

THE IMA–CNMNC DOMINANT-CONSTITUENT RULE REVISITED AND EXTENDED

The criteria for the definition of a new mineral species currently used by the Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (IMA) involve what should now be called the **rule of the dominant constituent**. The term ‘constituent’ may designate atoms (cations or anions), molecular groups, or vacancies. According to the rule, a mineral is a distinct species if the set of dominant constituents at the sites in the crystal structure is distinct from that of any other mineral with the same structural arrangement. Nickel (1992) called this rule for the sake of brevity the **50% rule**, a name which unfortunately is a source of confusion as this name can of course only be applied in binary systems.

The current dominant-constituent rule is applied in most approved new-mineral proposals. On the one hand, this rule has sometimes been applied rigorously, thus leading to some proliferation of new mineral species as, for example, in the complex labuntsovite and eudialyte groups. However, on the other hand, besides the well-known problems in the nomenclature system in the complex amphibole group, new nomenclature systems for minerals of the arrojadite and epidote groups have recently been approved by the CNMNC, but these systems do not follow the current definition of the dominant-constituent rule. For this reason, Hatert and Burke (2008) submitted a proposal to clarify, revise and extend the dominant-constituent rule, taking into account the recent problems encumbering or prohibiting a strict application of the rule.

The Dominant-Constituent Rule

In solid-solution series which involve mutual substitution of only two kinds of atoms, two different mineral names are required for each compositional range from the end members to the 50 mol% mark. When more than two kinds of homovalent atoms occur on a single crystallographic site, the predominant atom has to be considered for defining the mineral species. Consequently, the 50% mark is not applicable any more, and instead the limits become 33.3% (3 atoms), 25% (4 atoms) or 20% (5 atoms) in the dominant-constituent rule.

Valency-Imposed Double-Site Occupancy

Single-site heterovalent substitutions lead to end members with (disordered) sites occupied by two constituents, imposed by the differences in valency of the two constituents: this is **valency-imposed double-site occupancy**. An example is given by the substitution $\text{Fe}^{2+} \rightarrow 0.5 \text{Li}^{1+} + 0.5 \text{Al}^{3+}$ on the Y sites of the tourmaline mineral schorl, $\text{NaFe}^{2+}_3\text{Al}_6(\text{Si}_6\text{O}_{18})(\text{BO}_3)_3(\text{OH})_4$, which leads to the end member elbaite, $\text{Na}(\text{Li}_{1.5}\text{Al}_{1.5})\text{Al}_6(\text{Si}_6\text{O}_{18})(\text{BO}_3)_3(\text{OH})_4$.

Coupled heterovalent substitutions on two sites also lead to end members with **valency-imposed double-site occupancy** when there is a disparity in the multiplicity of these two sites. For example, the substitution $\square_A + \text{Ca}^{2+}_B \rightarrow \text{Na}^{1+}_A + \text{Na}^{1+}_B$ in the amphibole mineral tremolite, $\square\text{Ca}_2\text{Mg}_5(\text{Si}_8\text{O}_{22})(\text{OH})_2$, leads to a valency-imposed double occupancy of the B site in the end member richterite, $\text{Na}(\text{CaNa})\text{Mg}_5(\text{Si}_8\text{O}_{22})(\text{OH})_2$, because there are two atoms on the B site, but only one on the A site.

The Dominant-Valency Rule

Coupled heterovalent substitutions, on a single site or on two sites, become more complex when an additional homovalent substitution takes place. This nomenclatural problem can be solved by considering the elements of the homovalent substitution as a whole, so that the group of cations with the same valency are still dominant. Consequently, species with such coupled heterovalent/homovalent substitutions must be defined by the most abundant amongst the cations with the same valency state. This rule is called the **dominant-valency rule**, and is necessary to preserve charge balance in any end member formula. **This rule is thus an extension of the current dominant-constituent rule, by considering a group of atoms with the same valency state as a single constituent.**

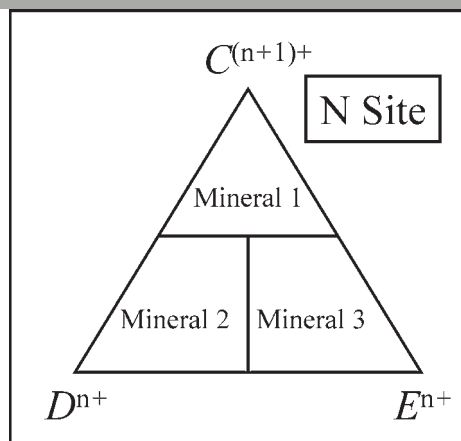


FIGURE 1 Ternary diagram showing the boundaries between mineral species when coupled heterovalent/homovalent substitutions are involved. These boundaries result from an application of the dominant-valency rule.

An important implication of this valency rule becomes evident when analyses of such minerals are plotted in a ternary diagram. As shown in **FIGURE 1**, the usual boundaries crossing at the centre of the diagram (33.3% of each component) are significantly displaced, and atom C needs dominance over the group (D + E) on the N site to allow the definition of a new species. More complex examples of minerals for which this dominant-valency rule has to be applied have recently been provided by Cámara et al. (2006) and Chopin et al. (2006) in the arrojadite group and by Armbruster et al. (2006) in the epidote group.

Grouping of Crystallographic Sites

It is frequently observed that a group of similar cations or anions can occupy more than one crystallographically distinct site. Such sites, with similar crystal-chemical roles, may be considered as a whole for nomenclature proposals. For example, the olivine structure has two octahedral sites, M1 and M2, which in the forsterite–fayalite series are occupied by Mg and Fe^{2+} , in a not completely disordered way. However, recognition of only two species is deemed to be appropriate as the two intermediate compositions and their implied arrangements are not approached in nature.

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