SECONDARY MINERALIZATIONS INSIDE GROTTA DEL FUMO – SMOKY CAVE – (1991/93 ETNA ERUPTION)

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Abstract

Grotta del Fumo, which is located in the high area of 1991/93 Etna lava flow, six years after the end of the volcanic phenomenon, still keeps, upstream its entry, a temperature of 40°C and continuous vapour emission flowing in the high part of the gallery. On the contrary the temperature and humidity are lower in the area close to the floor. In this environment, in the area preceding it and in the tube downstream the entry, where the internal temperature has already reached the external yearly average values (±5°C), salt secondary mineralizations, which are typical of ending eruption, are still present.

Three specimens were examined. They were drawn in three different parts of the tube: the first in the smoky gallery, the second in the preceding area and the last one downstream, directly below the entry. The presence of those minerals, that is Thenardite, Halite and Gypsum, which are usually found in these post-eruptive environments, was noticed. However in the first specimen the presence of tiny crystals of Celestine (30–40µ) associated with Halite was also noticed. This compound was previously not found in other deposits. If there is the chance to examine closely these deposits, more information about the composition of gaseous emissions, which still continue to come out from the eruptive fissure, will probably be obtained.

Introduction

Only in the last years, the study of lava flow secondary minerals, that is those which are directly not part of lava mineralogical composition has been exciting interest in the scientific environment. These minerals can be found, during the eruption or after it, near the “fumarole” which are located along the lava tube and inside the volcanic cave, but at least one year later the end of the effusive manifestation, that is when the temperature almost decreases to atmospheric values. They are in the shape of stalactites, patina, masses, flows etc… which cover, sometimes completely, the cavity surface.

After many analysis inside the new caves, it was possible to understand that, when the values of the inside temperature are next to those outside (45-35 °C), gas and residual magmatic vapour condense forming a large quantity of salt deposits (mainly sulphate minerals and chlorides of Na and Ca) which, when the temperature definitively stabilise to external average values, thanks to the high relative humidity, dissolve leaving only few traces.

Fig. 1 - The lava flow in the first days of eruption (12–29–1991).

Grotta del Fumo

The 1991/93 lava flow (fig. 1) came out from a fissure cracked on the west side of Valle del Bove, at an altitude of about 2400 metres and it flowed along a gully facing the bottom of the valley before becoming wide on the valley extend. In its first part it created a rectilinear canal, which is deep and very inclined, and almost close to form a long gallery, although it is open in three parts which let gas and vapour emission. The entry, which is located upstream the other two, emitted smoke for a long time. Two years later the end of the eruption we went inside this chasm and we could notice that downstream the temperature had already reached normal values and there were not evident concretions. On the contrary, from the gallery upstream leading to the eruptive fissure, a sort of vapour, which was still keeping high temperature, was coming from. It was flowing along the roof of the gallery where its height decreased to about one metre.

This is why it was called Grotta del Fumo (fig. 2). Temperature in the high part of the small gallery was still very high (about 80 °C). On the contrary, on the floor the temperature was close to 40°C. this situation let the formation of salt compounds only on land; on the contrary, on the roof there were still not concretions. To proceed into the lava tube was not possible for other four years, that is until when, in 1999, roof temperature decreased to 50 °C and on the floor it reached 30°C.

Although the inside conditions improved, even if to entry the cave was quite difficult because of the detritus sliding down which quite closed the entry, we moved forward only for few metres. In fact, over the area of one metre in height, the gallery grows to a height of two metres, but it is always full of vapour at temperature of 40°C and with 100% of humidity. We had difficulty in breathing properly and so we stop there just for few minutes. We could just see that the tube was longer. We wait that the temperature and humidity decrease further on to go over to verify the right length of the lava tube, unless the detritus completely close the narrow passage which still exist obstructing the way.

Fig. 2 - The well–shaped entry of the Grotta del Fumo

Previous Observations

Inside the numerous cavities deriving from the 1991/1993 eruption we observed the presence of mineralising deposits, which were white or variously coloured because of the presence of other elements, which were included at a molecular level inside the most abundant compounds: Thenardite (sodium sulphate), Halite (sodium chloride) and Gypsum (calcium sulphate).
The first to be examined were those which were found inside Grotta Cutrona (Cutrona Cave), in Valle del Bove (Forti et al., 1994). During the next years other descriptive studies of speleothemes have been carried out in other cavities of lava flow (Grotta del salto della Giumenta, Grotta della Macchia gialla, Grotta dell'arco, etc…).

Secondary Mineralizations inside Grotta del Fumo

During 1998 and 1999 summer seasons, salt deposits were drawn inside Grotta del Fumo: one in the area downstream the entry, which is closed by a landslide and possible to reach only by the second entry (Grotta della Macchia gialla – Yellow Spot Cave), where the temperature stabilised to the external yearly average one (±5 °C). Other two specimens were drawn inside the smoky gallery: one from the floor of the low gallery (fig. 3) and the other from the small balcony on the left side of the anterior high gallery.

Fig. 3 - The low cave where sample n.1 has been taken.

The specimens were catalogued according to the direction of lava flow:
N.1 – this specimen was drawn inside the low gallery: it is made up of a small stalagmite mass whose colour is translucid white.
N.2 – this specimen was drawn in the high gallery on the small balcony on the left side: it is made up of white-yellowish efflorescence.
N.3 – this specimen was drawn at the entry of the gallery, downstream: it is made up of a small stalagmite mass whose colour is semi-transparent white.

The analysis was conducted at the International Institute of Volcanology (I.I.V.) of Catania in collaboration with Dr. Massimo Pompilio.
Specimen n.1 is mainly made up of Halite (NaCL) mixed with micro crystals of Celestine ($SrSO_4$), 30–40µ length (fig. 4)
Specimen n.2 is made up of Thenardite (Na_2SO_4)
Specimen n.3 is made up of Thenardite (Na_2SO_4) and Halite (NaCL)
The minerals which are present in the three specimens, but Celestine, had already been found inside the other new cavities of Mount Etna.
Celestina enlarges the range of compounds which are present inside the secondary mineralizations of Etna caves. Its presence could be linked to the persistence of magmatic vapour which, over six years after the end of the eruption, continues to come out not only depositing the usual substances, but, probably, also new compounds. It is not a coincidence the finding of Celestine in the specimen which was drawn in the low gallery, where the deposit are more recent.

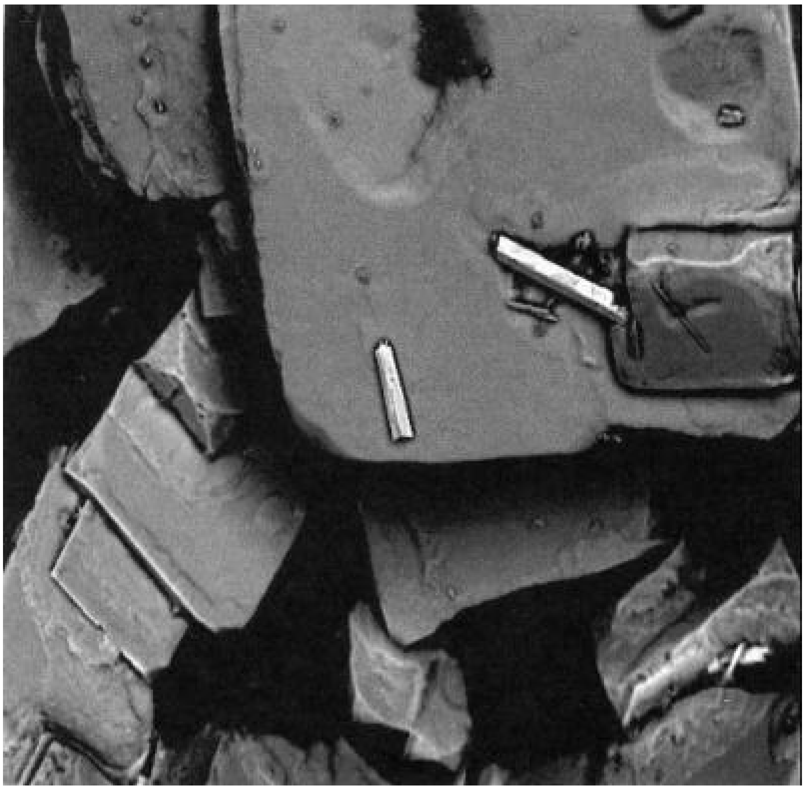

Fig. 4 - Celestine crystals ($SrSO_4$) 30–40 µ on to Halite crystal.

Conclusion

For a better understanding of the problem, the research should be deepened drawing new specimens and surveying the temperature, which would give us more information about the evolution of the phenomenon and the formation of new minerals. However the difficulty of reaching the cave and the lack of specific instruments has prevented us from making a constant monitoring of the phenomenon, which still keeps its scientific interest. We hope to achieve, in collaboration with Organisations and Institutes of research, a complete knowledge of the phenomenon.

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