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Early human collective practices and symbolism in the Early Upper Paleolithic of Southwest Asia

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Identifying communal rituals in the Paleolithic is of scientific importance, as it reflects the expression of collective identity and the maintenance of group cohesion. This study provides evidence indicating the practice of deep cave collective rituals in the Levant during the Early Upper Paleolithic (EUP) period. It is demonstrated that these gatherings occurred within a distinct ritual compound and were centered around an engraved object in the deepest part of Manot Cave, a pivotal EUP site in southwest Asia. The ritual compound, segregated from the living areas, encompasses a large gallery partitioned by a cluster of remarkable speleothems. Within this gallery, an engraved boulder stands out, displaying geometric signs suggesting a unique representation of a tortoise. Isotopic analysis of calcite crusts on the boulder's grooves revealed alignment with values found in speleothems from the cave dated to ~37 to 35 ka BP. Additionally, meticulous shape analysis of the grooves' cross-section and the discernible presence of microlinear scratches on the grooves' walls confirmed their anthropogenic origin. Examination of stalagmite laminae (36 ka BP) near the engraved boulder revealed a significant presence of wood ash particles within. This finding provides evidence for using fire to illuminate the dark, deep part of the cave during rituals. Acoustic tests conducted in various cave areas indicate that the ritual compound was well suited for communal gatherings, facilitating conversations, speeches, and hearing. Our results underscore the critical role of collective practices centered around a symbolic object in fostering a functional social network within the regional EUP communities.

symbolic behavior | rock engraving | collective practices | ritual compound | Upper Paleolithic Levant

Significance

This study presents evidence from the Levant of communal rituals centered around a carved boulder within a distinct hall in the deepest and darkest part of Manot Cave. It expands our understanding of the Upper Paleolithic period beyond material culture and subsistence, delving into the more ephemeral realm of the ritual lives of the people.

When and where initial forms of collective ritual practices first appeared is still an enigma. The study of Paleolithic prehistoric art provides an important insight into past human cultures. Remarkable examples of artistic expression in Europe (1, 2), Africa (3, 4), Southeast Asia (5–7), and Australia (8, 9)—illustrate the artistic skills, cognitive abilities, and cultural development of the Paleolithic people worldwide. However, evidence regarding the symbolic behavior of Paleolithic people (e.g., refs. 6, and 10–16) is still poorly understood and subject to ongoing debate. Symbolic behavior likely emerged alongside the development of complex cognitive abilities, enabling early humans to represent and communicate abstract concepts through symbols, embedded in artistic representation, language, and ritual practices. Archaeological evidence suggests that this capacity began to develop in the Middle Stone Age, with the earliest known examples of symbolic artifacts, such as ochre engravings and beads, appearing around 100,000 y ago (17). These artifacts indicate the ability to create and understand symbols, a critical step in the evolution of culture and social structures that help maintain large and more complex social networks (18). Communal rituals, as a specific form of symbolic behavior, often leave material traces, such as public-cum-ceremonial structures, communal burial grounds, and unique artifacts, which provide insights into the symbolic and social practices of prehistoric communities (19). The discovery of constructed stalagmite circles in Bruniquel Cave, France, suggests that some form of deep cave communal ritual was already practiced by Neanderthals during the Middle Paleolithic (20). Social evolution theories argue that the appearance of communal ritual practices is intimately interconnected with the evolution of social complexity as a mechanism aimed at promoting social cohesion (21).

In the archaeological record, identification of collective rituals is challenging and usually relies on physical elements such as exceptional stone structures interpreted as temples and

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shrines (22–24). In the earlier prehistoric periods, evidence may come in the form of confined spaces in caves, often decorated with paintings and engravings, that can host gathered people to perform nonmundane activities (25, 26). Such confined spaces provide options for seclusion, intimacy, selective attendance, and other modes needed in ritual activities (27, 28).

Rock engravings are already evident in the Middle Paleolithic period and became more complex and frequent during the Upper Paleolithic (29, 30) (*SI Appendix*, 1). In the Levant, engraved artifacts are uncommon and when found, they are often categorized as artistic items. These objects are usually portable and of a personal nature (31–36), commonly discovered in close association with domestic assemblages and other artifacts. In most Paleolithic sites in the Levant, there is no clear spatial division between areas designated for domestic activities and those used for other purposes [e.g., in Qafzeh Cave (37)]. Therefore, we cannot preclude the possibility that these small artifacts were mundane, made for aesthetic purposes, evidence for the adroitness of the artist, or meant to enhance prestige.

In this paper, we report the discovery of a confined space (referred to as the "ritual compound") with an engraved dolomite boulder found in the deepest and darkest part of Manot Cave (Fig. 1) (38–40). This space (Areas A, H, K; Fig. 1*C* and *SI Appendix*, Fig. S1), is distinctly separated from the domestic living area (Area E), which was located close to the cave entrance. Our research provides compelling evidence indicating the boulder and the space surrounding it dedicated communal space for ritual purposes.

Background to Manot Cave and the Deep Ritual Compound

Manot Cave is a key Early Upper Paleolithic (EUP) site in the Levant, a crucial time period when modern humans were reoccupying the Levant and local Neanderthals were disappearing (38). Manot Cave is situated in the western Galilee of Israel, approximately 9 km east of the present Mediterranean shoreline (Fig. 1*A*). The cave was intensively occupied between 46 to 33 ka Cal BP by EUP groups ascribed to the Ahmarian, Levantine Aurignacian, and Atlitian cultural entities (40–44). The cave's archeological horizons have provided extensive data that help us better understand the lives of *Homo sapiens* in this region during the EUP (38, 39, 42, 45).

Daily activities within Manot Cave included tasks such as flint knapping, animal butchering, food consumption, and the construction and maintenance of combustion structures, within living areas located at the cave's entrance (Areas E, I) (Fig. 1 *B* and *C*) (40, 44–46) (*SI Appendix*, 2 and Figs. S1 and S2). The Manot 1 skull was recovered in a small chamber at Area J (38). The cave's deeper sections were not used for domestic purposes (43, 47) (*SI Appendix*, 2 and Figs. S1 and S3).

The deeper section of Manot Cave, here referred to as the "ritual compound," encompasses a large, high gallery (Area H; 100 m^2, 20 m ht.) with an adjoining small and "hidden" chamber to the south (Area K; Fig. 1 *C* and *I* and *SI Appendice*, 2). The gallery (Area H) is separated from the main cavern by a prominent cluster of speleothems (*SI Appendix*, Fig. S3 and Movie S1). Within this gallery (Area H), we documented a large boulder (Fig. 1 *D* and *H* and *SI Appendix*, Fig. S6 *A–D*) bearing human-made engravings displaying geometric patterns. This area maintains a relatively dry environment, in contrast to other parts of the cave where stalactites continually drip water from the ceiling (47), excluding Area E (close to the entrance).

The southern hidden chamber (Area K) is separated by a "curtain" of speleothems that conceal it from the gallery and make it difficult to access (*SI Appendix*, Fig. S4). This hidden chamber is void of evidence of daily human activities (i.e., flint knapping, food processing, fire activity, animal butchering); however, it contained a complete antler of a fallow deer with use-wear signs (Fig. 1*E* and *SI Appendix*, Figs. S4 and S6 *E* and *F*).

Results

The Engraved Boulder. The dolomite boulder (28 kg, 29 × 22 × 25 cm) (Fig. 1 *D* and *H* and *SI Appendix*, Figs. S5–S7) features distinctive geometric markings creating a complex pattern. It is situated along the cave wall at the back of the deep gallery (Area H; Fig. 1*H* and *SI Appendix*, 3 and Figs. S2 and S6). The boulder (*SI Appendix*, Fig. S6 *A–D*), set in a niche adjacent to the northeastern gallery wall (*SI Appendix*, Fig. S5), was positioned with its engraved side oriented toward the gallery (*SI Appendix*, Fig. S5). It stands out from the surrounding stones, which are angular, with sharp edges and flat surfaces devoid of discernible signs. The geometric signs partially cover three sides of the boulder and are composed of polygons and chevrons arranged in two "rows" separated by a central line (Fig. 2*A* and *SI Appendix*, Fig. S6*A*). Some grooves are deep, whereas others are shallower (Fig. 2).

To investigate the anthropogenic nature of the grooves, we conducted the following analyses: a) excavating and surveying the area around the boulder; b) comparing the engravings to natural erosion features observed within the cave; c) performing shape analysis of the grooves on the boulder, and d) conducting experimental engraving using replicated flint artifacts on a comparable unmodified boulder from Manot Cave. The outcomes were compared to the geometric features of the grooves on Manot boulder.

(a) Examining the boulder's surroundings: Close inspection of the inner part of the cave, and test excavations in different parts of the gallery, did not reveal any stones with grooves similar to those found on the engraved boulder. Moreover, no archaeological artifacts were recovered from this area, suggesting it was not utilized for mundane activities (*SI Appendices*, 2 and 3). None of the numerous small to medium-sized stones discovered near the boulder exhibited any engraved markings or signs of artificial manipulation. The notable contrast between the boulder and its surroundings strongly suggests a purposeful placement in this location, situated at the rear of the cave, distanced from the residential areas.

(b) Inspect the physical features of the cave walls: A visual inspection of the cave walls and ceiling in the immediate vicinity of the boulder, as well as other parts of the cave (*SI Appendix*, 7) revealed grooves on naturally etched surfaces in two areas of the cave: one on the ceiling adjacent to the entrance and another within the chimney (*SI Appendix*, Fig. S13). These grooves exhibit variation in their length, breadth, and depth. The grooves appear on flat surfaces and are "fissure-like." They are irregular in shape and situated above vertically descending walls with flat surfaces at their base. Together, they are aligned with the natural fractures in the rock, forming a network of cracks. In contrast, the grooves on the boulder exhibit distinct characteristics. They possess beveled walls that converge toward the bottom (Fig. 2 and *SI Appendix*, 4 and Figs. S8–S10). The lines are continuous with fewer deviations compared to those observed in natural grooves. Furthermore, the grooves on the boulder appear on three different surfaces of the stone, and the areas between these grooves appear notably smooth.

(c) The grooves' topographical characteristics: The boulder exhibits a clear differentiation between deep and shallow grooves (Fig. 2 and *SI Appendix*, 3 and Fig. S6). The deep grooves are straight, with smooth beveled walls, displaying "V"-shape

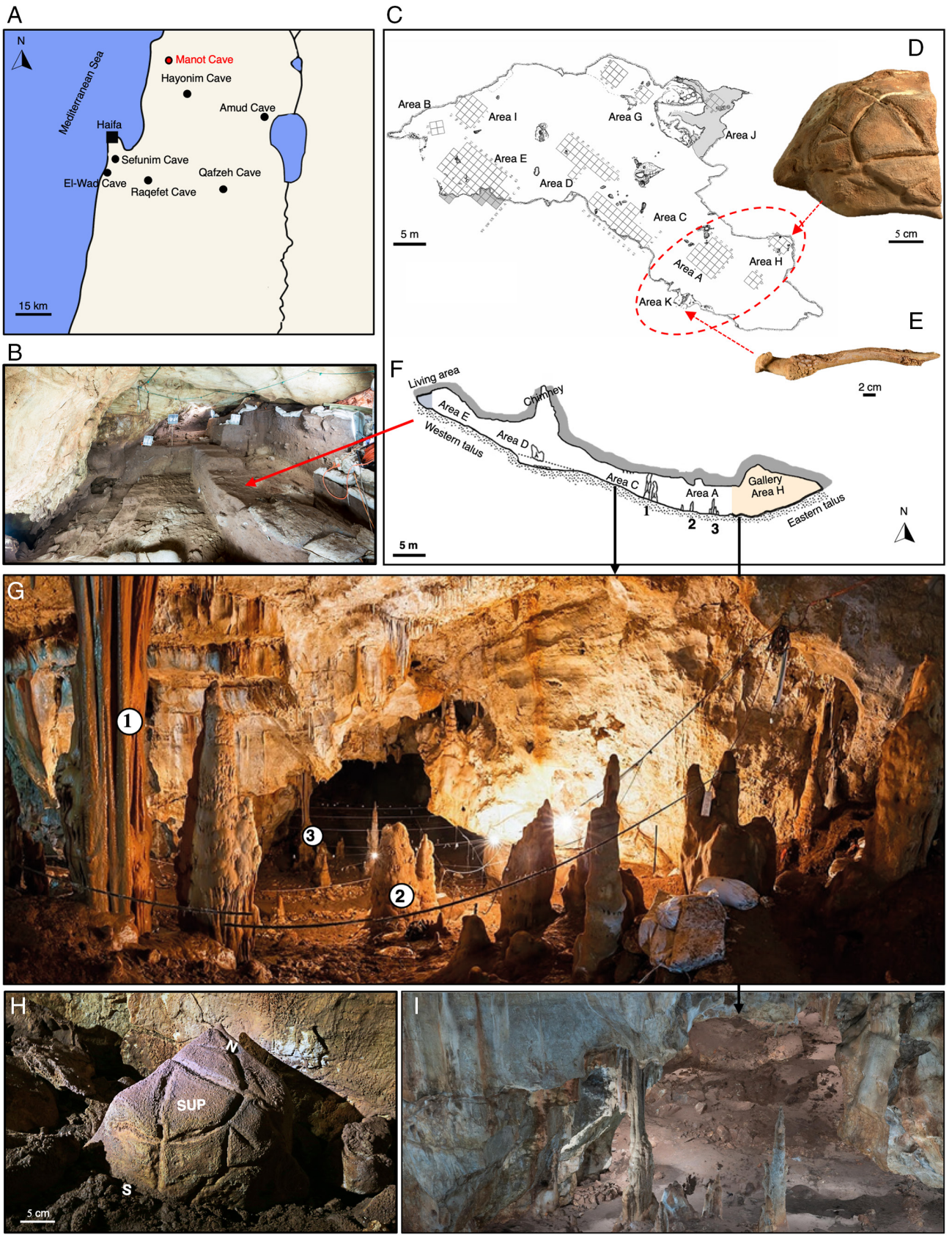

Fig. 1. The site location, the cave plan with excavated areas, and the major findings. (*A*) Location of Manot Cave and other Paleolithic sites with engraved objects. (*B*) Archaeological horizons in the major activity area at the cave entrance (Area E). (*C*) Plan of the cave with excavated areas marked. The ritual compound is marked with a dashed-line red circle. (*D*) The location of the boulder with its geometric markings. (*E*) Persian fallow deer antler retrieved from the southern "hidden" chamber next to the entrance to the gallery. (*F*) Cross-section of the cave. Note that the gallery is in the deepest part of the cave. Numbers (1, 2, 3) denote the main locations of groups of stalagmites. (*G*) Stalagmites within the cave. Note a row of speleothems at the bottom of the western talus, separating the gallery from the rest of the cave. (*H*) Superolateral view (looking northwest) of the recovered boulder (in situ). Note that the cave wall is void of similar engravings. (*I*) A three-dimensional image (3D) of the ritual compound where the engraved boulder was found. Notice the two pillars of stalagmites (forming the "gate") at its entrance.

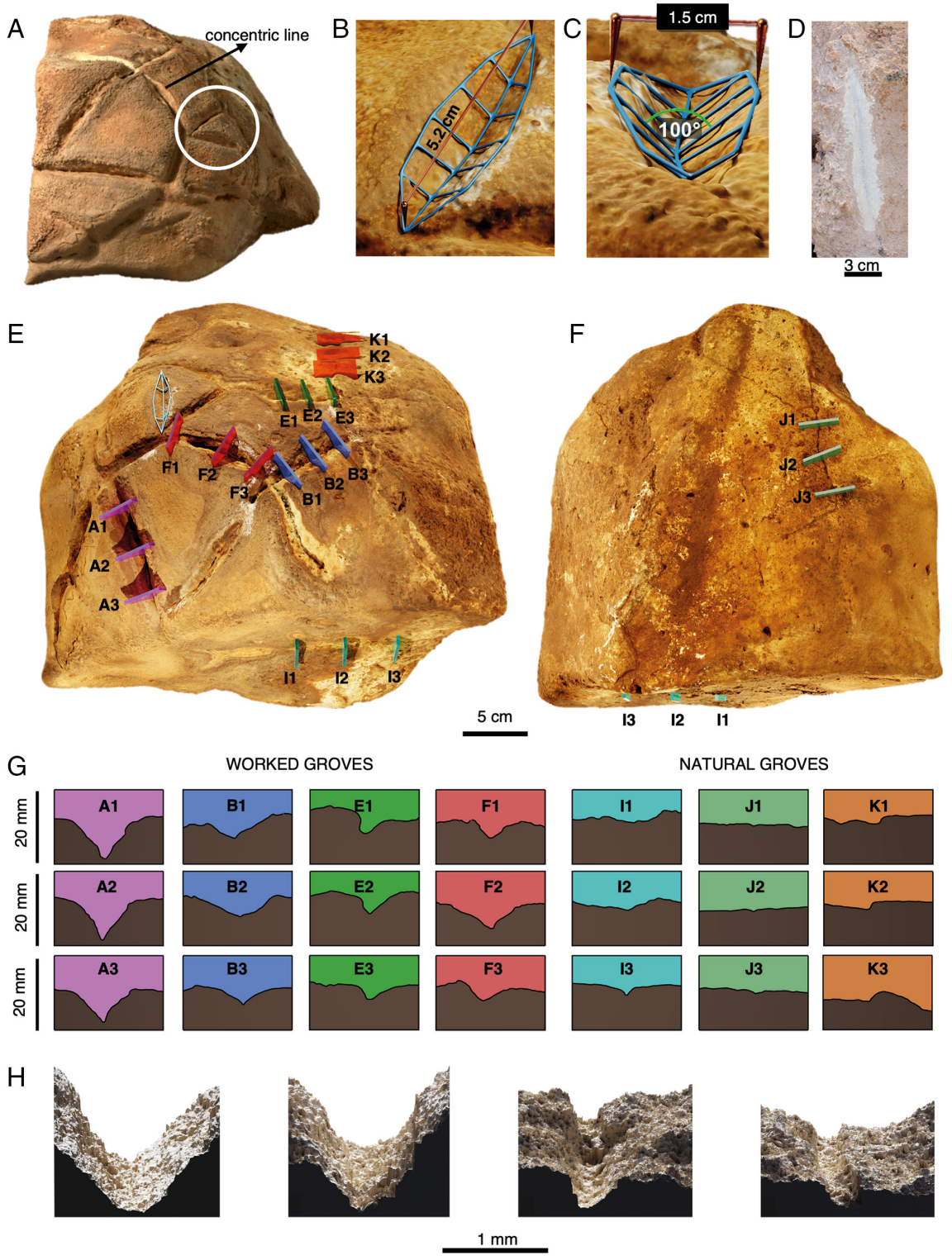

Fig. 2. Macrotopography of artificial and naturally occurring grooves on Manot Cave boulder. (*A*) The engraved boulder. Note the central concentric line (black arrow) connecting two levels of geometric signs. In the white circle "navicular," boat-shape, grooves. (*B* and *C*) Close-up views on a navicular groove, presented from two different angles. (*D*) A navicular groove was produced during the experimental study. (*E* and *F*) The locations where groove profiles were taken. (*G*) Profile (cross-section) of artificial (A1 to A3, B1 to B3, E1 to E3, F1 to F3) and natural (I1 to I3, J1 to J3, K1 to K3) grooves on the boulder surfaces. The worked groove maintains a linear appearance throughout its entire length. It possesses a V-shaped cross-section with well-defined shoulders and resembles the shape of a boat, i.e., wide in the middle and converging toward its ends. In contrast, a natural groove resembles a narrow fissure or crack. It is shallower and lacks the distinctive "V"-shape characteristic of an artificial groove. (*H*) Microphotography of both artificial (first two from *Left* to *Right*) and natural (first two from *Right* to *Left*) grooves. Natural grooves possess a gutter-like floor, in contrast to the reverse tapered sharp edge-shaped floor observed in the worked groove.

cross-sections; they appear uniform throughout their entire length (*SI Appendix*, 4 and Fig. S10) and feature distinct and sharp shoulders (Fig. 2 and *SI Appendix*, Fig. S6). Some of the deep grooves are "naviform-shaped": They are wide and deep at their mid-length and converge toward the extremities (Fig. 2 *B* and *C*). In contrast, the shallow natural grooves appear as superficial linear cracks (Fig. 2*F*) or as open cracks with irregular, rugged walls, and indistinct shoulders, often exhibiting slight crimping along the line.

Examination of the grooves on the dolomite boulder using a scanning confocal microscope (*SI Appendices*, 3 and 4) revealed linear microscratches (Fig. 3 *A*–*E*), further indicating that the grooves were produced by a repeated scratching action of the boulder surface by a sharp flint tool.

(d) Experimental engraving: A total of six grooves were reproduced on a dolomite boulder of similar size, retrieved from the cave, creating a geometric pattern with straight incisions (Fig. 3*H* and *SI Appendix*, 5 and Fig. S11). The grooves' length measures between 30 and 50 mm, with width ranging from 2 to 10 mm, and depth

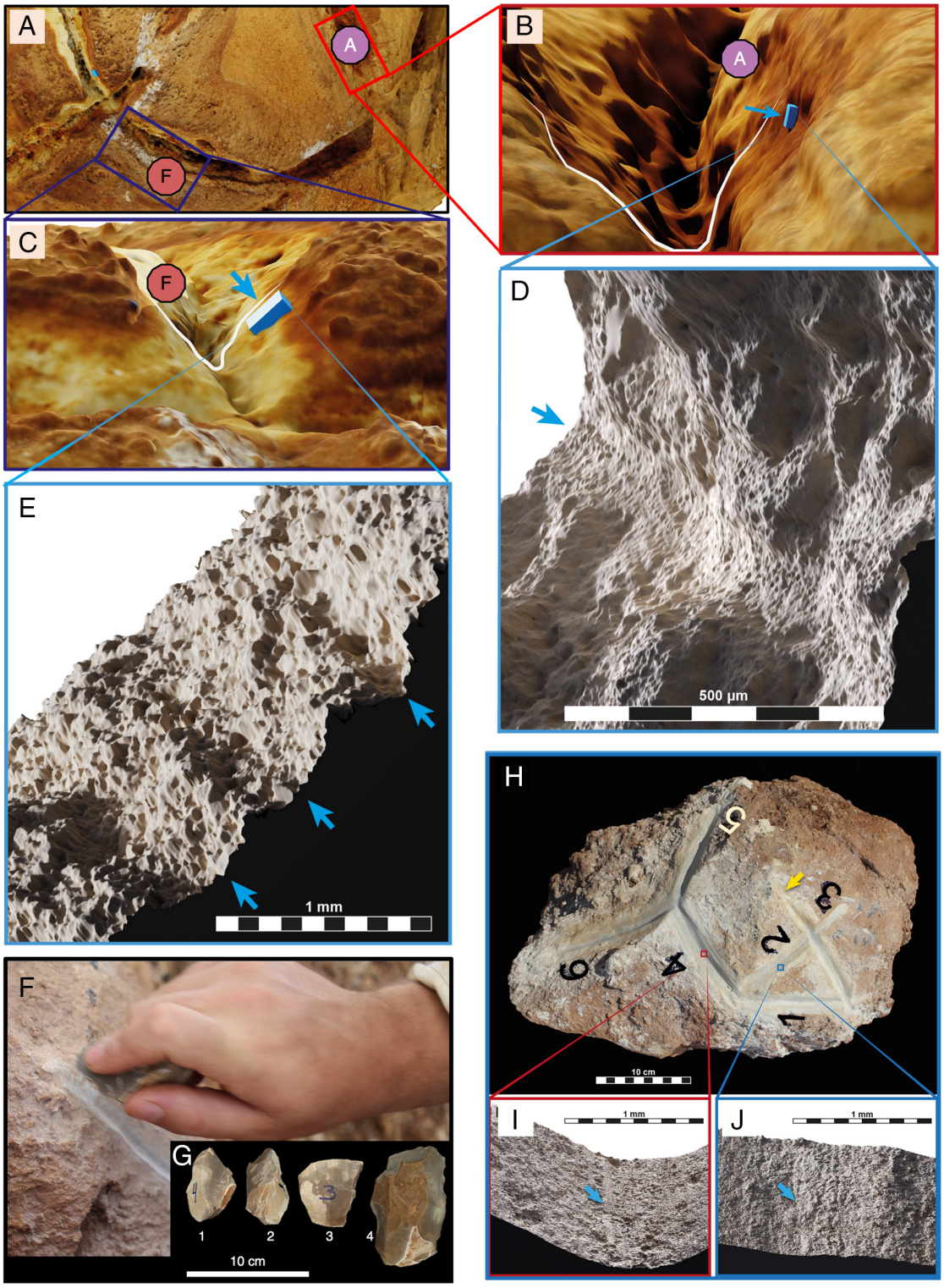

Fig. 3. Presence of microscratches on the slanting walls of the boulder grooves and experimental grooves. (*A*) The studied grooves on Manot boulder. (*B*) Groove A, a white line marks the profile of the groove, the blue arrow marks the location of the micro scratches. (*C*) Groove F, the white line marks the profile of the groove, the blue arrow points to the location of the micro scratches on the sidewall of the groove. (*D*) Micro scratches in groove A. (*E*) Micro scratches in groove F. Due to erosion, the scratches are hard to notice. Major parts of the groove were covered by crust and could not be inspected for micro scratches. (*F*) The experimental study carried out with flint tools, consisting of carinated and dihedral burins (#1 to 3) and a heavy-duty scraper (#4) (*G*) produced similar navicular-shaped grooves (*H*) and micro scratches on the side walls (*I* and *J*) due to repeated movements of the sharp flint. The starting point can be easily detected.

approximately 5 to 9 mm (Fig. 3*H*). More than 1 h was needed to create a groove with flint tools under dry conditions. Larger tools, such as heavy-duty scrapers, were more efficient than smaller tools like carinated and dihedral burins (Fig. 3*G*).

To imitate the cave's humidity conditions, water was added, resulting in increased efficiency and speed of carving. Under these conditions, a medium-sized groove was completed in 10 min. The experimentally produced grooves closely matched the shape of the grooves found on the studied boulder: They are straight, exhibit a V-shaped cross-section, and feature well-defined shoulders. Their starting point is clearly discernible, and their oblique walls converge to a shallow point (Figs. 2*D* and 3 *F* and *H*). Linear microstriations are easily detected on the sidewalls and bottom of the groove (Fig. 3 *I* and *J*). The fact that the patterns, on both the macro and micro levels, of the experimental and archeological grooves display similar characteristics further supports the anthropogenic origin of the grooves on the Manot boulder.

Determining the Age of the Engravings and Other Elements within the Complex. To establish a chronological framework for the creation of the engravings, we first dated the carbonate crust covering the boulder surfaces and the grooves using the U-Th dating method (*SI Appendix*, 8, and Fig. S14, and Table S1). The U-Th dates obtained (*SI Appendix*, Fig. S14*B*) reveal that the grooves were created before 27.8 ka and post 59.3 ka. As expected, the older dates originate from the unworked surface of the boulder.

To further refine the dating of the anthropogenic engravings, we compared the isotopic composition ($\delta^{18}O$ and $\delta^{13}C$) of the calcite crust samples taken from the boulder to the ones obtained for well-dated speleothems deposited in other parts of the cave (*SI Appendix*, 9). The isotopic values for the crust within the grooves (postengravings) on the boulder ranged between −4 and −5‰ for $\delta^{18}O$ and from −8 to −10‰ for $\delta^{13}C$ (*SI Appendix*, Fig. S14*D*). These values closely matched those of the speleothems deposited in Manot Cave approximately between ~ 37 to 35 ka (*SI Appendix*, Fig. S14*C*) (48).

Additionally, we measured the isotopic composition ($\delta^{18}O$ and $\delta^{13}C$) of the calcite crust covering a fallow deer antler recovered from the hidden chamber. The isotopic composition of this calcite crust aligns with the Manot Cave speleothems deposited at the age of 35 ka. Notably, this date aligns well with the time span of the engravings on the boulder (*SI Appendix*, Fig. S14*B*).

Space, Light, and Acoustics within the Ritual Compound. To provide additional evidence supporting the assertion that the dark, deep part of the cave was utilized for communal activities, we evaluated its capacity to host a group of individuals, indications suggesting the potential use of artificial lighting during gatherings, and the acoustic characteristics of the ritual compound to determine its suitability for public discussion and ritual ceremonies.

Space. The ritual compound spans an area of 100 m^2 and, therefore, could easily accommodate a substantial group of people (ca. 100 individuals; Jacobs' method, considering a light crowd with 0.93 m^2 per person). Given the low population density and the small group size during the Aurignacian period (49), maintaining a functional social network among groups was crucial for ensuring a viable population (n > 150). The size of the Manot Cave ritual compound could have facilitated the gathering of several human groups to engage in communal social ceremonies, in alignment with the unique features of the Levantine Aurignacian suggesting strong connections between different communities (50).

The characteristics of the Aurignacian occupation in the living area at Manot Cave, i.e., increased exploitation of small game, particularly birds, accelerated sedimentation rates, thick archaeological horizons (*SI Appendix*, Fig. S2*C*), a pronounced accumulation, and large variety of artifacts (including shells, bone tools, grinding stones, and incised bones) compared to the preceding settlement in the cave (45, 46), and the presence of skeletal remains of several individuals, (51), suggest that the cave intermittently functioned as a base camp, potentially experiencing more extended and intensive occupation periods. This may point to a shift toward a less mobile subsistence strategy, possibly facilitating the seasonal aggregation of several groups for collective practices (39, 46).

Light. We examined five stalagmites from various locations in the cave for traces of burnt organic material for potential evidence of the use of fire for lighting within the ritual compound (Fig. 4 and *SI Appendix*, 10). The sole stalagmite (#1048) that yielded evidence of dark carbon-rich particles (soot) in its lamina is from the ritual compound (Fig. 4). Moreover, carbon-rich particles within the stalagmite's matrix were exclusively detected in the lamina dated to ca. 36 ka, with no such spots in earlier or later laminae (*SI Appendix*, Fig. S15). Since no remnants of hearths were uncovered within the ritual compound, it is assumed that the use of fire was likely in the form of a portable source, such as torches or ephemeral, short-lived fireplaces that did not leave behind preserved traces. These means of lighting would produce less smoke and gas (52). The other speleothems examined, including those from the western talus (#1020; #1044, #1045) and the cave entrance (#1052), did not exhibit similar evidence of burnt wood ash particles.

It is well accepted that deep, dark places in caves where parietal art exists cannot be navigated without controlled artificial light (53). Evidence of artificial lighting in caves from the Upper Paleolithic appears in various forms, such as combustion residue on cave walls (charcoals and black charred marks), charred organic remains of fireplaces, wooden torches, and portable lamps (52, 54–59). Nevertheless, most of the direct evidence for artificial lighting emerges post-Aurignacian, notably during the Magdalenian onward (2).

Acoustics. To evaluate the acoustic properties of the ritual compound, acoustic tests were conducted at various locations within the cave. The reverberation time (Rt) measured for the ritual compound (0.7 s > Rt60 > 1.2 s) falls within today's standard for classrooms, allowing comfortable conversations and listening. The association between the location of cultural and artistic innovations in prehistoric caves and acoustic response has been noted in several studies (60–62).

Discussion

Exploring the temporal and geographical origins of communal rituals and associated activities within cave sites is crucial for understanding the evolution of social behavior among humans. While debates persist in the European context, this study provides a conclusive response for the Eastern Mediterranean region, indicating that such practices were conducted during the EUP period, approximately 38,000 to 36,000 y ago.

Identifying ritual compounds within archaeological sites poses significant challenges. The prevailing notion is that such compounds are usually associated with distinctive architectural elements or unique sets of objects that markedly differ from the broader cultural remnants of a studied site or region (e.g., refs. 21, 63, and 64). This task becomes even more complex in Paleolithic archaeology, where architectural and sacramental paraphernalia are rare and difficult to recognize, even when present within the material culture. Nevertheless, there are specific contexts that may bear evidence of Paleolithic ritual activities, such as diverse burial complexes associated with grave goods and offerings reflecting spiritual beliefs (65).

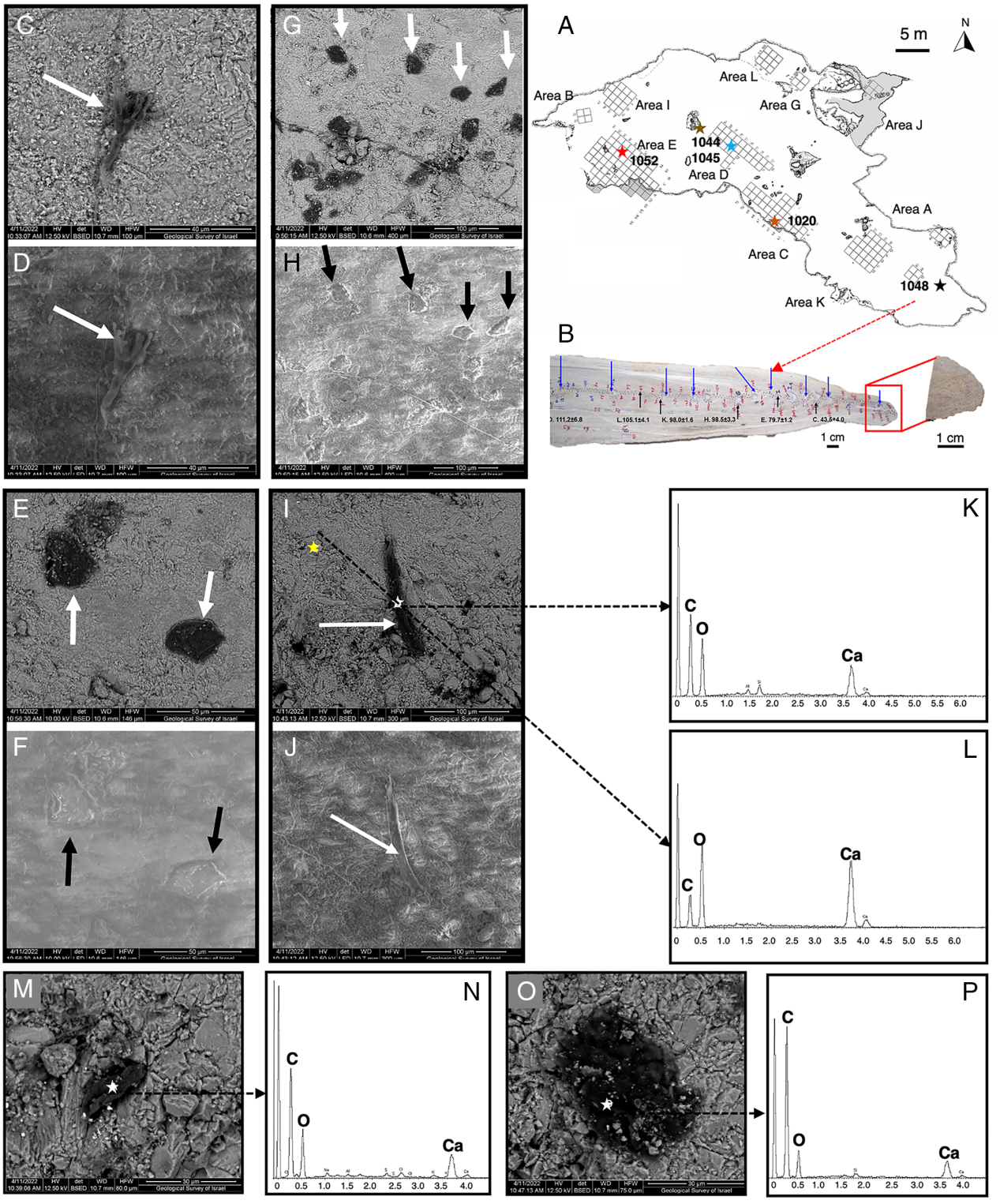

Fig. 4. Stalagmite analysis bearing evidence for fire within the ritual compound. (*A*) Map of the cave showing the locations of the stalagmites sampled for the presence of nearby fire (samples 1,020, 1,044, 1,045, 1,048, 1,052); (*B*) Stalagmite from Area A (sample 1,048; the entrance to the ritual compound). *C–D*, *E–F*, *G–H*, and *I–J* are pairs of Back Scattered Electron (BSE) and Secondary Electron (SE) images, respectively, of stalagmite 1048. The darker rounded spots are composed almost entirely of carbon (C) as determined by the Energy Dispersive Spectrometer (EDS) (*K*), whereas the small peaks of Ca and O derive from the $CaCO_3$ background. For comparison, the EDS spectrum of a typical $CaCO_3$ is presented, showing much higher peaks of Ca and O content relative to C (*L*). *M–N* and *O–P* are pairs of BSE and EDS of dark spots indicating also that they are C-rich organic matter.

Symbolism and Ritual in the Paleolithic Era. Paleolithic ritual practices leave various lines of evidence, with selected animal remains playing a crucial role. Antlers, jaws, and tortoise shells have been reported from Middle Paleolithic and Epipaleolithic burials in the Levant (66–68). Another compelling piece of evidence arises from the deliberate deposition of selected animal remains in specific areas of caves, as seen, for example, in Chauvet Cave (France), where a bear skull (*Ursus spelaeus*) was deliberately placed on a prominent limestone block (69), or by the abundance of herbivore crania in MP contexts at Cueva Des-Cubierta site in central Spain (70).

The third line of evidence supporting Paleolithic ritual practices is drawn from parietal (rock) art, widely acknowledged as a significant expression of ritual behavior (1, 71, 72). However, Upper Paleolithic (ca. 48 to 22 ka) rock art is predominantly concentrated in Western Europe, with no representation as yet in the Levant, and limited representation in other parts of the Old World, i.e., Central Asia (Georgia) (73), Southeast Asia, specifically Sulawesi and Borneo (5, 6, 74), Australia (8, 9), and Africa [Botswana (4) and Egypt (3)]. Does the absence of parietal art in certain regions, including the Levant, imply that very few ritual activities occurred outside Western Europe during the Upper Paleolithic period? Or did they simply involve different material accouterments than in Western Europe?

Numerous Upper Paleolithic sites in the Levant contain data suggestive of rituals, such as decorated artifacts (75). However, these findings often become "absorbed" within the general material culture characteristics of a specific cultural entity or are discussed in the context of cross-regional connections rather than being explicitly linked to ritual activity (50, 76–78).

The unique physical features of Manot Cave (Movie S1), with its clear separation between the entrance area designated for living and the cave's rear, enable us to focus on the unique elements recorded in the deep, dark part of the cave, disentangling them from the assemblages associated with daily life.

The deep, difficult-to-reach section of Manot Cave reveals distinctive features absent in the living area. Notable among these are a spacious, leveled circular hall physically separated from the living space by an impressive row of stalagmites, complete darkness, an absence of discernible archeological horizons, the presence of a large, engraved boulder strategically positioned adjacent to the ritual compound wall overlooking the hall, evidence of intentional lighting, and a fully preserved antler displaying signs of use (*SI Appendix*, Fig. S12). Remarkably, all these elements align temporally, dating approximately to the same period (37 to 35 ka), corresponding to the Levantine Aurignacian occupation at the cave (41, 44). Considering together the nature of the artifacts found and the characteristics of the setting strongly suggest that some form of nondomestic activity took place at the deep, dark part of Manot Cave, probably ritual in nature.

As demonstrated, the engraved boulder exhibits human-made geometric signs created with sharp tools. Notably, the grooves were made on the globular surface of the boulder, providing it with a three-dimensional perspective. The globular shape of the boulder, featuring two rows of incised geometric shapes, resembles a tortoise's shell (*SI Appendix*, Fig. S16 *A*–*F*). This marks, as of now, the only large engraved boulder identified from the Levantine Upper Paleolithic. The only additional Upper Paleolithic Levantine artifact featuring an animal representation is the unique incised small limestone slab discovered in Hayonim Cave Layer D, also attributed to the Levantine Aurignacian (78, 79). While engraved boulders portraying animals such as horses and aurochs or vulvas, cup and ring marks are common in Aurignacian sites in Europe, such as Abri Cellier and Abri Castanet, the depiction of tortoises is notably absent (80–82).

Also noteworthy, although geometric signs were prevalent in the Paleolithic era (83), none exhibit the level of complexity and sophisticated 3D spatial arrangement observed on the Manot Cave boulder. Furthermore, while most Paleolithic geometric patterns, whether engraved or painted, typically appear on cave walls (parietal art) or mobile objects, in Manot Cave, they appear on an isolated large boulder. The fact that the engraved boulder is different in shape and size from the surrounding stones (*SI Appendix*, 3) suggests that the stone was intentionally selected (due to its distinctive shape) for carving and that moving it to its desired location required the coordinated efforts of several individuals.

Considering the widely accepted notion that Paleolithic geometric signs reflect symbolic thought and are linked to the emergence of cognitively modern behavior (83), together with the context of the engraved boulder (located in a large, impressive hall), the evidence from Manot Cave suggests the existence of a ritual compound. The important role rituals play in the evolution of social complexity and the development of group cognition has been discussed in several studies (2, 21, 84–86).

Tortoise as a Symbol. The unique three-dimensional arrangement of the geometric signs on three faces and the overall shape of the Manot boulder has allowed us to identify it as a figurative depiction of a tortoise (*SI Appendix*, Fig. S16), likely serving as an important "icon" in the Upper Paleolithic culture. The reasoning behind the Manot artist's choice to represent the tortoise in a semiabstract and symbolic manner remains unknown. It is noteworthy, however, that abstract representations of animals were a common practice in the Paleolithic period (1, 71, 72, 87), and that Paleolithic people likely depicted animals that held significance in their myths, religious practices, or as subjects of hunting and gathering (25, 83).

Remains of the Mediterranean land tortoise (*Testudo graeca*) have consistently been identified in Levantine sites dating back to the late Lower Paleolithic (88). From the Middle Paleolithic onward, the number of tortoise remains increased, providing evidence for their extensive exploitation as an important dietary supplement at some sites (*SI Appendix*, Fig. S16*G*) (89–91). The presence of tortoise remains in the Aurignacian and Ahmarian assemblages at Manot Cave (*SI Appendix*, Fig. S16*G*) (46), suggests that the local inhabitants exploited this species (*SI Appendix*, 11). Beyond their dietary importance, tortoises probably played a major role in the spiritual world of the Paleolithic people, possibly because of the resemblance in form and function between the shell and the cave, both providing shelter and protection (*SI Appendix*, Fig. S16) (92, 93). In the Epipaleolithic period, tortoise remains have also been associated with burial practices (66, 94).

The engraved pattern on the Manot boulder exhibits a striking similarity to the engraved "chevron plaquette" discovered (ca. 25,000 to 23,000 cal BP) at the Epipaleolithic site of Ein Qashish South near Mount Carmel (95) (*SI Appendix*, Fig. S17). Despite differences in size and a temporal gap of approximately 12,000 y between the two, both objects share a comparable geometric pattern incised on the rounded surface of the stone.

The symbolic use of tortoises became notably more prominent during the Late Epipaleolithic, as evident in various Natufian sites. At Hilazon Tachtit Cave, approximately 70 tortoise shells were discovered in association with a burial suggested to be that of a shaman (66). Another example is the decorated monolithic limestone featuring a schematic depiction of a tortoise found in building 2 at the Natufian site of Wadi Hammeh 27 (96). This monolith, measuring 1.2 m, likely formed part of a communal arrangement.

The portrayal of the tortoise in Natufian contexts appears more naturalistic (albeit still schematic) compared to the one discussed here, with the scutes marked by concentric patterns rather than chevrons and triangles.

In the Levant and across the broader Eastern Mediterranean region, from the Neolithic onward, turtles (terrestrial and aquatic) continue to hold significant cultural and religious importance within local populations (97–99). One of the most exciting findings from the Pre-Pottery Neolithic period is the depiction of two dancing persons and a turtle between them on a sherd of a limestone bowl from Nevalı Çori (19).

While various animals play a crucial role in many religious and mythological beliefs (92, 93), the tortoise has received notable attention as a cosmic symbol in different cultures, e.g., in Mayan symbolism, the tortoise's shell represents the earth. Likewise, among indigenous peoples in North America, the world was thought to have been created on a turtle's back (100). Characterized by its distinctive body form and slow motion, the tortoise is seen as the embodiment of the entire cosmos, symbolizing perseverance, solidity, strength, and stability across space and time (92, 93).

The assembly of a substantial crowd in the deepest and darkest section of Manot Cave would have been impractical without a viable light source. The presence of dark carbonized particles in the speleothem (#1048), positioned five meters away from the engraved boulder, strongly suggests the utilization of fire within the deep chamber. While previous studies have proposed the use of fire to illuminate deep cave areas, primarily in the context of creating rock art in the Upper Paleolithic (101, 102), they often lacked compelling evidence for such practice, a gap addressed in our current study.

The absence of evidence for permanent hearth features in the deep part of Manot Cave, coupled with the detection of carbon-rich particles in the lamina of the single stalagmite #1048, points toward the use of portable fire sources, possibly torches, in this section of the cave.

The reason for the presence of carbon-rich particles in stalagmites at the ritual compound, but not in stalagmites close to the entrance where the remains of hearths were found can be related to two entwined factors: 1. In the ritual compound, torches were held high above the ground, and in the absence or minimal presence of air circulation, wood ash particles dropped from the torches, scattered, and were trapped in the speleothems; 2. Near the cave entrance, where the living area is located, fire was used for food cooking. These open fires were situated on the floor in a well-ventilated area that allowed smoke and ash to disperse quickly outside the cave. It has been shown that proper ventilation of the living area is mandatory for cave habitation (103, 104).

The complete fallow deer antler with signs of use (*SI Appendix*, Fig. S12) on the floor of the hidden chamber (*SI Appendix*, Figs. S4 and S6 *E* and *F*), coinciding with the dates of the grooves and lighting (*SI Appendix*, 8), is significant and may relate to the function of the deep part of the cave. While antlers were commonly utilized as raw material for various purposes in Upper Paleolithic European cultures (15, 77, 101), in the Levantine Upper Paleolithic they were relatively scarce except during the Aurignacian when they were systematically exploited for crafting, making hunting weapons, and decoration (78, 105). Complete antlers from the Levant are documented from the Middle Paleolithic, often serving as grave goods. For example, a Mesopotamian fallow deer antler was intentionally deposited with the burial of Qafzeh 11 (37), and a roe deer shed antler was recovered in proximity to the partially articulated Neanderthal remains at Ein Qashish (106).

Thus far, Manot Cave is the only site in the Levant to yield clear evidence for the existence of a communal ritual compound in the Upper Paleolithic. Until this discovery at Manot Cave, it was generally believed that ritual and communal spaces in the Levant, either in caves or in the open air, began in the late Epipaleolithic Natufian culture (66). The current study demonstrates that the first step toward communal ritual ceremony was made in the Levant at least by the EUP. The practice of ritual activities in designated compounds continued after the Upper Paleolithic, where spaces at the deepest part of the caves were used. Natufian people still used caves for ritual purposes [e.g., Hilazon-Tachtit Cave (66)], but had also built special communal structures in open areas [e.g., Wadi Hammeh 27 (96)]. In the Neolithic, these communal structures evolved into what we generally conceived as shrines [e.g., Gobekli Tepe (19, 23)]. From the Neolithic period onward, the focus shifted to human representations, as seen in the plastered skulls and human lime plaster statues (107, 108).

The Manot Cave ritual compound also marks the shift to animal representations. While early engravings, evident in the Middle Stone Age and Middle Paleolithic sites such as Blombos, Qafzeh, and Gorham Caves, were simple (the incised patterns consisted of lines, chevrons, and triangles), and usually applied to portable objects (33, 109–112), no animal representations are evident. In the Upper Paleolithic, there is a shift to animal representations, as shown in the European cave parietal and portable art (18, 83). In the Levant at Manot Cave, but also at Qashish South (95, 113), simple engraved patterns were applied to three-dimensional objects such as boulders and pebbles to create an abstract animal depiction (*SI Appendix*, Fig. S17). Such representations are also noted in the West European Aurignacian, with animals depicted on boulders (80), although realistic representations are also documented, such as in the German Swabia region (18). Yet, these small carved animal figurines in European Aurignacian sites were used in daily life (18) rather than being contextually isolated and used in special settings such as the Manot boulder. Realistic animal representations in the Levant appeared in the Natufian, portraying turtles, deer, and other animal figures in a very accurate way, and continued thereafter (114–116).

Summary. Our data from Manot Cave testify to the existence of some initial forms of collective ritual practices already in the EUP. This paper presents the earliest evidence of ritual in a deep cave in the Levant.

It has long been suggested that the deep, dark part of Paleolithic caves were used as cult shrines (117) or ritual spaces (118, 119). Clottes (2), who studied ritual cave use in the European Paleolithic, concluded that deep caves played a major role in humans' evolving religion. Manot Cave thus supplies the earliest evidence for some sort of religious behavior from the Paleolithic Levant. As rituals promote group cohesion (120), the existence of a ritual compound at Manot Cave is not surprising, it served to enhance the union (increase intra- and intergroup solidarity) between people in and around the cave, a successful adaptive strategy to cope with the large demographic and economic challenges human society faced in the Upper Paleolithic. This aligns with our understanding of the Levantine Aurignacian, which was characterized by more permanent settlements, and intensive occupations (40), compared to other cultural entities in the Levantine Upper Paleolithic (46).

Regarding the unique ritual object within the compound in Manot Cave, we have demonstrated that the Manot engraved boulder is unique in several aspects: A) it is the only engraved boulder found in the Upper Paleolithic Levant; B) its size and location differ from those of other engraved Upper Paleolithic objects; C) it was closely associated with an artificial source of lighting; and D) it features geometric signs that suggest the representation of an animal, specifically a tortoise. This discovery marks the beginning of a transition toward portraying animals in Levantine prehistoric art and initiating rituals centered around an animal figurine.

Conclusions

The current study suggests that the Upper Paleolithic Aurignacian inhabitants of Manot Cave engaged in communal activities centered around a symbolic object located in the deep, dark part of the cave. The Manot engraved boulder serves as a profound testament to the vibrancy of Paleolithic life and exemplifies the

intricate mechanisms that early human societies developed to sustain social cohesion and expand social networks.

Methods

The applied methodologies are detailed in the main text, while the technical procedures conducted in this study are extensively outlined in the accompanying supplements: groove shape analysis (*SI Appendix*, 4)–Our approach involved analyzing and comparing the morphology of the grooved pattern using topographic cross-sections of the boulder's surface. These cross-sections were computed from the 3D model perpendicular to the locality of the carved sections and were treated as planar curves. A stereomicroscope was used to identify microscratches within the grooves; experimental engravings (*SI Appendix*, 5)–Using lithic flint tools, comparable grooved patterns were reproduced on a dolomite block of similar size; dating (*SI Appendix*, 8)–For the purpose of U-Th dating, carbonate crust samples were drilled from ten localities on the boulder. Two control samples were extracted from the boulder's surface, assumed to represent aged calcite accumulations. The remaining eight samples were obtained from crusts within the grooves; (*SI Appendix*, 9)–Oxygen and carbon isotopic composition ($\delta^{18}O$ and $\delta^{13}C$) of the calcite crust samples taken from the boulder was compared to the ones obtained for well-dated speleothems deposited in the cave; lighting identification (*SI Appendix*, 10)–the use of fire within the ritual compound in the form of a portable source, such as torches, was identified by carbon-rich particles within the stalagmite's matrix, detected using environmental scanning electron microscope images: Back scattered electrons image (top line), and secondary electron images. The chemical composition of the darker spots was determined by an energy dispersive spectrometer (EDS),

Data, Materials, and Software Availability. All study data are included in the article and/or supporting information.

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