Szakáll Sándor,

Mineralogy and Petrology

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Új Magyarország Fejlesztési Terv

A Műszaki Földtudományi Alapszak tananyagainak kifejlesztése a TÁMOP 4.1.2-08/1/A-2009-0033 pályázat keretében valósult meg.

IV. Classification of minerals

1. Introduction

The diversity and variety of minerals – currently 4,500 mineral species are known and around 50-60 new ones are identified by scientists annually – requires their classification. Philosophers of antiquity classified rocks in their environment according to their appearance; however, the first books on the scientific systemization of minerals are known only from the 16^{th}–18^{th} century. Numerous mineral classifications have been published since then. The first mineralogy written in Hungarian was in fact a mineral classification. ***Ferenc Benkő***'s "*Hungarian Mineralogy*" was published in Kolozsvár in 1786. Classification went through various phases with the development of mineralogy (and chemistry and physics at the same time).

2. Mineral classification based on crystal chemistry

The base of the current mineral classification is crystal chemistry, as crystal chemistry is the most important determining factor of material structure, chemical, physical and morphological properties. The framework of the system is given by the **mineral classes**, determined by simple and complex anions. To know a mineral identification of its chemical composition is not enough, as chemical composition defines the solid material only together with crystal structure.

The order of mineral classes on the basis of this is:

I. Native elements;

II. Sulphides;

III. Halogenides;

IV. Oxides and hydroxides;

V. Carbonates and nitrates;

VI. Borates;

VII. Sulphates;

VIII. Phosphates and arsenates;

IX. Silicates;

X. Organic minerals.

Further division within classes is presented by sub-classes based on crystal chemical relations. Minerals of close crystal structural relation are classified into groups. Groups usually mean isomorphic series. Finally, minerals (mineral species) are the basic units of mineral classification.

Names used for minerals

Minerals formed in nature – in contrast to compounds produced only in laboratory – are given separate names. Minerals are named after finding locations where they were found, persons or their features (chemical composition, physical specifics). Different name types in mineralogy are reviewed briefly below.

- **group name:** such category above species name that can mark several species or units of different systematic levels, mainly groups summarizing (e.g. olivine, garnet, plagioclase, alkali feldspar).
- **species name:** the base of mineral classification is the species, therefore this is the most important mineral name category. Species name is the valid scientific name of the mineral species accepted by the authoritative committee of the International Mineralogical Association (IMA).
- **variation name:** lower category than species name used for versions differing on the basis of a certain characteristic of a mineral species (e.g. colour, specific shape). Several variation names may occur within a species name. For example red and blue coloured versions of the basically colourless corundum are ruby and sapphire respectively, while among the numerous shape versions of quartz we can find the sceptre shaped sceptre quartz or the thin bars

of pin quartz. Chemically differing versions of a species have to be indicated not by a separate name but by an attribute indicating the chemical difference. Formerly these were frequently called by separate names like manganese containing calcite or manganese containing siderite.

- **popular names:** names originating primarily from the mining-smelting phrases of the late Middle Ages and modern age and suggesting the metal content or characteristic physical properties (e.g. calc-spar, heavy spar) of the mineral are classified here. In Hungary they are known mainly in their Hungarian form, translated from the original German.
- **field names:** it frequently occurs that the exact mineral species or mixture of species of material found in the field cannot be decided by the naked eye or by a routine analysis; however, we know which mineral species can occur like that or what mixture of what minerals are likely to compose our sample. In this way possibilities are reduced significantly. Such names can be used – prior to more detailed analyses – however, we have to know our limits (e.g., brown ironstone, manganomelane, asbestos, mountain leather).

Factors of describing minerals

In addition to the classification units, longer and shorter description is given highlighting characteristics for the given unit, with special regard to crystalline structures. Minerals to be presented are generally distributed in the Earth’s crust, thus they are significant from petrological-geological points of view, or their importance is great regarding both economic and environmental distribution. Descriptions follow the following structure.

Mineral name: official name of the mineral. Writing style of mineral names. Writing of mineral names according to the correct writing laws.

Chemical composition: crystal chemical writing is reflected by formulae in which atoms or ions filling the same position replacing each other are joined by two brackets. It is important to bear in mind that formulae are chemical formulae related to the ideal chemical composition.

Crystallographic, morphologic conditions: first we give the crystal system to which our mineral belongs based on its symmetries. Minerals – as known – may appear in the *form* of *monocrystals*. In this case they can be idiomorphic characteristic to their symmetry in relation to their inner crystal structure or independent from them, *hypidiomorphic, xenomorphic*. In the case of idiomorphic shape *one* form or *several crystal forms* can border the crystals. In the latter case *combination* appears. For every mineral 3D animations related to crystal forms or combinations are shown. Animations where different forms have different colours make the identification of crystal sheets belonging together easy, while animations where gyres and symmetry planes are indicated make the study of symmetry easy.

Twin crystals can be formed by the growing together of two or more monocrystals. There are mineral species in which twin formation is especially characteristic and these are always noted. Minerals, however, are more frequently not in the form of separate monocrystals but compact or loose crystal agglomerates (polycrystalline agglomerates). The shape of a crystal agglomerate is characteristic not of the monocrystals forming them but of the conditions of formation. (Rocks are polycrystalline materials but they are composed of not one but generally several mineral crystals.) Photos in which these characteristics can be clearly detected can be found for both monocrystals and characteristic polycrystals.

Physical properties:

Hardness (K) is given on the Mohs scale that is based on scratching.

Direction and quality of *cleavage* are related strongly to crystal structure. *Fracture* is also mentioned with cleavage.

Density (S) of a mineral is described in g/cm^3.

Descriptions always include macroscopically visible *optical specifics* (colour, streak colour, lustre, transparency). Occasionally the lustre of crystal agglomerates can be a characteristic data as well, in that case these are also given.

Other physical characteristics (mechanical, magnetic, electric, heat specifics and radioactivity and luminescence) are mentioned if they are regarded to be important in identifying the mineral.

Chemical characteristics: data related to element replacement are presented primarily.

Geological conditions of formation, distribution: the most important types of formation for the given minerals should be provided, indicating the geological-petrologic framework in the sequence of igneous, metamorphic and sedimentary mineral formation. Closely related to this, the localities in which the minerals can be found in Hungary, the Carpathian belt, occasionally in Europe or in other continents are mentioned. (These latter ones only in the case of species less widespread in Hungary.) It is important to note that a part of the listed localities are not actively mined any more, however, they supplied important samples considering mineralogy while at other, currently active localities the minerals can be still found even today.

Mineral association: the most frequently associated minerals of the given mineral are listed here. Knowing them makes their recognition and the determination of formation types easier.

Industrial utilization: application purposes of the mineral are referred to briefly. Fields of application known for centuries are highlighted.

Environmental effect: mentioned for minerals that have any known negative environmental effects.