Es folgen Zusammenfassungen von Vorträgen, die im vergangenen Vereinsjahr im Zuge der Vortragsreihe der ÖMG gehalten wurden.

UNDERSTANDING THE "STRANGE" ACTIVITY OF MOUNT ETNA, THE ULTIMATE CHALLENGE IN VOLCANOLOGY

Carmelo Ferlito

Università di Catania, Dipartimento di Scienze Biologiche Geologiche e Ambientali, Corso Italia 57, I-95129 Catania, Italy

e-mail: cferlito@unict.it

Mount Etna is an awesome volcanic edifice, whose summit craters are looming above the eastern coast of Sicily at 3340 m (a.s.l.). Mount Etna cannot easily fall within the classic definitions of either shield or stratovolcano, being instead constituted by the superimposition of several diacronic eruptive centers.

The oldest activity in the Etnean area can be dated back to 500 ka. It is at present visible as pillow lavas cropping out along the coast north of Catania. After this pristine activity, to recover further signs of past Etnean activity we have to move forward of 300 ka, again we find a small outcrop of plutonic basalt cropping as small rocky islands north of Catania. Only 130 ka ago the volcanic activity moved westwards in the area of the present-day volcano, originating the first polygenic stratovolcanoes, whose deeply eroded remains are well exposed in the deep depression of the Valle del Bove, on the eastern flank of Mount Etna. There are at least five volcanic centers whose activity and evolution can be reconstructed out of the eroded remains along the western and southern steep slopes of the Valle del Bove. The most important of these earlier volcanoes is the Ellittico, active between 40 to 15 ka. It was the tallest, and most active of all, its lava flows and pyroclastics are piled up to constitute the frame bone of the present day Etnean edifice.

The summit craters undoubtedly represent the most relevant construction of the present day volcano. There are three main volcanic cones with a variable number of active vents inside them. To these it must be added the fumaroles that constellate the rims of all the craters. For what concerns the petrological characteristics of the presently erupted Etnean volcanics, they can be considered as Na-rich basalts, with SiO_2 content ranging between 47 and 49 wt.%, with a noticeable increase in the K recorded in most of the products erupted in the last 50 years. The volcanic activity of Mount Etna is extremely variegated; we can group it into three main types:

1) The steady state effusive eruptions, characterized by a long lasting emission of quiet lava flows with a very low output rate, traditionally ranging 1-4 m3/sec; such eruptions can last for several months or even years, individual flows are short and rarely are longer than 2 km; the final outcome of this activity are lava fields formed by large fans of hundreds of short and narrow flow units. In recent years these flows have produced a blocky or "aa" morphology, but back in historical times and in particular during the XVII century this kind of activity was able to produce ropy or "pahoehoe" morphology.

2) The explosive Strombolian to paroxysmal activity. In this case is generally disrupted and fragmented. Fragments and lava shards are ejected away from the mouth by the sudden expansion of the gas within innumerable bubbles. Strombolian explosions can occur in conjunction with the first phase of an eruption during the opening of a fracture. Paroxysmal activity is way more energetic with "lava fountains" up to 1 km high. In spite of its high energy and violence the durations of these episodes are very short, lasting only few hours or less. Scoriae and pyroclastics produced during such episodes can be carried away and deposited on the leeside of Mount Etna.

3) Non eruptive gas emission, this is the most continuous and characteristic activity of the Etnean volcano. Gas emission occurs mainly through the vents and the fumarolic fields located on the summit craters area. The amount of gas flux emitted by the summit craters can only be systematically measured for SO_2, which represent less the 10 % of the total gas emitted. The daily SO_2 flux in non eruptive periods averages 3000-5000 tons, whereas it increases up four-fivefold during the violent explosive paroxysms.

This last type of emission constitutes the root of the most intriguing problem in trying to explain the functioning of Mount Etna volcano. In fact the systematic measurements of the gas flux emitted through the summit craters and the comparison with the amount of lava emitted in the same period has brought up the problem of an excess degassing.

At mount Etna the maximum H_2O found in olivine melt inclusions is 3.5 wt %, which would correspond to a moles H_2O/moles basalt ratio of 0.14. The results of the comparison with the moles of basalt emitted in a specific period are surprising: the moles H_2O/moles basalt ratio is 1.41 which means that Mount Etna erupts ten times the maximum H_2O that could be dissolved in magma and 40 % more moles of gas (H_2O, CO_2 and S) than moles of basalt. By calculating the molar volume of the basaltic melt components (silicatic tetrahedra and metallic cations) and of the gas phase at pressure of 250 MPa it is possible to envisage the magma within the deep plumbing system as a solution made for ~ 70% of a continuum gas phase (mostly H_2O) at supercritical state (density 360 kg/m^3) and the remaining 30 % by the basaltic melt components. The transition from this low density (1140 kg/m^3) Water Melt Solution (WMS) to the high density (2800 kg/m3) basalt usually erupted (defined as a Continuous Melt Phase, CMP) occurs in the last 2 km and marks the boundary between a deep and a shallow plumbing system. The depth of this boundary varies with time, being driven by the rate at which the gas escapes the WMS to feed the persistent gas plume at the summit craters, leaving the CMP, which accumulates within the shallow plumbing system until erupted. The overpressure of the gas phase in the WMS, acting like a piston cylinder is fundamental in driving the eruption. In this work the thermal contribution provided to the CMP by the large gas flux has also been considered, proving that it can supply the heat necessary to maintain molten the CMP. The volcano is here considered as a dynamic system in which the eruptive activity is ruled by discontinuities in flux of gas and heat. Negative fluctuations in the gas flux would decrease the heat supply, promote viscosity and trigger eruptions. Moreover, this view of the volcanic system, subverting the common paradigm in which the gas emitted is associ-ated to an equivalent amount of degassing magma, explains the phenomenon, known as the "excess degassing problem", affecting volcanoes of basaltic and andesitic nature worldwide.

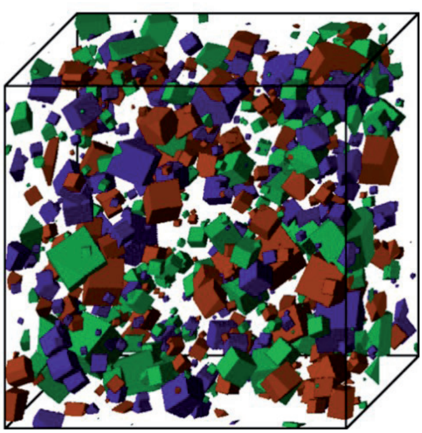
SIMULATING AND INTERPRETING IGNEOUS TEXTURE: FROM CRYSTAL NUCLEATION TO INTRUSION DYNAMICS

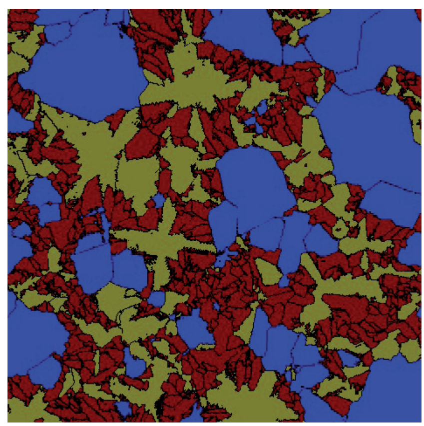
David Dolejš

Institute of Earth and Environmental Sciences, University of Freiburg,
Albertstraße 23b, D-79104 Freiburg i.Br.

e-mail:.david.dolejs@minpet.uni-freiburg.de

Magma differentiation by crystal fractionation represents one of the fundamental mechanisms producing chemical diversity of the Earth's oceanic and continental crust, and all of igneous bodies. The processes, which involve crystal nucleation and growth, crystal-melt mechanical interactions, dictate rheology of the evolving magma suspension and define appearance of the resulting igneous texture, but did it form? We developed a set of high-resolution models, which predict crystal nucleation and growth in three dimension and link this information to mechanical interactions and rheology in cooling magma bodies. These models lead to a new proposal of genetic typology of plutons in the Earth's crust – illustrating various combinations of internal dynamics, accumulation or destruction of crystallization fronts, and diversity or spatial trends in textures.





Reconstruction of fluid fluxes and genetic typology of hydrothermal systems

Many mineralization styles require concentration factor of 100-1000 to produce economic ore deposits. This constraint implies that chemical efficiency (reactivity) or physical setting (fluid dynamics and flux) between the metal source region and the ore deposition site must differ by two or three orders of magnitude. Using fluid-mineral thermodynamics we illustrate how fluid fluxes and volumes can be estimated, using an example of tin-mineralized greisens in the Erzgebirge batholith in central Europe. To further generalize, we address progress of mineralization reactions by identifying individual contributions arising from solute transport to the mineralization site, solute lateral dispersion, and reaction efficiency. As these phenomena operate on variable length and time scales, we can construct a simple genetic classification of hydrothermal systems, which unravels their driving mechanisms and continuous or episodic behavior.