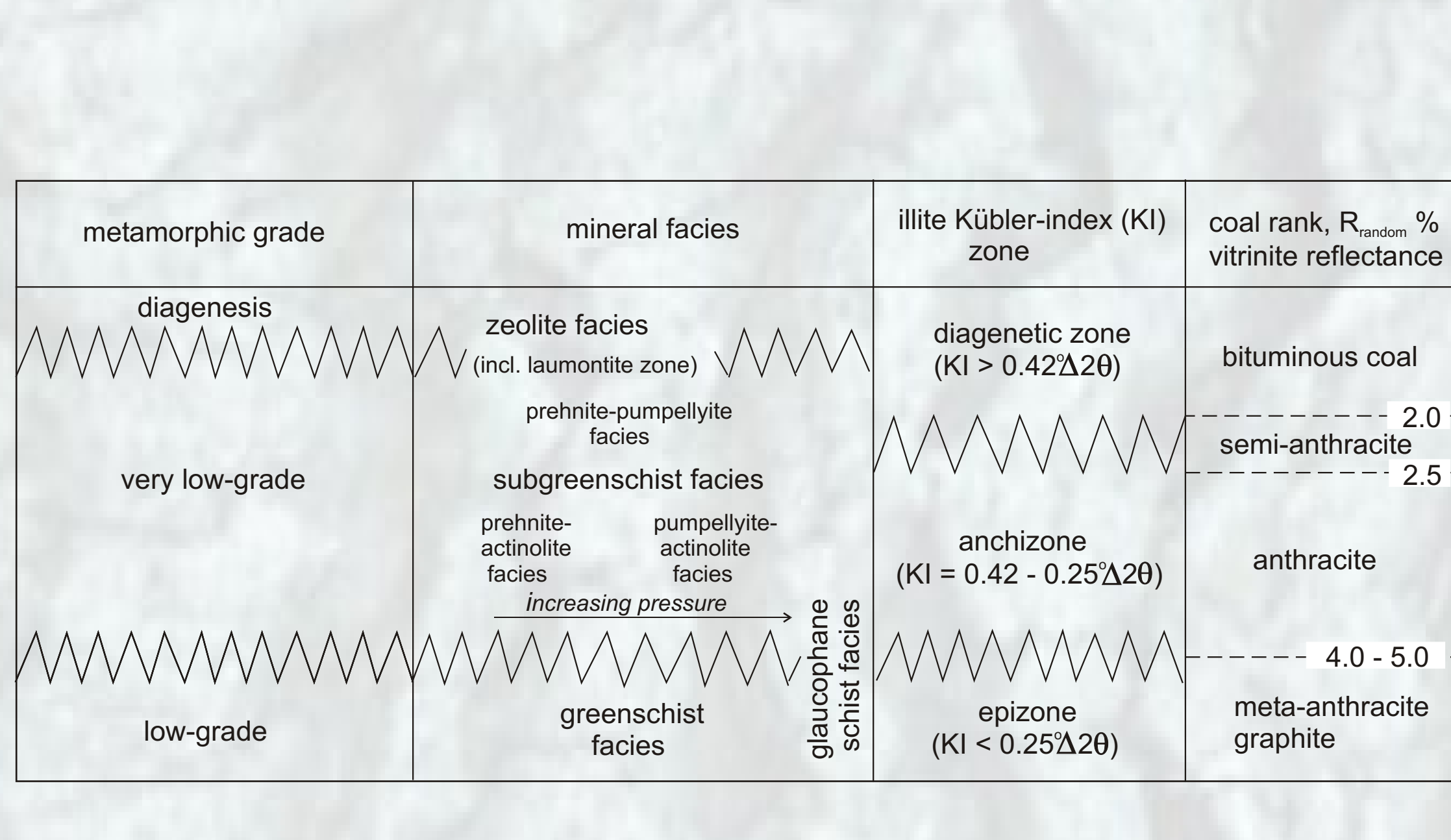


FIG. 3 - Nomenclature in very-low grade.

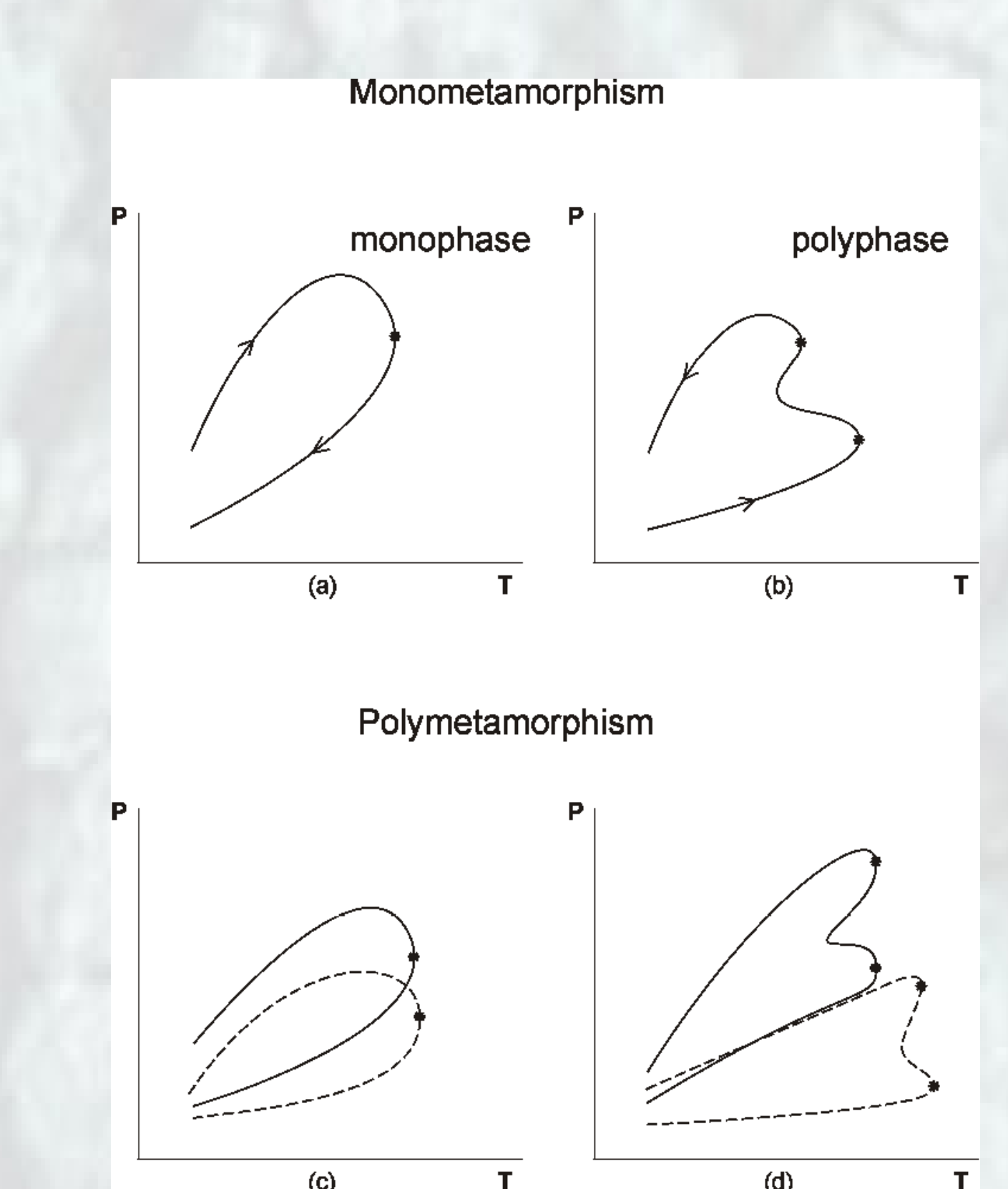


FIG. 4 - Monometamorphism and polymetamorphism.