4. HIGH P/T METAMORPHIC ROCKS

Recommendations by the IUGS Subcommission on the Systematics of Metamorphic Rocks: Web version of 01.02.07

Jacqueline Desmons[1] and Witold Smulikowski[2]

[1] CNRS, Nancy, France
[2] Institute of Geological Sciences, Polish Academy of Sciences, Warsaw, Poland

Introduction

A Study Group under the leadership of J. Desmons was set up to prepare the nomenclature of rocks which form at high P/T. Questionnaires were sent to a world-wide panel of specialists on high P/T metamorphism. Twenty-two agreed to cooperate. This paper summarises the results of the discussions and presents the recommended definitions.

Eclogite (term created by Haüy in 1822)

The SCMR definition of eclogite is:

Eclogite: *Plagioclase-free metamorphic rock composed of ≥75% vol. of omphacite and garnet, both of which are present as major constituents, the amount of neither of them being higher than 75% vol.*.

In this definition omphacite is taken as defined by the IMA Subcommittee on pyroxene nomenclature (Morimoto et al., 1988; Fleitscher & Mandarino, 1991, see also Carswell, 1990), that is, based on its chemical composition, which, in the field, can be more or less inferred from its colour.

The wording of the above definition resulted from the many comments given by members of the Study Group and the Subcommission. Here follow a few explanatory comments.

1. 'Major constituent' means, according to the SCMR rules, present in an amount of ≥5% vol. This percentage may be considered to be too low, especially for omphacite. However, together with the ≥75% vol. amount of both omphacite and garnet it is intended to allow enough, and not too much, flexibility to the term.

2. Rocks in which either omphacite or garnet is present in an amount exceeding 75% vol., have to be called, according to the SCMR rules, garnet omphacitite or omphacite garnetite (see the use of the suffix '-ite' in Schmid et al., this vol.).

3. K-feldspar can be present in an eclogite (hence plagioclase-free, not feldspar-free).

4. The basaltic composition (which in the field is only inferred from the mineral composition), or basic to ultrabasic composition does not need to be mentioned because it is implicitly given by the mode specified in the definition.

5. The colour term 'melanocratic' is not used in the definition of eclogite because:

(i) The SCMR recommends that colour terms for metamorphic rocks are not used, owing to the greater variability of colours in such rocks compared to igneous rocks (Schmid et al., this vol.).

(ii) 'Melanocratic' implies a lower boundary of 65% of mafic and related minerals (Le Maitre, 1989, p. 6), which is too low an amount for eclogite.

6. Consistent with IMA recommendations (Fleischer & Mandarino, 1991), the discredited Na-pyroxene chloromelanite has now been included under omphacite and its name does not therefore appear in the definition of eclogite.

7. The SCMR defines rocks, as far as possible, on their properties visible to the eye, that is, as they appear in the field. The amount of ≥75% has, therefore, to be taken as roughly three quarters or more of the rock as seen in hand specimen. From a rapid literature survey it appears that a majority of eclogites has modal compositions consistent with the above definition. However, there is a tendency to put the stress on the presence of eclogite minerals by naming the rock eclogite even when the amount of the characteristic minerals are lower than that required by the definition. The SCMR recommends that the term eclogite should not apply to such rocks but that another rock term preceded by the adjective eclogitoid should be used (as long as both omphacite and garnet are present, see the next section).

8. The additional presence of rutile may be mentioned as complementary information, as also may the names of other possible additional phases, for example, paragonite, kyanite, etc. These minerals are not essential in the definition of eclogite. According to the SCMR rules (Schmid et al., this vol.), the following style should be used: 'kyanite-paragonite eclogite' (if both minerals are major constituents, that is, present as ≥5%, and where paragonite is more abundant than kyanite), or 'rutile-bearing eclogite' (if rutile is a minor constituent, i.e., present as ≤5%).

9. The SCMR defines rocks primarily according to their appearance in hand specimen. Therefore, classifications of eclogites based on garnet and/or whole rock chemical compositions, or with respect to their environment of formation (Smulikowski, 1964, 1972, 1989; Coleman et al., 1965; Banno, 1970) are beyond the scope of the SCMR.

10. Rocks consisting of pyrope-rich garnet and Cr-rich Ca-clinopyroxene, associated with ultrabasic rocks have been called eclogites in the past (Eskola, 1939). The correct name for these rocks is pyrope pyroxenite or pyroxene garnetite (see also griquaite below).

Names for rocks related to eclogites

There are two different groups of rocks related to eclogites. Terms referring to them should be clearly distinguished.

(i) Various suffixes have been proposed, such as '-oid', '-oidic', and '-ic', for unaltered rocks that contain omphacite and garnet, but in a smaller amount than required by the definition for eclogite, owing to an unsuitable bulk composition.

The Study Group members felt that the most appropriate use of the suffix '-ic' is to form an adjective the meaning of which is strictly related to the noun from which it derives. *Eclogitic*, thus, means: 'Applying to eclogite'. The suffix '-oid', commonly used in igneous nomenclature (Le Maitre, 1989, 2002), rather loosely means, 'in some way related to the

noun', including the noun itself (e.g. the use of granitoid, syenitoid, etc.). Accordingly, an *eclogitoid* would be a metamorphic rock containing both omphacite and garnet.

It may be noted, for example, that the Eclogitic Micaschists ('Micascisti eclogitici') of the Sesia-Lanzo zone in the Western Alps thus would remain as a formation name only. The omphacite-garnet rocks contained in this formation would encompass, on the above definitions, both 'eclogitoids' and 'eclogites'.

(ii) Eclogites that have experienced a later metamorphism and which now contain omphacite and garnet as abundant relics in an amphibolite groundmass have been given a long list of names. These include amphibolitised eclogite, post-eclogite amphibolite, retro-eclogite amphibolite, eclogitogene amphibolite, etc. Among the Study Group members, no one term emerged as favourite and acceptable to the SCMR. For the time being, it is left to each author to use their personally preferred term and to define it clearly.

Eclogite facies, eclogite facies rocks

Eclogite is also the name of a facies, which was established by Eskola (1915, 1921). As is the case with the other metamorphic facies, not all rocks metamorphosed in the eclogite facies are called eclogites (e.g. 'whiteschist', as defined below). For referring to all such rocks, the term '*eclogite-facies rocks*' or '*rocks in eclogite facies*' may be used. The definition of 'metamorphic facies' and a diagrammatic representation of metamorphic facies are given in Smulikowski et al. (this vol.).

Glaucophane schist, glaucophane-schist facies and glaucophane-schist facies rocks

According to the rules of the SCMR (Schmid et al., this vol.) the term 'glaucophane schist' is used for a schist having only one major constituent, that is, glaucophane or ferroglaucophane ('major' meaning present in a modal proportion ≥5%). If additional minerals are present, as major or minor constituents, they have to be given as prefixes, for example, jadeite-bearing glaucophane-phengite schist, epidote-glaucophane schist, etc. Therefore the definition of 'glaucophane schist' is covered by the SCMR rules and no further special definition is required.

The term, however, has evolved to cover all rocks belonging to the glaucophane-schist facies (Eskola, 1915, 1920), commonly called by the synonym 'blueschist facies' (see below). This ambiguity and such a genetic meaning are things that the SCMR wishes to avoid. Accordingly, the SCMR recommends that the term 'glaucophane schist' as a rock name is used in the manner given above, and that rocks in the glaucophane-schist facies are explicitly called *'glaucophane-schist facies rocks'*. If a more specific name than 'rocks' is required, then one of the structural root terms (schist, gneiss or granofels) may be used (Schmid et al., this vol.; Brodie et al., this vol.), and reference to the glaucophane-schist facies can be made by adding 'in glaucophane-schist facies'.

Glaucophanite

The term glaucophanite can be, or has been, used in three different ways.

1. As stated above, the SCMR proposes to use the suffix '-ite', appended to a mineral name, for metamorphic rocks which consist of ≥75% of that mineral (Schmid et al., this vol.). Following this proposal, glaucophanite is a general name for a rock consisting of ≥75% of glaucophane or ferroglaucophane. Thus, the term does not need any further definition under the SCMR rules.

2. For Japanese and Russian geologists, among others, glaucophanite is a gneiss or granofels consisting of ≥50% glaucophane.

3. The terms 'glaucophanite' and 'glaucophane schist' are used by some scientists as synonyms, in spite of the structural connotation of glaucophane schist.

The SCMR, therefore, recommends the use as defined under 1 (above).

Blueschist, blueschist facies and blueschist facies rocks

The name 'blueschist' was established by Bailey in 1962. At that time doubts had arisen whether glaucophane was only stable at elevated pressures or also under greenschist facies conditions. Jadeite and/or lawsonite were considered to be more reliable pressure indicators and the term 'blueschist' was introduced. It has now become clear that glaucophane requires a high P/T for its formation. Eskola's term glaucophane schist has, therefore, regained its former significance, but in the meantime 'blueschist' has become well entrenched both as a rock and a facies term.

As a rock name, blueschist is currently defined by the SCMR in a loose descriptive way with a recommendation to replace it by other terms if a more precise description of the rock is required. The proposed SCMR definition is as follows:

Blueschist: S*chist whose bluish colour is due to the presence of alkali amphibole*.

The definition is complemented by:

1. *More precise terms should be used wherever possible (e.g. jadeite-bearing glaucophane schist)*.

A schist containing blue amphibole is more explicitly called glaucophane schist, with the addition of the names of main or critical minerals, for example, jadeite-bearing glaucophane-phengite schist, or epidote-glaucophane schist, etc.

2. *This term is also used as a facies name and if used in this sense the facies context should be made clear (by saying 'blueschist-facies rock')*.

As stated above, the terms 'glaucophane schist facies' and 'blueschist facies' are regarded as synonyms (Smulikowski et al., this vol.).

Whiteschist (Schreyer, 1973)

Whiteschist is defined by the SCMR in a loose descriptive manner, in a similar way to blueschist:

Whiteschist: *Light-coloured schist containing kyanite and talc. More precise rock terms should be used wherever possible (e.g. kyanite-talc-phengite schist)*,

complemented with:

Whiteschists represent Al-rich rocks metamorphosed under the conditions of the eclogite facies.

Ultrahigh-pressure metamorphism

The discovery of coesite and diamond in rocks of crustal origin showed that these rocks had been subject to pressures equivalent to those found in the mantle. This increased the range of metamorphic conditions considered to have operated on crustal rocks. The additional field of metamorphism was termed ultrahigh-pressure metamorphism or UHPM for short (Coleman & Wang, 1995; Carswell & Compagnoni, 2003). The SCMR defines UHPM as follows:

Ultrahigh-pressure metamorphism: *That part of the metamorphic P-T field where pressures exceed the minimum necessary for the formation of coesite. Pressure may be sufficient for the formation of diamond*.

Ultramafic rock names

As stated in Schmid et al. (this vol.), the SCMR definitions of the ultramafic rocks, such as harzburgite, lherzolite and websterite follow those given by Le Maitre (1989, 2002), without implication to the genesis of the rock. If it is desirable to emphasise the metamorphic nature of the rock, mineral-structural root names should be used, for example, pyroxene-olivine gneiss. The presence of garnet or other accessory minerals should be indicated by the appropriate prefix.

Restricted and unnecessary rock names: Griquaite, Grospydite, Mucronite, Alkremite

The SCMR regards the three terms griquaite, grospydite and alkremite as restricted terms and mucronite as an unnecessary term (sensu Schmid et al., this vol.) Their further use in international journals is not recommended, although the restricted names may be given if qualified with a full, unambiguous definition. A widely accepted equivalent term is preferable (see below).

Griquaite (Beck, 1907): *Rock composed of pyrope-rich garnet, diopside ± orthopyroxene*. It may contain diamond. An equivalent term is, for example, orthopyroxene-bearing garnet-diopside gneiss.

Grospydite (Bobrievich et al., 1960): *Plagioclase-free rock mainly composed of Ca-Al clinopyroxene and calcic garnet together with some kyanite*. An equivalent term is, for example, kyanite-bearing grossular-clinopyroxene gneiss.

Alkremite (Ponomarenko, 1975): *Ultramafic rock composed of about 75% of spinel and pyrope-rich garnet, both of which are present in a large proportion*. An equivalent term is, for example, spinel-pyrope granofels.

Mucronite (Reinsch, 1977): *Metamorphic rock mainly composed of jadeitic clinopyroxene, garnet, phengite, quartz ± K-feldspar*. An equivalent term is, for example, jadeite-garnet-phengite schist.

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JD, These two references are in the reference list but do not appear in the paper. Is that correct??

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