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Carbon storage potential in Pleistocene volcanic rocks of the Magnesia area (Central Greece)

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The Porfyrio and Mikrothives volcanoes in the Magnesia area (SE Thessaly, Central Greece) are located a few km (∼8 and 12 km respectively) south-southwest of the industrial area of Volos city and are relatively small in size (∼3 and 10 km^2 respectively). They are closely associated with other scattered volcanic centers of Late-Pleistocene-Quaternary age, appearing at the western shores of Pagasitikos gulf and at the Northern Euboikos gulf (e.g. Achilleion, Lichades, Agios Ioannis). This volcanic activity is attributed to back-arc extensional volcanism and may be further associated with propagation tectonics of the North Anatolian fault [1,2,3]. Volcanic rocks from the Porfyrio and Mikrothives mostly consist of basaltic and trachyandesitic lavas and pyroclastic tuffs.

Porous basaltic lavas (10-15% porosity) exhibit porphyritic textures with a holocrystalline trachytic groundmass. The groundmass consists of lath-shaped plagioclase crystals, alkali feldspar, clinopyroxene, olivine, oxide minerals (ilmenite, titanomagnetite and magnetite), along with other accessory minerals such as quartz, calcite, apatite and pyrite. Phenocrysts are mostly subhedral and anhedral clinopyroxene crystals (mostly augite and less often diopside), olivine and less often plagioclase and quartz. Cr-spinel crystals have been identified within olivine phenocrysts. Pyroclastic tuffs exhibit vesicular textures, with their porosity varying between 20 and 40%. Their groundmass is hypocrystalline vesicular being either trachytic or aphanitic, often enriched in oxide minerals. Phenocrysts are less frequent compared to the lava samples, most often being feldspars. In some samples, pores are partially filled with secondary calcite.

From recent literature it is well known that CO_2 can be injected, trapped and retained within the pore spaces of volcanic rocks, forming chemically stable carbonate minerals [4,5,6,7]. The Porfyrio and Mikrothives volcanics can be considered as potential sites for applying *in situ* and under certain preconditions *ex situ* [8] geologic carbon capture and storage (CCS) practices. This is due to the textural properties of the volcanic and pyroclastic rocks that are characterized by their high porosity, the chemistry of the rocks, as they contain rather high amounts of Ca, Mg, Fe – the necessary chemical constituents for forming stable carbonate minerals, but also because of the relatively short distance of the outcrop of the rocks with the industrial area of Volos city. It should be noted some of the studied samples already incorporate calcite within the pores, demonstrating the capability of these rocks for CCS applications. An estimated amount of about 3 tons of CO_2, dissolved in water, could be stored in the frames of a small pilot project either in the Porfyrio or the Mikrothives volcanics, considering that the average porosity of these volcanics is about 20%. CO_2 storage could be possibly applied at a depth greater than 400 meters below the surface, occupying a minimum area of about 104 m^3 [cf. 7].

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