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A multidisciplinary approach for high-resolution reconstruction of the eruptive past of La Soufrière (Guadeloupe) over the last 12 000 years: Implications for hazards assessment.

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La Soufrière de Guadeloupe is a dangerous andesitic composite volcano characterized over the last 12 000 years by numerous phreatic eruptions that alternate with few magmatic eruptions, including the last magmatic and best-studied "Soufrière" subplinian eruption in 1530 AD, and unusually numerous flank-collapse events. Field analysis of the deposits provide constraints for values of the physical input parameters for simple models which provide with first-order simulation of eruptive phenomena, and from which quantitative probabilistic hazard maps can be elaborated in which epistemic and aleatory uncertainty can be incorporated and quantified. The study of yesterday's eruptions provide key insights for elaborating realistic simulations and describing potential eruptive scenarios for tomorrow's eruptions. However hazard assessment is biased towards eruptions of significant magnitude that produce extensive, and relatively thick deposits. Nevertheless, eruptions of moderate magnitude which are often more frequent, can significantly affect vulnerable island communities living at short distances from the vent. However, their deposits are ephemeral in the geologic record on account of intense erosion from tropical rainfall, important soil development and erosion by the emplacement of recurrent pyroclastic density currents, debris avalanches, and mudflows. We have developed a novel approach by using a manual sediment corer to obtain undisturbed sedimentary eruptive archives in sheltered zones on the volcano where a longer eruption record has been preserved. We describe two such cores (6.32 and 6.64 m long) that extend over at least 8700 years and that contain several thin tephra layers missing at the outcrop scale. We combine these new data with the analysis of more than 120 stratigraphic sections on outcrops studied over the last decade to provide a new eruptive chronology for La Soufriere volcano over the last 12 000 years. This chronology is robustly constrained by 105 new 14C age dates of wood, charcoal, and paleosoil samples that complete the existing 14C database (total of about 261 dates). A multidisciplinary analysis (sedimentology, lithology, microtextures, magnetic susceptibility) of the sediment cores and field data has allowed us to identify hidden, and missing eruptions, and to re-interpret mis-identified eruptions. For the last 12 000 years we have identified at least 5 distinct new pumice fallout deposits, some of which are associated with pumice pyroclastic flow deposits. We also identified several deposits formed by magmatic turbulent pyroclastic density currents (blasts) mostly associated with flank-collapse events. Thus, the number of Holocene magmatic eruptions has significantly increased compared to previous knowledge. More over we have identified eruptive sequences that consist of a diverse range of phenomena including edifice-collapse, associated laterally directed explosions (blasts), pumice fallout with column-collapse and dome growth similar to the AD1530 most recent magmatic eruption. The magmatic eruptive rate could be twice as important with 11–13 magmatic eruptions in 12 000 years, a rate of about 0.92–1.08 magmatic eruption by 1000 years. This new data will allow a better determination of the recurrence, magnitude, intensity, and the spatio-temporal evolution of deposit types that define different eruptive scenarios. Hence, this high-resolution reconstruction of the eruptive past will provide the basis for an improved probabilistic hazard and risk assessment for La Soufrière of Guadeloupe, a dangerous volcano, currently experiencing prolongued unrest since 1992.