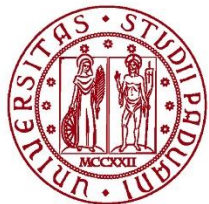


# Materials Properties, Use and Conservation: Construction Materials and Binders

## Structural binders in Pompeii: the example of the Sarno Baths

Michele Secco



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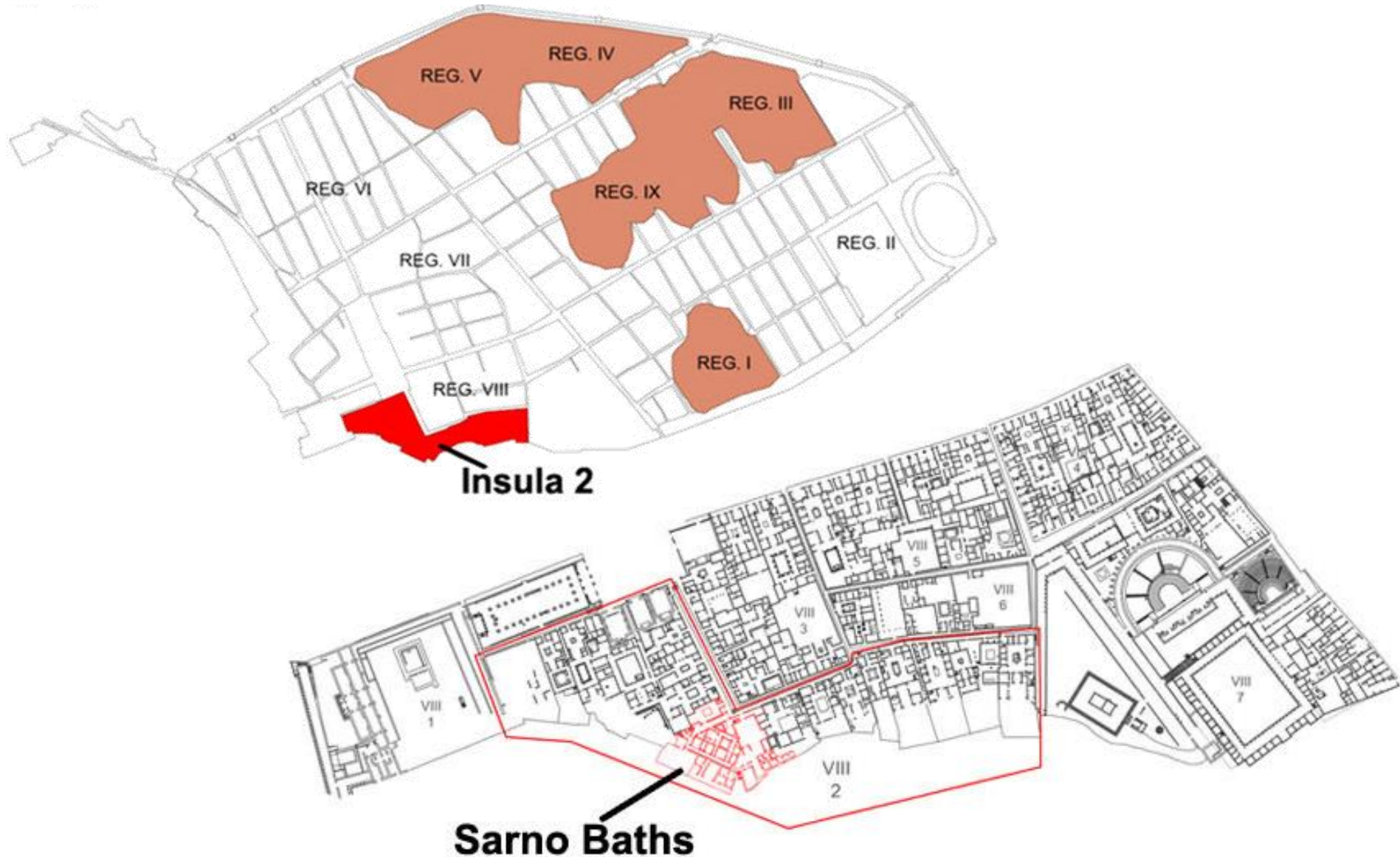
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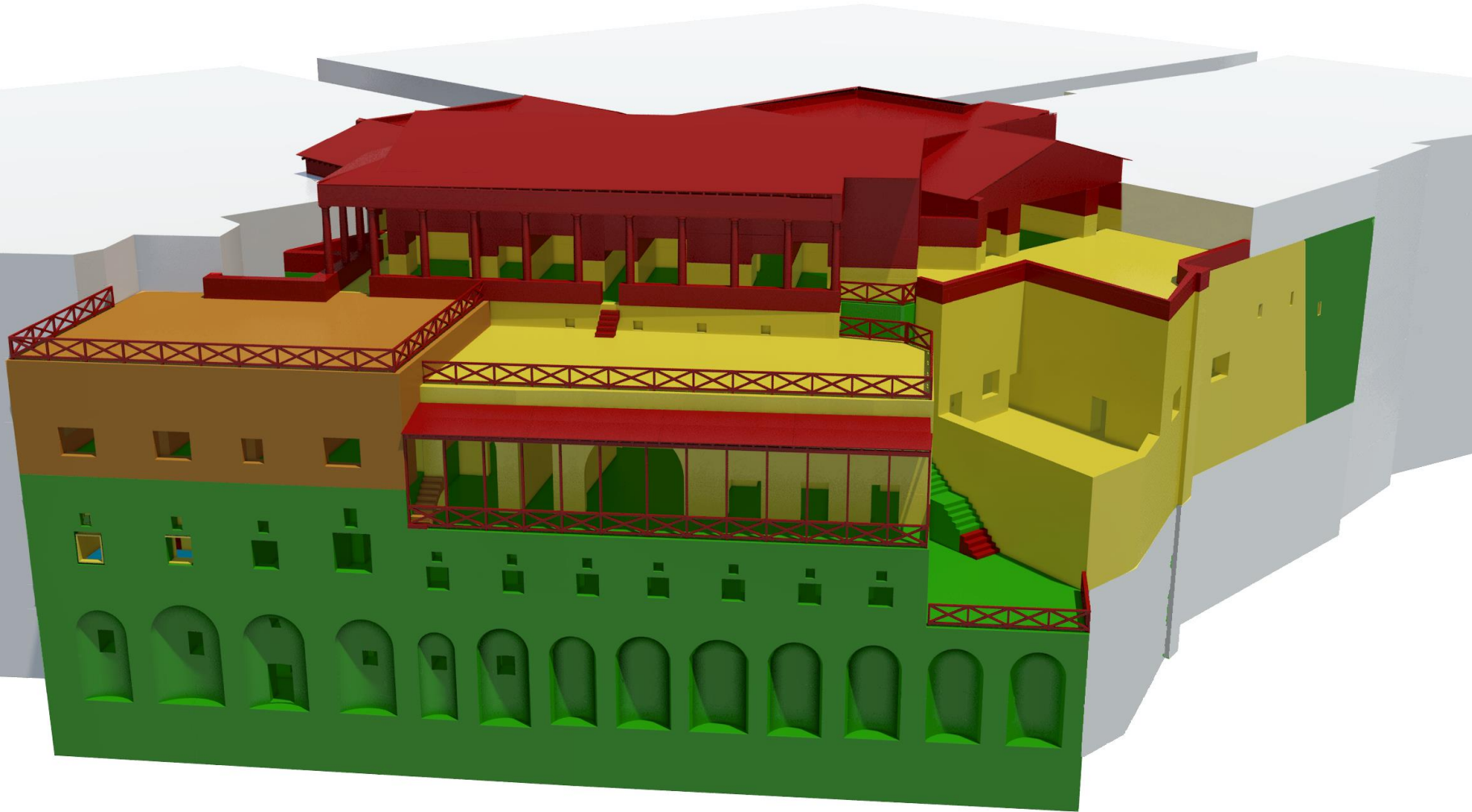
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## The Sarno Baths Complex



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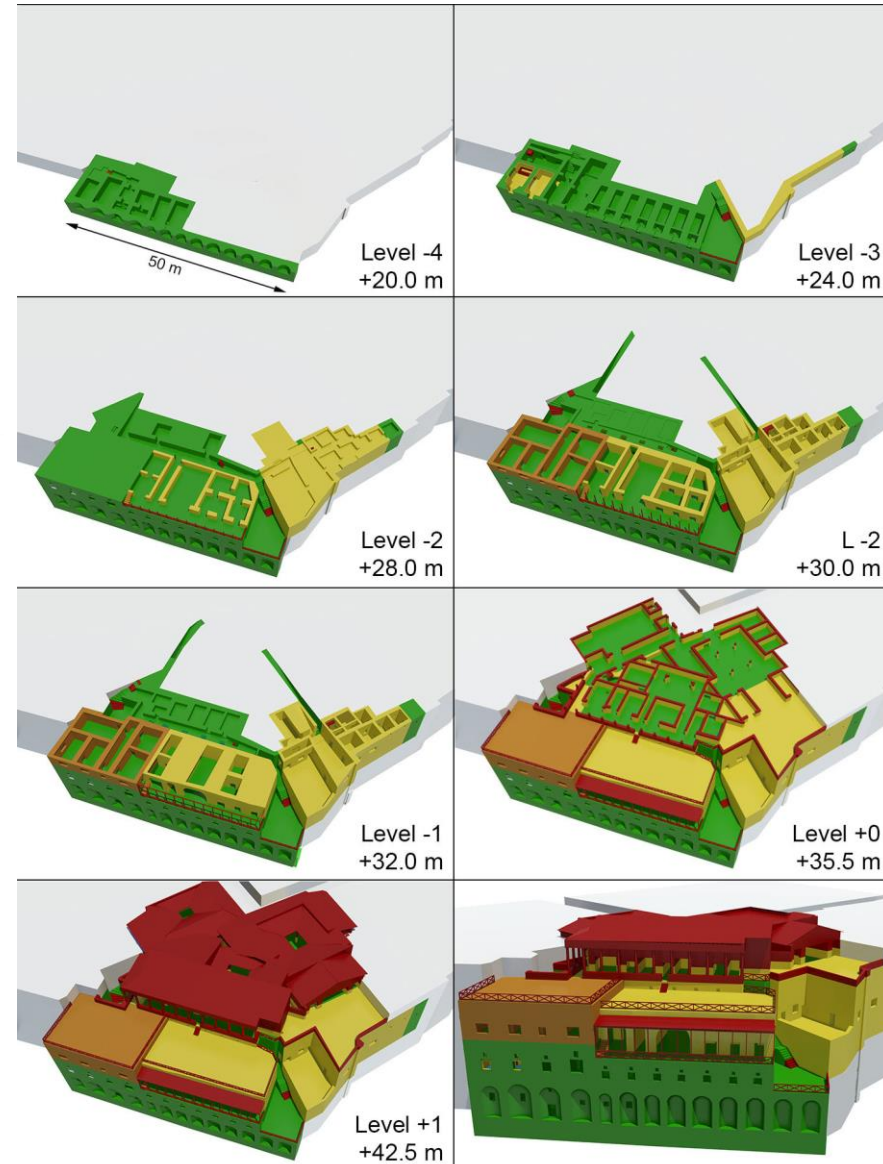
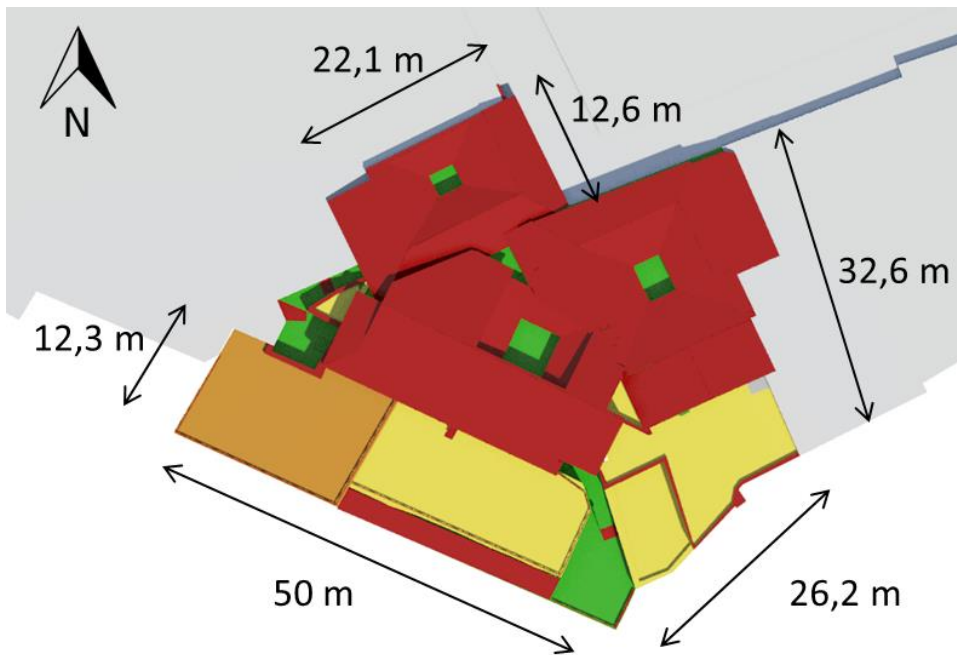
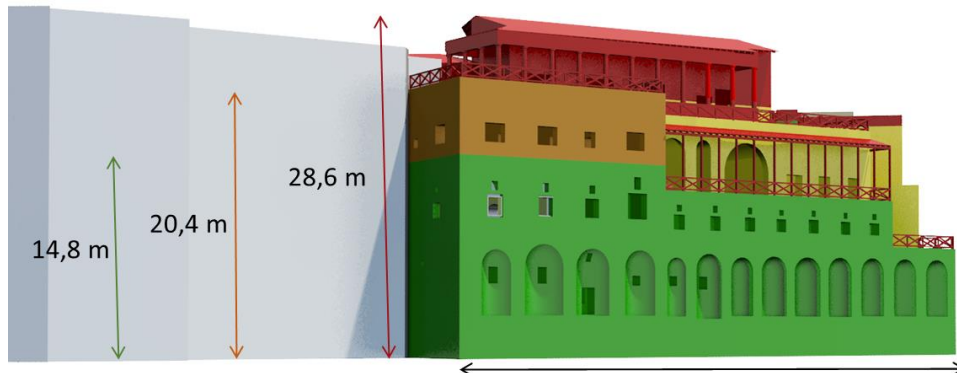
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# Structural binders in Pompeii

## CHRONOLOGY

**Domus at Level +0 and lower foundational levels: Republican Age (II Cen. b.C.)**

**Modifications and merging with other buildings:**

**1) First Augustean Age (Kolosky Ostrow, 1990)**

**2) Claudian Age (Noack, Lehmann-Harteleben, 1936 and Pugliese Carratelli, Baldassarre, 1990)**

**Reconstructions: after the 62 A.D. earthquake**

## DATING METHODS:

-Construction materials

-Building techniques

-Decorative layouts



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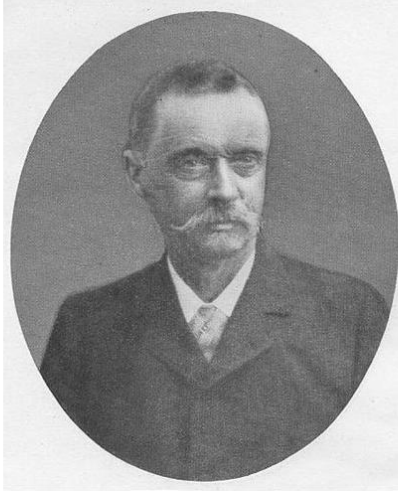
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**August  
Mau  
(1880's -  
1890's)**



**Amedeo  
Maiuri  
(1930's -  
1950's)**





# Structural binders in Pompeii





# Structural binders in Pompeii

MINISTERO PER I BENI CULTURALI E AMBIENTALI  
SOPRINTENDENZA ARCHEOLOGICA DI POMPEI

MONOGRAFIE

5

## LE TERME DEL SARNO A POMPEI

Iter di un'analisi per la conoscenza, il restauro e la protezione  
sismica del monumento

GIOVANNI IOPPOLO

con testi di

Laura Bussi, Franco Carraro, Franco Cavallotti, Giuseppe Centauro,  
Marisa Mastroberro, Maria Grazia Pancani, Mario Petrocchi,  
Fabrizio Rampa, Maurizio Seracini, Sergio Vannucci

«L'ERMA» DI BRETSCHNEIDER

Le due sezioni trasversali dell'edificio (figg. 12-13), passanti la prima per gli ambienti 5 e 8 del piano delle terme e la seconda per l'ambiente 1a dello stesso livello, si sono basate sui punti topografici di dettaglio sia planimetrici che altimetrici. Le misurazioni dirette in situ hanno permesso di rilevare l'andamento delle pareti interne, delle volte e della copertura; un esame particolare delle cortine di rivestimento in pietra si è reso necessario al fine di distinguere i tratti originali della muratura da quelli restaurati pochi decenni or sono. Le differenze riscontrate tra murature che utilizzano lo stesso tipo di materiali, se non gli stessi frammenti di pietra provenienti dal crollo di altre strutture antiche, sono talmente minime che a prima vista potrebbero sembrare coeve. Per distinguere questi interventi dalle strutture originarie servirebbe una continua analisi chimico-mineralogica per ciascun tratto di parete. Tale difficoltà è scaturita dalla consuetudine, in atto sino a pochi decenni or sono, di intervenire con restauri monumentali ad imitazione delle murature antiche: una tendenza oggi superata dopo le disposizioni della Carta Internazionale del Restauro che chiede la differenziazione degli interventi, proprio al fine di evitare confusioni interpretative e facili arrangiamenti estetici, validi solo per un'osservatore superficiale e frettoloso.<sup>4</sup>



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1 cm



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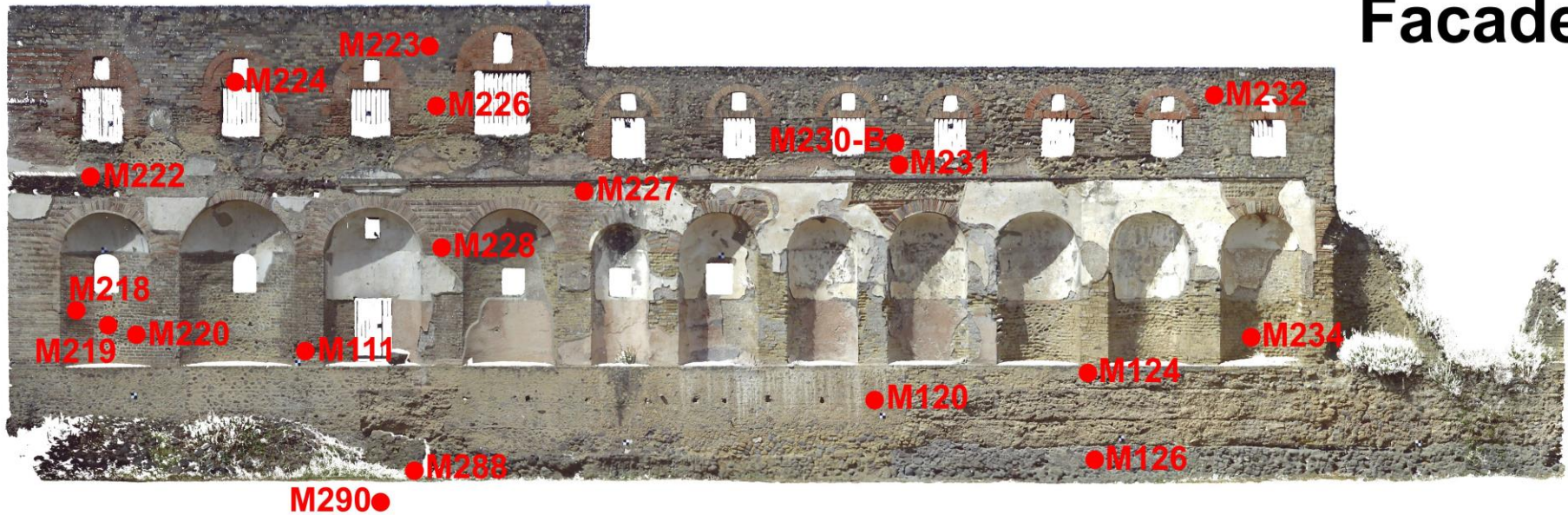
# Structural binders in Pompeii





# Structural binders in Pompeii

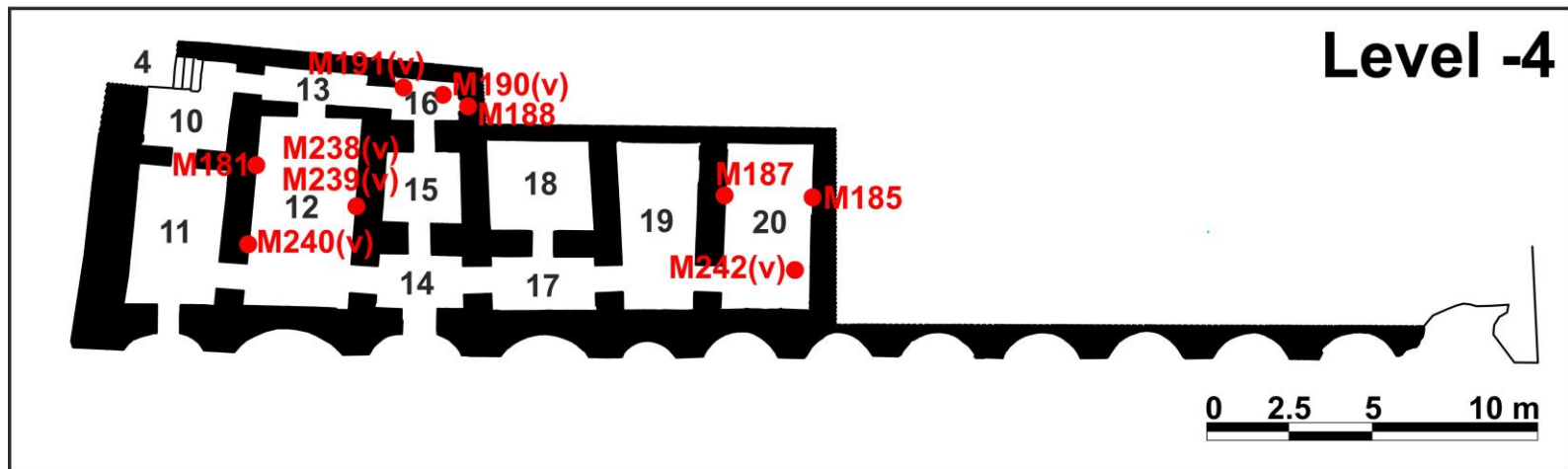
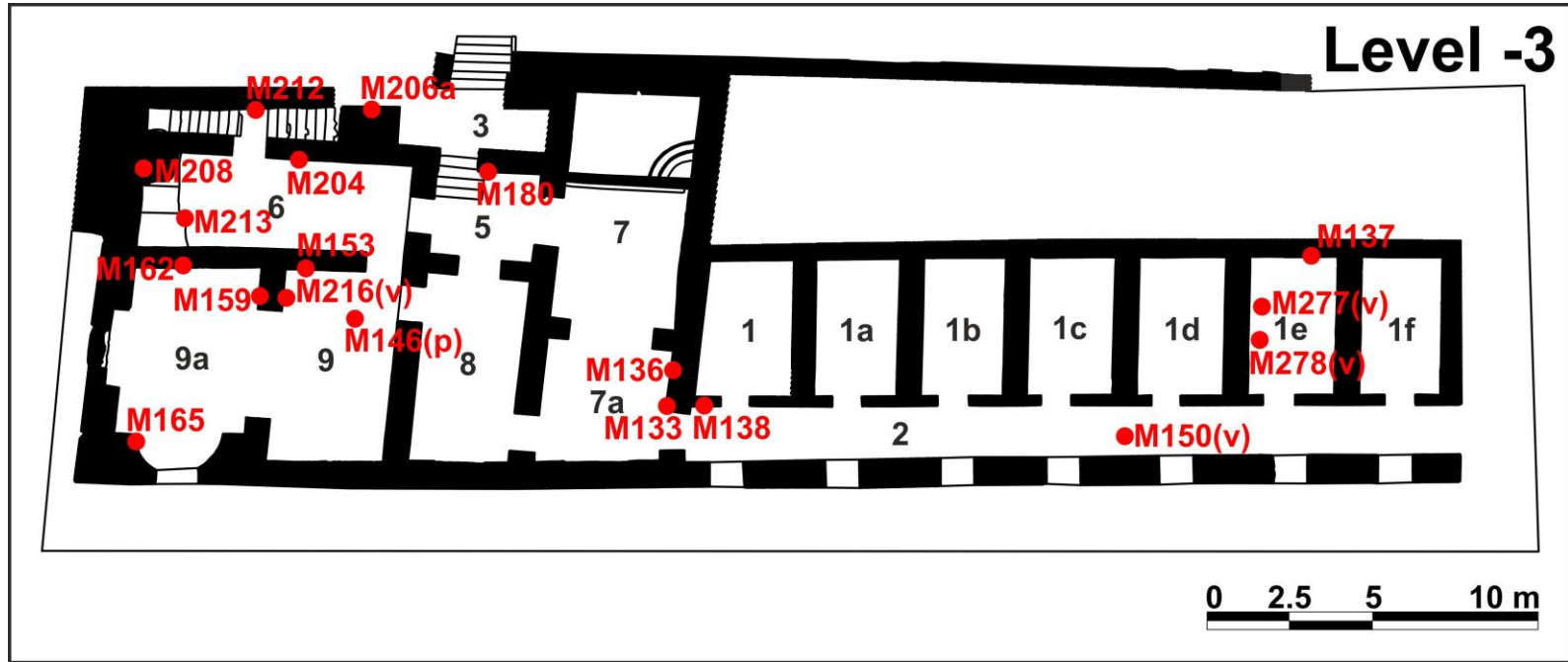
## Facade



0 2.5 5 10 m

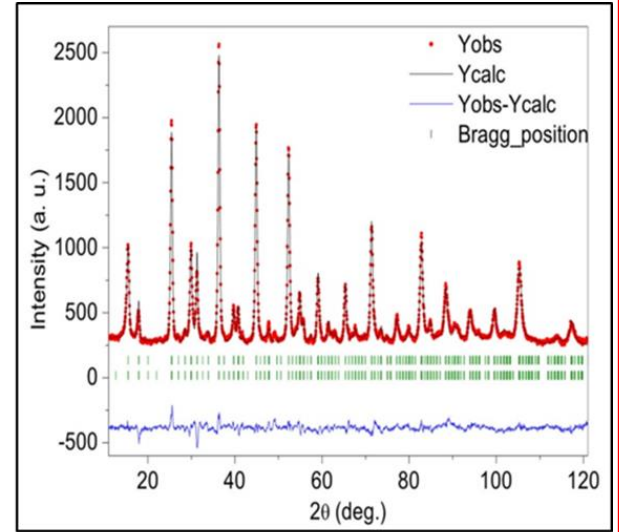
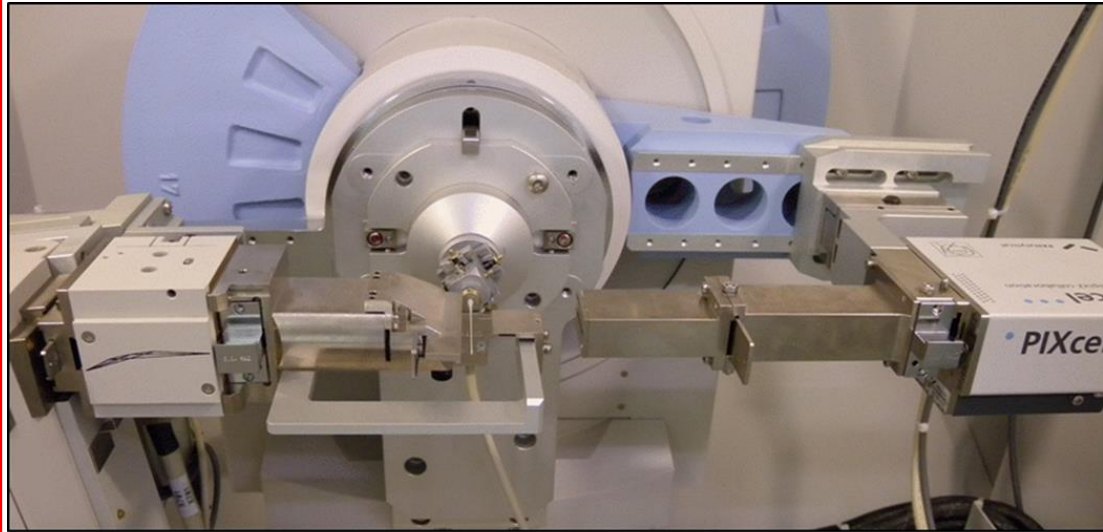


# Structural binders in Pompeii





# Structural binders in Pompeii



# Structural binders in Pompeii

Sample	Position	Structural Element	Calcite	Aragonite	Vaterite	Carbonate-Afm	C3S	C2S	Dolomite	Quartz	Labradorite	Sanidine	Na-Sanidine	Leucite	Augite	Amphibole	Biotite	Hematite	Analcime	Gypsum	Syngentite	Halite	Sylvite	Gaullussite	Amorphous
M111	Facade, level-4	Perimeter wall	16.0	0.0	4.3	0.0	0.0	0.0	0.0	1.5	13.2	0.0	11.4	1.7	12.6	0.0	1.0	1.0	5.1	0.0	0.0	0.0	0.0	0.0	32.2
M120	Facade, foundation	Foundation	6.1	0.0	0.0	0.0	0.0	0.0	0.0	5.2	12.9	0.0	8.9	1.3	11.1	0.0	0.7	0.7	9.3	0.8	0.0	0.0	0.0	0.0	43.2
M124	Facade, foundation	Foundation	13.4	0.0	0.0	0.0	0.0	0.0	0.0	4.1	10.6	0.0	9.5	2.6	8.1	0.0	0.8	1.0	4.7	2.4	0.0	0.0	0.0	0.0	42.8
M126	Facade, foundation	Foundation	18.3	0.0	2.2	1.1	0.0	0.0	0.0	3.4	10.7	0.0	5.9	4.5	8.1	0.0	0.5	0.8	2.5	0.0	0.0	0.5	0.0	0.0	41.4
M133	Level -3, room 7a	Internal wall	17.5	0.0	0.0	0.0	0.0	0.0	0.4	0.2	9.6	5.9	0.0	13.4	24.8	0.0	0.8	1.3	2.3	0.0	0.0	0.0	0.0	0.0	23.9
M136	Level -3, room 7a	Internal wall	9.7	0.0	0.0	0.0	0.0	0.0	0.0	1.1	20.0	0.0	12.7	2.2	18.6	0.0	0.8	2.0	8.3	0.0	0.0	0.0	0.0	0.0	24.7
M137	Level -3, room 1e	Perimeter wall	14.4	0.0	0.0	0.0	0.0	0.0	0.0	1.7	13.9	0.0	12.3	2.2	16.7	0.0	1.0	1.2	5.2	0.0	0.0	0.0	0.0	0.0	31.4
M138	Level -3, room 2	Internal wall	17.5	0.0	0.0	0.0	0.0	0.0	0.8	0.2	9.3	5.0	0.0	12.6	23.9	0.0	0.8	1.4	2.4	0.0	0.0	0.0	0.0	0.0	26.1
M146	Level -3, room 9	Floor	16.4	0.0	0.0	0.0	0.0	0.0	0.0	1.3	9.1	0.0	12.1	1.1	13.8	0.0	1.0	1.3	2.9	0.0	0.0	0.0	0.0	0.0	41.1
M150	Level -3, room 2	Vault	16.1	0.0	0.0	1.8	1.0	1.1	1.5	0.4	13.7	3.9	0.0	12.5	22.1	0.0	1.2	1.8	1.3	0.0	0.0	0.0	0.0	0.0	21.7
M153	Level -3, room 9	Internal wall	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	13.4	0.0	31.3	6.5	12.9	0.0	0.8	2.7	0.8	0.0	0.0	0.0	0.0	0.0	25.6
M159	Level -3, room 9a	Internal wall	17.1	0.0	0.0	0.0	0.0	0.0	1.5	0.2	8.7	4.7	0.0	12.1	23.1	0.0	0.6	1.2	2.3	1.0	0.0	0.0	0.0	0.0	27.6
M162	Level -3, room 9a	Internal wall	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	12.6	0.0	10.1	2.4	18.1	0.0	0.9	0.7	3.8	0.0	0.0	0.0	0.0	0.0	26.7
M165	Level -3, room 9a	Perimeter wall	12.8	0.0	0.0	0.0	0.0	0.0	0.0	2.6	12.0	0.0	12.4	3.2	18.9	0.0	0.7	1.2	3.4	0.0	0.0	0.0	0.0	0.0	32.9
M180	Level -3, room 5	Internal wall	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.5	13.7	0.0	11.6	3.5	15.8	0.0	1.4	1.6	4.9	0.0	0.0	1.3	0.0	0.0	31.0
M181	Level -4, room 12	Internal wall	19.5	0.0	0.0	0.0	0.0	0.0	1.1	0.3	9.8	6.4	0.0	10.6	20.0	0.0	0.6	1.1	3.7	0.2	0.0	0.0	0.0	0.0	26.8
M185	Level -4, room 20	Perimeter wall	15.6	0.0	0.0	0.0	0.0	0.0	0.0	1.7	12.5	0.0	10.5	3.1	15.6	0.0	0.9	0.9	4.8	0.0	0.0	0.0	0.0	0.0	34.3
M187	Level -4, room 20	Internal wall	22.4	0.0	0.0	0.0	0.0	0.0	1.2	0.3	8.3	4.3	0.0	12.2	24.0	0.0	1.2	1.4	2.0	0.0	0.0	0.0	0.0	0.0	22.8
M188	Level -4, room 16	Perimeter wall	8.6	0.0	2.5	0.7	0.0	0.0	0.0	2.2	12.4	0.0	12.0	1.7	12.3	0.0	0.8	0.9	4.9	0.0	0.0	0.0	0.0	0.0	41.0
M190	Level -4, room 16	Vault	15.1	0.0	0.0	0.0	0.0	0.0	0.8	0.4	9.2	4.5	0.0	14.1	25.3	0.0	1.4	1.1	2.7	0.0	0.0	0.0	0.0	0.0	25.4
M191	Level -4, room 16	Vault	32.2	0.0	0.0	0.0	0.0	0.0	0.1	0.2	6.1	2.9	0.0	10.3	20.4	0.0	1.4	1.1	2.6	1.2	0.0	0.0	0.0	0.0	21.6
M204	Level -3, room 6	Internal wall	11.3	0.0	2.9	0.0	0.0	0.0	0.0	1.6	11.9	0.0	11.6	1.7	14.3	0.0	1.0	1.0	4.8	0.0	0.0	0.0	0.0	0.0	37.8
M206A	Level -3, room 6	Perimeter wall	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	0.0	10.6	3.5	21.1	0.0	0.8	2.1	2.9	0.0	0.0	2.0	0.7	0.0	26.7
M208	Level -3, room 6	Perimeter wall	11.0	0.0	4.4	2.1	0.0	0.0	0.0	0.8	10.7	0.0	11.7	1.2	13.6	0.0	0.8	1.2	6.1	0.0	0.0	0.0	0.0	0.0	36.4
M212	Level -3, room 4	Perimeter wall	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.7	0.0	11.5	4.1	21.7	0.0	0.9	2.1	4.0	0.0	0.0	0.0	0.0	0.0	22.5
M213	Level -3, room 6	Praefurnium	7.5	1.0	7.4	0.0	0.0	0.0	0.0	1.4	7.6	0.0	10.9	0.9	12.0	0.0	0.8	0.5	3.5	0.0	0.0	0.0	0.0	0.0	46.7
M216	Level -3, room 9	Vault	20.9	0.0	0.0	0.0	0.0	0.0	0.6	0.7	8.6	4.6	0.0	11.9	19.1	0.0	0.5	2.0	2.9	0.0	0.0	0.0	0.0	0.0	28.2
M218	Facade, level-4	Perimeter wall	13.3	0.0	0.0	0.0	0.0	0.0	0.0	1.6	9.0	0.0	10.7	1.1	11.9	0.0	0.7	1.1	3.6	2.2	5.2	0.0	0.0	0.0	39.6
M219	Facade, level-4	Perimeter wall	17.7	1.8	5.9	0.0	0.0	0.0	0.0	1.9	11.1	0.0	11.1	1.0	10.4	0.0	0.4	0.7	4.0	0.5	0.0	0.0	0.0	0.0	33.7
M220	Facade, level-4	Perimeter wall	20.8	0.0	0.0	0.0	0.0	0.0	0.0	1.5	10.7	0.0	11.3	1.1	11.1	0.0	0.5	1.1	3.9	1.1	0.0	0.0	0.0	0.0	36.9
M222	Facade, level-3	Perimeter wall	13.9	0.0	0.0	0.0	0.0	0.0	0.0	1.5	11.3	0.0	10.9	2.3	15.0	0.0	0.8	1.4	4.4	0.0	0.0	0.0	0.0	0.0	38.6
M223	Facade, level-3	Perimeter wall	15.3	0.0	0.0	0.0	0.0	0.0	5.1	0.6	8.8	4.9	0.0	11.8	24.0	0.0	1.7	1.2	2.6	0.0	0.0	0.0	0.0	0.0	23.9
M224	Facade, level-3	Perimeter wall	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	7.6	3.9	0.0	10.3	20.7	0.0	0.9	1.7	1.9	0.0	0.0	0.0	0.0	0.0	33.4
M226	Facade, level-3	Perimeter wall	15.9	0.0	0.0	0.0	0.0	0.0	0.0	0.5	11.9	7.2	0.0	10.3	23.7	0.0	1.4	1.4	3.0	0.0	0.0	0.0	0.0	0.0	24.6
M227	Facade, level-4	Perimeter wall	19.9	0.0	0.0	0.1	0.0	0.0	0.0	2.0	6.8	0.0	9.4	2.7	13.4	0.0	0.5	1.2	3.0	0.0	0.0	0.0	0.0	4.0	36.9
M228	Facade, level-4	Perimeter wall	25.2	0.0	0.0	0.0	0.0	0.0	0.0	4.2	11.7	0.0	10.0	2.4	12.0	0.0	0.7	0.8	2.1	2.6	0.0	0.0	0.0	0.0	28.3
M230-B	Facade, level-3	Perimeter wall	19.2	0.0	0.0	0.0	0.0	0.0	2.5	0.3	8.6	7.0	0.0	7.1	19.3	0.0	1.0	1.1	2.9	0.0	0.0	0.0	0.0	0.0	31.1
M231	Facade, level-3	Perimeter wall	11.4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	13.7	0.0	9.7	1.5	13.1	0.0	0.8	1.0	5.5	1.3	3.7	0.0	0.0	0.0	36.6
M232	Facade, level-3	Perimeter wall	20.2	0.0	0.0	0.0	0.0	0.0	1.5	0.7	7.3	6.3	0.0	7.3	16.8	0.0	1.5	1.2	3.4	0.0	0.0	0.0	0.0	0.0	34.0
M234	Facade, level-4	Perimeter wall	7.8	0.0	3.0	0.0	0.0	0.0	0.0	1.9	9.6	0.0	9.9	0.8	11.3	0.0	0.7	1.0	4.2	0.0	4.8	0.0	0.0	0.0	45.0
M238	Level -4, room 12	Vault	12.8	0.0	0.0	0.0	0.0	0.0	0.2	0.4	10.5	5.1	0.0	12.0	24.6	1.3	0.9	1.1	2.9	0.3	0.0	0.0	0.0	0.0	28.0
M239	Level -4, room 12	Vault	5.1	0.0	0.0	0.0	0.0	0.0	0.5	0.2	11.5	6.0	0.0	15.8	27.1	0.0	0.7	1.4	3.8	0.0	0.0	0.0	0.0	0.0	27.9
M240	Level -4, room 12	Vault	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	11.5	6.3	0.0	13.8	22.6	0.0	0.7	1.3	4.0	0.3	0.0	0.0	0.0	0.0	29.7
M242	Level -4, room 20	Vault	16.0	0.0	6.7	0.0	0.0	0.0	0.0	1.6	10.1	0.0	9.0	1.3	15.6	0.0	0.8	0.7	4.3	0.0	1.0	0.0	0.0	0.0	33.0
M277	Level -3, room 1e	Vault	18.9	0.0	0.0	0.0	0.0	0.0	2.2	1.1	8.9	4.6	0.0	11.3	21.5	0.0	2.1	1.1	2.7	0.0	0.0	0.0	0.0	0.0	25.7
M278	Level -3, room 1e	Vault	14.9	0.0	0.0	0.0	0.0	0.0	1.2	0.8	9.2	6.4	0.0	11.8	23.8	0.0	1.6	1.2	2.8	0.0	0.0	0.0	0.0	0.0	26.4
M288	Facade, excavation	Perimeter wall	11.6	0.0	0.0	0.0	0.0	0.0	0.0	2.4	14.3	0.0	12.8	3.1	13.9	0.0	0.8	1.2	5.2	0.0	0.0	0.0	0.0	0.0	34.7
M290	Facade, excavation	Perimeter wall	7.3	2.6	0.0	0.0	0.0	0.0	7.9	1.5	12.6	0.0	13.1	2.2	13.3	0.0	0.9	1.5	4.2	0.0	0.0	0.0	0.0	0.0	32.9



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per lo Studio dei Materiali Cementizi  
e dei Leganti Idraulici



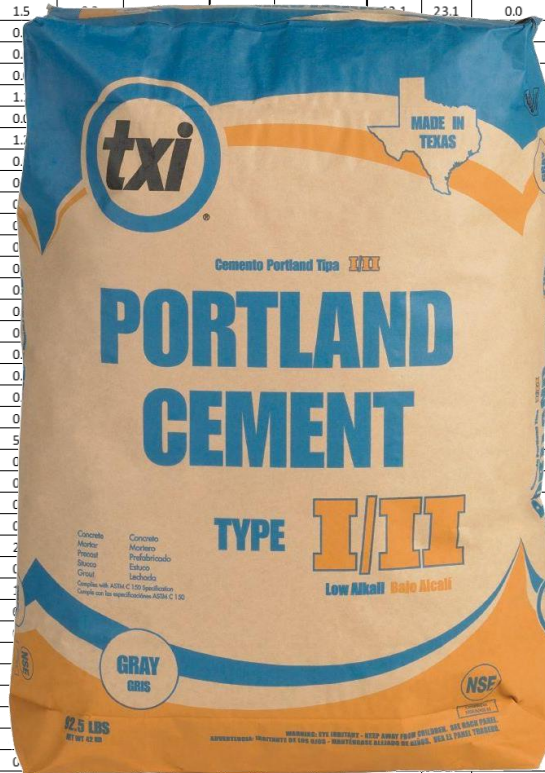
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DIAGNOSTICA - RILIEVO - TECNOLOGIE

Materials Properties, Use and Conservation:  
Construction Materials and Binders

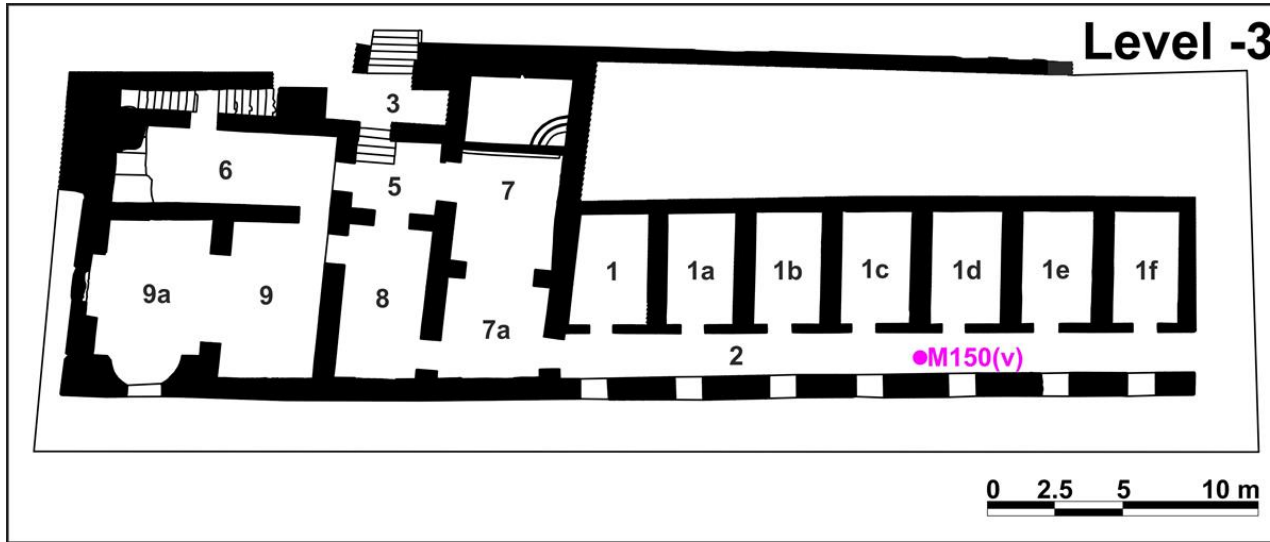


# Structural binders in Pompeii

Sample	Position	Structural Element	Calcite	Aragonite	Vaterite	Carbonate-Afm	C3S	C2S	Dolomite	Quartz	Labradorite	Sanidine	Na-Sanidine	Leucite	Augite	Amphibole	Biotite	Hematite	Analcime	Gypsum	Syngenite	Halite	Sylvite	Gaylussite	Amorphous
M111	Facade, level-4	Perimeter wall	16.0	0.0	4.3	0.0	0.0	0.0	0.0	1.5	13.2	0.0	11.4	1.7	12.6	0.0	1.0	1.0	5.1	0.0	0.0	0.0	0.0	0.0	32.2
M120	Facade, foundation	Foundation	6.1	0.0	0.0	0.0	0.0	0.0	0.0	5.2	12.9	0.0	8.9	1.3	11.1	0.0	0.7	0.7	9.3	0.8	0.0	0.0	0.0	0.0	43.2
M124	Facade, foundation	Foundation	13.4	0.0	0.0	0.0	0.0	0.0	0.0	4.1	10.6	0.0	9.5	2.6	8.1	0.0	0.8	1.0	4.7	2.4	0.0	0.0	0.0	0.0	42.8
M126	Facade, foundation	Foundation	18.3	0.0	2.2	1.1	0.0	0.0	0.0	3.4	10.7	0.0	5.9	4.5	8.1	0.0	0.5	0.8	2.5	0.0	0.0	0.5	0.0	0.0	41.4
M133	Level -3, room 7a	Internal wall	17.5	0.0	0.0	0.0	0.0	0.0	0.4	0.2	9.6	5.9	0.0	13.4	24.8	0.0	0.8	1.3	2.3	0.0	0.0	0.0	0.0	0.0	23.9
M136	Level -3, room 7a	Internal wall	9.7	0.0	0.0	0.0	0.0	0.0	0.0	1.1	20.0	0.0	12.7	2.2	18.6	0.0	0.8	2.0	8.3	0.0	0.0	0.0	0.0	0.0	24.7
M137	Level -3, room 1e	Perimeter wall	14.4	0.0	0.0	0.0	0.0	0.0	0.0	1.7	13.9	0.0	12.3	2.2	16.7	0.0	1.0	1.2	5.2	0.0	0.0	0.0	0.0	0.0	31.4
M138	Level -3, room 2	Internal wall	17.5	0.0	0.0	0.0	0.0	0.0	0.8	0.2	9.3	5.0	0.0	12.6	23.9	0.0	0.8	1.4	2.4	0.0	0.0	0.0	0.0	0.0	26.1
M146	Level -3, room 8	Floor	16.4	0.0	0.0	0.0	0.0	0.0	0.0	1.3	9.1	0.0	12.1	1.1	13.8	0.0	1.0	1.3	2.9	0.0	0.0	0.0	0.0	0.0	41.1
M150	Level -3, room 2	Vault	16.1	0.0	0.0	1.8	1.0	1.1	1.5	0.4	13.7	3.9	0.0	12.5	22.1	0.0	1.2	1.8	1.3	0.0	0.0	0.0	0.0	0.0	21.7
M153	Level -3, room 9	Internal wall	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	13.4	0.0	31.3	6.5	12.9	0.0	0.8	2.7	0.8	0.0	0.0	0.0	0.0	0.0	25.6
M159	Level -3, room 9a	Internal wall	17.1	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	23.1	0.0	0.6	1.2	2.3	1.0	0.0	0.0	0.0	0.0	27.6
M162	Level -3, room 9a	Internal wall	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.7	3.8	0.0	0.0	0.0	0.0	0.0	26.7
M165	Level -3, room 9a	Perimeter wall	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.2	3.4	0.0	0.0	0.0	0.0	0.0	32.9
M180	Level -3, room 5	Internal wall	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.6	4.9	0.0	0.0	1.3	0.0	0.0	31.0
M181	Level -4, room 12	Internal wall	19.5	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1	3.7	0.2	0.0	0.0	0.0	0.0	26.8
M185	Level -4, room 20	Perimeter wall	15.6	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	4.8	0.0	0.0	0.0	0.0	0.0	34.3
M187	Level -4, room 20	Internal wall	22.4	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.4	2.0	0.0	0.0	0.0	0.0	0.0	22.8
M188	Level -4, room 16	Perimeter wall	8.6	0.0	2.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	4.9	0.0	0.0	0.0	0.0	0.0	41.0
M190	Level -4, room 16	Vault	15.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.1	2.7	0.0	0.0	0.0	0.0	0.0	25.4
M191	Level -4, room 16	Vault	32.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.1	2.6	1.2	0.0	0.0	0.0	0.0	21.6
M204	Level -3, room 6	Internal wall	11.3	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	4.8	0.0	0.0	0.0	0.0	0.0	37.8
M206A	Level -3, room 6	Perimeter wall	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	2.9	0.0	0.0	2.0	0.7	0.0	26.7
M208	Level -3, room 6	Perimeter wall	11.0	0.0	4.4	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.2	6.1	0.0	0.0	0.0	0.0	0.0	36.4
M212	Level -3, room 4	Perimeter wall	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.1	4.0	0.0	0.0	0.0	0.0	0.0	22.5
M213	Level -3, room 6	Praefurnium	7.5	1.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.5	3.5	0.0	0.0	0.0	0.0	0.0	46.7
M216	Level -3, room 9	Vault	20.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.0	2.9	0.0	0.0	0.0	0.0	0.0	28.2
M218	Facade, level-4	Perimeter wall	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.1	3.6	2.2	5.2	0.0	0.0	0.0	39.6
M219	Facade, level-4	Perimeter wall	17.7	1.8	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	4.0	0.5	0.0	0.0	0.0	0.0	33.7
M220	Facade, level-4	Perimeter wall	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	3.9	1.1	0.0	0.0	0.0	0.0	36.9
M222	Facade, level-3	Perimeter wall	13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	4.4	0.0	0.0	0.0	0.0	0.0	38.6
M223	Facade, level-3	Perimeter wall	15.3	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.2	2.6	0.0	0.0	0.0	0.0	0.0	23.9
M224	Facade, level-3	Perimeter wall	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.7	1.9	0.0	0.0	0.0	0.0	0.0	33.4
M226	Facade, level-3	Perimeter wall	15.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	3.0	0.0	0.0	0.0	0.0	0.0	24.6
M227	Facade, level-4	Perimeter wall	19.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	3.0	0.0	0.0	0.0	0.0	4.0	36.9
M228	Facade, level-4	Perimeter wall	25.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.8	2.1	2.6	0.0	0.0	0.0	0.0	28.3
M230-B	Facade, level-3	Perimeter wall	19.2	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.1	2.9	0.0	0.0	0.0	0.0	0.0	31.1
M231	Facade, level-3	Perimeter wall	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.0	5.5	1.3	3.7	0.0	0.0	0.0	36.6
M232	Facade, level-3	Perimeter wall	20.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.2	3.4	0.0	0.0	0.0	0.0	0.0	34.0
M234	Facade, level-4	Perimeter wall	7.8	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.0	4.2	0.0	4.8	0.0	0.0	0.0	45.0
M238	Level -4, room 12	Vault	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.1	2.9	0.3	0.0	0.0	0.0	0.0	28.0
M239	Level -4, room 12	Vault	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.4	3.8	0.0	0.0	0.0	0.0	0.0	27.9
M240	Level -4, room 12	Vault	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.3	4.0	0.3	0.0	0.0	0.0	0.0	29.7
M242	Level -4, room 20	Vault	16.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.7	4.3	0.0	1.0	0.0	0.0	0.0	33.0
M277	Level -3, room 1e	Vault	18.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.1	2.7	0.0	0.0	0.0	0.0	0.0	25.7
M278	Level -3, room 1e	Vault	14.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.2	2.8	0.0	0.0	0.0	0.0	0.0	26.4
M288	Facade, excavation	Perimeter wall	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.2	5.2	0.0	0.0	0.0	0.0	0.0	34.7
M290	Facade, excavation	Perimeter wall	7.3	2.6	0.0	0.0	0.0	0.0	7.9	1.5	12.6	0.0	13.1	2.2	13.3	0.0	0.9	1.5	4.2	0.0	0.0	0.0	0.0	0.0	32.9



# Structural binders in Pompeii





# Structural binders in Pompeii

Sample	Position	Structural Element	Calcite	Aragonite	Vaterite	Carbonate-Afm	C3S	C2S	Dolomite	Quartz	Labradorite	Sanidine	Na-Sanidine	Leucite	Augite	Amphibole	Biotite	Hematite	Analcime	Gypsum	Syngentite	Halite	Sylvite	Gaylussite	Amorphous
M111	Facade, level-4	Perimeter wall	16.0	0.0	4.3	0.0	0.0	0.0	0.0	1.5	13.2	0.0	11.4	1.7	12.6	0.0	1.0	1.0	5.1	0.0	0.0	0.0	0.0	0.0	32.2
M120	Facade, foundation	Foundation	6.1	0.0	0.0	0.0	0.0	0.0	0.0	5.2	12.9	0.0	8.9	1.3	11.1	0.0	0.7	0.7	9.3	0.8	0.0	0.0	0.0	0.0	43.2
M124	Facade, foundation	Foundation	13.4	0.0	0.0	0.0	0.0	0.0	0.0	4.1	10.6	0.0	9.5	2.6	8.1	0.0	0.8	1.0	4.7	2.4	0.0	0.0	0.0	0.0	42.8
M126	Facade, foundation	Foundation	18.3	0.0	2.2	1.1	0.0	0.0	0.0	3.4	10.7	0.0	5.9	4.5	8.1	0.0	0.5	0.8	2.5	0.0	0.0	0.5	0.0	0.0	41.4
M133	Level -3, room 7a	Internal wall	17.5	0.0	0.0	0.0	0.0	0.0	0.4	0.2	9.6	5.9	0.0	13.4	24.8	0.0	0.8	1.3	2.3	0.0	0.0	0.0	0.0	0.0	23.9
M136	Level -3, room 7a	Internal wall	9.7	0.0	0.0	0.0	0.0	0.0	0.0	1.1	20.0	0.0	12.7	2.2	18.6	0.0	0.8	2.0	8.3	0.0	0.0	0.0	0.0	0.0	24.7
M137	Level -3, room 1e	Perimeter wall	14.4	0.0	0.0	0.0	0.0	0.0	0.0	1.7	13.9	0.0	12.3	2.2	16.7	0.0	1.0	1.2	5.2	0.0	0.0	0.0	0.0	0.0	31.4
M138	Level -3, room 2	Internal wall	17.5	0.0	0.0	0.0	0.0	0.0	0.8	0.2	9.3	5.0	0.0	12.6	23.9	0.0	0.8	1.4	2.4	0.0	0.0	0.0	0.0	0.0	26.1
M146	Level -3, room 9	Floor	16.4	0.0	0.0	0.0	0.0	0.0	0.0	1.3	9.1	0.0	12.1	1.1	13.8	0.0	1.0	1.3	2.9	0.0	0.0	0.0	0.0	0.0	41.1
M150	Level -3, room 2	Vault	16.1	0.0	0.0	1.8	1.0	1.1	1.5	0.4	13.7	3.9	0.0	12.5	22.1	0.0	1.2	1.8	1.3	0.0	0.0	0.0	0.0	0.0	21.7
M153	Level -3, room 9	Internal wall	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	13.4	0.0	31.3	6.5	12.9	0.0	0.8	2.7	0.8	0.0	0.0	0.0	0.0	0.0	25.6
M159	Level -3, room 9a	Internal wall	17.1	0.0	0.0	0.0	0.0	0.0	1.5	0.2	8.7	4.7	0.0	12.1	23.1	0.0	0.6	1.2	2.3	1.0	0.0	0.0	0.0	0.0	27.6
M162	Level -3, room 9a	Internal wall	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	12.6	0.0	10.1	2.4	18.1	0.0	0.9	0.7	3.8	0.0	0.0	0.0	0.0	0.0	26.7
M165	Level -3, room 9a	Perimeter wall	12.8	0.0	0.0	0.0	0.0	0.0	0.0	2.6	12.0	0.0	12.4	3.2	18.9	0.0	0.7	1.2	3.4	0.0	0.0	0.0	0.0	0.0	32.9
M180	Level -3, room 5	Internal wall	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.5	13.7	0.0	11.6	3.5	15.8	0.0	1.4	1.6	4.9	0.0	0.0	1.3	0.0	0.0	31.0
M181	Level -4, room 12	Internal wall	19.5	0.0	0.0	0.0	0.0	0.0	1.1	0.3	9.8	6.4	0.0	10.6	20.0	0.0	0.6	1.1	3.7	0.2	0.0	0.0	0.0	0.0	26.8
M185	Level -4, room 20	Perimeter wall	15.6	0.0	0.0	0.0	0.0	0.0	0.0	1.7	12.5	0.0	10.5	3.1	15.6	0.0	0.9	0.9	4.8	0.0	0.0	0.0	0.0	0.0	34.3
M187	Level -4, room 20	Internal wall	22.4	0.0	0.0	0.0	0.0	0.0	1.2	0.3	8.3	4.3	0.0	12.2	24.0	0.0	1.2	1.4	2.0	0.0	0.0	0.0	0.0	0.0	22.8
M188	Level -4, room 16	Perimeter wall	8.6	0.0	2.5	0.7	0.0	0.0	0.0	2.2	12.4	0.0	12.0	1.7	12.3	0.0	0.8	0.9	4.9	0.0	0.0	0.0	0.0	0.0	41.0
M190	Level -4, room 16	Vault	15.1	0.0	0.0	0.0	0.0	0.0	0.8	0.4	9.2	4.5	0.0	14.1	25.3	0.0	1.4	1.1	2.7	0.0	0.0	0.0	0.0	0.0	25.4
M191	Level -4, room 16	Vault	32.2	0.0	0.0	0.0	0.0	0.0	0.1	0.2	6.1	2.9	0.0	10.3	20.4	0.0	1.4	1.1	2.6	1.2	0.0	0.0	0.0	0.0	21.6
M204	Level -3, room 6	Internal wall	11.3	0.0	2.9	0.0	0.0	0.0	0.0	1.6	11.9	0.0	11.6	1.7	14.3	0.0	1.0	1.0	4.8	0.0	0.0	0.0	0.0	0.0	37.8
M206A	Level -3, room 6	Perimeter wall	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	0.0	10.6	3.5	21.1	0.0	0.8	2.1	2.9	0.0	0.0	2.0	0.7	0.0	26.7
M208	Level -3, room 6	Perimeter wall	11.0	0.0	4.4	2.1	0.0	0.0	0.0	0.8	10.7	0.0	11.7	1.2	13.6	0.0	0.8	1.2	6.1	0.0	0.0	0.0	0.0	0.0	36.4
M212	Level -3, room 4	Perimeter wall	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.7	0.0	11.5	4.1	21.7	0.0	0.9	2.1	4.0	0.0	0.0	0.0	0.0	0.0	22.5
M213	Level -3, room 6	Praefurnium	7.5	1.0	7.4	0.0	0.0	0.0	0.0	1.4	7.6	0.0	10.9	0.9	12.0	0.0	0.8	0.5	3.5	0.0	0.0	0.0	0.0	0.0	46.7
M216	Level -3, room 9	Vault	20.9	0.0	0.0	0.0	0.0	0.0	0.6	0.7	8.6	4.6	0.0	11.9	19.1	0.0	0.5	2.0	2.9	0.0	0.0	0.0	0.0	0.0	28.2
M218	Facade, level-4	Perimeter wall	13.3	0.0	0.0	0.0	0.0	0.0	0.0	1.6	9.0	0.0	10.7	1.1	11.9	0.0	0.7	1.1	3.6	2.2	5.2	0.0	0.0	0.0	39.6
M219	Facade, level-4	Perimeter wall	17.7	1.8	5.9	0.0	0.0	0.0	0.0	1.9	11.1	0.0	11.1	1.0	10.4	0.0	0.4	0.7	4.0	0.5	0.0	0.0	0.0	0.0	33.7
M220	Facade, level-4	Perimeter wall	20.8	0.0	0.0	0.0	0.0	0.0	0.0	1.5	10.7	0.0	11.3	1.1	11.1	0.0	0.5	1.1	3.9	1.1	0.0	0.0	0.0	0.0	36.9
M222	Facade, level-3	Perimeter wall	13.9	0.0	0.0	0.0	0.0	0.0	0.0	1.5	11.3	0.0	10.9	2.3	15.0	0.0	0.8	1.4	4.4	0.0	0.0	0.0	0.0	0.0	38.6
M223	Facade, level-3	Perimeter wall	15.3	0.0	0.0	0.0	0.0	0.0	5.1	0.6	8.8	4.9	0.0	11.8	24.0	0.0	1.7	1.2	2.6	0.0	0.0	0.0	0.0	0.0	23.9
M224	Facade, level-3	Perimeter wall	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	7.6	3.9	0.0	10.3	20.7	0.0	0.9	1.7	1.9	0.0	0.0	0.0	0.0	0.0	33.4
M226	Facade, level-3	Perimeter wall	15.9	0.0	0.0	0.0	0.0	0.0	0.0	0.5	11.9	7.2	0.0	10.3	23.7	0.0	1.4	1.4	3.0	0.0	0.0	0.0	0.0	0.0	24.6
M227	Facade, level-4	Perimeter wall	19.9	0.0	0.0	0.1	0.0	0.0	0.0	2.0	6.8	0.0	9.4	2.7	13.4	0.0	0.5	1.2	3.0	0.0	0.0	0.0	0.0	4.0	36.9
M228	Facade, level-4	Perimeter wall	25.2	0.0	0.0	0.0	0.0	0.0	0.0	4.2	11.7	0.0	10.0	2.4	12.0	0.0	0.7	0.8	2.1	2.6	0.0	0.0	0.0	0.0	28.3
M230-B	Facade, level-3	Perimeter wall	19.2	0.0	0.0	0.0	0.0	0.0	2.5	0.3	8.6	7.0	0.0	7.1	19.3	0.0	1.0	1.1	2.9	0.0	0.0	0.0	0.0	0.0	31.1
M231	Facade, level-3	Perimeter wall	11.4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	13.7	0.0	9.7	1.5	13.1	0.0	0.8	1.0	5.5	1.3	3.7	0.0	0.0	0.0	36.6
M232	Facade, level-3	Perimeter wall	20.2	0.0	0.0	0.0	0.0	0.0	1.5	0.7	7.3	6.3	0.0	7.3	16.8	0.0	1.5	1.2	3.4	0.0	0.0	0.0	0.0	0.0	34.0
M234	Facade, level-4	Perimeter wall	7.8	0.0	3.0	0.0	0.0	0.0	0.0	1.9	9.6	0.0	9.9	0.8	11.3	0.0	0.7	1.0	4.2	0.0	4.8	0.0	0.0	0.0	45.0
M238	Level -4, room 12	Vault	12.8	0.0	0.0	0.0	0.0	0.0	0.2	0.4	10.5	5.1	0.0	12.0	24.6	1.3	0.9	1.1	2.9	0.3	0.0	0.0	0.0	0.0	28.0
M239	Level -4, room 12	Vault	5.1	0.0	0.0	0.0	0.0	0.0	0.5	0.2	11.5	6.0	0.0	15.8	27.1	0.0	0.7	1.4	3.8	0.0	0.0	0.0	0.0	0.0	27.9
M240	Level -4, room 12	Vault	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	11.5	6.3	0.0	13.8	22.6	0.0	0.7	1.3	4.0	0.3	0.0	0.0	0.0	0.0	29.7
M242	Level -4, room 20	Vault	16.0	0.0	6.7	0.0	0.0	0.0	0.0	1.6	10.1	0.0	9.0	1.3	15.6	0.0	0.8	0.7	4.3	0.0	1.0	0.0	0.0	0.0	33.0
M277	Level -3, room 1e	Vault	18.9	0.0	0.0	0.0	0.0	0.0	2.2	1.1	8.9	4.6	0.0	11.3	21.5	0.0	2.1	1.1	2.7	0.0	0.0	0.0	0.0	0.0	25.7
M278	Level -3, room 1e	Vault	14.9	0.0	0.0	0.0	0.0	0.0	1.2	0.8	9.2	6.4	0.0	11.8	23.8	0.0	1.6	1.2	2.8	0.0	0.0	0.0	0.0	0.0	26.4
M288	Facade, excavation	Perimeter wall	11.6	0.0	0.0	0.0	0.0	0.0	0.0	2.4	14.3	0.0	12.8	3.1	13.9	0.0	0.8	1.2	5.2	0.0	0.0	0.0	0.0	0.0	34.7
M290	Facade, excavation	Perimeter wall	7.3	2.6	0.0	0.0	0.0	0.0	7.9	1.5	12.6	0.0	13.1	2.2	13.3	0.0	0.9	1.5	4.2	0.0	0.0	0.0	0.0	0.0	32.9



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DIAGNOSTICA - RILIEVO - TECNOLOGIE

Materials Properties, Use and Conservation:  
Construction Materials and Binders

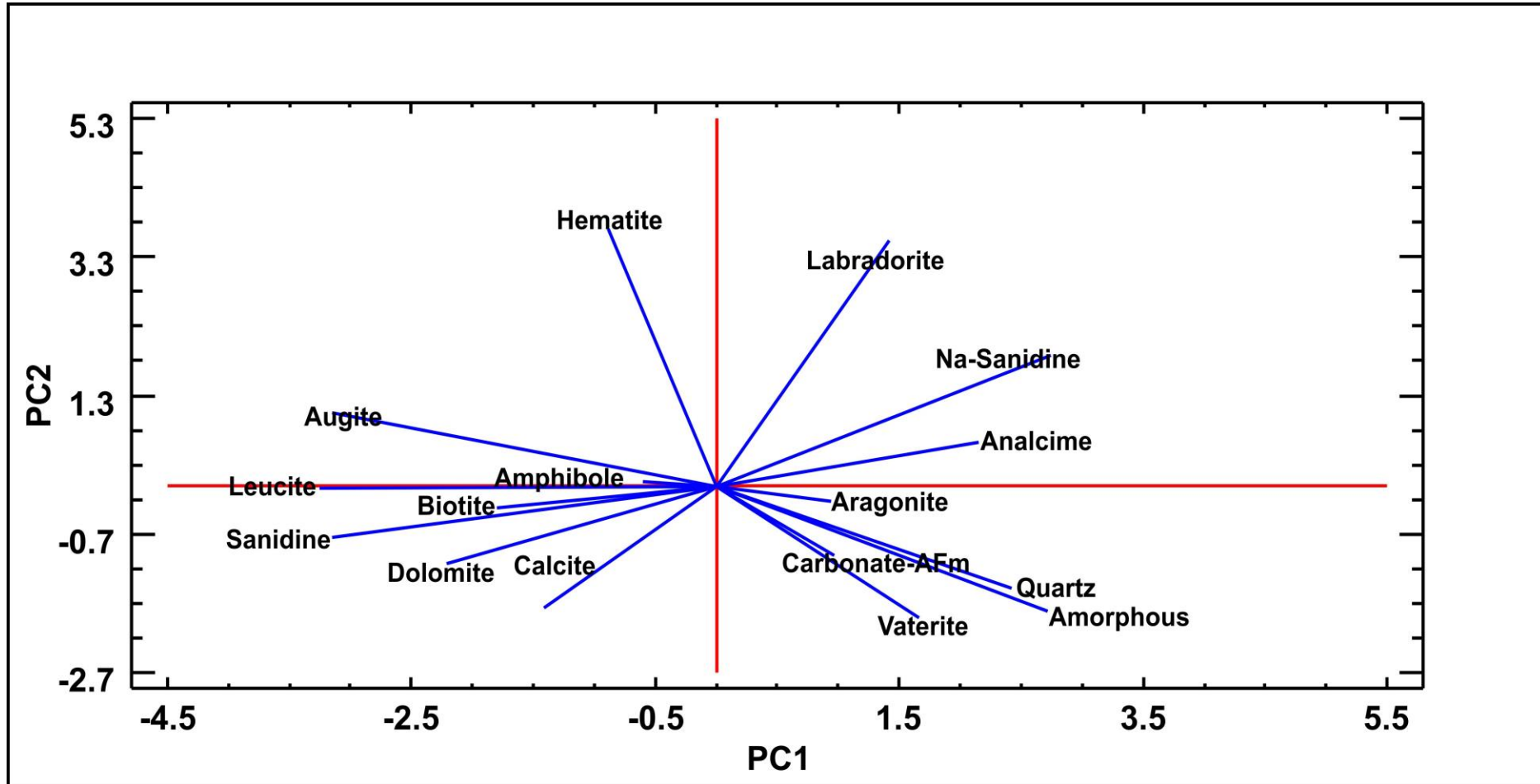
# Structural binders in Pompeii

	Calcite	Dolomite	Aragonite	Vaterite	AFm	Quartz	Plagioclase	K-feldspar	Leucite	Clinopyroxene	Olivine	Biotite	Hematite	Amphibole	Analcime	Sodalite	Chabazite	Amorphous
Calcite	-	0,30	-0,33	-0,10	-0,01	0,14	-0,22	-0,33	-0,03	-0,03	-0,03	-0,27	-0,11	-0,05	<b>-0,47</b>	0,13	0,09	-0,23
Dolomite	0,30	-	-0,27	-0,10	0,03	<b>0,60</b>	-0,11	<b>-0,44</b>	<b>0,45</b>	<b>0,41</b>	-0,09	-0,16	0,17	-0,04	-0,27	<b>0,61</b>	-0,17	<b>-0,42</b>
Aragonite	-0,33	-0,27	-	-0,04	-0,09	-0,12	0,07	0,16	-0,35	-0,26	-0,08	-0,14	-0,02	0,14	0,33	-0,16	0,23	0,19
Vaterite	-0,10	-0,10	-0,04	-	0,09	-0,26	0,27	0,18	-0,26	0,01	<b>0,44</b>	0,01	0,27	0,29	-0,06	-0,13	-0,12	-0,18
AFm	-0,01	0,03	-0,09	0,09	-	-0,19	0,32	0,21	-0,19	0,01	0,02	-0,12	0,31	-0,07	0,23	-0,10	-0,09	-0,17
Quartz	0,14	<b>0,60</b>	-0,12	-0,26	-0,19	-	<b>-0,41</b>	<b>-0,41</b>	0,24	-0,13	-0,22	0,26	-0,36	-0,09	-0,23	<b>0,53</b>	-0,12	0,17
Plagioclase	-0,22	-0,11	0,07	0,27	0,32	<b>-0,41</b>	-	<b>0,46</b>	-0,25	0,29	<b>0,69</b>	-0,21	<b>0,82</b>	0,26	0,31	-0,29	-0,17	<b>-0,65</b>
K-feldspar	-0,33	<b>-0,44</b>	0,16	0,18	0,21	<b>-0,41</b>	<b>0,46</b>	-	<b>-0,66</b>	-0,28	0,36	0,09	0,29	-0,06	0,21	-0,36	0,07	0,03
Leucite	-0,03	<b>0,45</b>	-0,35	-0,26	-0,19	0,24	-0,25	<b>-0,66</b>	-	<b>0,59</b>	-0,28	0,02	-0,02	-0,12	-0,29	0,36	-0,19	-0,27
Clinopyroxene	-0,03	<b>0,41</b>	-0,26	0,01	0,01	-0,13	0,29	-0,28	<b>0,59</b>	-	0,11	-0,24	<b>0,47</b>	-0,02	-0,11	0,16	-0,11	<b>-0,78</b>
Olivine	-0,03	-0,09	-0,08	<b>0,44</b>	0,02	-0,22	<b>0,69</b>	0,36	-0,28	0,11	-	-0,18	<b>0,47</b>	0,29	-0,11	-0,25	-0,13	<b>-0,46</b>
Biotite	-0,27	-0,16	-0,14	0,01	-0,12	0,26	-0,21	0,09	0,02	-0,24	-0,18	-	-0,23	-0,04	-0,15	0,02	0,07	0,37
Hematite	-0,11	0,17	-0,02	0,27	0,31	-0,36	<b>0,82</b>	0,29	-0,02	<b>0,47</b>	<b>0,47</b>	-0,23	-	0,18	0,16	-0,17	-0,10	<b>-0,75</b>
Amphibole	-0,05	-0,04	0,14	0,29	-0,07	-0,09	0,26	-0,06	-0,12	-0,02	0,29	-0,04	0,18	-	0,09	-0,06	-0,06	-0,12
Analcime	<b>-0,47</b>	-0,27	0,33	-0,06	0,23	-0,23	0,31	0,21	-0,29	-0,11	-0,11	-0,15	0,16	0,09	-	-0,17	0,09	0,11
Sodalite	0,13	<b>0,61</b>	-0,16	-0,13	-0,10	<b>0,53</b>	-0,29	-0,36	0,36	0,16	-0,25	0,02	-0,17	-0,06	-0,17	-	-0,08	-0,07
Chabazite	0,09	-0,17	0,23	-0,12	-0,09	-0,12	-0,17	0,07	-0,19	-0,11	-0,13	0,07	-0,10	-0,06	0,09	-0,08	-	0,10
Amorphous	-0,23	<b>-0,42</b>	0,19	-0,18	-0,17	0,17	<b>-0,65</b>	0,03	-0,27	<b>-0,78</b>	<b>-0,46</b>	0,37	<b>-0,75</b>	-0,12	0,11	-0,07	0,10	-



# Structural binders in Pompeii

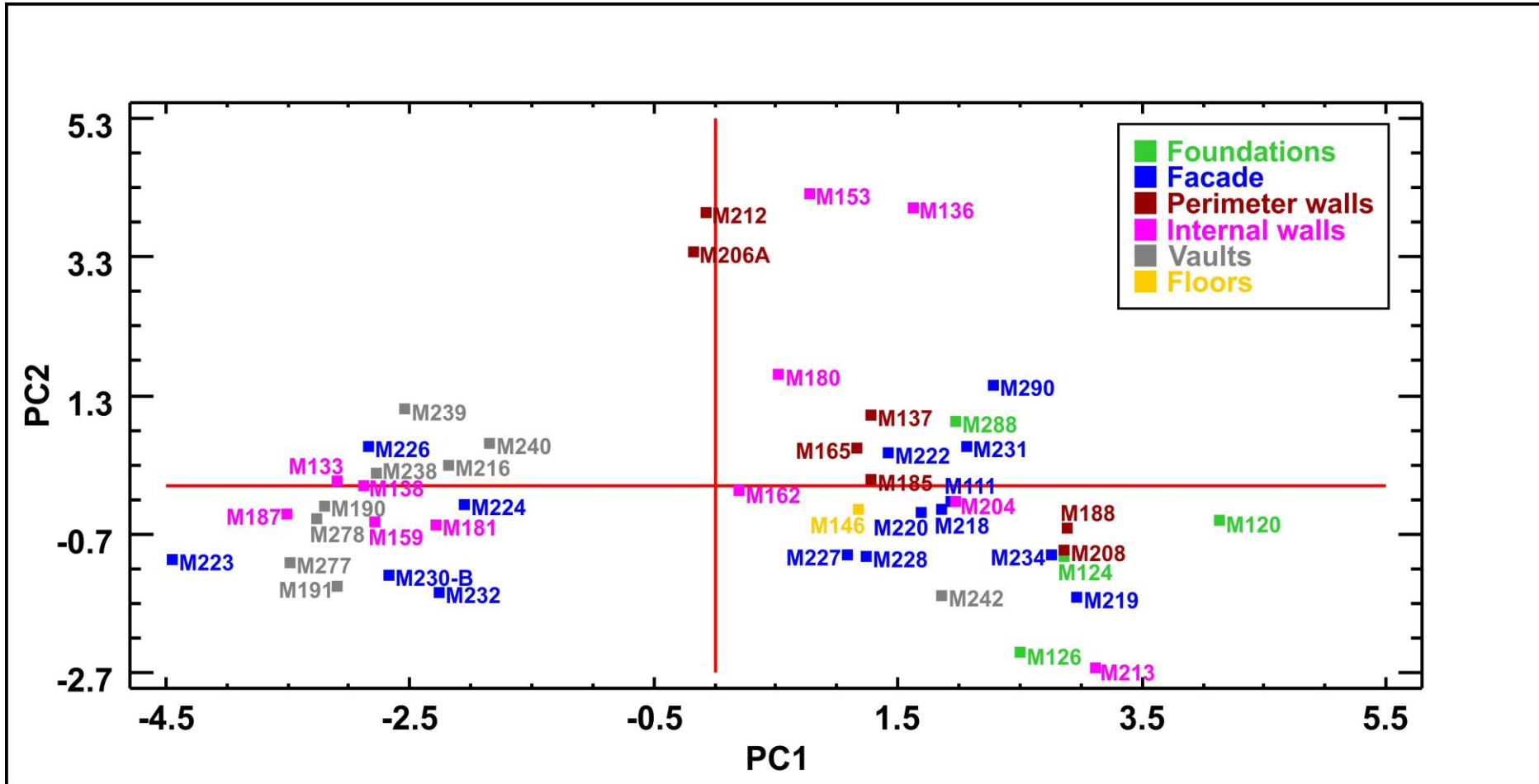
## Principal Component Analysis (PCA)





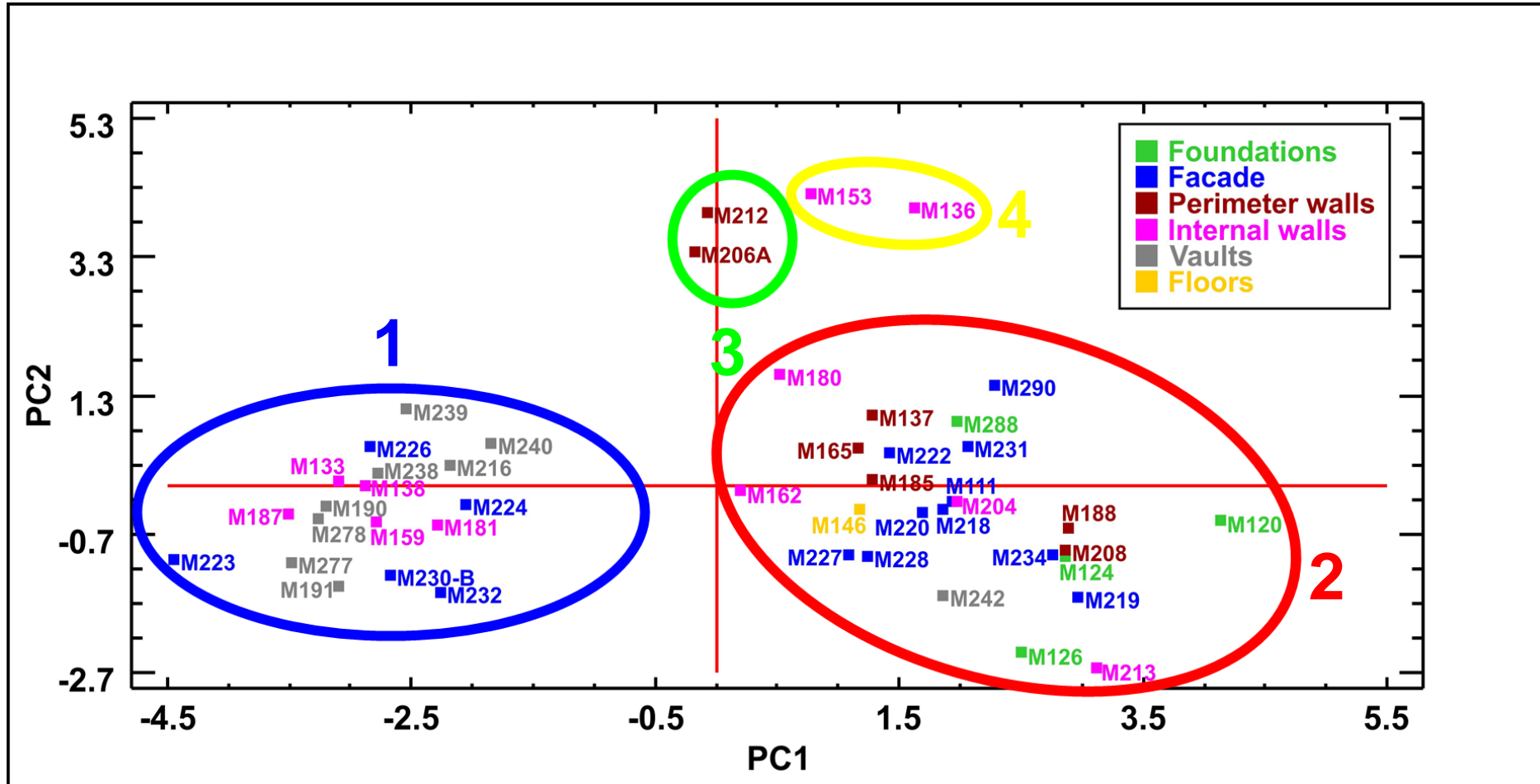
# Structural binders in Pompeii

## Principal Component Analysis (PCA)



# Structural binders in Pompeii

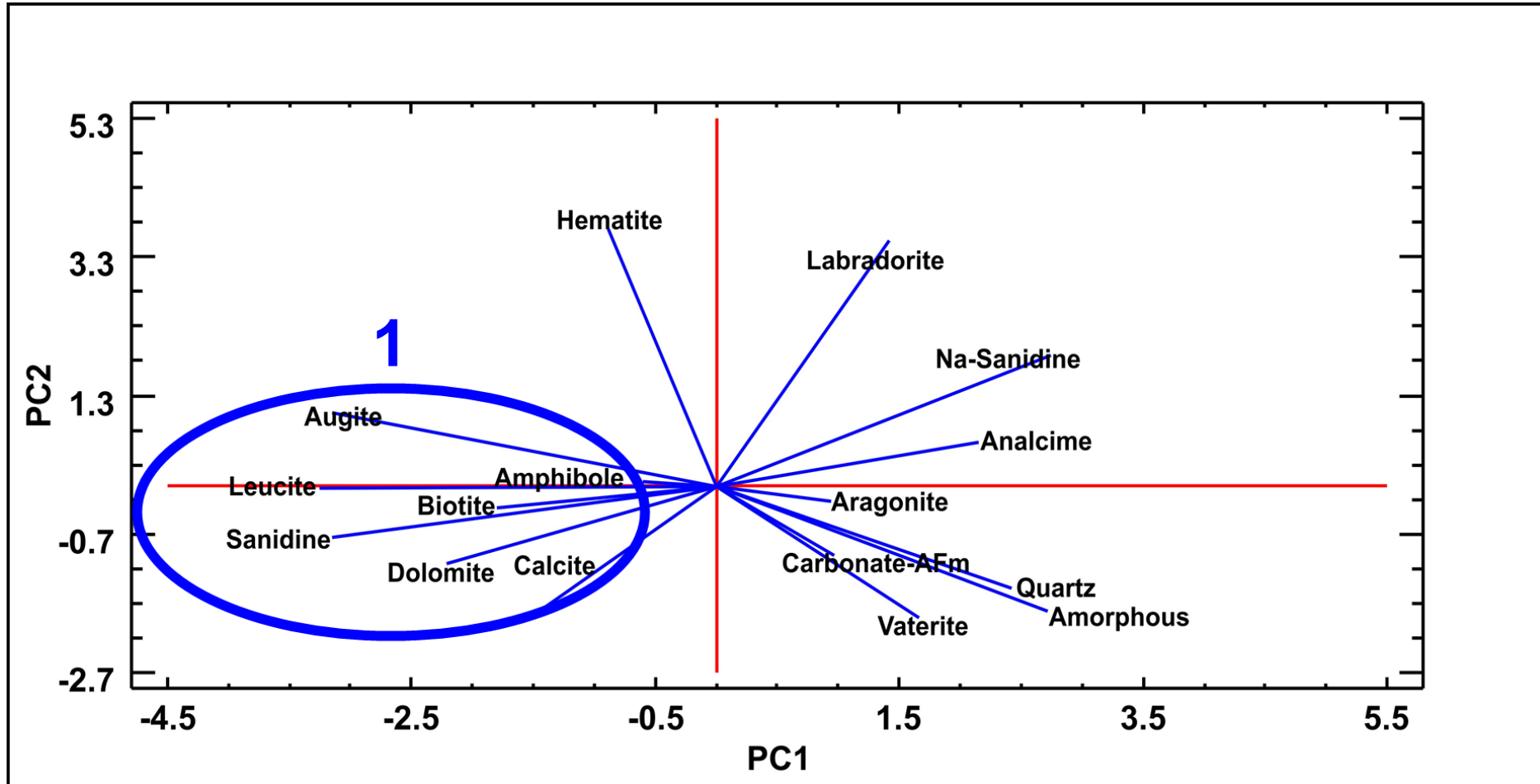
## Principal Component Analysis (PCA)



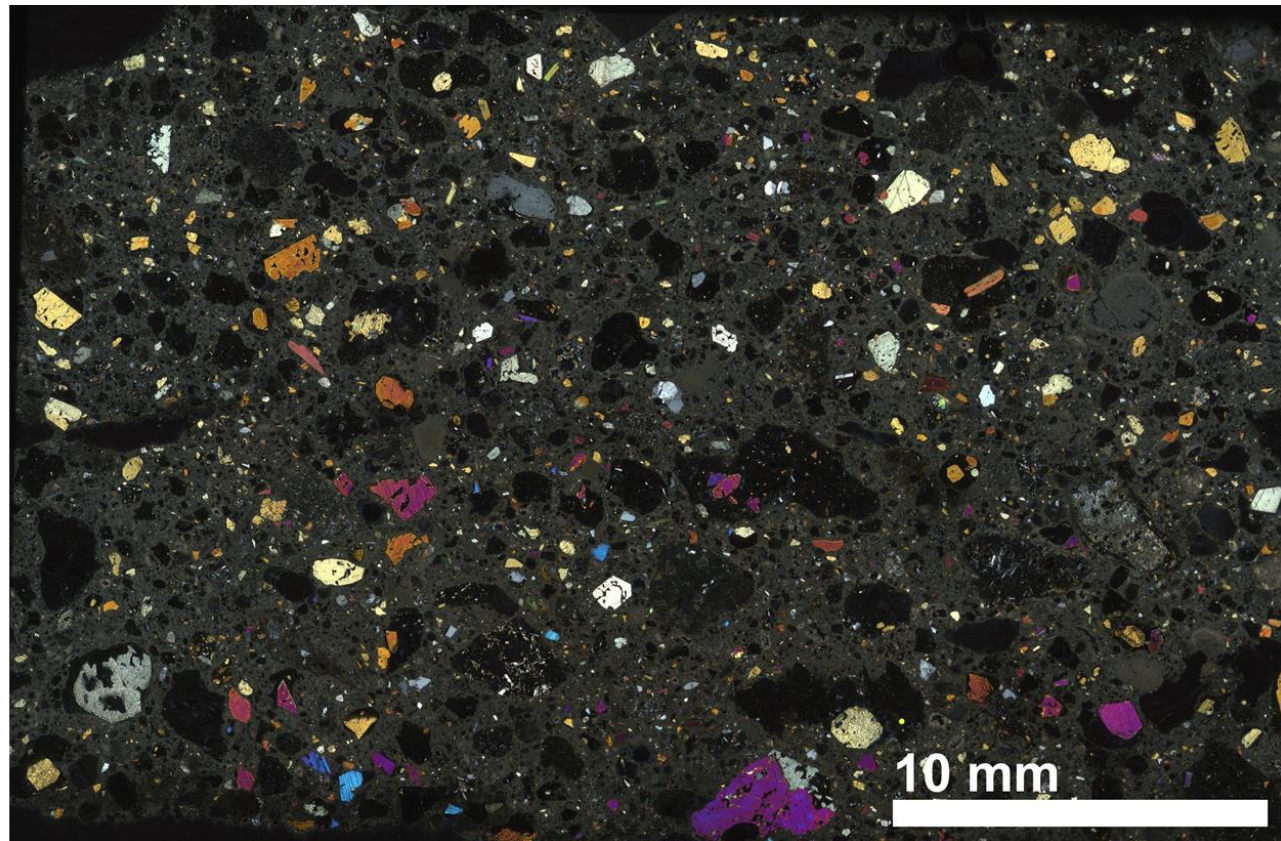
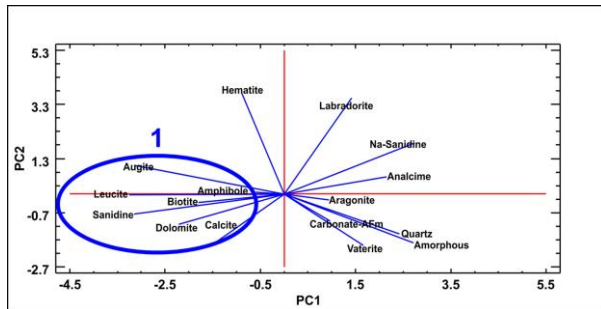


# Structural binders in Pompeii

## Principal Component Analysis (PCA)

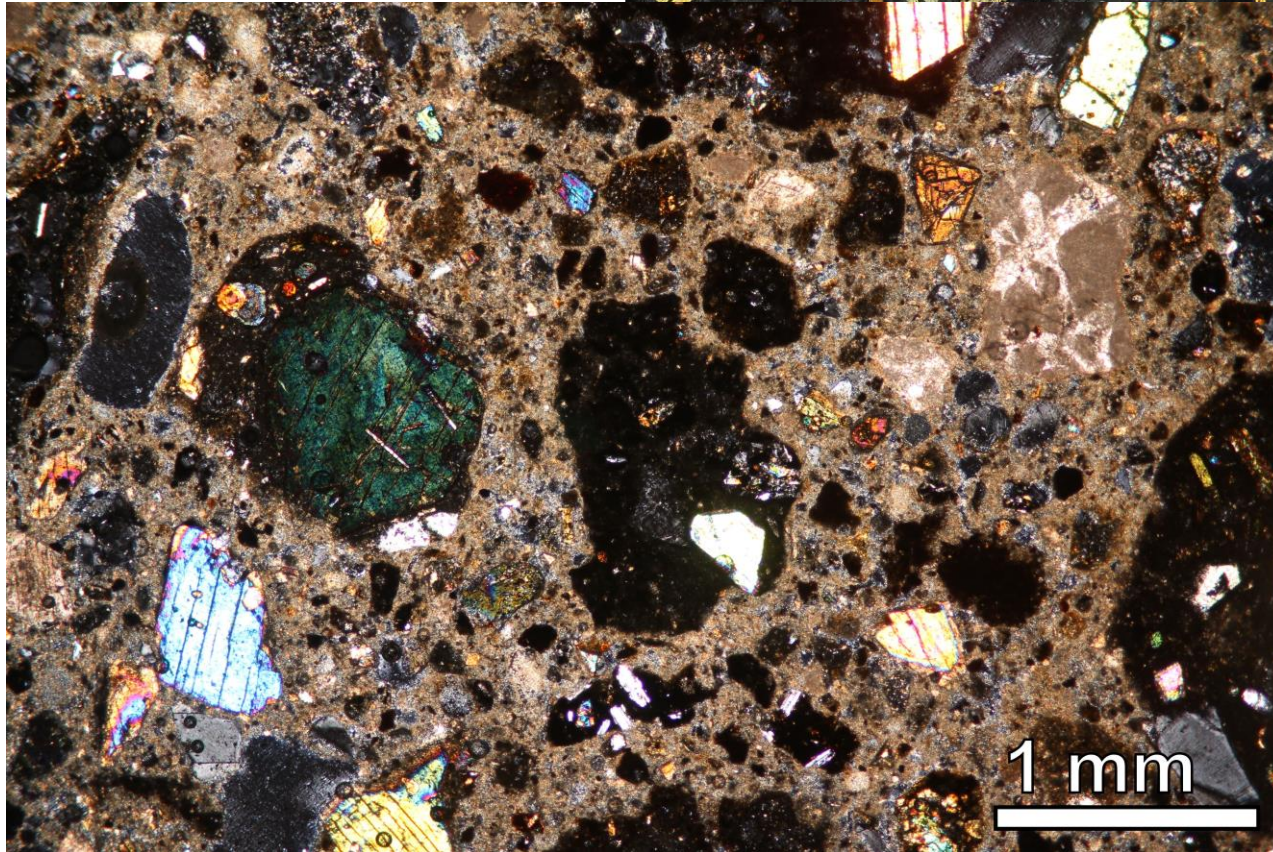
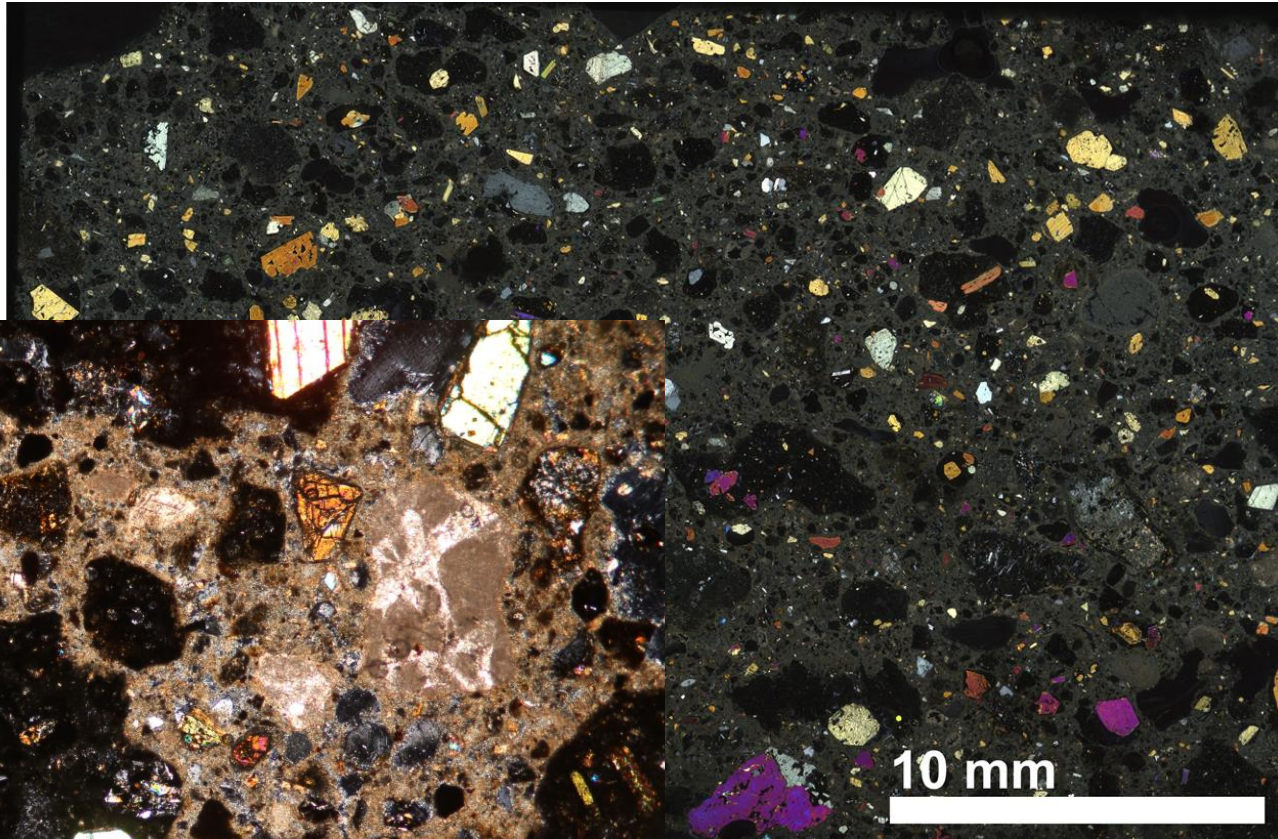
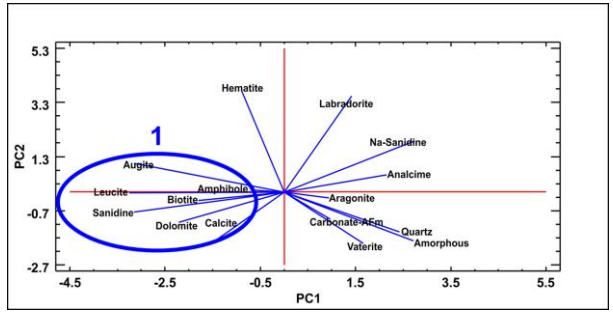


# Structural binders in Pompeii





# Structural binders in Pompeii



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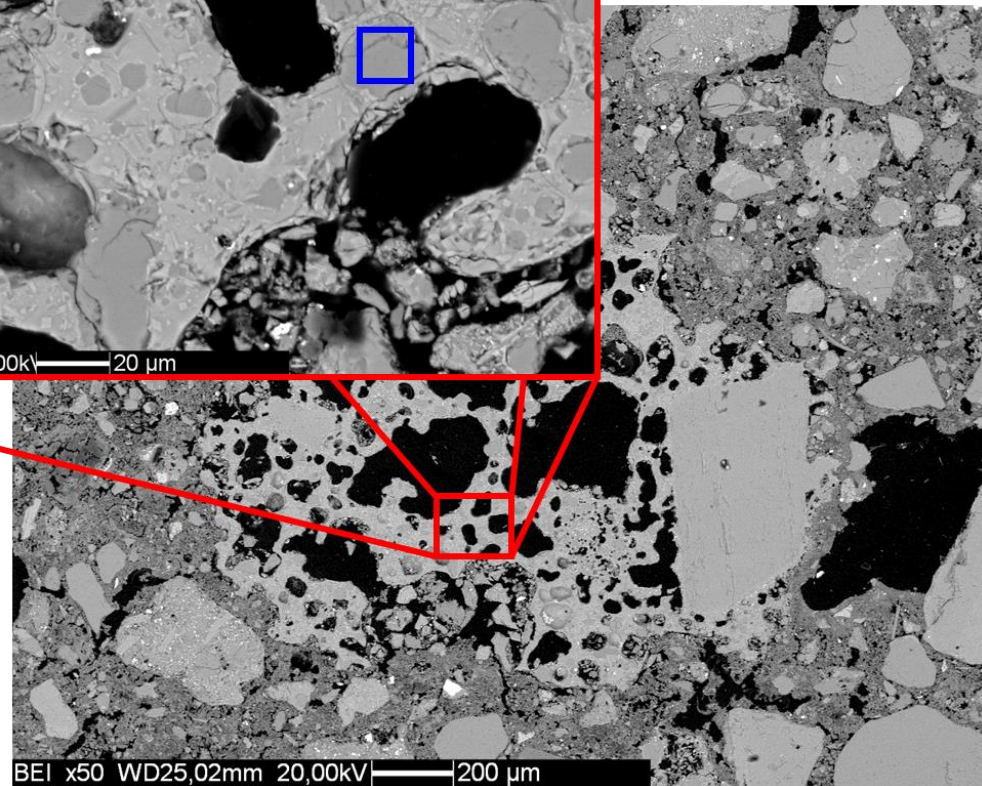
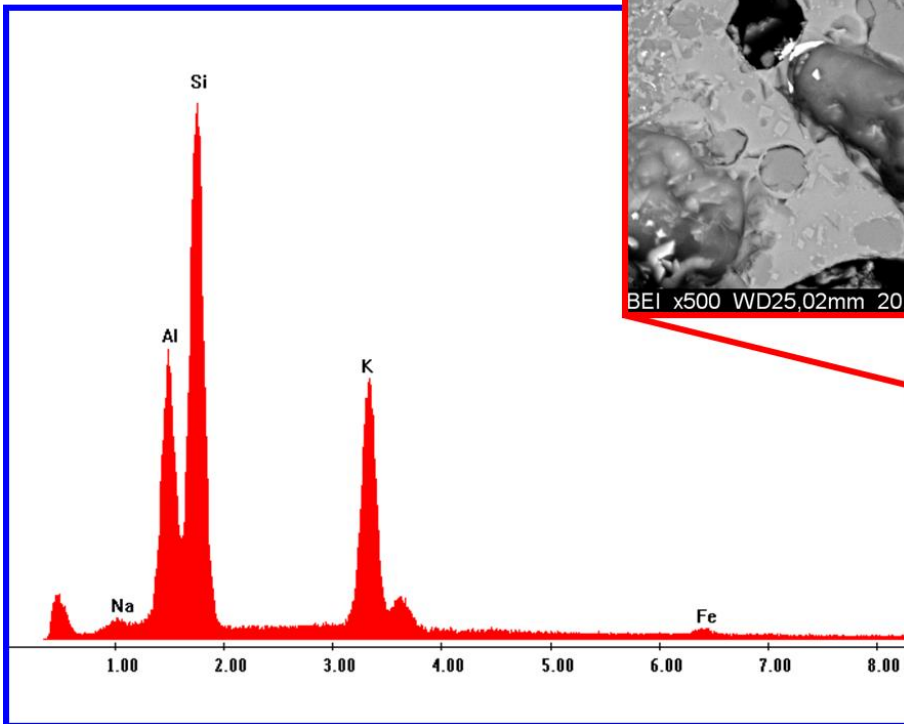
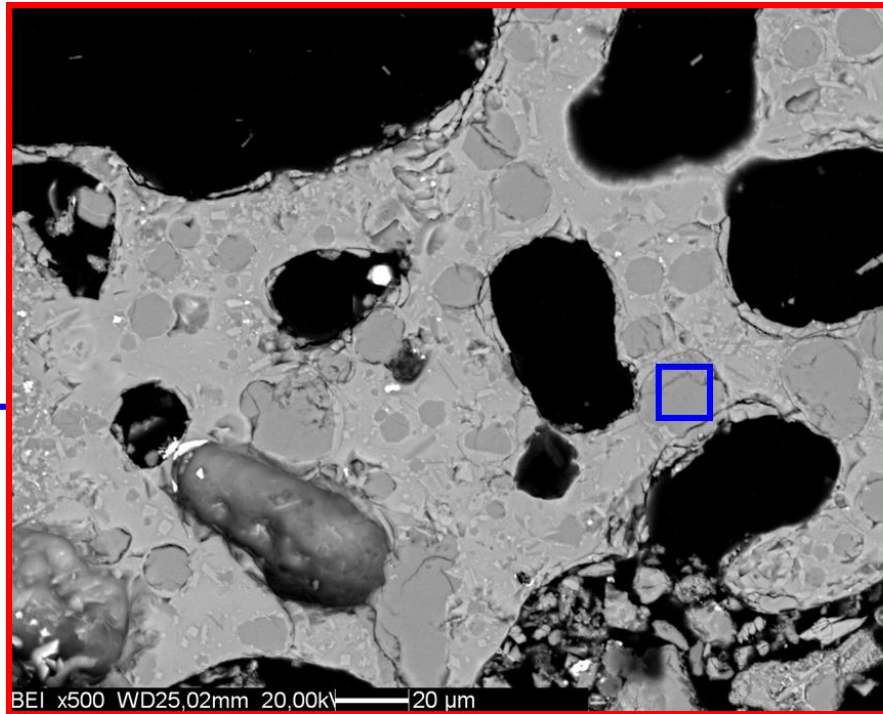
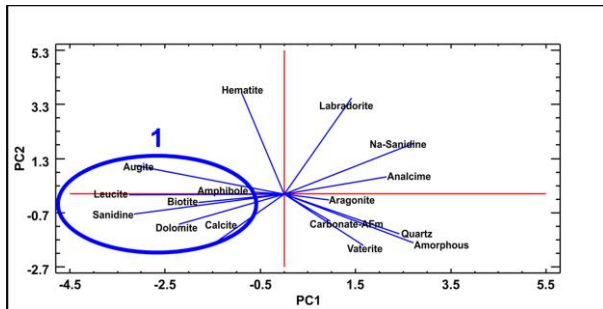
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Materials Properties, Use and Conservation:  
Construction Materials and Binders



# Structural binders in Pompeii





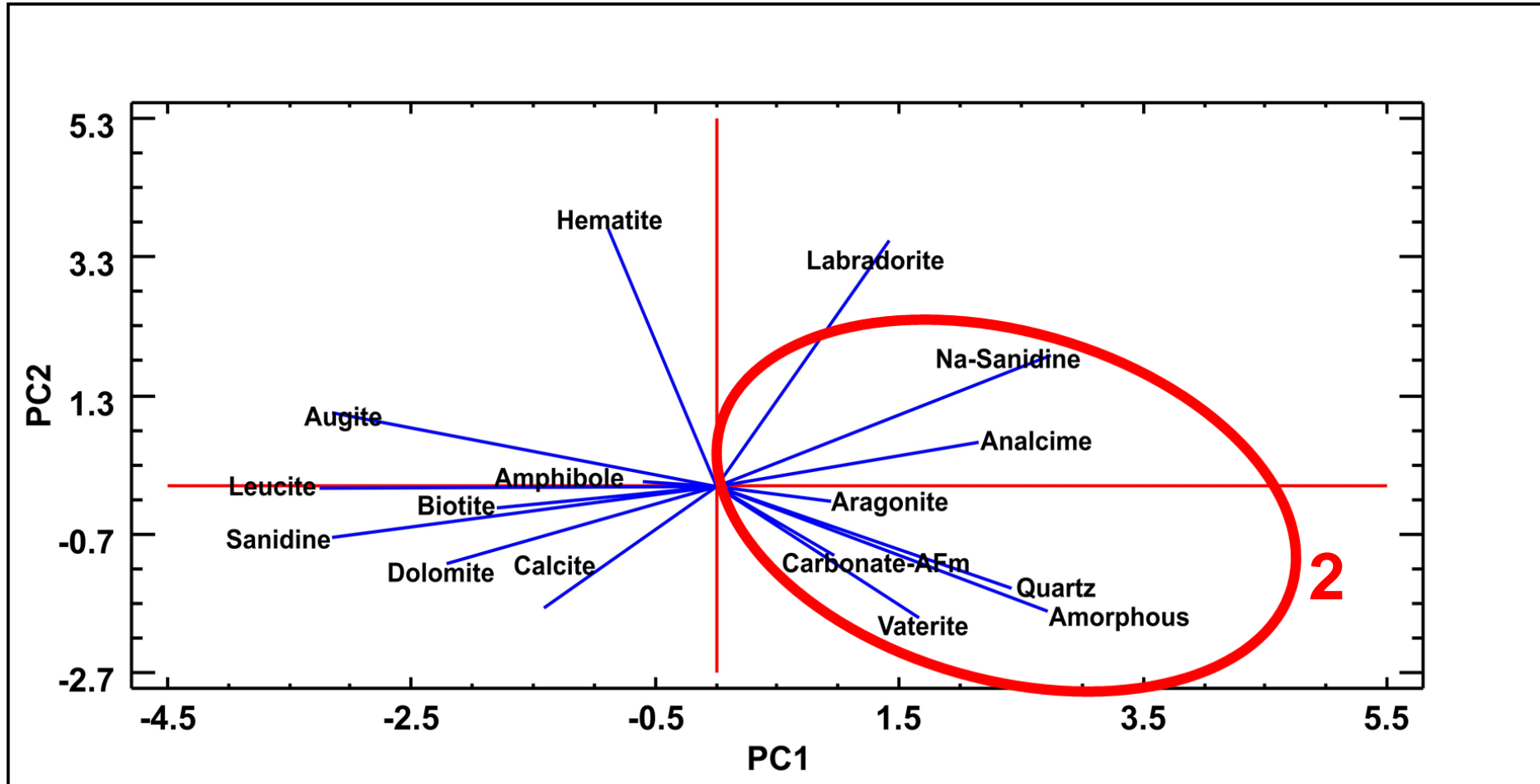
# Structural binders in Pompeii



**Vesuvian  
ultrapotassic  
products of  
the 79 AD  
eruption and  
younger  
ones**

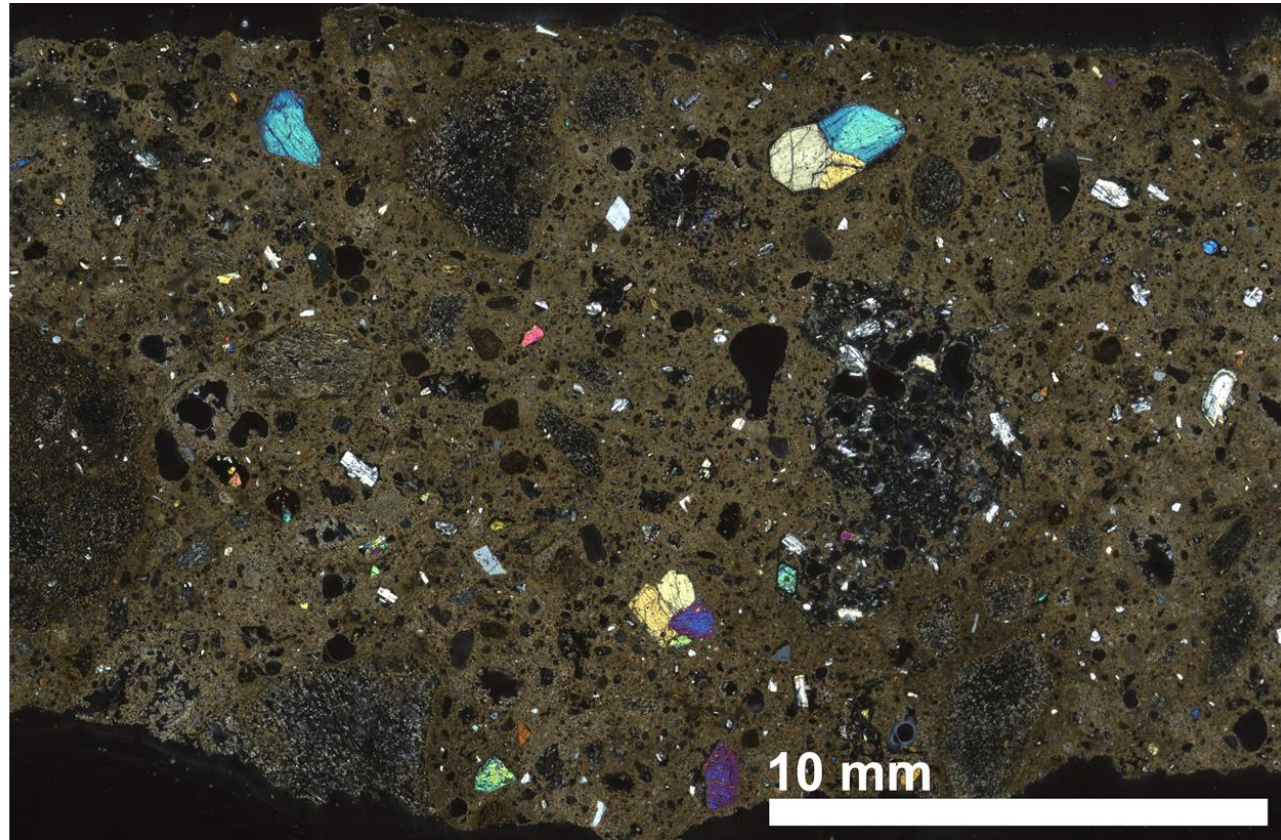
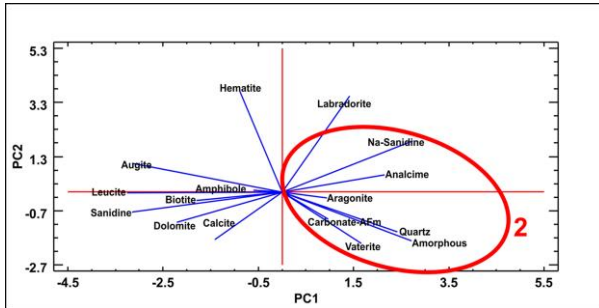
# Structural binders in Pompeii

## Principal Component Analysis (PCA)



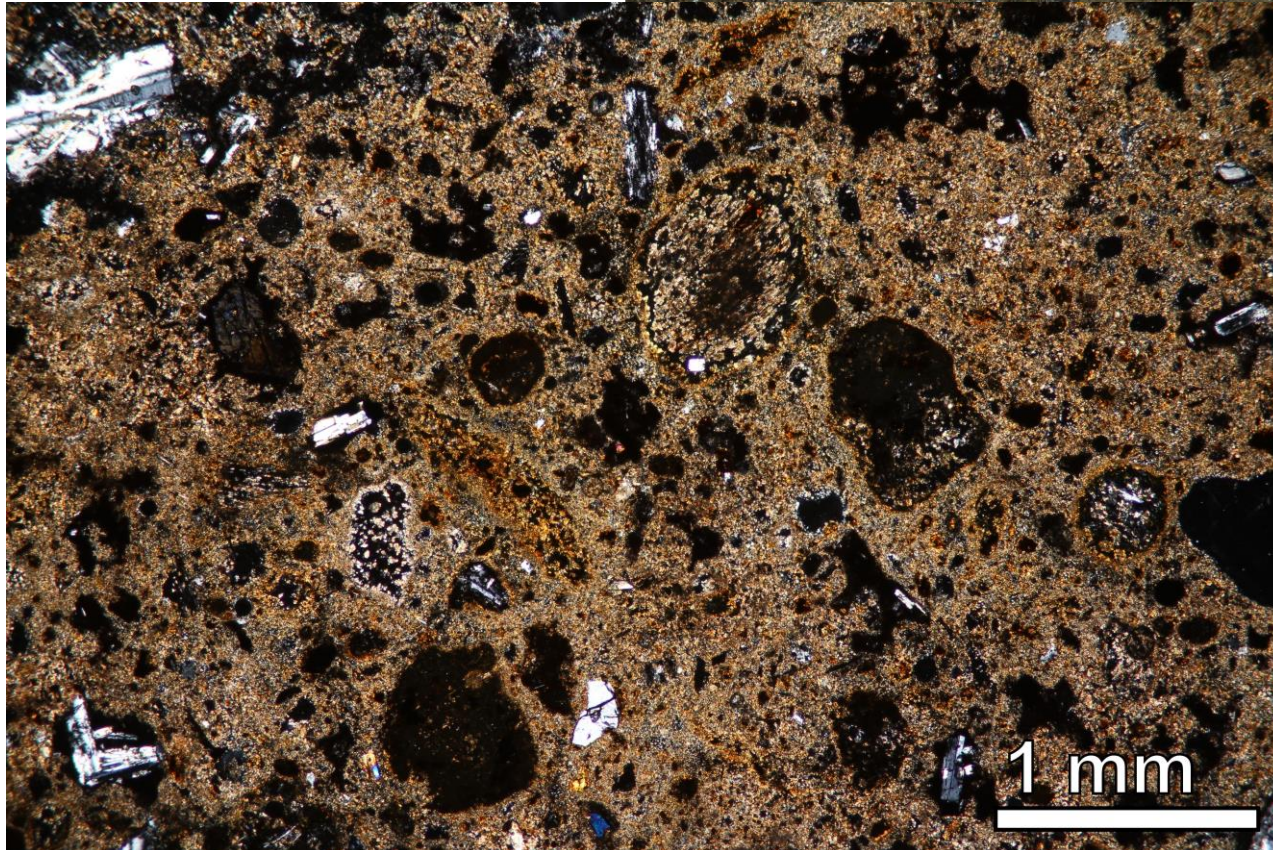
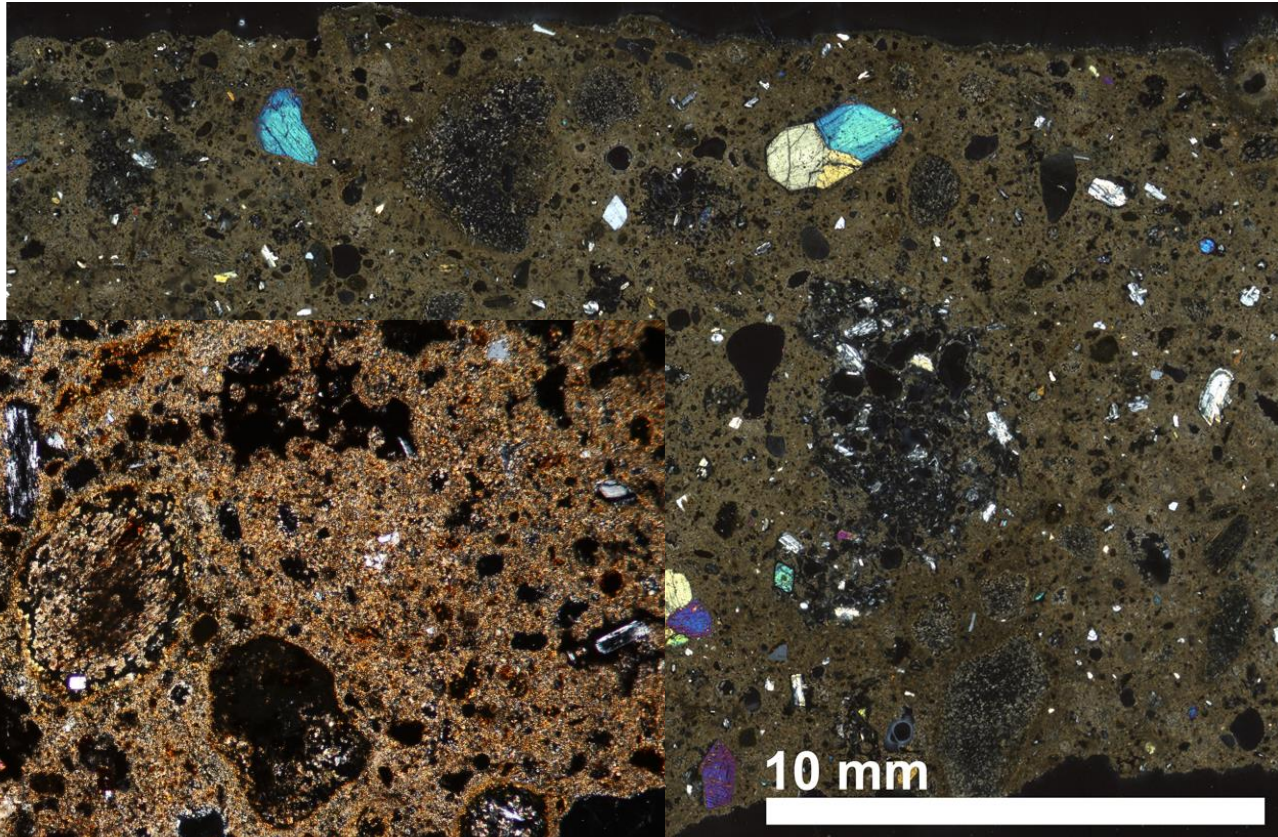
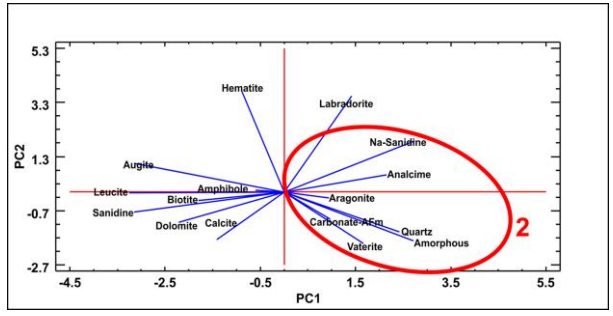


# Structural binders in Pompeii



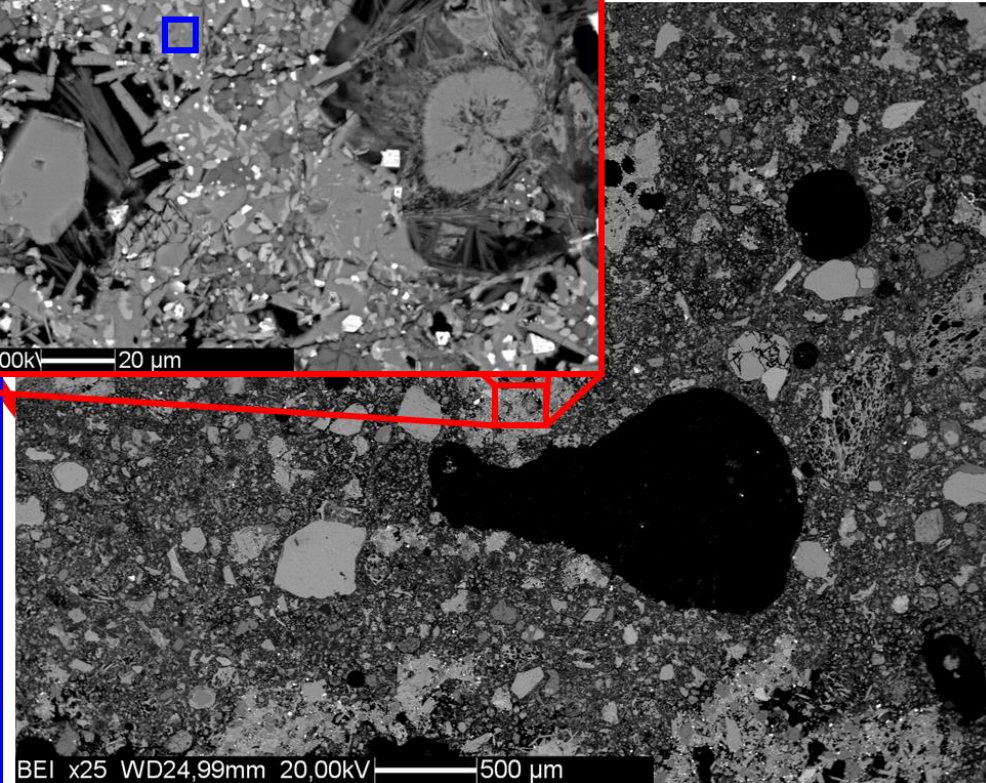
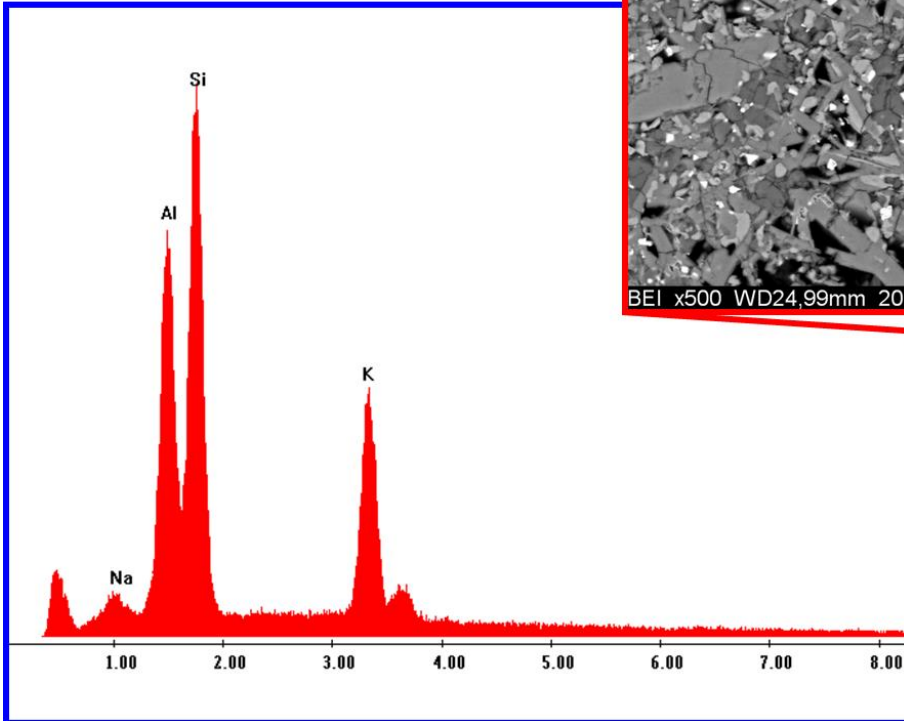
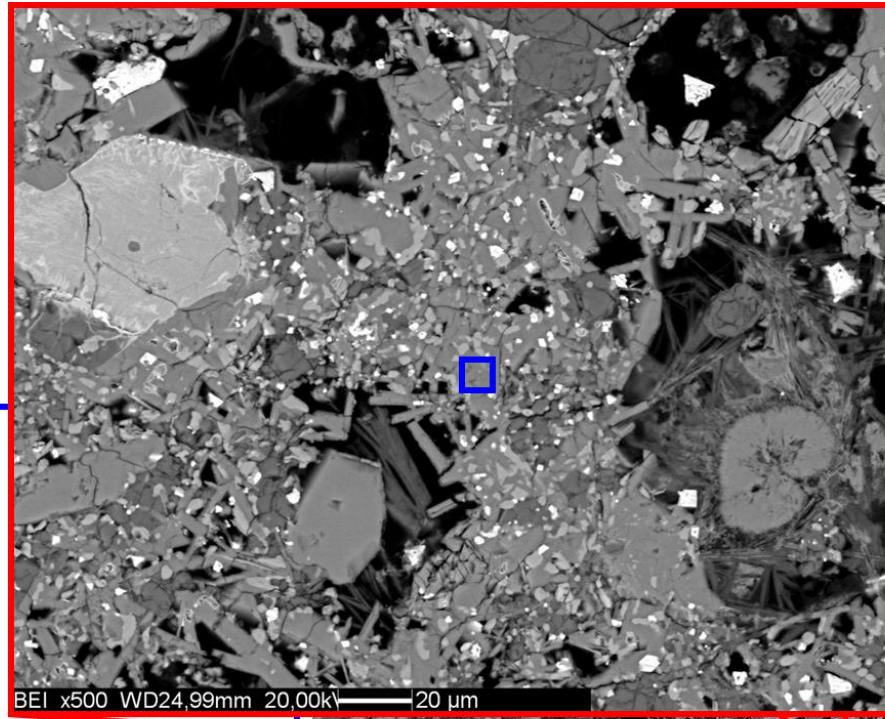
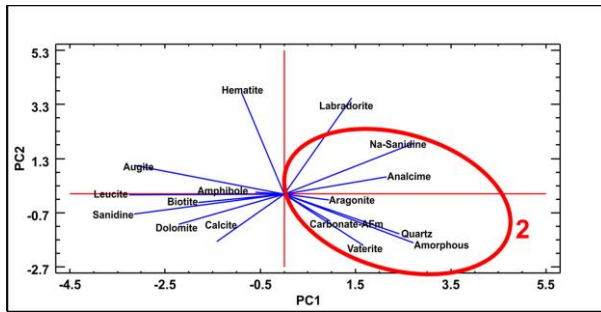


# Structural binders in Pompeii





# Structural binders in Pompeii



# Structural binders in Pompeii

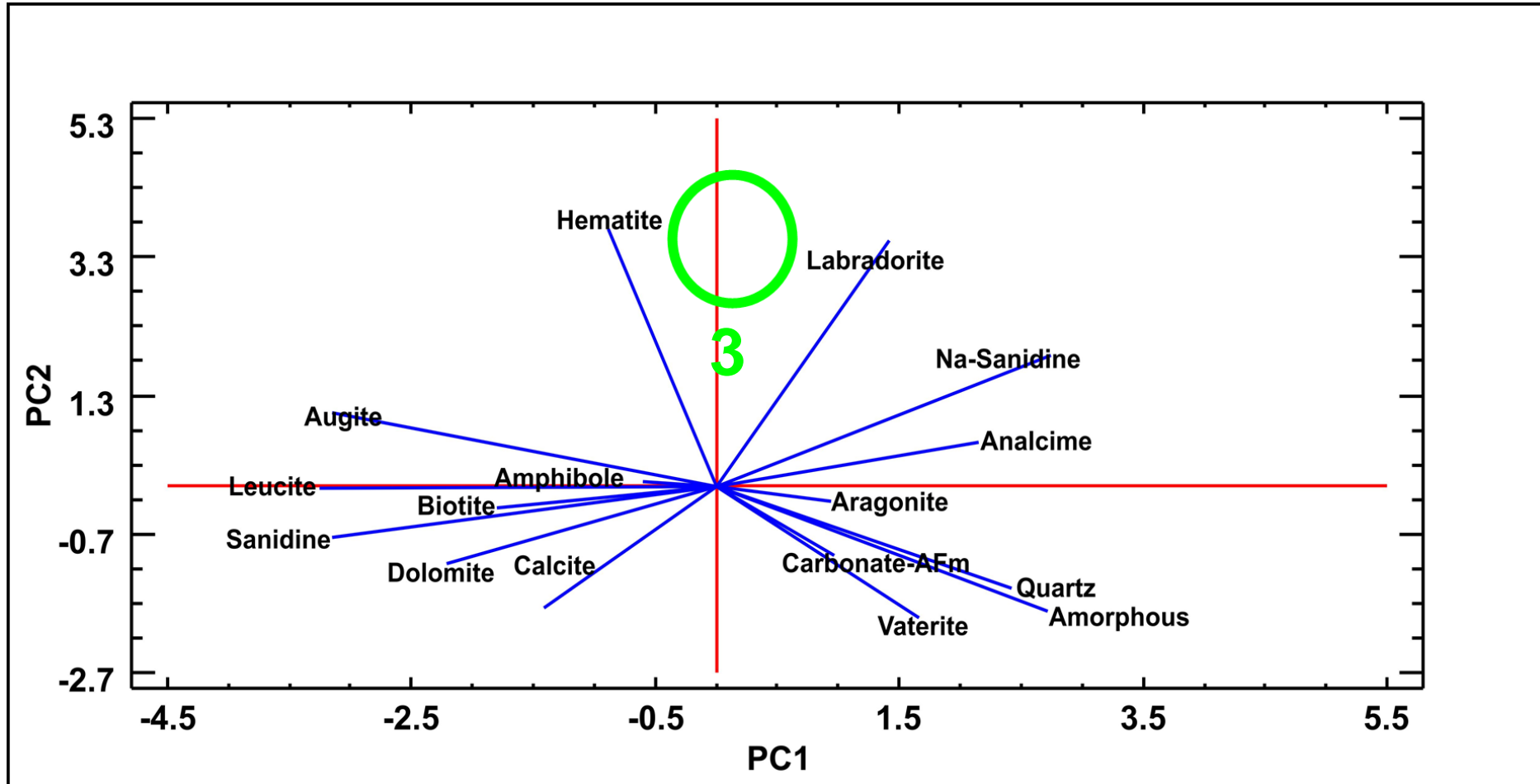
**Volcanic  
tephra of the  
main  
Phlegrean  
eruptive  
phases  
(Campanian  
Ignimbrite +  
Neapolitan  
Yellow Tuff +  
Post  
Neapolitan  
Yellow Tuff)**



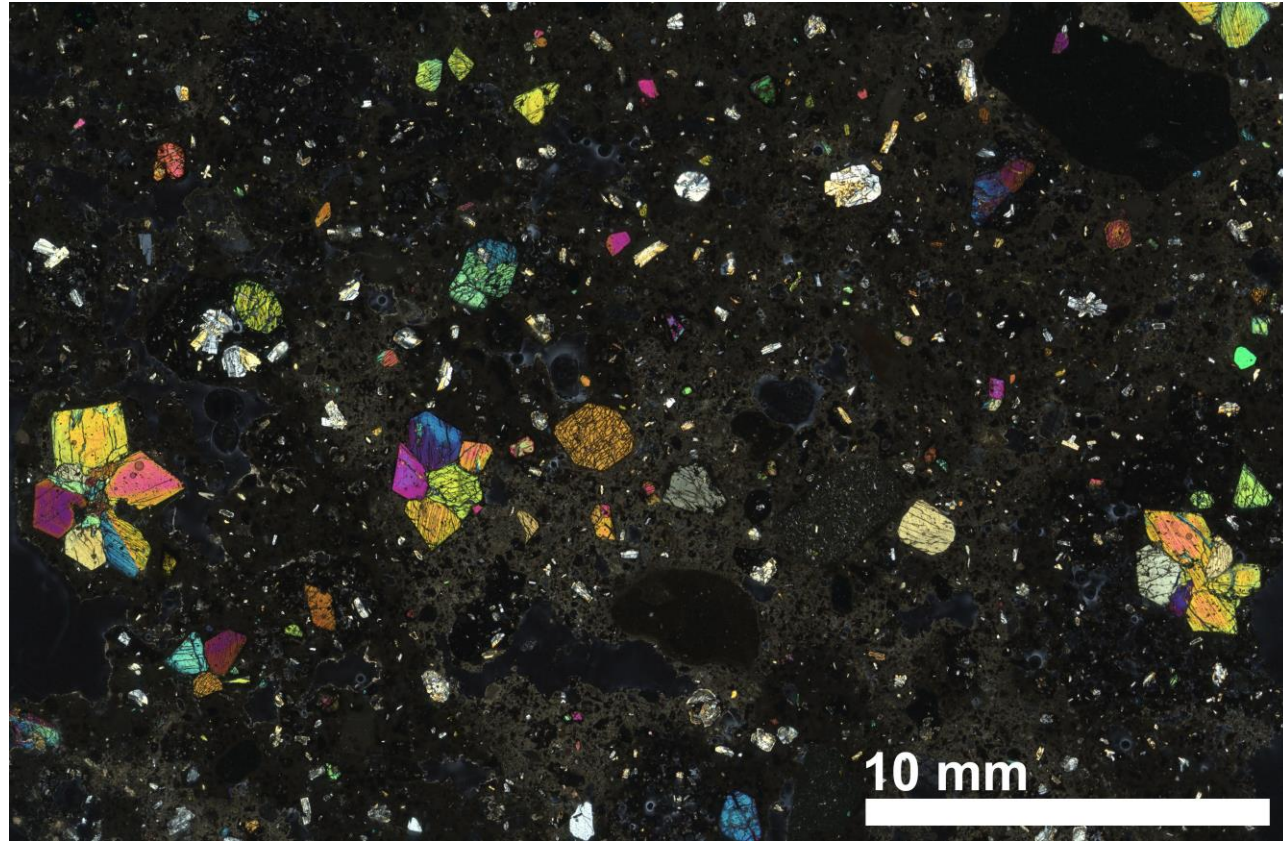
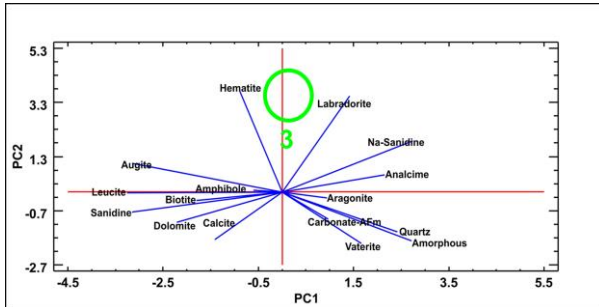


# Structural binders in Pompeii

## Principal Component Analysis (PCA)

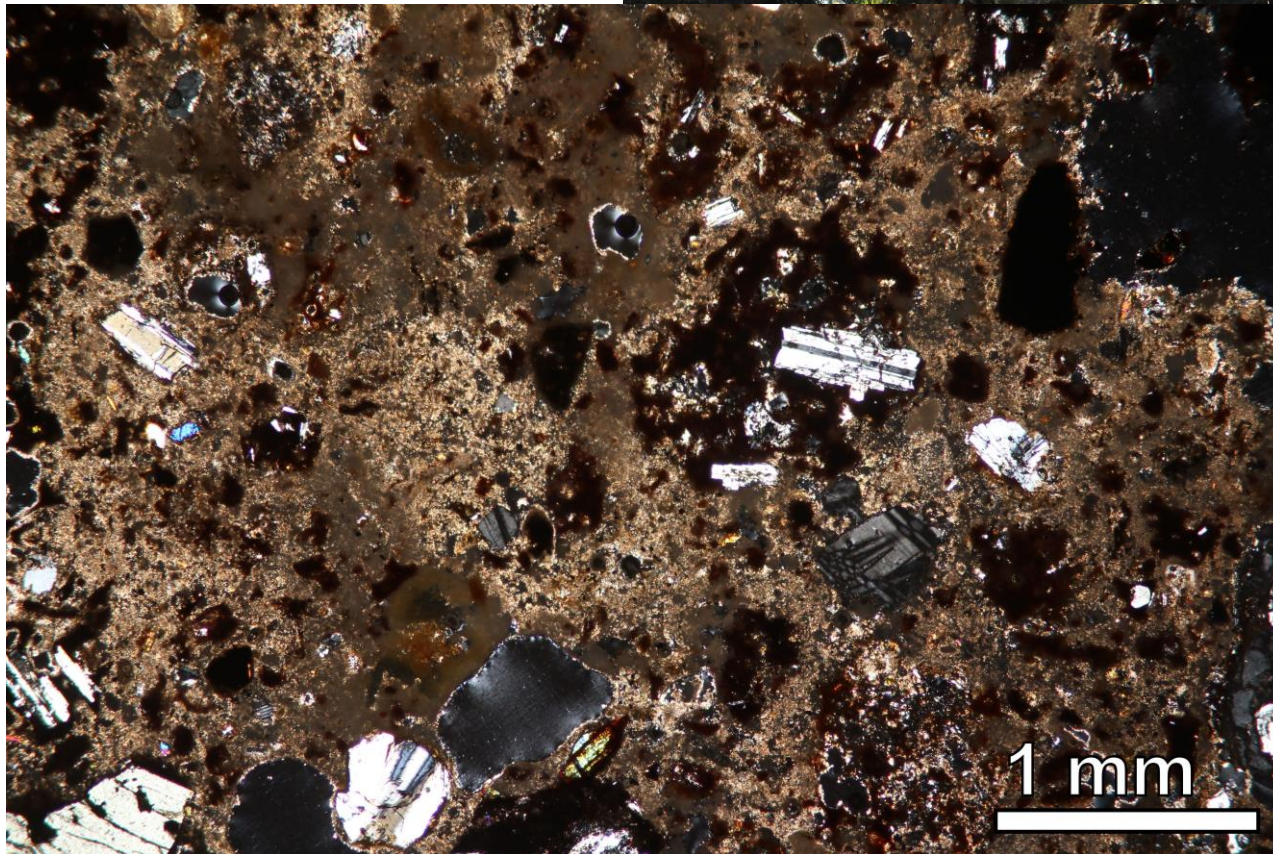
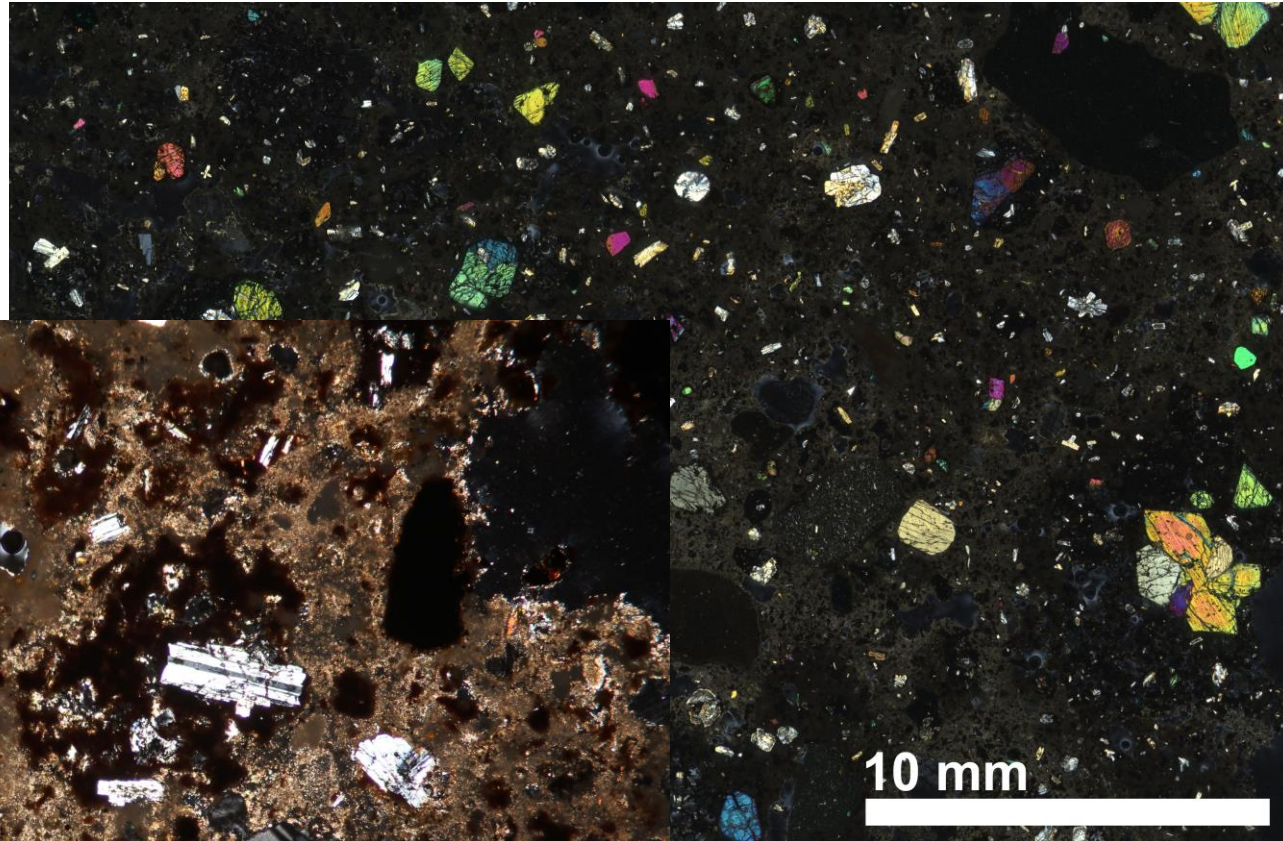
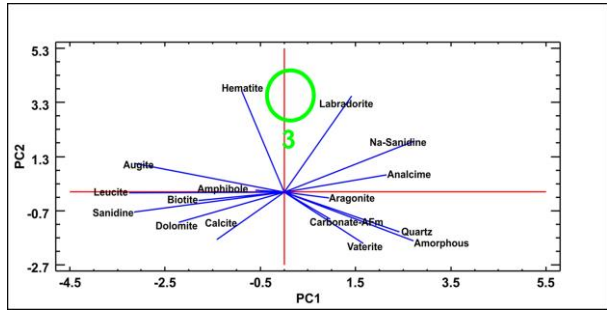


# Structural binders in Pompeii





# Structural binders in Pompeii



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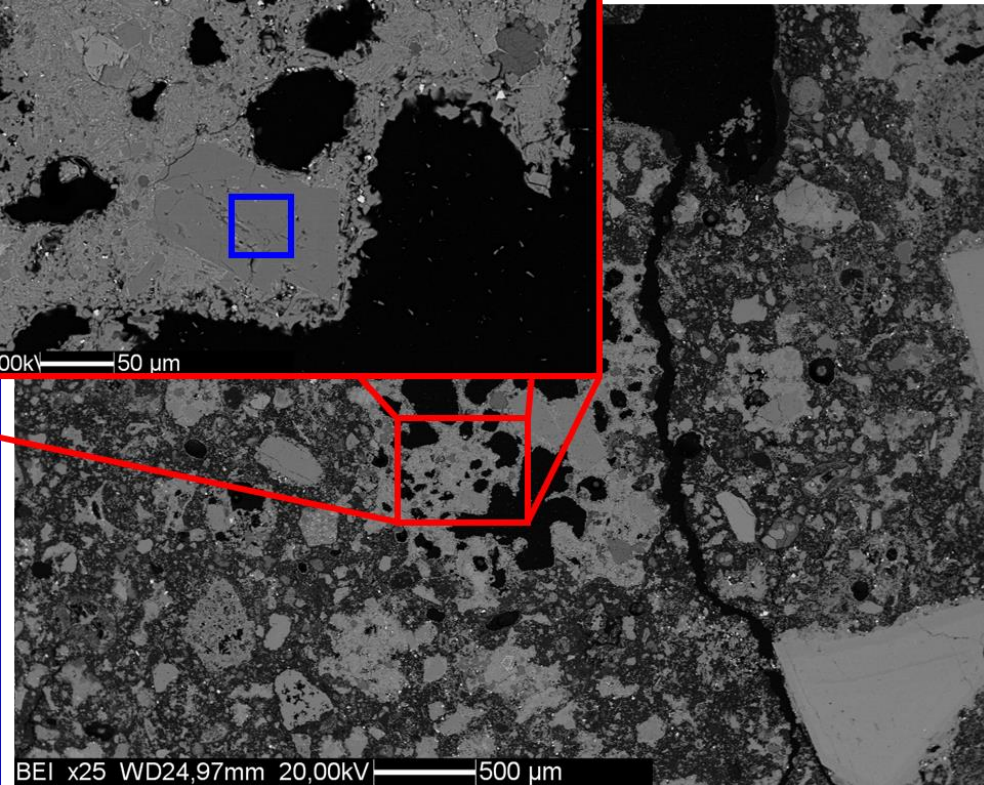
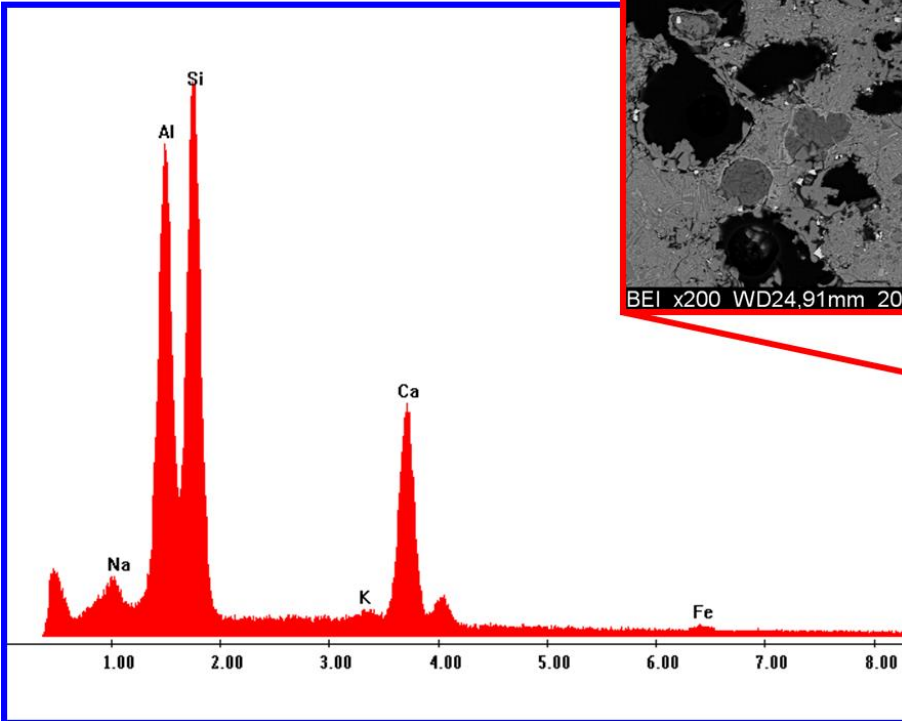
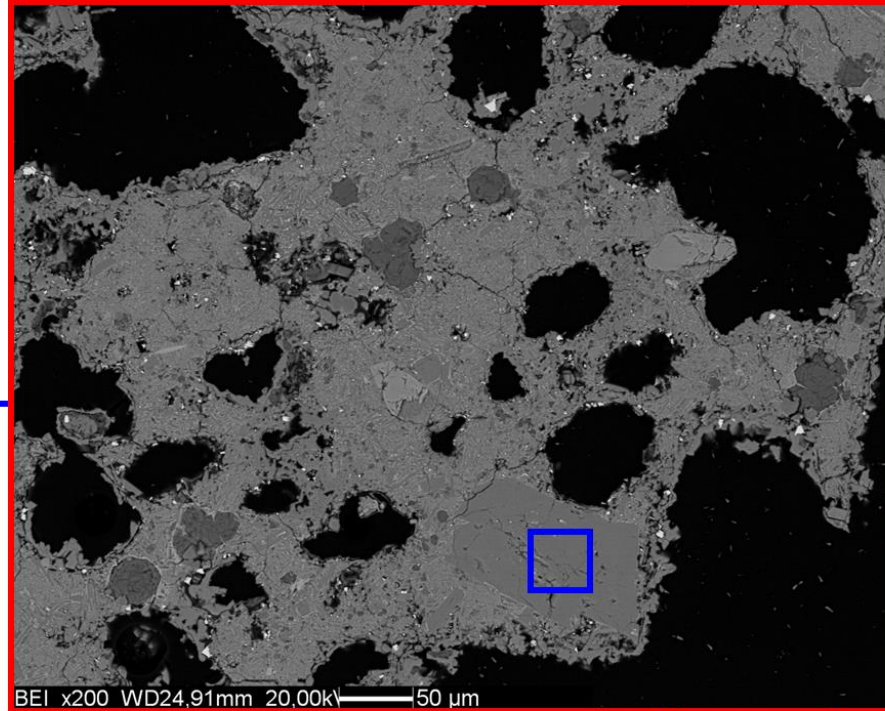
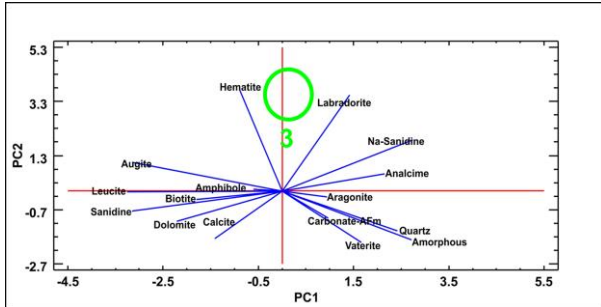
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# Structural binders in Pompeii





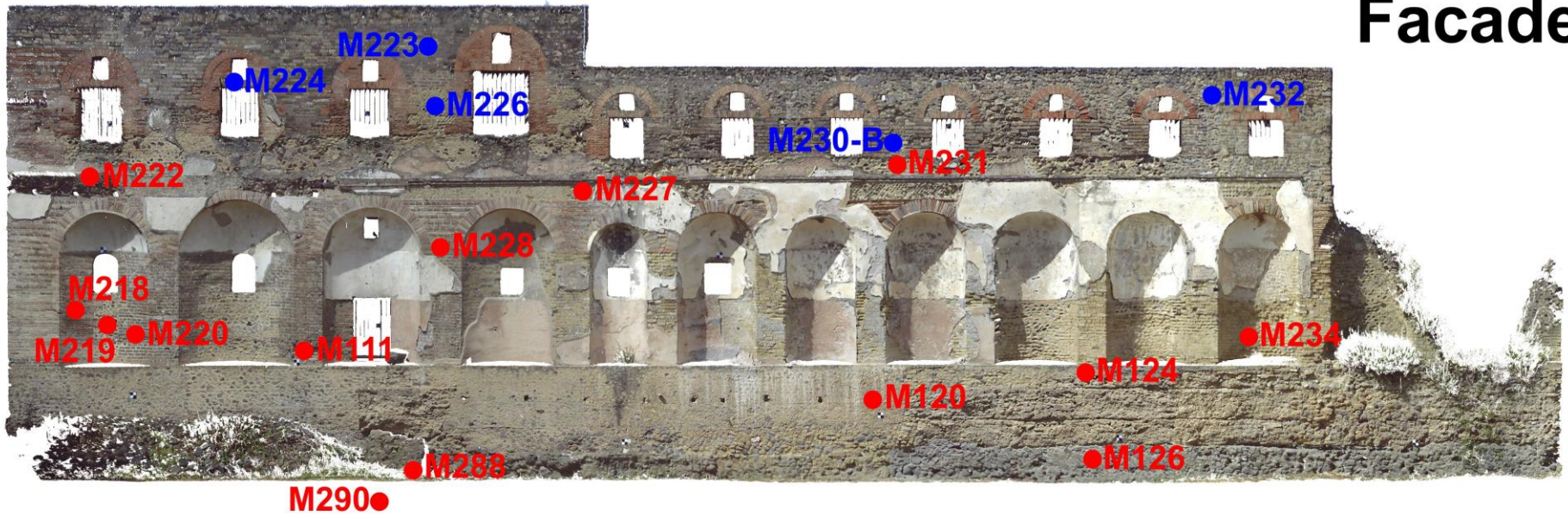
# Structural binders in Pompeii



**Phonolitic  
tephrite of  
the Somma-  
Vesuvio  
eruptive unit  
(foam lava)**

# Structural binders in Pompeii

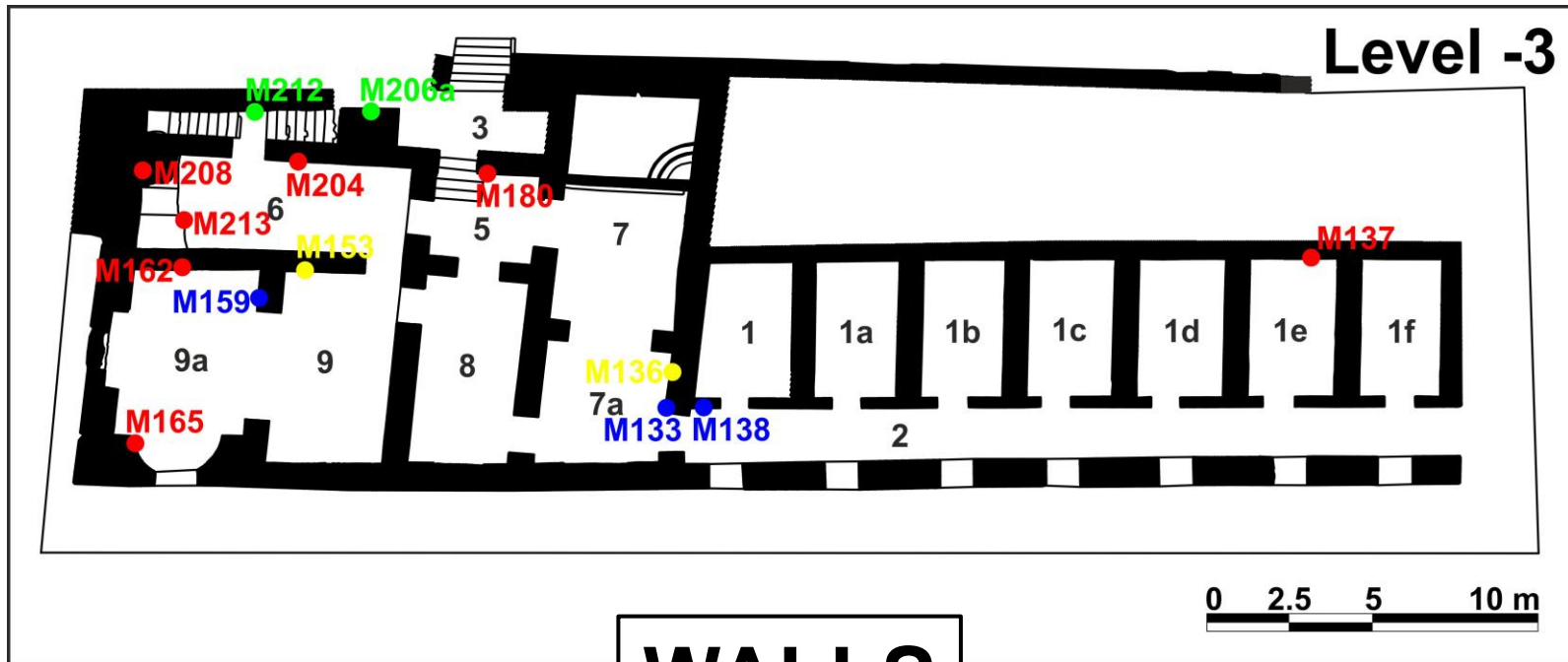
Facade



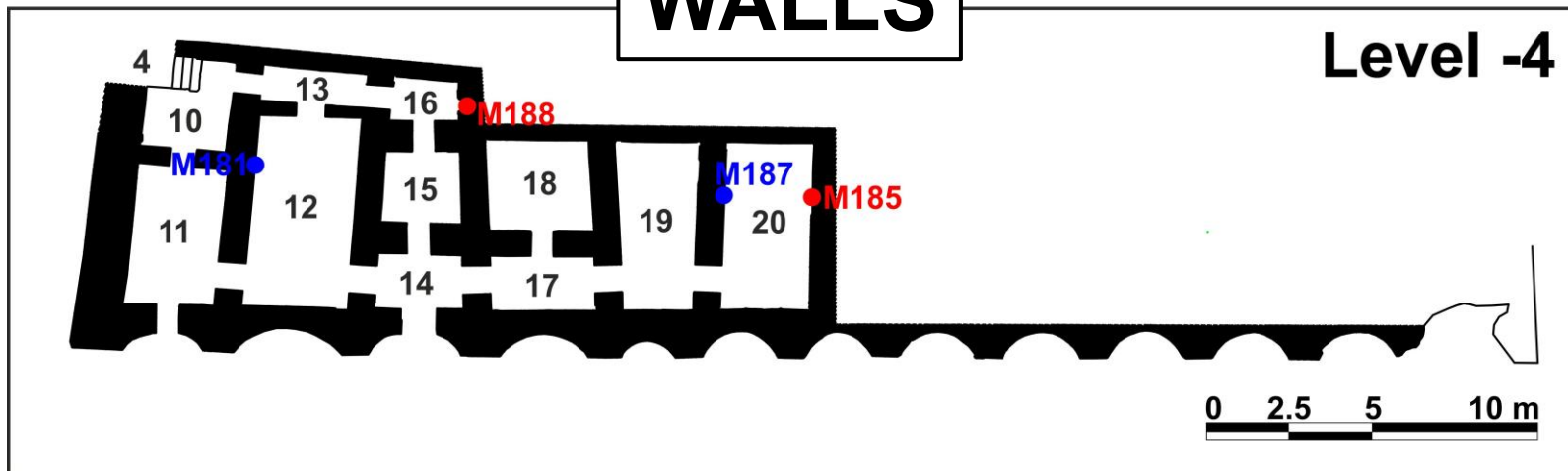
0 2.5 5 10 m



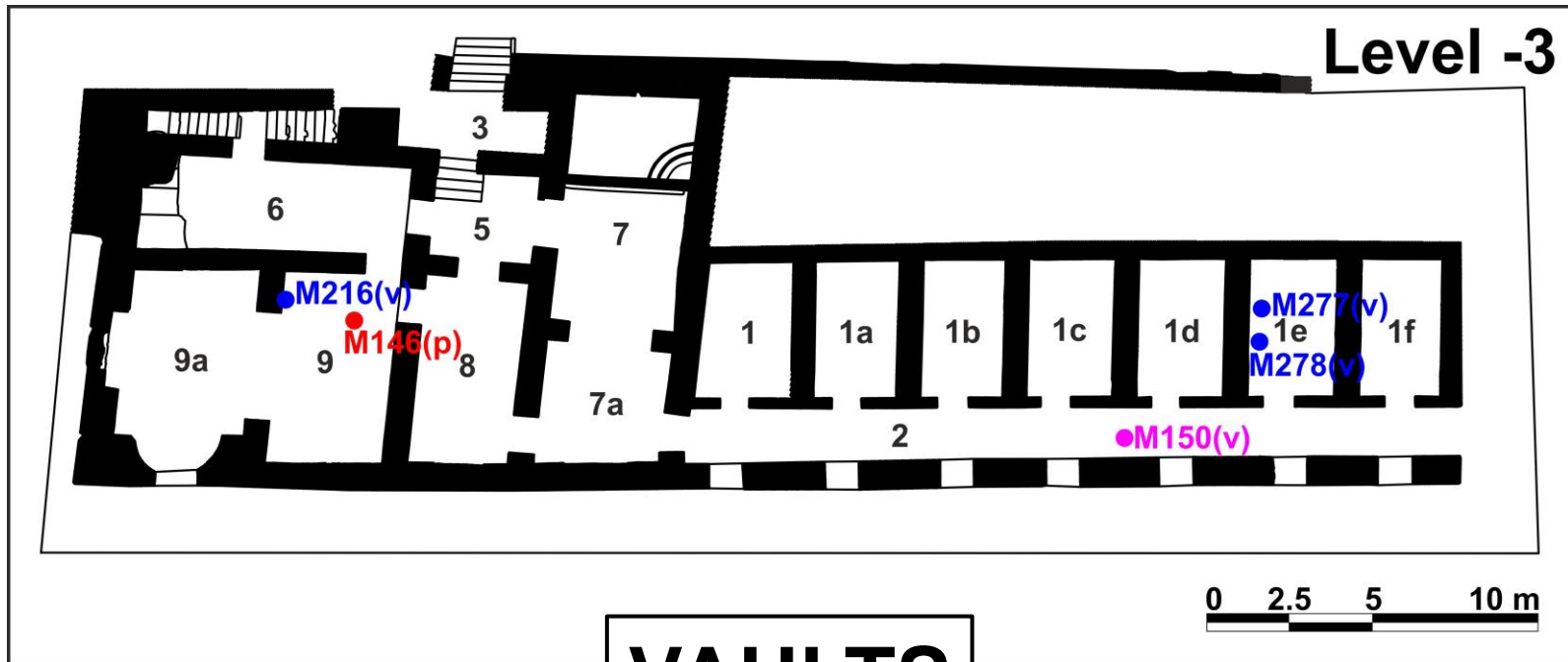
# Structural binders in Pompeii



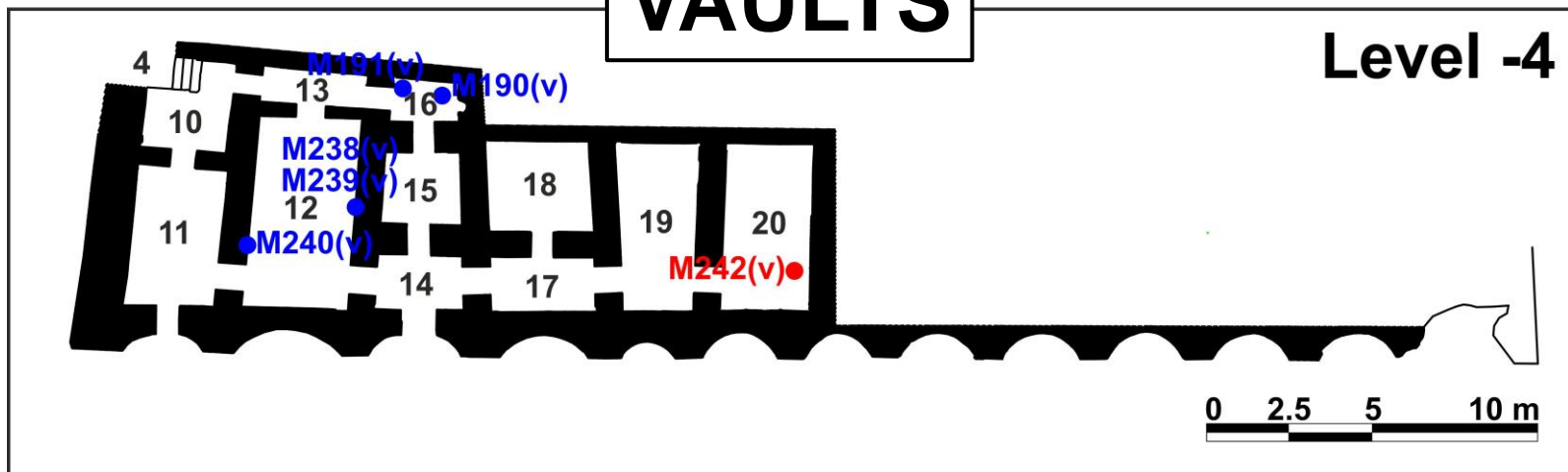
## WALLS



# Structural binders in Pompeii



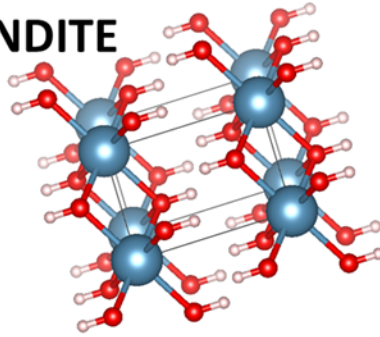
## VAULTS



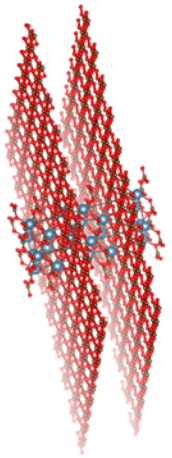


# Structural binders in Pompeii

**PORTLANDITE**



**CALCITE**



$\text{CO}_2$

$\text{H}_2\text{O}$

pH > 12

**AERIAL REACTION**

$\text{CO}_2$

$\text{H}_2\text{O}$

pH > 12

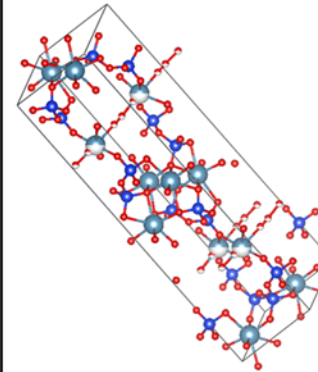
**POZZOLANIC REACTION**

$\text{SiO}_2$

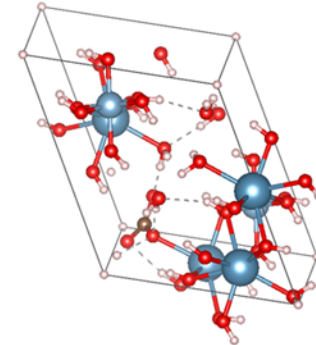
$\text{Fe}_2\text{O}_3$

$\text{Al}_2\text{O}_3$

**C-S-H**



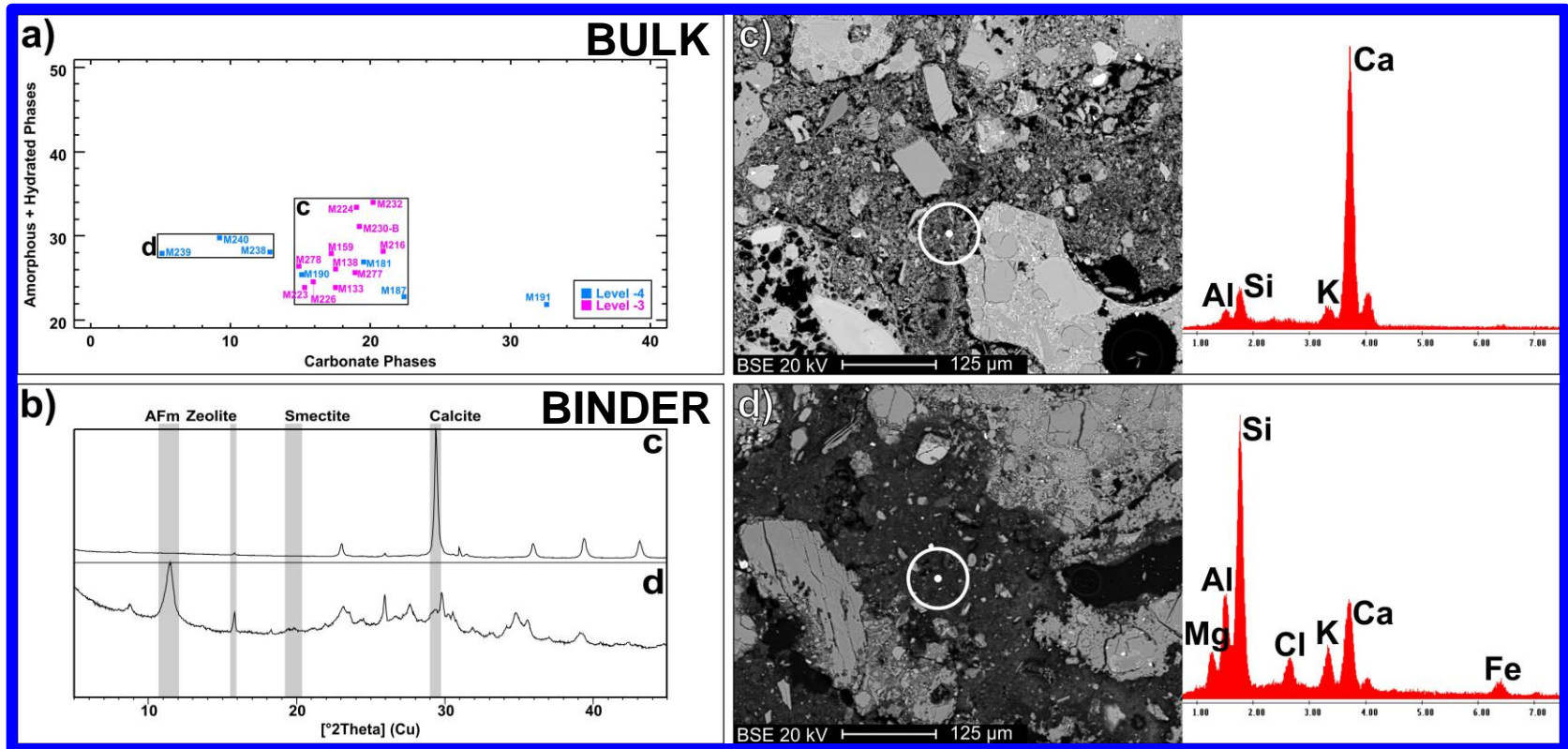
**AFm**



# Structural binders in Pompeii

B  
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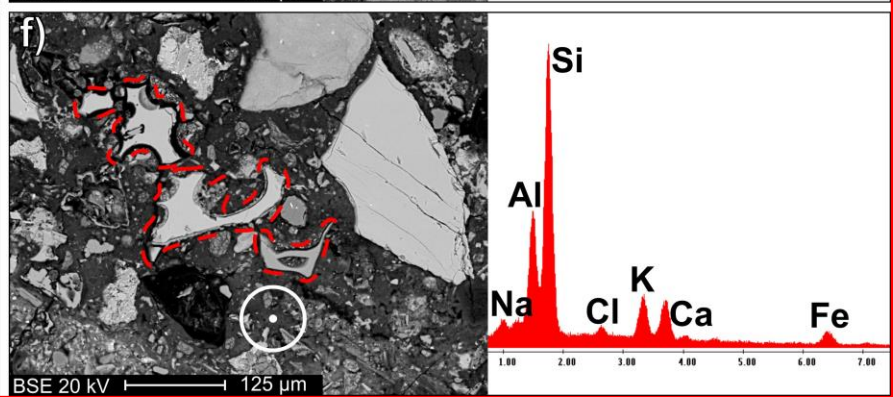
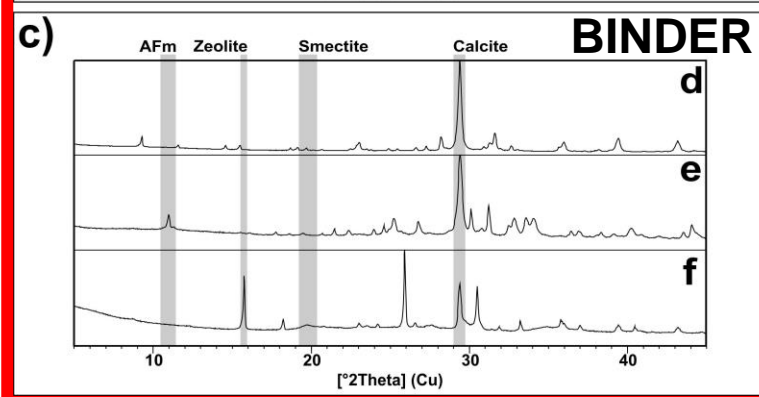
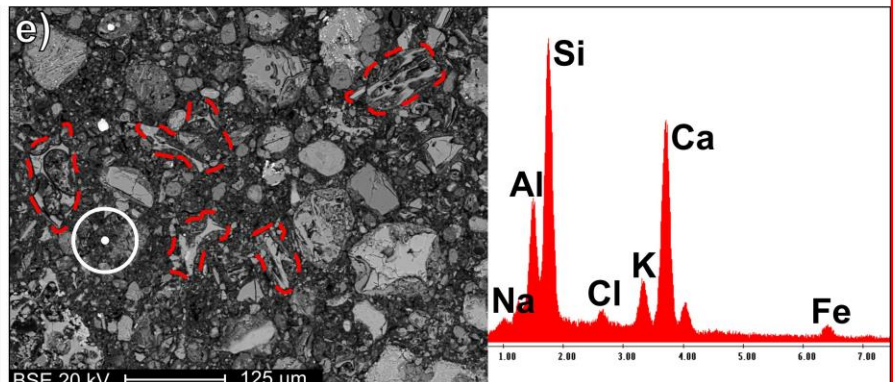
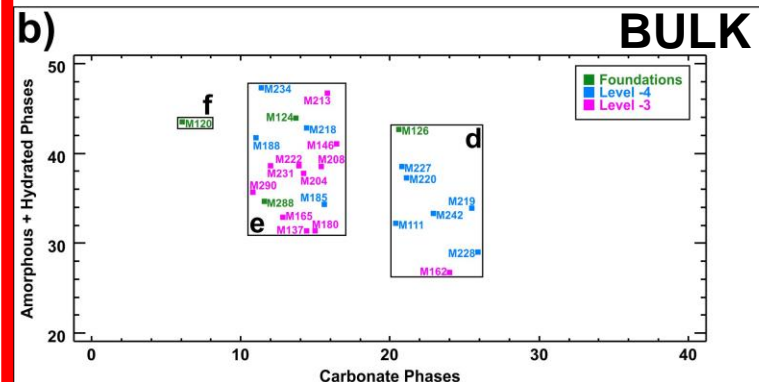
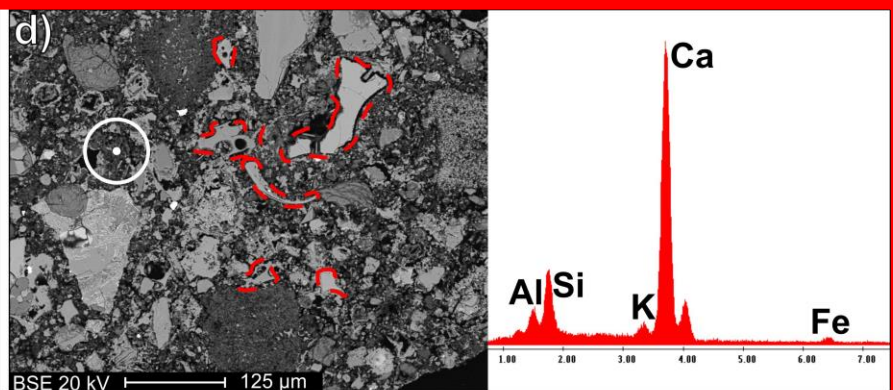
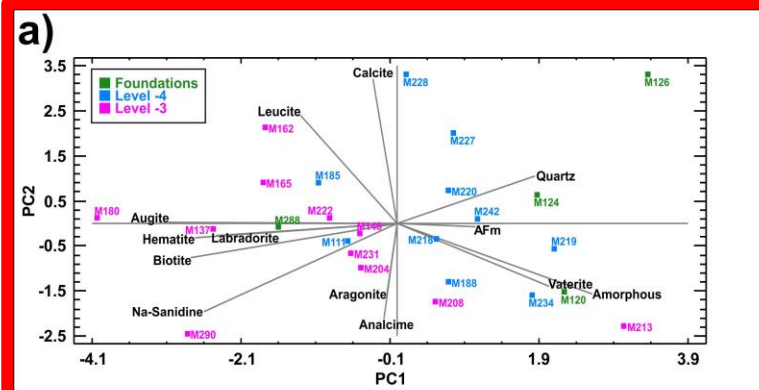




# Structural binders in Pompeii

BINDER PROPERTIES

GROUP 2



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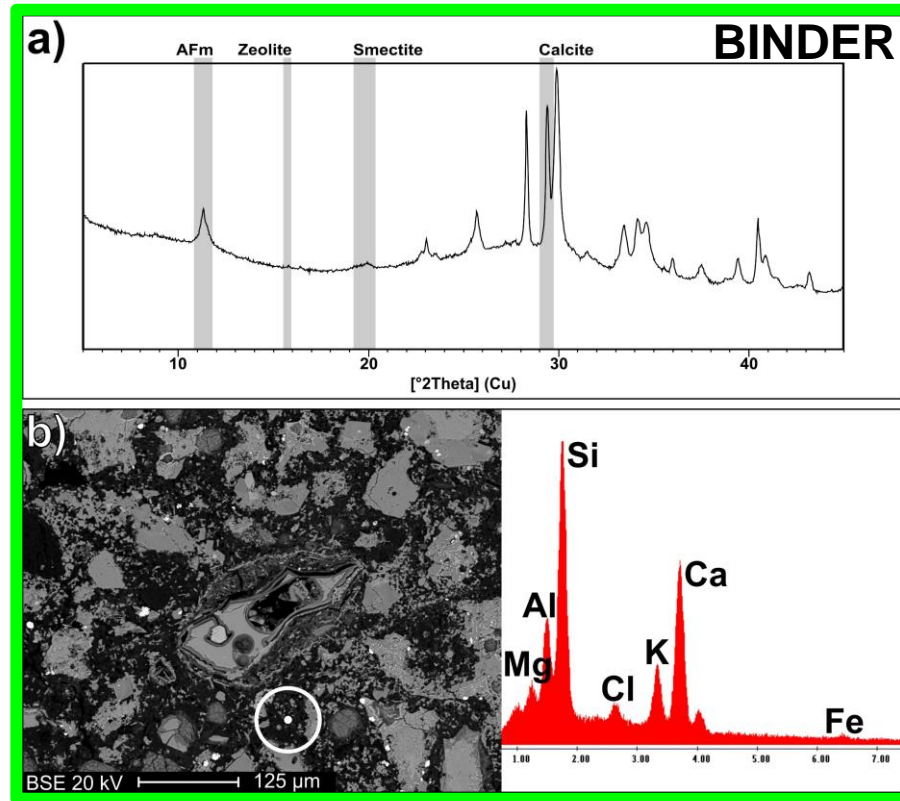
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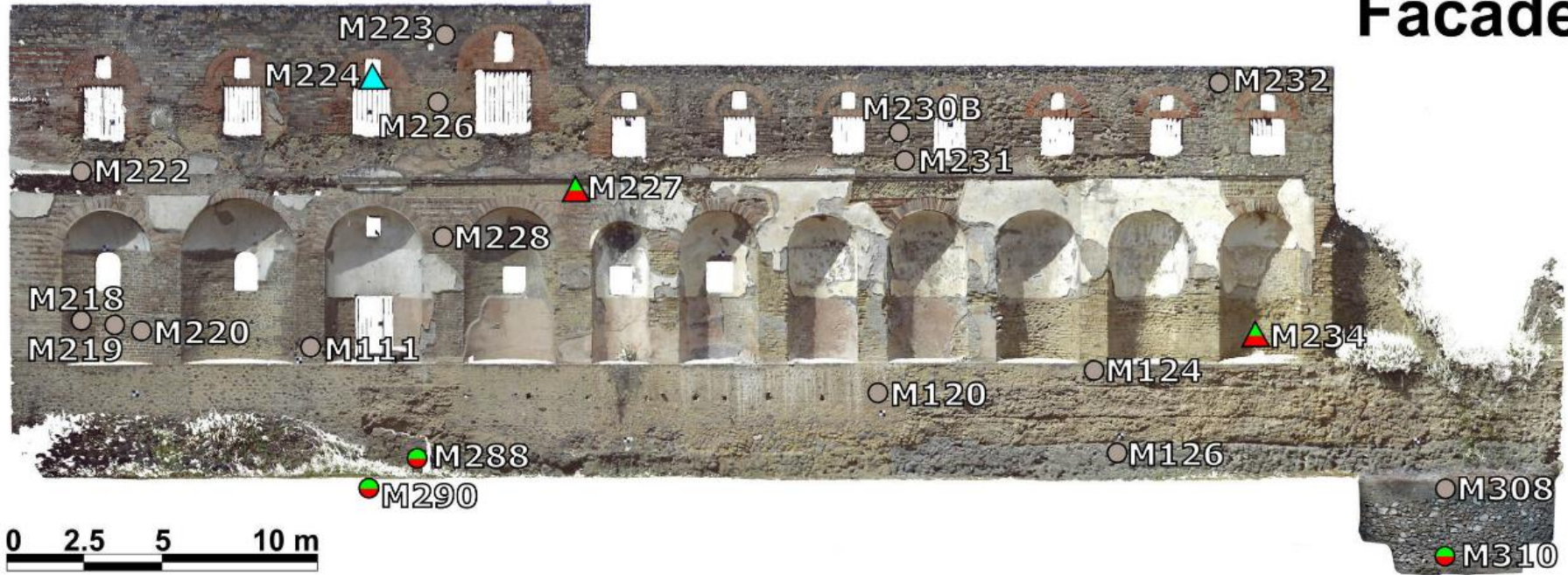
# Structural binders in Pompeii





# Structural binders in Pompeii

Facade



- Pre-Imperial Age
- Imperial Age
- Roman Age
- ▲ Roman Age (uncertain)
- ▲ Modern Restoration
- ▲ Modern Rest. (uncertain)
- N.D.



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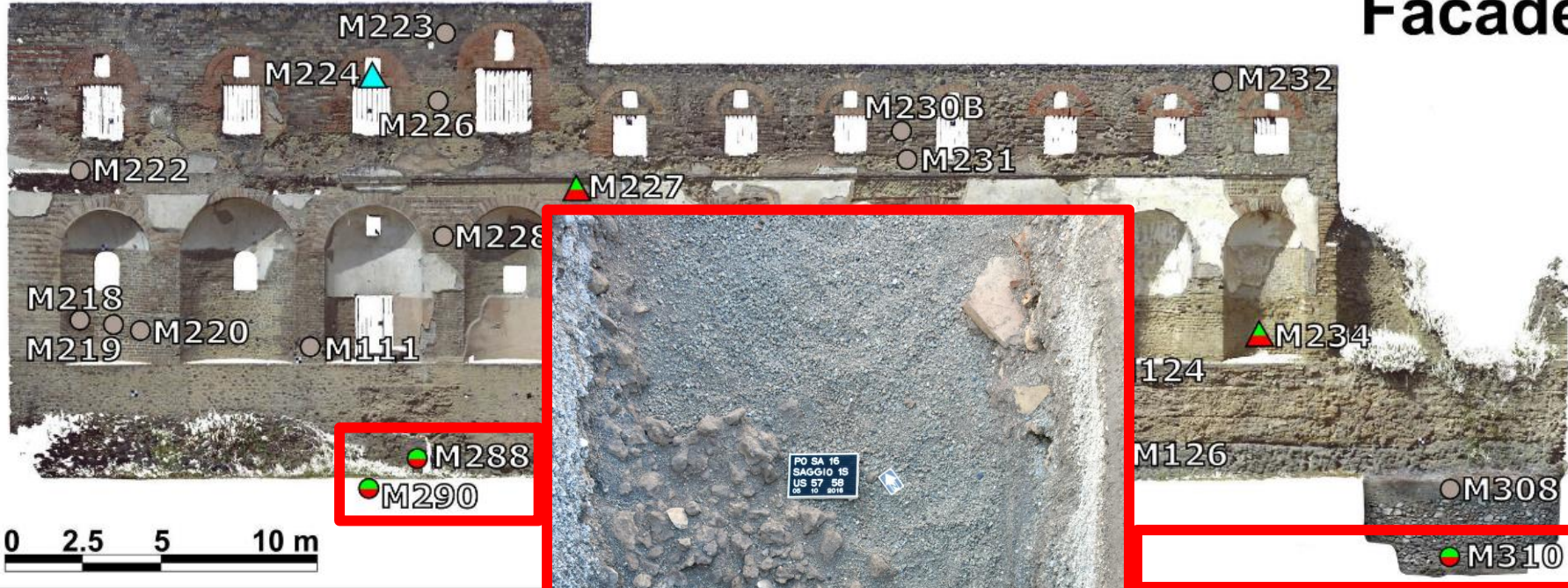
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# Structural binders in Pompeii

## Facade



M288  
M290

M234  
M126  
M308  
M310

- Pre-Imperial Age
- Imperial Age
- Roman Age
- ▲ Roman Age (uncertain)
- ▲ Modern Restoration
- ▲ Modern Rest. (uncertain)
- N.D.



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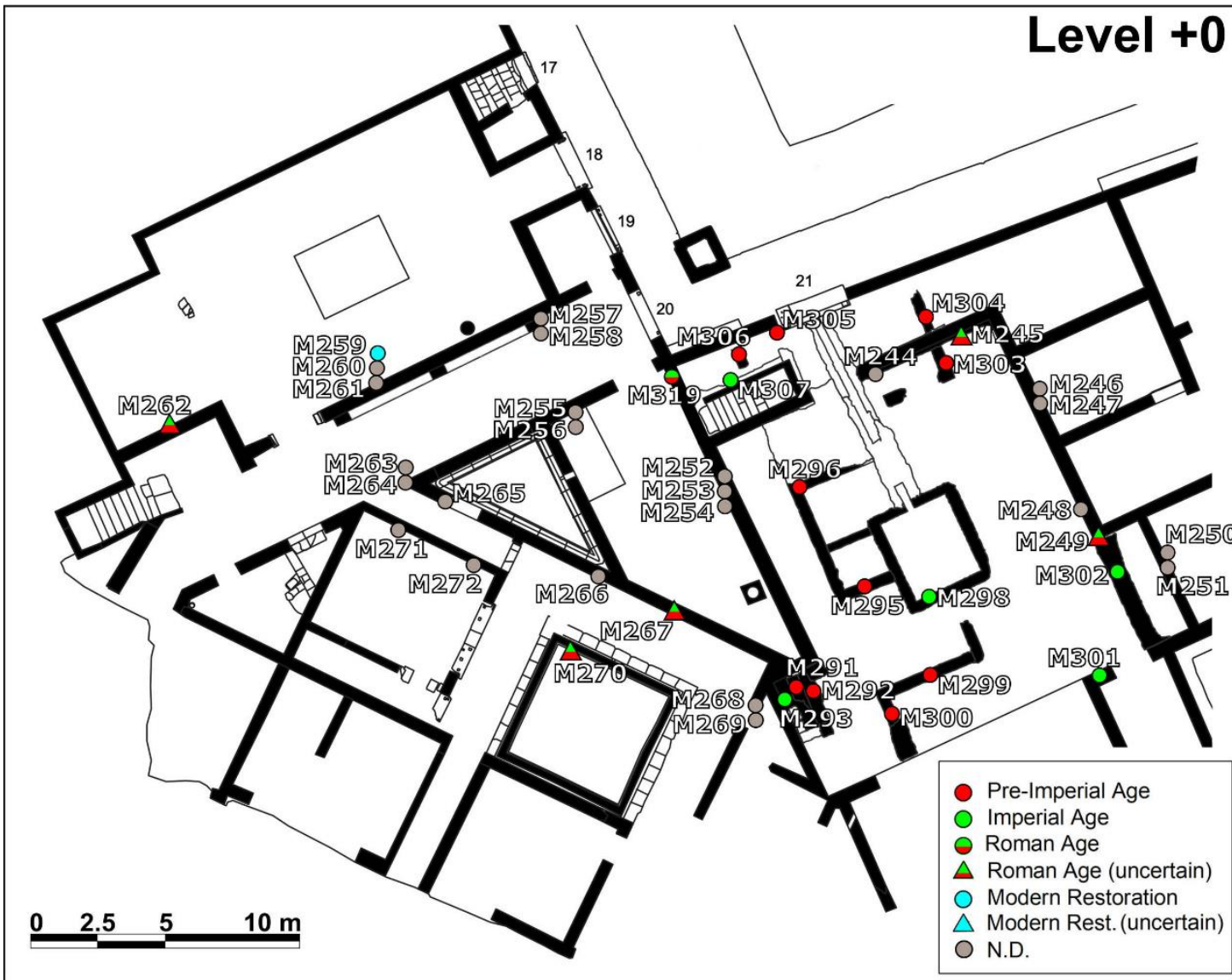


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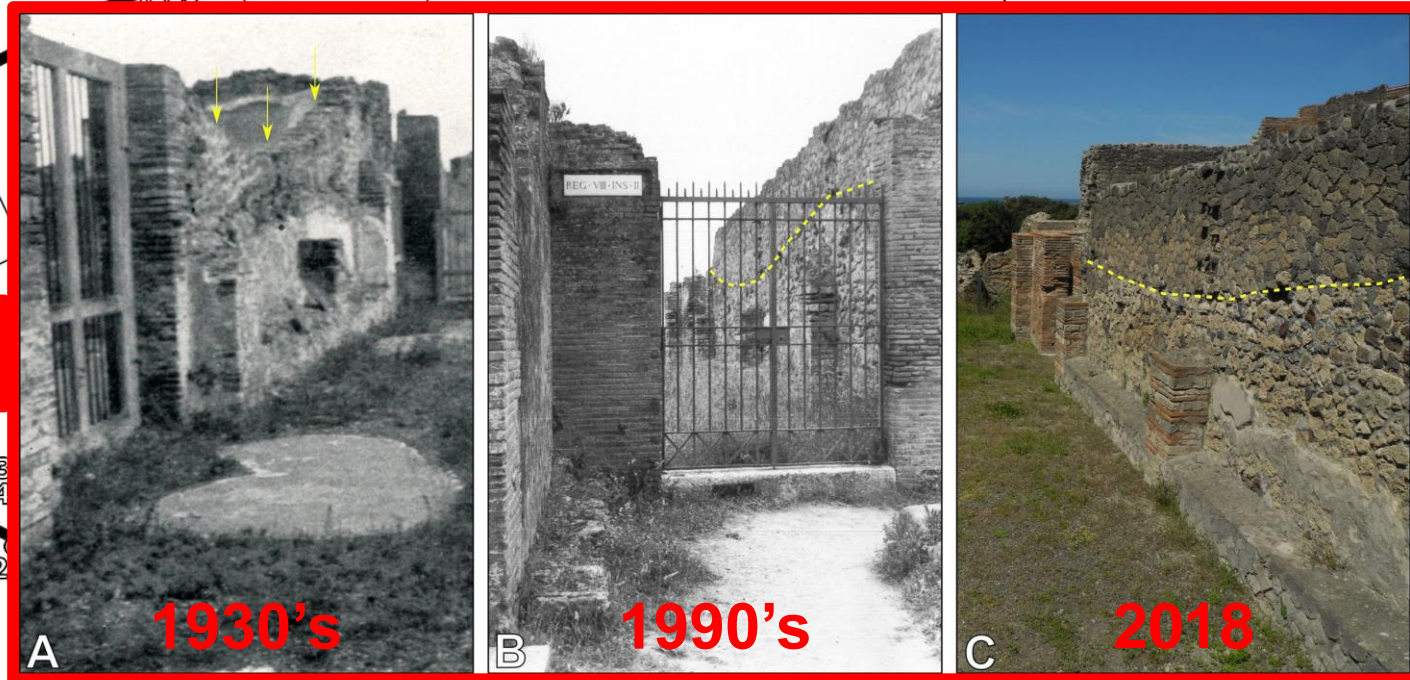


# Structural binders in Pompeii



# Structural binders in Pompeii

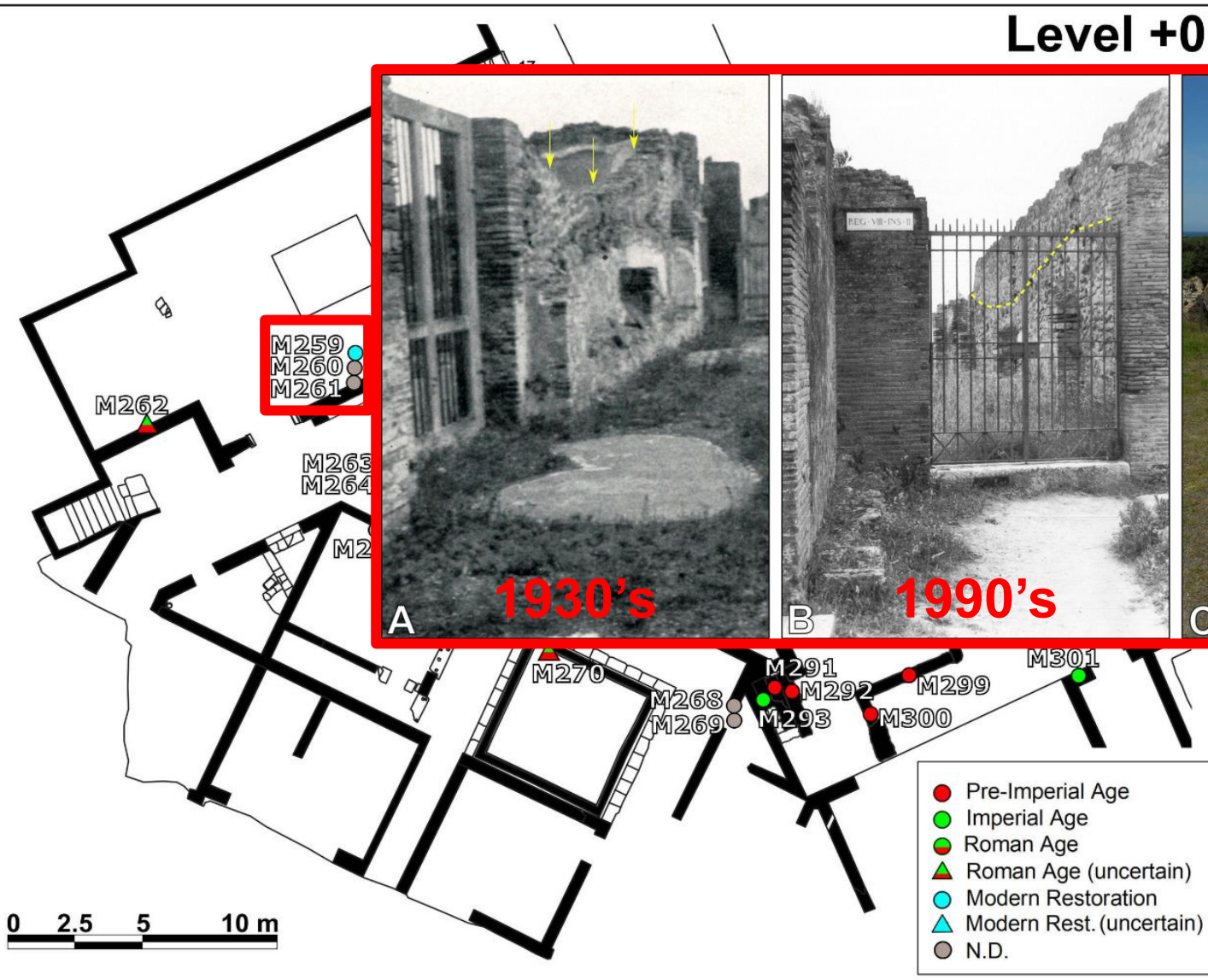
Level +0



1930's

1990's

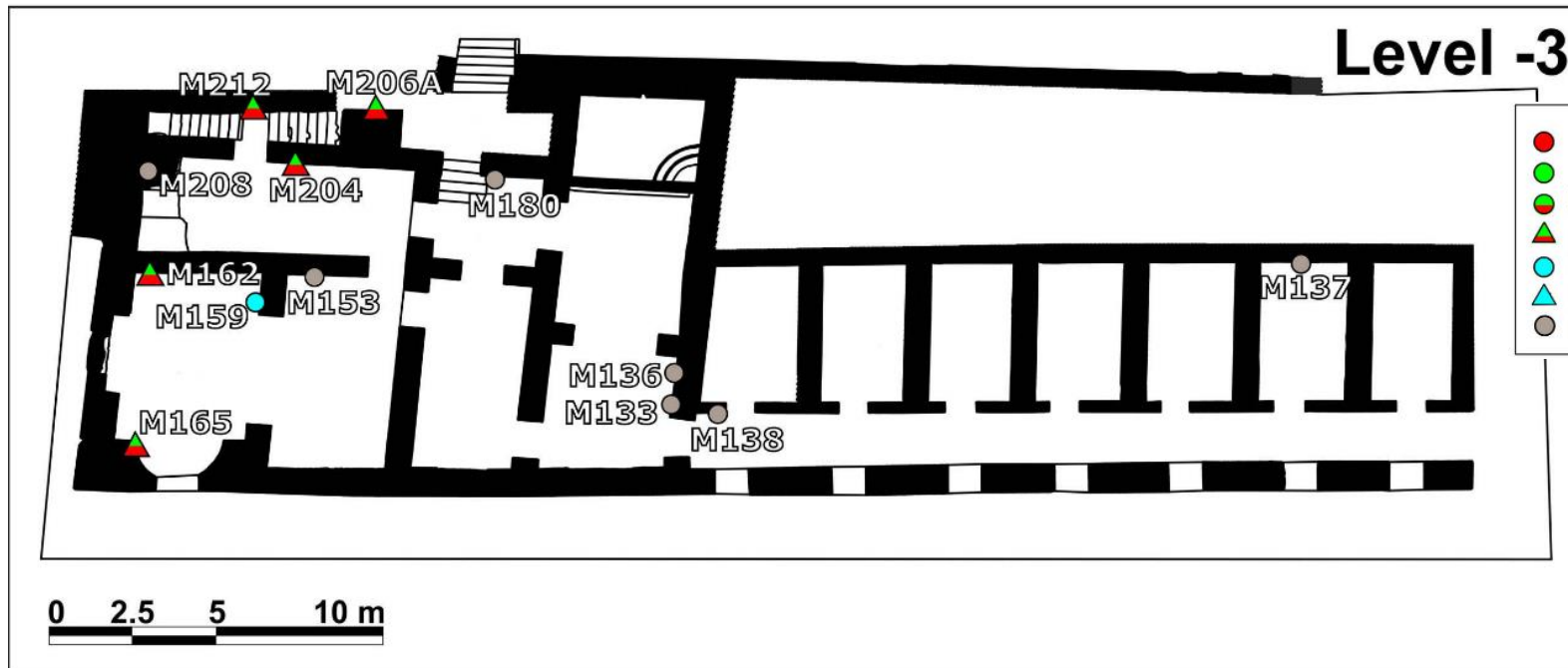
2018



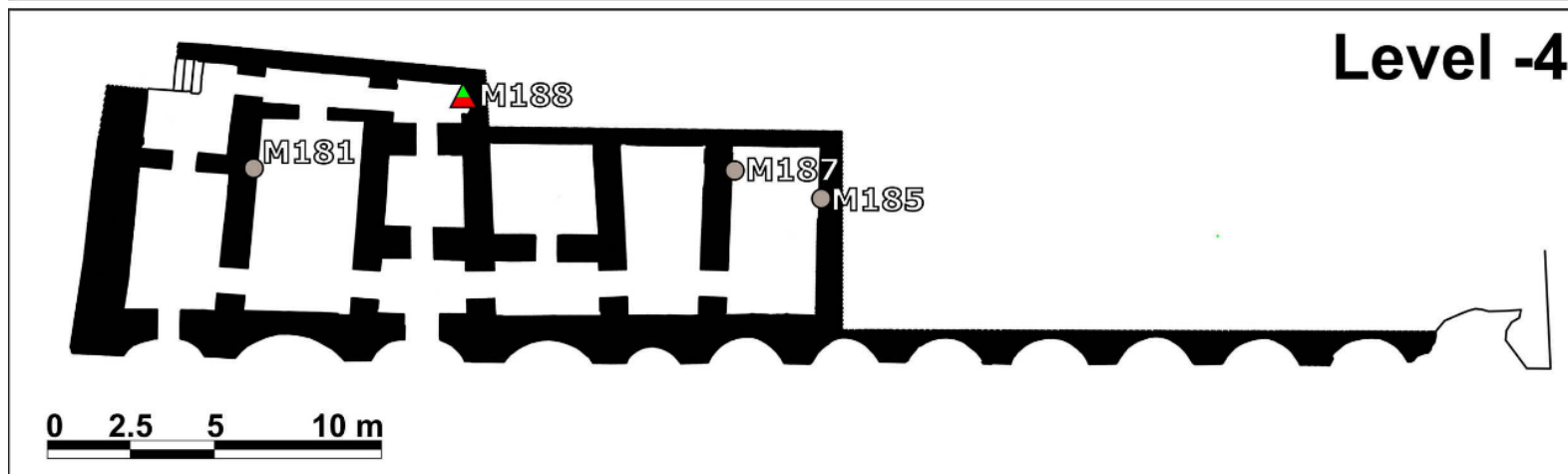
- Pre-Imperial Age
- Imperial Age
- Roman Age
- ▲ Roman Age (uncertain)
- Modern Restoration
- ▲ Modern Rest. (uncertain)
- N.D.



# Structural binders in Pompeii



- Pre-Imperial Age
- Imperial Age
- Roman Age
- ▲ Roman Age (uncertain)
- Modern Restoration
- ▲ Modern Rest. (uncertain)
- N.D.

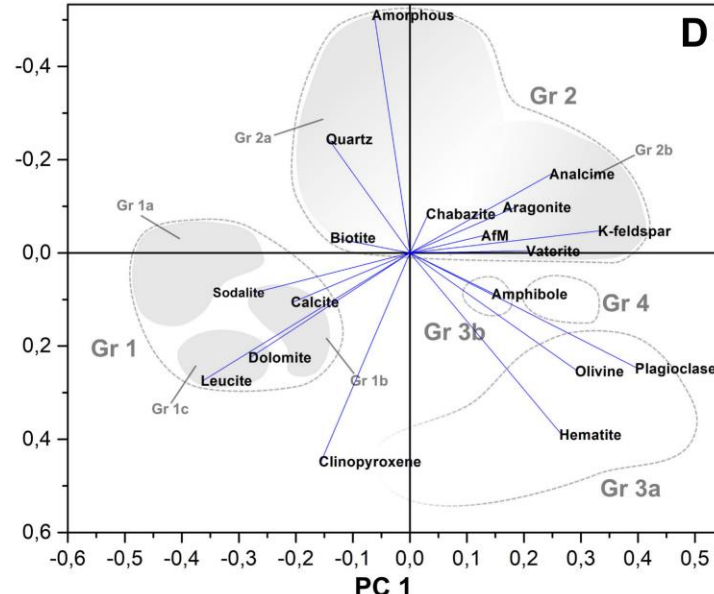
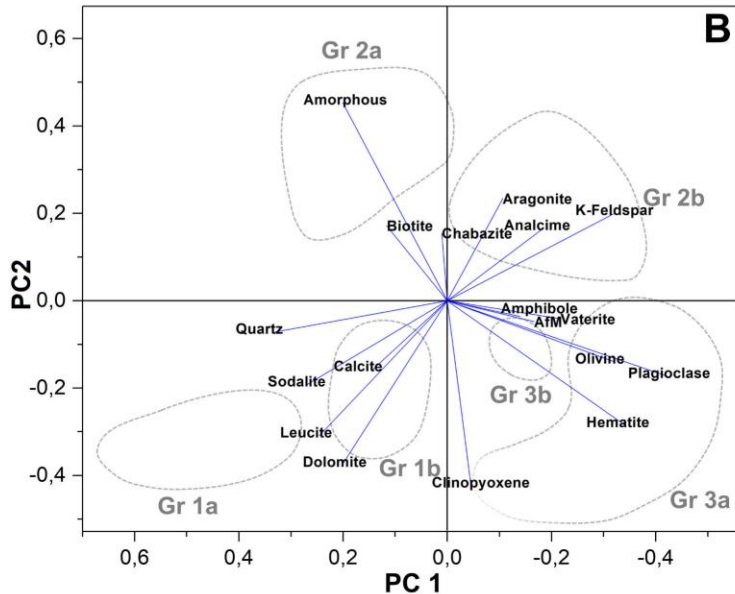
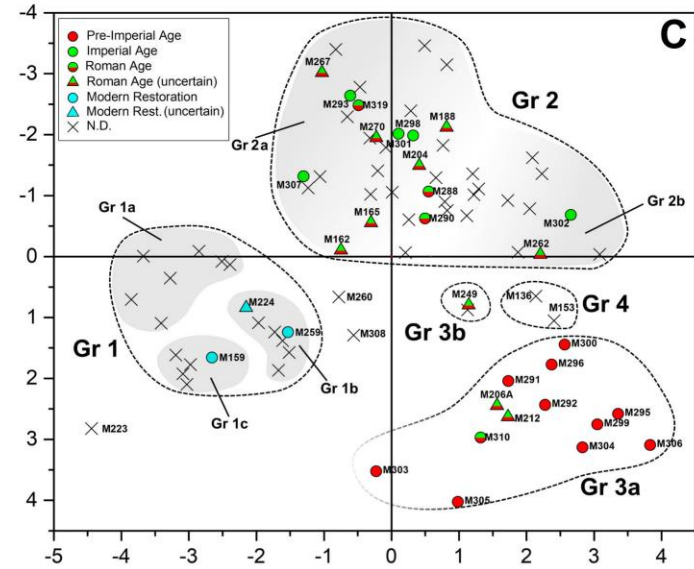
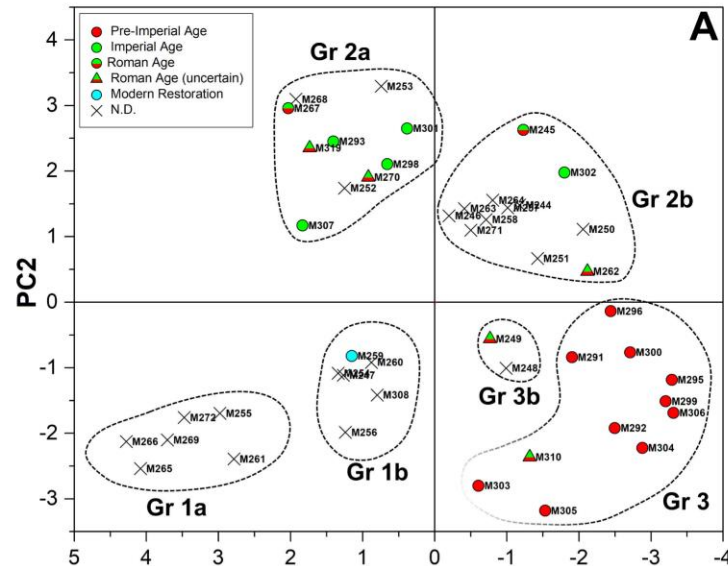


# Structural binders in Pompeii

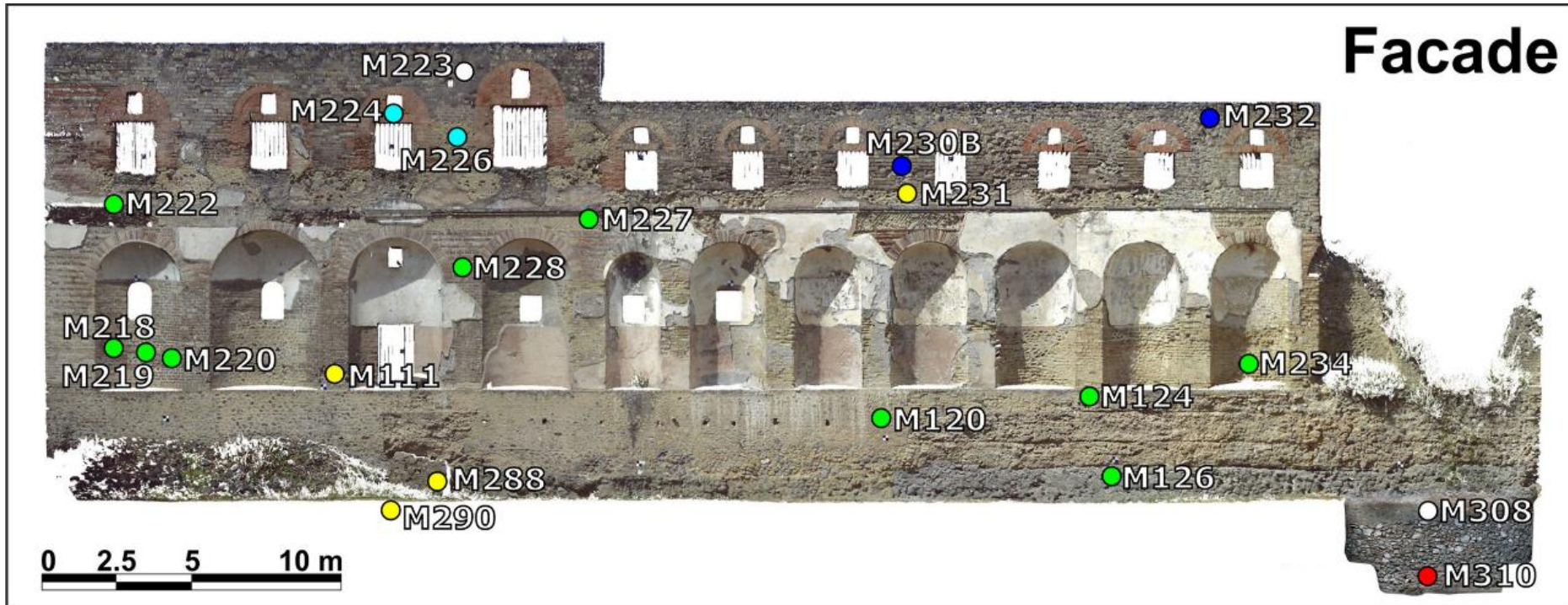




# Structural binders in Pompeii



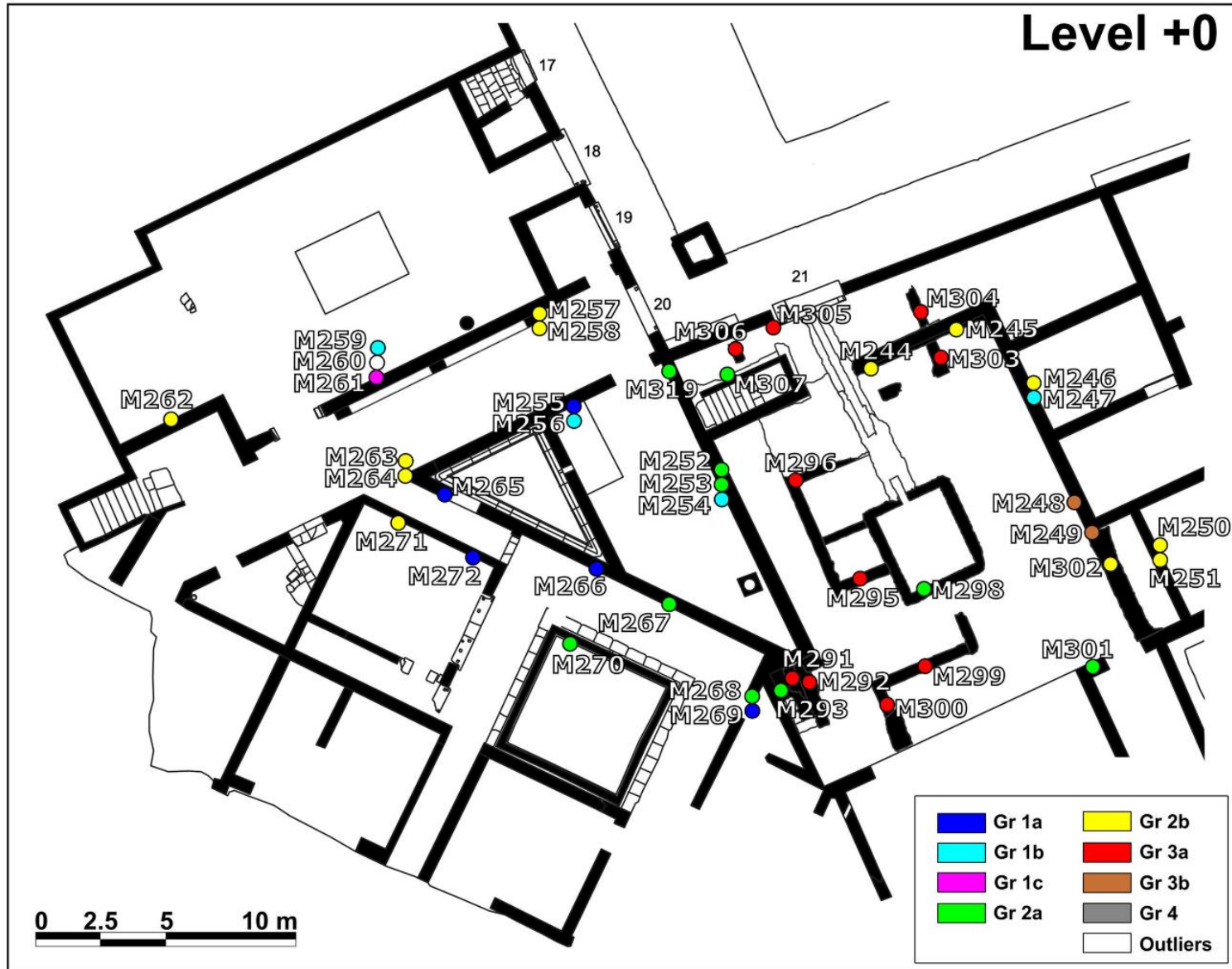
# Structural binders in Pompeii



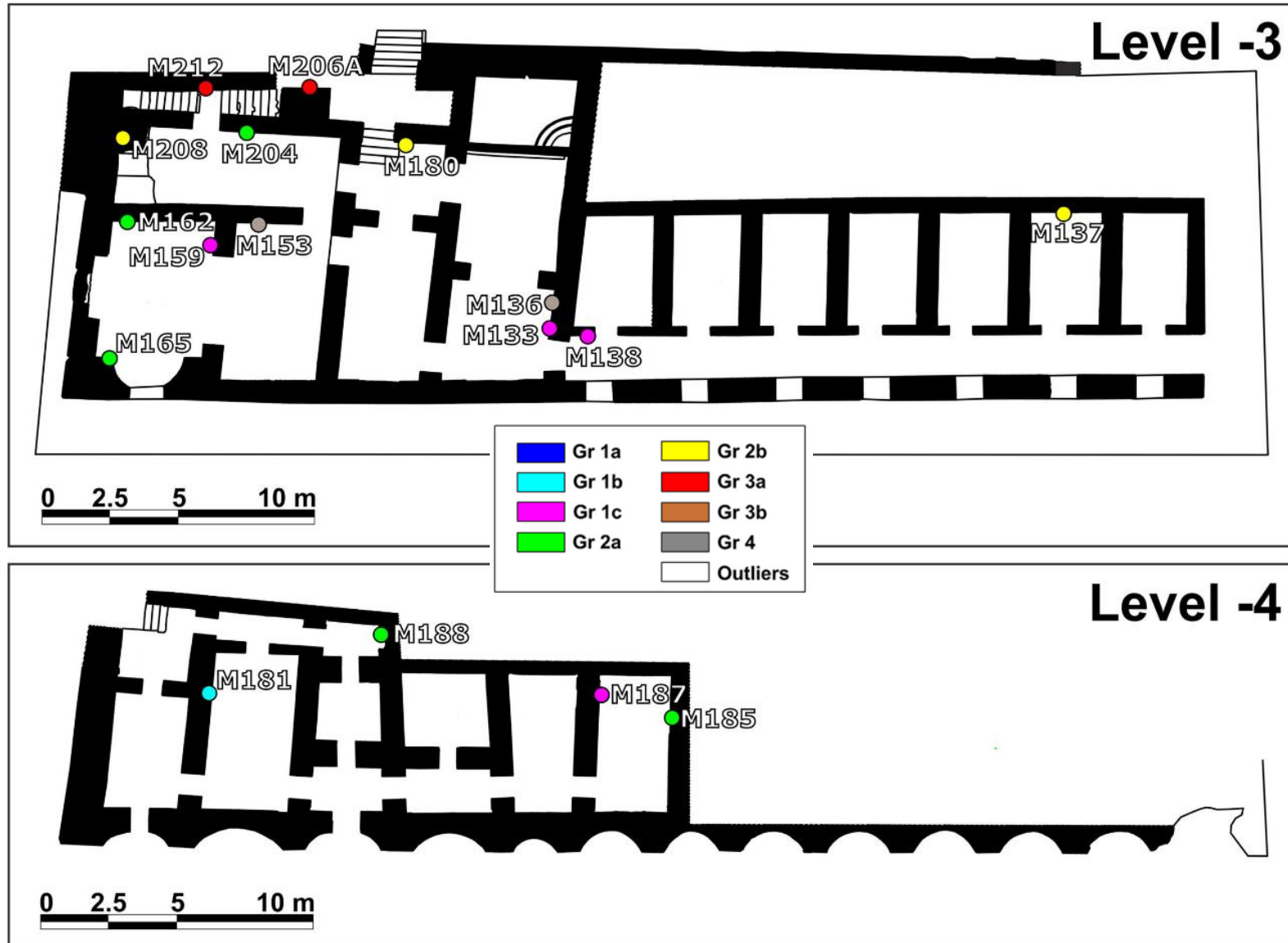
<span style="color: blue;">●</span> Gr 1a	<span style="color: yellow;">●</span> Gr 2b
<span style="color: cyan;">●</span> Gr 1b	<span style="color: red;">●</span> Gr 3a
<span style="color: magenta;">●</span> Gr 1c	<span style="color: brown;">●</span> Gr 3b
<span style="color: green;">●</span> Gr 2a	<span style="color: gray;">●</span> Gr 4
	<span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span> Outliers



# Structural binders in Pompeii



# Structural binders in Pompeii



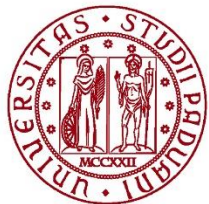


# Structural binders in Pompeii



# Materials Properties, Use and Conservation: Construction Materials and Binders

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ATTENTION!



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