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Proximal and distal deep submarine tephra deposits: the Marsilian-like eruptions

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Two submarine gravity cores CORE02 (839 m b.s.l., 95 cm thick) and Marsili1 (943 m b.s.l., 235 cm thick) distant 942 m from each other were sampled on the uppermost portion of the Marsili Seamount. The former core contains two tephra layers composed of ashes: TEPH01 (15 cm) and TEPH02 ($\geq$ 60 cm), emplaced at about 3 and 5 ky B.P.. Marsili1 core hosts five tephra layers, thicked few cm. The two uppermost tephras in Marsili1 appear to be the distal equivalent of TEPH01 and TEPH02 sampled in CORE02 and could represent a unicum, since proximal and distal explosive sub-marine fall deposits have never been reported before.
This finding potentially allows to constrain mechanism of deep submarine explosive phenomena. To demonstrate these features, the textures of minerals, bubbles and external shape of ash grains in loose tephras have been investigated by 2D techniques and 3D imaging using phase-contrast synchrotron X-ray computed microtomography. CORE02 log was studied using 13 samples, tephras from Marsili1 log were characterized trough 6 samples.
The amount of bubbles is invariably comprised between 5 and 40 vol.%. Composition of glasses, ages and 3D textures of bubbles indicate that tephras in CORE02 and the two shallowest in the Marsili1 log are the proximal and distal facies of the same two deep submarine eruptions. This also corroborates that flow-like deposits are found only in the proximal CORE02 site. The size of ashes decreases from CORE02 towards Marsili1.
Starting from the amount of bubbles and still dissolved volatiles in glass matrix (up to 0.5 wt.%), we performed numerical simulations to attain a fragmentation threshold of 80:20 (gas:liquid), by modulating X, T, P, initial amount of H_2O in the system and using gas law plus volatile solubility models in magmas. Results indicate that an initial and minimum 3 wt.% amount of H_2O is necessary to fragment and explosively erupt these magmas. These outcomes are validated by 3D external shapes on relative large pumice clast, where mm-sized bubble walls are imaged, with typical elliptical shadows. These large bubbles are totally un-recognizable on thin-sections.
The analytical and numerical approaches carried-out in this study demonstrate that deep submarine pyroclastic fall can mantle km2 area, similar to moderate sub-aerial volcanic explosive eruptions, while pyroclastic flows can occur near vents. Moreover, only 3D images analysis can be able to fully capture bubble features, external shapes of pumices and hints on the presence of large bubbles; in the absence of 3D data, the actual amount of bubbles can be easily undetected. All these outcomes outline a new type of eruption, labeled here Marsilian-like. It is characterized by the coexistence of sub-mm and mm-sized bubbles, able to accumulate tephras via flow- and fall-like mechanisms to form deposits at significant submarine depths.