

2013-04: Mineralogical and chemical characteristics of alterations in high-grade metamorphic rocks – phase I

The mass balance calculation is the most commonly used method for recognising hydrothermally altered rocks and for assessing the intensity of the alteration. However, this method requires the identification of a less altered rock belonging to the same unit (single precursor mass balance; Grant, 1986), or the identification of a rock with magmatic origin (modelled precursor mass balance; Trépanier, 2008). However, in high-grade metamorphic terrains, recognising the nature of protoliths is not always easy.

The development of a new tool in 2011 (Trépanier, 2011), the CONSOREM norm, proved to be more suited to the study of rocks whose mineralogy was altered by the passage of volatiles. It is a complement to the mass balance method and also has the advantage of not needing trace element analyses, such as Zr, Nb, Y and others. It can also be used with every rock type whatever the nature of their protoliths.

However, the CONSOREM norm can only be used with low-grade metamorphic rocks (lower greenschist, upper greenschist, and lower amphibolite facies). The objective of this project is to extend the principle of the CONSOREM norm calculation to the highest-grade rocks by developing the HautGrade norm for 17 new facies (Figure 1). Just like the CONSOREM norm, the new norm is available in the LithoModeleur software, version 3.6.0 – software that already comprises several published lithogeochemical tools or those developed at CONSOREM.

The HautGrade norm calculates accessory minerals, Fe-Ti oxides, carbonates, sulphides and silicates. Fe-Ti oxide calculations are carried out using measured Fe_2O_3 or Fe_2O_3 estimated from $\text{FeO}_{\text{total}}$; carbonates are calculated using measured CO_2 or normative CO_2 estimated from loss on ignition; sulphides are calculated from measured S or from the analysed metals if S is not available. The greatest effort, however, was focused on the silicates, where a complex sequence of calculations was implemented (Figure 1). Therefore, the HautGrade norm is more adapted to silicate-rich rather than to sulphide-rich rocks.

Several preliminary tests carried out on published data show that normative calculations reproduce well the mineralogy described from a variety of rock types in a high-grade context. Application of these calculations for the study of altered rocks will be addressed in the second phase of this project as part of the 2014-2015 program.

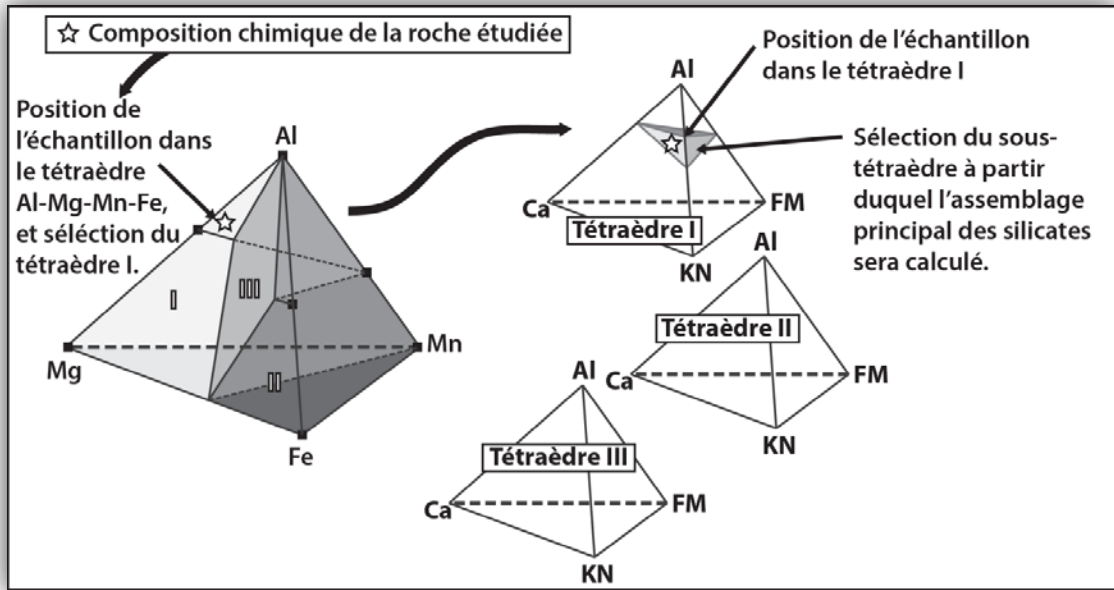


Figure 1. Diagram showing the metamorphic tetrahedra used in normative calculations to determine the main silicate paragenesis.

Project 2013-04: Summary	
Objectives	<ul style="list-style-type: none"> To develop a tool to facilitate the recognition of hydrothermally altered rocks that were then metamorphosed under high-grade metamorphic conditions.
Results and Innovations	<ul style="list-style-type: none"> Development of the HautGrade norm and integration of the calculation into CONSOREM's LithoModeleur software. Testing of the norm using published data. Establishment of normative calculations for high-grade metamorphic rocks. Establishment of a method that can be used with altered or unaltered rocks with either magmatic or sedimentary protoliths.