

Supplementary Information for

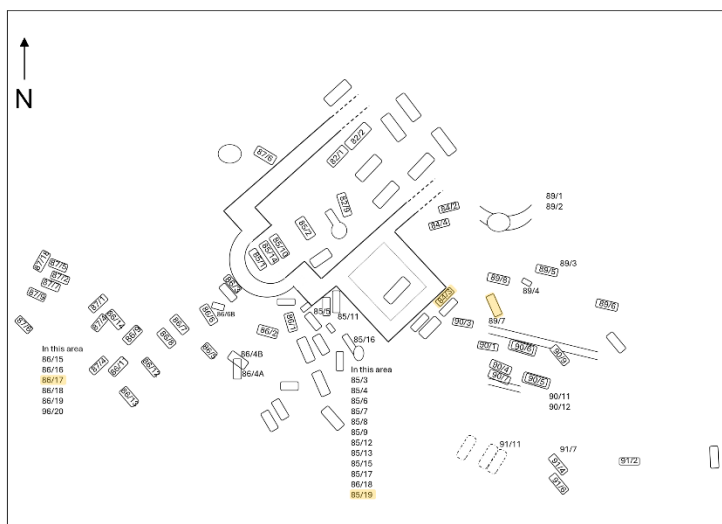
Bioarchaeological evidence of mycoses during the Late Antiquity – Early Middle Ages transition in Central Italy

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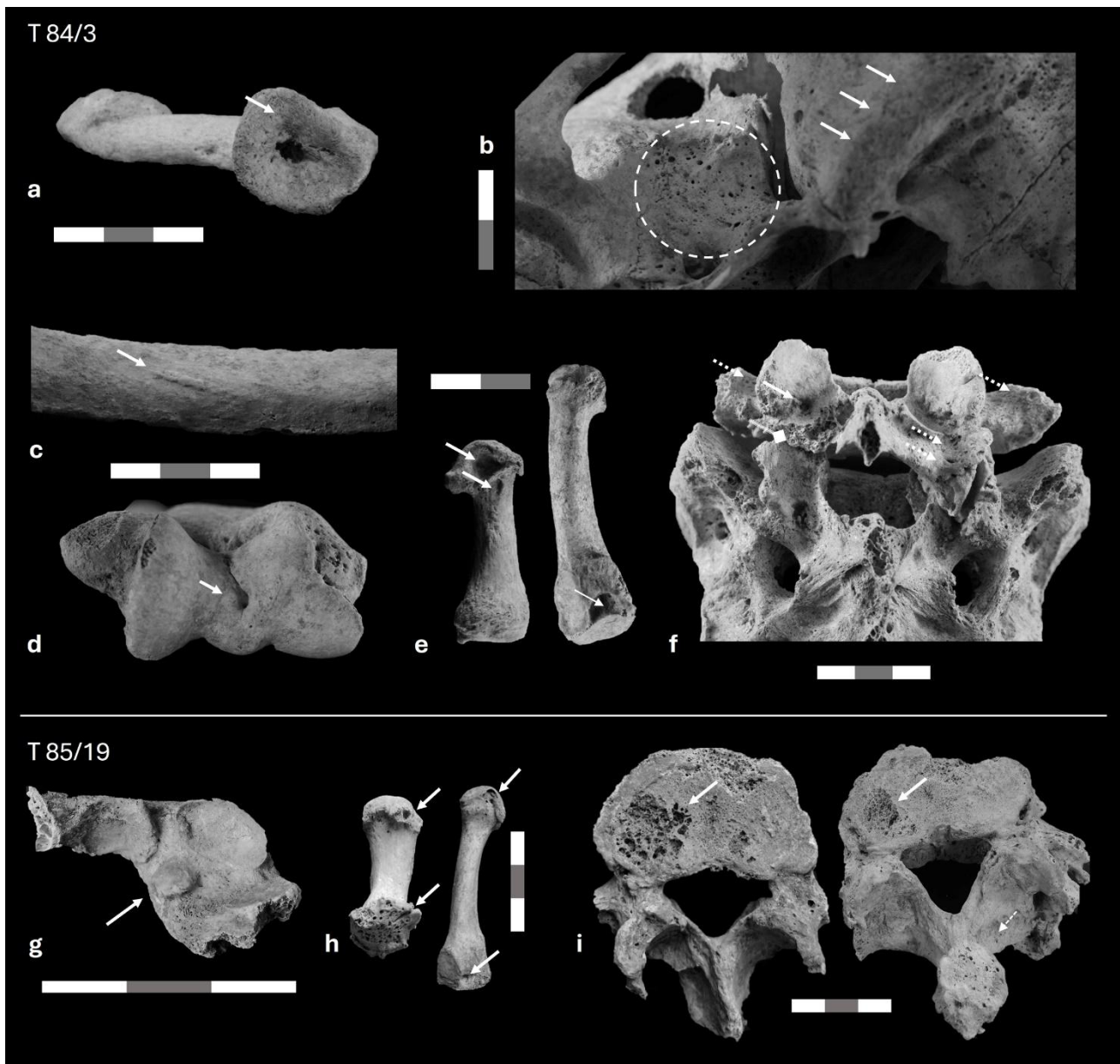
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This PDF file includes:

Supplementary Figs. 1 to 5
Supplementary Table 1 and 2
Supplementary Text 1 and 2
Supplementary References 78 to 105



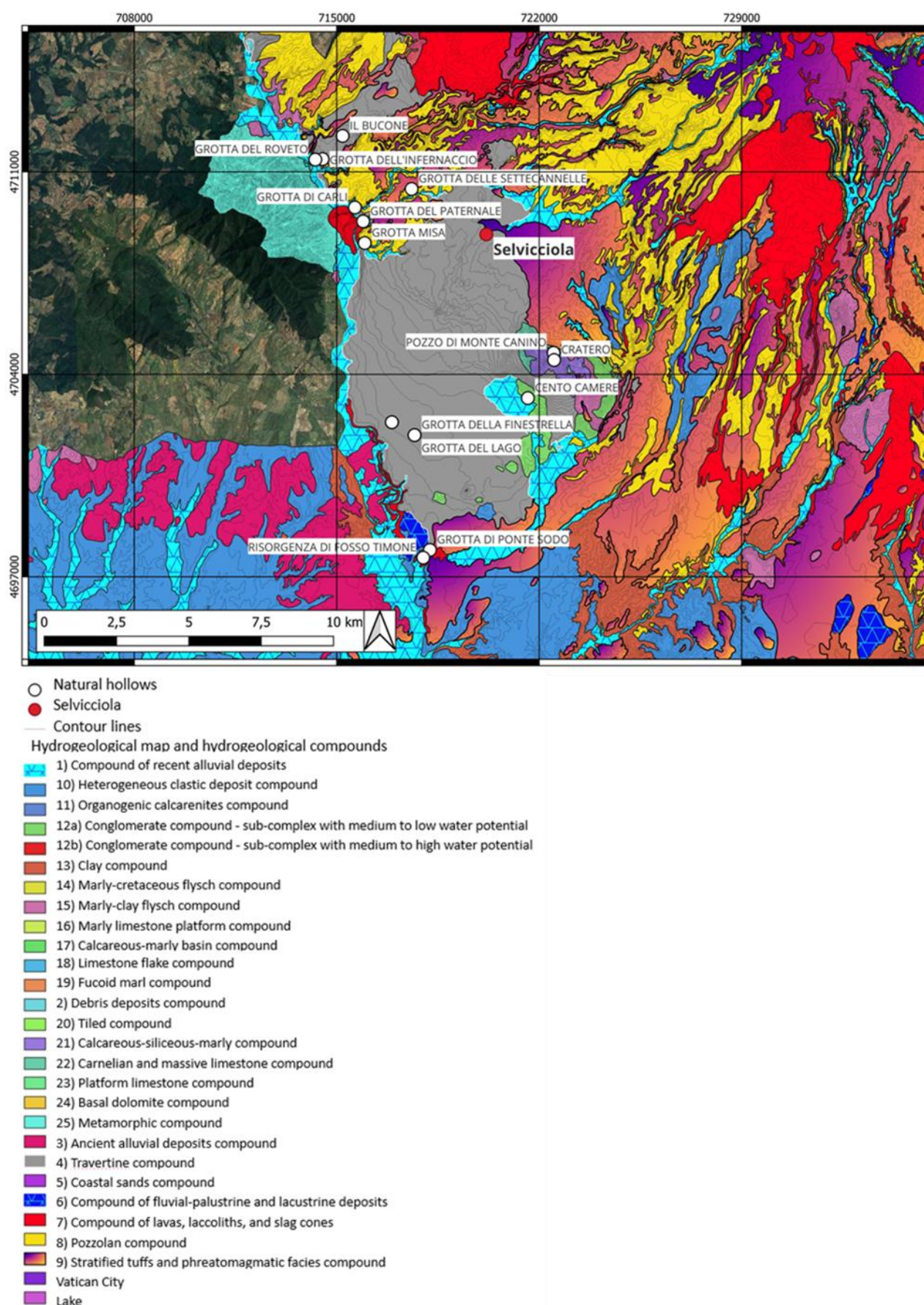
Supplementary Fig. 1. The location of the Selvicciola funerary area in Central Italy. On the right is the necropolis with the building and the burials. The burials of the individuals of study are highlighted in yellow. The location of one of the individuals (Unlabeled) is not defined.



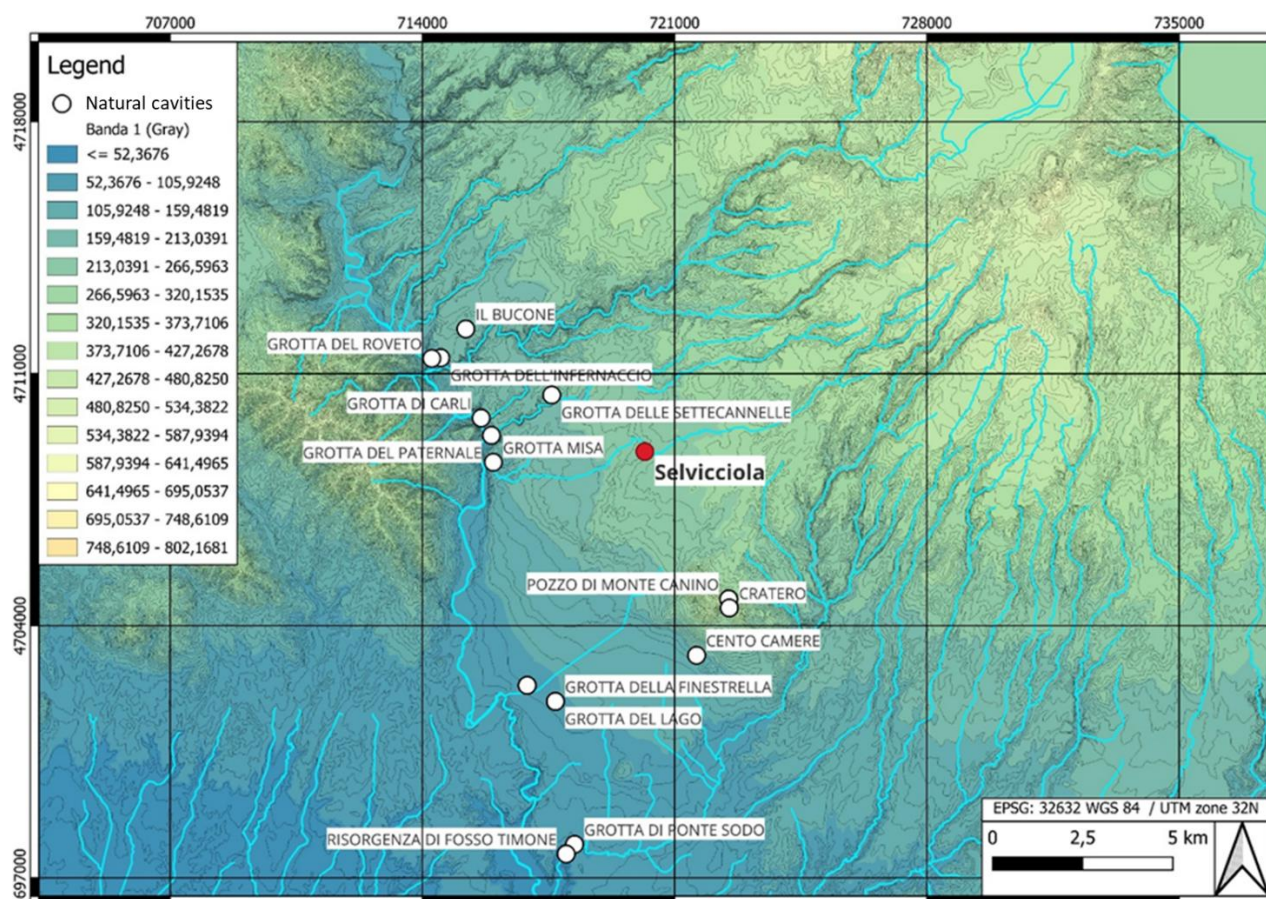
Supplementary Fig. 2. Additional lesions assessed on the individuals T 84/3 and T 85/19. **a.** Left clavicle: sharp-edged lesion on the articular surface of the manubrium (arrow). **b.** Medium-sized lytic lesions on the left sphenoid (dotted circle); the white arrows indicate the right edentulous maxilla, for reference. **c.** New bone apposition on the inner surface of a fragment of rib (arrow). **d.** Large lytic lesions with smooth edges on the trochlea surface of the right humerus (arrow). **e.** Large lytic lesions with smooth edges on the proximal epiphysis of the first left metacarpal (medial view) and on the distal epiphysis of the fourth left metatarsal (medial view). **f.** Stress fracture on the pars interarticularis of L5 (squared arrow), small pits lesions on the transverse processes (dotted arrows), small lytic lesions with smooth edges on the right superior articular process. **g.** Possible blunt spicula on the right half of the vertebral arch of C1 (arrow). **h.** Medium-sized lytic lesions with smooth edges on the proximal epiphysis of the first left metacarpal (arrow) and degenerative joint disease on the proximal epiphysis (arrow) (palmar view) and proximal and distal epiphyses of the fourth right metatarsal (medial view). **i.** Medium-sized lytic lesions on the superior surface of two lumbar vertebrae (possible L3 and L4; full arrows) and an extra-articular facet on the spinous process (interspinous process; dotted arrow; superior view). All scale bars are in centimeters.



Supplementary Fig. 3. Additional lesions assessed on the individuals T 86/17 and T 89/7. **a.** Small pit lytic lesions on right sphenoid (dotted circle). **b.** Fusion of the bodies for three lower thoracic vertebrae. **c.** Possible blunt spicula on hand phalanx. **d.** Medium-sized lytic lesion with smooth edges on the left scaphoid (fragmented; arrow). **e.** Medium-sized lytic lesion with smooth edges along the surgical neck of both humeri (posterior view; arrows). **f.** Medium-sized lytic lesion on the proximal epiphysis of the first left metatarsal (arrow). **g.** Medium-sized lytic lesion with smooth edges in the left acetabulum (lateral view; arrow). **h.** Medium-sized lytic lesion with smooth edges close to the surgical neck of both humeri (posterior view; arrows). **i.** New bone apposition on the inner surface of a fragment of rib (arrow). **j.** Medium-sized lytic lesion with smooth edges on the right capitate (lateral and dorsal view; arrows). All scale bars are in centimeters.



Supplementary Fig. 4. Hydrogeological map of the area of Selvicciola. The major natural cavities are marked.



Supplementary Fig. 5. Height contour map of the Area of Selvicciola. The current courses of rivers, streams and rivulets are included; the major natural cavities are marked.

Supplementary Table 1. Macroscopic osseous lesions attributed to mycotic infection. Includes lesion type, anatomical associations, differential diagnoses reported in the bioarchaeological literature for comparable lesion patterns, relevant clinical and paleopathological references on mycoses, diagnostic weighting, and illustrative examples presented in this paper. The table follows the structure proposed by Dittmar and colleagues (Table 1 in 36), Vlok and colleagues (Table 2 in 40), and Snoddy and colleagues (Table 1 in 45). The differential diagnostic framework is restricted to adult individuals, as the paleopathological literature on fungal infections in non-adult skeletal remains is extremely limited.

Lesion location	Lesion type	Differential diagnosis (other pathologies than mycoses)	Palaeopathological references	Clinical support	Proposed diagnostic strength	Figures
Meningeal groove	Abnormal blood vessel impressions	Tuberculosis (78)	None, anatomically intuitive	79-81	D	Fig. 1
Nasal cavity/Ethmoid bone	Pneumatization of the middle turbinate	Chronic rhinosinusitis, fungal sinusitis, nasal masses (82)	None, anatomically intuitive	44	D	Fig. 2 (T 84/3, 86/17, 89/7, Unlabeled)
Sphenoid: pterygoid fossae/plates	Abnormal cortical porosity	Metabolic disorders (83), systemic infections (e.g., 35)	5	None, anatomically intuitive	S	Fig. 3 and Suppl. Fig. 2 (a), both from (5)
Sphenoid: greater wing	Abnormal cortical porosity, focal osteolytic lesion with a larger lesion	Treponematoses, mycosis, neoplasms (35)	25, and cited literature	None, anatomically intuitive	S	Fig. 1 (g), Suppl. Fig. 3 (a)
Sphenoid: lesser wing	Abnormal cortical porosity	Metabolic disorders, (83)	5	None, anatomically intuitive	S	Fig. 1 (g)
Vertebral bodies	Focal osteolytic lesions affecting one or more vertebra with substantial reactive bone formation	Neoplasms, brucellosis, osteomyelitis, tuberculosis (35, 55)	5, 12, 35, 55, 68	84, 85	S	Fig. 1 (a), Suppl. Fig. 2 (i)
Vertebrae transverse and spinous processes	Lamellar bone and small, rounded osteolytic lesions	Brucellosis, osteomyelitis, neoplasms (35)	5, 35, 55	None, anatomically intuitive	D	Fig. 1 (b, c, f)
Ribs	Diffuse subperiosteal new bone formation on the visceral surfaces of multiple ribs	Chronic respiratory diseases that cause pleural inflammation (pneumonia, actinomycosis, bronchitis, emphysema, pleurisy etc.), lung cancer, poor air quality. Neoplasms, brucellosis, tuberculosis, osteomyelitis (36)	5, 14, 35, 55, 68	85, 86	S	Suppl. Fig. 2 (c), Suppl. Fig. 3 (i)
	Osteolytic lesion(s) on the visceral surfaces	Neoplasms; pulmonary sarcoidosis tuberculosis, osteomyelitis (35, 36)		87	S	No figure, anatomically intuitive

Proximal and distal ends of metacarpals and metatarsals	Round lytic lesions	Septic arthritis, osteoarthritis, psoriatic arthritis, rheumatoid arthritis (36, and cited literature)	5, 14, 55	88	D	Suppl. Fig. 2 (e, h), Suppl. Fig. 3 (f)
Carpals, tarsals and phalanges				88	D	Suppl. Fig. 3 (d, j)
Sub-articulation (e.g. humerus metaphysis)	Focal destruction/medium/small lytic lesions with smooth edges	Septic arthritis, osteoarthritis, psoriatic arthritis, rheumatoid arthritis (36, and cited literature)	5, 55, 89	88	S	Suppl. Fig. 3 (e, h)
Articular surfaces (e.g. sternal end of the clavicle, acetabulum, humerus trochlea)	Medium/large lytic lesions with smooth edges	Tuberculosis (36, and cited literature, 55), early stages of metastatic carcinoma (11, and cited literature)	54 (pp. 629-630), 55	88	S	Suppl. Fig. 2 (d), Suppl. Fig. 3 (g)
Everywhere	Blunt spicula	n/a	5, 11, 55, 68	None, anatomically intuitive	SD	Fig. 1 (e). Possible presence in Suppl. Fig. 2 (g), Suppl. Fig. 3 (c). Fig. 5 (a) from (5)

Supplementary Table 2. List of the natural caves within a radius of 5 km and 10 km from Selvicciola (see Fig. 8 in the Main Text). **Grotta Nuova* and *Grotta dell'Infernetto* are part of a single underground compound. The waters of the *Bucone* flow into those of the *Grotta Nuova* and reappear after about 100 m in the small cave *Grotta del Roveto*.

Name of the cave	Within a radius of 5 or 10 km	Period of the archaeological artefacts found in the cave	References	Fully excavated	Depth (m)	Length (m)
<i>Grotta del Paternale</i>	5 km	From the Bronze Age (e.g., abundant pottery and charcoal frustules) to the medieval period (e.g., a few fragments of pottery)	90	yes	0	20
<i>Grotta Misa</i>	5 km	Middle Bronze Age (funerary cave)	91, 92	yes	24	119
<i>Grotta di Carli</i>	5 km	From the Neolithic period to the Bronze Age (funerary cave)	93, 94	no	0	22
<i>Grotta delle Settecannelle</i>	5 km	From the Neolithic to the Medieval period (e.g., Roman and medieval pottery, a wall and wooden structures that can be interpreted as planks and troughs, typologically referable to medieval cave constructions)	93, 95, 96	yes	25	0
<i>Pozzo di Monte Canino</i>	5 km	n/a	97	n/a	0	0
<i>Cratero</i>	5 km	n/a	n/a	n/a	0	0
<i>Grotta della Finestrella</i>	10 km	n/a	n/a	n/a	9	9
<i>Cento camere</i>	10 km	n/a	n/a	n/a	0	0
<i>Grotta del Lago</i>	10 km	From the Bronze Age (artifacts lost)	97, 98	yes	50	55
<i>Grotta dell'Infernaccio (or Grotta Nuova)*</i>	10 km	From the Bronze Age to XX c. CE	99-101	no	0	850
<i>Il Bucone (or Grotta dell'Infernetto)*</i>	10 km	Iron Age (close to a funerary area) and other phases (artifacts not thoroughly analyzed)	102, 103	no	0	1250
<i>Grotta del Roveto*</i>	10 km	n/a	97	yes	13	0

Supplementary Text 1

We restricted the differential analysis (Table 2 in the main text) to tuberculosis, brucellosis, and echinococcosis, as the conditions producing lesions most similar to those attributable to mycotic infections. In previous literature, lesions from mycotic infections have been compared with cancer lesions (11, 12, 35, 40, 68). We could rule out these pathologies, thanks to the following considerations. Metastatic carcinoma typically produces lytic lesions with scalloped margins and radiating osteoblastic reactions, often showing a preferential distribution in the axial skeleton, features that are not characteristic of skeletal mycoses. Leukemia lacks well-defined, diagnostic skeletal signatures in paleopathological contexts and is generally associated with diffuse metaphyseal and subperiosteal changes rather than focal destructive lesions. Multiple myeloma, while known to partially overlap with fungal infections in skeletal appearance, is classically characterized by numerous small, uniform lytic lesions, particularly involving the cranial vault, and by endocranial involvement detectable radiographically. The absence of these lesion morphologies, distribution patterns, and radiological features supports excluding neoplastic processes from the differential diagnosis of mycotic infection. Furthermore, broader comparisons with non-infectious and neoplastic conditions are presented in detail in previous work by Micarelli and colleagues (5).

Supplementary Text 2

The long-term use and reuse of cavities across different periods is a crucial issue for the medieval settlements in Tuscia (northern Lazio/southern Toscana). Research on the medieval reuse of ancient sites has rarely focused on whole classes of monuments, instead examining reused construction materials or individual artifacts (decorations, friezes, marble, and single structures). Modifications include transforming funerary beds into mangers, creating hooks, and adding grooves for wooden dividers to accommodate animals, as well as a *columbarium*, possibly from this phase (104). Cavities show signs of reuse as stables and agricultural storage. It is possible to speculate that *Pozzo di Monte Canino* has a heat flow related to a convective low-temperature hydrothermal system, with a rate of up to 200 mW/m² (105). This type of grotto may have served as a shelter for animals in the past, providing protection and warmth in winter. Notably, no tombs were repurposed as houses. Medieval settlements near necropolises systematically avoided using tomb cavities as living spaces, preferring instead to construct new ones, despite the effort required. Tombs were generally avoided except for service uses such as agricultural storage, stables, or *colombarii*.

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