

Table S2. OM characterization.

Group	Sample	Layer	Binder	Aggregate with pozzolanic behaviour		Other type of aggregate	Aggregate dimension	Single crystals dispersed in the binder	Lumps	Binder-to-aggregate ratio	Porosity
				natural origin	artificial materials						
Group 1	VIR1	1	amorphous	Pozzolane Rosse, Pozzolane Nere.	Not present.	Volcanic rock fragments with holocrystalline groundmass of clinopyroxene and opaques, and phenocrysts of leucite with concentric inclusions. Lava fragment, with black groundmass and phenocrysts of leucite.	Coarse fraction: max 8 mm. Fine fraction: 50 µm.	clinopyroxenes, feldspars, leucite, and micas	No.	1 to 3	Prevalence of rounded pores with medium dimension (750 µm), except one bigger (3,2 mm). Presence of some cracks. Irregular distribution, no orientation.
	VIR2	1	amorphous	Pozzolane Rosse, Pozzolane Nere.	Not present.	Volcanic rock fragments with holocrystalline groundmass of clinopyroxene and opaques, and phenocrysts of leucite with concentric inclusions.	Coarse fraction: max 4.5 mm. Fine fraction: 50 µm.	clinopyroxenes, feldspars, leucite, and micas	No.	1 to 3	Rounded pores, with medium-big dimensions (max 3 mm), irregularly distributed, with no preferential orientation.
Group 2	VIR3	1	amorphous	Pozzolane Rosse.	Not present.	Holocrystalline rock fragments constituted by crystals of feldspar and clinopyroxene.	The area of the sample constituted by a mortar is not significant enough.	Not evaluable.	No.	Not evaluable	The area of the sample constituted by a mortar is not significant enough.
Group 3	VIR4	1	calcic lime binder	Pozzolane Rosse, Pozzolane Nere.	Not present.	Volcanic rock fragments with phenocrysts of euhedral leucite and zoned clinopyroxenes light green in colour dispersed in a groundmass formed by microcrystals of clinopyroxene and opaques.	Coarse fraction: max 4,5 mm. Fine fraction: 50 µm.	Clinopyroxenes, feldspars and a mica (1277 µm).	Abundant.	1 to 3	Pores are rounded, with medium-small dimensions (max dimension 870 µm), irregularly distributed and with no preferential orientation.
	VIR5	1	calcic lime binder	Pozzolane Rosse, Pozzolane Nere.	Not present.	Volcanic rock fragments with phenocrysts of euhedral leucite and zoned clinopyroxenes light green in colour dispersed in a groundmass	Coarse fraction: max 7 mm.	Clinopyroxenes and feldspars.	Present.	1 to 3	Rounded pores (max dimension 1,4 mm) and cracks, both with casual distribution.

Group 4						formed by microcrystals of clinopyroxene and opaques. Tuff-like fragments.	Fine fraction: 50 μm.				
	VIR6	1	calcic lime binder	Pozzolane Rosse, Pozzolane Nere.	Not present.	Volcanic rock fragments with phenocrysts of euhedral leucite and zoned clinopyroxenes light green in colour dispersed in a groundmass formed by microcrystals of clinopyroxene and opaques. Tuff-like fragments. Sedimentary carbonate rock.	Coarse fraction: max 6 mm. Fine fraction: 65 μm.	Clinopyroxenes, feldspars and micas.	Present (calcination relicts of fossiliferous limestone)	1 to 3	Abundant pores (max dimension 3,8 mm) and cracks, interconnected, with casual distribution.
	VIR7	1	calcite	No aggregate.					No.	Not evaluable.	
		2	calcic lime binder	Pozzolane Rosse.	Not present.		Coarse fraction: max 1,3 mm. Fine fraction: 35 μm.	Clinopyroxenes.	No.	1 to 2	Pores with irregular shape and medium dimension (max 1,4 mm).
3		calcic lime binder	Pozzolane Rosse.	Not present.	Flint (diameter 2,3 mm).	Coarse fraction: max 2,3 mm. Fine fraction: 65 μm.	Clinopyroxenes and feldspars.	One lump (calcination relict of a fossiliferous limestone).	1 to 2	Abundant elongated pores, with irregular shapes and medium-big dimension (max 2,1 mm).	

Group 5	VIR8	1	amorphous	Pozzolan.	Ceramic fragments: the biggest one (8 mm) is reddish in colour, with big crystals of clinopyroxene, feldspar and quartz, other fragments are orange-reddish, with quartz as temper, and in some cases also pozzolanic fragments (50 µm).		Coarse fraction: max 8 mm. Fine fraction: 100 µm.		One lump, completely amorphous.	1 to 2	Pores are rounded (max 1 mm) but also cracks are present.
Group 6	VIR9	1	amorphous	Pozzolane Rosse.	Not present.	Pyroclastic rock fragments with porphyritic structure containing only euhedral leucite crystals (some showing concentric inclusions). Rare glassy fragments.	Coarse fraction: max 7 mm. Fine fraction: 80 µm.	Clinopyroxenes and feldspars.	No.	1 to 3	Big (millimetric) pores with irregular shape and casual distribution.
	VIR10	1	calcite	no aggregate					No.	Not evaluable.	
		2	amorphous	Pozzolane Rosse.	Not present.	Marble fragment. Altered volcanic rock fragment with a groundmass formed by clinopyroxene, and phenocrysts of leucite.	Coarse fraction: max 4 mm. Fine fraction: 80 µm.	Clinopyroxenes, feldspars, and amphiboles.	No.	1 to 3	Few pores with irregular shape and casual distribution, with maximum dimension 380 µm.
Group 7	VIR11	1	calcic lime binder	Pozzolane Rosse.	Ceramic fragments, centimetric.	One holocrystalline rock fragment with leucite with concentric inclusions and few phenocrysts of clinopyroxene. One marble fragment. One small (300 µm) flint fragment.	Coarse fraction: centimetric. Fine fraction: 60 µm.	Clinopyroxenes and feldspars.	One.	1 to 3	Few rounded pores with casual distribution; the biggest is 1.36 mm.

	VIR12	1	calcic lime binder	Pozzolane Rosse.	Ceramic fragments, centimetric.	Volcanic rock fragments with leucite phenocrysts, in a groundmass formed by microcrystals of clinopyroxene and opaques. Altered volcanic rock fragment with a groundmass formed by clinopyroxene and phenocrysts of leucite (similar to the one found in VIR10). Altered fragment of marble.	Coarse fraction: centimetric. Fine fraction: 60 µm.	Clinopyroxenes and feldspars (very few).	No.	1 to 3	Big (up to 1.33 mm) pores with irregular shape and casual distribution have been filled with calcite. Few small (360 µm) rounded pores have not been filled with calcite recrystallizations. The distribution is casual.
Group 8	VIR13	1	amorphous	Pozzolane Rosse. Pozzolane Nere. Pozzolanelle.	Not present.	Associated elongated calcite crystals dispersed in the binder.	Coarse fraction: 3 mm. Fine fraction: 120 µm.	Clinopyroxenes, leucite, micas and feldspars.	No.	1 to 3	Abundant pores, variable in shape (from round to irregular), with casual distribution, maximum dimension 1,5 mm. Also cracks are present.
Group 5	VIR14	1	calcic lime binder	not optically resolvable					No.	1 to 1	
		2	amorphous	Pozzolane Rosse.	Ceramic fragments.	Volcanic rock fragments with holocrystalline groundmass of clinopyroxene and opaques, and phenocrysts of leucite.	Coarse fraction: 3 mm. Fine fraction: 80 µm.	Clinopyroxenes, micas and feldspars.	No.	1 to 2	Pores have rounded shape, casual distribution, and max diameter 500 µm. Cracks are also present.
Group 3	VIR15	1	calcic lime binder	Pozzolane Rosse. Pozzolane Nere.	Not present.	Volcanic rock fragments with holocrystalline groundmass of clinopyroxene and opaques, and phenocrysts of leucite. A mortar fragment.	Coarse fraction: 1.5 mm. Fine fraction: 70 µm.	Clinopyroxenes, micas and feldspars.	No.	1 to 3	Pores have irregular or rounded shape, casual distribution, and max diameter 3,35 mm.
Group 9	VIR16	1	amorphous	Pozzolane Rosse.	Ceramic fragments.	Volcanic rock fragments with leucite phenocrysts, in a groundmass formed by microcrystals of clinopyroxene and opaques.	Coarse fraction: 2.2 mm. Fine fraction: 70 µm.	Clinopyroxenes.	One, altered and with cracks.	1 to 3	Pores have irregular shape, max dimension 1,15 mm. One small crack is present.
		2	calcic lime binder	Pozzolane Rosse.	Ceramic fragments.	One volcanic rock, characterized by phenocrysts of clinopyroxene, olivine	Coarse fraction: 8 mm.	Clinopyroxenes.	Present.	1 to 3	Some pores present a rounded shape, others

						and leucite in a cryptocrystalline groundmass. Two mortar fragments.	Fine fraction: 95 µm.				irregular. The distribution is casual.
Group 10	VIR17	2*	calcic lime binder	Pozzolane Rosse.	Not present.	One volcanic rock fragment characterized by the presence of euhedral phenocrysts of leucite and one of clinopyroxene, in a groundmass rich in clinopyroxenes and opaques.	Coarse fraction: 1.6 mm. Fine fraction: 75 µm.	Sanidine and clinopyroxenes.	Present and highly altered.	1 to 3	Abundant cracks are present (max 5 mm long), as also porosities rounded or with irregular shape. The distribution is casual.
Group 11	1Y	1	calcic lime binder	Pozzolan (fine), and the bigger fragments are identifiable as Pozzolane Rosse.	Ceramic fragments.		Coarse fraction: centimetric. Fine fraction: 60 µm.	Clinopyroxenes and feldspars.	No.	1 to 3	Few pores, medium dimension, generally rounded.
	2Y	1	calcic lime binder	Pozzolan (fine), and the bigger fragments are identifiable as Pozzolane Rosse.	Ceramic fragments.		Coarse fraction: centimetric. Fine fraction: 60 µm.	Clinopyroxenes and feldspars.	No.	1 to 3	Few pores, medium dimension, generally rounded.
	3Y	1	calcic lime binder	Pozzolan (fine), and the bigger fragments are identifiable as Pozzolane Rosse.	Ceramic fragments.		Coarse fraction: centimetric. Fine fraction: 60 µm.	Clinopyroxenes and feldspars.	No.	1 to 3	Few pores, medium dimension, generally rounded. Some are filled with secondary calcite.

* the 1st layer, visible macroscopically as very thin and white, was not preserved in the final thin section.