Research statement

Experimental petrology is the field I am dealing with during the last 20 years of my scientific career. Since I started my PhD in 2002, at the University of Hannover, Germany, I discovered the potential that this research field can offer. Magmatology, Volcanology, Mineralogy but also Materials Sciences are disciplines that need experimental approaches to quantify transport processes and exchange processes between various phases.

Concerning my research, I started to deal with experiments at high pressure and temperature to study physical processes, such as viscosity, in silicate melts. I used different techniques and methodologies during my PhD (falling sphere, creep, micropenetration concentric cylinder, dilatometer) and results were then published in international journals. Magma viscosity studies, as key parameter for magma ascent and lava flow, were applied successfully to natural case studies (such as the Unzen volcano with the aim to characterize processes happening before the dramatic events in 1991-1994). I studied and modeled the viscosity of different magmatic compositions (basalt, andesite, latite, shoshonite, dacite, pegmatite,) and I quantified the role Fe^{2+}/Fe_{tot} ratio on melt viscosity. Recently, I also studied the effect of crystals on the magma viscosity. Up to now, seven studies have been published on this topic, showing the dramatic effect crystals contents, shapes and sizes have on magma viscosity.

Since 2009, I also focused part of my research on solubility of volatiles species, such as water and CO_2, S and Cl in silicate systems. As one of the most (if not the most) important factor controlling viscosity and as a consequence volcanic eruption styles, volatiles behavior in magmatic setting was studied in different compositions (latite, shoshonite, phonotephrite, basalt) and at different pressures and temperatures providing a unique dataset allowing modelers to better constrain the evolution of volatile at different T-P-X conditions (the new app MagmaSat of M. Ghiorso was partly calibrated using my data). The natural evolution of this type of study would be to reproduce, as much as possible, natural scenarios. This is actually what I am experimentally exploring, adding to water and CO_2, sulfur and chlorine and try to understand the complex behaviors and interplay between different volatile ratios in different magmas.

From 2010 I focused part of my research on the Glass Formation Ability quantified via the so-called “critical cooling rate (Rc)” of silicate melts. Compositions studied vary from basalt to rhyolite. The results on the crystallization kinetics of the most abundant and common silicate melts in nature will be applied to retrieve solidification conditions of volcanic rocks in terms of lava flow, as well as to design glass-ceramics using natural and low cost starting materials.

Combining my expertise in rheological properties of magmas with my knowledge on chemical properties of melts and magmas (volatile solubilities and phase equilibria), I plan to focus my research on kinetic processes occurring in magmatic systems, in which chemical and physical properties are changing strongly with ongoing ascent, cooling and degassing. I have started a program in which decompression experiments are conducted to quantify the effect of degassing and crystallization on the rheology in magmatic conduits. Such kind of work can be applied to various volcanic systems and can be conducted in the frame of cooperation with many partners focusing on the investigation of natural case studies.

Recently, I worked high temperature high pressure experiments on basalt with temperature cycling approach. It turned out that temperature cycling has huge effects on crystals size and textures. Since I believe that magmatic and volcanic processes are non isothermal in nature the idea to test how temperature cycling will affect the elements partitioning between melts and crystal is motivating and stimulating me although challenging. On this concern, I started a scientific cooperation together with Researchers at UniPG and at the Institute of Mineralogy in Hannover, Germany.

Last but not least, I start to have interest in “planetary magma rheology” and I applied magma viscosity experimental study to Mercury and Mars in order to better understand rheology, eruption and emplacement dynamics of lavas from solar system planetary body.

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Yours Sincerely

Francesco P. Vetere