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ASSESSING LONG-TERM HAZARDS FOR LA SOUFRIERE OF GUADELOUPE VOLCANO: INSIGHTS FROM A NEW ERUPTIVE CHRONOLOGY, CREDIBLE SCENARIO DEFINITION, AND INTEGRATED IMPACT MODELLING

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► **To cite this version:**

J-C Komorowski, Y Legendre, S. Barsotti, T. Esposti-ongaro, S Jenkins, et al.. ASSESSING LONG-TERM HAZARDS FOR LA SOUFRIERE OF GUADELOUPE VOLCANO: INSIGHTS FROM A NEW ERUPTIVE CHRONOLOGY, CREDIBLE SCENARIO DEFINITION, AND INTEGRATED IMPACT MODELLING. IAVCEI General Assembly, Jul 2013, Kagoshima, Japan. hal-03138247

HAL Id: hal-03138247

<https://hal.science/hal-03138247>

Submitted on 11 Feb 2021

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Komorowski, J.-C.¹, Legendre, Y.^{1,2}, Barsotti, S.³, Esposti-Ongaro, T.³, Jenkins, S.^{4,5}, Baxter, P.J.⁶, Boudon, G.¹, Leone, F.⁷, Denain, J.-C.⁷, Gherardi, M.⁷, Lesales, T.⁷, Bonnel, C.¹, Heymann, A.⁷, Neri, A.³, Spence, R.⁴, Aspinall, W.⁵, Grancher, D.⁸, Redon, M.⁹, Mas, M.⁷, Chenet, M.⁸, Magnier, A.⁷, Lemaître, E.⁷, Chopineau, C.¹⁰, Baillard, M.D.¹¹, Villemant, B.¹², De Chabalière, J.-B.^{13,1}, and the CASAVA Consortium



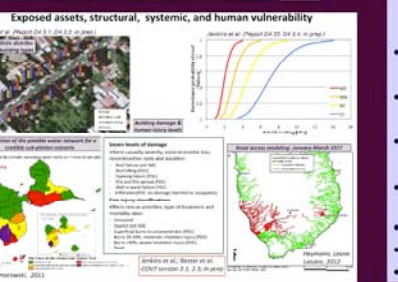
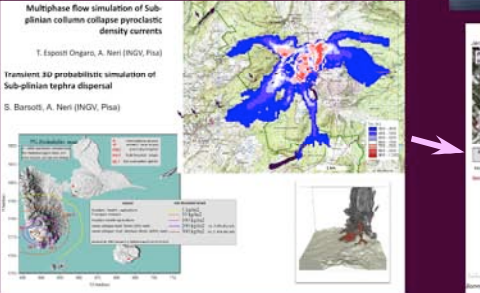
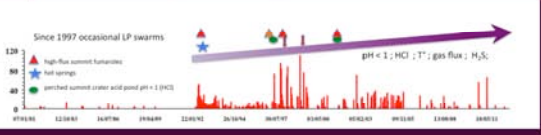
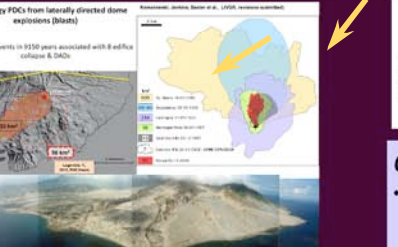
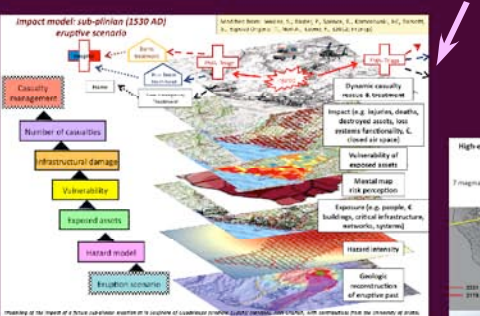
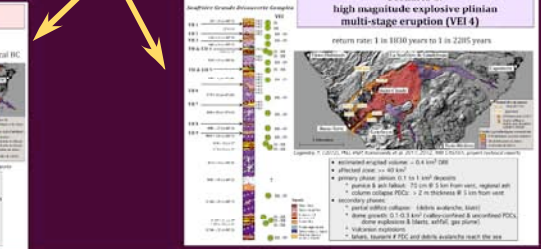
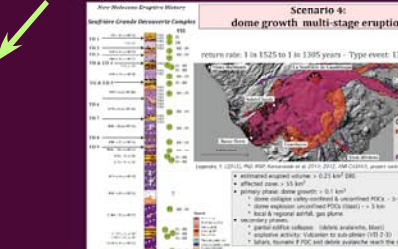
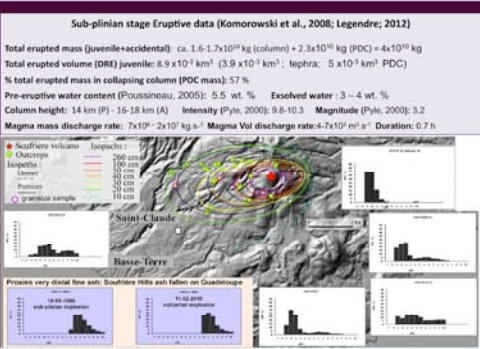
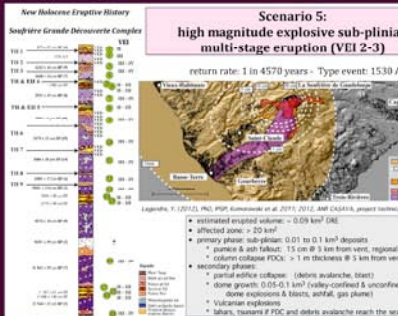
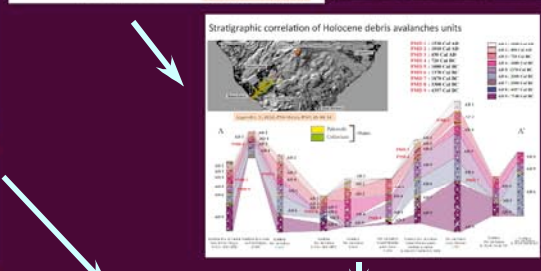
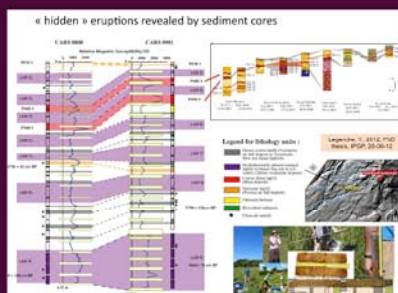
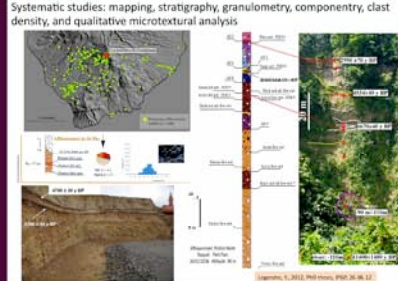
IAVCEI GENERAL ASSEMBLY, KAGOSHIMA, JAPAN, 19-24 JULY 2013

Contact: Jean-Christophe Komorowski komorow@ipgp.fr

1: Institut de Physique du Globe de Paris, Sorbonne Paris Cité, Université Paris Diderot, UMR CNRS 7154, Paris, France; 2: Bureau de Recherches Géologiques et Minières, Guadeloupe; 3: Istituto Nazionale di Vulcanologia e Geofisica, Sezione Pisa, Pisa, Italy; 4: Cambridge Architectural Research, Cambridge, UK; 5: University of Bristol, UK; 6: Institute of Public Health, University of Cambridge, UK; 7: GREC - Gouvernance, Risque, Environnement, Développement (ex. GESTER), Univ Paul Valéry Montpellier 3 & IRD, France; 8: Laboratoire de Géographie Physique UMR 8591, Université Paris 1 Panthéon Sorbonne; 9: PRODIG, Paris, & Université Paris 13-Nord, Paris, France; 10: MASA Group, Paris, France; 11: Centre de Recherche sur les Pouvoirs Écousés dans la Caraïbe, Université des Antilles de la Guyane, Guadeloupe; 12: Université Pierre et Marie Curie, Paris, France; 13: Observatoire Volcanologique et Sismologique de Guadeloupe, IPGP, La Houailmont, Guaybourey, Guadeloupe.



ABSTRACT: Mild but persistent seismic and fumarolic unrest since 1992 at La Soufrière volcano prompted renewed interest in geologic studies, monitoring, hazard, risk modeling, and crisis response planning. We present results of our new detailed chronology for the last 12 000 years of La Soufrière eruptive activity based on the stratigraphy of more than 250 outcrops and 181 new radiocarbon age dates. The magmatic activity of La Soufrière (frequency and magnitude) is significantly higher than previously interpreted with ≥ 16 eruptions in the last 1500 years. Activity over the last 12 000 years consists of at least 10 major explosive eruptive phases with a large range in magnitude (erupted volume: 0.01 to 1 km³), and at least 9 dome-forming eruptive phases of large magnitude (> 0.1 km³) characterized by an important explosivity including vulcanian pumice-producing phases and the generation of at least 6-7 high-energy pyroclastic density currents. At least 8 flank-collapse events are associated with these eruptive events. La Soufrière activity is dominated by multi-stage eruptive events (e.g. flank-collapse, dome growth, explosive open-conduit activity) that occur over a short yet unknown span of time. Hence, base-rate eruption probabilities for Soufrière de Guadeloupe can be updated now with this new chronology of activity. Moreover, eruptive recurrence, magnitude and intensity place quantitative constraints on the event tree of La Soufrière to elaborate credible scenarios in case the current unrest, with evidence of the involvement of magmatic fluids, leads to a renewal of activity at La Soufrière. Thus, the most probable scenario would involve a major dome-forming phase that is likely to be associated with partial flank instability of the dome and a major explosive subplinian phase that could share some analogy to the 1530 AD event. However, the detailed reconstruction of the eruptive past also highlights the occurrence of smaller vulcanian explosive eruptions as well as less frequent Plinian eruptions of higher magnitude that would have much more widespread impact. As an example of what is being considered for each major eruptive scenario, we present preliminary results of computational deterministic as well as probabilistic simulations of subplinian tephra dispersal and fountain collapse PDCs. This serves as a basis for elaborating a quantitative framework for the assessment of their impact on vulnerable infrastructures, networks, and population including preliminary results on the influence of socio-cultural risk perception and governance issues on disaster preparedness. This work has implications for volcano monitoring, risk-informed decision-making for crisis response and long-term strategies of volcanic risk mitigation for Lesser Antilles volcanoes.



CONCLUSIONS - QUESTIONS:

- Holocene activity is much more explosive than previously assessed 6-7 subplinian-Plinian VEI 3-4 eruptions; last magmatic explosive eruption in 1657 Cal AD. What are source & ascent/conduit controls on eruptive style transitions? Magmatic capacity?
- Do historical failed-magmatic eruptions (1797-98, 1836-37, 1976-77) and recurrent Cl degassing pulses record recurrent magmatic fluid injections from depth (dykes?) into hydrothermal system? Will this lead to a new magmatic eruption? What style and magnitude?
- Multi-stage magmatic versus failed magmatic eruptions (eg. 1976) – contrasting hazards & monitoring / forecasting / crisis response challenges
- What about edifice intrinsic instability and pressurization of the hydrothermal system including during recurrent failed-magmatic eruption?
- time-series of volcanic intensity & magnitude – ramping-up multistage eruption versus slow-onset activity versus multiple peak & on-off activity
- conduit control on eruptive style transition with ascent of slow partially degassed magma (dome) evolving within 1 eruption to ascent of fast gas-rich magma
- Coupled chain-link hazard sequence (tectonic – volcanic – tsunami; climatic forcing)
- Protracted low-level gas and ash emission activity: 1976 (2hrs), 1797 (3 days), 1837 (2 months)
- Maximal scenario: Soufrière versus Grand Découverte Soufrière complex (caldera eruptions)