

Hydrothermal alteration studies  
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Preface

*The following three articles are the result of a thematic research project financed by the PIRSEM (France). The specific programme whose major results are reported here, was centred on the types of alteration mechanism responsible for hydrothermal effects in silicate rocks and mineral assemblages. Such alterations are usually associated with the late stages of acidic magmatism. Initially, a petrographic and mineralogical study was made on a hydrothermal alteration produced on the island of St Martin, in the Caribbean, reported in detail by Beaufort et al. (The fossil hydrothermal system of Saint Martin: Geology and lateral distribution of alterations, J. Volc. Geotherm. Res., 40, 219-243, 1990). This example was chosen for the relative simplicity of development in the stages of alteration which were seen to be initiated from vein type alteration. In the PIRSEM programme we have used it as a general case for hydrothermal alteration, which may or may not be totally justified. Nevertheless, the studies which follow seem to explain the observations of alteration made on the island of St Martin. There, it is clear that alteration can occur in two modes, one of a massive, pervasive type (generally called propylitic), an other which is initiated from veins and which may become apparently pervasive also. Transfer of material (into and out of the local rock system) is the major means of mineral transformation in the vein alteration mode whereas the propylitic alteration seems to be more isochemical excepting volatile and aqueous phases. There is a clear spatial relationship between the mineral assemblage produced and the water/rock interaction observed which is obviously governed by temperature and fluid availability. Superposition of alteration, i.e. veins cutting massive or locally generalised alteration, can be observed on St Martin. This type of phenomenon is very common in other hydrothermally altered areas which has led to confusion in the past concerning the sequence of events and the relative importance of the processes. For example, alteration halos of vein origin often can crosscut another mineral assemblage, giving a complex assemblage as seen under the petrographic microscope, or more so using X-ray diffraction identification methods. Often, the small differences in the mineral assemblages can lead to a diagnostic of similarity when in reality the superposition can be the result of rather different chemical and thermal conditions.*

*Following the observations of Beaufort et al. (1990) we have tried to elucidate the causes of mineral genesis and transformation using detailed petrographic observation and chemical equilibrium calculations. Use has been made of SEM observations to determine the presence of dissolution features, of micro-X-ray diffraction to identify new phases as they form in specific sites, and of the EQ6 and EQ3 codes to identify the phases stable at equilibrium under the alteration conditions. The objective has been to relate the spatial features of alteration to temperature variations (as reported by Beaufort et al., 1990) and to chemical transfer observed via the alteration assemblages. In this manner one can interpret the nature and importance of phase changes as a function of the distance from the altering agent (fluids in the vein).*

*Two types of alteration have been considered. The first is that of global rock recrystallization induced by the interaction of the initial plutonic rock with volatiles dominated by aqueous fluids. This is the propylitic alteration process or mineral facies which leads to pervasive alteration. In this study, the effect of rock and fluid composition was modelled, using the EQ6/EQ3 code for different temperatures in an attempt to duplicate the mineral parageneses observed in many hydrothermal alteration*