

Large chemical mass-transfer and volume change during skarn formation in the Quérigut massif (Eastern Pyrénées, France)

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Chemically reactive fluid flows play an important role during contact metamorphism and, especially, during skarn development and associated mineralogical, chemical and isotopic evolutions. In this study, we focus on the understanding of chemical-mass transfer and fluid flow at the contact between metacarbonate septa entirely enclosed inside granitic rocks from the Quérigut massif (Eastern Pyrénées, France). Important chemical mass transfers have been quantified during contact metamorphism.

Mass-balance and stable isotopic results show that this system behaved like a closed system with respect to external fluids and chemical elements input, although important CaO and CO₂ output occurred. The δ¹⁸O values define sigmoid profiles typical of diffusion processes between the two contrasted chemical rocks: δ¹⁸O values progressively evolve from 24 ‰ to 14.8 ‰ in metacarbonates and from 9.2 ‰ to 13.4 ‰ in granitic rocks. The evolution of δ¹³C calcite values is only explained by dissolution and decarbonation processes.

In granitic rocks, chemical mass transfers are restricted to a leucocrate feldspathic zone (Kfs- and Qtz-rich with Augite apparition), developed on few cm to dm close to the contact. This endoskarn is characterized by a significant increase of K₂O, Rb, Y, Ce, Nb and Ba contents. The most probable origin for these mobile elements is the granitic intrusion itself.

In metacarbonate septa, chemical mass transfers are observed up to two metres away from the contact zone. The mineralogical evolution is characterized by the Di apparition from few meters from the contact and a mm to cm-sized wide exoskarn zone with a Di, Grt, Ves, Wo and Czo metamorphic assemblage. A strong and progressive decrease of the CaO, Sr and CO₂ contents (up to 80 to 90 %) is correlated with a decrease of modal calcite content. The others chemical elements, like SiO₂, Al₂O₃, initially present in the limestone, behave like immobile elements and are therefore passively concentrated. This geochemical evolution is achieved by: (i) decarbonation reactions with the formation of calc-silicate minerals and release of CO₂ and (ii) pressure-solution reactions responsible for large calcite loss. A large volume decrease results from these calcite loss processes: up to 80 % of the initial carbonate volume is lost at the contact with granitic intrusions. Thus, mass transfers are characterized by the lack of large chemical exchanges with the granitic protolith.

Furthermore, the important CO₂ release and volume loss during skarn formation is of importance concerning the mass balance budget of CO₂-rich fluid circulations above magmatic intrusions and related economic ore deposit processes.