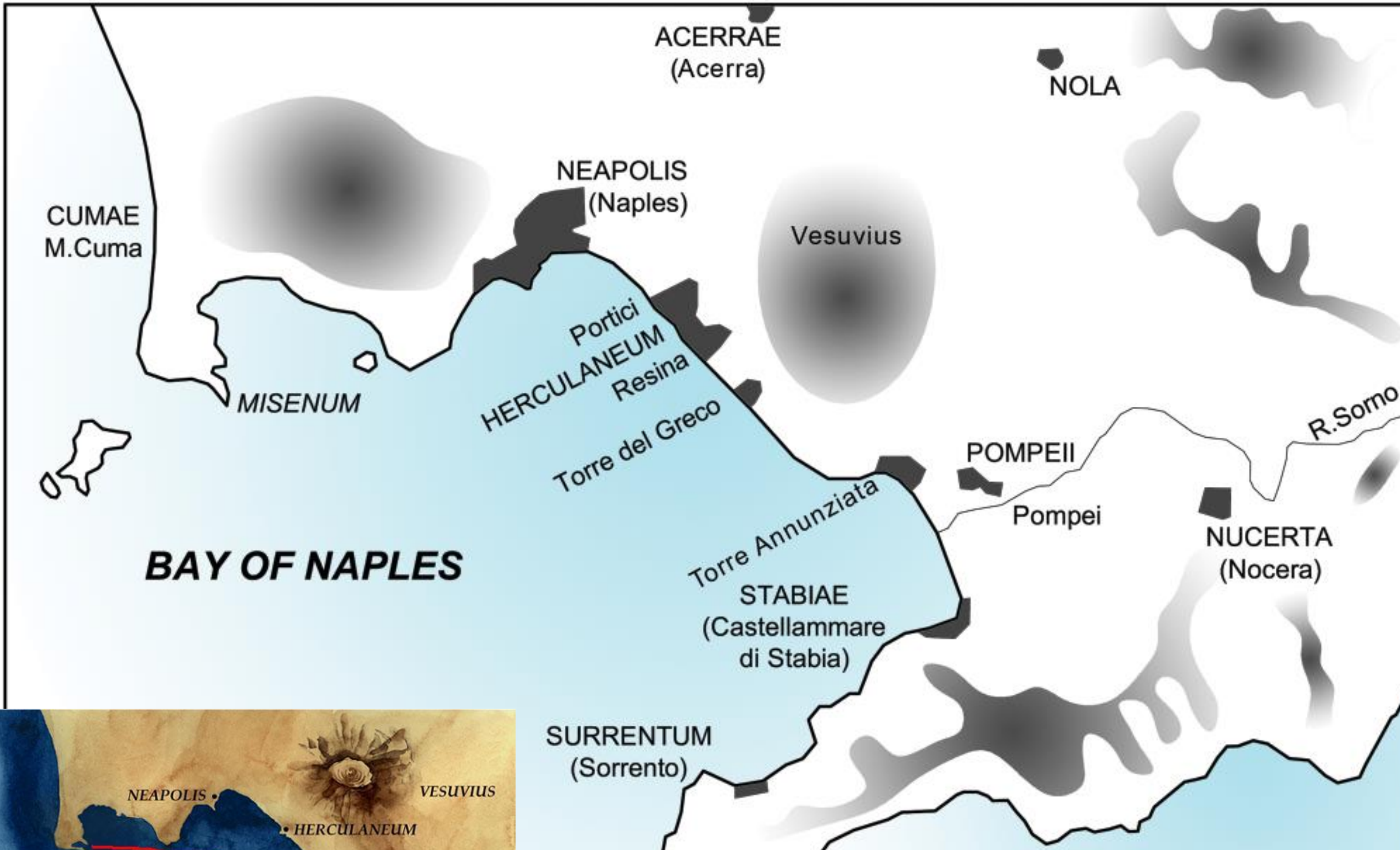
Pompei, Ercolano, Oplonti

Stefano Lugli


NO WARNING.
NO ESCAPE.
POMPEII IN 3D
TRISTAR PICTURES AND FILMDISTRICT PRESENT A CONSTANTIN FILM INTERNATIONAL/IMPACT PICTURES (POMPEII) PRODUCTION A FILM BY PAUL W.S. ANDERSON "POMPEII" KIT HARINGTON CARRIE-ANNE MOSS
EMILY BROWNING ADEWALE AKINNUOYE-AGBAJE JESSICA LUCAS WITH JARED HARRIS AND KIEFER SUTHERLAND CASTING BY RONNA KRESS C.S.A. DEIRDRE BOWEN MUSIC BY CLINTON SHORTER DIGITAL VISUAL EFFECTS BY MR. X INC. VISUAL EFFECTS SUPERVISOR DENNIS BERARDI
COSTUME DESIGNER WENDY PARTRIDGE EXECUTIVE IN CHARGE OF PRODUCTION CHRISTINE ROTHE EDITED BY MICHELE CONROY PRODUCTION DESIGNER PAUL DENHAM AUSTERBERRY DIRECTOR OF PHOTOGRAPHY GLEN MacPHERSON ASC, CSC EXECUTIVE PRODUCERS MARTIN MOSZKOWICZ PETER SCHLESSEL JON BROWN
Soundtrack on Milan Music and Koenigskinder Music
PRODUCED BY JEREMY BOLT PAUL W.S. ANDERSON ROBERT KULZER DON CARMODY WRITTEN BY JANET SCOTT BATCHLER & LEE BATCHLER AND MICHAEL ROBERT JOHNSON DIRECTED BY PAUL W.S. ANDERSON
Constantin Film
IMPACT PICTURES
FILMDISTRICT
PG-13
IN THEATERS FEBRUARY 2014
PompeiiMovie.tumblr.com
Sony Entertainment Network
SONY
TRI STAR


ACERRAE
(Acerra)
NOLA
CUMAE
M.Cuma
NEAPOLIS
(Naples)
Vesuvius
Portici
HERCULANEUM
Resina
Torre del Greco
MISENUM
R.Sorno
POMPEII
Pompei
Torre Annunziata
NUCERTA
(Nocera)
BAY OF NAPLES
STABIAE
(Castellammare
di Stabia)
SURRENTUM
(Sorrento)


NEAPOLIS
VESUVIUS
HERCULANEUM
MISENUM
POMPEII
BAY OF NAPLES
STABIAE
route of Pliny the Elder

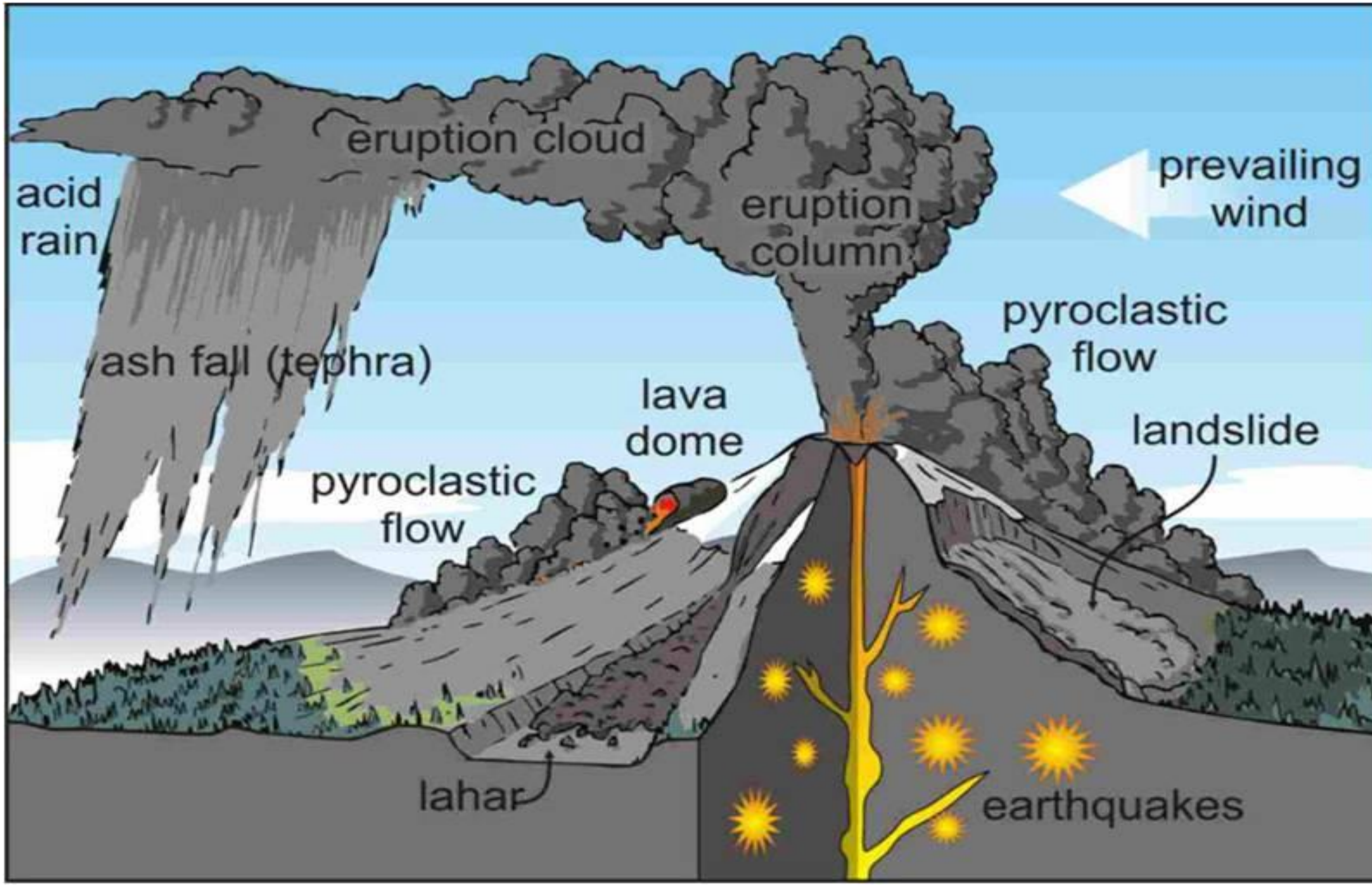
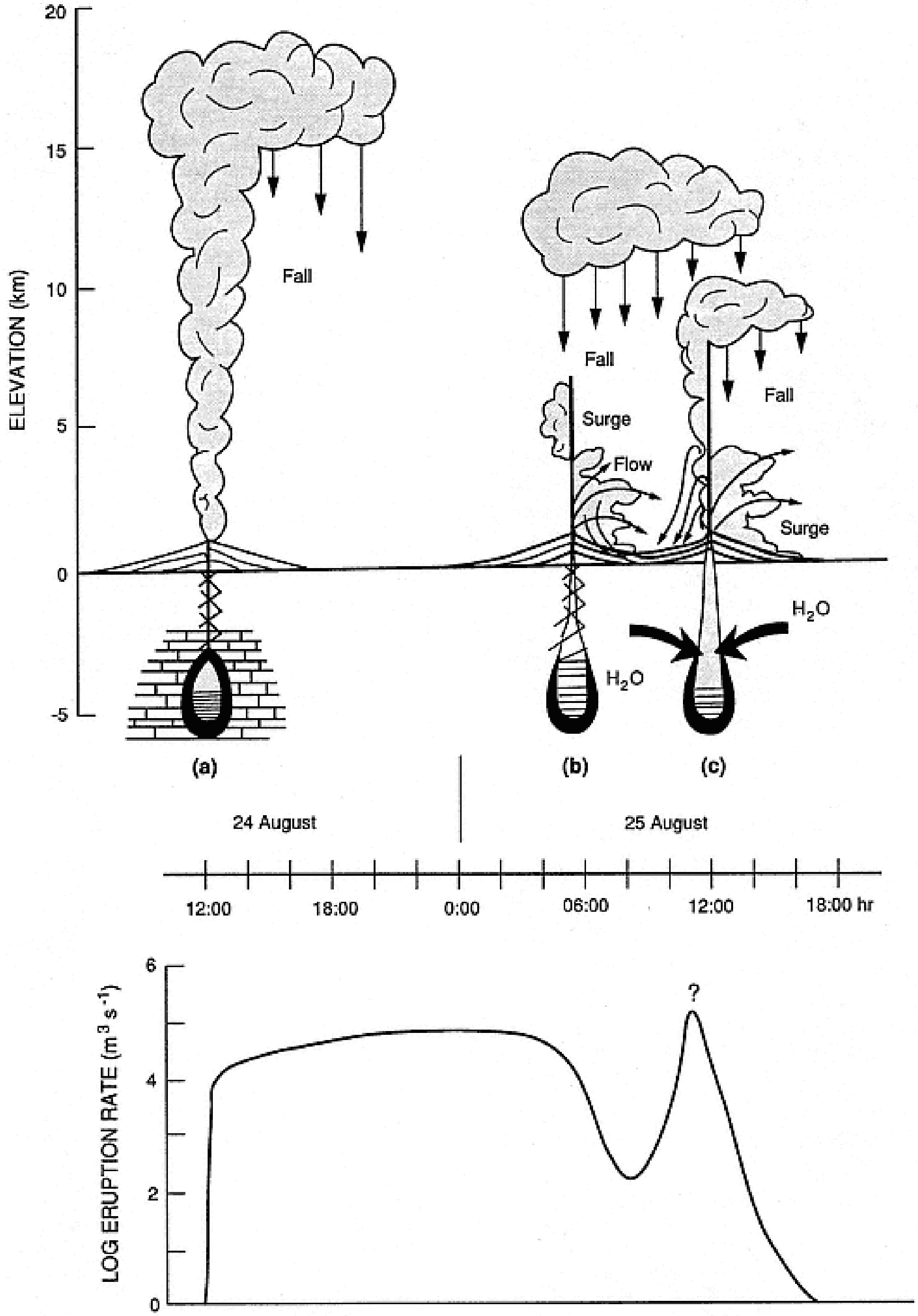

eruption cloud
acid rain
eruption column
prevailing wind
pyroclastic flow
ash fall (tephra)
lava dome
pyroclastic flow
landslide
lahar
earthquakes

Table 3.6 Classification of volcaniclastic grains and sediments on grain-size.

	Volcaniclastic grains	Size	Volcaniclastic sediment terms (tephra)
	bombs – ejected fluid blocks – ejected solid	coarse – 256 mm – fine	agglomerate volcanic breccia
64 mm			
	lapilli	coarse – 16 mm – medium – 4 mm – fine	lapillistone
2 mm			
	ash	very coarse – 1 mm – coarse – 0.5 mm – medium – 0.06 mm – fine	tuff – vitric tuff – lithic tuff – crystal



ELEVATION (km)
20
15
10
5
0
-5
Fall
Fall
Surge
Flow
Fall
Surge
H_2O
H_2O
(a)
(b)
(c)
24 August
25 August
12:00
18:00
0:00
06:00
12:00
18:00 hr
LOG ERUPTION RATE ($m^3 s^{-1}$)
6
4
2
0
?

3.11.1.1 Pyroclastic fall deposits

These include subaerial and subaqueous (submarine or sublacustrine) fallout tephra. They are characterised by a gradual decrease in both bed thickness and grain-size away from the site of eruption. Beds are typically well sorted and normally graded. However, they are frequently reworked by currents and waves if deposited in water, or wind if subaerial, and thus may show cross- or planar lamination (strictly these would then be epiclastic deposits). Larger fragments of pumice may occur on top of the beds if they floated before being deposited. These deposits can be spread over wide areas and are useful for stratigraphic correlation, forming marker beds. Pyroclastic fall deposits mantle the topography, with layers of roughly constant thickness over both hills and valleys (Fig. 3.24).

3.11.1.2 *Pyroclastic flow deposits*

These are the product of hot gas/solid high-concentration density currents, which may travel at velocities of 20–100 $m\,s^{-1}$. One common pyroclastic flow deposit is an *ignimbrite*, produced by a violent plinian eruption, which generally occurs in subaerial situations, although the flows may continue into the sea or a lake. Ignimbrites are characterised by their homogeneous appearance with little sorting of the finer ash particles, so they lack internal stratification. Coarse lithic clasts in the bed may be normally graded (size decreasing upward) whereas large pumice clasts (which are very light at the time of eruption) may show reverse grading (size increasing upward), or

glassy material is deformed around them. Some ignimbrites have a columnar jointing, also indicating that they were still hot on deposition. Typical thicknesses of an ignimbrite deposit are 1 m to 10 m or more. The flows are topographically controlled and so the deposits fill valleys and depressions (Fig. 3.24).

3.11.1.3 Pyroclastic surge deposits

These result from highly expanded turbulent gas–solid density currents with low particle concentrations. Phreatomagmatic and phreatic eruptions involve steam and generate base-surge deposits. They are characterised by well-developed unidirectional sedimentary bedforms (dunes) giving cross-stratification (Fig. 3.26), pinch-and-swell features and antidune cross-bedding (Section 5.3.3.15), since they are deposited by very fast-flowing ash-laden steam flows. Individual laminae are generally well sorted. These deposits tend to blanket the topography, although they do thicken into the depressions (Fig. 3.24). There is a complete gradation between high-particle concentration pyroclastic flows and low-particle concentration pyroclastic surges.

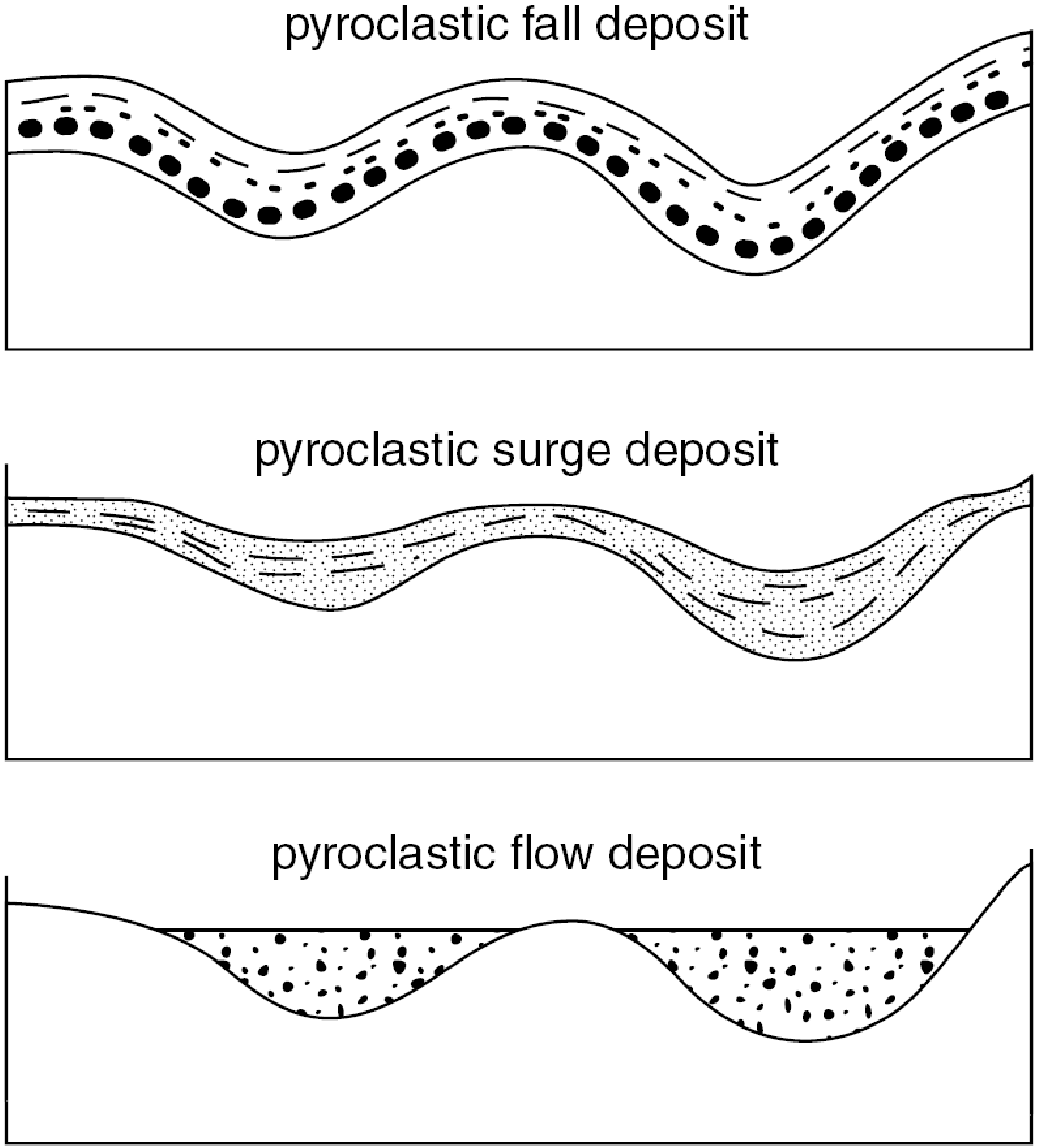
Pyroclastic flows are high-density mixtures of hot, dry rock fragments and hot gases that move away from the vent that erupted them at high speeds. They may result from the explosive eruption of molten or solid rock fragments, or both. They may also result from the nonexplosive eruption of lava when parts of dome or a thick lava flow collapses down a steep slope. Most pyroclastic flows consist of two parts: a basal flow of coarse fragments that moves along the ground, and a turbulent cloud of ash that rises above the basal flow. Ash may fall from this cloud over a wide area downwind from the pyroclastic flow.

A pyroclastic flow will destroy nearly everything in its path. With rock fragments ranging in size from ash to boulders traveling across the ground at speeds typically greater than 80 km per hour, pyroclastic flows knock down, shatter, bury or carry away nearly all objects and structures in their way. The extreme temperatures of rocks and gas inside pyroclastic flows, generally between 200°C and 700°C, can cause combustible material to burn, especially petroleum products, wood, vegetation, and houses.

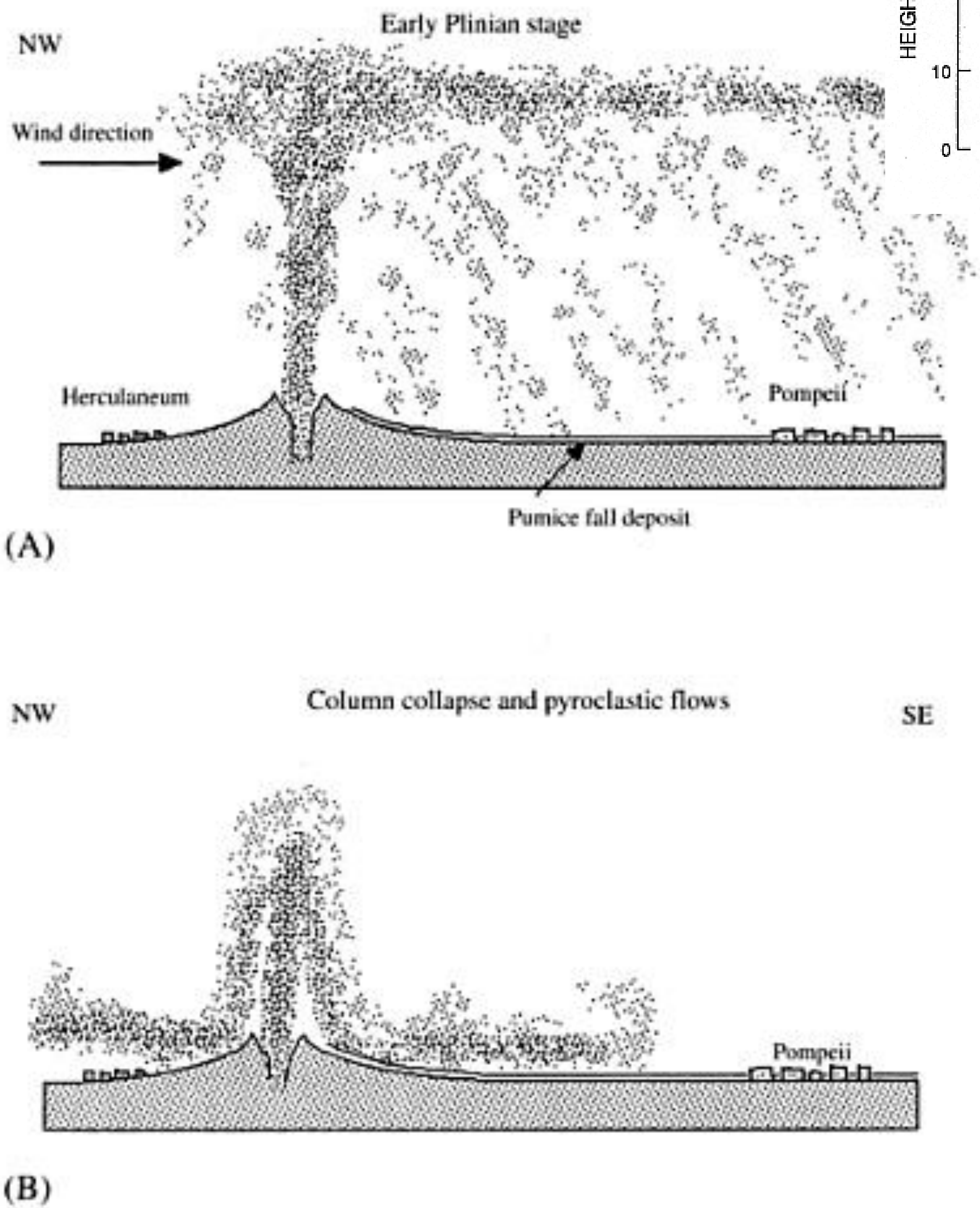
Pyroclastic flows vary considerably in size and speed, but even relatively small flows that move less than 5 km from a volcano can destroy buildings, forests, and farmland. And on the margins of pyroclastic flows, death and serious injury to people and animals may result from burns and inhalation of hot ash and gases.

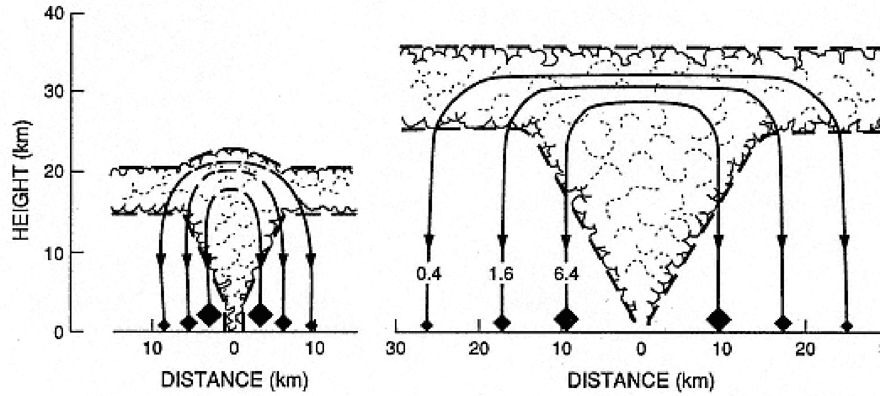
Pyroclastic flows generally follow valleys or other low-lying areas and, depending on the volume of rock debris carried by the flow, they can deposit layers of loose rock fragments to depths ranging from less than one meter to more than 200 m.

USGS

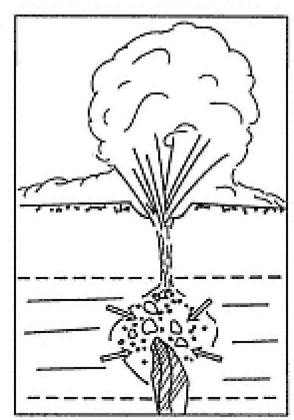

pyroclastic fall deposit
pyroclastic surge deposit
pyroclastic flow deposit

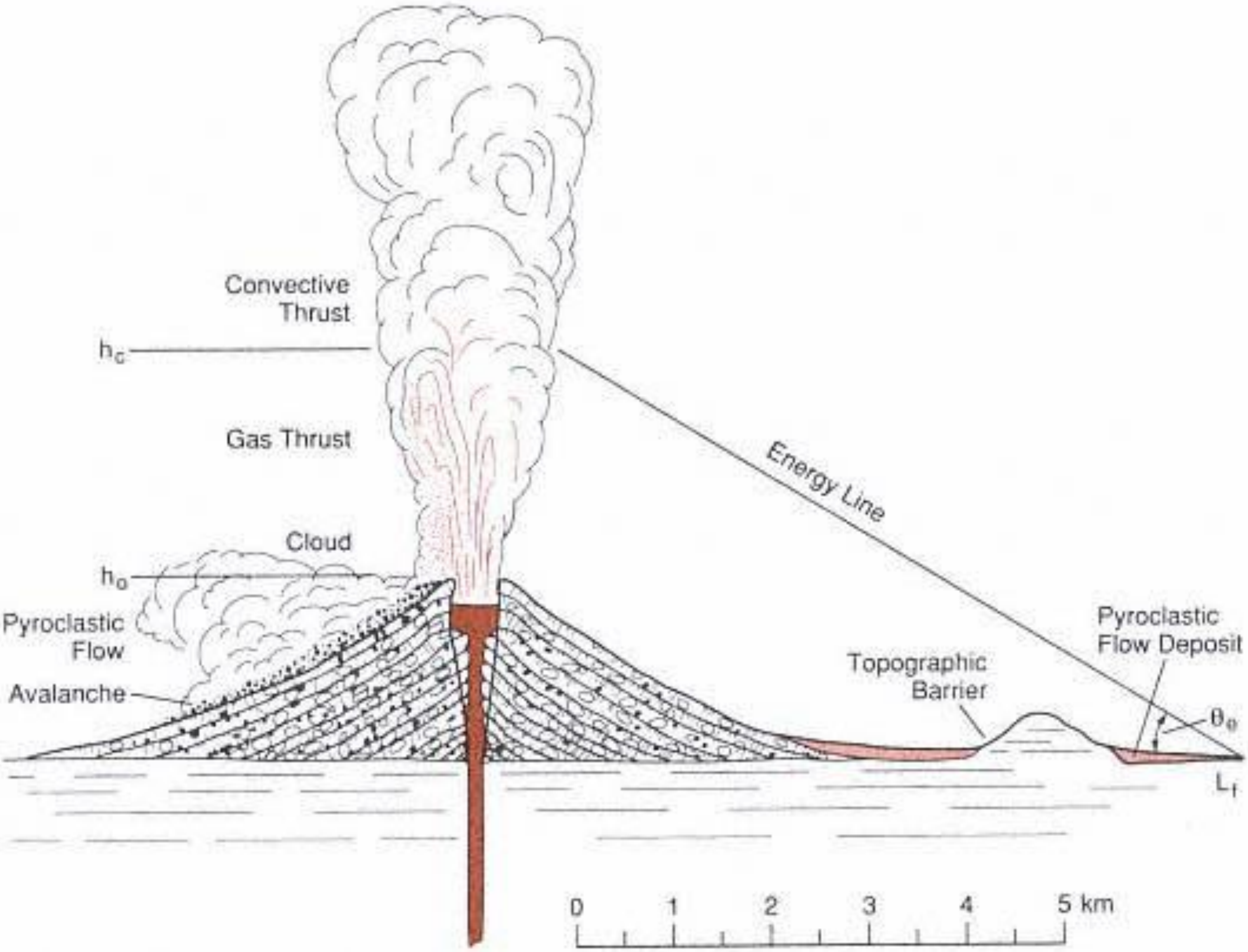
Haraldur Sigurdsson and Steven Carey



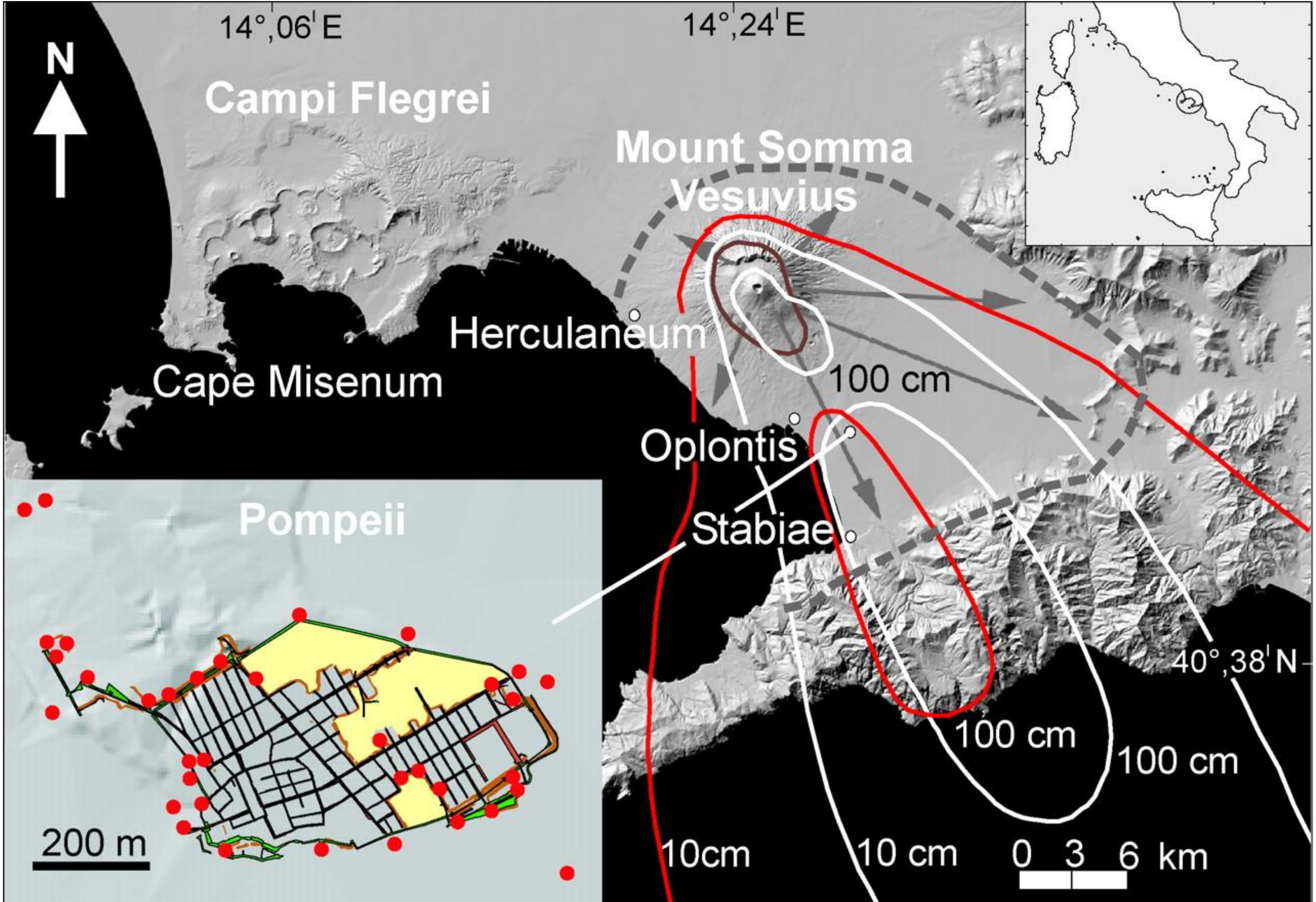


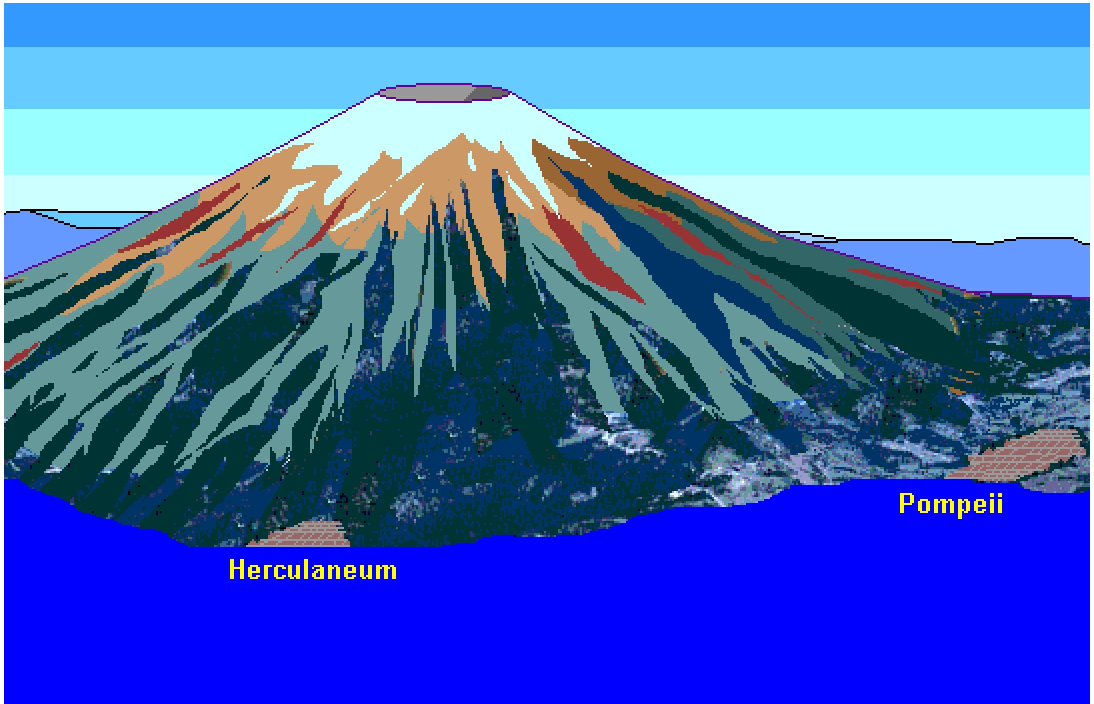
Clast trajectories from the umbrella region of a Plinian eruption column; clast sizes are given in centimeters. Note that the dispersal is greater for the 35-km-high column than for the 21-km-high column. (Adapted from Carey and Sparks, 1986.)



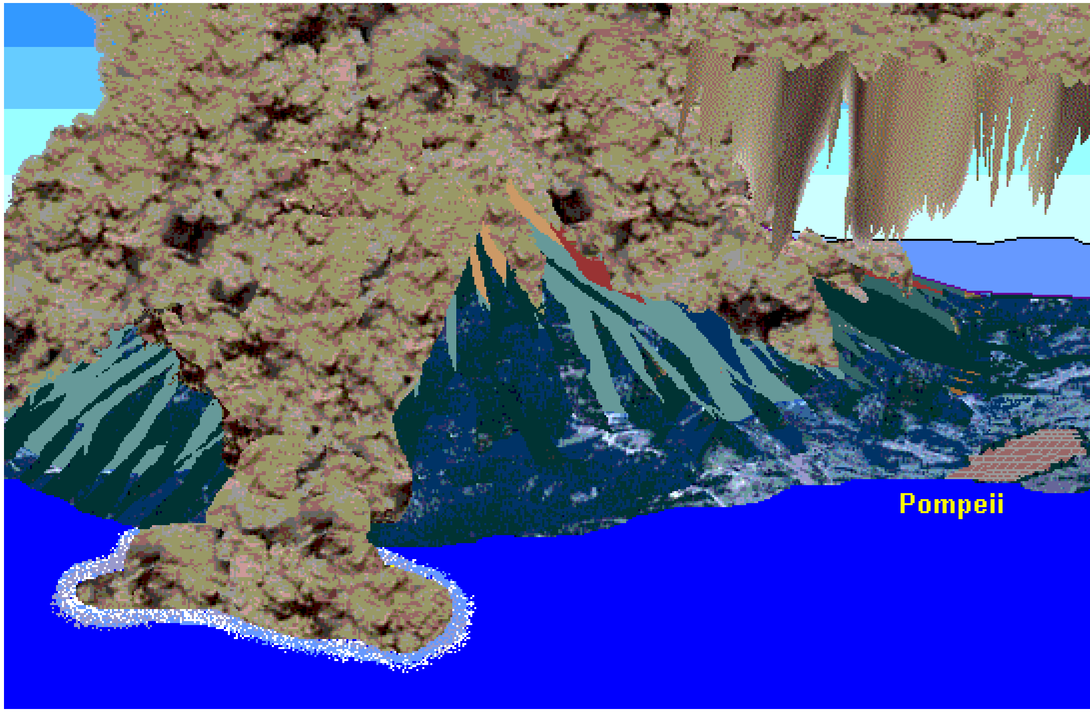


Convective
Thrust
h_c
Gas Thrust
Energy Line
Cloud
h_o
Pyroclastic
Flow
Avalanche
Pyroclastic
Flow Deposit
Topographic
Barrier
θ_e
L_f
0
1
2
3
4
5 km

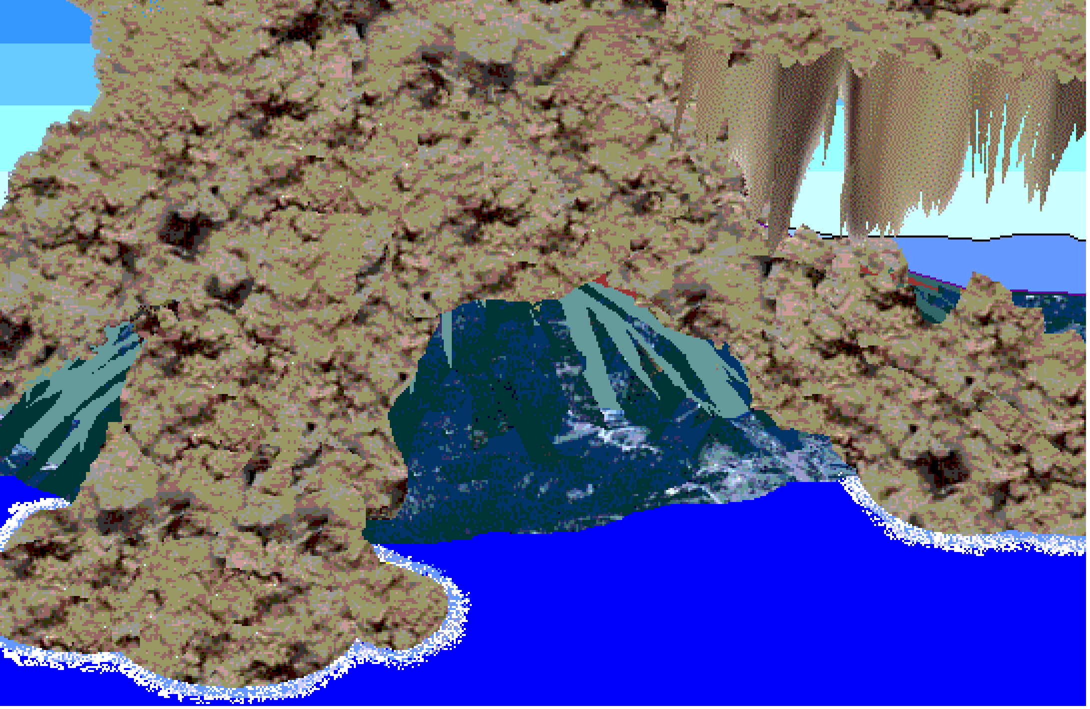

14°,06' E
14°,24' E
N
Campi Flegrei
Mount Somma
Vesuvius
Herculaneum
Cape Misenum
100 cm
Oplontis
Stabiae
Pompeii
40°,38' N
100 cm
100 cm
200 m
10cm
10 cm
0 3 6 km

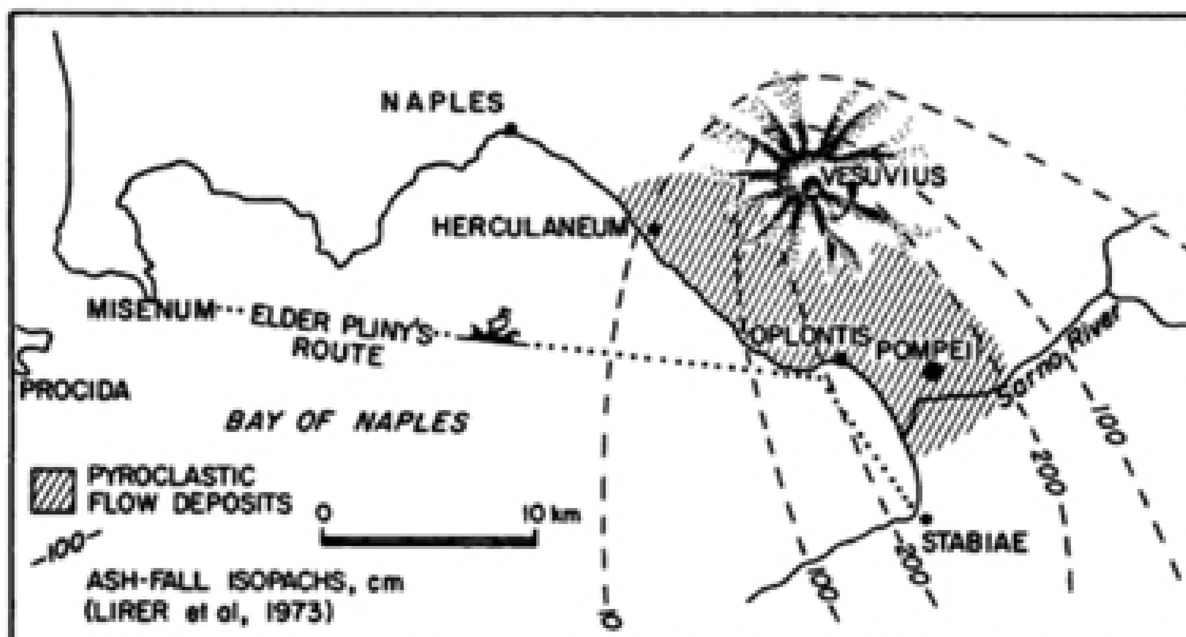

Pompeii
Herculaneum


Pompeii
Herculaneum



S. Dutch




NAPLES
VESUVIUS
HERCULANEUM
MISENUM
ELDER PLINY'S ROUTE
OPLONTIS
POMPEII
Sarno River
PROCIDA
BAY OF NAPLES
PYROCLASTIC FLOW DEPOSITS
0
10 km
100
200
STABIAE
ASH-FALL ISOPACHS, cm
(LIRER et al, 1973)

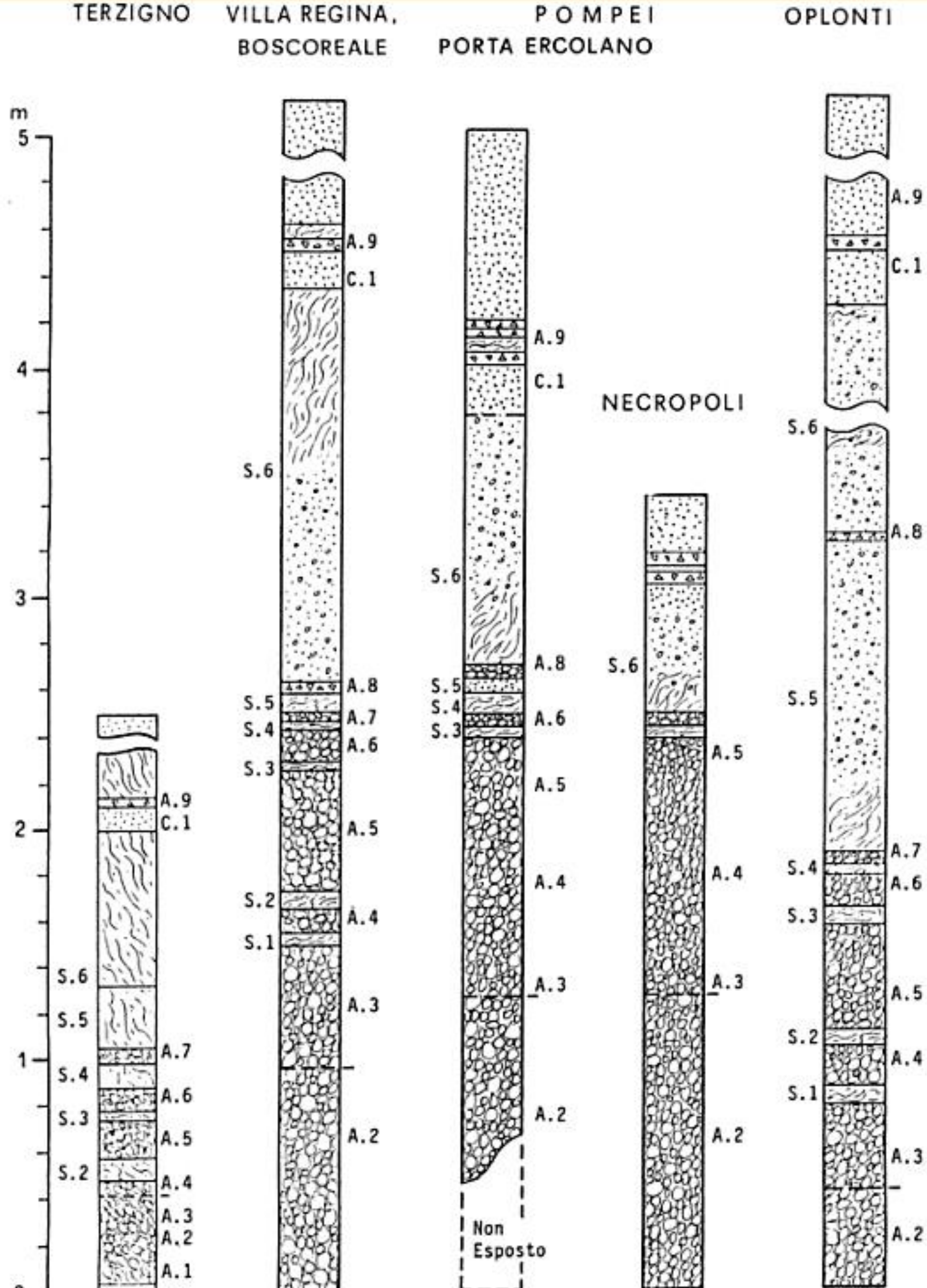
S. Dutch

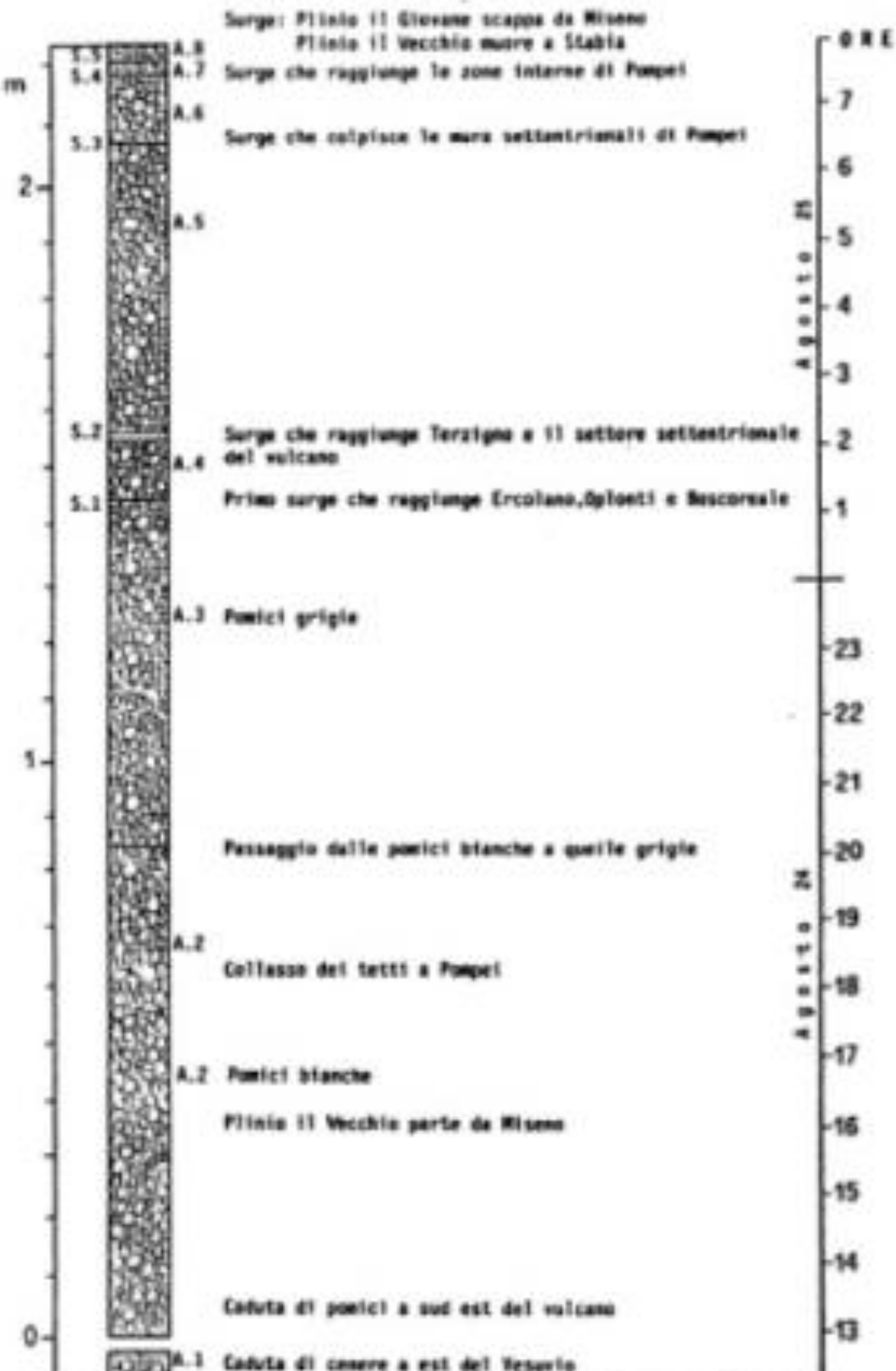
VESUVIUS

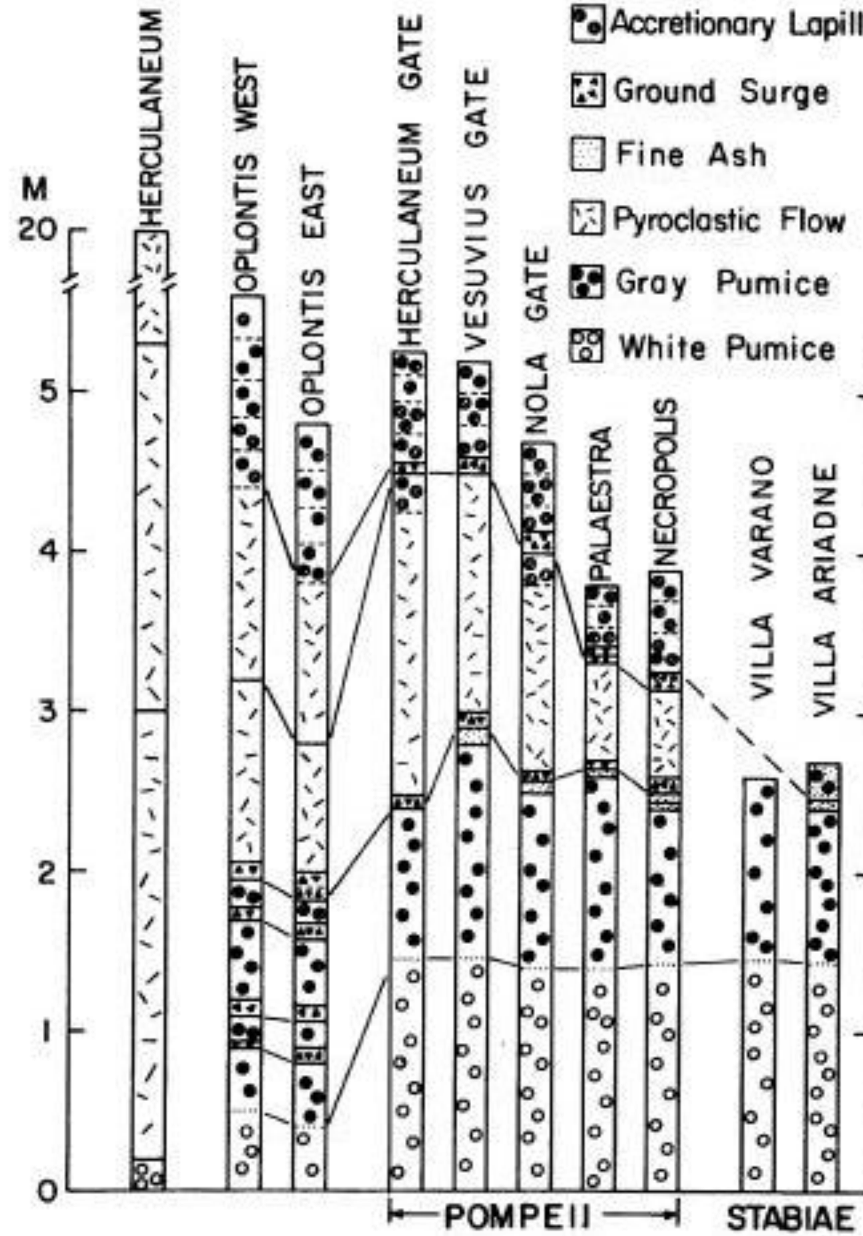
Areas of ash-fall and pyroclastic flow in Naples bay area.

Wind direction determined the ash-fall pattern.

The direction of the pyroclastic flows supports the "two peak" theory of how Vesuvius looked before the 79 AD eruption.


TERZIGNO
VILLA REGINA, BOSCOREALE
POMPEI PORTA ERCOLANO
NECROPOLI
OPLONTI
m
5
4
3
2
1
0
A.9
C.1
S.6
A.8
S.5
A.7
S.4
A.6
S.3
A.5
S.2
A.4
S.1
A.3
A.2
A.1
Non Esposto





Ill. 2. Stratigraphy of the deposits of A.D. 79 in excavations west and south of Vesuvius

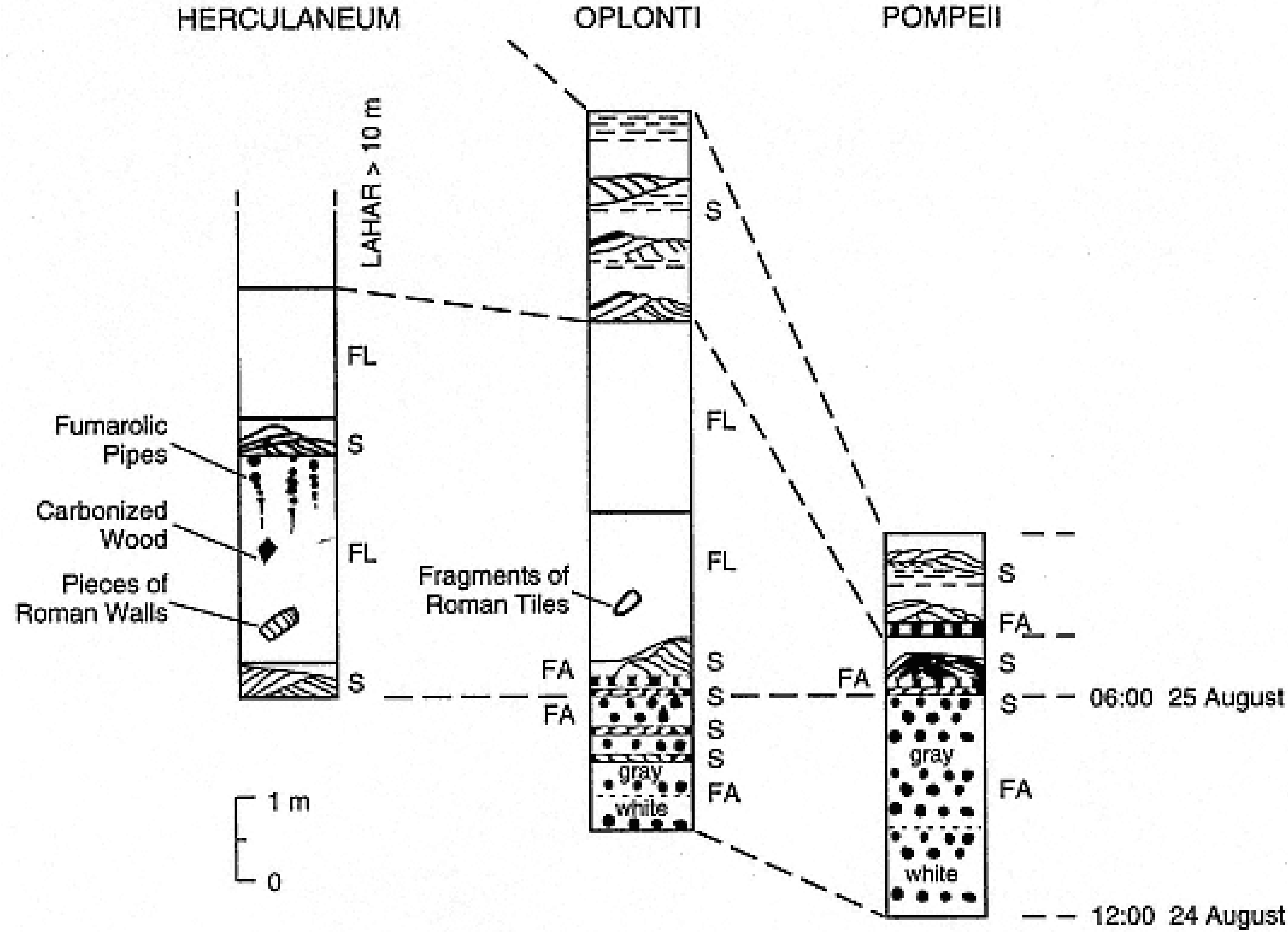
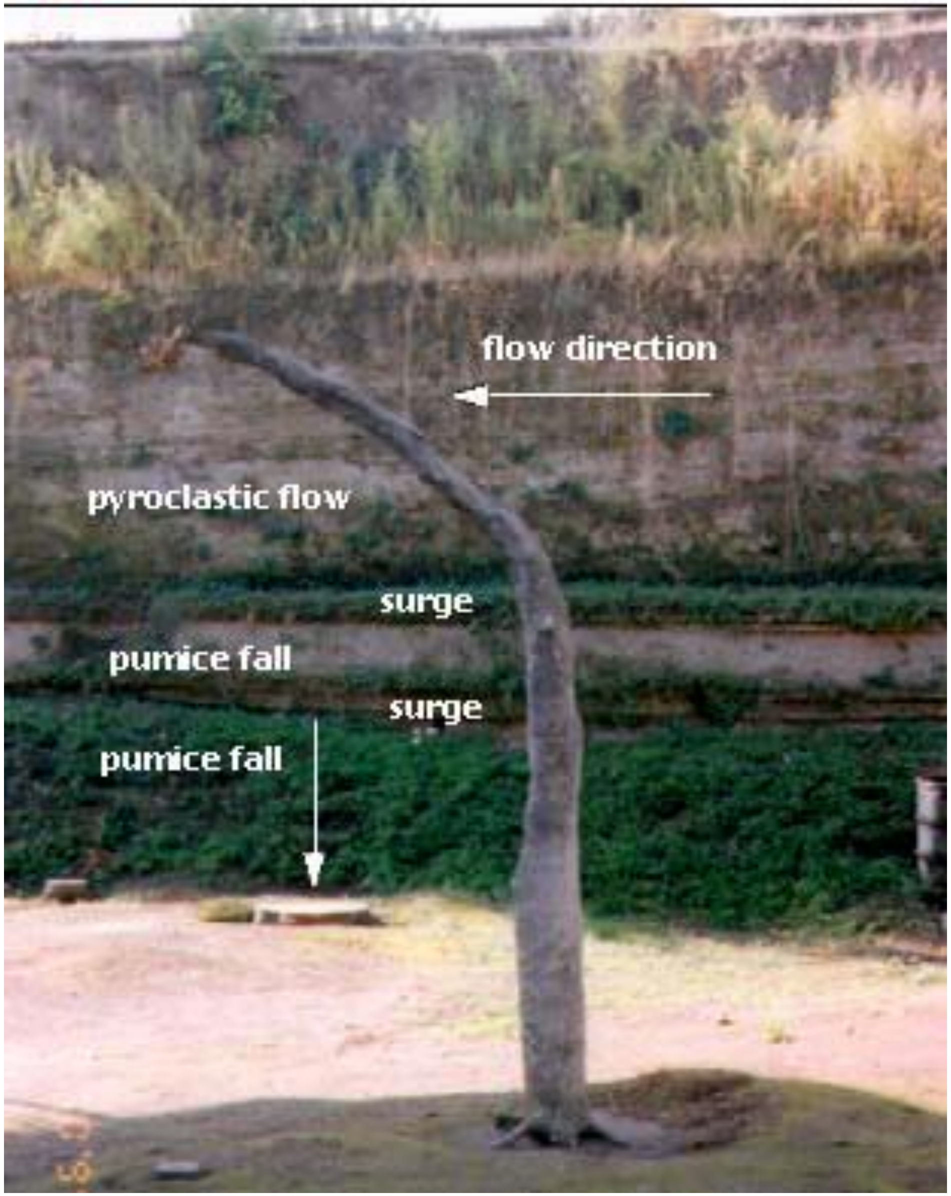
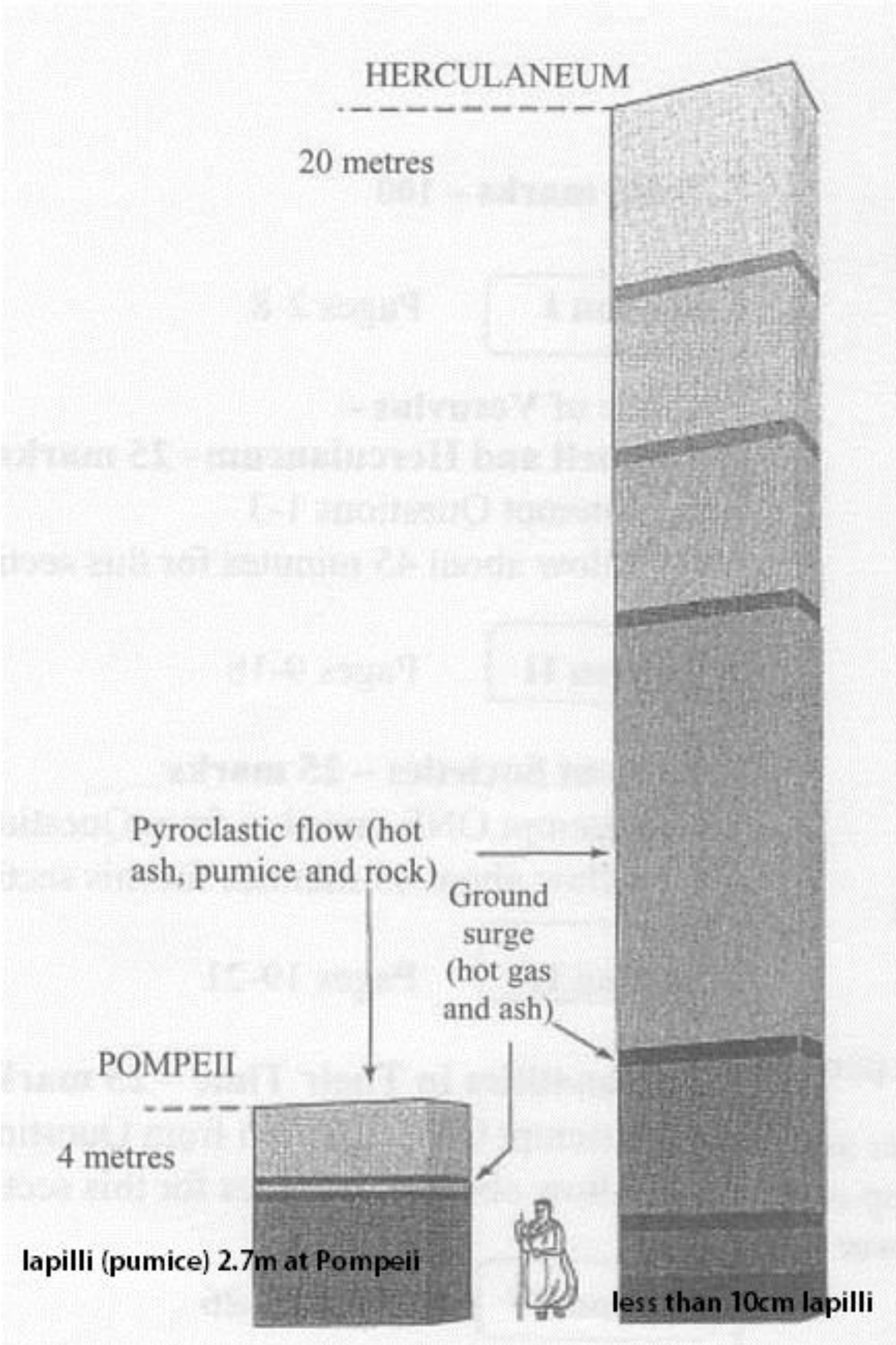


Fig. 2.18 Representative stratigraphy of AD 79 pyroclastic deposits exposed in archaeological excavations along the coastal side of Vesuvius; FA = pumice fallout, FL = pyroclastic flows, and S = surges. The basal white and gray pumice fallout was from early

Villa Regina (Boscoreale)

The tree was partially buried by the fall of pumice and then was bent by the pyroclastic flow

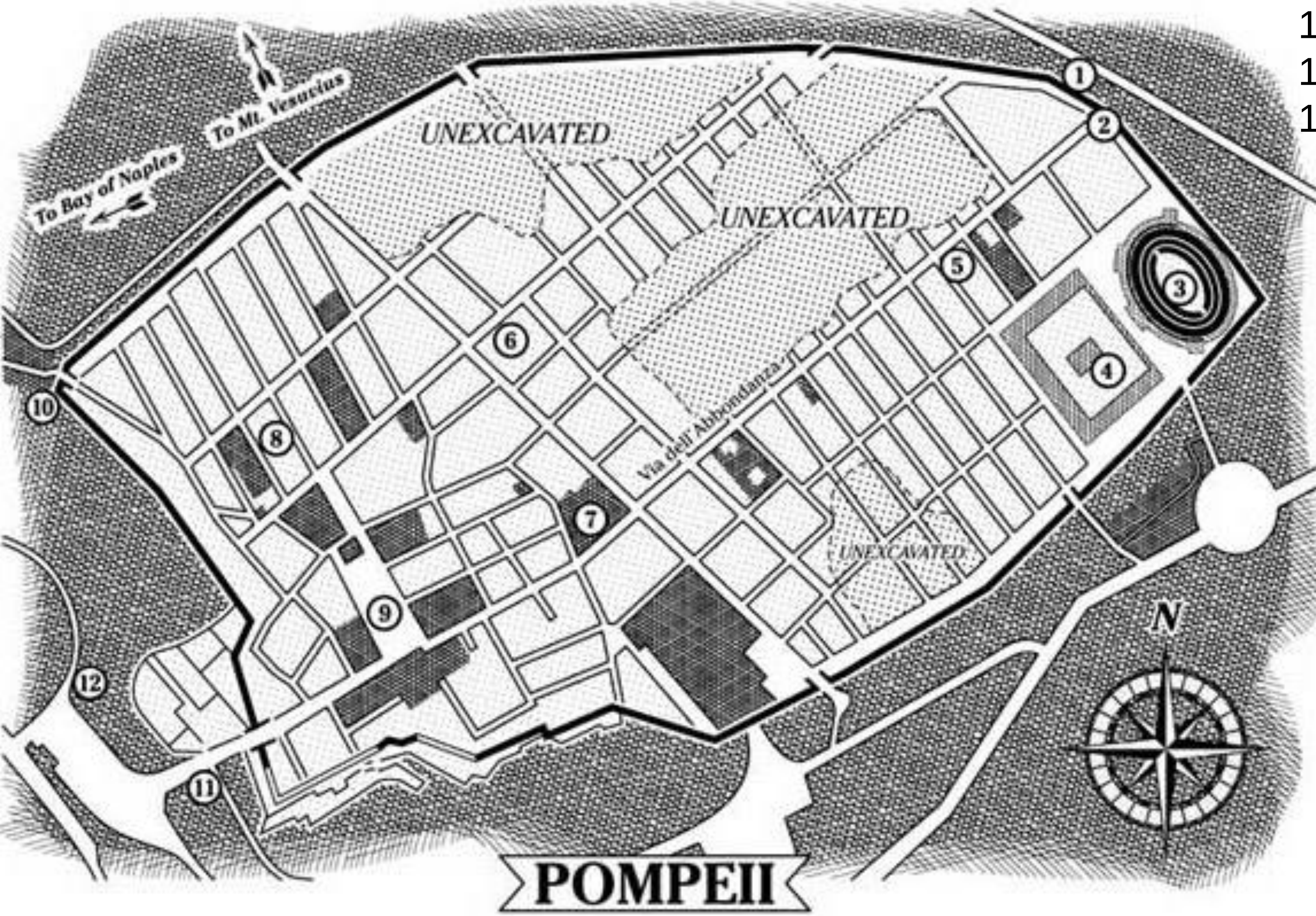




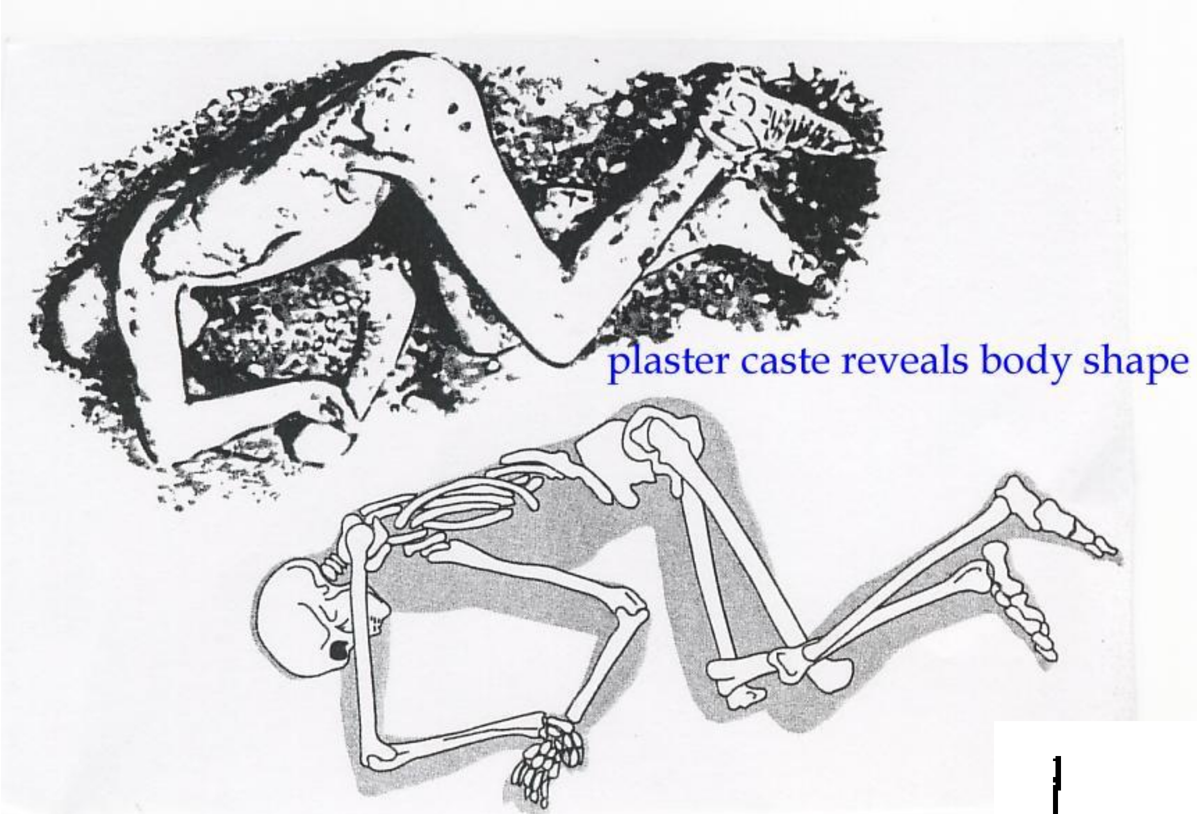
HERCULANEUM
20 metres
Pyroclastic flow (hot ash, pumice and rock)
Ground surge (hot gas and ash)
POMPEII
4 metres
lapilli (pumice) 2.7m at Pompeii
less than 10cm lapilli

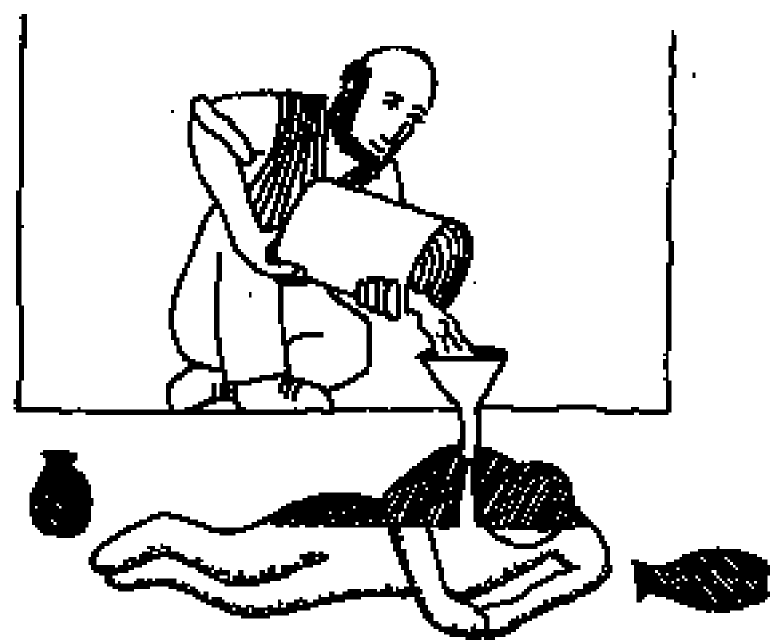
Oplonti (Torre Annunziata)

12000 abitanti
1047 vittime
103 calchi

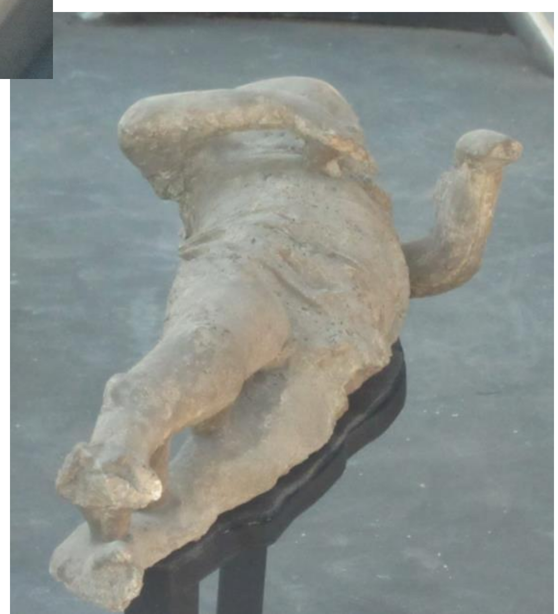


1	VILLA DEIDAMIA	5	HOUSE OF OCTAVIUS QUARTUS	9	FORUM
2	PORTA DI SARNO	6	HOUSE OF JULIA FELIX	10	PORTA ERCOLANO
3	AMPHITHEATRE	7	STABIAN BATHS	11	PORTA MARINA
4	GRAND PALAESTRA	8	HOUSE OF THE TRAGIC POET - Cave Canem	12	UMBERTO'S CAFE


plaster caste reveals body shape

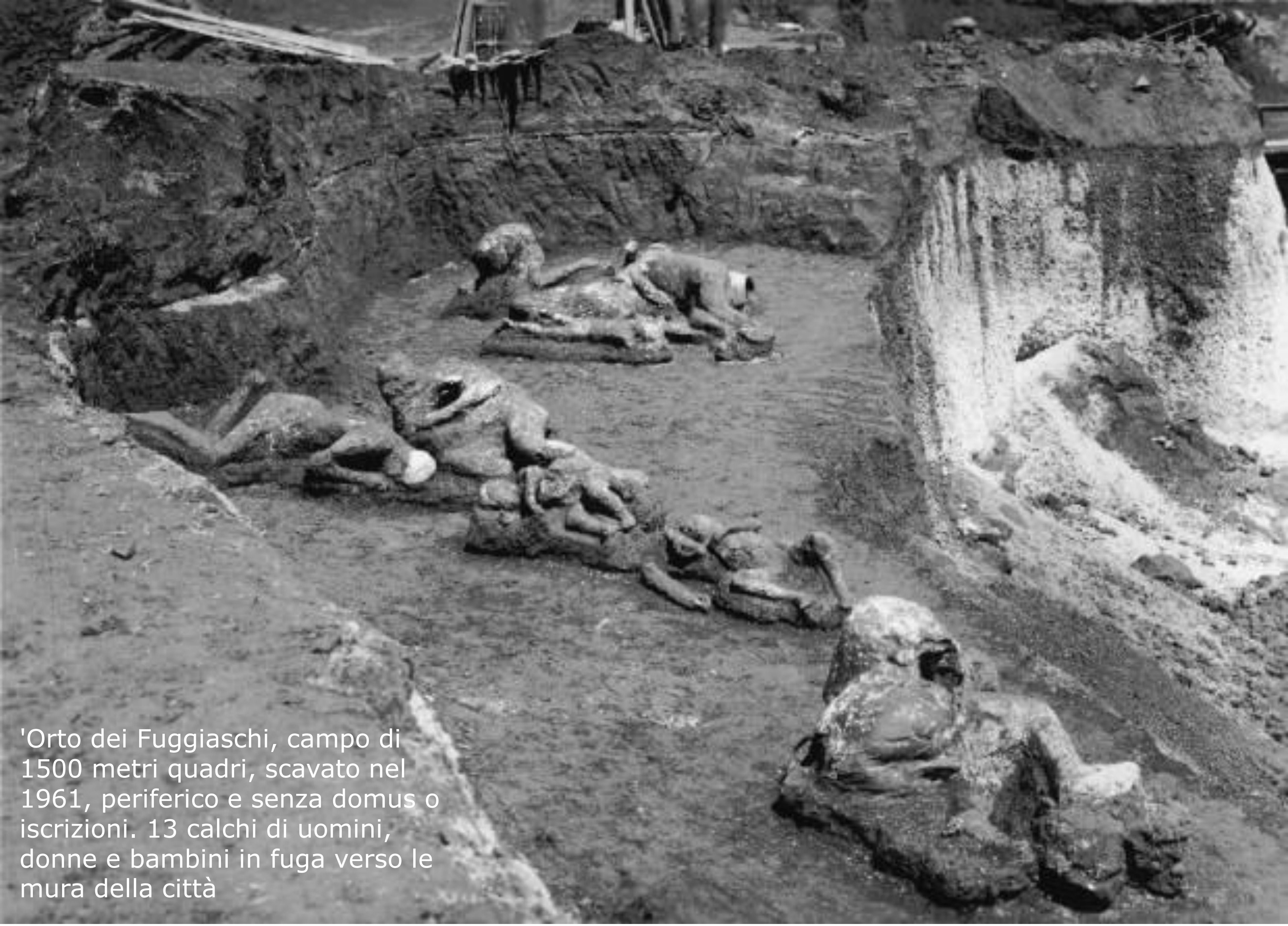




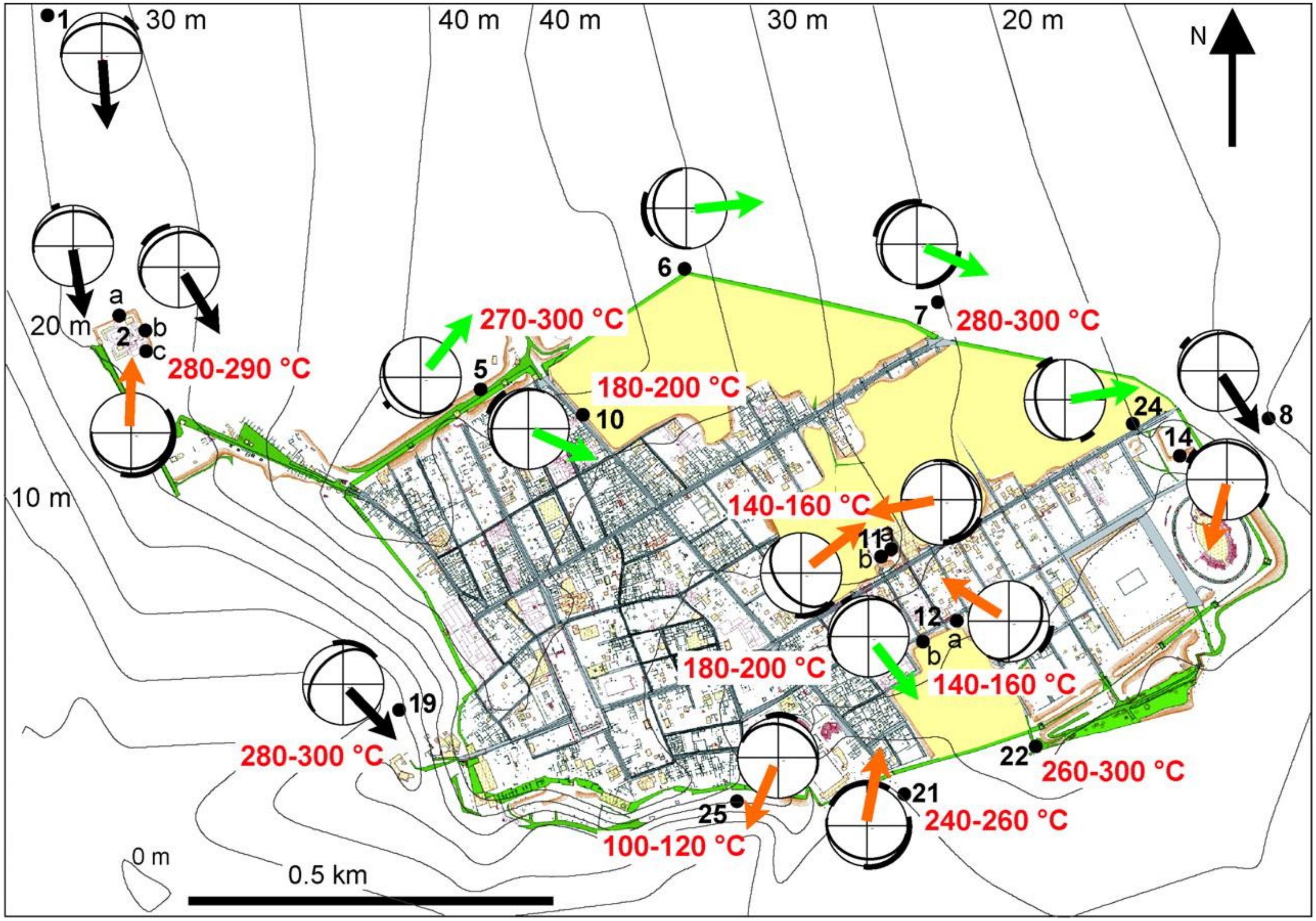

Group of corpses (casts and skeletons) near the Casa del Criptoportico 1914. They were encountered in the ash and pumice PDCs deposit above a thick, white^grey, lapilli pumice fall deposit. Below the human cast on the right side the stratigraphic sequence from unit B to E1 is well exposed. (Soprintendenza Archeologica di Pompei)
Luongo et al., 2004

Casa del Criptoportico



'Orto dei Fuggiaschi, campo di 1500 metri quadri, scavato nel 1961, periferico e senza domus o iscrizioni. 13 calchi di uomini, donne e bambini in fuga verso le mura della città

Variations in EU4pf flow direction (anisotropy of magnetic susceptibility [AMS] data) and temperature (thermal remanent magnetization [TRM] data).

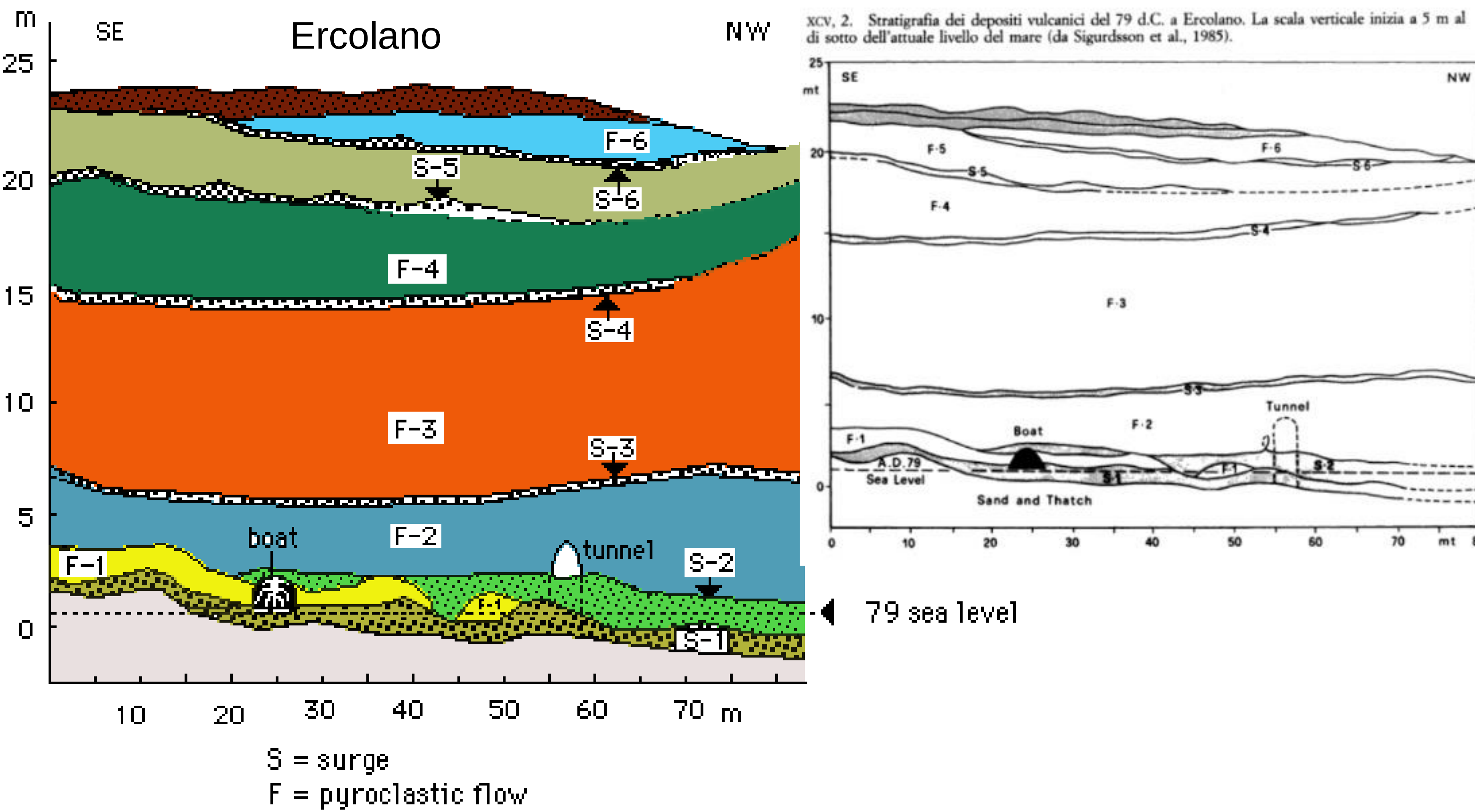


Lucia Gurioli et al. Geology 2005;33:441-444

THE GEOLOGICAL SOCIETY OF AMERICA

©2005 by Geological Society of America

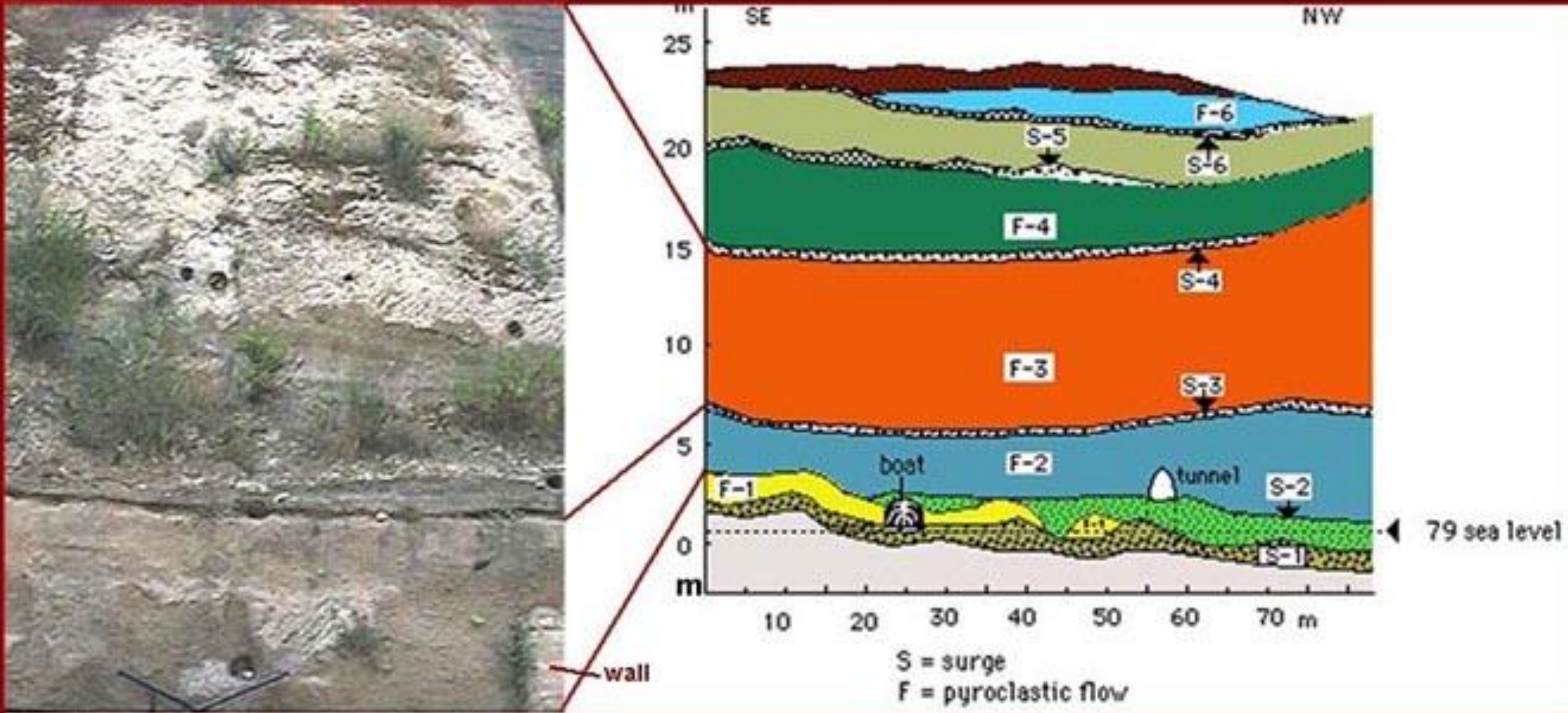
Ercolano



XCV, 2. Stratigrafia dei depositi vulcanici del 79 d.C. a Ercolano. La scala verticale inizia a 5 m al di sotto dell'attuale livello del mare (da Sigurdsson et al., 1985).

Pyroclastic Flow: A hot, chaotic avalanche of pumice, ash, and gasses. Pyroclastic flows can move at high speeds along the ground and pass over substantial objects. Their distribution is strongly controlled by topography.

Pyroclastic Surge: A turbulent cloud of volcanic ash and hot gasses, which hugs the ground and travels at speeds often exceeding 100 km per hour. Surge deposits are more widely distributed than pyroclastic flow deposits though not as widespread as air fall pumice layers.



At Herculaneum, there were six surge/flow pairs, and, although they may have contained moisture, none of them could be characterized as "mud flows" (lahars). Because Herculaneum was so close to the crater, the flow deposits were much hotter than those at Pompeii -- hot enough to fuse together into the much harder overlay than the deposits at Pompeii. The flows did act as a liquid, however: Solid particles were suspended in a gas (mostly just hot air) and fluid mechanics determined how the flows spread.

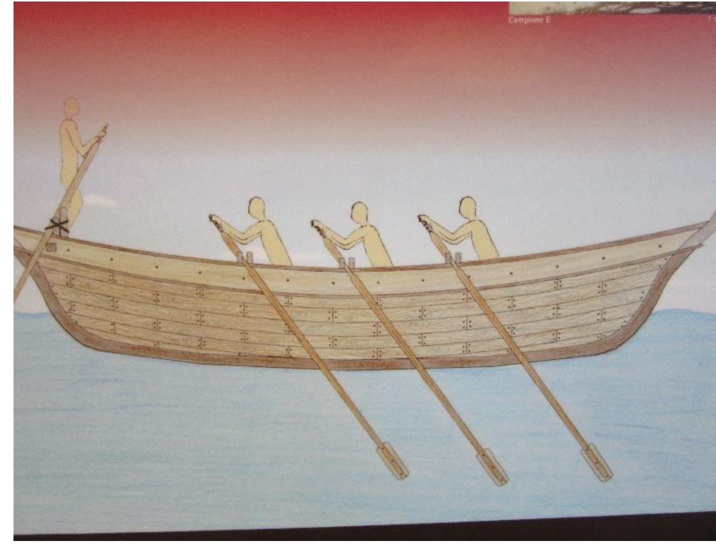
Stratigraphy of the AD 79 Eruption Deposits seen at Herculaneum

The diagram (by Roberto Scandone)above shows the stratigraphy at Herculaneum, as identified by Haraldur Sigurdsson in 1985. (The **upper flow units** F4 etc can also be identified in Pompeii). There is a very thin base lapilli layer of a few centimetres. The first broad deposit shown immediately above the ancient coast is an ashy layer interpreted as a surge. It is 20-40 cm thick and is a result of a surge of gaseous material. The majority of the skeletons found in this area lie within this deposit. Above this layer is a deposit of a pyroclastic flow containing carbonized wood and fragments of tiles. The thickness of this deposit is less than 1.5 m. Above this layer are several alternating surge and pyroclastic flow layers resulting in a 20 to 23 metre thick cover. Flow 3 is particularly strong. According to some authors (Mike Sheridan, for example) the topmost layers are related to mudflows.

In many houses there is abundant evidence of processes of carbonization of wood due to the high temperature of the first surge and flow. On this profile, the extension of the coastline is identifiable. Also notice the location of the boatshed.

Surge 3 reached the walls of Pompeii. The next three surges covered Pompeii, S-4, S-5 and S-6. The first of these surges would have been most damaging to people, whereas the last surge would have been most damaging to buildings. S-4 may have had temperatures around 400°C upon its arrival at Pompeii. (Martini *et al. 1995*)

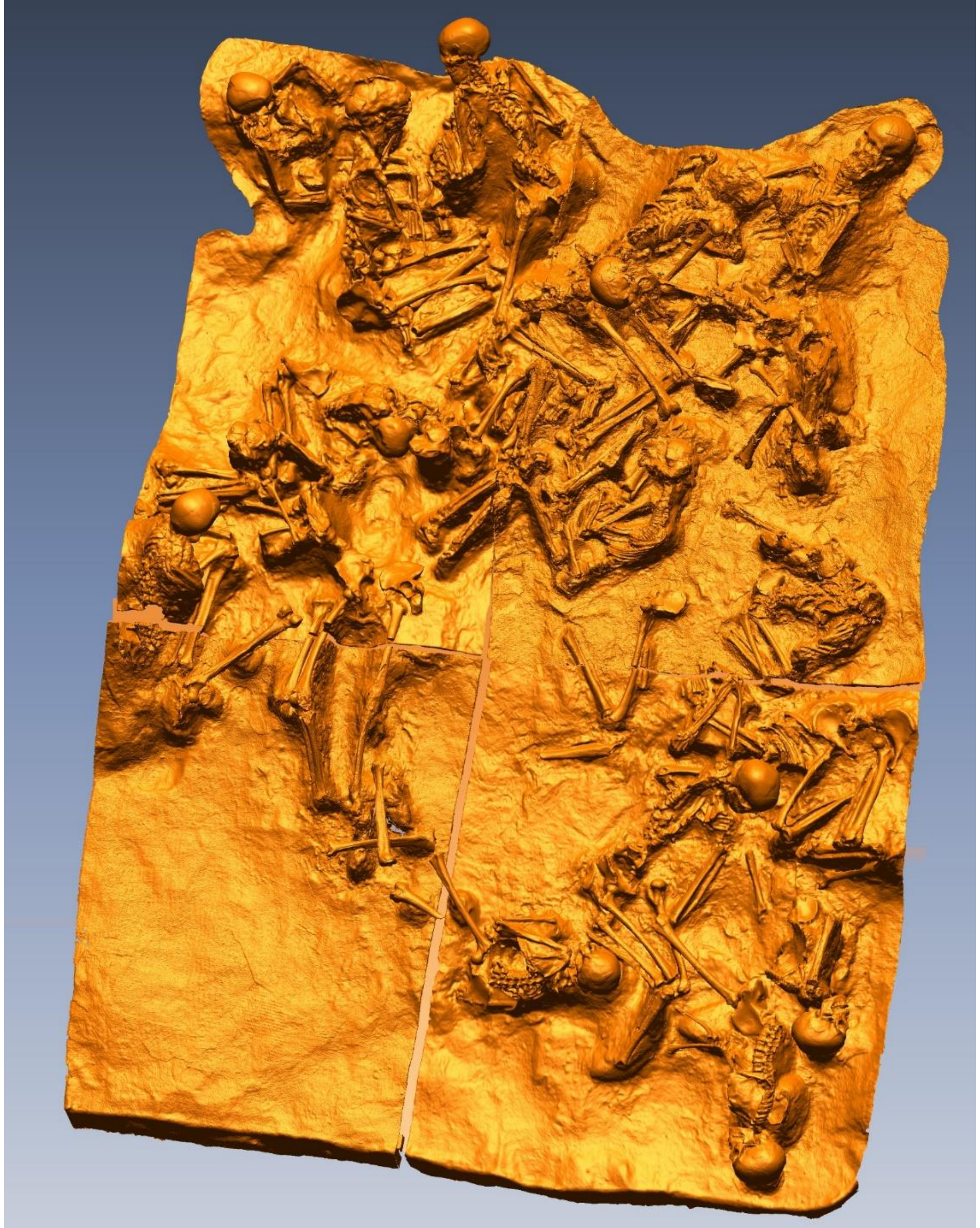
The key basis for distinction is the amount and nature of the pyroclastic material included in the mixture of volcanic solids and gas. Denser mixtures which include larger fragments at higher solid concentrations are typically categorized as pyroclastic flow, while less dense mixtures where the pyroclasts are primarily fine dust and ash are categorized as pyroclastic surge. The term "glowing avalanche" is sometimes used to describe pyroclastic flow, while the terms "glowing cloud" and "ground surge", are sometimes used to describe pyroclastic surge. The French term "nuée ardente" is often used to describe a common phenomenon where an avalanche of coarse material, a pyroclastic flow, is accompanied by an overriding ash cloud of fine material, a pyroclastic surge. The diagram below shows how the ash cloud (surge) layer of a nuée ardente separates from the ash-and-block (flow) layer. The surge layer may separate from the flow layer climbing hills and travelling greater distances
Fisher 1995

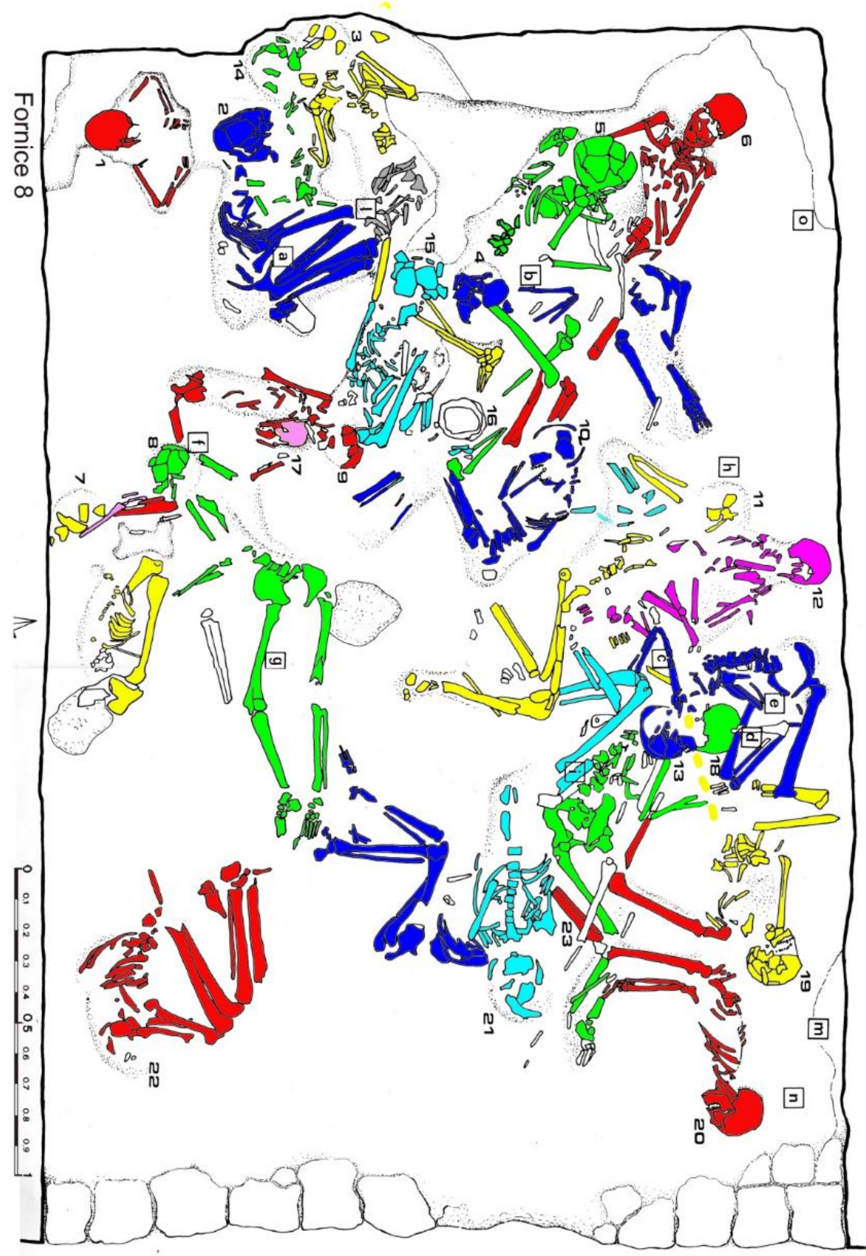


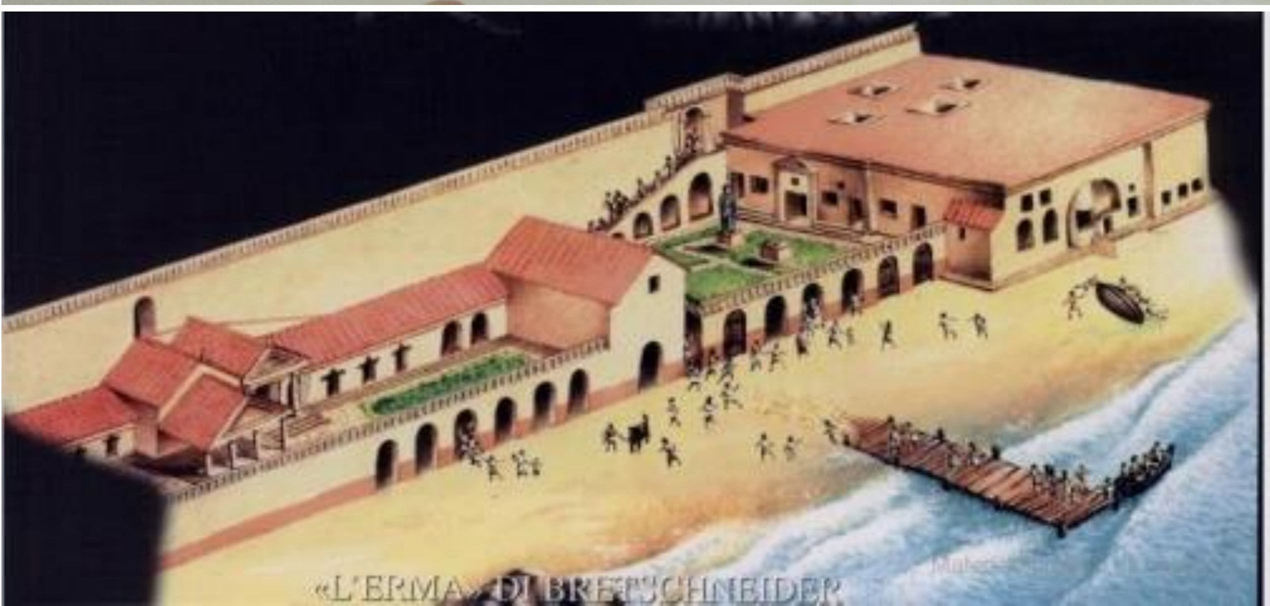
Ercolano

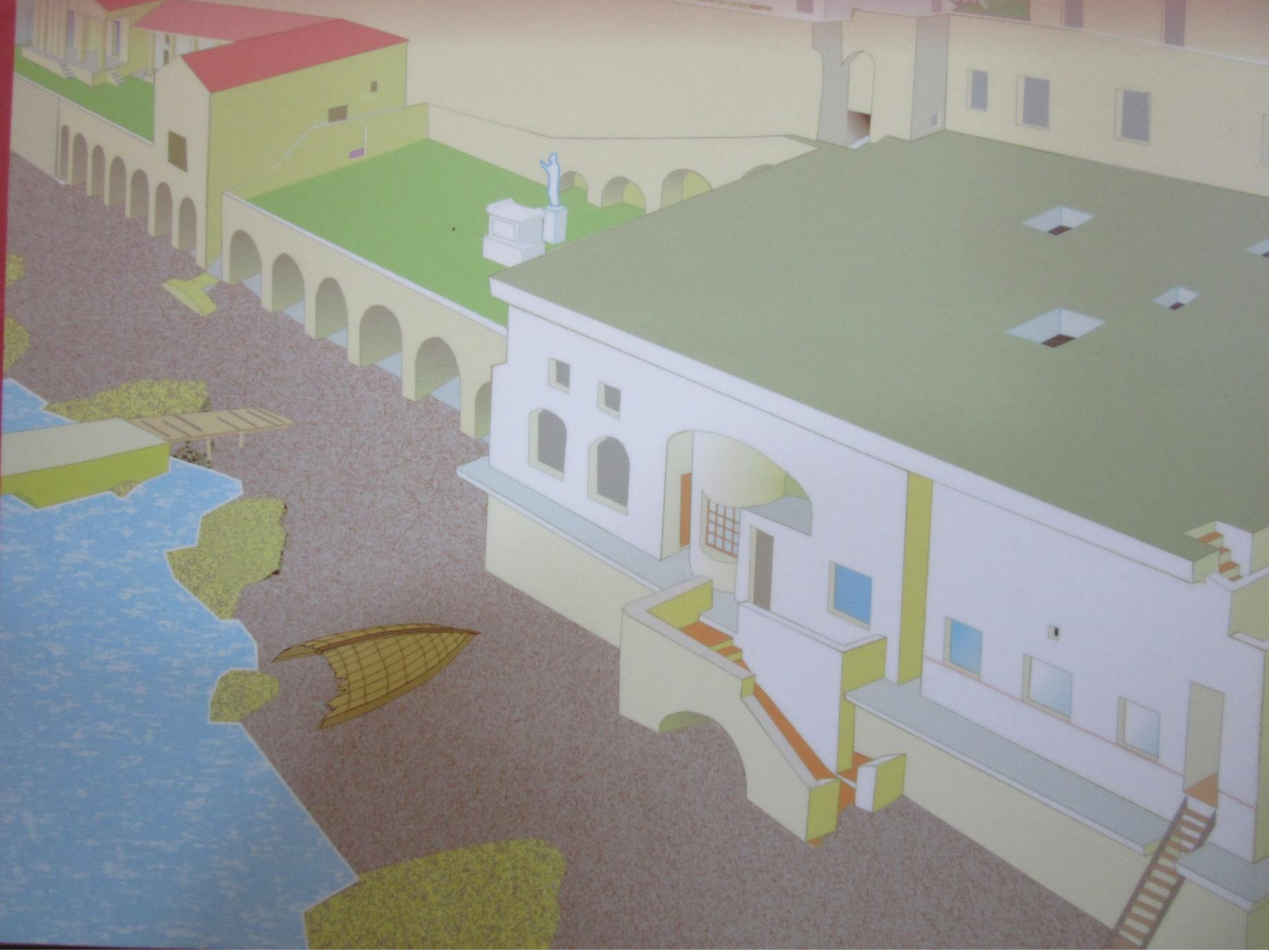
Scoperta 1738
Spoliata attrraverso cunicoli fino al 1828
Pochi resti umani
Città evacuata?
1981 scavo dei fornici sulla spiaggia
160 scheletri di cui 12 bambini
Popolazione stimata: 5000






Fornice 8


«L'ERMA» DI BRETSCHNEIDER




«L'ERMA» DI BRETSCHNEIDER

Fig. 29 - Ricostruzione degli effetti dell'impatto del *surge 1* sulla antica spiaggia di Ercolano circa all'1 di notte del 25 agosto del 79 d.C.

Fig. 32 - Ricostruzione della situazione sull'antica spiaggia di Ercolano nella notte fra il 24 ed il 25 agosto 79 d.C. dopo la deposizione del primo flusso piroclastico.

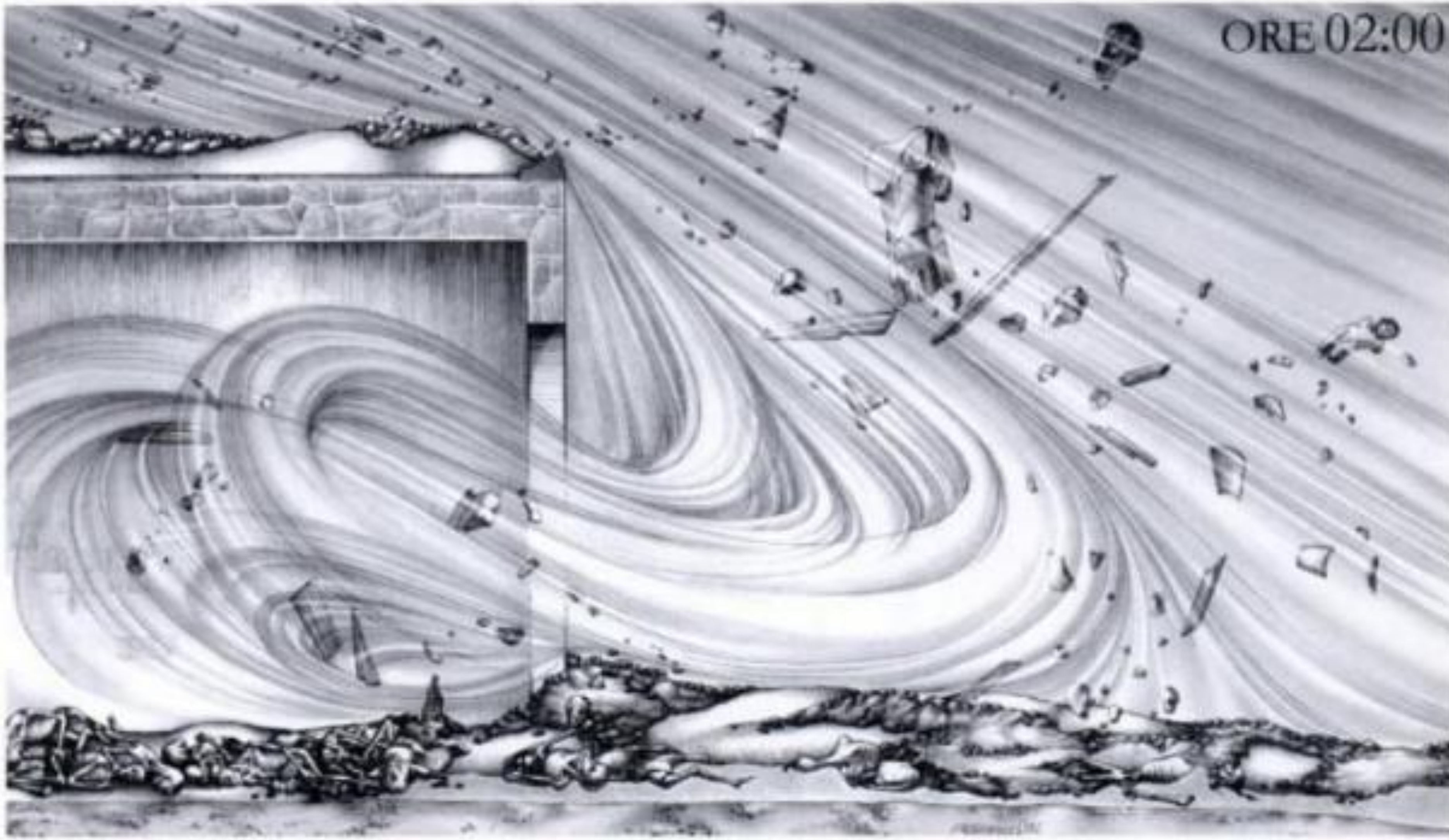


Fig. 33 - Ricostruzione degli effetti dell'impatto del *surge 2* sull'antica spiaggia di Ercolano circa alle ore 2 del 25 agosto 79 d.C.

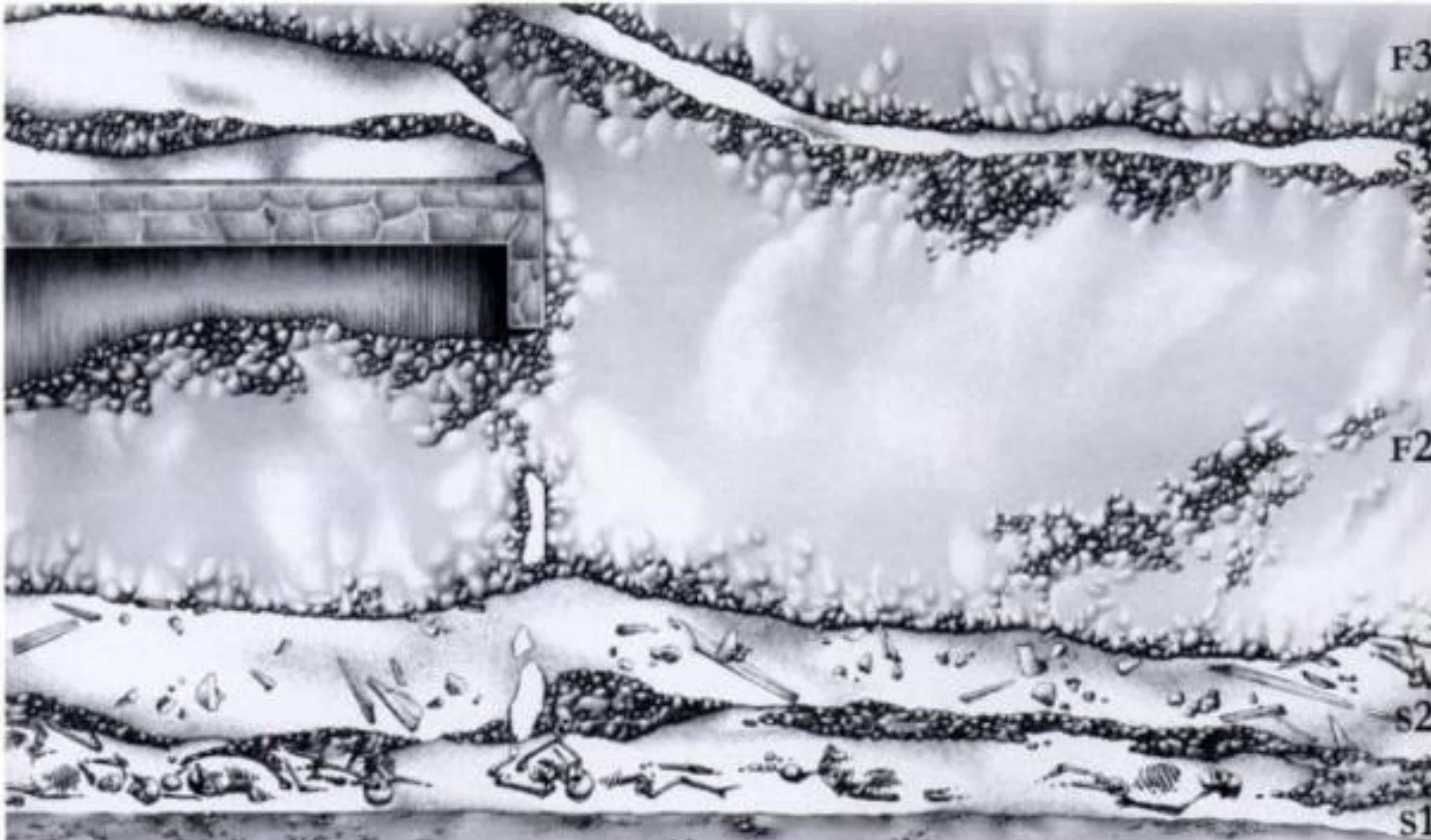


Fig. 34 - Ricostruzione della situazione sull'antica spiaggia di Ercolano dopo la deposizione dei vari flussi piroclastici e *surges* che si susseguirono nel corso della giornata del 25 agosto 79 d.C.