ABSTRACT

The study area focuses on two islands of the Comoros archipelago, Grande Comore and Mayotte, located within the Mozambique Channel and in a complicated geodynamic system of great interest due to the volcanic and seismic activity that currently exists and of which a complete descriptive picture is currently lacking. In particular, there is still very limited knowledge of gas and fluid geochemistry.

On Grande Comore, the focus was on the Karthala volcano, the most active volcano in the western Indian Ocean after Piton de la Fournaise in La Reunion. Karthala is a basaltic shield volcano that has erupted regularly over the last century, fourteen eruptions are listed from 1904 to the present, with the last eruption in 2007. The knowledge of the diffuse degassing of the Karthala volcano, with particular attention to the emission of CO_2 from the flanks and of the summit fumarolic area is fundamental for the assessment of the state of activity of the volcano.

Mayotte is the oldest island in the archipelago and no recent eruptions have been recorded since the last one around 2050 BC ± 500; however, volcanic activity in Mayotte is still present in the form of a large area of subaerial and underwater outgassing on the small island to the north-east of Mayotte: Petite Terre. Two areas of high outgassing are present here: the south-eastern beach (BAS); and Lake Dziani located in the northern part of the island of Petite Terre. The island was recently affected by a seismic crisis that lasted several months, and was accompanied by the formation of the largest submarine volcano in recent centuries, about 50 km from its coast.

The thesis is divided into two sections: the first focuses on gas emissions from Karthala and the BAS area at Petite Terre, with the aim of identifying the main characteristics, similarities and differences; the second section of the thesis focuses on the difference between the two bubbling areas at Petite Terre, where the study of gas emissions from Lake Dziani, which have only been investigated in more recent surveys, will be included.

The results of this thesis converge towards the recognition of some remarkable peculiarities:

1. Soil CO_2 emissions are spatially distributed along the main structural features of both Grande Comore and Petite Terre; however, the carbon isotopic signature of soil CO_2 emissions shows a low magmatic contribution in the distal areas of Karthala volcano, and vice-versa a higher magmatic contribution in CO_2 emissions at Petite Terre, relative to the period of observation.

2. The helium isotopic signature is typically low and in the range of $\sim 6 \leq Rc/Ra \leq \sim 7.5$ at Petite Terre and $\sim 4.6 \leq Rc/Ra \leq \sim 5.8$ at Karthala.

3. The bubbling area on the sea (BAS) and at Dziani lake (Mayotte) are likely fed by a common source; however, Dziani lake is significantly affected by secondary processes that are mainly related to biotic activities in the lake, which result in the higher variability of gas chemistry, $\delta^{13}C$ in methane and CO_2 than BAS.

4. The increased value of Rc/Ra between 2008 and 2018-19, and a not-reached isotopic equilibrium of $\delta^{13}C_{CH4}$ from the hydrothermal fluid, may be ascribed to the volcanic activity that generated the new submarine volcano 50 km offshore from Petite Terre.

The latter consideration is also consistent with the final interpretation of this work, where the input of heated CO_2-rich fluid into the Petite Terre hydrothermal system is a consequence of the perturbation of the shallow plumbing system by the offshore submarine eruption, resulting in higher equilibrium temperatures in 2018 and subsequent cooling down during and after the seismo-volcanic activity.