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Is CO_2 output from volcanoes related to the age of the last activity?

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The global volcanic emissions of CO_2 have been estimated mainly from measurements taken at active volcanoes. Recent studies have shown that soil-diffuse degassing and magmatic CO_2 dissolved in groundwater make a significant contribution to the total CO_2 budget from both active and quiescent volcanoes. In this study, we investigated the CO_2 total budget released at Mt. Vulture in the southern Apennines (Italy), an alkaline quaternary stratovolcano composed mainly of pyroclastic deposits and lava flows of tephritic-phonolite, foidite, melilitite and carbonatites. The last volcanic activity occured about 140ky ago and it is the eastern-most occurrence of the Quaternary Italian volcanism. Furthermore Mt. Vulture volcano is the only volcano to the east of the Apennine mountain belt. The origin of the volcanism has been ascribed to a NE–SW trending lithospheric discontinuity, generated by variation in the velocity of rollback along the length of the subducting Adriatic plate, producing a deep vertical slab window throught magma escaped from the mantle towards the surface and intruded in to the crust.

Our estimate takes into account all the possible emissions of CO_2 at Mt. Vulture volcano: 1) CO_2 dissolved in groundwater, 2) CO_2 budget into the two maar lakes located on the SW flank of the volcano, and 3) CO_2 emitted from the main pools on the volcanic edifice (Caracausi et al., 2015). The relationship δ13C vs CO_2 indicates that the CO_2 is a mixture of a biogenic and a mantle-derived end-members. The mantle-derived CO_2 output in the study area is 4.85×108 molyr^{-1}, which is more than double of the previously estimated ones. In addition, such value is higher than that observed in younger volcanic systems elsewhere, supporting the existence of actively degassing mantle melts below the Mt. Vulture. The estimated CO_2 output in the Mt. Vulture area, together with literature data on CO_2 output from historically active and inactive Italian volcanoes, suggests a power-law functional relationship between the age of the most recent volcanic eruption and both total discharged CO_2 (R2=0.7) and volcano size-normalized CO_2 flux (R2=0.7). This relationship is also valid by using data from worldwide volcanoes highlighting that deep degassing occurs over very long time and it progressively decrease over time. In turn, the identified relationship has geodynamical implications and can probably reflect variations in the magmatic feeding system of volcanoes, providing crucial advices for volcano monitoring and/or civil protection. Lastly this study provides an important tool for better evaluating the state of activity of a volcano whose last volcanic activity occurred long enough ago for it to be considered “quiescent” or even “extinct.