

The historical record of pyroclastic density currents at Stromboli and perspective for future hazard assessment

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PDC on "basaltic" volcanoes

Historical cases: Aso, Shin-Fuji and Asama (Japan); Mayon (Philippines); Fuego Volcano, Guatemala (1974); Ngauruhoe, NZ (1975);

In Italy: Vesuvius (1779, 1822, 1906, 1944, etc.); Mt. Etna (several events, the last in 2014); Stromboli (...1906, 1930 and 1944);



Characterizing features:

- Small-mid volumes ($< X \cdot 10^7 \text{ m}^3$);
- High speed ($> 15\text{--}25 \text{ m/s}$);
- Very high temperatures (up to $700\text{--}900^\circ$);
- Long run-out, comparable to those of classic
- PDC of the same volume (es. $> 8 \text{ km}$ at Ngauruhoe, NZ);

PDC on “basaltic” volcanoes

Main triggering mechanism:

- Collapsing columns (Calvari et al., 2006; Rosi et al., 2006);
- **Over-pressurized explosions** (Pistolesi et al., 2011; Bonaccorso et al., 2012);
- Gravitational collapse of the crater rim (Alvarado and Soto, 2001; Pinkerton and Calvari, 2002; Cole et al., 2005; Behncke, 2010)
- **Non-explosive gravitational collapse/sliding of hot pyroclasts emplaced on steep slopes** ($>27^{\circ}$ - 33° ; Miyabuchi et al., 2006; Di Roberto et al., 2014; Andronico et al. 2018);

Flow mechanisms:

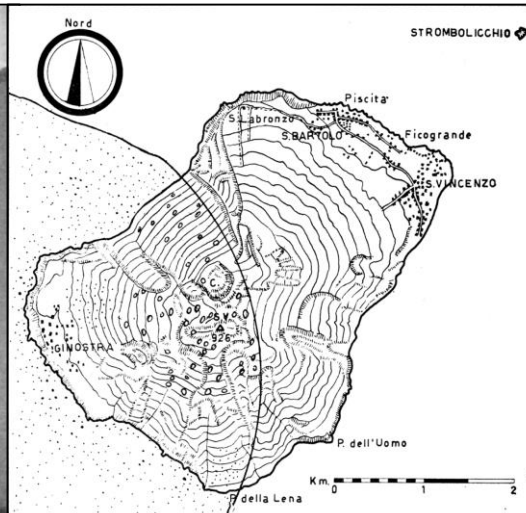
- Grain flow to rock avalanche-like dynamics;
- Very low fluidization;
- Gravity-controlled, strongly influenced by the slope morphology;
- Run out strongly influenced by channelization (*up to twice the normal run out for highly channelized flows*)

PDC - Why study them on Stromboli?

PDCs similar to those of 3 July and 28 August 2019 are not uncommon **INSIDE** the Sciara del Fuoco during paroxysm:



28 August 2019



11 July 1959
and many
others...

PDC - Why study them on Stromboli?

Gravity-induced PDC occurred also **OUT** of the Sciara del Fuoco at least in:

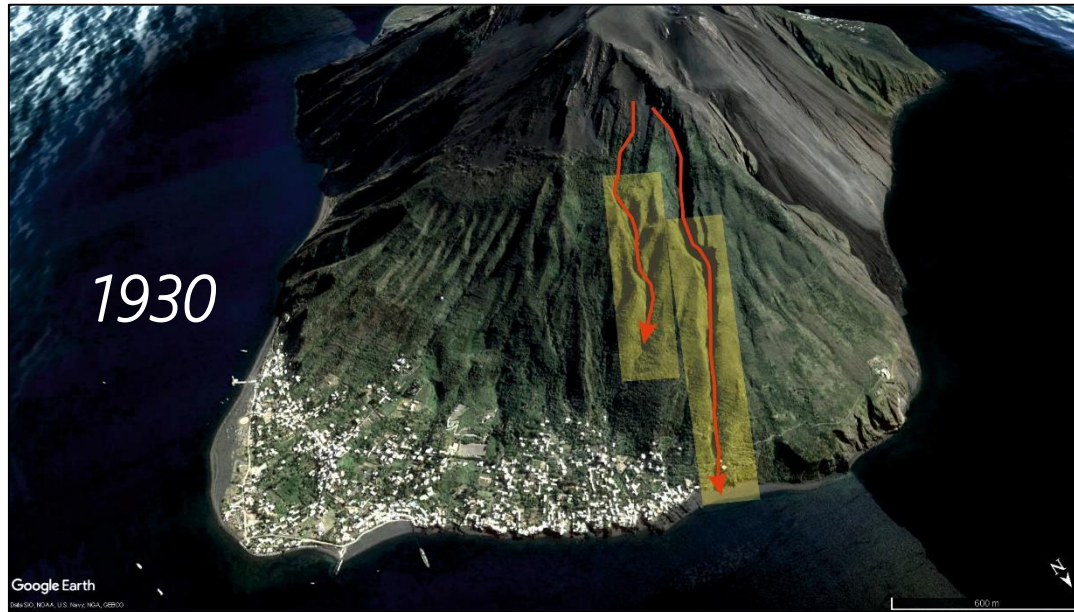
1906 "...una grande quantità di materiale incandescente che investe la località Forgia Vecchia...ed arriva a mare...**Una colata di materiale ignescente si riversa nella direzione della Borgata Ginostra...**" *Riccò, 1907.*

1930 "alle 10:40 (più di un ora dopo la fine del parossismo)...**sopra S. Bartolo si formava una valanga incandescente**...durante l'eruzione si formava un deposito spesso quasi un metro di scorie e cenere senza sostegno che cominciava di scivolare giù...**Le vigne venivano devastate dai gas e dal caldo fino ad una distanza di 50-100 m dal Vallonazzo...**" *Rittmann 1931.*

1930 " Il primo si fermò a poche decine di metri dalla Chiesa di S. Bartolo, mentre il secondo arrivò fino al mare, formando un piccolo promontorio, largo metri 20 e lungo metri 25, a partire dalla linea di spiaggia... "" essa (la valanga) superato l'orlo della fossa si abbattè fin verso la località Campaneddu **e lì si divide incanalandosi nei due torrenti**" *Abbruzzese 1935*

1944 "enorme materiale rovente misto a blocchi...cadde sulla parte alta del volcano e sul declivio di Forgia Vecchia fino alla spiaggia **protendendosi nel mare per circa 100 m...**" *Ponte 1948*

PDC - Why study them on Stromboli?



"...Le vigne venivano devastate dai gas e dal caldo fino ad una distanza di 50-100 m dal Vallonazzo..."
Rittmann 1931

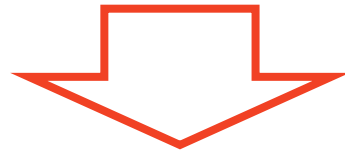
"protendendosi nel mare per circa 100 m..."
Ponte 1948



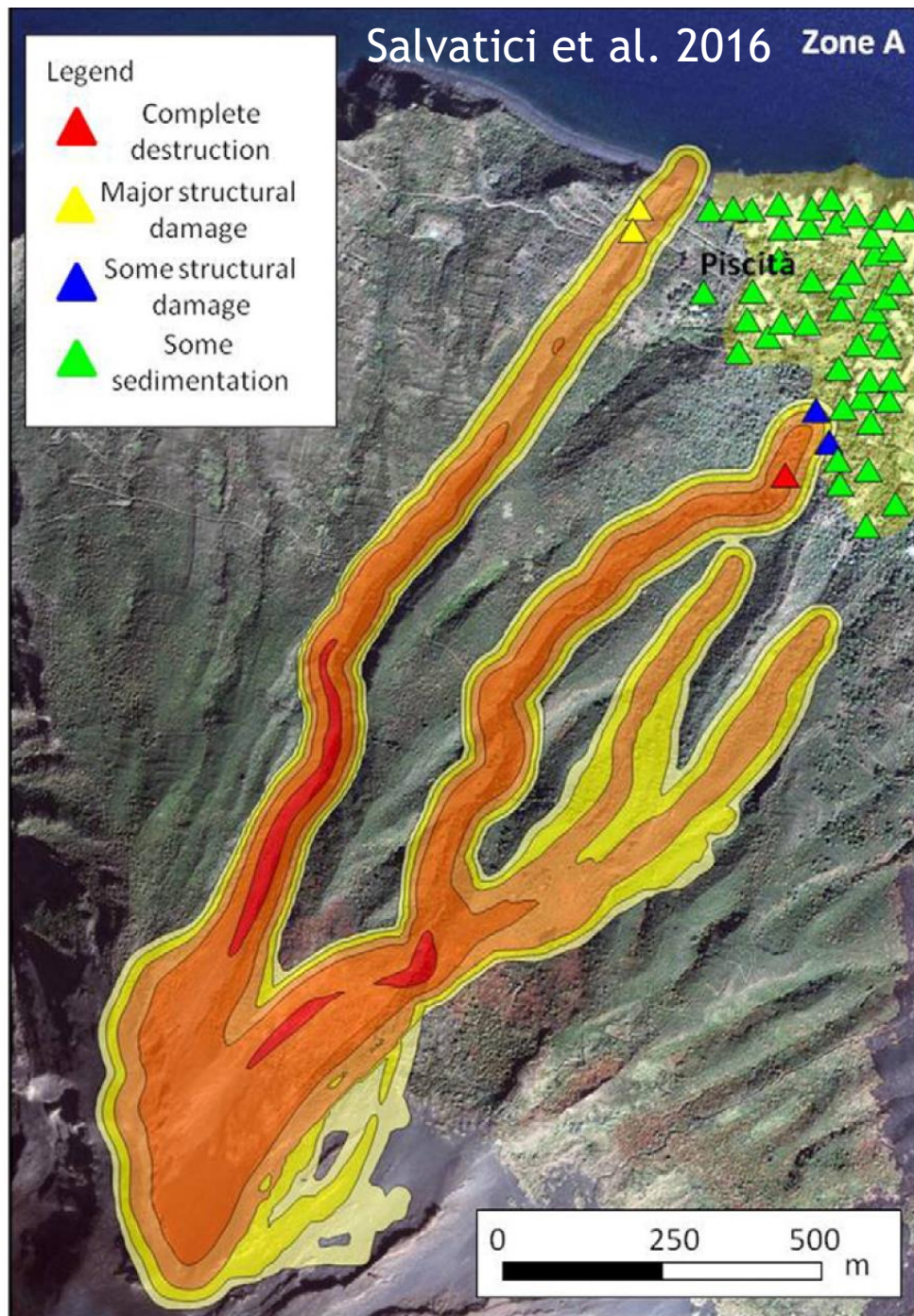
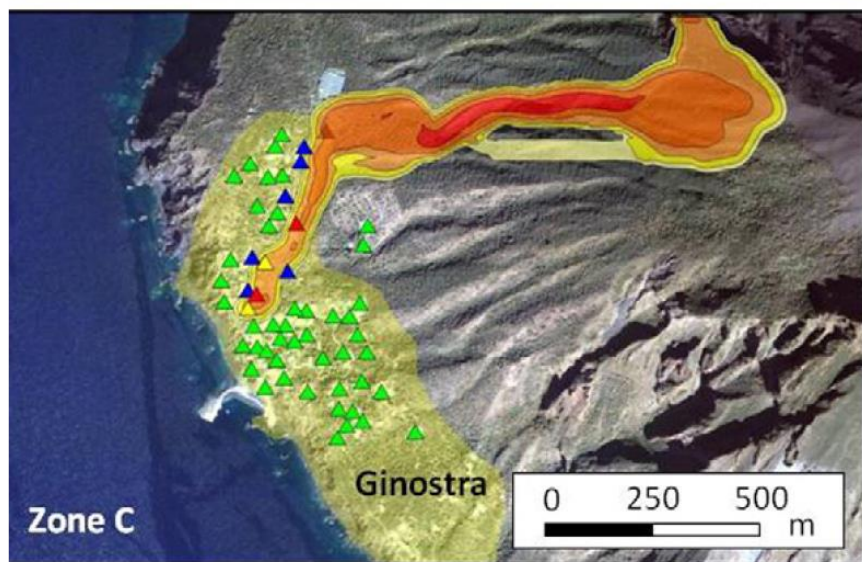
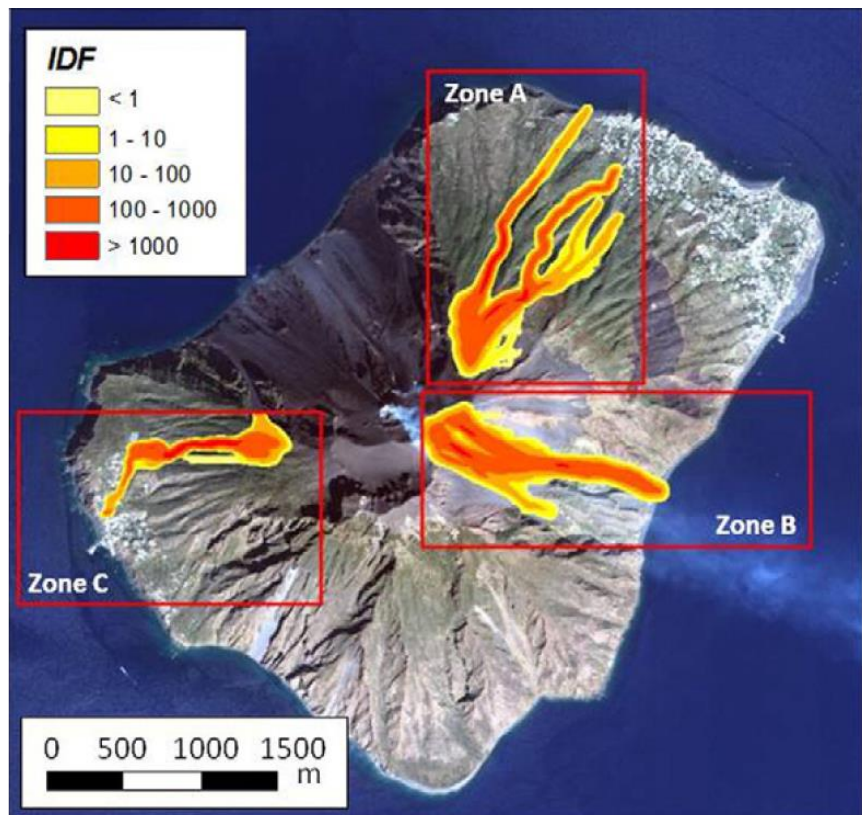
General remarks

Information on Stromboli derived from studies published so far (Bertagnini et al 2011; Di Roberto et al. 2014; Salvatici et al 2016):

1. Not uncommon INSIDE and OUTSIDE the SdF;
2. Have the possibility to severely hit the inhabited areas;
3. Fast (15-20 m/s) and hot (<750°);
4. Strongly influenced by the slope morphology (channelization);
5. They can extend the hazard related to paroxysm (1-2 hrs);

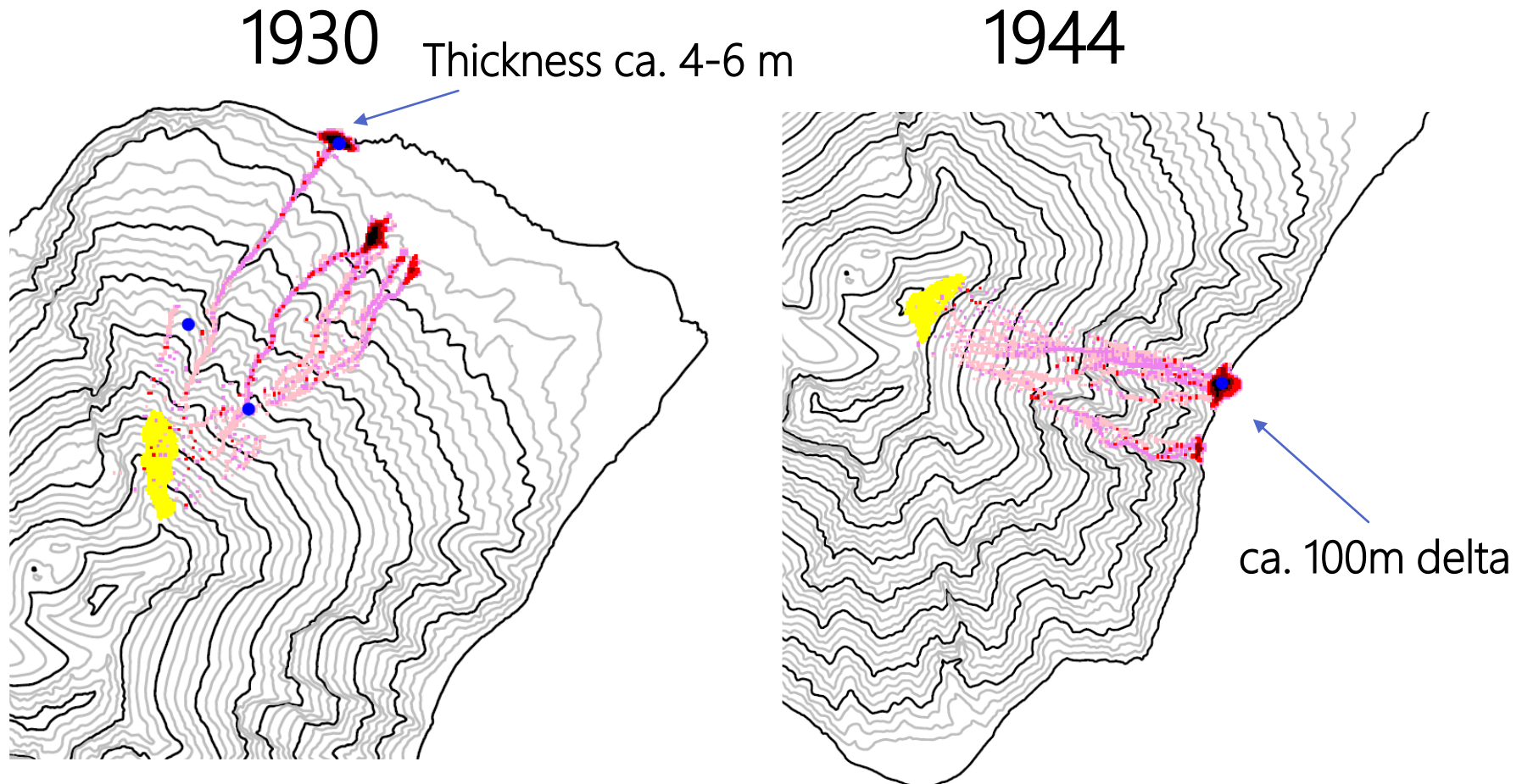


NO HAZARD ASSESSMENT



Modeling of PDCs at Stromboli

Preliminary results of numerical simulation (1930 and 1944) using `IMEX_SfloW2D` (de' Vitturi et al., 2019) depth averaged granular model based on previous works of Di Roberto et al. (2014) and Salvatici et al. (2016).



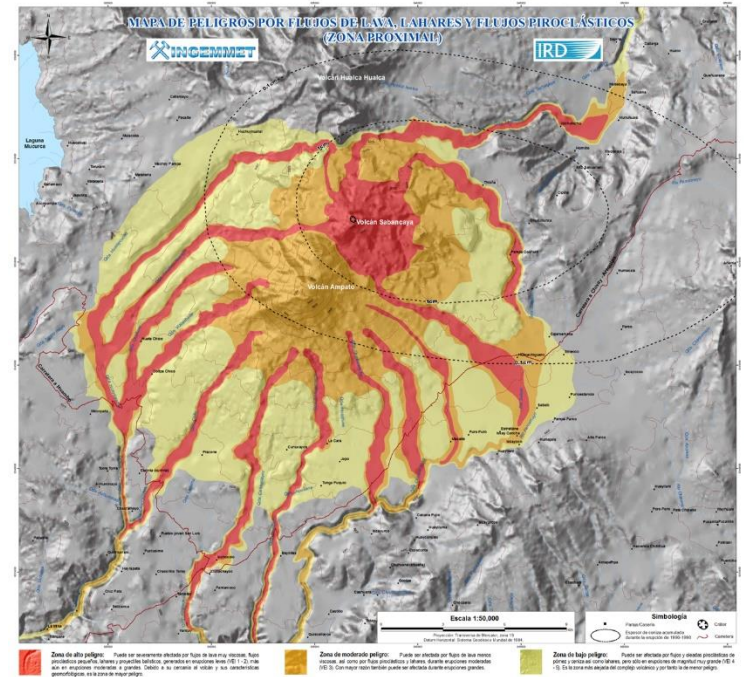
Future developements

These preliminary results will be followed by:

- Characterization of volcano slope for the determination of possible source areas of PDC (es. drainage patterns and slope gradients, etc...), in case of paroxysm;
- A set of numerical simulations using **IMEX_SfloW2D code** (de' Vitturi et al., 2019);



FIRST PDC HAZARD ASSESSMENT QUALITATIVE/QUANTITATIVE EVALUATION



A map illustrating hazards at the Ampato-Sabancaya volcanic complex (high danger, red; moderate danger, orange; and low danger, yellow). Types of volcanic hazards include pyroclastic flows (including debris flows), mudflows, lava flows, and avalanches.