Mineral versus chemical zoning in the high temperature, high CO_2 activity contact zone from Măgureaua Vaţei, Apuseni Mountains, Romania

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A shallow-level monzodioritic to quartz-monzodioritic pluton of Upper Cretaceous age caused extensive contact metamorphism of Tithonic - Kimmeridgian reef limestones at Măgureaua Vaţei (Metaliferi Massif, Apuseni Mountains, Romania). The preserved peak metamorphic assemblage includes gehlenite, monticellite, wollastonite-2M, Ti-poor calcic garnet, and Ca-Tschermak diopside. An obvious periplutonic zoning could be observed. From the monzodioritic body to the calcitic marble, this zoning can be described as: monzodiorite / agpaitic syenite-like inner endoskarn / gehlenite + (Al-poor) diopside + monticellite ± wollastonite / gehlenite + wollastonite + Ti-poor garnet + perovskite (outer endoskarn) / wollastonite + vesuvianite + titanian garnet ± perovskite (inner exoskarn) / wollastonite + Al-rich diopside + grossular (outer exoskarn) / calcitic marble. The peak metamorphic assemblage contains gehlenite (in which the solid solution toward åkermanite vary from Ak 33.64 to Ak 38.13 - mean Ak 36.22), diopside (which up to 11.15 mol.% Ca-Tschermak molecule), wollastonite-2M, perovskite, monticellite. Three generations of Ca garnets could be identified, as follows: a first generation consist in Ti-poor grossular (Grs 54.22 – 580.49 mol.%) in equilibrium with gehlenite, a second one is a Ti-rich grossular (Grs 50.44 – 55.39 mol.% with up to 19.41 mol.% morimotoite in solid solution) and a third generation consists in titanian andradite with up to 28.39 mol.% morimotoite in solid solution. A subsequent paragenesis corresponds to an early hydrothermal stage and produced retrogression of the first stage and a paragenesis including vesuvianite, hydroxylellestadite (or rather Si-substituted apatite), clinochlore, hibschite. A second, late hydrothermal event induced the formation of lizardite, chrysotile, kaolinite, thomsonite-Ca, thaumasite, okenite and tobermorite. A last, weathering, paragenesis includes allophane, C-S-H gels and probably portlandite, unpreserved because its transformation in aragonite then calcite. Imprints of these late events on the primary zoning are quite limited.