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Recent magmatic system behavior of the Villarrica Volcano (Chilean Southern Andes) from five lavas erupted during the last 230 years

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The Villarrica Stratovolcano is considered to be one of the most active volcanoes of Chilean Southern Andes, with more than fifty effusive and slightly explosive eruptions over the past 450 years. It is located close to important urban centers and touristic places. Therefore, a better understanding of its magmatic system behavior would contribute to a better volcanic hazard assessment. The main purpose of this work is to determine the Villarrica pre-eruptive parameters during the last 230 years. We compare textures and whole-rock and mineral compositions of the most relevant basaltic lavas, which were erupted in 1787, 1921, 1948, 1971 and 1984. Thermometry calculations together with textural analyses indicate a major heating event from 1171 to 1205°C in the 1948 lava and a subtle heating of about 20°C is recognized in 1984 lava. The maximum H₂O contents in the studied lavas show a rather cyclic variation with time, where the 1787 lava exhibit the highest values (~1.2 wt.%) and the lowest value (~0.3 wt.%) was obtained in the 1948 lava. Similar cyclic pattern is observed in both MgO and VEI variations with time. A negative correlation between maximum VEI and maximum H₂O content of the lavas is observed, which is similar to the observed correlation between maximum MgO content and maximum H₂O content. Consequently, a positive correlation between VEI and MgO content exist, which is the opposite of the commonly expected. We hypothesize that the decrease in H₂O solubility is response to increase in melt temperature and that the subsequent extensive water exsolution would generate more explosive eruptions.