**A systematic nomenclature for metamorphic rocks:**

# 1. HOW TO NAME A METAMORPHIC ROCK

Recommendations by the IUGS Subcommission on the Systematics of Metamorphic Rocks: Web version 1/4/04.

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## ABSTRACT

The usage of some common terms in metamorphic petrology has developed differently in different countries and a range of specialised rock names have been applied locally. The Subcommission on the Systematics of Metamorphic Rocks (SCMR) aims to provide systematic schemes for terminology and rock definitions that are widely acceptable and suitable for international use. This first paper explains the basic classification scheme for common metamorphic rocks proposed by the SCMR, and lays out the general principles which were used by the SCMR when defining terms for metamorphic rocks, their features, conditions of formation and processes. Subsequent papers discuss and present more detailed terminology for particular metamorphic rock groups and processes.

The SCMR recognises the very wide usage of some rock names (for example, amphibolite, marble, hornfels) and the existence of many name sets related to specific types of metamorphism (for example, high P/T rocks, migmatites, impactites). These names and name sets clearly must be retained but they have not developed on the basis of systematic classification. Another set of metamorphic rock names, which are commonly formed by combining mineral names with structural terms (for example, quartz-mica schist, plagioclase-pyroxene granofels) is capable of being used in a systematic way. The SCMR recommends that such compound names are systematically applied using three root names (schist, gneiss and granofels), which are defined solely by structural criteria. Such systematic names are considered particularly appropriate when specific names are unknown or uncertain. A flow chart on 'How to Name a Metamorphic Rock' enables any earth scientist to assign a name to a metamorphic rock, following this scheme. The paper further gives guidelines on the appropriate use of these systematic names and on the use of possible alternatives based on the protolith and other specific names.

## INTRODUCTION

### Constitution of the SCMR

The Subcommission on the Systematics of Metamorphic Rocks (SCMR) is a branch of the IUGS Commission on the Systematics in Petrology (CSP). It started operating in 1985, with

Rolf Schmid from ETH Zürich as chairman, succeeded by Douglas Fettes in 2001. The Subcommission 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 Subcommission was done by correspondence and during annual working 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 Subcommission's task is now complete and emphasis is currently placed on publication of its recommendations. The Subcommission'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.

## Scope of the Subcommission

The SCMR has dealt with all metamorphic rocks. This was taken to include rocks which are quenched melts produced by, or closely associated with metamorphic processes and which are not defined by the Igneous Subcommission, for example, fulgurite, tektite, buchite and pseudotachylite. In addition the SCMR has defined a number of structural terms and processes closely associated with metamorphic processes, for example fault rocks.

The SCMR also includes the systematics of impactites. Although many impactite products and processes are not strictly metamorphic it was considered expedient to deal with the group as an entity, especially as no part of the subject was being considered elsewhere by the CSP.

## 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.

a) The scheme must provide a consistent set of names to cover the spectrum of rock types and their characteristics without any terminology gaps.
b) 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 or parameters are used to divide rocks into groups or sets, and the criteria for such divisions or subdivisions are fundamental to the terminology. The SCMR decided (see Schmid and Sassi, 1986) that the above principles would only be fulfilled if the criteria for any specific division/subdivision were defined using only one type of characteristic feature. For example, the criterion for a specific division/subdivision might be a particular feature of mineral content or structure, but it should not be both mineralogical and structural. In a series of divisions/subdivisions in a classification scheme, structure and mineral content may be applied at different stages, but they should not be applied simultaneously.

At a given stage of division/subdivision a set of rock groups may be recognised in a classification scheme, and these will be given group names (or **root names** in the case of major divisions). Such names form a fundamental element of the classification. The development of a nomenclature scheme in this way follows that used for the classification of Igneous Rocks (Le Maitre et al., 1989, 2002).

One of the main purposes of this paper is to propose that a simple but comprehensive terminology for common metamorphic rocks may be based upon their division into three major groups on the basis of their structure (as seen in hand specimen). These three groups are given the structural root names**: schist, gneiss and granofels**. In conjunction with the recognition of a systematic terminology of this type, the SCMR has also recognised a number of non-systematic names or *specific names*, which may be used as alternatives to the systematic names or to impart additional information. A flowchart and guidelines for the use of the nomenclature scheme are presented below.

## POTENTIAL BASES FOR THE CLASSIFICATION OF METAMORPHIC ROCKS

Ignoring characteristics like magnetic or electrical properties or age, which can rarely be determined or even inferred without special equipment, 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.

Of the above, (a) and (b) form the most obvious major parameters for rock classification or nomenclature, and would also often be involved indirectly in classifications based on (c) and (d). Mineral content would necessarily also provide much basic information for (e) if this were not to depend on the use of specialised techniques for chemical analysis.

Examination of metamorphic rocks shows great mineralogical, structural and chemical diversity. Their chemical and mineralogical diversity results in a large part from the fact that they may be formed from any pre-existing igneous or sedimentary rock. Added to this diversity of rock types subjected to metamorphism, there are wide variations in the conditions (temperature, pressure, deformation) of metamorphism itself; and as a consequence the metamorphic rocks derived from only one igneous or sedimentary precursor may show an extensive range of mineral assemblages and structures.

In contrast to igneous rocks, the large range in mineral content and chemistry for even common metamorphic rocks means that schemes of classification cannot be devised using a small number of parameters. Thus there are no simple metamorphic equivalents to classification plots based on $SiO_2$ vs. $Na_2O+K_2O$, or quartz, feldspar, feldspathoid ratios, as used by igneous petrologists (for example, Le Maitre et al., 1989, 2002). The only way of reducing the number of mineralogical variables in metamorphic rocks to a small number of defining parameters is by inferring conditions of genesis (usually pressure-temperature conditions of formation). The metamorphic facies classification is very useful in this context, but assignment of facies to specific genetic conditions (for example, pressure and temperature) rests on a number of assumptions and is susceptible to changes in knowledge and understanding. It also essentially ignores the structure of the rocks concerned. Furthermore, although facies terms are based on mineralogical changes, they do not imply that rocks of all chemical compositions have different mineral assemblages in each facies; nor do they imply that rocks of a particular chemical composition must have constant mineral content within a particular facies. Thus a facies terminology does not match one-to-one with the actual mineral assemblages seen in all rock compositions.

Following the precedents set by most other rock classification schemes, the SCMR decided, therefore, that the most comprehensive and applicable nomenclature scheme should be based on the following two principles:

1. 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.** (Thus the definitions of rock terms recommended by the SCMR refer, as far as possible, to features observable in hand specimen, making allowance for the possible need for microscopic examination in some cases).
2. **Genetic terms should not be the basis of primary definition of rock types.** (Genetic terms are clearly useful in genetic discussions, but should only be applied to a rock if the genetic process concerned is clearly defined and criteria for its recognition are clearly stated.)

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. (In some instances this allows for the use of a protolith term in describing and defining metamorphic rocks, see below).

## PREVIOUS TERMINOLOGY LARGELY BASED ON MINERALOGICAL AND STRUCTURAL CHARACTERISTICS

### Compound names

Metamorphic petrologists have traditionally coped with the variety and complexity of mineral content and structure as outlined above, 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 an immense flexibility of description and naming of metamorphic rocks, and the SCMR has seen them as having considerable merit. However, their widespread usage has not usually been systematic, and it is a major recommendation of the SCMR that they are now used in a systematic way (see below) to provide a wide-ranging system of nomenclature for metamorphic rocks in general.

### Specific rock names and name sets.

The existing terminology for metamorphism and 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: the exception being the metamorphic facies classification that, as discussed above, is not appropriate for a descriptive rock nomenclature.

Some of these specific names have become extremely widely used for common rock types. Examples of such terms are: amphibolite (for rocks largely made of amphibole and plagioclase); quartzite (in which quartz is by far the major constituent); marble (in which carbonate minerals predominate); slate (for a fine-grained rock with a well-developed regular fissility or schistosity). Amphibolite and slate illustrate names based on mineral content or structure respectively. The terms quartzite and marble are essentially mineralogical, as indicated, but it has also often been assumed that such rocks have equigranular or granofelsic structures.

Most of the specific terms including some of those just referred to may be subdivided into groups associated with individual types of metamorphism (high P/T metamorphism, impactites, fault and shear rocks, migmatites, carbonate rocks, etc.). These groups have been called *specific name sets* by the SCMR. Many of the names comprising these sets have a connotation on the context or genesis of the rock (ultramylonite, anatexite, skarn, etc) and may provide important detail or additional information on these features.

As such these specific terms are a fundamental part of metamorphic nomenclature. However, from the viewpoint of the development of an ordered system of classification, and the guiding principles outlined above, specific terms present a major problem. Specific names have not been developed into a general systematic framework that embraces the whole range of metamorphic rocks, even though some name sets, related to types of metamorphism, may possess a systematic structure, for example, mylonites which may be subdivided into protomylonite, mesomylonite, ultramylonite, etc. Despite this lack of systematisation, it has to be recognised that the specific terms are an integral part of metamorphic terminology and that allowance for their use has to be made in any scheme of common nomenclature. This fact has been recognised by the SCMR who has attempted to produce a definitive list of specific names and has set up guidelines on their use (see below).

**Protolith names**

Metamorphic rock names based on protoliths (the lithological compositions of rocks prior to metamorphism) are very useful for two reasons:

a) Determination of the original nature of the rock is often a fundamental consideration in establishing geological history.
b) In weakly metamorphosed rocks and particularly those subjected to little deformation, the structural and mineralogical features of the protoliths may still be the principal observable features.

In the second instance, use of a protolith-based name may be a more appropriate name for a rock than one emphasising metamorphic characteristics. Meta-conglomerate (for a metamorphosed conglomerate) is an obvious example where the structure of the protolith is usually still the most obvious characteristic of the rock (and in any case the metamorphic mineral content of such a rock will change with the bulk chemical composition of each pre-existing clast).

The use of protolith names in the nomenclature of metamorphic rocks is very straightforward, and largely consists of prefixing the name of the protolith with ‘meta’ or ‘meta-‘ (for example, metagranite, metabasalt, meta-arkose). As we have seen, 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[1].

However, this is usually only the case in rocks of low metamorphic grade and/or those that have been only weakly deformed. In most metamorphic rocks applying the protolith name is not a matter of direct observation but is a matter of inference after its mineral content and microstructure have been taken into account, with the mineral content serving as a guide to bulk chemical composition when a chemical analysis is not available. Thus in many cases protolith names do not reflect the principal minerals and structural features of the rocks under observation.

It follows that although protolith terminology for metamorphic rocks is therefore clearly very useful and straightforward, and the SCMR recommends its continued usage (see below), it provides a poor basis for a comprehensive and mainly descriptive terminology.

## SYSTEMATIC CLASSIFICATION SCHEME USING ROOT NAMES

The sets of names referred to above clearly provide a means for naming metamorphic rocks and allow for flexibility in nomenclature which is necessary given the diverse structural, mineralogical and protolith (chemical) nature of metamorphic rocks as a whole. 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 suggests the adoption of a standard procedure for applying compound hyphenated names. As discussed above, this type of name allows for considerable flexibility, but the final or root term may be based on diverse criteria. Standardisation on the basis of mineral content is impossible without a huge array of root names, but standardisation on the basis of structural[2] 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 essentially cover the principal varieties of structure found in metamorphic rocks, particularly as seen in hand specimen (and therefore easily applicable). 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. It is proposed that these terms have **only a structural connotation, with no mineralogical or compositional implication**[3]. Essentially the terms

[1] It is important in using names such as metabasalt and metagabbro that the grainsize criteria of the protoliths can be fully established.

[2] For the purposes of this discussion the term 'structure' refers to mesostructure or the structure of a rock at hand specimen scale.

[3] The SCMR recognised that the use of the term 'gneiss' in a purely structural sense might prove a difficult concept to some geologists. For example, although the name has evolved in English language usage to imply a type of structure, for many non-English users the name also has mineralogical implications, in particular the presence of feldspar +/- quartz. However, the suitability of the name as a structural root term to denote a poor fissility was very attractive and the SCMR decided to accept the English language meaning . This decision was taken, after inquiry of the Working Group members, partly on the basis that the SCMR's recommendations were being made for English language use only, and also, critically, it was noted that all rocks currently considered as 'gneisses' would still be defined as such. A complementary concern was that a purely structurally based definition should not include rocks that in established practice, could never be considered as gneisses, for example finely banded metasandstones and metamudstones at low/medium metamorphic grade. Although the SCMR accepted this difficulty it was felt that in practice an adequate

reflect the degree of fissility or schistosity shown by the rock. Their definitions (see also glossary and paper 3, Table 3) derive from the recommended SCMR definition of 'schistosity', which is:

*Schistosity:* 'A preferred orientation of inequant mineral grains or grain aggregates produced by metamorphic processes. A schistosity is said to be *well developed* if inequant mineral grains or grain aggregates are present in a large amount and show a high degree of preferred orientation, either throughout the rock or in narrowly spaced repetitive zones, such that the rock will split on a scale of less than one centimetre. A schistosity is said to be *poorly developed* if inequant mineral grains or grain aggregates are present only in small amounts or show a low degree of preferred orientation or, if well developed, occur in broadly spaced zones such that the rock will split on a scale of more than one centimetre.'

Thus, according to the SCMR scheme if the schistosity in a metamorphic rock 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*.

It should be noted that each of these structural root terms will cover a number of specific rock names. Thus, the term 'schist' encompasses a number of names for rocks that possess a well-developed schistosity (as defined), for example, slate and phyllite. Similarly, the term granofels encompasses subsidiary names for rocks in which schistosity is essentially absent, for example hornfels.

*Note: see below for the relative use of systematic names and specific names*

**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 (see below).

*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.*

guideline could be provided to encourage the use of protolith based terms to cover these limited cases. These points and the evolution of the terms 'schist and gneiss' are further discussed in the paper on structural terms to which the interested reader is referred.

***This nomenclature scheme for metamorphic rocks is set out in the lower part of the flowchart in Table 1.*** A compound hyphenated name of the type recommended may always be applied and allows a systematic set of names for petrographic descriptions. The only complexity to this simple scheme is the need to allow for the use of the specific names and name sets, described above, which have widespread usage.

## 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' (Fig. 1). The **recommended rock names** are the basis of the SCMR nomenclature scheme. They comprise the systematic **root names** (Table 2) and a comprehensive range of **specific names**.

### The Recommended Specific Names

In selecting the recommended specific names and name sets for use in the nomenclature scheme the SCMR relied on the work of its various Study Groups who established and defined the specific names and sets of names for their respective subjects. The conclusions of the Study Groups are contained in a series of papers (Table 3), which form part of the products of the SCMR. These papers are an essential element of the nomenclature scheme: they contain a range of terms related to their area of study (e.g.,the specific name sets), background information on the terms as well as figures and subsidiary flowcharts.

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 listed in Table 2. The list is presented for information only; it is not intended to be exhaustive.

As discussed above the specific names may also be grouped into *specific name sets* (for example, migmatites, fault rocks) linked to individual types of metamorphism (see the SCMR papers (Table 3)).

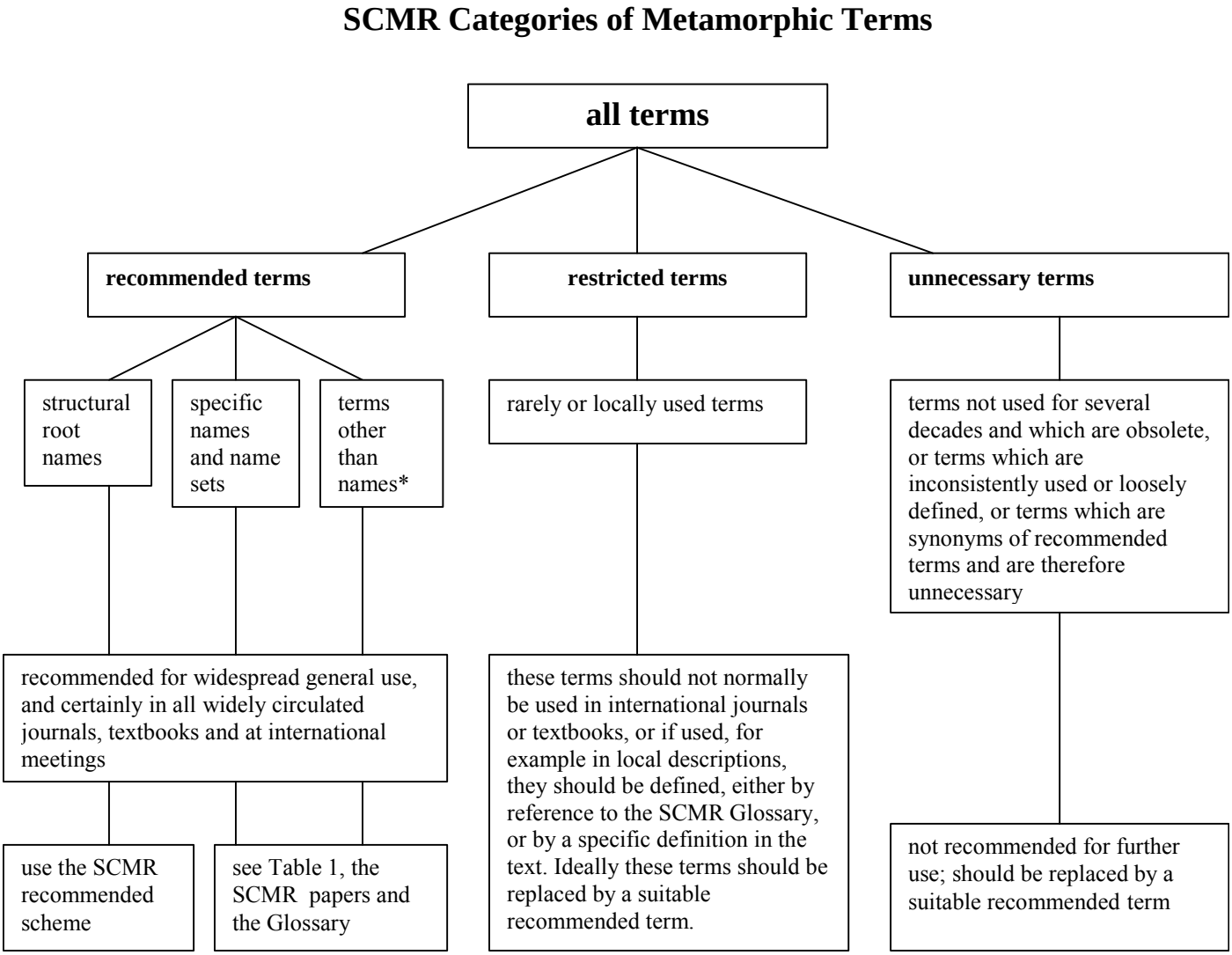


Fig. 1. Categories of rock terms as defined by the SCMR. The classification of a term as 'recommended', 'restricted', or 'unnecessary' is given in the SCMR Glossary.
* 'Terms' comprise the vocabulary of metamorphic nomenclature; 'names' are those terms used for types of rock; 'terms other than names' therefore comprises all adjectives, process terms, etc.

## THE SCMR 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'. The basis of the categorisation of the terms is given in Figure 1. That is, '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.
This glossary is nearing completion and it is hoped that it will become widely available in the near future.

## RECOMMENDED GUIDELINES FOR NAMING A ROCK

The procedure for giving a systematic name to any metamorphic rock, based on structural root terms, is given above and in the lower part of Table 1 starting with step 3. It is understood that this process does not encompass the use of specific rock names, 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 may commonly provide a more concise, refined and detailed terminology than is available with the systematic structural root terms. In addition, it is recognised that under particular circumstances a protolith name may be the most descriptive name for a metamorphic rock.

It follows from these points that a single metamorphic rock may have up to three correct names, that is, a protolith, non-systematic/specific and systematic/structural root name (for example, metabasalt, amphibolite, hornblende-plagioclase gneiss or metalimestone, 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). The systematic nomenclature scheme is intended to complement not replace the non-systematic names. Well-founded non-systematic names will generally take precedence over systematic alternatives: systematic names will generally be appropriate when there is no suitable non-systematic name or the user is unsure or unaware about the applicability of a non-systematic name. Guidance on when to use systematic or non-systematic name is given below.

### General procedure for naming a rock as set out in Table 1.

The procedure for deriving an appropriate name is presented in Table 1. At several points 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 (Table 1) some simple guidelines may be followed.

> ***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[4] 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

[4] It is generally inappropriate to apply a protolith-based name to a rock at the hand specimen scale if the rock does not clearly exhibit definitive features of the protolith.

'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, biotitite, epidotite, glaucophanite).

Note: There are several exceptions to this guideline, namely: *amphibolite*, this name refers to an amphibole + plagioclase rock (see glossary); *hornblendite* and *pyroxenite*, these names have been defined by Le Maitre et al. (1989, 2002) as igneous rocks with ≥90% modal content of hornblende and pyroxene respectively, the SCMR recognises that such rocks may occur as a result of metamorphic processes, however to avoid confusion the SCMR has adopted the same definition and modal values as Le Maitre et al. (1989, 2002); *olivinite* is reserved for igneous rocks (see Le Maitre et al., 1989, 2002) and should not be applied to metamorphic rocks. The suffix 'ite' should not be applied to *calcite*, *aragonite* or *dolomite*, because a rock consisting of 75% of any of these minerals is a marble and should be named as such (for example, calcite marble)

***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 (for example, amphibolite, eclogite, marble, slate, calc-silicate rock, see also Table 2). 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 (Table 3).

The specific and protolith names may carry mineralogical prefixes as outlined below and/or structural prefixes or qualifiers (see also Table 4) (for example, garnet amphibolite, schistose marble, pyroxene-biotite amphibolite with gneissose structure)

*Use of 'metamorphic/igneous' ultramafic terms*

Ultramafic rocks containing olivine, and/or pyroxene and/or hornblende such as peridotite, harzburgite, lherzolite, wehrlite, websterite, pyroxenite and hornblendite may be formed by either metamorphic or by igneous processes and therefore fall in the common ground between metamorphic and igneous terminology. The SCMR recommends that for these rocks the definitions, based on mineral content, as given by Le Maitre et al. (1989, 2002) should be used. These definitions are adopted without any implication to the rock genesis. When garnet or other major or minor minerals are present they should be indicated by the appropriate prefix. If it is desirable to emphasise the metamorphic nature of one of these ultramafic rocks then this should be specifically stated. Alternatively, a structural root name may be given (for example, pyroxene-olivine gneiss, ultramafic garnet-pyroxene granofels).

Note: under the SCMR rules, terms such as metaperidotite imply that the protolith was a peridotite, and do not make any statement about the present mineral content or structure of the rock.

*Use of protolith names*

When protolith names are used they should be prefixed with 'meta'. Care should be taken to ensure that the protolith name conforms to internationally applicable standards. For igneous rocks such standards are defined by Le Maitre et al. (1989, 2002). To date the IUGS has not published recommendations on the nomenclature of sedimentary rocks; users should therefore consider giving the source reference for any sedimentary protolith name. The prefix 'meta' should never be used for former metamorphic rocks (for example, meta-eclogite is not an acceptable term, see Table 4).

*Use of the terms pelite, psammite and psephite*

The terms pelite, psammite and psephite are generally considered to be sedimentary terms indicating increasing grain size and synonymous with lutite, arenite and rudite respectively, and broadly equivalent to mudstone, sandstone and conglomerate (see, for example, Tomkeieff, 1983; Bates and Jackson, 1987). However, Tyrrell (1921) proposed that the terms pelite, psammite and psephite should be used for the metamorphosed equivalents of the sedimentary rocks. Although psephite is now obsolete the terms pelite and psammite still persist locally, at least in English literature, as terms for mica-rich and quartz-feldspar-rich metamorphic rocks respectively (for example, Robertson 1999). In addition, the term (meta)pelite has developed as a broad compositional term for an alumina-rich metasedimentary rock[5] (for example, Bowes, 1989; Barker, 1990). Thus the terms pelite and psammite have a grain size connotation for sedimentary rocks and a more localised mineralogical and chemical (in the case of pelite) connotation for metamorphic rocks. Given this ambiguous usage, at least in English language literature, the SCMR recommends that the use of the terms pelite and psammite is restricted to sedimentary rocks and when an indicator of mineralogical or chemical composition in metamorphic rocks is intended the names metapelite and metapsammite may be used. However, whenever practical, the terms metamudstone and metasandstone should be given in preference.

*Use of mineral prefixes*

The following rules have been set up by the SCMR.

All the *major mineral constituents* (see Table 4) that are present in a rock should be prefixed. The prefixes should be hyphenated and placed in order of increasing abundance. For example biotite-quartz-plagioclase gneiss contains more plagioclase than quartz and more quartz than biotite. However mineral constituents whose presence is inherent in the definition of the rock, that is *'essential constituents'* (see Table 4), should not be added to the name (for example, *cf*. garnet amphibolite and hornblende-plagioclase-garnet granofels)[6]

If *minor constituents* (see Table 4) are named the form 'mineral'-bearing should be used and placed at the beginning of the name (e.g. rutile-bearing biotite-quartz-plagioclase gneiss). If

[5] Note: the sedimentary term pelite may be taken to comprise all fine-grained sediments. As such it covers a broad range of rock chemistry including for example, calcilutites. However the metamorphic term (meta)pelite has developed a more restricted meaning for rocks characteristically derived from alumina-rich sediments.

[6] It may be appropriate to name an essential constituent if the mineral name is more specific than that given in the definition, for example andesine amphibolite is an acceptable name even though plagioclase is an essential constituent of amphibolite.

more than one minor constituent is named, the names should be arranged in order of increasing modal abundance, for example, rutile-ilmenite-bearing quartz-plagioclase gneiss, where rutile is less abundant than ilmenite.

Prefixing of minor constituents is optional but is recommended for *critical mineral constituents* (see Table 4), conveying particular information on conditions of metamorphism.

If reference is made to a rock body in which some mineral constituents are not present throughout, the form ± may be used and placed at the end of the prefixes or after the rock name; in these cases no relative modal abundances are implied (for example quartz-biotite-plagioclase±muscovite schist, amphibolite±garnet).

Because the structural root terms used in the SCMR nomenclature scheme have no mineralogical implication the list of major constituents in a rock may be extensive (for example, quartz-feldspar-staurolite-kyanite-biotite gneiss). The SCMR has therefore established a list of abbreviations of mineral names (Table 3, Paper 12) for the purpose of shorter prefixing of such names. It is recommended that these abbreviations are also used for other purposes, for example, when writing chemical reactions and for inserting mineral names into figures, diagrams and tables.

*Use of other qualifiers, prefixes and suffixes*

The more general qualifiers, prefixes and suffixes recommended by the SCMR are given in Table 4. More qualifiers and descriptive terms are given in the various specialist papers.

*Use of acid, basic, metabasic, mafic, ultramafic, etc.*

The terms acid, basic, ultrabasic refer to the chemical composition of a rock (Table 4), as defined, for example, by Le Maitre et al. (1989, 2002). Normally in metamorphic rock nomenclature the terms are only used to indicate the chemical composition of the protolith. Under the SCMR rules terms such as metabasic rock or metabasite describe a rock of basic chemistry that has been metamorphosed. Such terms give no indication of the current structure or mineral content of the rock.
The terms felsic, mafic, ultramafic refer to the relative content of felsic and mafic minerals in a rock (Table 4). If it is desirable to indicate that the rock is metamorphic then constructions such as mafic metamorphic rock, ultramafic metamorphic rock should be used. Terms such as metamafitite, meta-ultramafite, etc., which are ill defined, should be avoided. The adjectival terms may be used with compound or specific names, for example, mafic quartz-feldspar-biotite schist, ultramafic garnet-pyroxene granofels.

*Retrograde or relict minerals*

For practical purposes, it is accepted that rock names that are defined on the basis of a characteristic diagnostic mineral assemblage, may also be used for rocks that contain small amounts of retrograde or relict minerals not fitting into the definition. On the other hand the presence of small amounts of retrograde or relict minerals should not be reflected by the main name even if they are critical (see Table 4).

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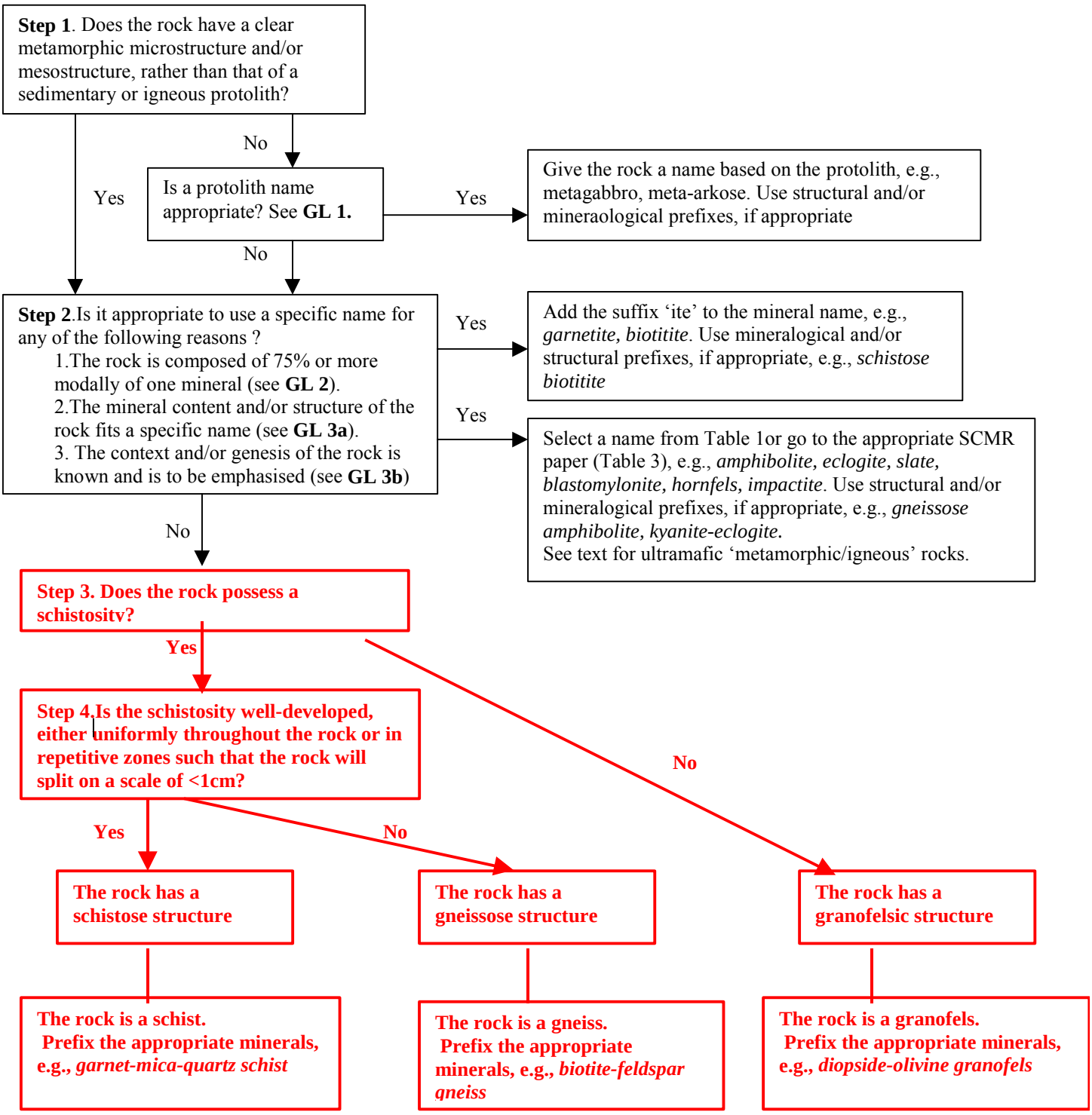


## Table 1: Flowchart for Naming a Metamorphic Rock

**he upper part of the chart outlines the procedure for deriving a non-systematic name: the lower art outlines the procedure for deriving a systematic structural root name (use lower red part only go directly to a structural root name)**

## List of some common Specific Rock Names

| | | |
|---|---|---|
| Amphibolite | Greenschist | Phyllite |
| Calc-silicate rock | Hornfels | Quartzite |
| Cataclasite | Marble | Serpentinite |
| Eclogite | Migmatite | Skarn |
| Granulite | Mylonite | Slate |

**Table 2.** List of some of the most widely used specific names recommended by the SCMR (note: this list is given for information; it is not exhaustive). Definitions are given in the SCMR glossary and the various SCMR papers. Such names would commonly be given preference over the equivalent structural root name: see text for discussion.

| No. | Title | Provisional Authorship |
|---|---|---|
| 1 | How to name a Metamorphic rock | Schmid, Fettes, Harte, Davis, Desmons, Meyer-Marsilius, Siivola |
| 2 | Types, grade and facies of metamorphism | Smulikowski, Desmons, Fettes, Harte, Sassi, Schmid |
| 3 | Structural terms, including fault rocks | Brodie, Fettes, Harte |
| 4 | High P/T metamorphic rocks | Desmons, Smulikowski |
| 5 | Very-low and low grade metamorphic rocks | Arkai, Sassi, Desmons |
| 6 | Migmatites | Wimmenauer, Bryhni |
| 7 | Metacarbonate and related rocks | Rosen, Desmons, Fettes |
| 8 | Amphibolite and Granulite | Coutinho, Krautner, Peinado, Sassi, Schmid, Sen |
| 9 | Metasomatic rocks | Pertsev, Callegari |
| 10 | Contact metamorphic rocks | Callegari, Pertsev |
| 11 | Impactites | Stoeffler, Grieve |
| 12 | Abbreviations of mineral names | Schmid, Siivola |

**Table 3: List of papers in the SCMR series 'A systematic nomenclature for metamorphic rocks'**

## Table 4. Qualifiers, Prefixes and Suffixes used and recommended by SCMR

### Grain-size terms

*phaneritic*: Individual grains visible with the unaided eye (ca. >0.lmm)
*aphanitic:* Individual grains not visible with the unaided eye (ca. <0.lmm)

The SCMR decided, following extensive discussions, not to recommend absolute grain-size values for the expressions 'coarse-grained', 'fine-grained', etc. This decision reflected the feeling in the earth-science community that there was currently no common standard for grain size classification covering igneous, metamorphic and sedimentary rocks and that, if fixed values were recommended the methods of grain-size measurement would also have to be defined. If absolute values are required then the most favoured values are: >16mm: very coarse grained, 16-4mm: coarse grained, 4-1mm: medium grained, 1-0.1mm: fine grained, 0.1- 0.01mm very fine grained, <0.01 mm: ultra-fine grained. However, if this scale is used the fact should be specifically stated.

### micro, micro-, meso, meso-, mega, mega-

Prefixes indicating that a feature is only visible at thin section (microscopic), hand specimen (mesoscopic) or outcrop or larger (megascopic) scale respectively.
When used in conjunction with a rock name, mineral type, etc., the prefix implies that the object is unusually large or small compared to the standard for such objects (e.g. megacryst = crystal of much larger size than the other crystals in a rock, microtektite = tektite with a smaller grain size compared to most other tektites).

### acid, intermediate, basic, ultrabasic

Terms defining the chemical composition of rocks based on $SiO_2$% wt. The terms have been defined for igneous rocks, by Le Maitre et al. (1989, 2002) as, acid >63%, intermediate 52-63%, basic 45-52%, and ultrabasic <45% (all $SiO_2$%wt.).

### colour terms for minerals and rocks

Because of the greater variety of mineral colours present in metamorphic rocks compared to igneous rocks, the SCMR recommends that the terms leucocratic, mesocratic and melanocratic are **not** used to indicate the colour of metamorphic rocks (cf Le Maitre et al. 1989, 2002). For metamorphic rocks the SCMR recommends that simple terms such as light-, intermediate-, dark-coloured are used. However, the SCMR recommends the use of the following colour prefixes (following Le Maitre et al., 1989, 2002):
*leuco-* : prefix indicating that a rock contains considerably less coloured minerals than would be regarded as normal for that rock type.
*mela-* : prefix indicating that a rock contains considerably more coloured minerals than would be regarded as normal for that rock type.

### %

percent by volume (if not otherwise specified).

**±, +/-**
Symbols to indicate that minerals are either present in variable, undefined quantities, or absent. For example, muscovite-biotite-quartz-plagioclase±kyanite±garnet schist (gneiss) indicates a schist (gneiss) that may contain kyanite and/or garnet.

**'..ite'**
Suffix added to a mineral name to generate a rock name where the rock contains ≥75% modally of that mineral (for example, garnetite, epidotite). The suffix should not be added to dolomite, calcite or aragonite. The following rocks are defined differently, amphibolite, hornblendite, pyroxenite, olivinite and carbonatite.

**mono-mineralic, bi-mineralic, tri-mineralic**, **….**
Expressions indicating the number of major constituents forming 95% of the rock.

**'mainly composed of'**
Used where a mineral(s) form more than 50% by volume of the rock.
**'mainly composed of mineral A and mineral B'**
Used where both minerals are present at least as major constituents (see below) and together form more than 50% of the rock.
**'mainly composed of mineral A +/- mineral B**
Used where mineral A is present at least as a major constituent and mineral B may be present in an undefined quantity or absent, both minerals together forming more than 50% of the rock.

**main constituent**
Constituent (mineral) present in modal content ≥50%.

**major constituent**
Constituent (mineral) present in modal content ≥5%

**minor constituent**
Constituent (mineral) present in modal content <5%

**essential constituent**
Constituent (mineral) that must be present in a rock in a certain minimum amount to satisfy the definition of a rock. The minimum amount is given in the definition of the rock term. May be present as major or minor constituent.

**critical constituent**, **critical phase assemblage**
Constituent (mineral) or phase assemblage indicating by its presence or absence distinctive conditions for the formation of a rock and/or a distinctive chemical composition of a rock. May be present as a major or minor constituent.

**felsic minerals**
Collective term for modal quartz, feldspar and feldspathoids.

**mafic minerals**

Collective term for modal ferromagnesian and other non-felsic minerals

**meta..., meta-**
Prefix in front of an igneous or sedimentary rock name indicating that the rock is metamorphosed (for example, metasandstone, meta-igneous). The use of the prefix does not have any implications about the present mineral content or structure of the rock, which may or may not have been substantially changed from that of the protolith. The prefix should, of course, only be applied to a protolith name when the protolith can be fully identified by some means. The prefix 'meta' should never be used for a former metamorphic rock (for example, meta-eclogite is not an acceptable term)*. If the protolith was a metamorphic rock it should be referred to in the form 'metamorphosed eclogite', or more specifically, 'amphibolitised eclogite' or 'retrogressed eclogite', etc.
*Note:if the protolith is established as an ultramafic rock which may have formed as a result of metamorphic or igneous processes, it is acceptable to use the prefix 'meta', without any implication about the genesis of the prototlith (for example, metaperidotite)

**ortho..., ortho-**
Prefix indicating, when in front of a metamorphic rock name, that the rock derived from an igneous rock (e.g. orthogneiss).

**para..., para-**
Prefix indicating, when in front of a metamorphic rock name, that the rock derived from a sedimentary rock (e.g. paragneiss).

**plagioclase**
Feldspar of the series albite-anorthite (including albite). This usage conforms to the recommendations of the IMA but differs from Le Maitre et al. (1989, 2002).