

Volcanology and geophysical investigations at Vesuvius

Giovanni Macedonio (on behalf of the MURAVES Collaboration)

Istituto Nazionale di Geofisica e Vulcanologia Osservatorio Vesuviano, Naples, Italy

Tokyo, 12 November 2014

G.Macedonio (MURAVES)

Muon Radiography of Vesuvius

< ロ > < 同 > < 回 > < 回 > < 回 > <

Summary



2 The knowledge of the internal structure of Vesuvius





くぼう くほう くほう

Active volcanoes in Italy and Vesuvius



The principal active volcanoes (10)

G.Macedonio (MURAVES)

Active volcanoes in Italy and Vesuvius



The principal active volcanoes (10)



- Last eruption occurred in 1944

- Now the conduit is closed
- Monitored 24/24

Vesuvius has the highest risk

More than 550,000 people live in the "Red Zone" of Vesuvius



Vesuvius today

G.Macedonio (MURAVES)

Muon Radiography of Vesuvius

Knowledge of the internal structure of Vesuvius

What we know about the volcano structure?

- Previous knowledge (Kircher, 1638)
- Active seismic tomography (TOMOVES-1996/MAREVES-1997)
- Passive seismic tomography (based on natural earthquakes)
- Gravimetric field inversion
- Direct observations of the interior of the crater
- Muon radiography

くぼう くほう くほう

Knowledge of the internal structure of Vesuvius The first studies of Kircher in 1638



G.Macedonio (MURAVES)

Knowledge of the internal structure of Vesuvius

Seismic active tomography (TOMOVES-1996 and MAREVES-1997 experiments)

- Active seismic tomography
- Spatial resolution $\approx 0.5 1 \, \text{km}$



(modified from Di Stefano and Chiarabba, JGR, 2002)



< 回 ト < 三 ト < 三

⁽from Auger et al., Science, 2001)

The internal structure of Vesuvius

Study of the natural seismicity



• Typical magnitude $M_L < 2.0$

(from D'Auria et al., Annals of Geophysics, 2013)

< 回 ト く ヨ ト く ヨ

• Largest earthquake $M_L = 3.6$

The internal structure of Vesuvius

High resolution passive seismic tomography (300-500 m)



(from Scarpa et al., GRL, 2002)

The internal structure of Vesuvius

Gravimetric field inversion (spatial resolution \approx 250-500 m)



(from Cella et al., JVGR, 2007)

Observations of the upper part of Vesuvius



(from Imbò, 1949)

Observations of the upper part of Vesuvius



Vesuvius crater in 1944



Vesuvius crater today



(from Imbò, 1949)

The MURAVES Project

Muon radiography of Vesuvius

Investigation of the internal structure of Vesuvius by using **cosmic muons**

Map of the rock thickness of Vesuvius (possible radiography)



イロト 不得 トイヨト イヨト

Objectives of the MURAVES Project

Objectives

- To develop a synergy between geophysics and particle physics
- Achieve an integrated model of the Vesuvius' structure based on muon radiography, gravimetric and seismological data

Method

- Build of new telescopes for volcano radiography using cosmic muons with better resolution and background suppression than previous experiments
- Development of an innovative model for the integration of data from muon radiography, gravimetry and seismology

3

Muon radiography of Vesuvius

The MURAVES Project

Previous projects

- MU-RAY Project (INFN, INGV, UNINA)
- MURAY2 Project (INFN, in collaboration with INGV)

MURAVES Project

- Funded by MIUR (Project "Premiale 2012")
- INGV (host institution) + INFN (main partner)
- Budget 860 kEuro

Project duration: 3 years

- First year: Laboratory setup on Vesuvius, beginning of data acquisition
- Following years: Data acquisition and analysis

イロト 不得 とくほ とくほ とうほ

The MURAVES Project structure



G.Macedonio (MURAVES)

Muon Radiography of Vesuvius

Tokvo, 12 November 2014 15 / 17

э

イロト 不得 トイヨト イヨト

The MURAVES Project Gantt

	First Phase																							- 3	Se	con	nd	Pl	has	e										
	First year												Second year													Third year														
	1	2	3	4	5	6	7	8	9	1	0 11	1	2	13	14	15	16	1	7 1	8	19	20	21	22	2	$3 _{2}$	24	25	26	27	28	29	3	0	31	32	33	34	35	36
WP1.1		÷.																																						
WP12																																								
WP13	:	1	1		5ý			ş		1																														
WD1 4						_																																		in t
WP1.4			- 10	-				-	1																															
WP2.1																																								
WP2.2								I																																
WP2.3										1																														
WP2.4																																								
WP31	· · · · · · · · · · · · · · · · · · ·							ę		-		1																												
WD22						_			:			1																												
WI 0.2	-	- 7				_	i	2	1			22																												
WP4.1	100	-										·						ġ						1.00.	÷								÷							
WP4.2																																								
WP4.3																																								
WP4.4	10 100	100	10		-			i.	i.	100			200				10.5		Ċ.				3 6			12.5														
WP4.5	-		÷.	÷				Ē)	1	1	1	1	1	1			1	÷.,						ŧ					1											
WP5.1	1	11111																							5	1	÷												-	
WD5 9	-	- 1		en ĝi	j																																			in the
WF 0.2	-	110	1	- 1	- 10	_		÷,				- j,					·		4					ļ							·			4						
WP5.3																						_														_				
WP5.4				1				E .																																

2

ヘロト ヘアト ヘビト ヘビト

The MURAVES Project Gantt



э

(4回) (4回) (4回)

The MURAVES Project Gantt

	Implementation												Data acquisition and analysis																									
	First Phase													Second Phase															_									
	First year													1			Se	con	d y	ear	1		-							Γ	hir	d ye	ar					
	1 :	2 3	4		5 0	6	7	8	9	10 1	1	12	13	14	18	5 1	6	17	18	19	20	2	1 2	2	23	24	25	26	27	28	29	30	31	32	33	34	35	36
NP1.1																																						
VP1.2	20025203											40																										
VP1.3						-																																
VP1.4		10	w.																																			
VP2.1	s (46)																																					
WP2.2					144																																	
WP2.3																																						
WP2.4																																						
WP3.1	in San		1							10010																												
WP3.2		-	- di 																																			<u>.</u>
WP4.1	in the	10																																				
WP4.2											Ì													÷														
WP4.3											Ī									,																		
WP4.4	-	100	-0													100	10		-		i.	ain -			13.5		8											
WP4.5			ł.				i.				1					1	1					1	d.,															
WP5.1		11.12111	i.																					T		1											1	
WP5.2	-	1		- ip-i																																		
VP5.3	-			-	3			****			į>				4		2			· · · · ·			-									à						
WP5.4			-	1										-		- 1			-		-			-			-		-			-						
1.1.0.1		-	-	-			-																															

2

ヘロア 人間 アメヨア 人口 ア

Conclusion

The challenge

- The investigation of the internal structure of Vesuvius using cosmic muons is a **challenge**
- The integration between seismic, gravimetric and muon radiography data is completely **innovative**
- The cooperation between INGV, INFN and ERI is an important step to begin this challenge

< 回 > < 三 > < 三 >