The Salinelle of Paternò mud volcanoes: first results on water and soils compositions and continuous temperature monitoring aimed at a correlation with Mt. Etna activity

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The Salinelle of Paternò mud volcanoes: first results on water and soil compositions and continuous temperature monitoring aimed at a correlation with Mt. Etna activity.

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1. INTRODUCTION

Aiming at monitoring and correlating mud volcanoes activity to effusive phenomena, gaseous emissions and seismic activity, the Department of Earth Sciences of the University of Torino in collaboration with the INGV of Catania, began a detailed study in May 2018. The study area is located in the flat area SW Etnean flank (western periphery of Paternò village, Fig. 1), and corresponds to emissions of muddy and salty water in clayey sediments typical of compressive tectonic settings, known as "Salinelle dei Capuccini" (Panzera et al., 2016). Since over the past few years, an intense activity of the Salinelle with temperatures up to more than 40°C probably moving up to Mt. Etna activity was reported (Giammanco et al., 2016), in the next years we will continue the study through continuous temperature measurements in hydrothermal mud volcanoes, and periodic sampling of gas, water and mud, in order to obtain more precise correlations.

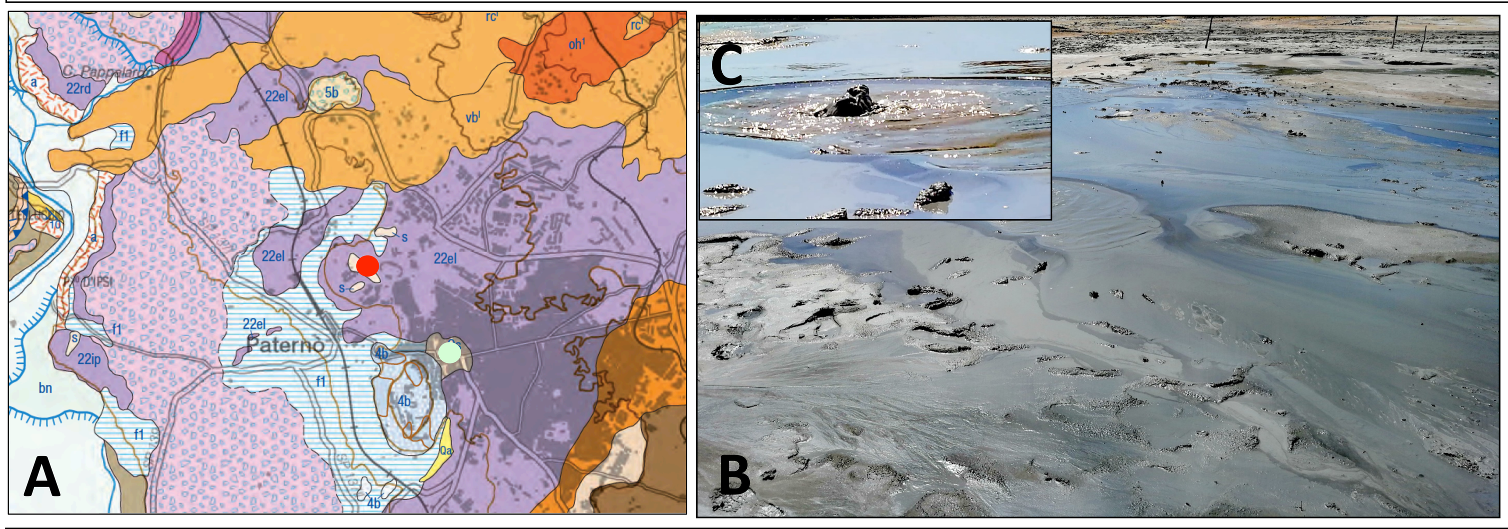


Fig.1 A: Geological sketch map from Branca et al., 2015, with the location of the studied area (d circle). The green circle represents a second study area in the centre of Paternò village: temperature monitoring into a hydropotable well; B: mud volcano field; C: detail of a typical mud and gas emission.

2. FIELD AND LAB ACTIVITIES

2.1 Temperature and Thermal conductivity measurements (Fig. 2A): were carried out adopting the transient line source based on the approximation of the general heat transfer equation of an infinite line source (De Vries and Peck, 1958)

2.2 Temperature monitoring (Fig. 2B): by means of three submersible recorders, operating from -40 ºC to +80 ºC and measuring in continuous temperature changes of water/mud, inside pooling waters.

Fig. 2 A Temperature and thermal conductivity device; B: submersible temperature recorder

2.3 Thermographic measurements (Fig. 2C): realized through the use of an infrared thermocamera based on three collected radiation power terms

2.4 Geochemical analysis:
i) use of a combined field device, to detect CO_2 and radon concentrations in mud waters (Fig. 2D); ii) mud/water sampling for VOC (Volatile Organic Content), Oxygen, alkalinity and electrical conductivity lab analysis.

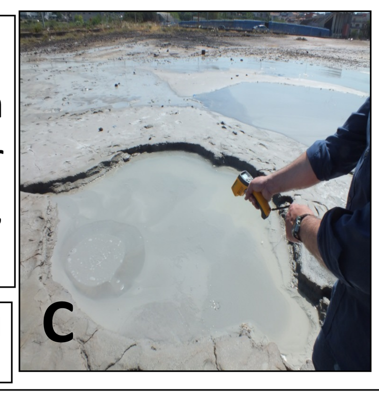
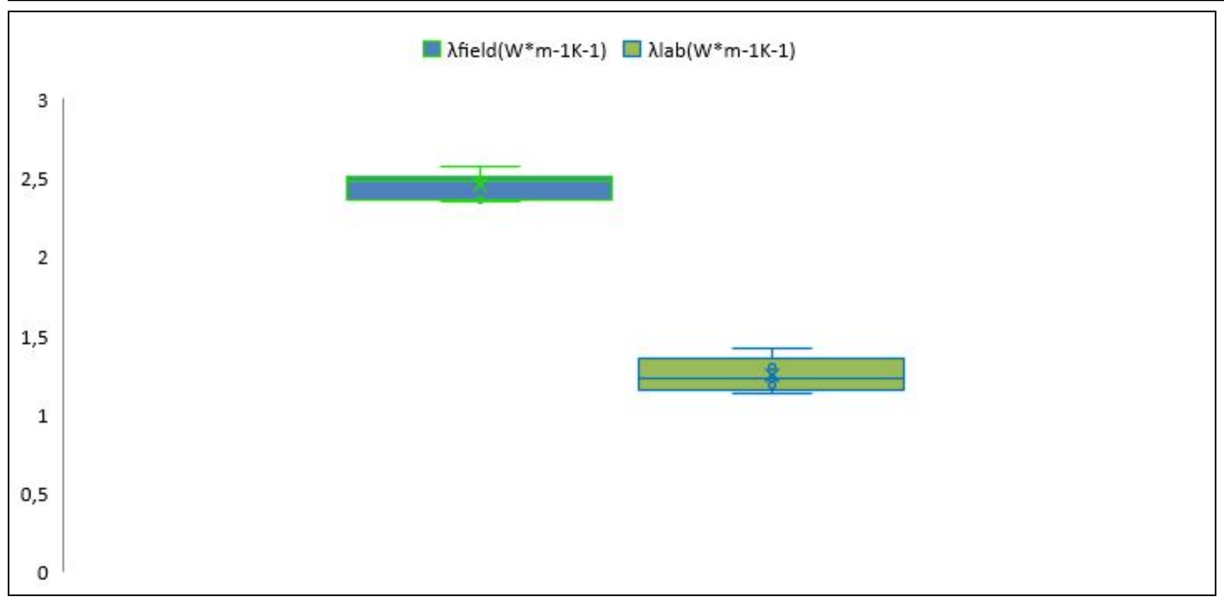


Fig. 2C Field measures with IR camera based on: i) emission from a object; ii) reflected emission; iii) emission from the atmosphere; D: CO_2 logger and radon detector

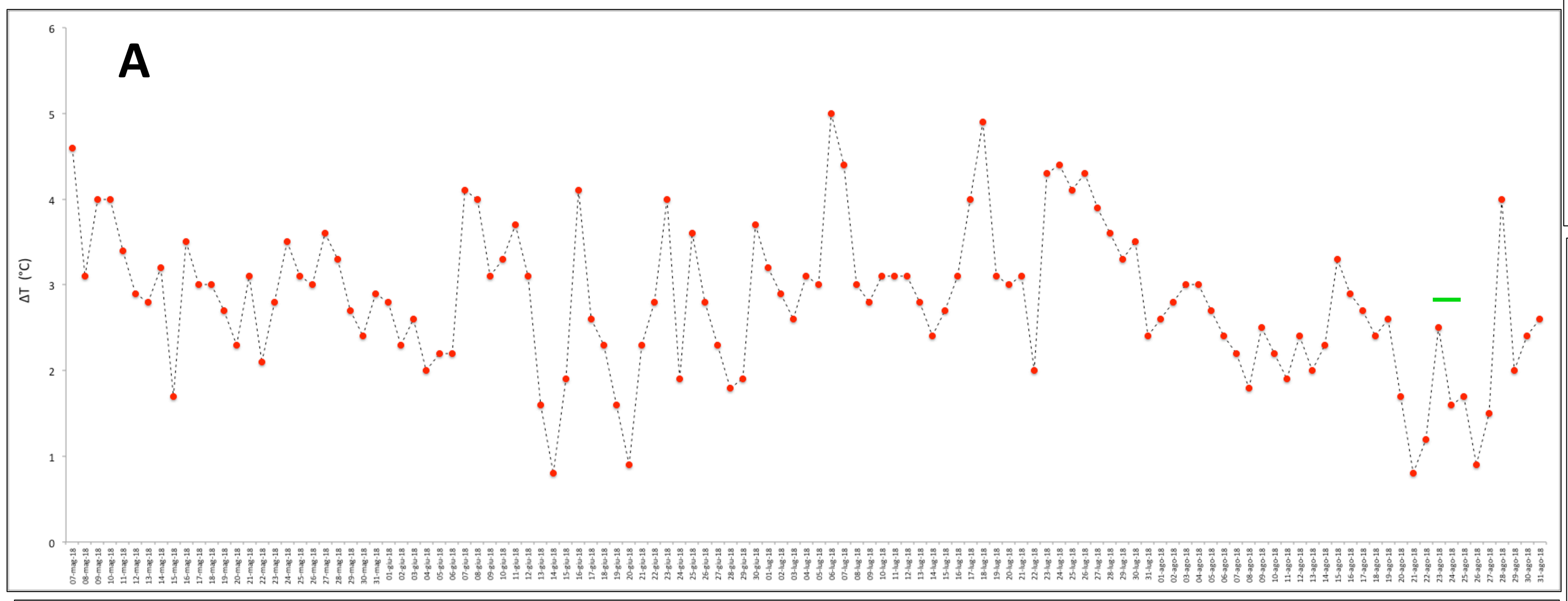
3. RESULTS

3.1 THERMAL PROPERTIES



Measures were conducted by means of the same device (Transient Line Source, Par. 2.1). Obtained data, are average values over 50 measurements. The large difference between the two dataset can be ascribed to weather trend, during field work influencing thermal properties.

Fig.3 Comparison between field (blue) and lab (green) data for thermal conductivity.



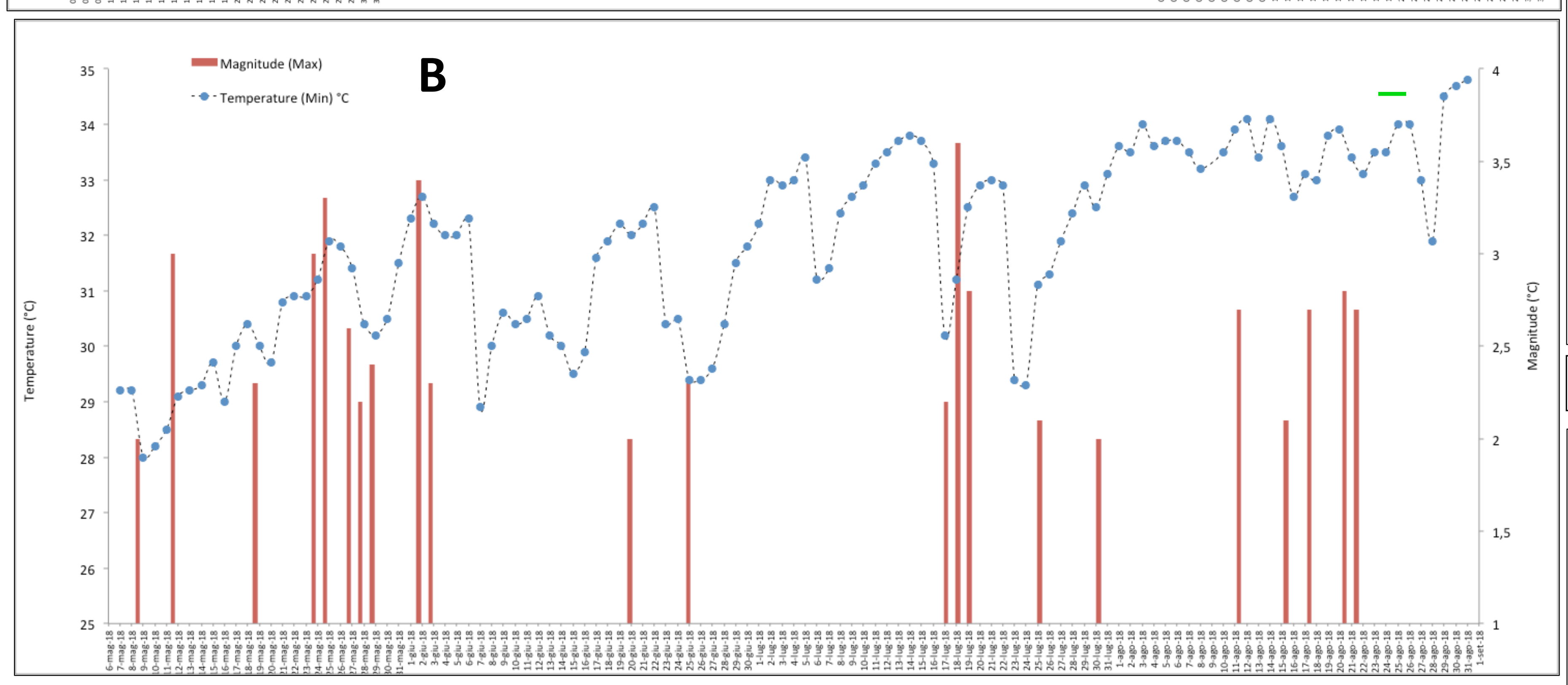


Fig. 4 A: daily variation of temperature recorded in continuous inside mud volcanoes in the "Salinelle dei Capuccini" B: Comparison between seismic activity (from "Bollettino settimanale Etna", INGV Catania) in the Mt. Etna area and temperature variations of the mixture of mud and water in the Salinelle. In particular, we compare the maximum magnitude (> 2.0 M) with the minimum temperature. The green line in A and B, indicates the Mt. Etna volcanic activity, between 23 and 24, August 2018.

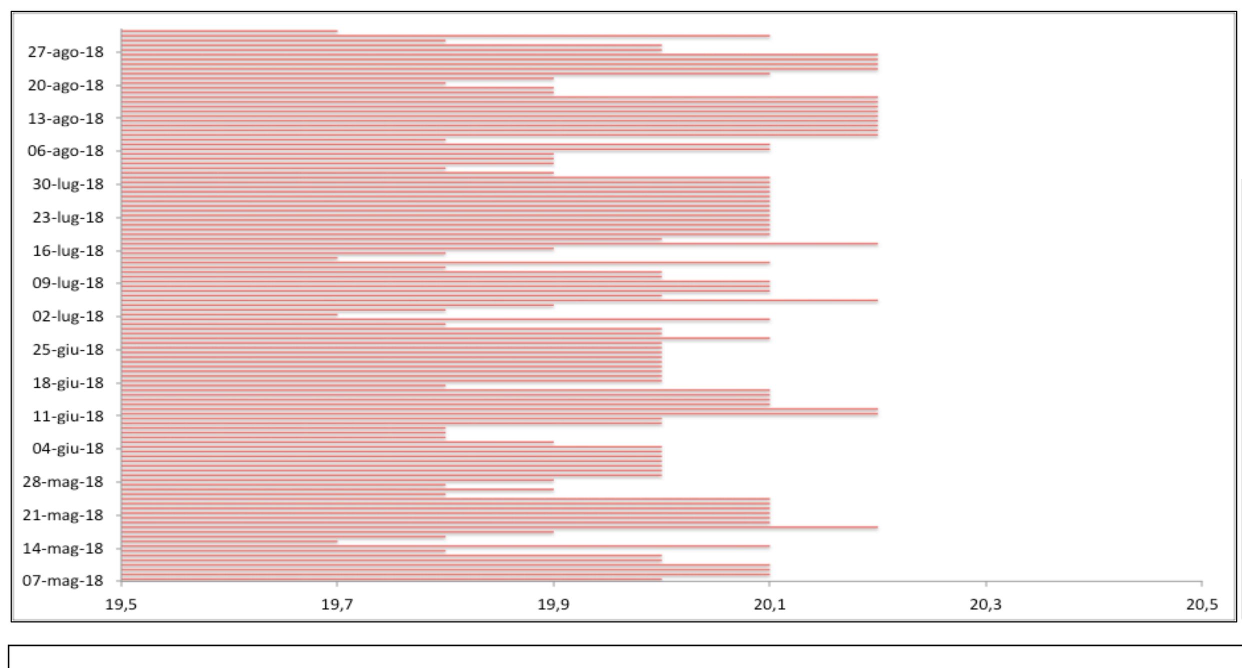
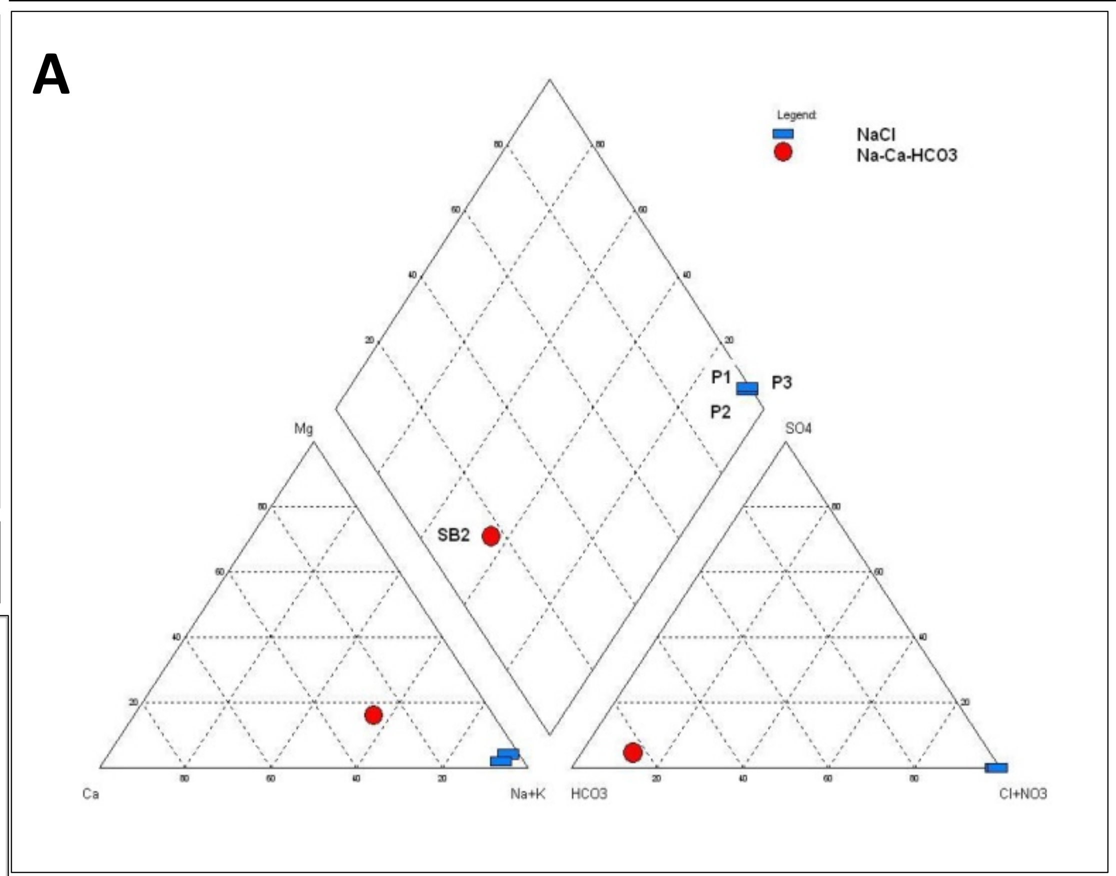
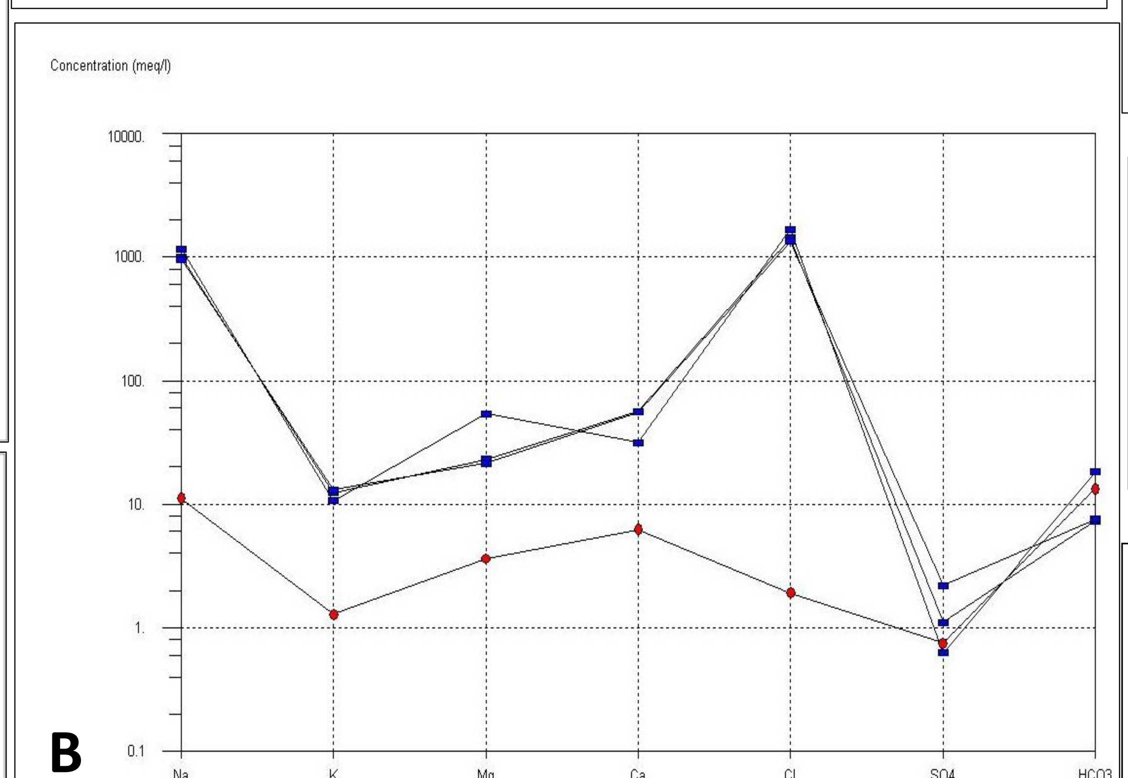


Fig. 5 Temperature monitoring at Santa Barbara wells, 1.2 Km SW from "Salinelle dei Capuccini" (Fig. 1A), in the centre of Paternò village

Temperature variations from the Santa Barbara well, detected between May 2018 and August 2018, are not relevant (between 19.7 and 20.2 °C). Therefore, we can ascribe a different origin for this groundwater systems with respect to that of the Salinelle

3.2 GEOCHEMICAL ANALYSIS





Temperature, pH, and electrolytic conductivity, were measured in the field: values ranging between 6 and 6.5 pH units and between 92 and 112 mS for electrolytic conductivity. Major ionic species, instead, were determined by ionic chromatography in the lab: Li^+, Na^+, K^+, $NH4^+$, Ca^{2+}, Mg^{2+} F^-, Cl, NO^{2-}, Br^-, $NO3^-$, $PO4^{3-}$, $SO4^{2-}$.

Ni, Fe, Mn, Zn, Al, Ba, Cd, Co, Cr, Pb, B, Se, Sr were also determined, by means of the ICP/OES. Ba, B and Sr, are the main content: 3.7 mg/l of B in P2, 0.01mg/l of Ba in P1 and, 2.8 mg/l of Sr in P3. For SB2 these chemical species are less than one order of magnitude.

Piper and Schoeller diagrams (Fig. 6) allow us to identify two categories of waters: i) P1, P2 and P3 with an hydrochemical sodium chloride facies; ii) SB2, with a Ca-alkaline bicarbonate facies.

Fig. 6
A: Piper diagram: field and lab data obtained from three different emissions in the "Salinelle dei Capuccini" area (P1, P2, P3) together with data coming from the Santa barbara well (SB2), are represented.
B: Schoeller diagram: the red symbol represents the Santa Barbara well corresponding to SB2 in A.

4. DISCUSSIONS

From first field and lab results together with data related to the Mt. Etna activity, seems that the deep activity of the Etna magma chamber influences the more superficial hydrothermal circuits, leading to temperature and gas emissions variations of the "Salinelle dei Capuccini". This interaction could be related to the ascent of magma to surface, producing fractures of the more superficial rocks along which magma enriched of volcanic gases, pass through. These gases come into contact with the superficial aquifers with which they mix and therefore modify their geochemical and temperature characteristics. Understanding how these blends occur and their relationships with Mt. Etna volcanic activity, could give a further aid in the prediction of paroxysmal events or, at least, could be a proof of deep activities that could have relation with effusive events .

5. FINAL CONSIDERATIONS

The present work a brief summary of our study, and it expects to integrate thermal and geochemical studies that already exist, through continuous temperature monitoring and geochemistry analysis of solid and liquid blend emissions coming from the studied mud volcanoes. First observations highlight that the mud/water in the pools can be affected by the atmospheric temperature recording clear variations of the daily temperatures compatible with seasonal temperatures changes (Fig. 4A). Within these trends we recognize, however, some abrupt variations whose origin - for now - is yet to be defined. Comparing these temperatures with the seismic activity (Fig. 4B) would seem to highlight some correlations but, objectively, the time frame is still too small and the case history absolutely insufficient to draw definitive considerations.

6. REFERENCES

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