

Etude structurale des volcans par
couplage de méthodes géoélectriques,
thermique et gaz diffus:
implication en surveillance volcanologique.

Anthony Finizola

*Laboratoire GéoSciences Réunion – IPGP
Université de la Réunion*

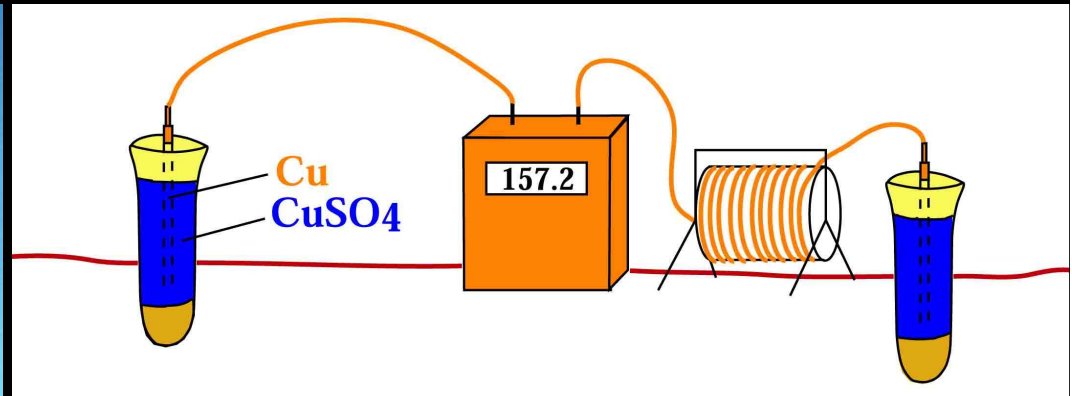
GéoSciences
www.geosciencesreunion.fr
Réunion

1. Self-potential mapping

- * Hydrothermal systems
- * Structural boundaries
- * Highest permeability areas
 - * Structural
 - * Monitoring

2. 2D cross section: Electric Resistivity Tomography + Self-potential + subsurface soil temperature + CO_2 soil degassing

Self-potential : ΔV (mV)



Meteoritic water

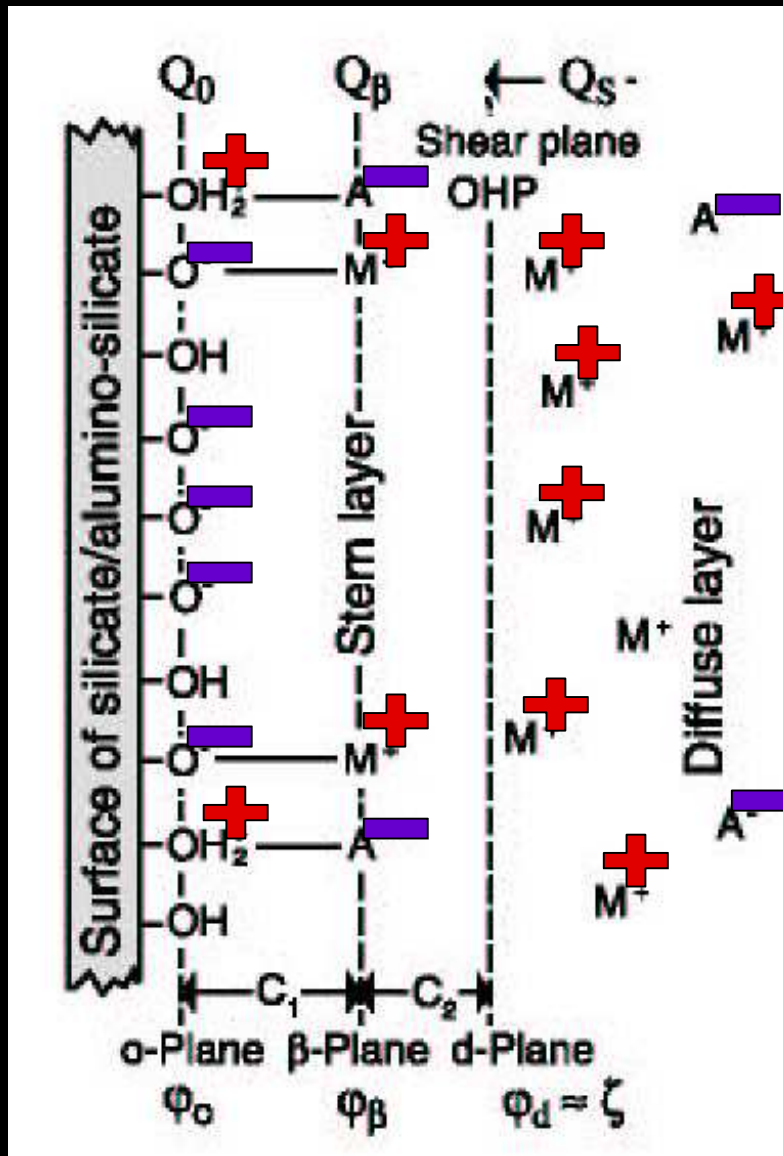
H₂O



Dif. potential (mV) Streaming potential

Water/mineral interaction

Mineral



Water

* Diffuse layers of Volcanic rocks : Positive charges

* Fluid flow : Drags positive charges toward the flow direction

→ Electrical Potential at the macroscopic scale

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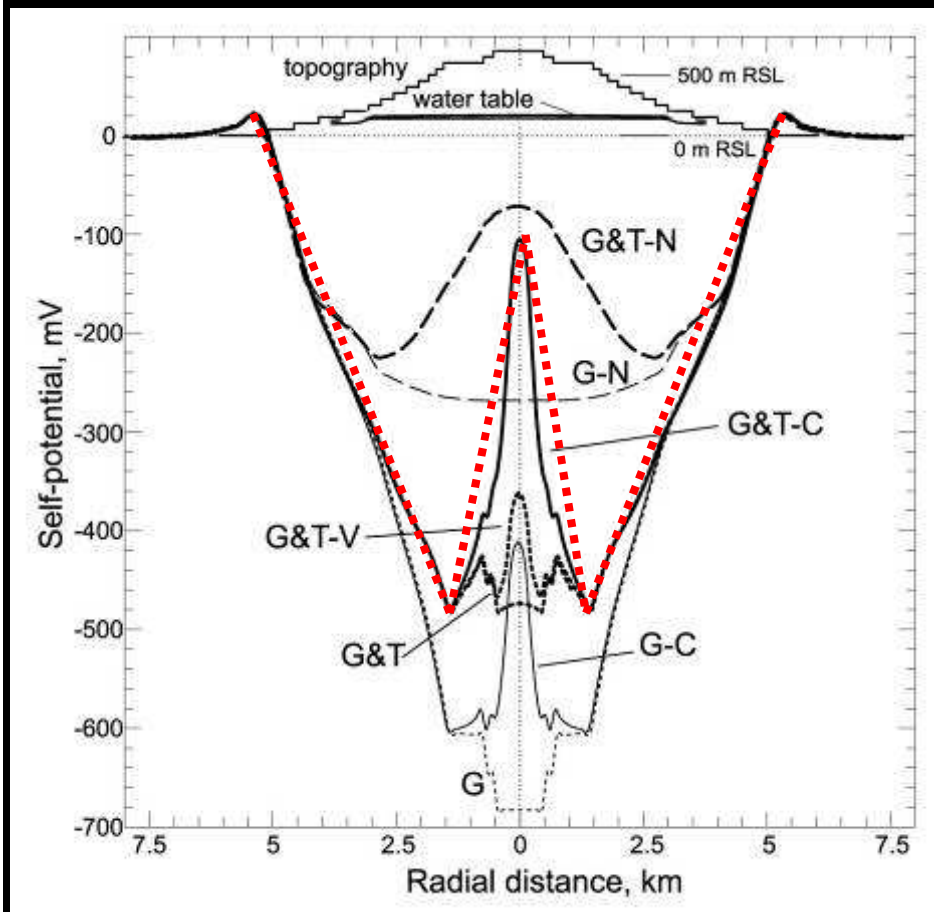
2. 2D cross section: ERT + Self-potential - subsurface soil temperature - CO_2 soil degassing

Electrokinetic mechanism for the “W”-shaped self-potential profile on volcanoes

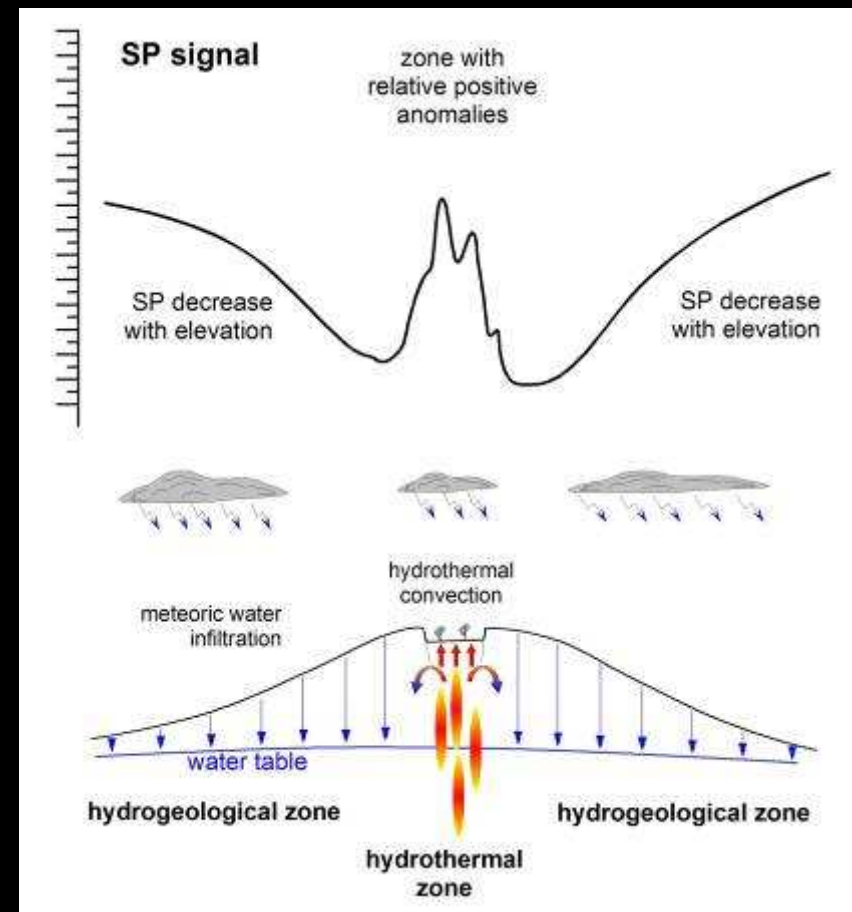
Streaming potential

T. Ishido

Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan

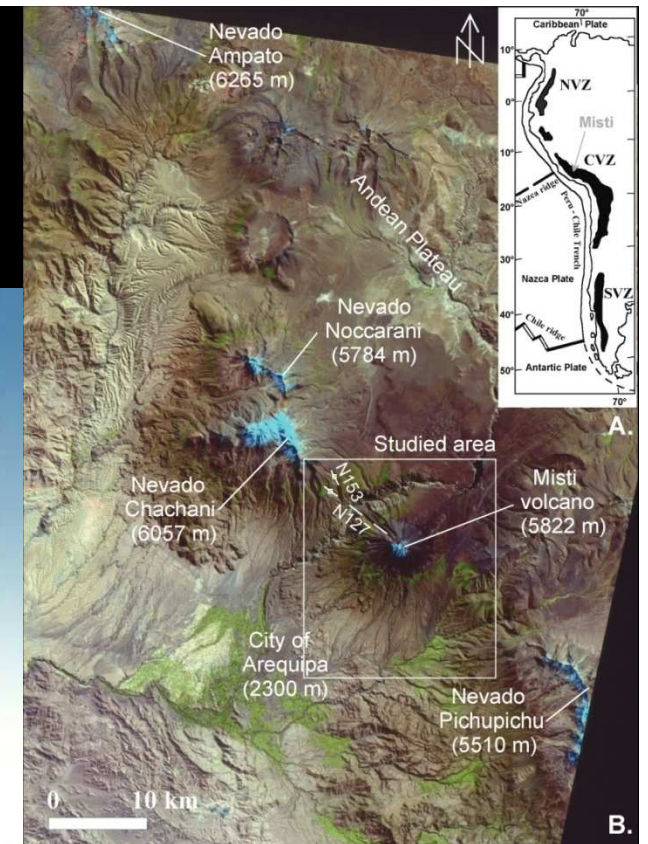


Ishido, GRL (2004)

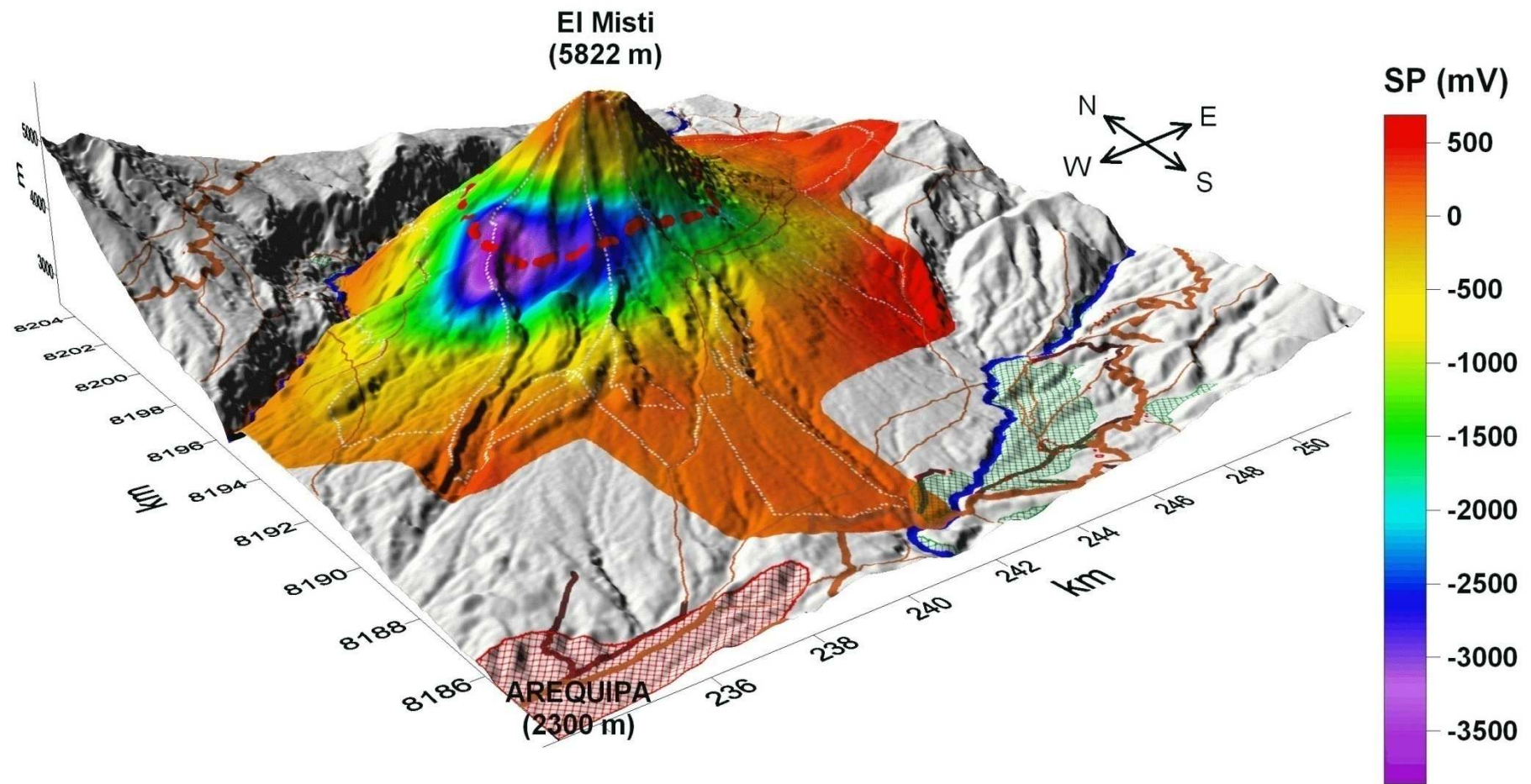


Lénat, NSG (2006)

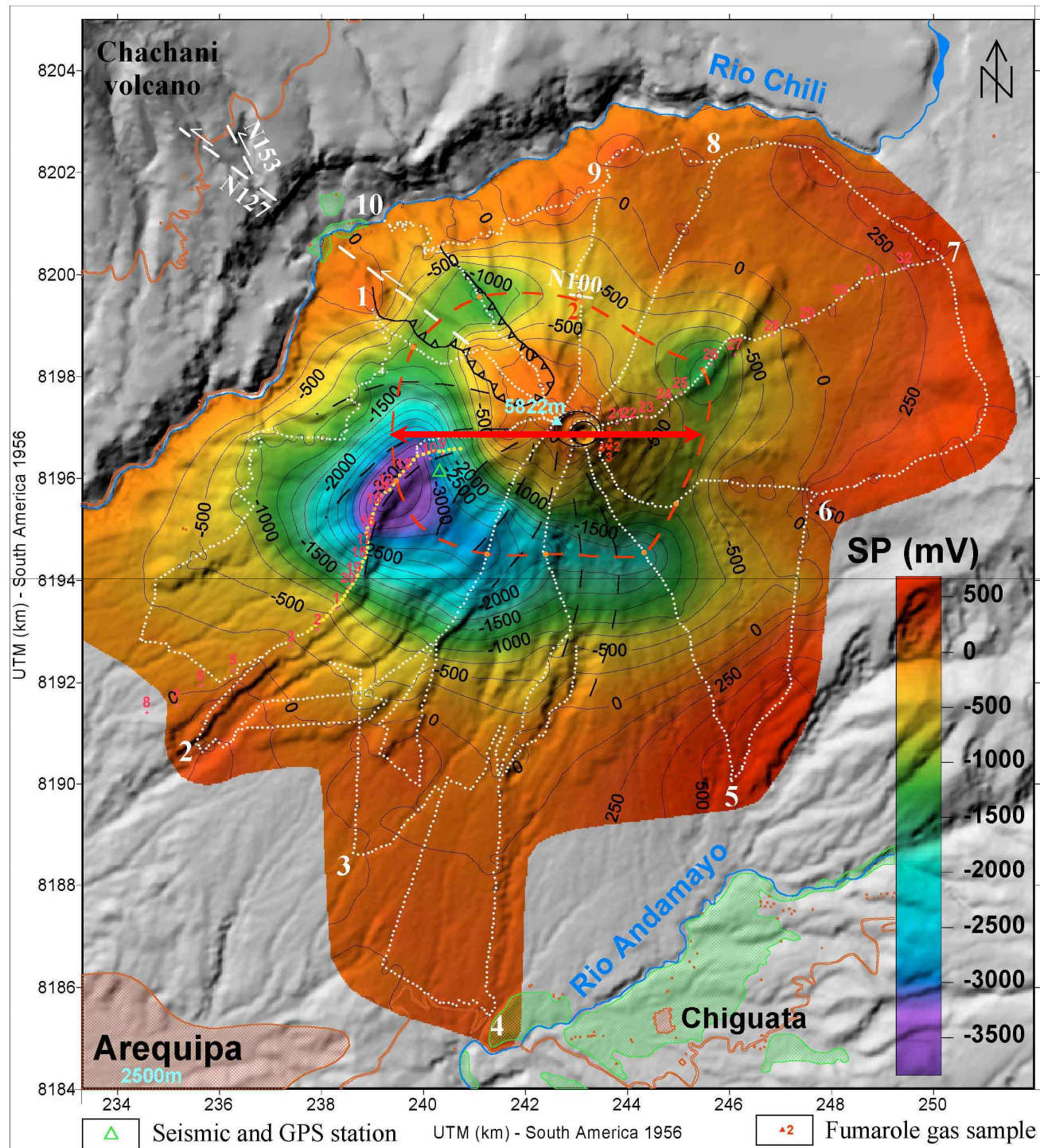
Misti (southern Peru)



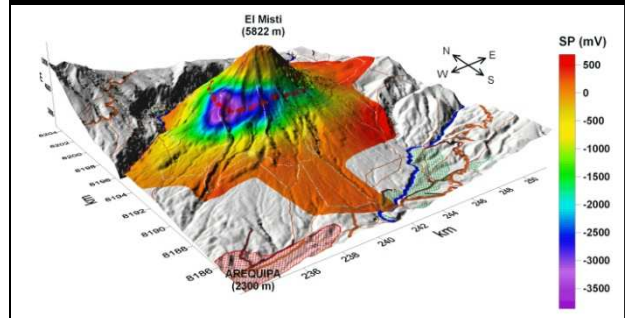
Misti



Finizola et al., JVGR (2004)



Misti

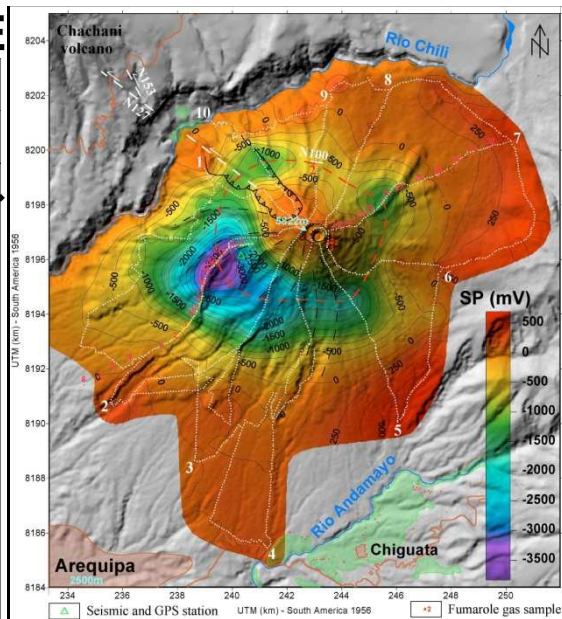
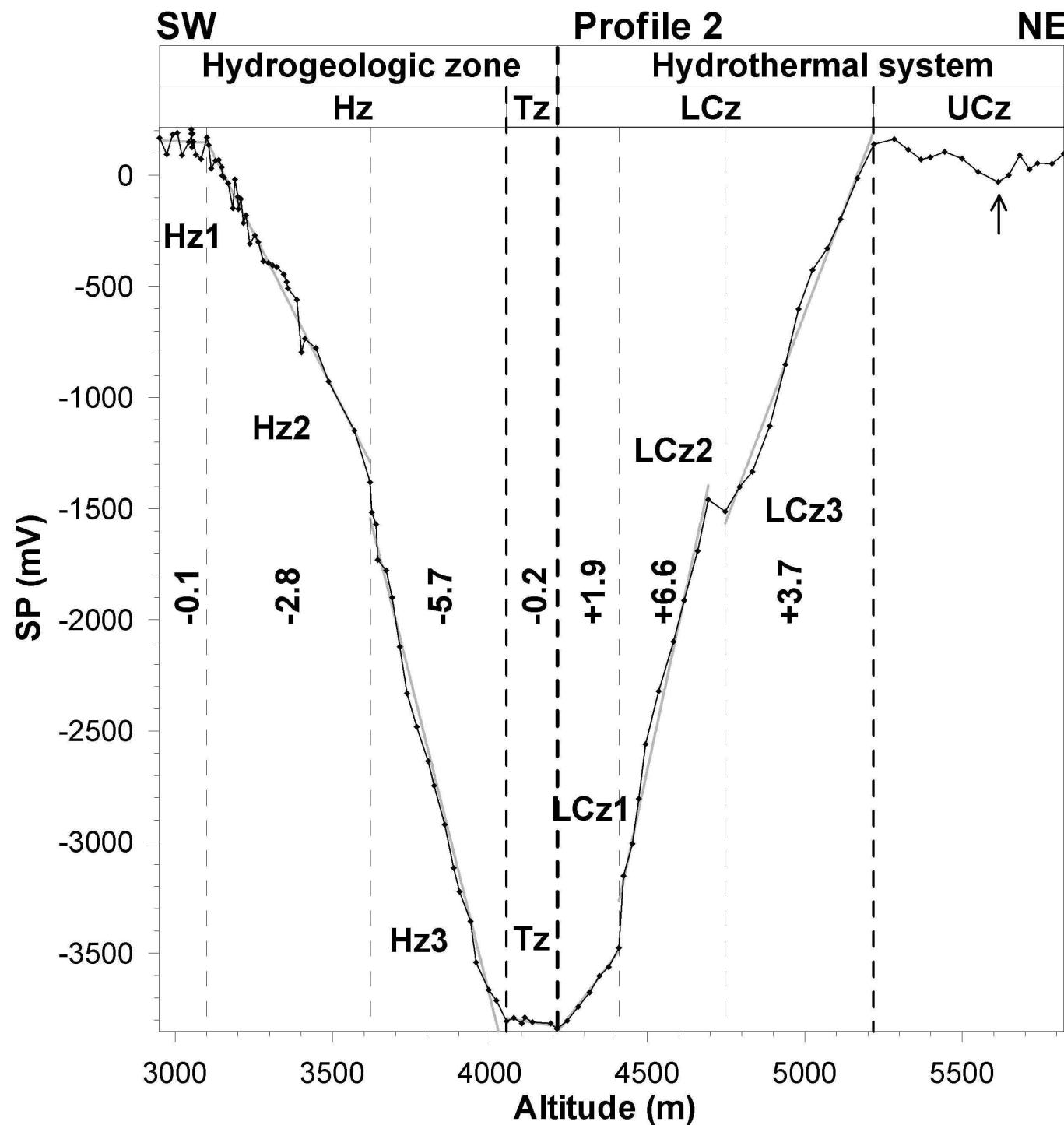


Finizola et al., JVGR (2004)

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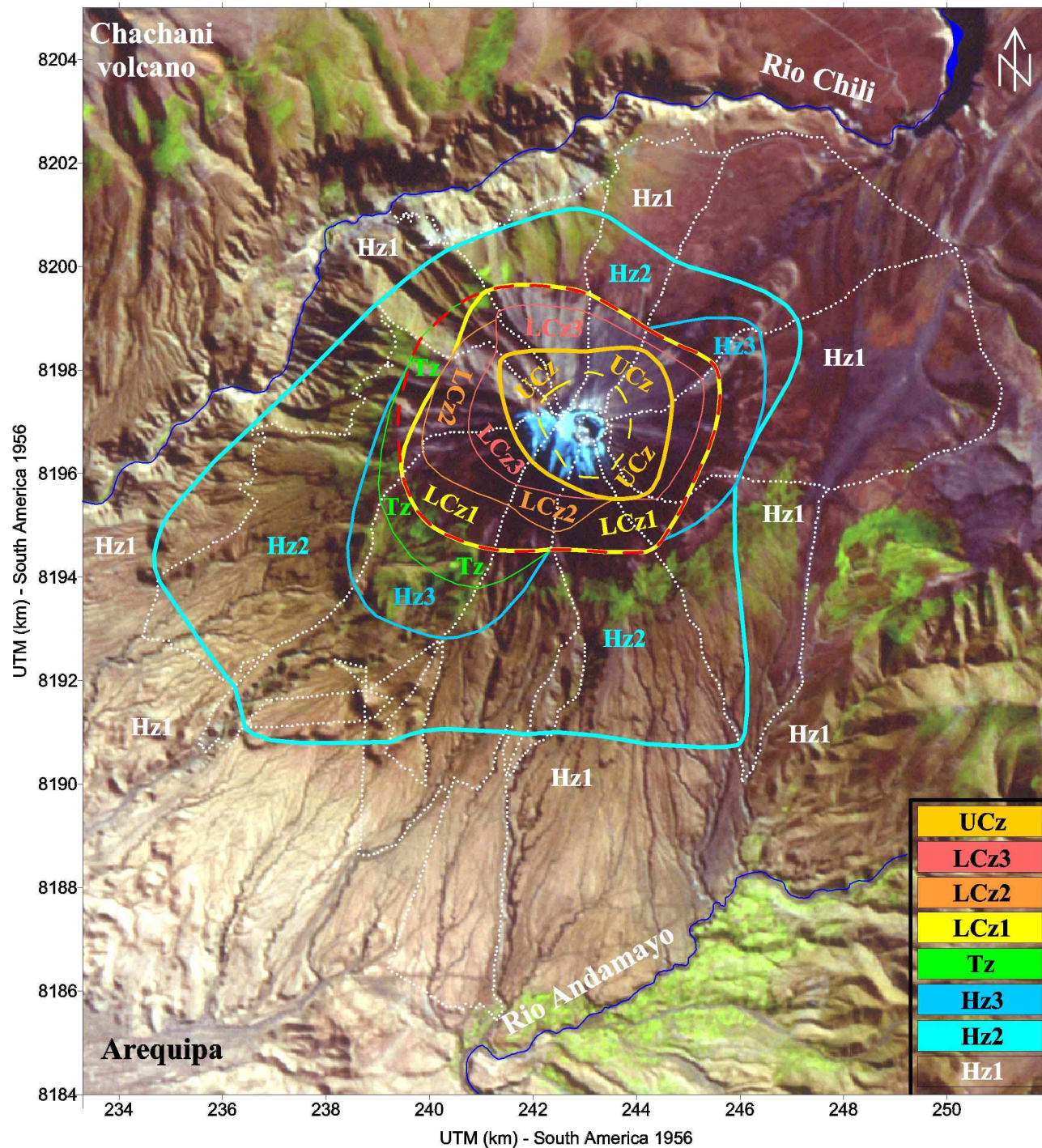
2. 2D cross section: ERT + Self-potential - subsurface soil temperature - CO_2 soil degassing



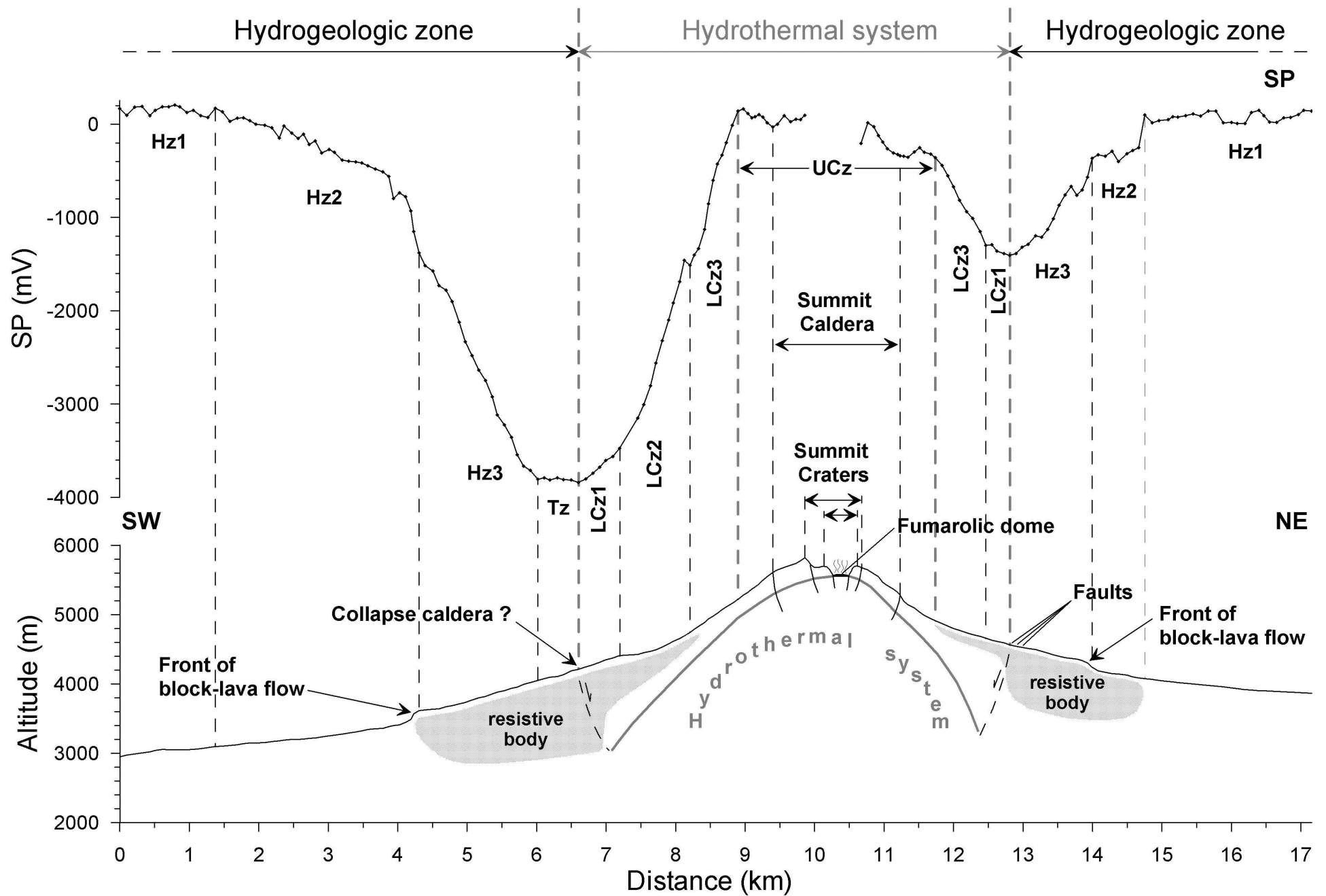
Misti

Finizola et al.,
JVGR (2004)

Misti



Finizola et al.,
JVGR (2004)



Misti

Finizola et al., JVGR (2004)

1. Self-potential mapping

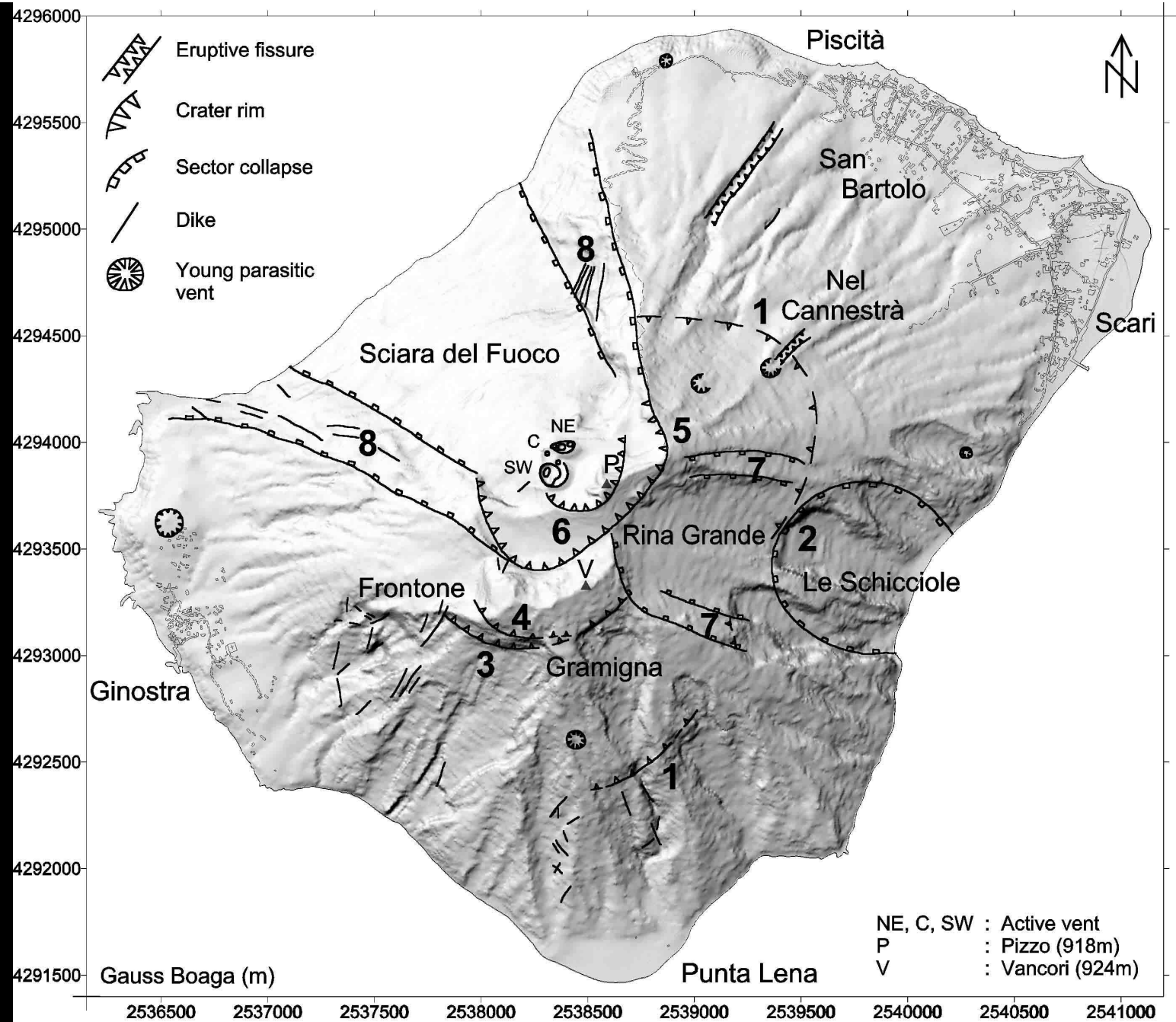
- * Hydrothermal systems
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2. 2D cross section: ERT + Self-potential - subsurface soil temperature - CO_2 soil degassing

A photograph of the Stromboli volcano in Italy, showing a large, dark, conical mountain rising from the sea. The sky is clear blue, and the water is dark blue with small waves. A small plume of white smoke or ash is visible at the peak of the volcano.

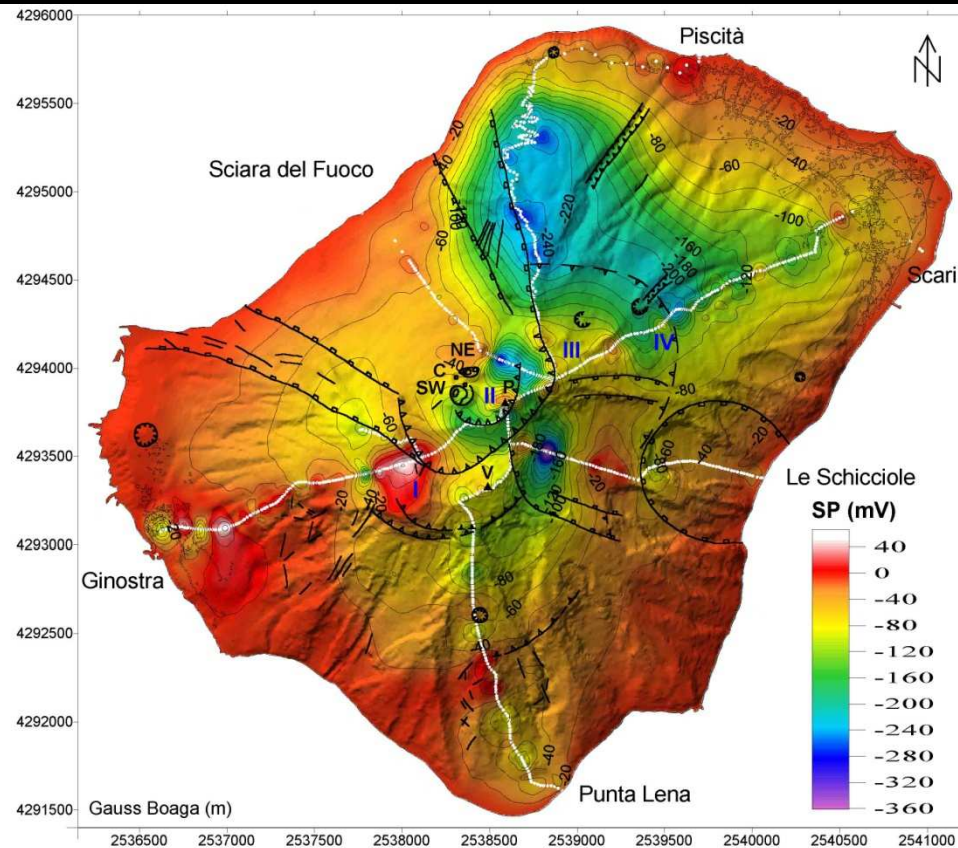
Stromboli (Italy)

Stromboli

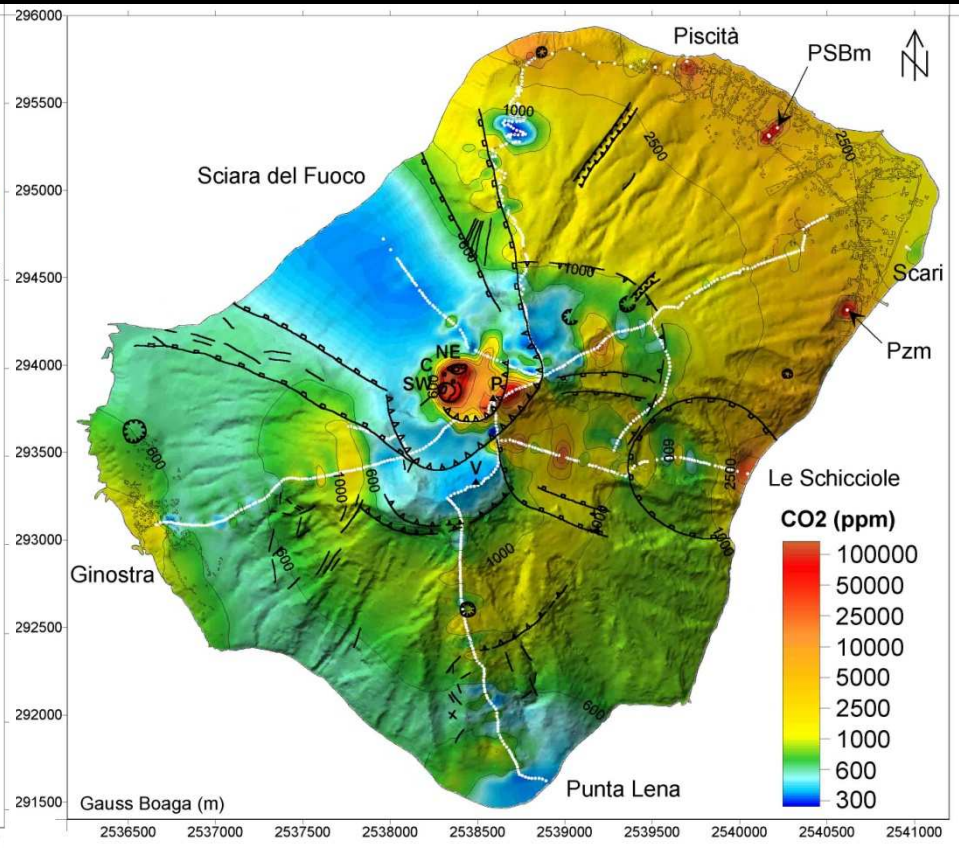


Finizola et al., JVGR (2002)

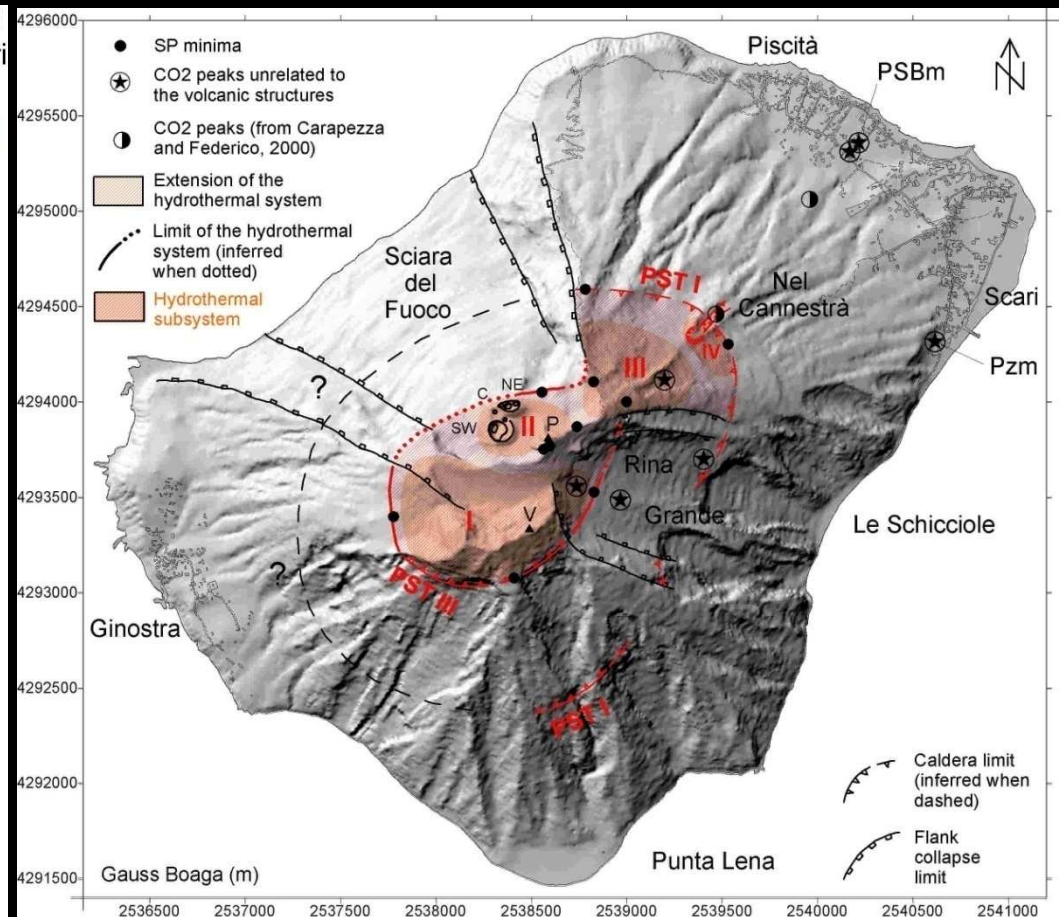
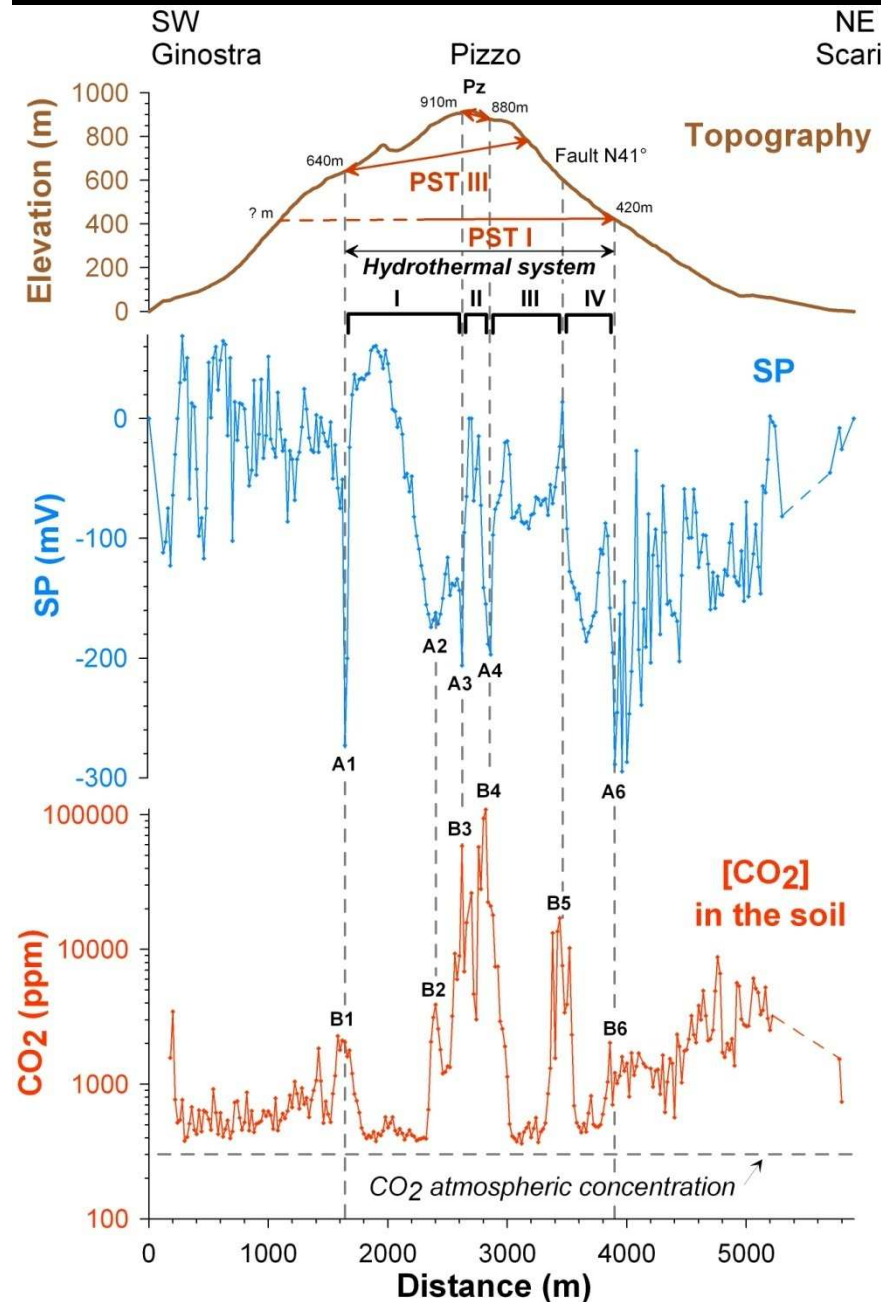
SP map



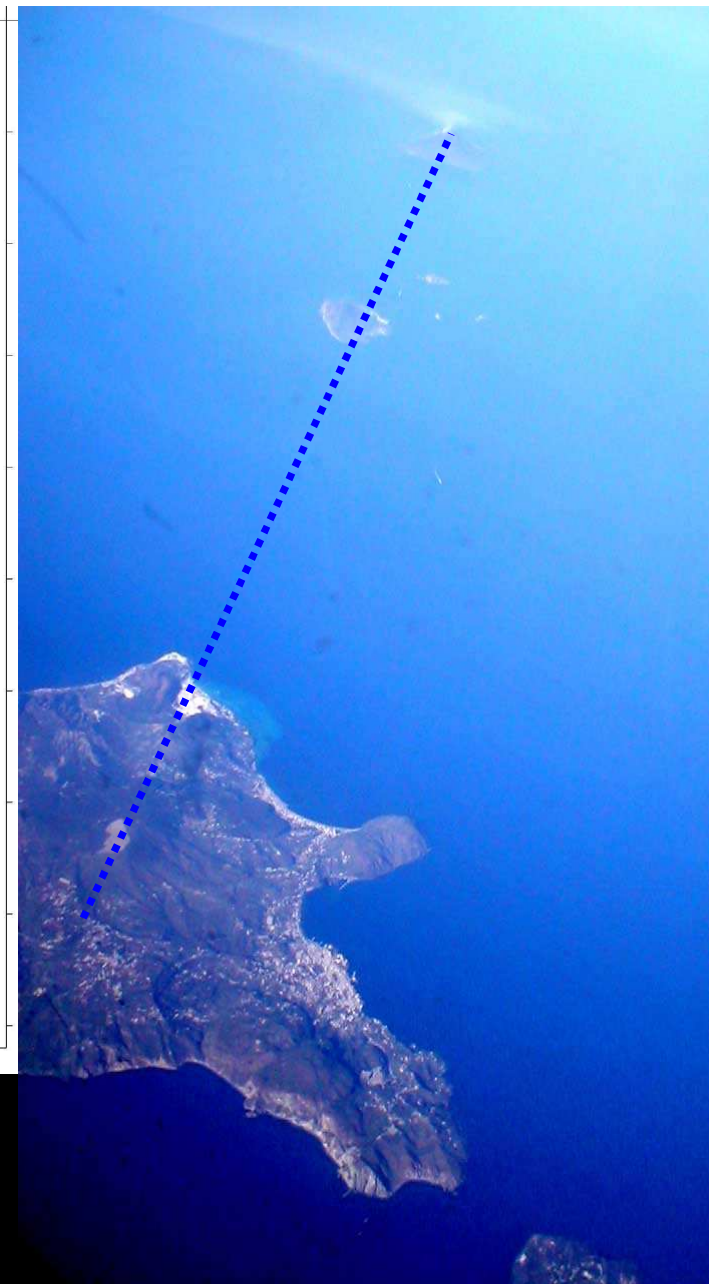
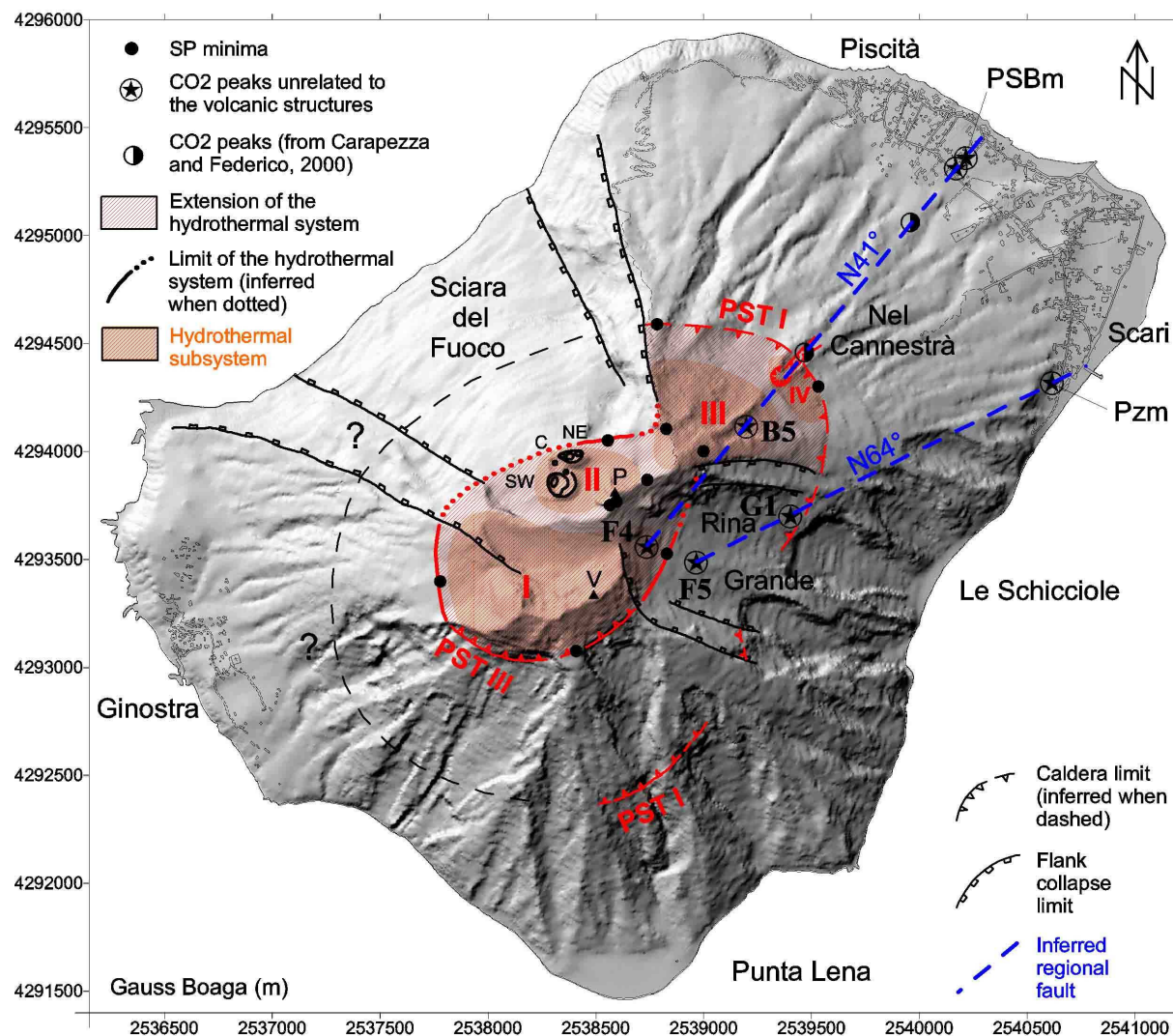
CO2 map



General trend: *SP minima with CO₂ peaks*



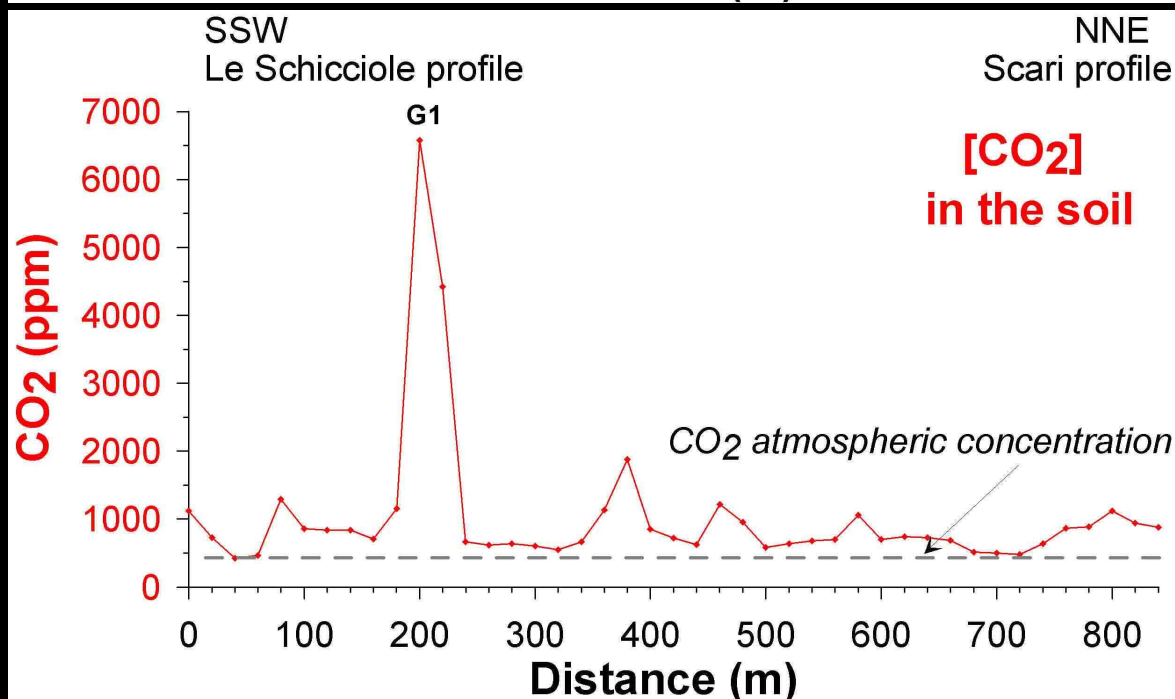
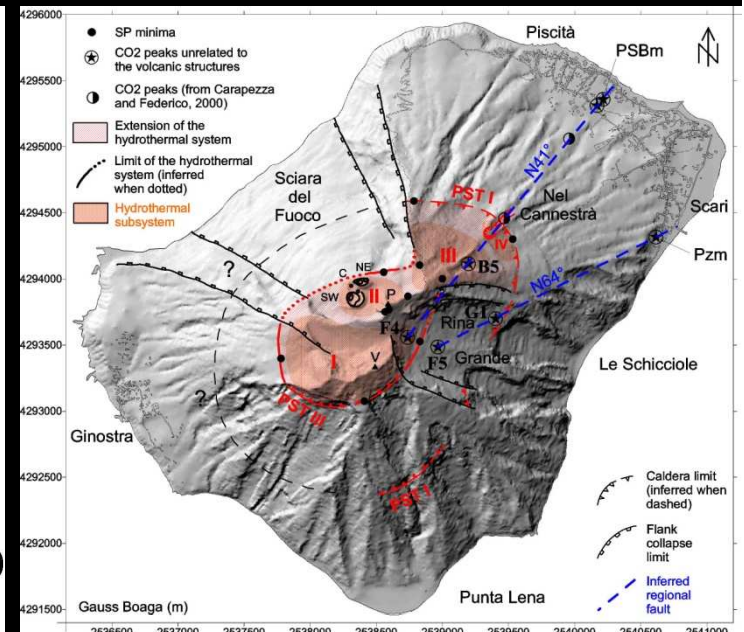
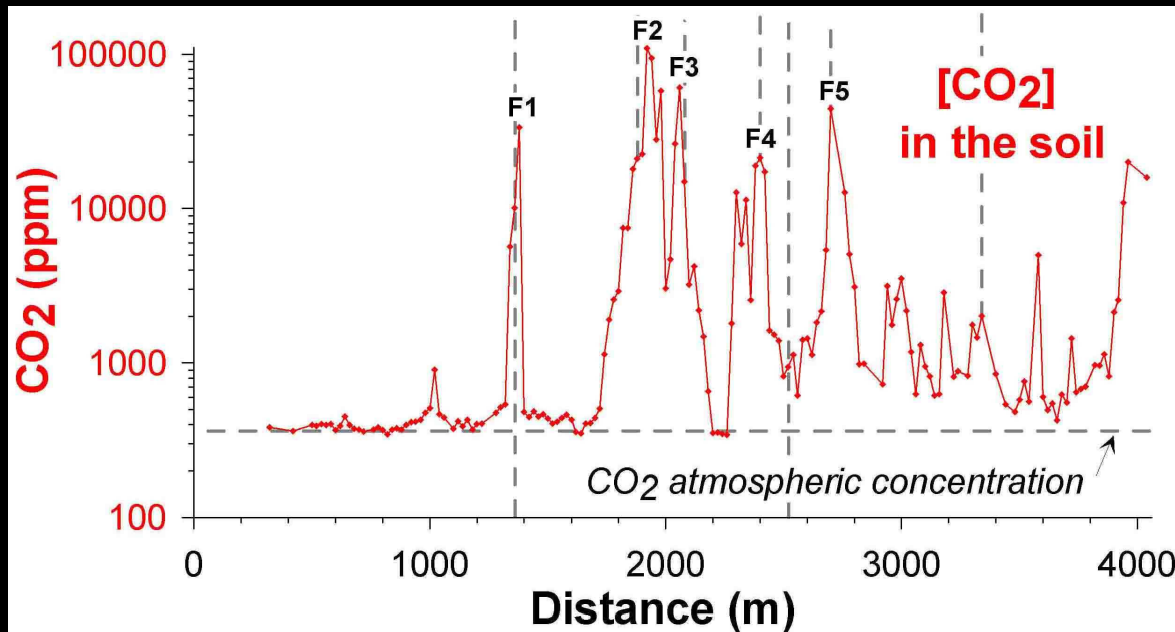
Finizola et al., JVGR (2002)



Volcanological and tectonical boundaries

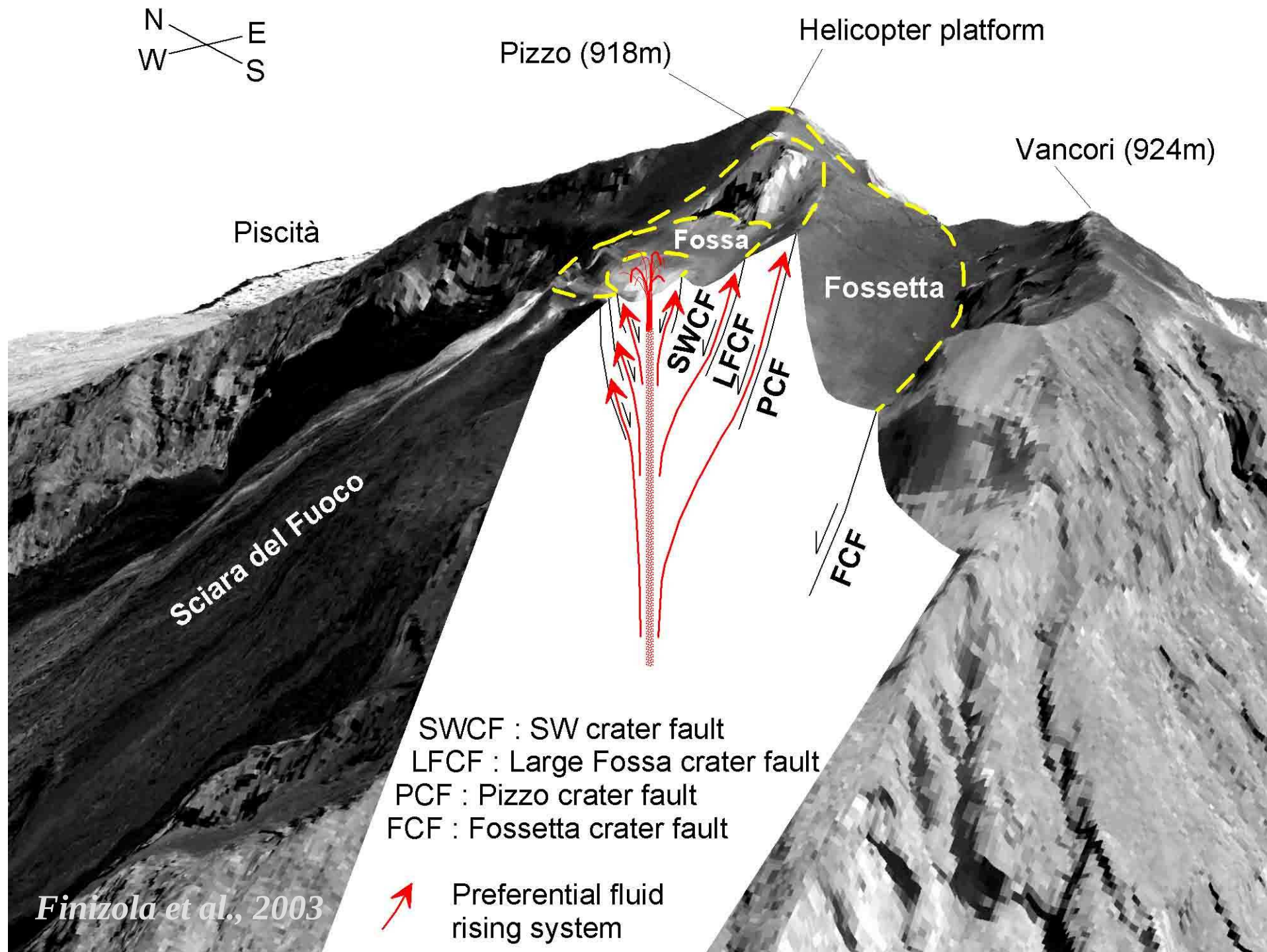
Finizola et al., JVGR (2002)

How these boundaries have been identified ?



*20 meters of step
of measurement !*

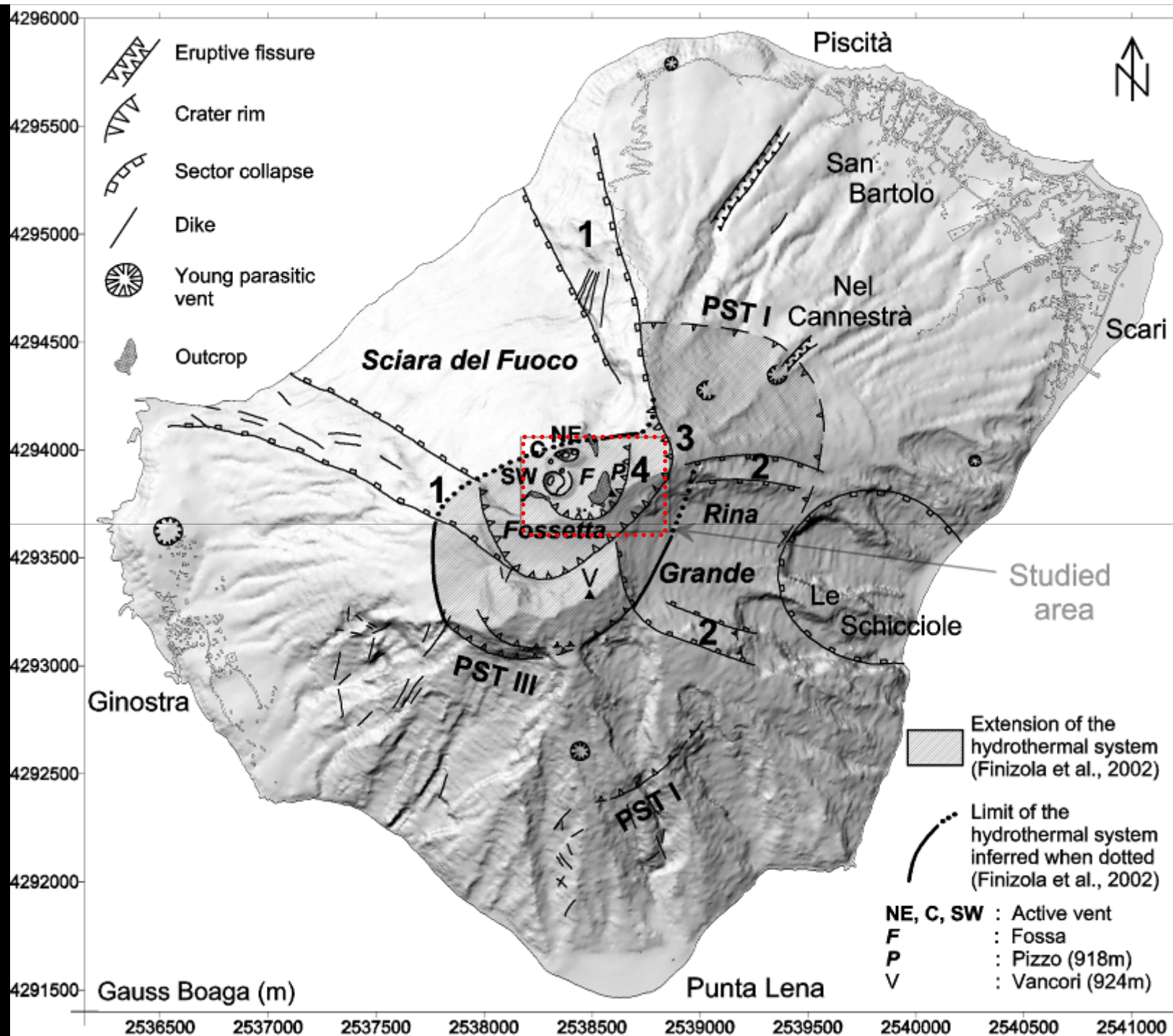
Finizola et al., JVGR (2002)



1. Self-potential mapping

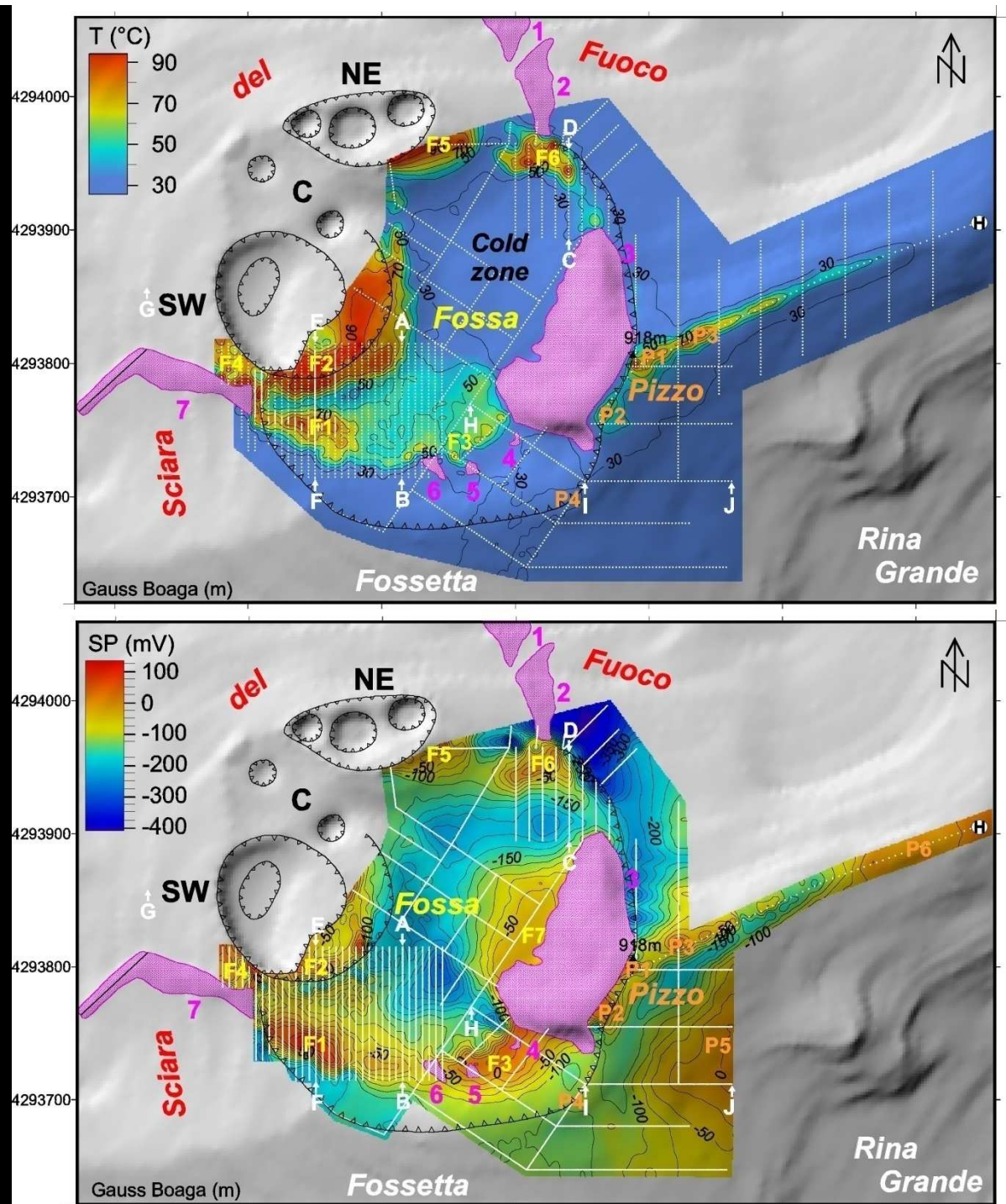
- * Hydrothermal systems
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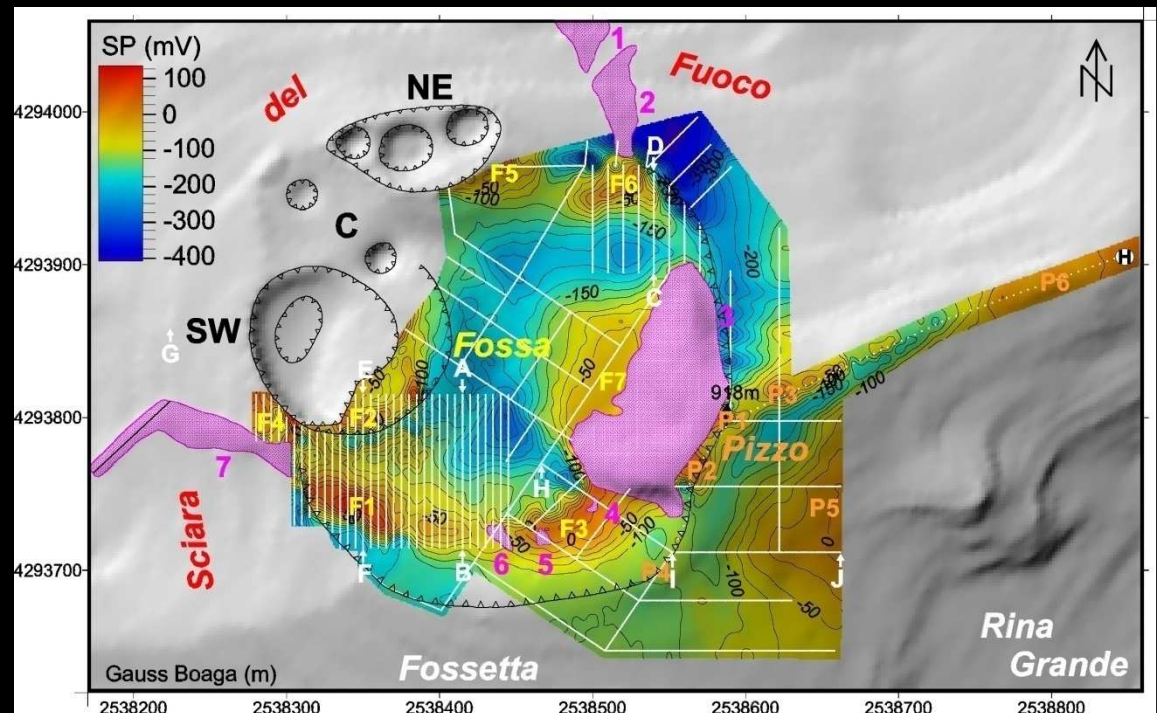
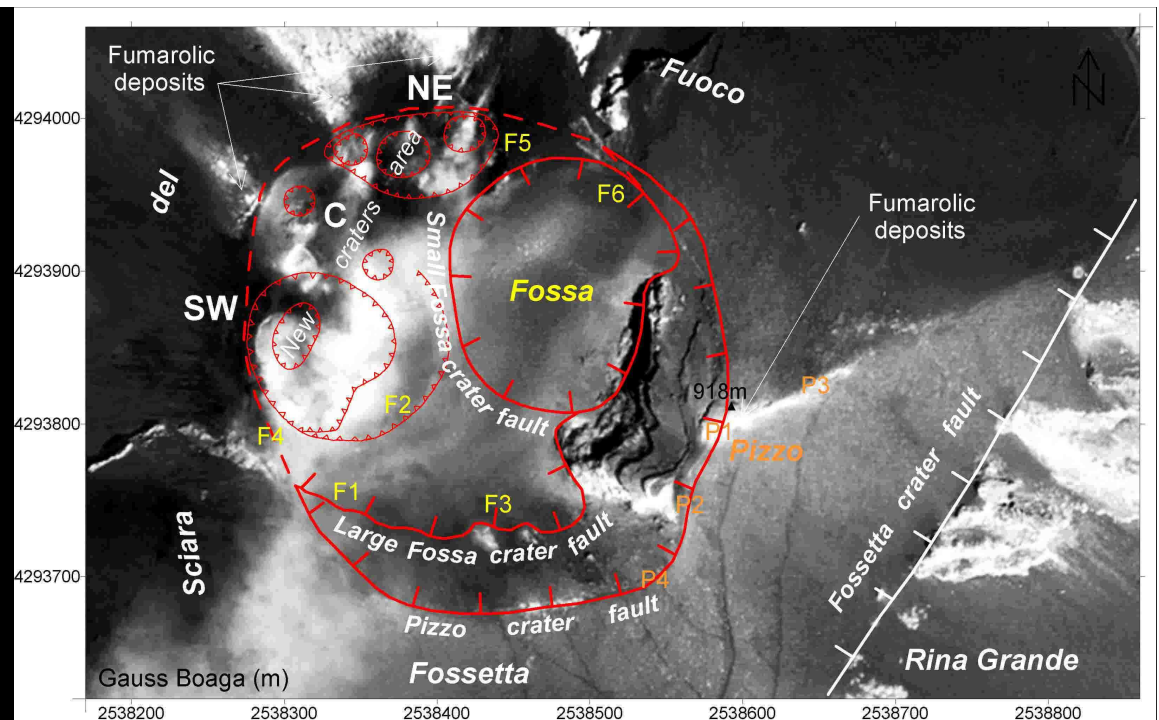




Finizola et al.,
Bull. Volcanol. (2003)

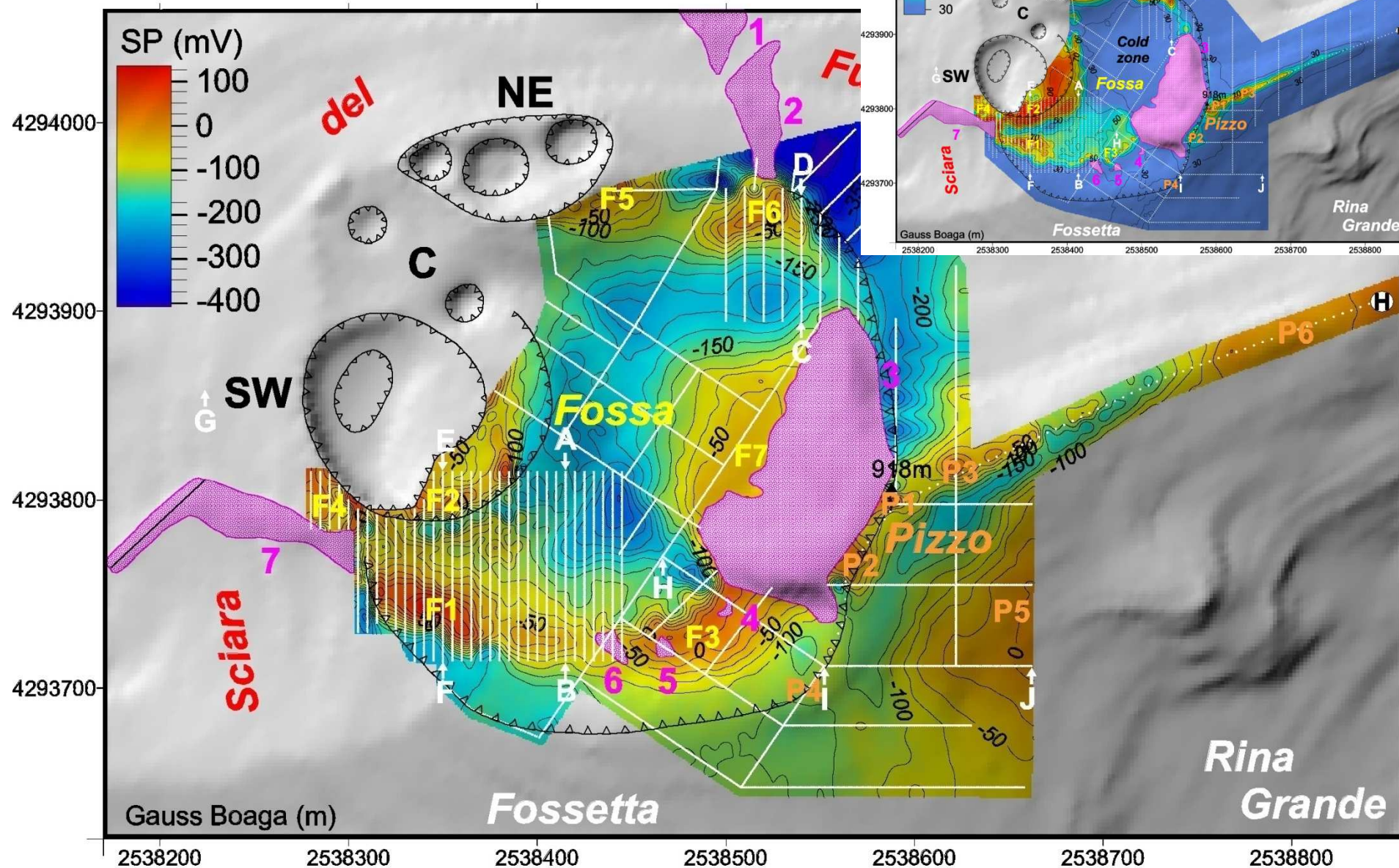


Identification of preferential fluid circulation



Finizola et al.,
Bull. Volcanol. (2003)

F1 Anomaly !!!



Finizola et al., Bull. Volcanol. (2003)

F1 Anomaly !!!

Pizzo 918 m



Finizola et al., Bull. Volcanol. (2003)

SP MAXIMUM
and
2002-2003 Stromboli
Eruptive crisis ?



Stromboli eruptive crisis : 28 December 2002

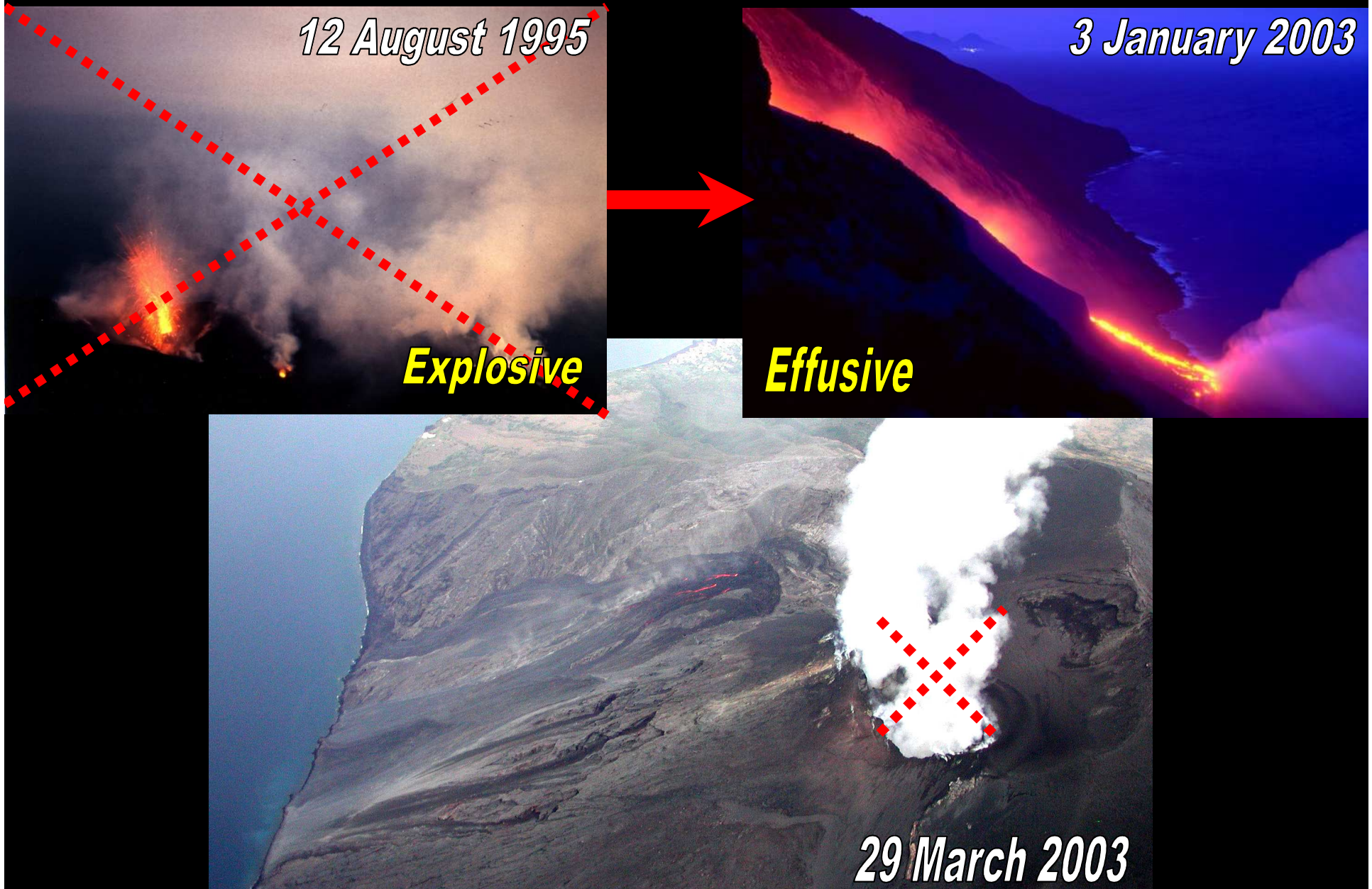
12 August 1995

Explosive

3 January 2003

Effusive

29 March 2003



Stromboli eruptive crisis

28 December 2002

***Eruptive fissure
and Lava flow***

cf. 1967-1975-1985/86



30 December 2002

2 Landslides :

13:15 and 13:22



Stromboli eruptive crisis



30 December 2002

2 Landslides :

13:15

and

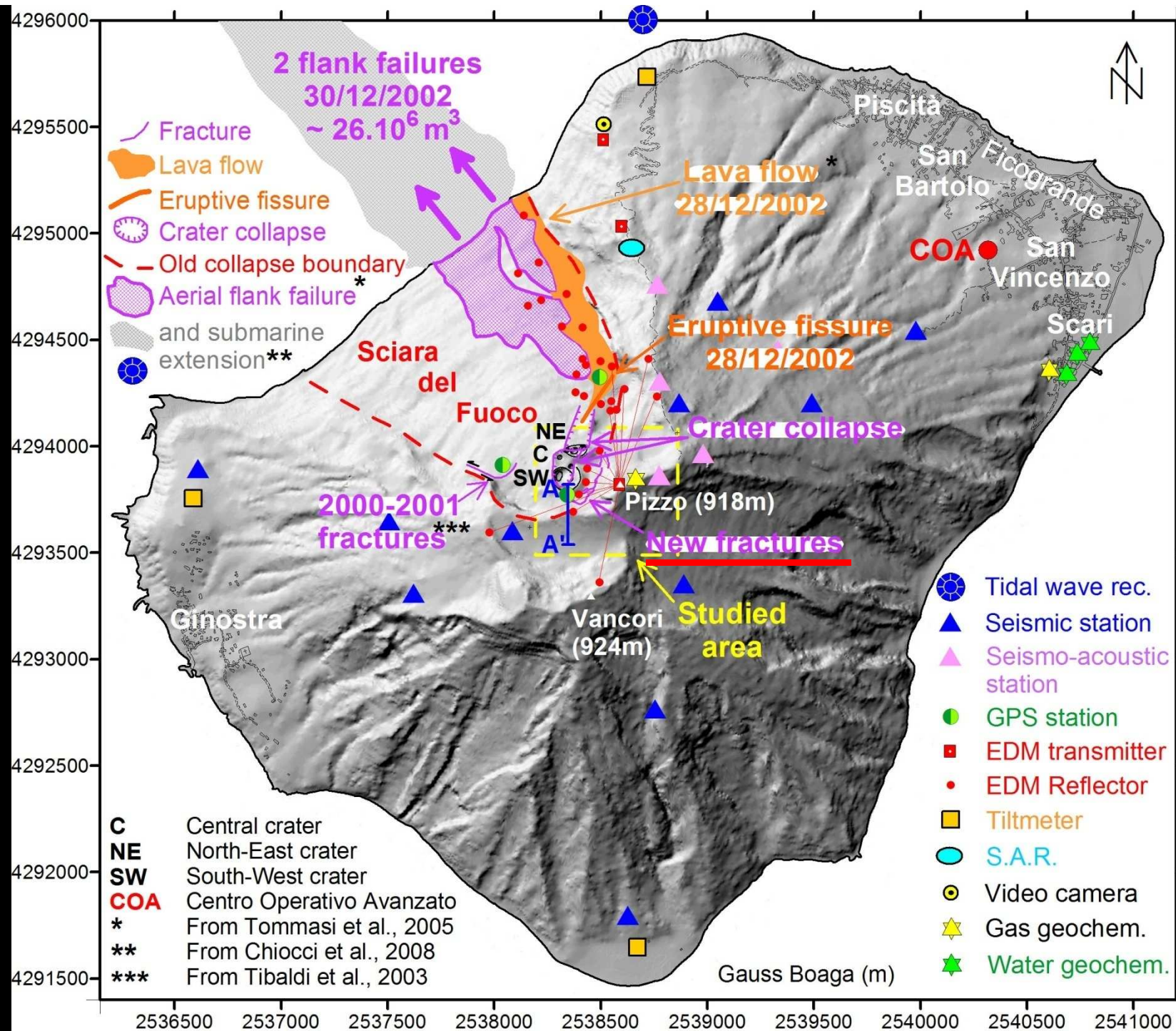
13:22

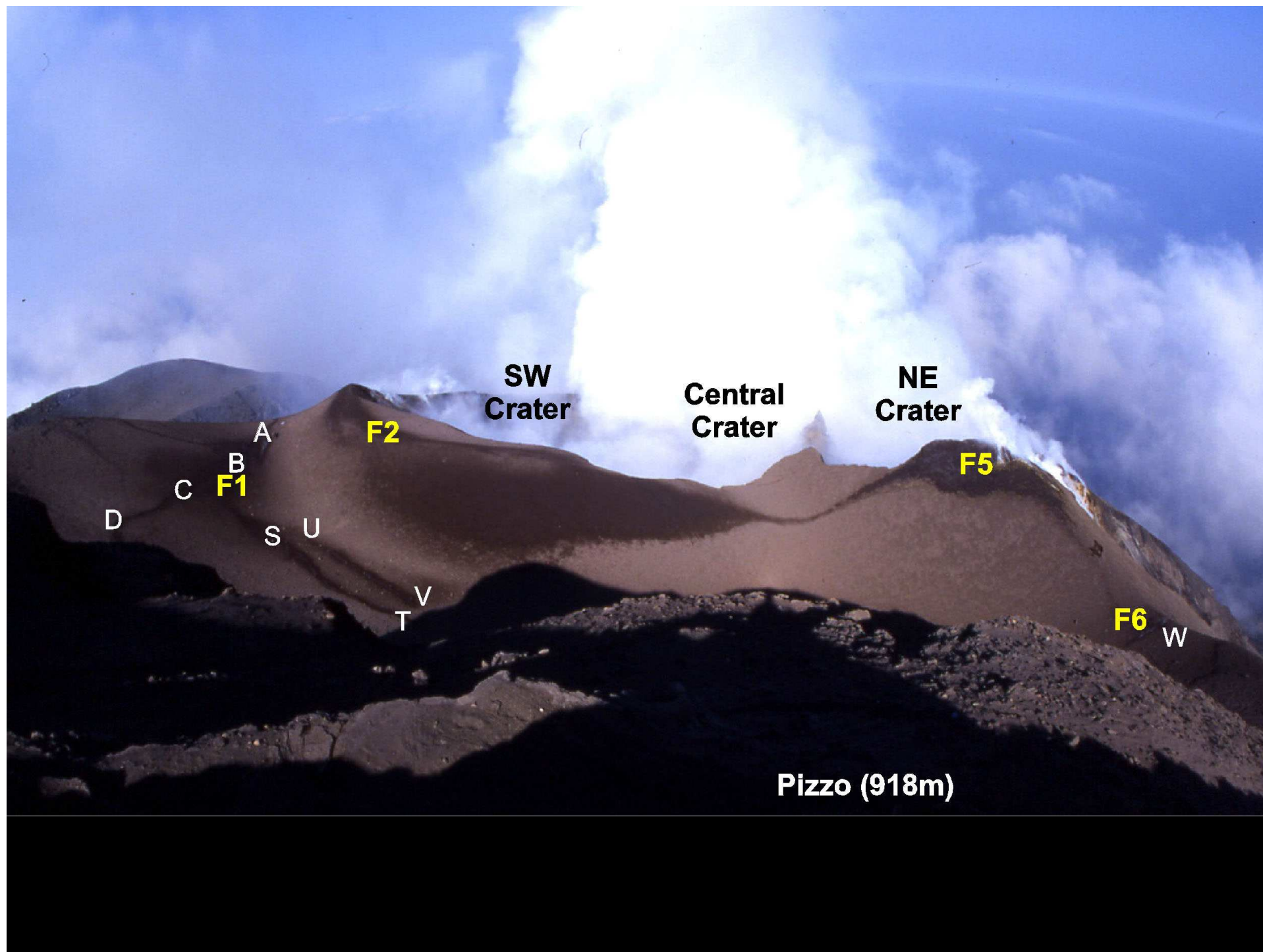


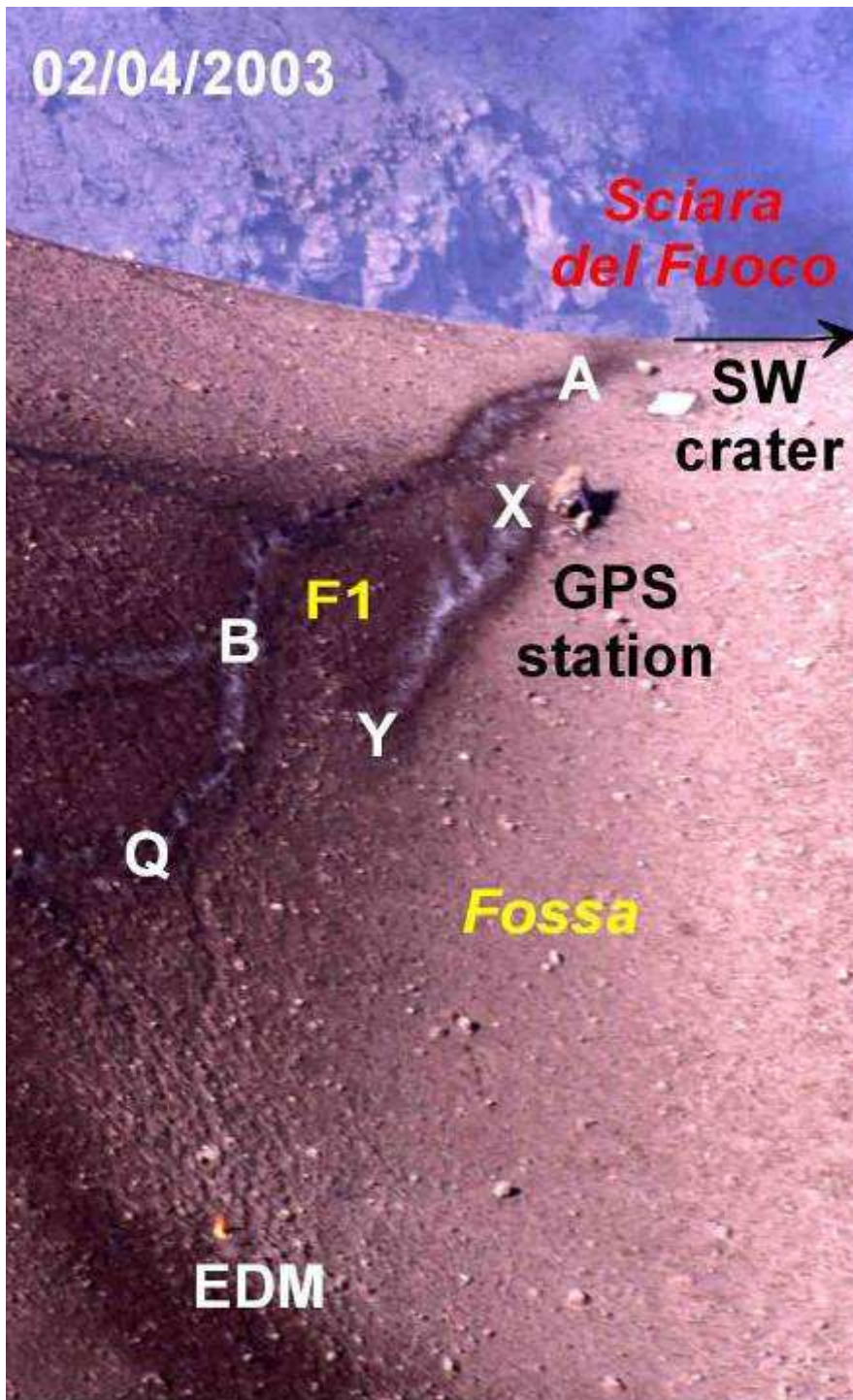
Massimo Pompilio (INGV-Catania)

30 December 2002 - 2 Landslides - 13:15 and 13:22

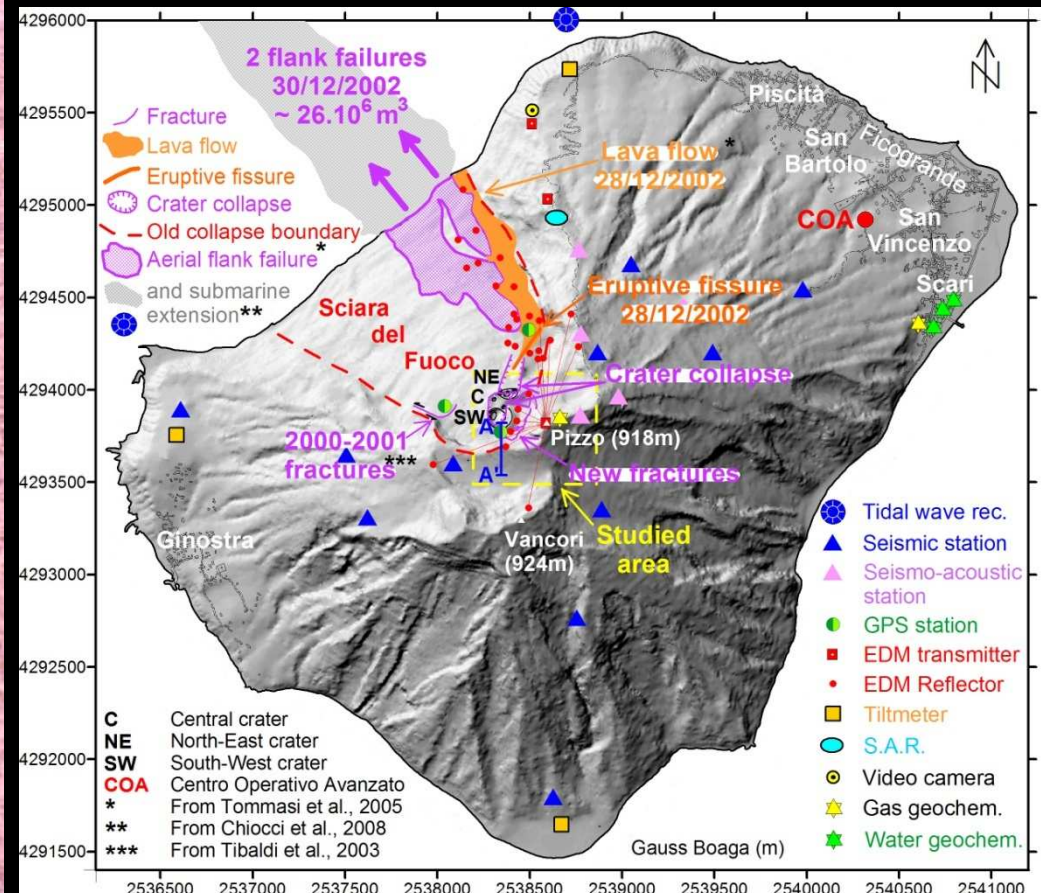


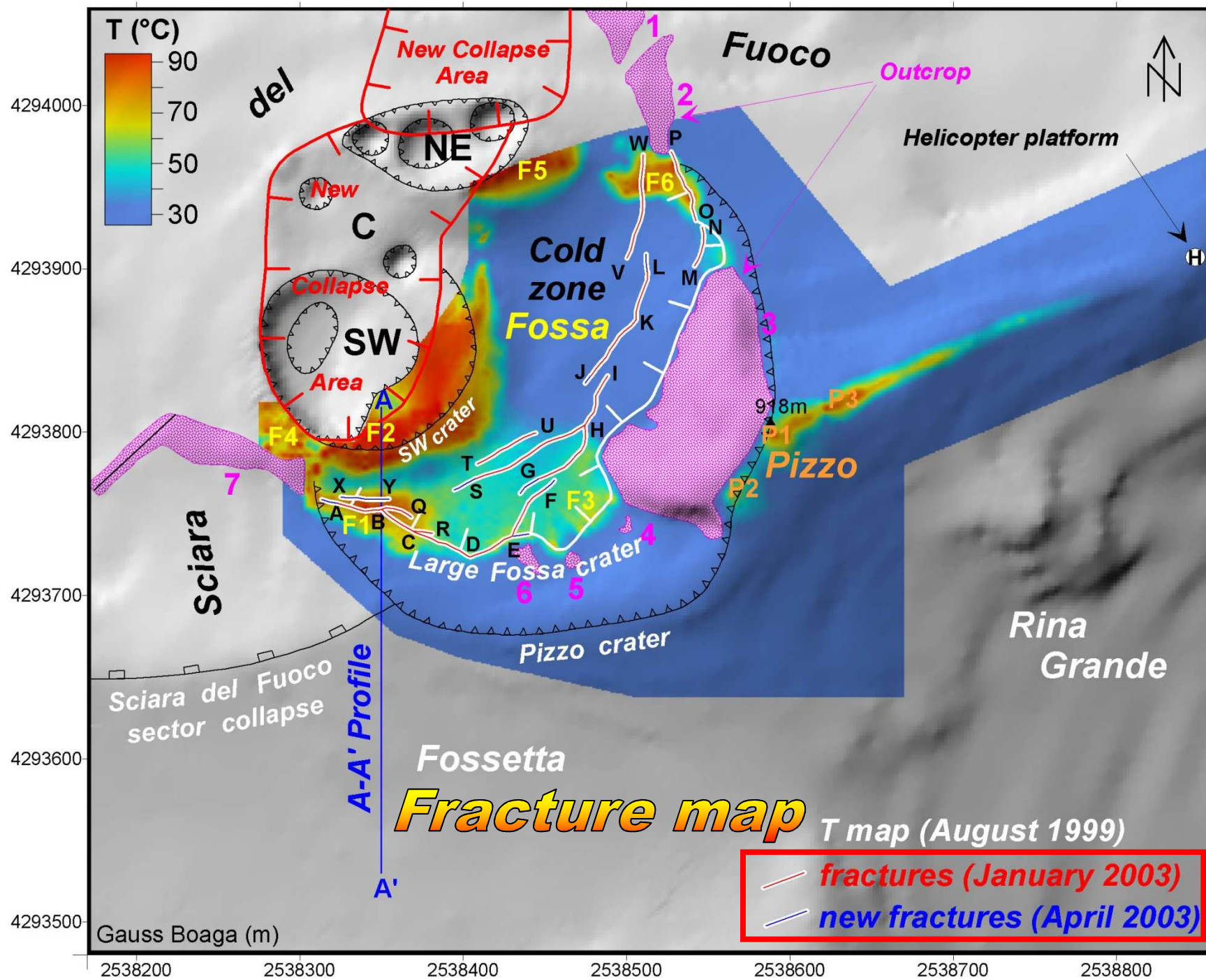




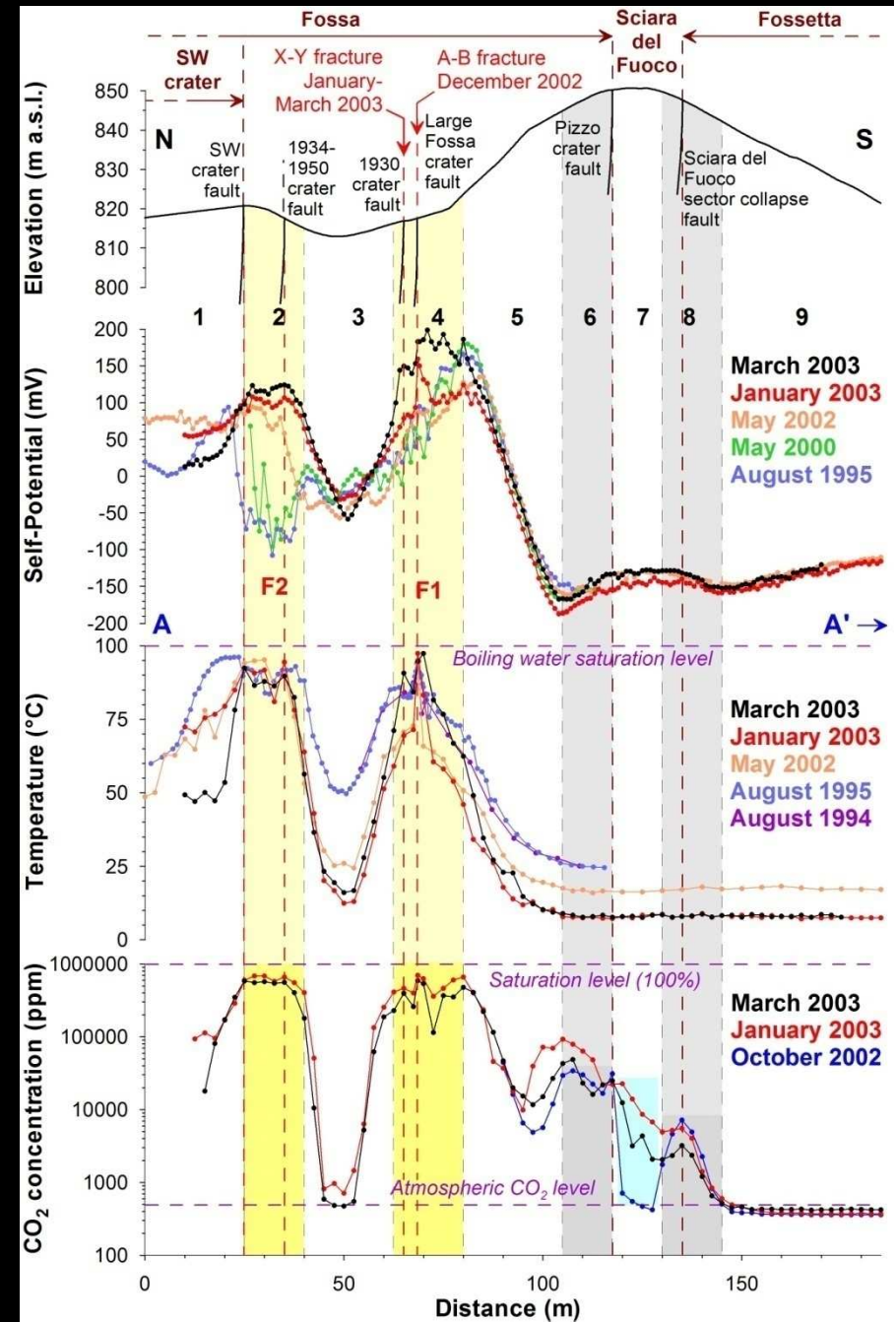
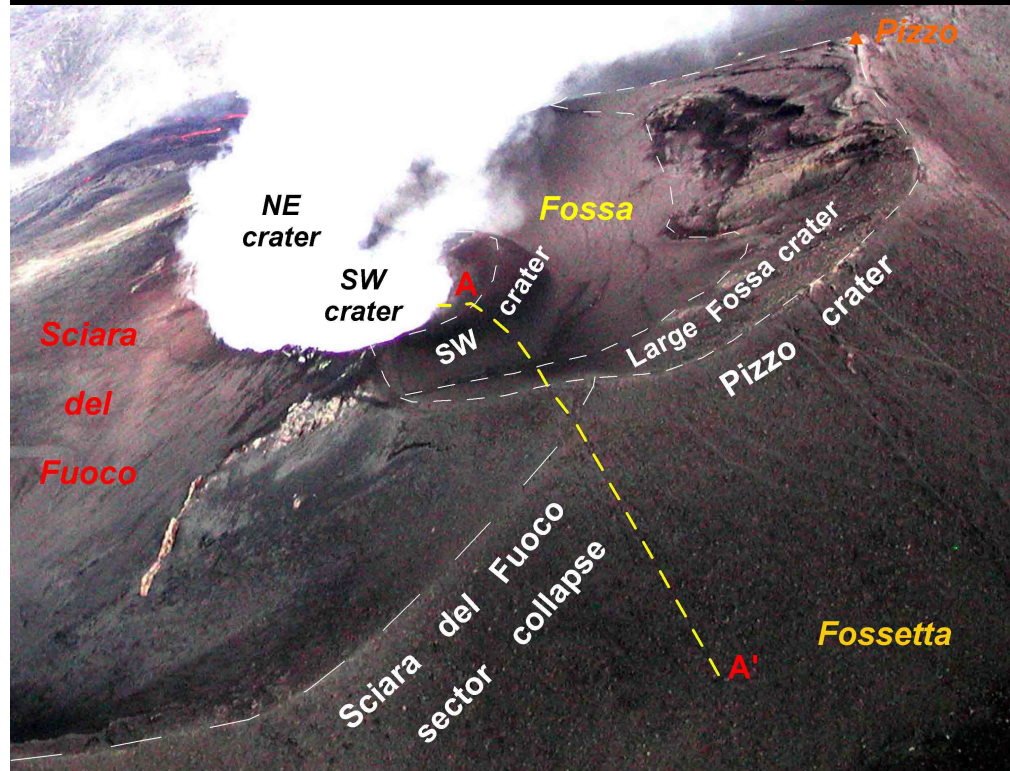


GPS and EDM Stations





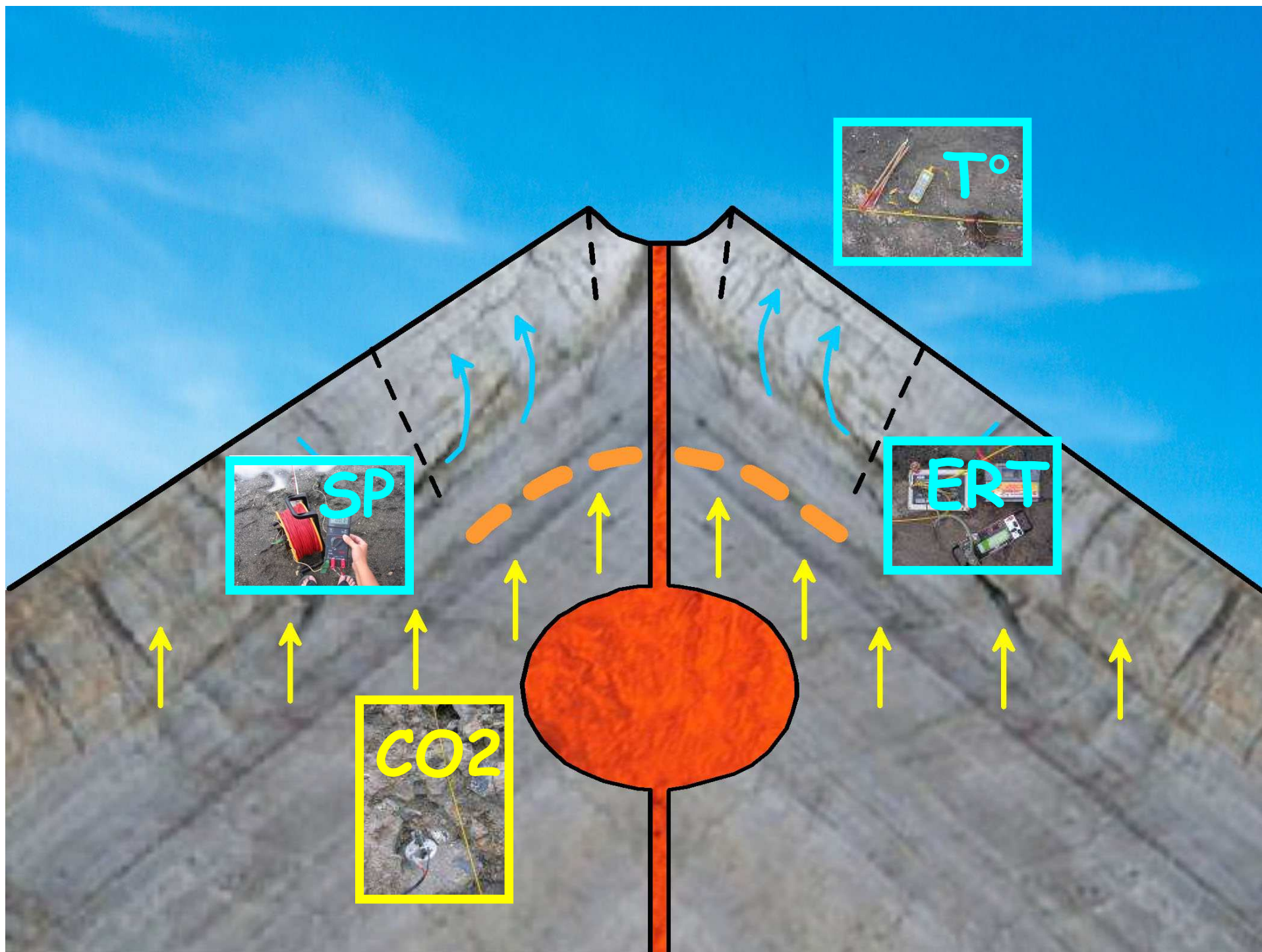
Reiteration of SP, temperature and CO₂ measurements



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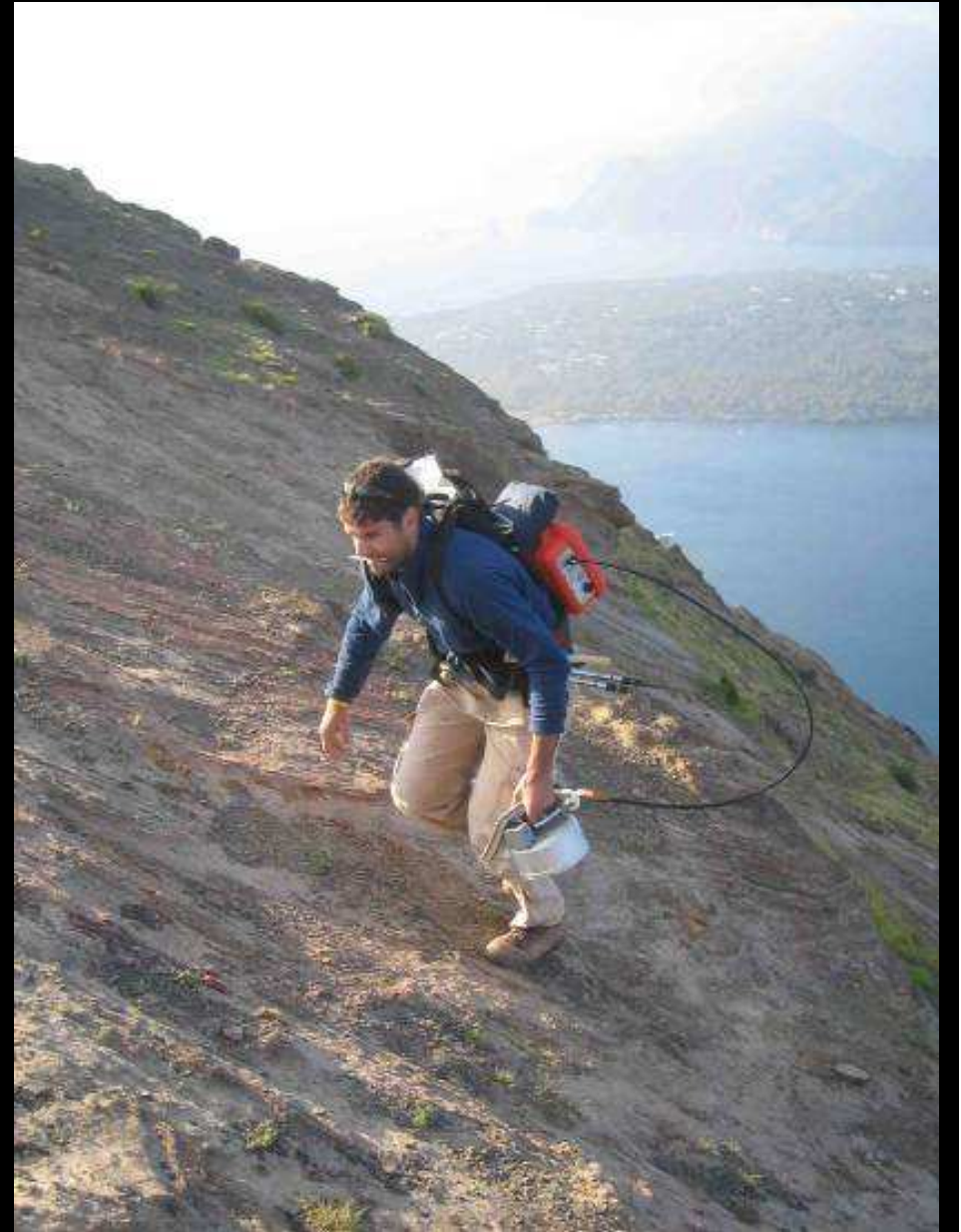
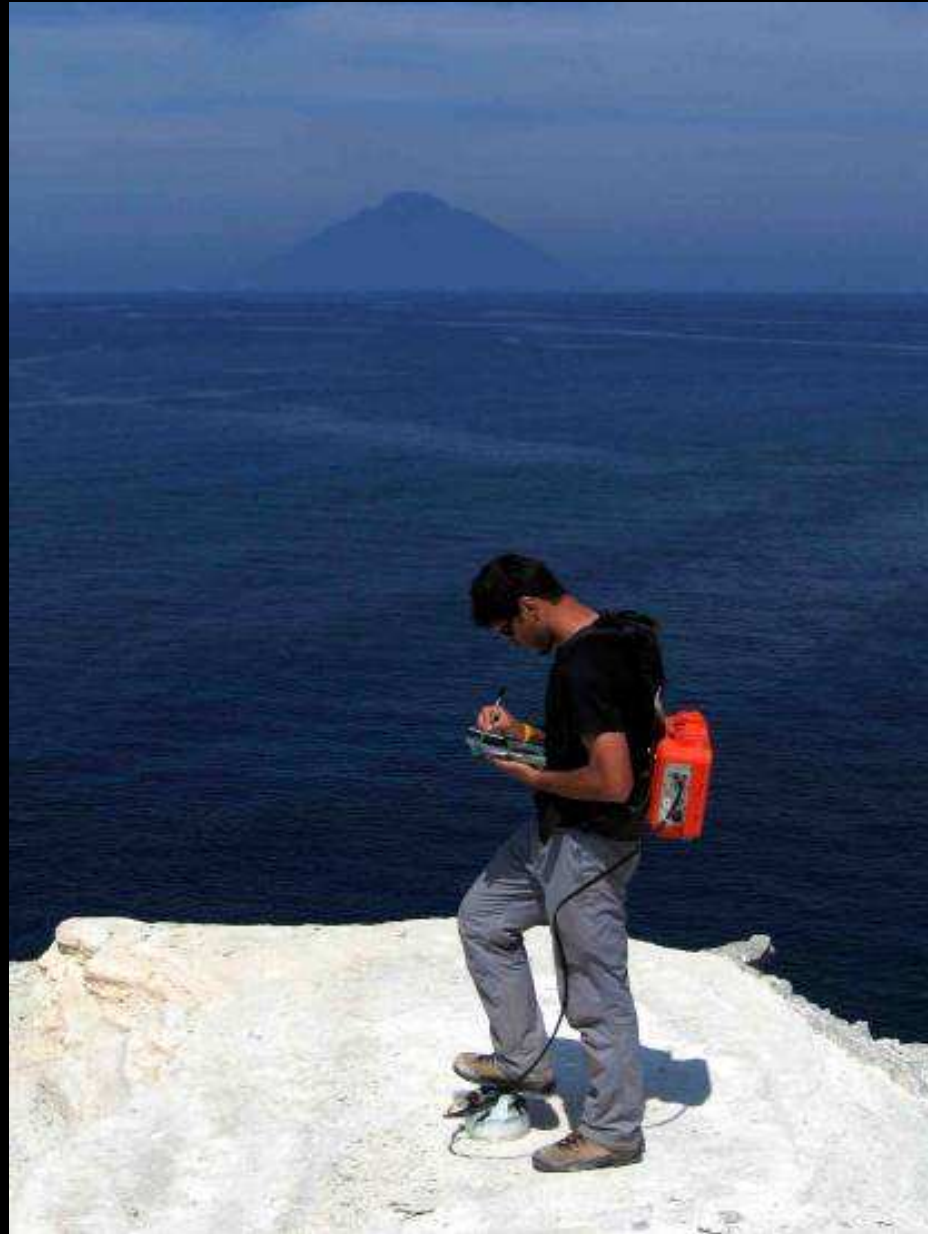
Electric Resistivity Tomography:

8 reels of 25 kg each one - 1280m - 64 electrodes





CO₂ soil measurements with an accumulation chamber method : CO₂ fluxes in g/m².d



CO₂ soil concentration measurements



Temperature soil measurements at 30cm depth



Electric Resistivity Tomography, Self-Potential, CO₂ soil flux, and soil Temperature at Vulcano



Marianna Balasco (IMAA-CNR, Potenza, Italy)

Angela Perrone (IMAA-CNR, Potenza, Italy)

Sabatino Piscitelli (IMAA-CNR, Potenza, Italy)

Enzo Rizzo (IMAA-CNR, Potenza, Italy)

Tullio Ricci (Università Roma tre, Italy)

Nicolo Carzaniga (Università di Milano, Italy)

Matteo Rossi (Università di Milano, Italy)

Fabio Di Gangi (INGV-Palermo, Italy)

Julie Morin (LGSR-IPGP, Réunion, France)

Anthony Finizola (LGSR-IPGP, Réunion, France)

Agnès Crespy (CEREGE, Aix, France)

André Revil (Colorado School of Mines, USA)

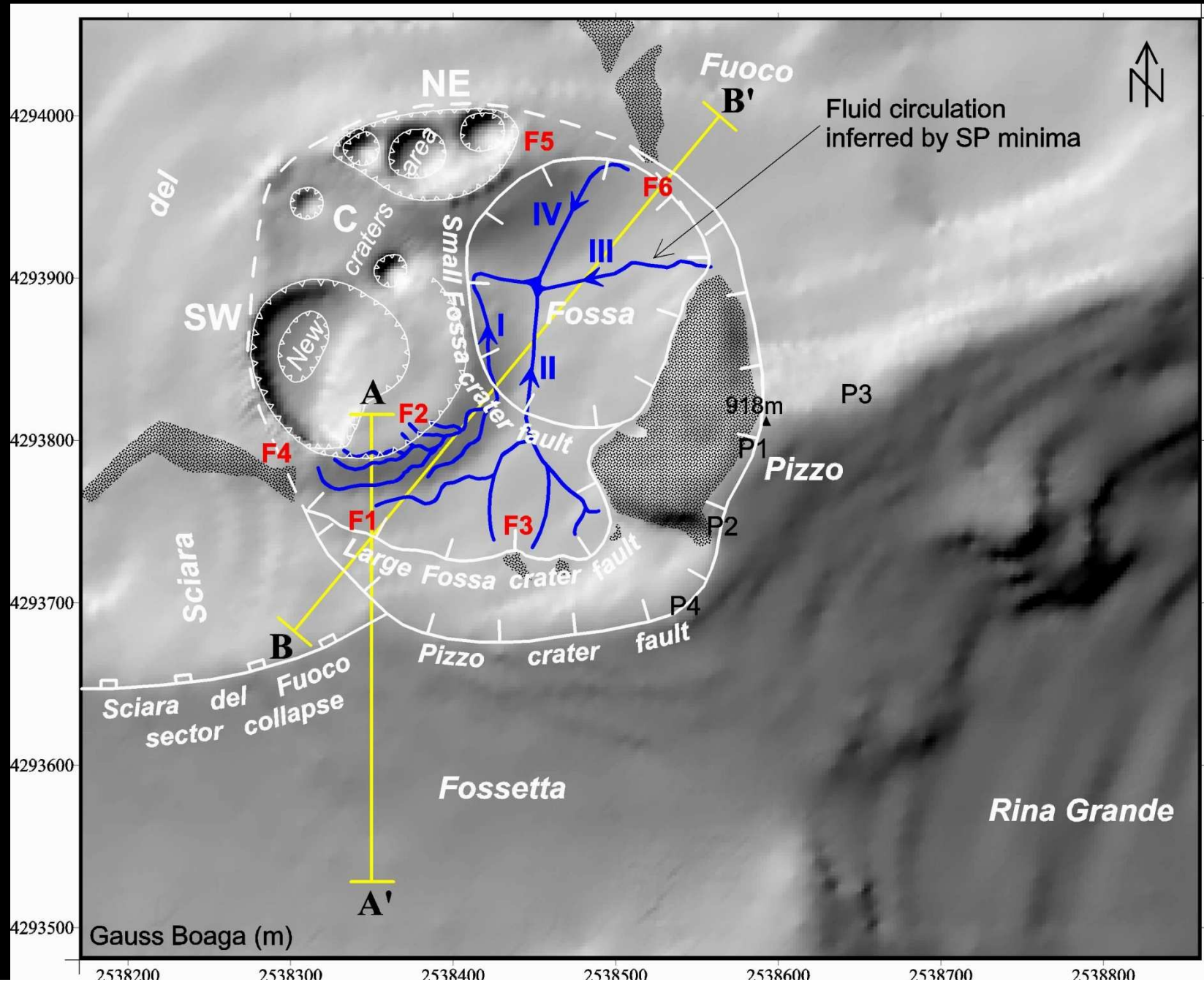
Barbara Suski (Université de Lausanne, Switzerland)

Svetlana Byrdina (LGIT, Chambéry, France)

Stéphanie Barde Cabusson (INGV Roma, Italy)

Emilie Roulleau (UQAM, Montréal, Canada)

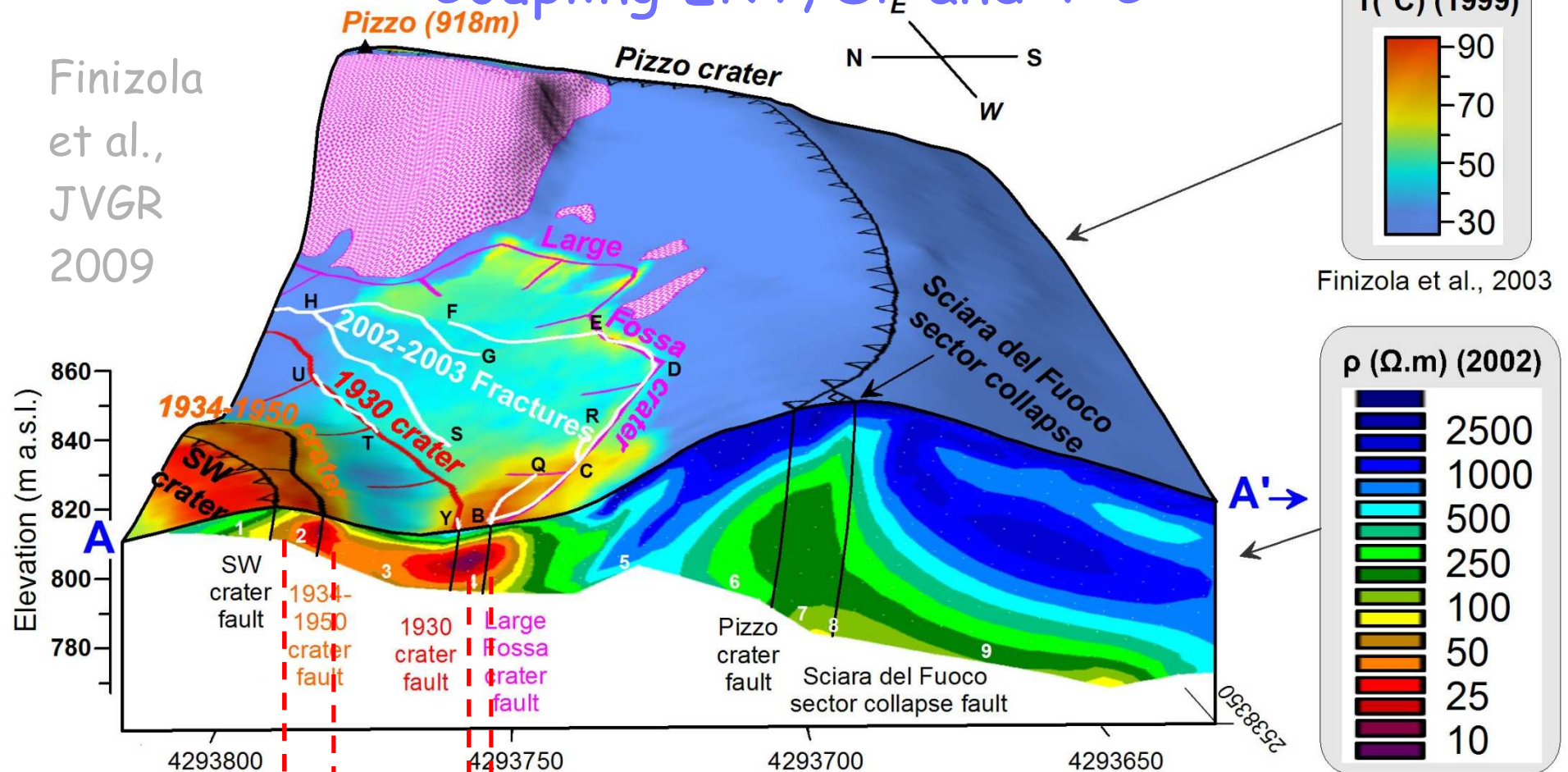
Coupling ERT - SP - T - CO₂



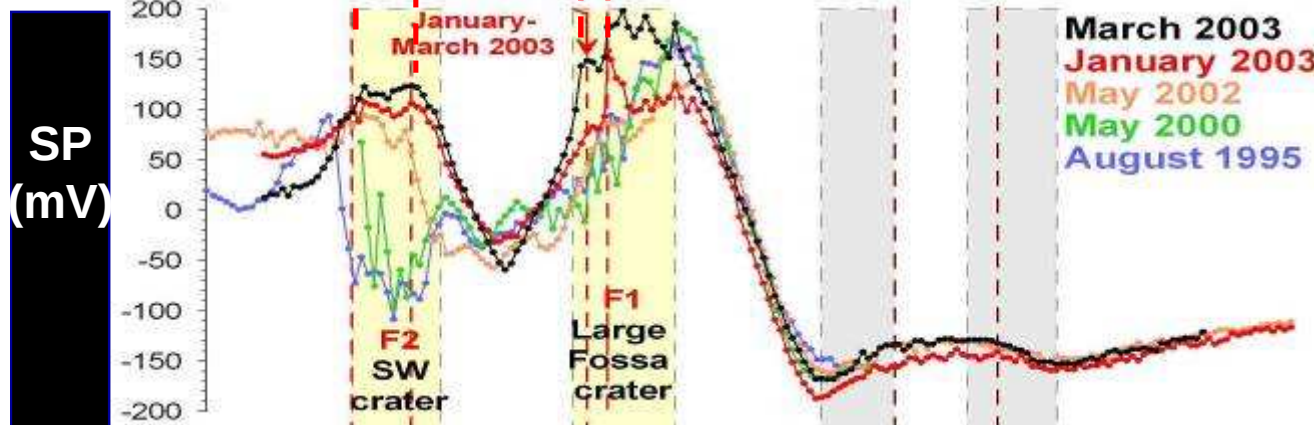
Finizola
et al.,
JVGR
(2009)

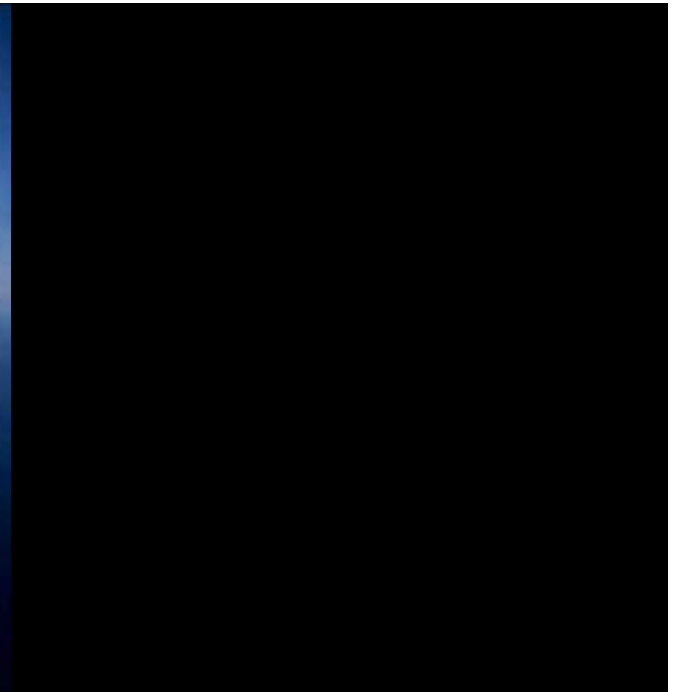
Coupling ERT, SP and T°C

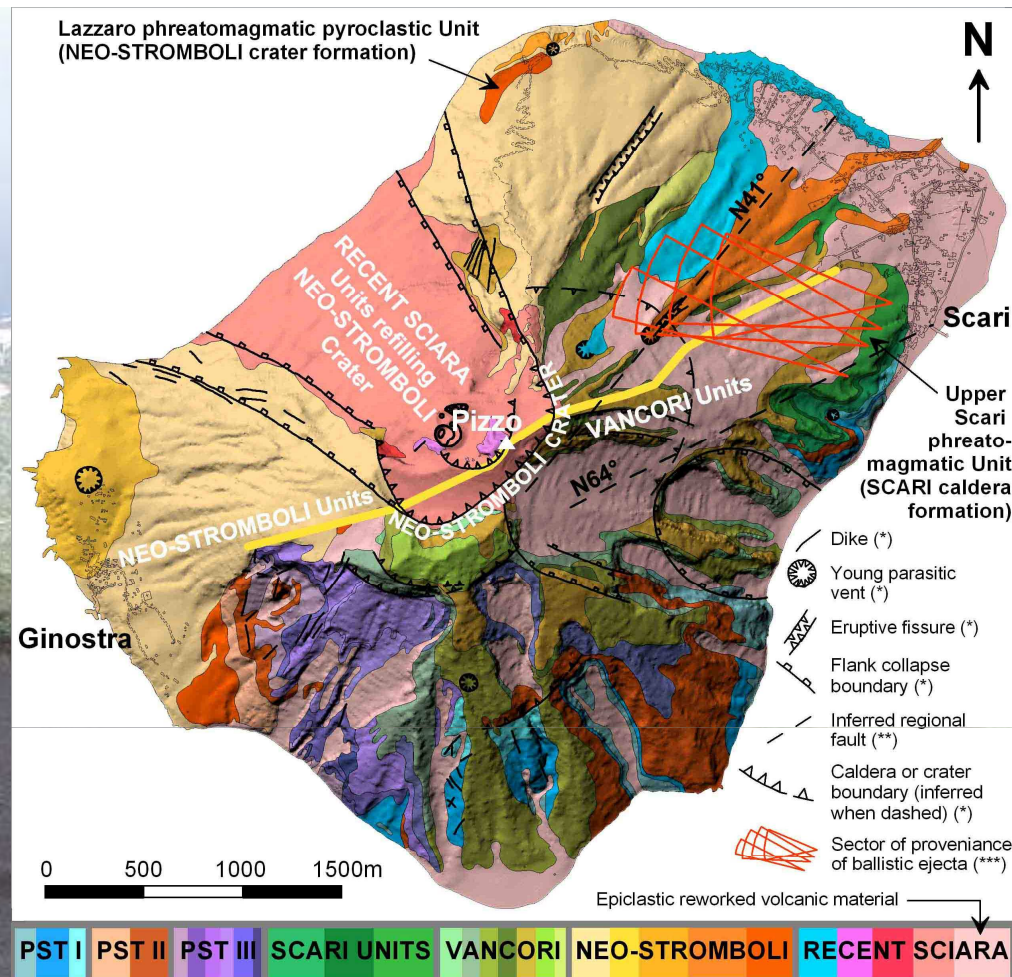
Finizola
et al.,
JVGR
2009



Revil et al., 2004

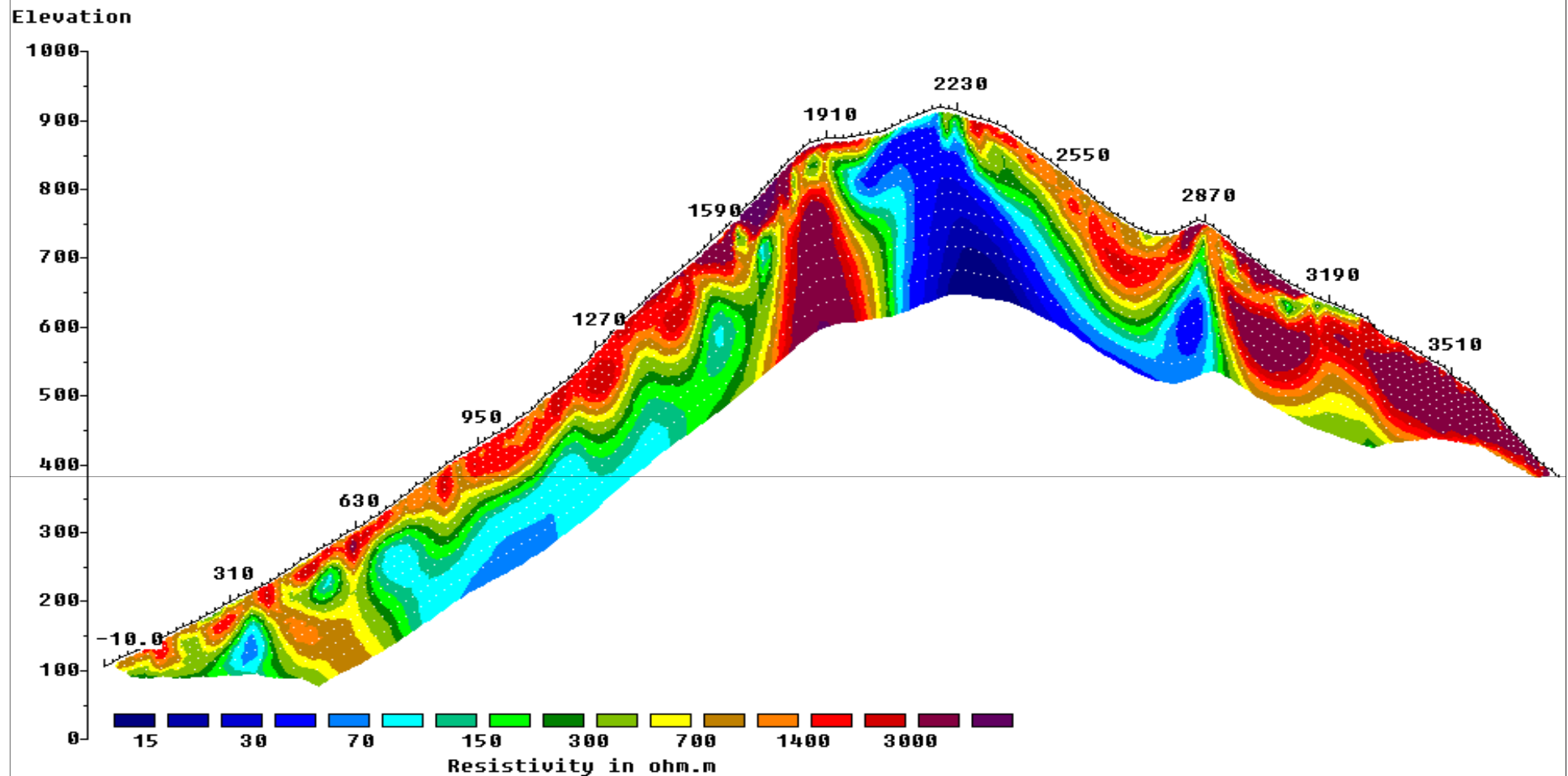






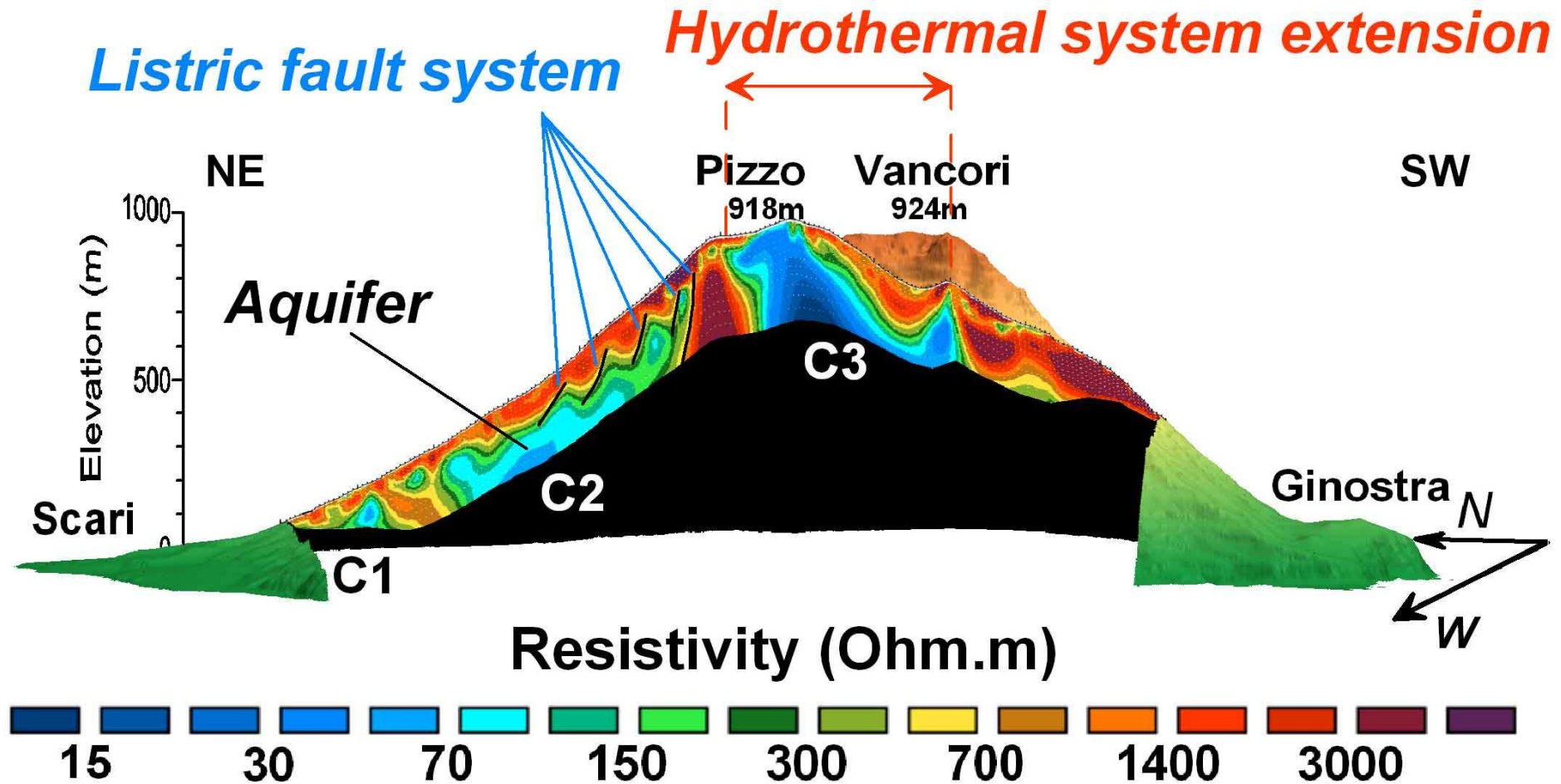
Finizola et al., GRL (2006)

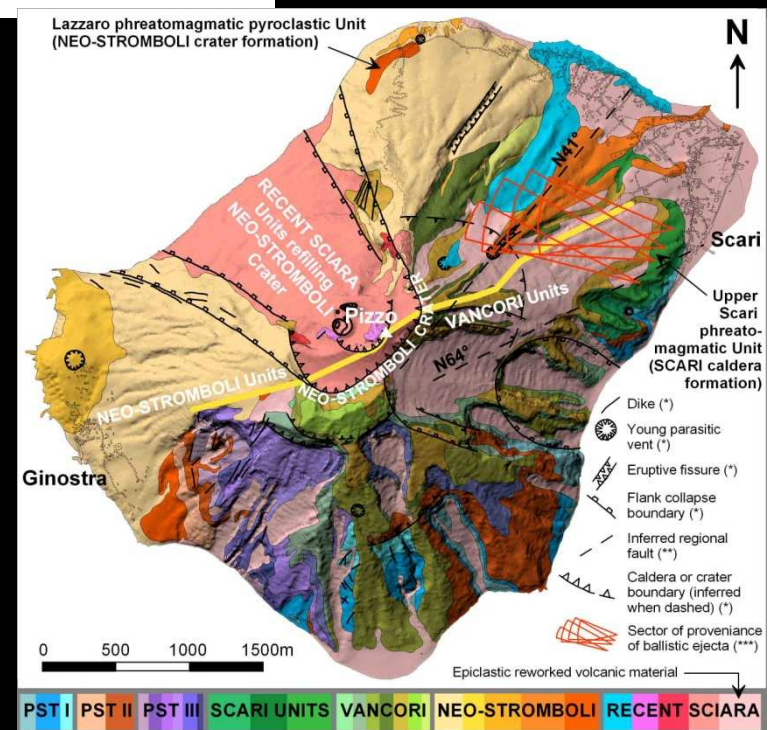
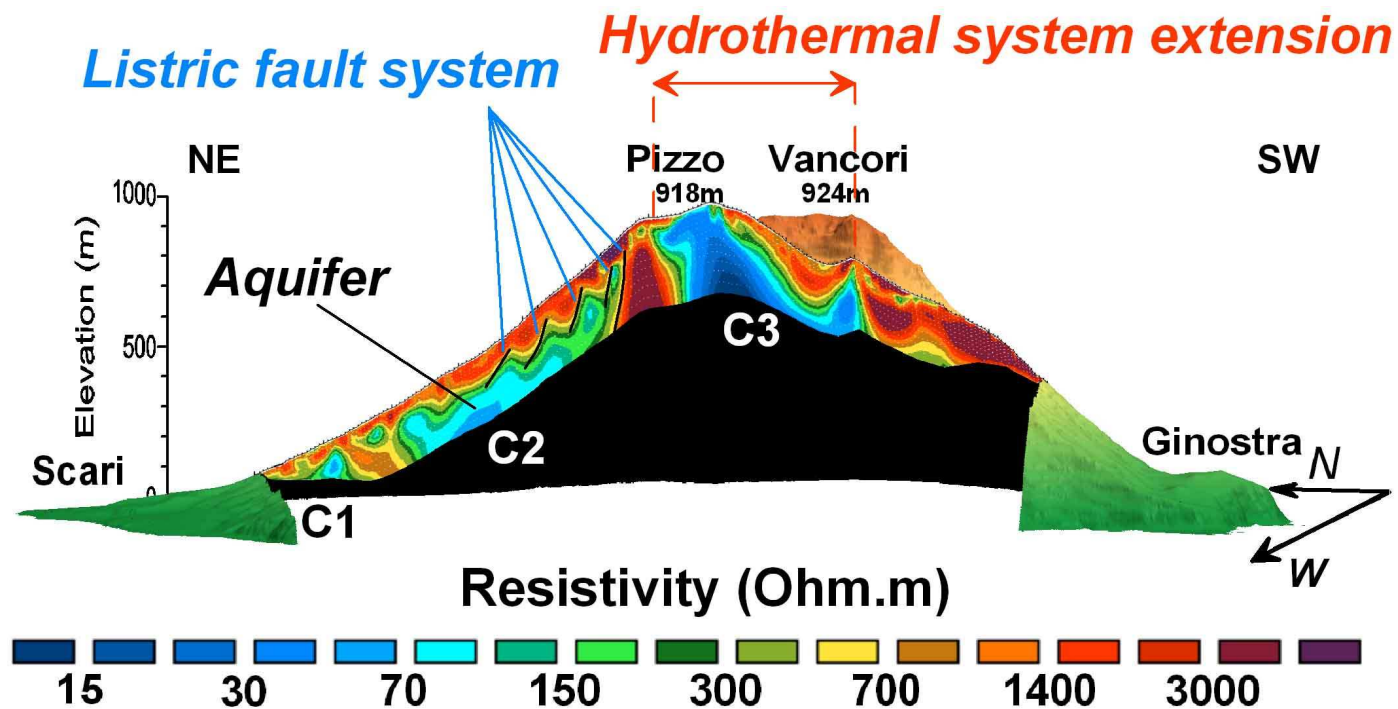
High Resolution Electric Resistivity Tomography



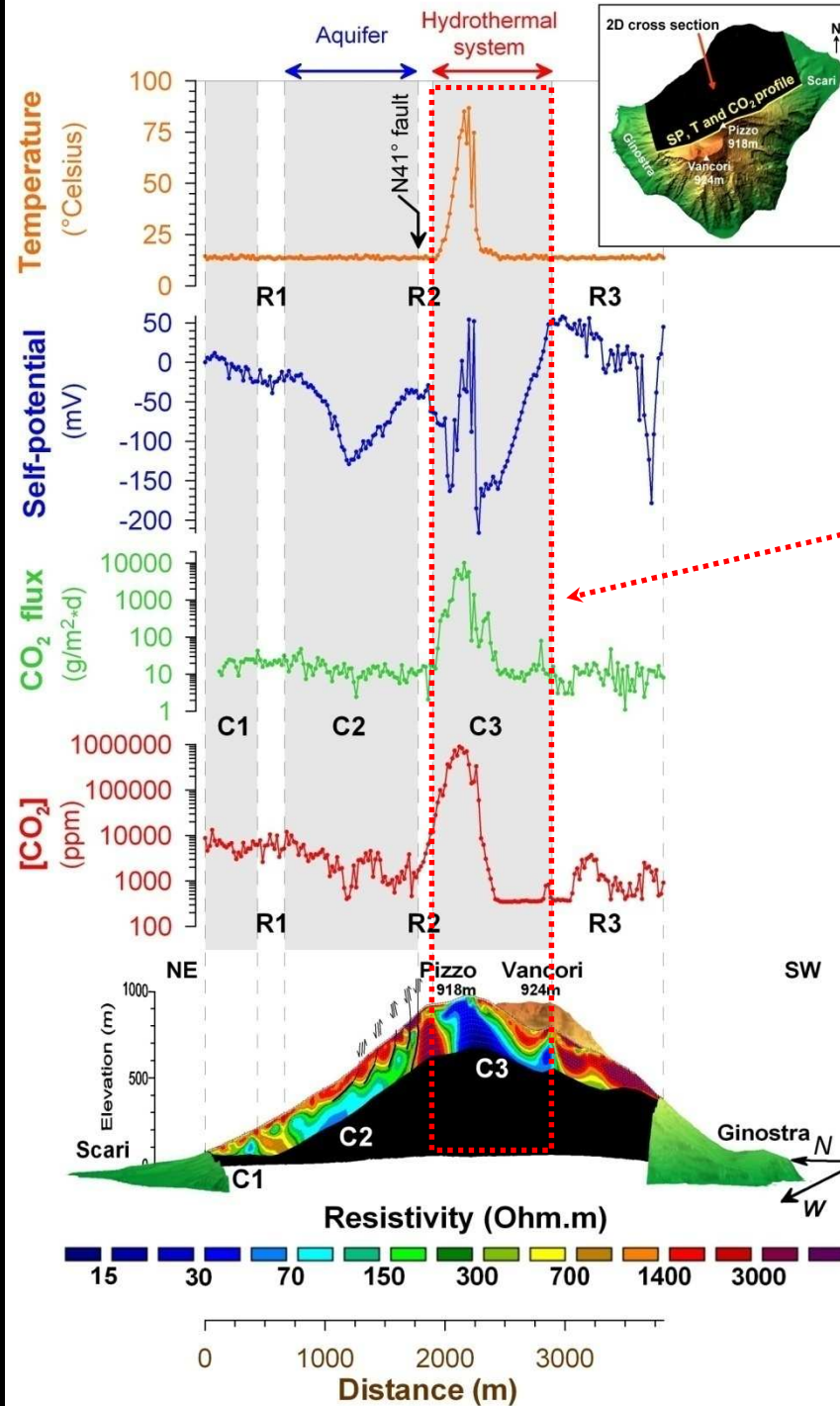
Finizola et al., GRL (2006)

Electric resistivity tomography



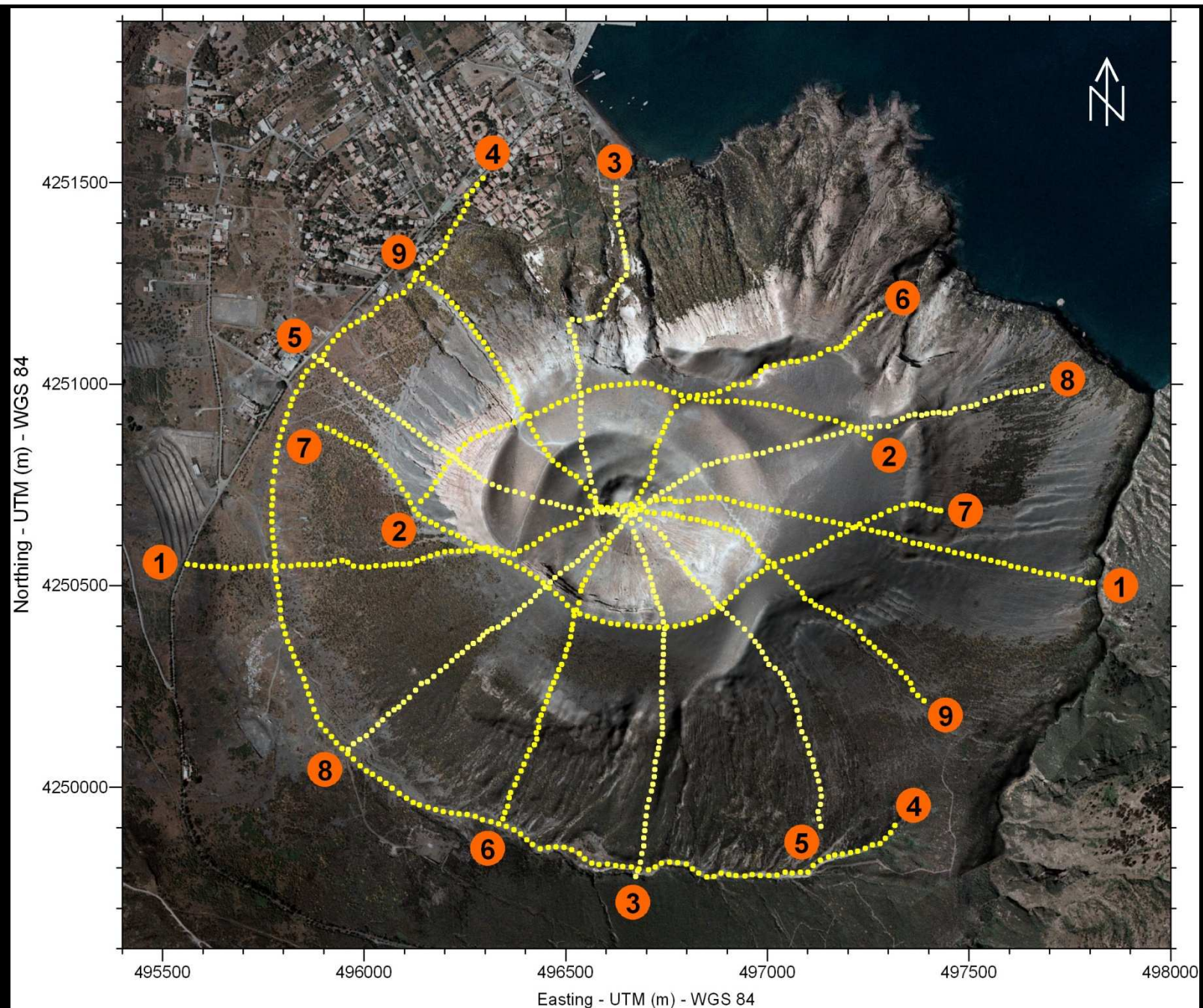


Finizola et al., GRL (2006)

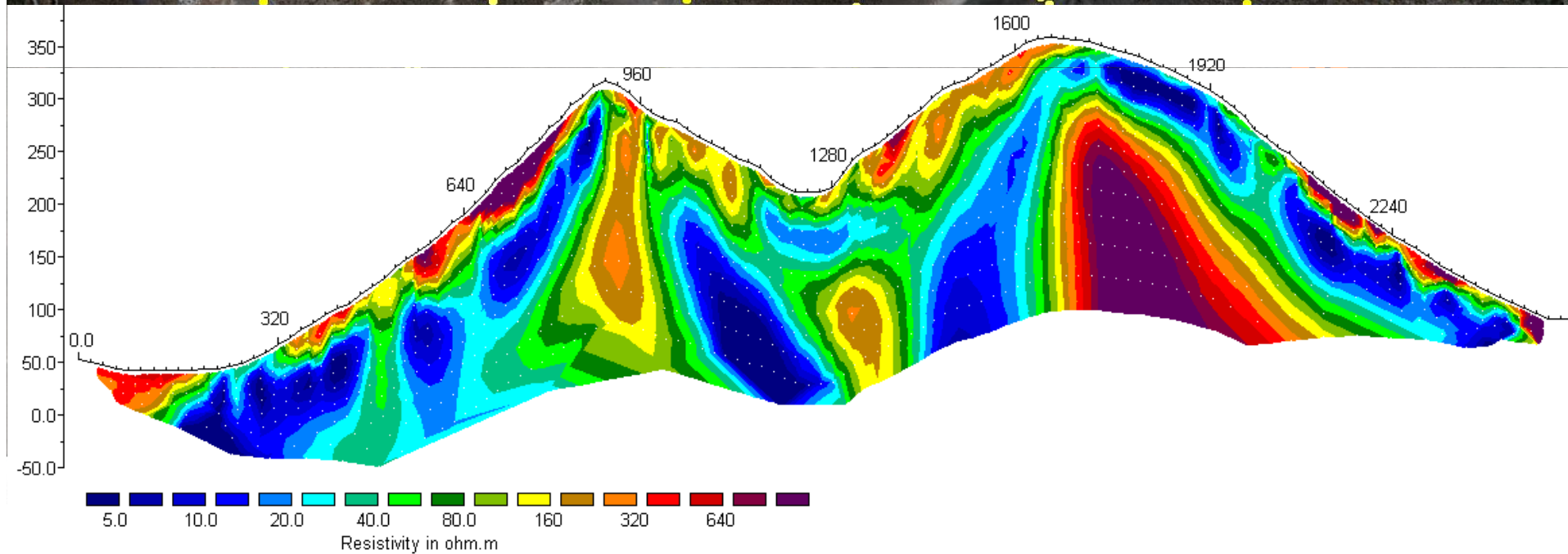


Hydrothermal system

Finizola et al., (2006)

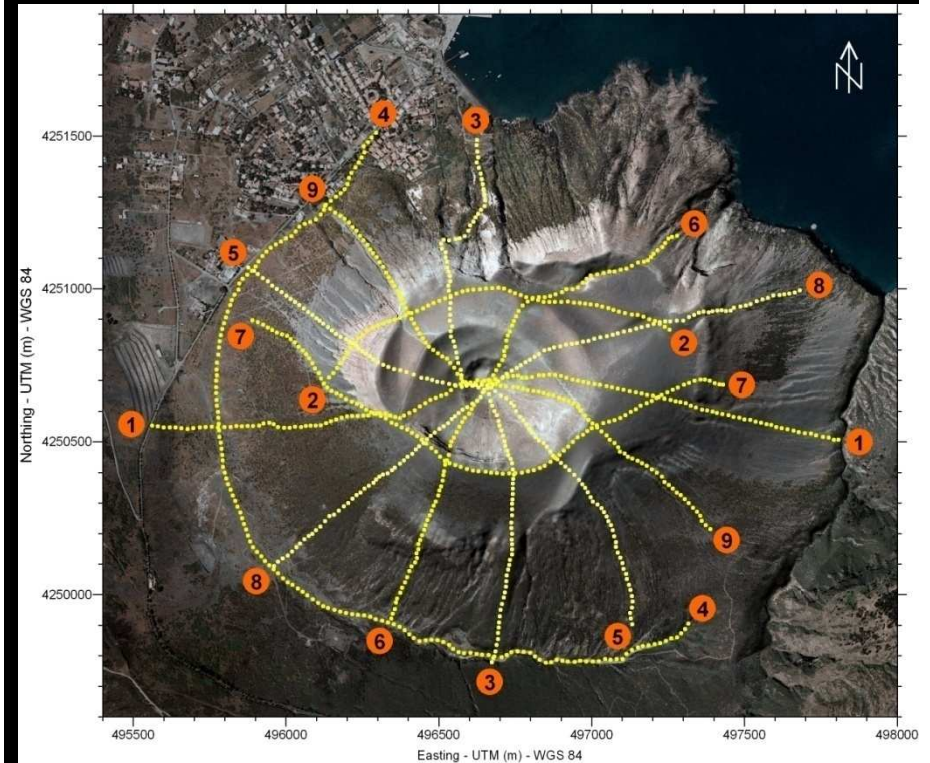
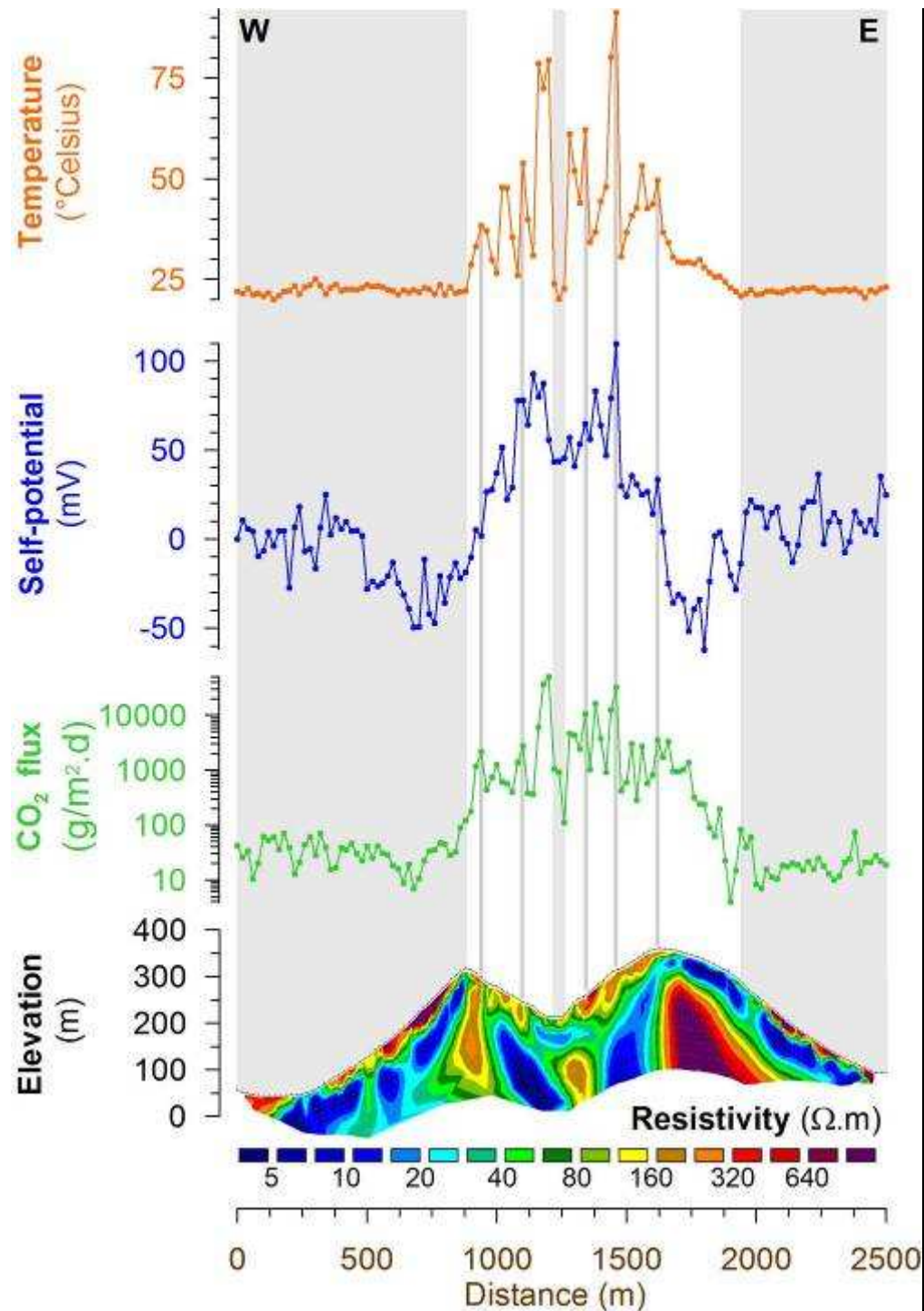


Revil, Finizola et al., JGR (2008)



Revil, Finizola et al., JGR 2008)

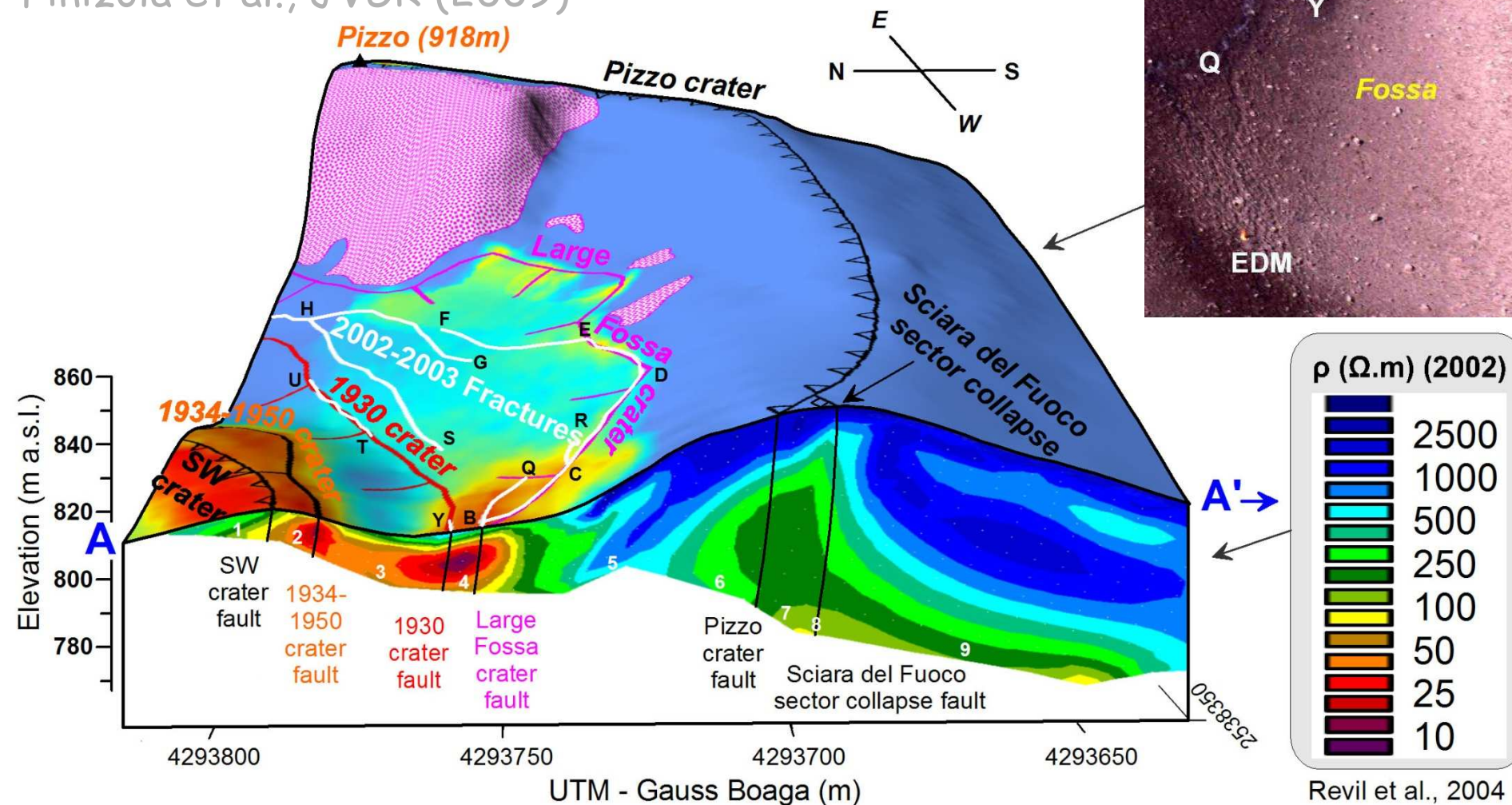
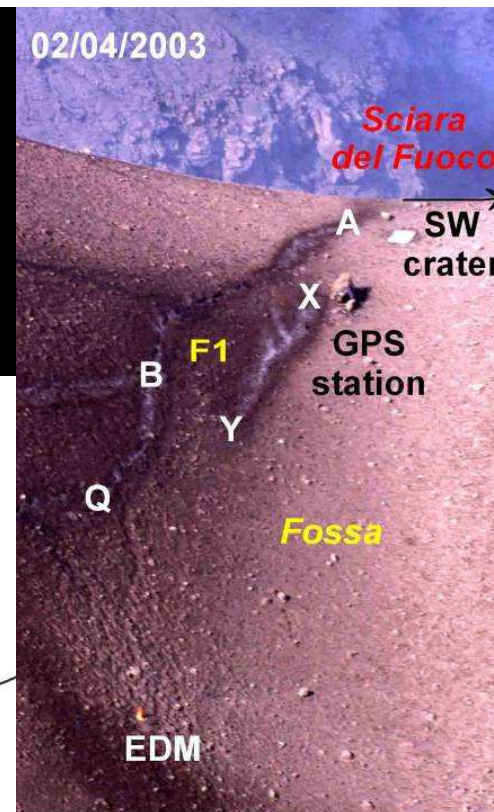
Profile 1



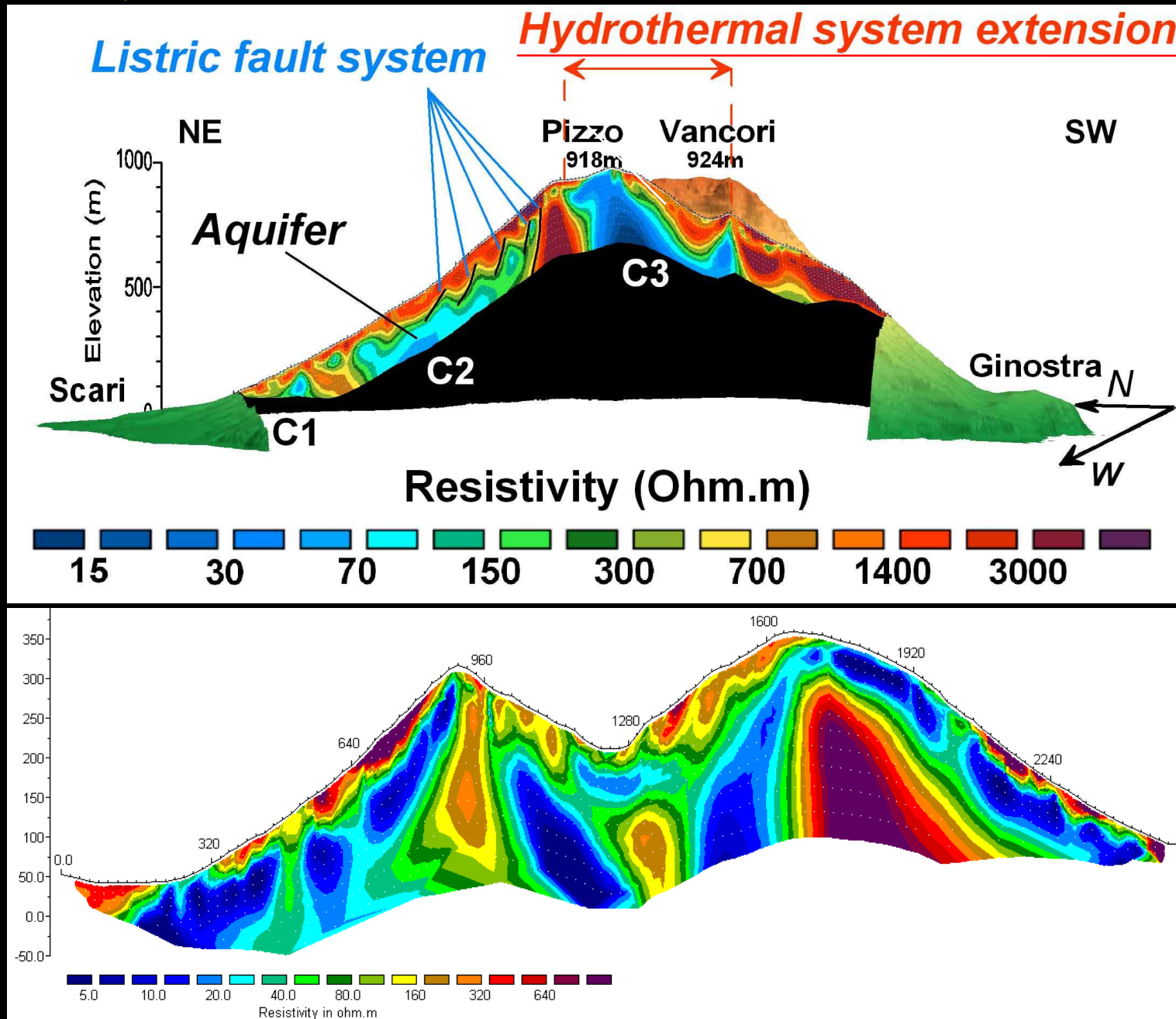
Revil, Finizola et al., JGR (2008)

Importance of structural boundaries

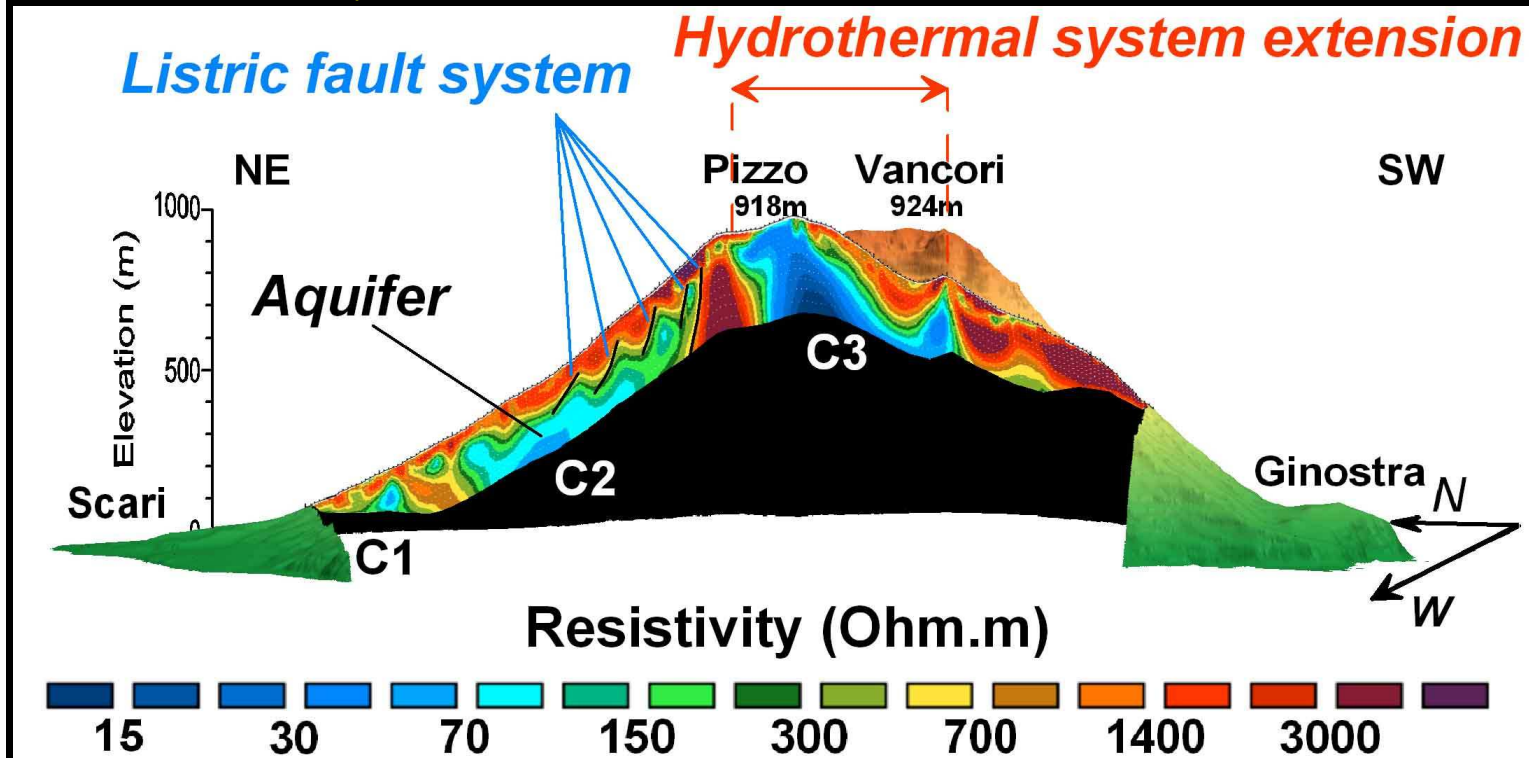
Finizola et al., JVGR (2009)



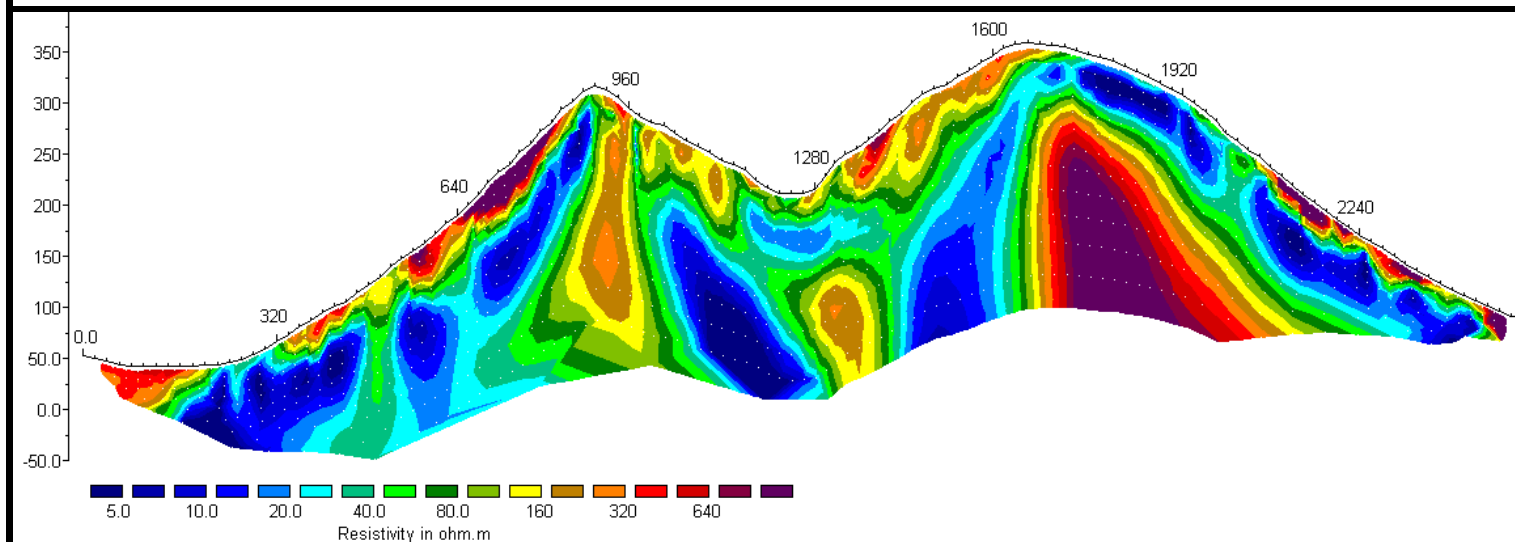
Importance of structural boundaries



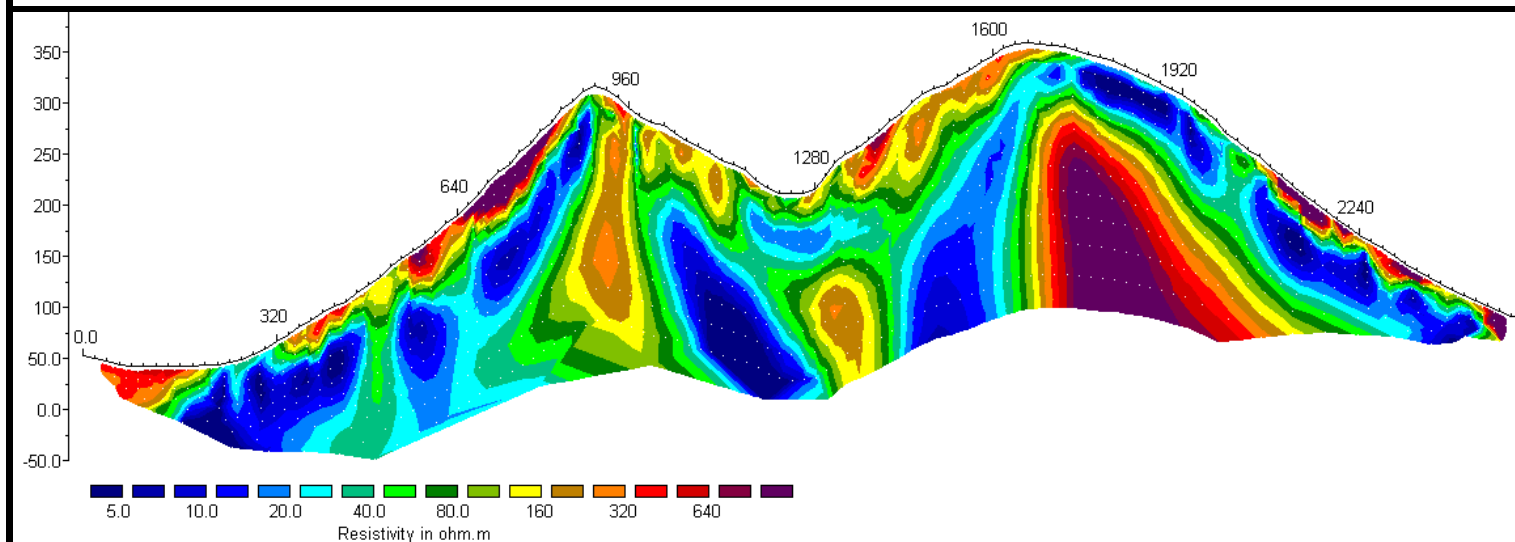
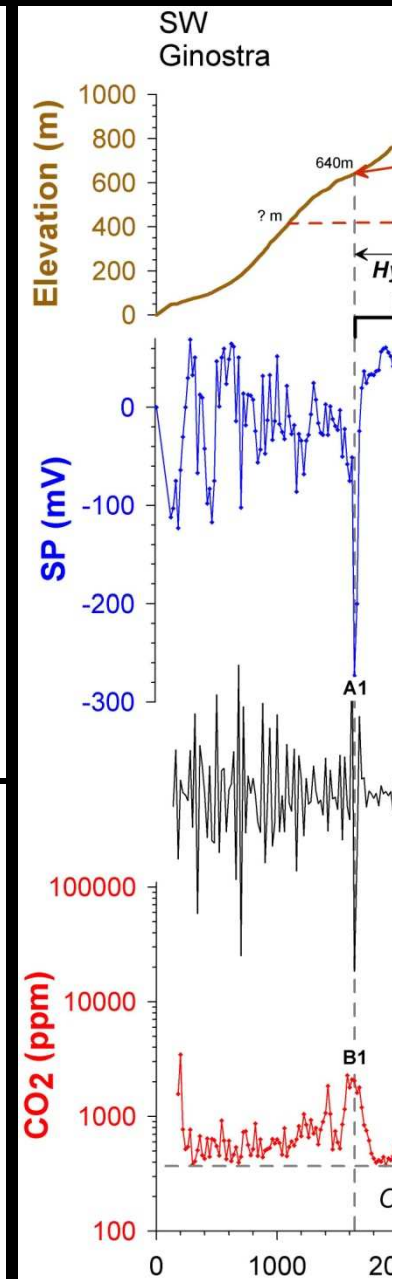
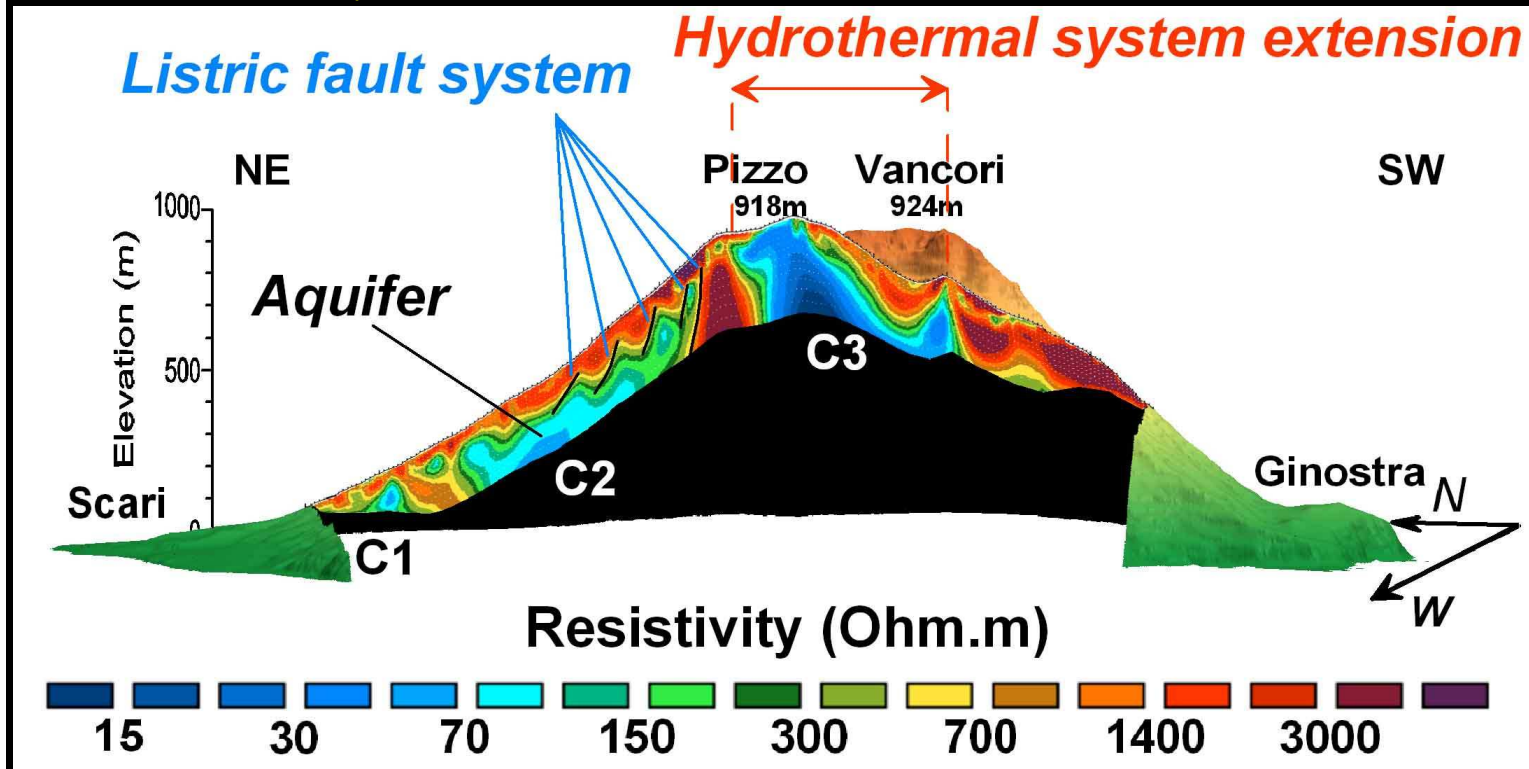
Importance of structural boundaries



1.
≠
Lithology
2.
≠
Permeability



Importance of structural boundaries

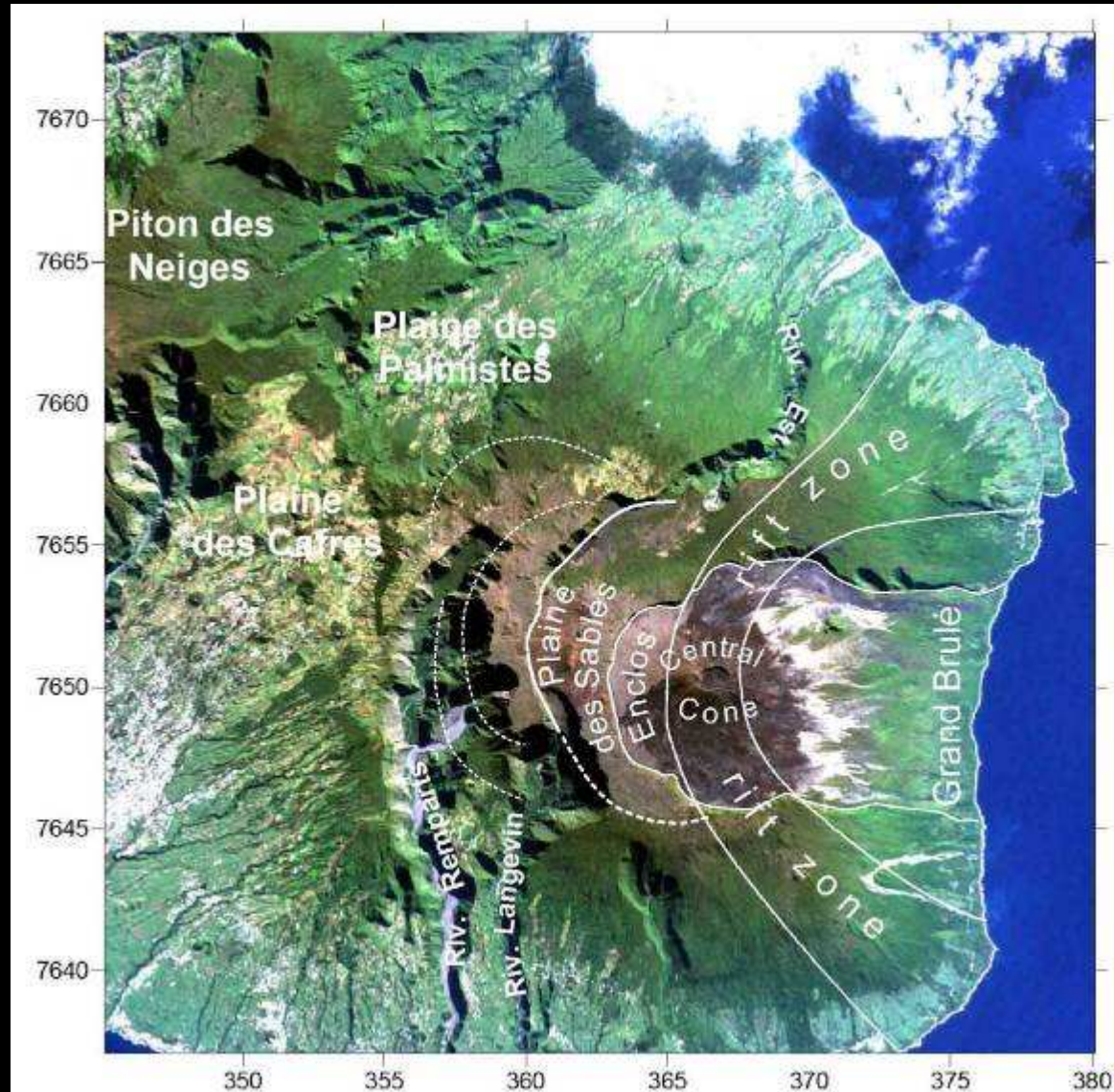


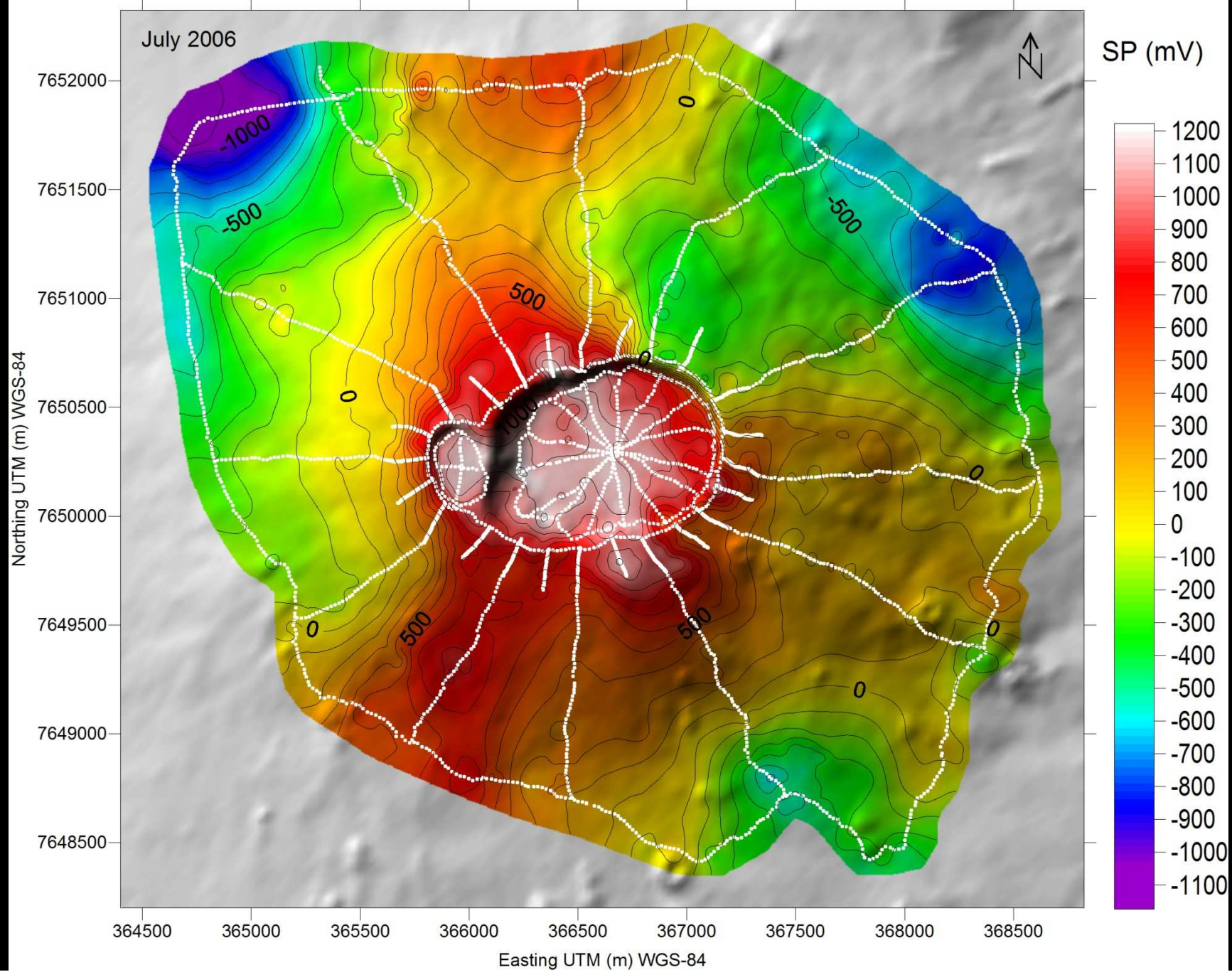
Hydrothermal systems are often
constrained inside structural boundaries

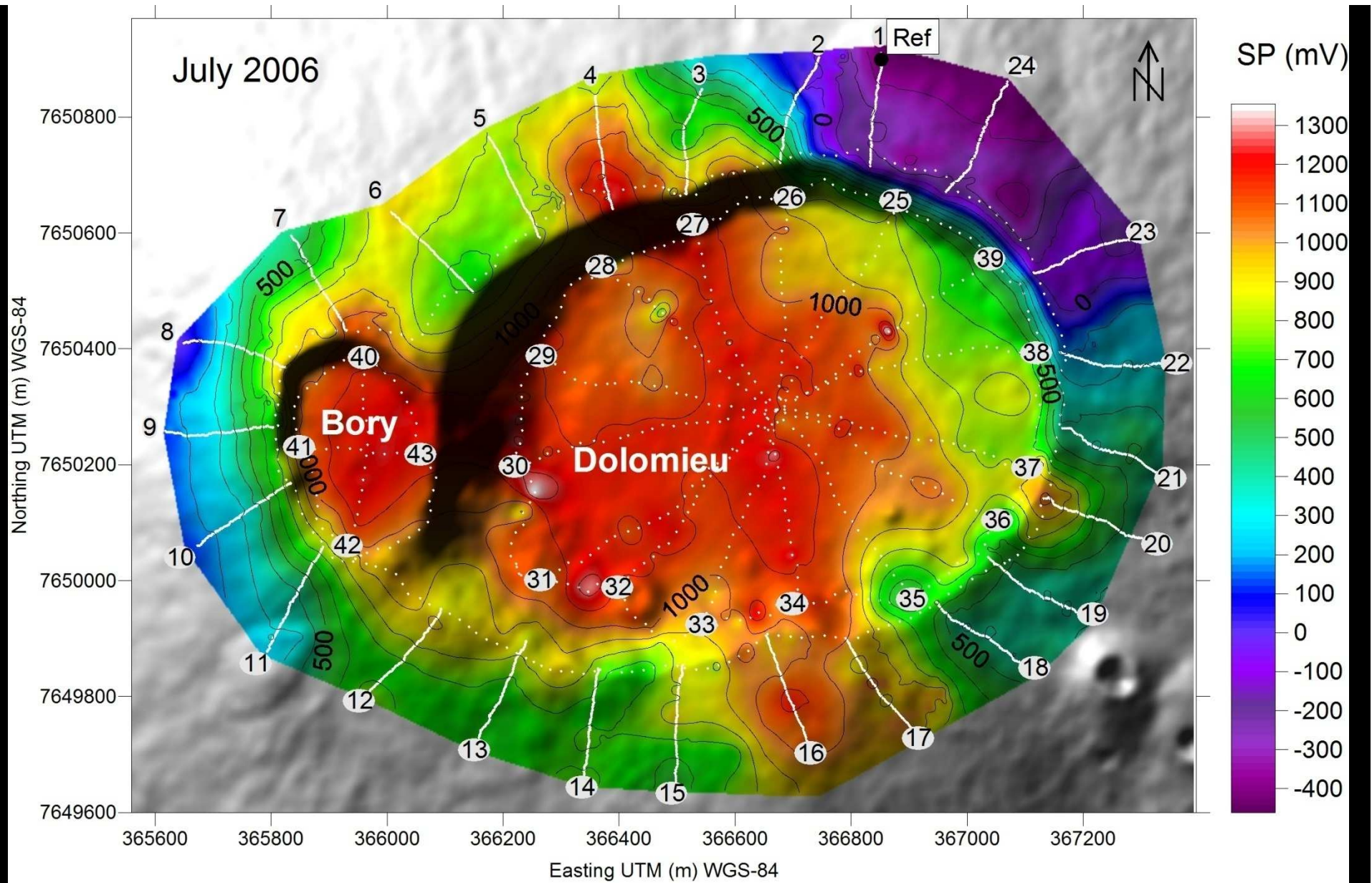


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couplage de méthodes géoélectriques,
thermique et gaz diffus:
implication en surveillance volcanologique.

1.b. Structuration - Piton de la Fournaise





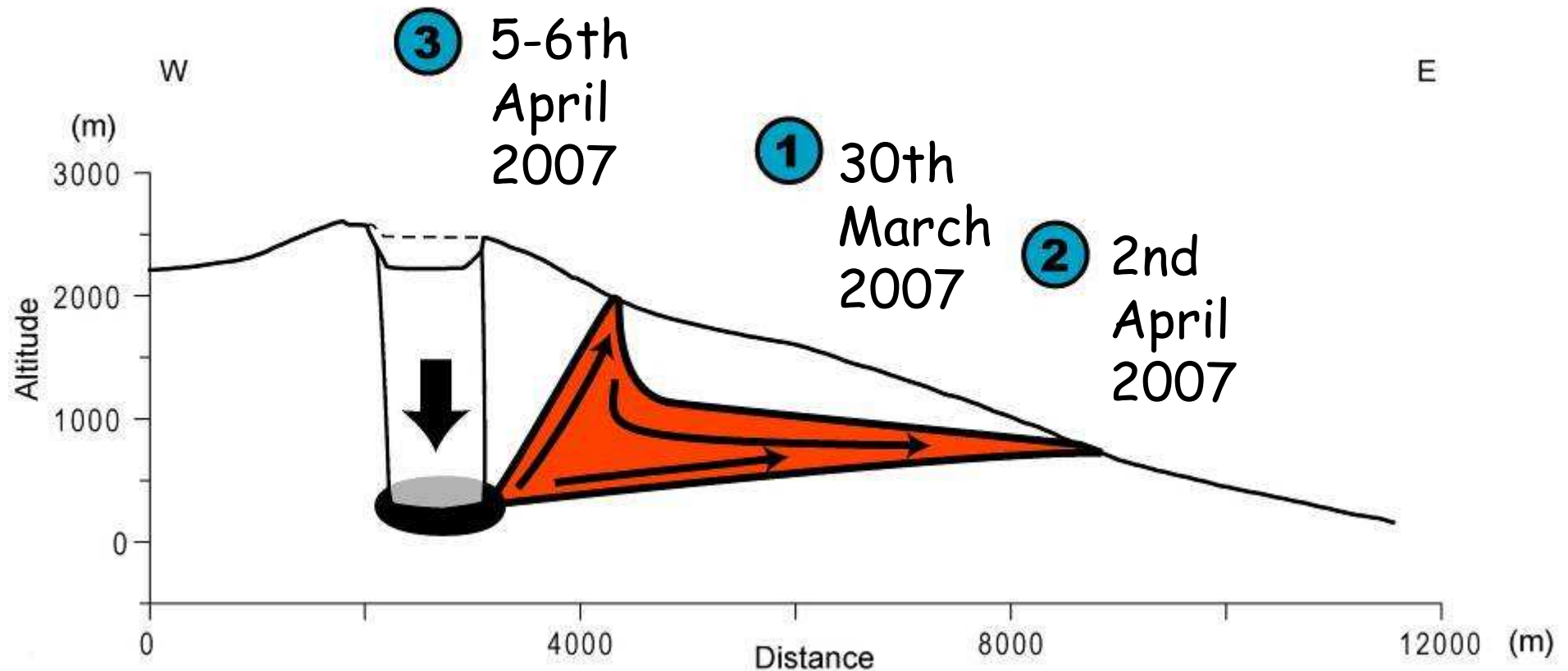


Finizola et al., in prep

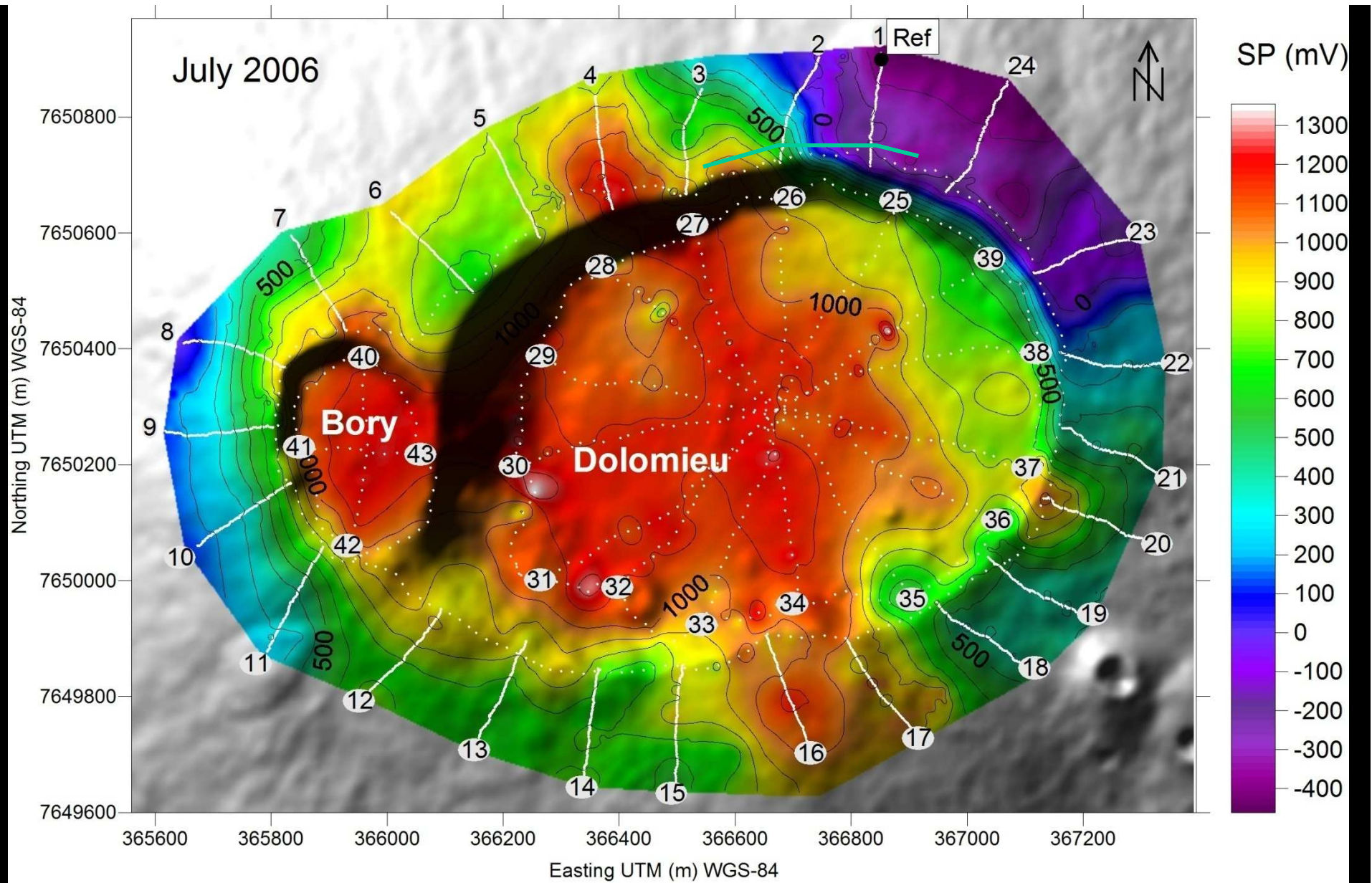
2.b. Monitoring - Piton de la Fournaise



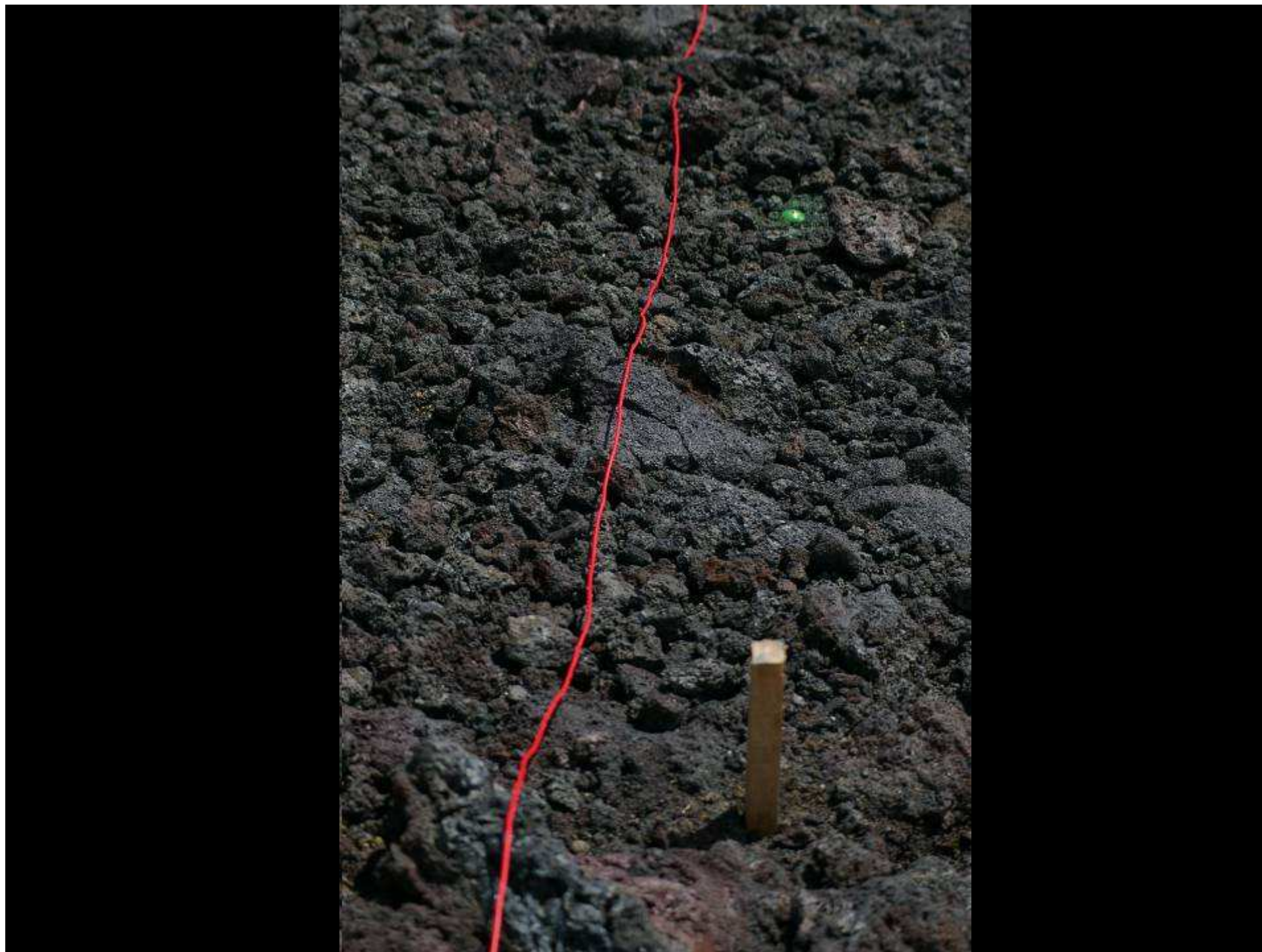
Piton de la Fournaise eruptive crisis



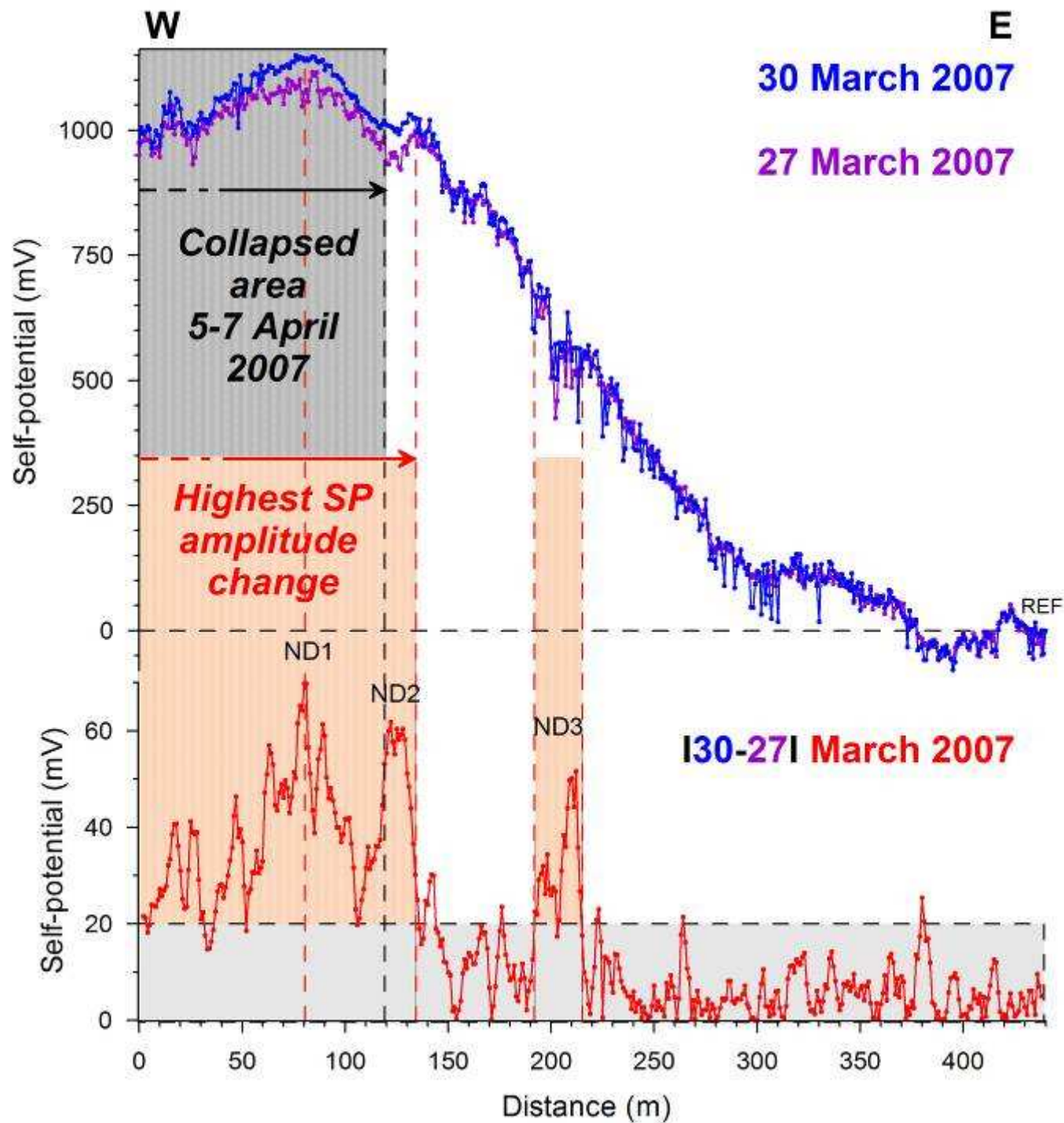




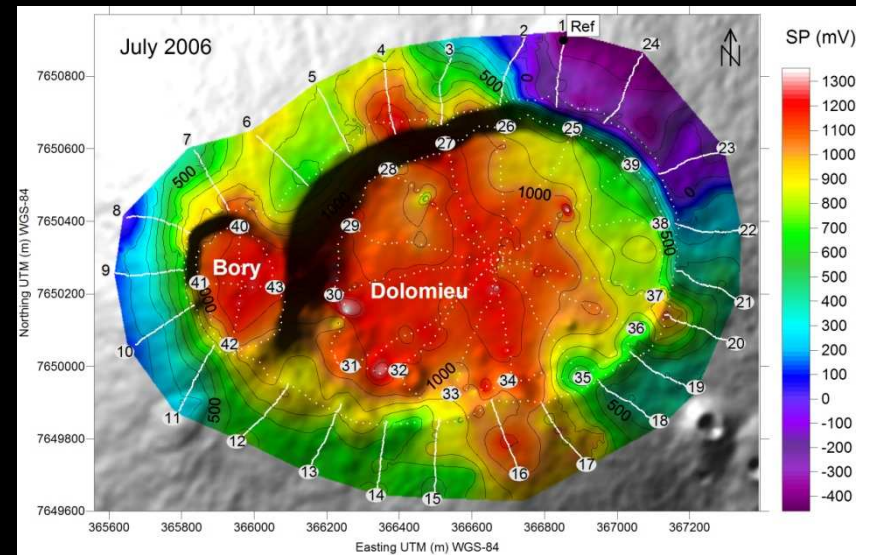
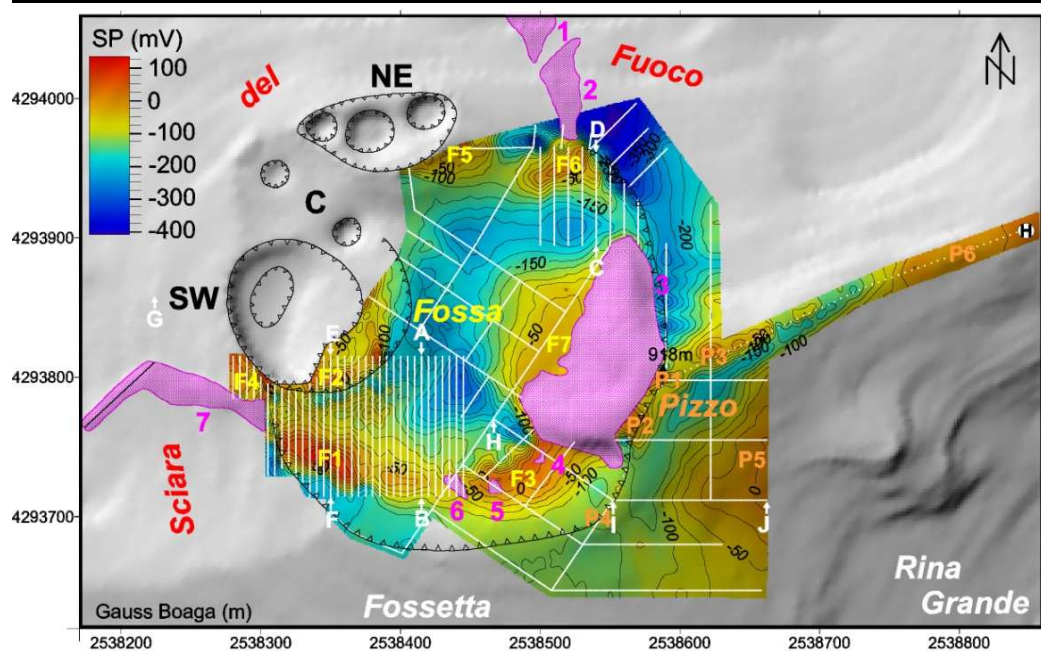
Finizola et al., in prep

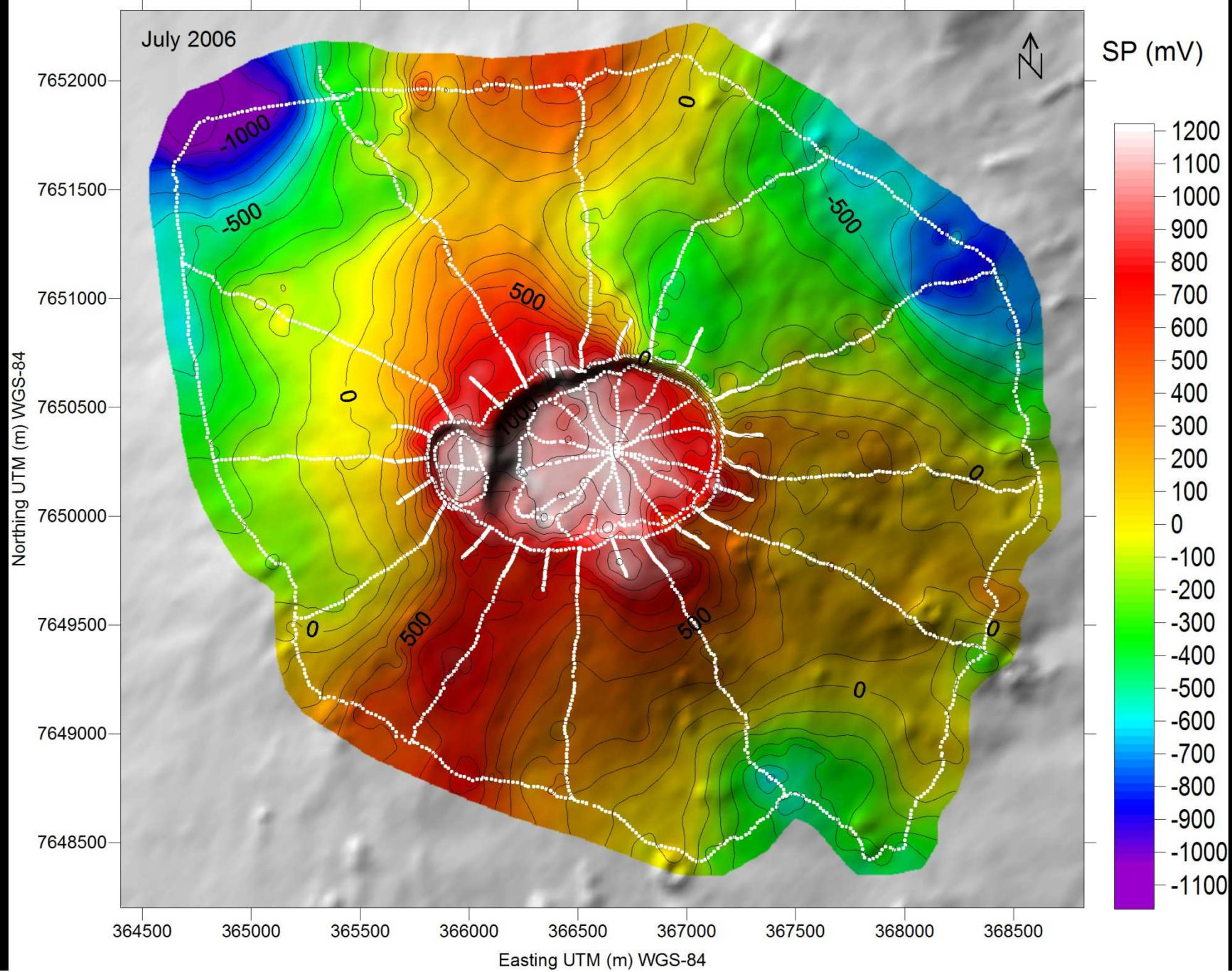




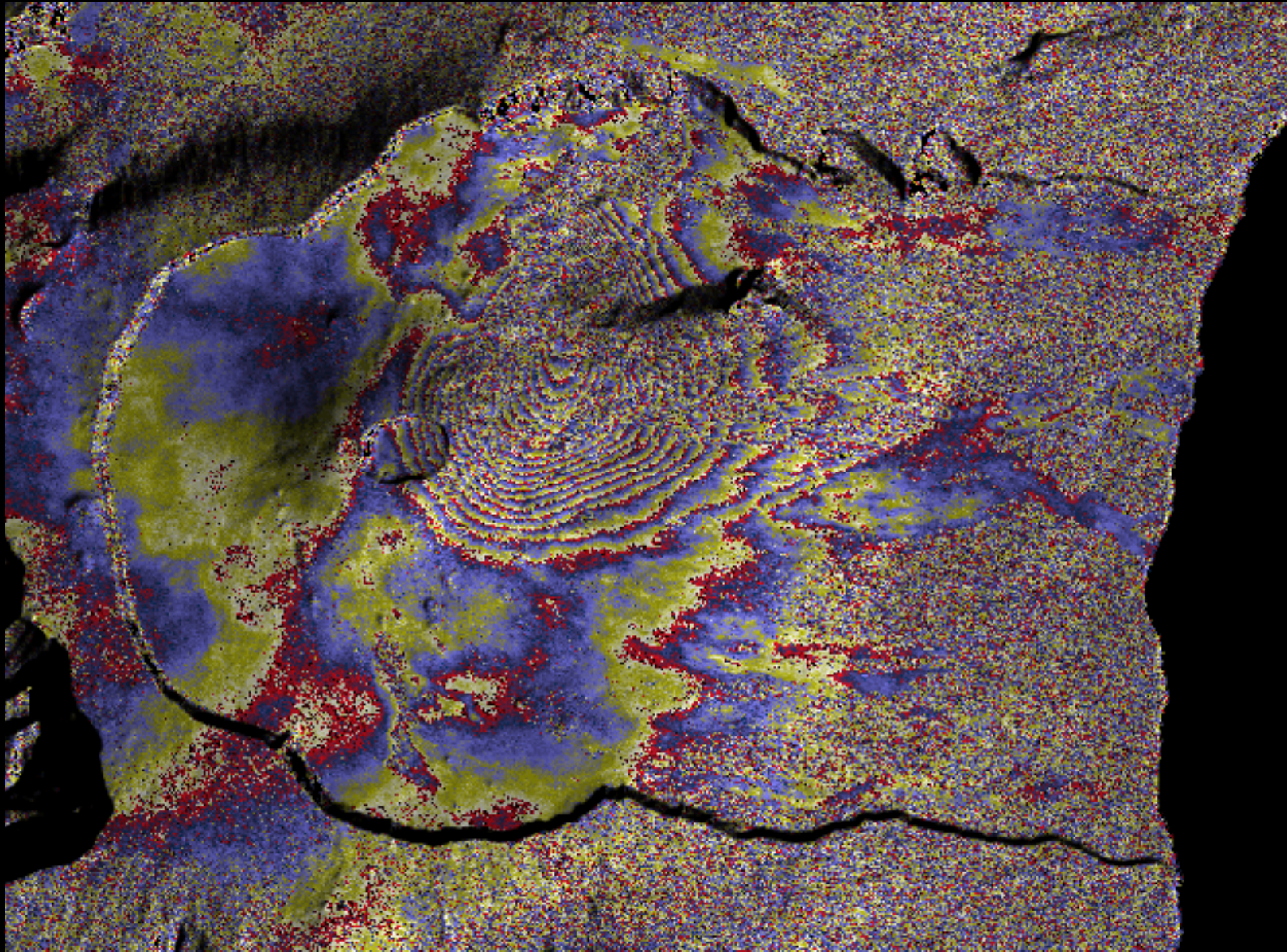


Importance of SP Maximum

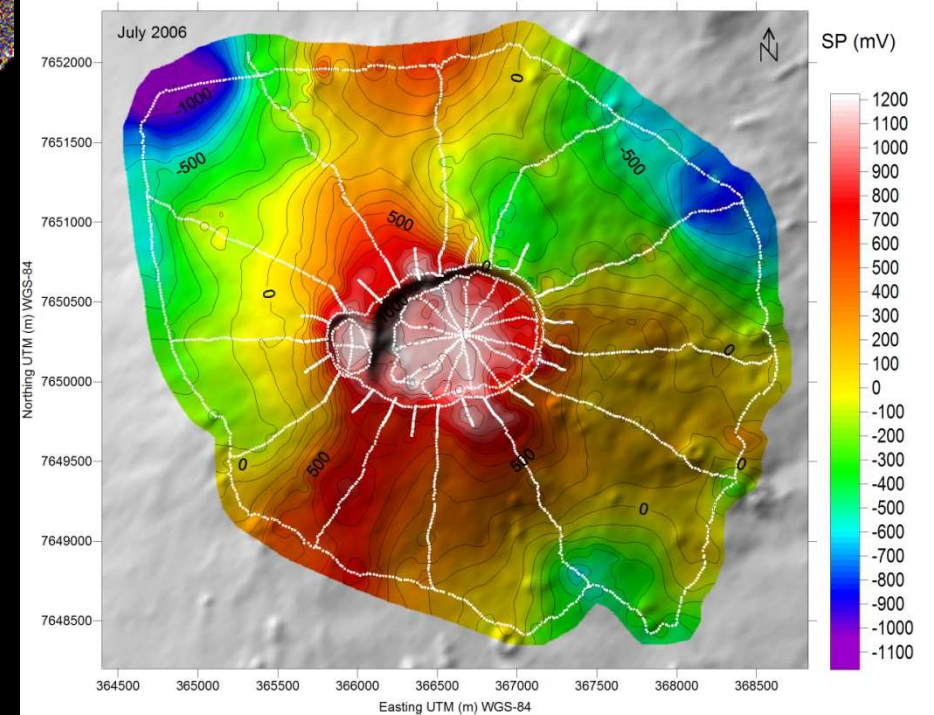
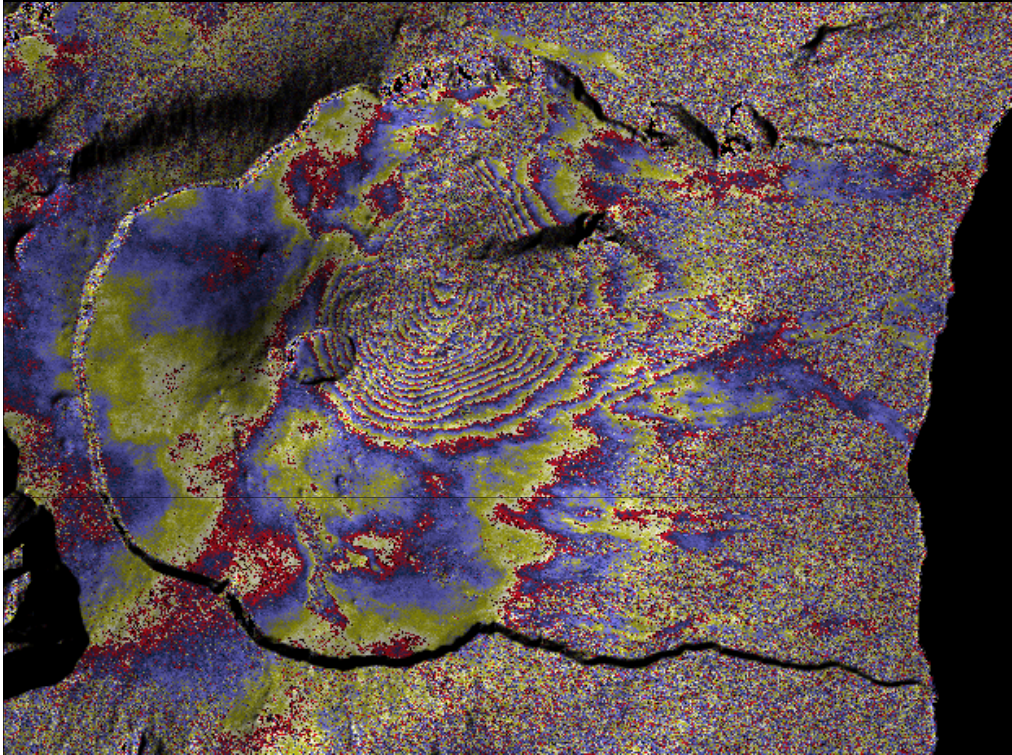




Eruption of February 2005 (Envisat)



Courtesely from Jean-Luc Froger



Perspective of ERT

