

Cl in magmas: A tool for degassing processes

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Volatiles are responsible of magma ascent from reservoir to surface. For differentiated melt, H₂O is the main volatile species, the behavior of which control the eruptive style. But H₂O is generally difficult to measure precisely that limits the dataset available. Halogens are interesting to study and particularly Cl that is easier to analyse in volcanic glass (residual glass and melt inclusions) by electronic microprobe at the concentrations that occurred in natural samples.

Cl is generally controlled by its partitioning into the H₂O phase that explains a wide range of behavior. Here we present different results on Cl behavior in magmas, from basic to acid composition, in order to highlight how Cl may be a useful parameter for degassing processes. In rhyolitic melt, Cl follows H₂O behaviour and provides the same information of closed- vs. open-system degassing. In alkali magmas such as phonolitic or trachytic magmas, Cl content in magmatic melt may be buffered in precised (P, T, composition) domain corresponding to magma storage at depth in equilibrium with a two-phase fluid composed of H₂O-rich vapor and a brine. At that conditions, Cl content depends on the pressure at which the magma is stored, and thus acts as a barometer. The pressure at which the magma is deduced from the solubility law corresponding to the melt composition studied. In some cases, Cl may only behaves as a pure incompatible and non-volatile element and images a stratified reservoir. Whatever the composition, effective Cl degassing potentially affecting the environment.

We illustrate these different behaviors with data on glass (melt inclusions and residual glass) from different eruptions from various contexts (Vesuvius, Etna, Azores, Lesser Antilles and Vanuatu arc).

Cyclic dolomitization of limestone at Oker (Germany)

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Magnesium and sulfur are one of the major elements that control dolomitization in marine, low-temperature environments. However, conditions and reaction mechanisms, which are related to dolomitization are poorly understood.

We investigated partly dolomitized limestone (Oker, Langenberg, Germany) of Upper Jurassic age (~153 Ma) that was deposited in a shallow marine, sabkha environment. X-ray diffraction (XRD), δ¹⁸O and δ¹³C isotope measurements, and electron microprobe (EMP) analyses were completed on porous dolomite, sandwiched by layers of limestone.

The lower limestone layer consists of micritic calcite (-1.7 to -2.9‰ of δ¹⁸O and 1.3 to -0.7‰ of δ¹³C, VPDB), which formed under marine conditions. EMP analyses revealed low-Mg calcite (LMC) of (Ca_{0.96-0.99}Mg_{0.004-0.03}Sr_{0.001}Na_{0.01}Fe_{0.002})_{0.99-1.0}CO₃. Samples from the contacts between dolomite and limestone layers contain LMC, high-Mg calcite (HMC), and dolomite, which are associated in single grains. The dolomite core, (Ca_{0.97-1.14}Na_{0.01})_{0.97-1.14}(Mg_{0.75-0.97}Fe_{0.02}Mn_{0.01})_{0.76-0.99}[(C_{0.998-1.0}S_{0.002})O₃]₂, is ~10 μm in diameter, and is surrounded by LMC, (Ca_{0.86-0.99}Mg_{0.006-0.05}Fe_{0.004}Na_{0.002}Mn_{0.001})_{0.96-0.97}CO₃, and subsequently deposited HMC, (Ca_{0.64-0.78}Mg_{0.19-0.32}Fe_{0.004}Na_{0.003}Mn_{0.002})_{0.91-0.99}CO₃. The “pure” dolomite (2.2 to 1.7‰ of δ¹⁸O and 1.7 to -0.1‰ of δ¹³C, VPDB) comprises of 2-50 μm sized euhedral crystals of (Ca_{1.02-1.12}Na_{0.02})_{1.02-1.13}(Mg_{0.82-0.94}Fe_{0.02}Mn_{0.002})_{0.83-0.97}[(C_{0.994-1.0}S_{0.006})O₃]₂, and shows alternate growth zones of S and Fe. XRD data confirm non-stoichiometric dolomite with 51-54 mol% of CaCO₃. The degree of order in dolomite, in respect to dolomite super structure, decreases from 83% to 42% with increasing S contents from 0.02 to 0.06 S [a.p.f.u.], respectively. The upper limestone layer contains no dolomite or HMC, and displays marine conditions; i.e., micritic LMC (-1.8 to -3.4‰ of δ¹⁸O and -1.6 to -4.0‰ of δ¹³C, VPDB).

The euhedral shape and the (Fe, S)-growth zoning of the dolomite crystals, and the alternate zones of dolomite, LMC, and HMC suggest dolomitization via dissolution of primary carbonates and subsequent cyclic and abrupt changes in the chemical (Mg, Fe, and S), and isotopic composition of the interstitial solutions.