Revising the volume of the Minoan eruption (Santorini) based on new marine geophysical and sedimentological data

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With a maximum volume estimate of up to 86 km³ dense-rock equivalent (DRE), the Minoan Eruption is considered one of the largest Holocene eruptions. However, as most eruption products were deposited in the Mediterranean, previous volume estimates based on a limited database. We present new marine geophysical and sedimentological datasets allowing us to reassess the volume of the Minoan eruption in unprecedented detail. We combine high-resolution reflection seismic and P-wave tomography datasets with more than 40 marine sediment cores, constrained by X-ray computer-tomography (CT) scanning. The reflection seismic profiles indicate an ignimbrite volume of ~5.7 km³ DRE deposited on Santorini's flanks, which is seven times smaller than previous estimates, while the P-wave tomography indicates ~5.5 km³ DRE of Minoan intra-caldera deposits, which is four times smaller than previous estimates. CT-guided analysis of the sediment cores allows us to differentiate two ash layers, which are separately integrated into ash deposit isopach maps and allows determine deposit porosities with high accurary. The combined ash volume of ~19.5 km³ DRE is in the same order as previous estimates. This yields a total eruption volume of ~31 km³ DRE. In addition, we use the new datasets to constrain the post-eruptive topography of the caldera and estimate the caldera collapse volume to be ~31.5 km³. The internal consistency of both independent approaches implies high confidence in our estimates, likely representing the most precise volume reconstruction of any major (M6.5+) volcanic eruption in the Holocene. Our analysis implies that the Minoan Eruption was smaller and produced significantly less ignimbrites than previous reconstructions indicated, while still causing a devastating tsunami. This highlights the significant tsunamigenic potential of submarine-emplaced ignimbrites.