Footprint Record of Upper Paleolithic Caves in NW Eurasia

Version 8 — 2026-06-16

Part 1: Sealed caves — 9 sites, ~36,000–7,000 BP — chronological order (oldest → most recent)

This chart synthesises footprint data from nine naturally sealed caves documented in Pastoors and Lenssen-Erz (Springer, 2021), supplemented by five post-publication studies. The footprint record shows that cave visitors frequently comprised multi-generational groups including small children, with direct evidence of child play at multiple sites. These 9 sites are caves where the environment was naturally sealed — by collapse, stalagmite growth, or restricted access — preserving footprints dating from ~36,000 to ~7,000 BP.

These are not the only caves with prehistoric footprints — they are the caves where footprints happened to survive. Six of nine are in southwestern France, reflecting the intersection of limestone karst geology and natural sealing events rather than any underlying pattern of prehistoric cave use. Part 2 documents sites where caves were not sealed — and what happened to the evidence.

Sources beyond the book: Ledoux (2019) PhD thesis, Univ. Bordeaux (Cussac + Fontanet); Ledoux et al. (2021) Sci. Reports 11:22727 (Cussac footwear); Pastoors et al. (2016) Quat. Int. (Pech-Merle San trackers); Citton et al. (2017) Quat. Sci. Rev. 169: 50–64 (Basura); Garcia (1999) Int. Newsl. Rock Art 24: 1–4 (Chauvet).

Patterns Across All Sites

Multi-generational groups with children:

Seven of nine caves record children among visitors, including ages as young as three (Basura). Group compositions are small (typically <15 individuals), mixed-age, consistent with multi-generational groups rather than institutional gatherings.

Evidence of child activity:

Sustained play behaviour documented at Fontanet (sliding, clay-throwing, multi-directional movement) and Basura (clay balls on walls, originally interpreted as ritual by Blanc 1960, now understood as children's activity per Citton et al. 2017).

Spatial structuring:

Different activities in different chambers at every site. Deepest and hardest-to-reach points consistently associated with the most significant activities (art-making, clay modelling, funerary deposits).

Rare visitation:

At the three sites with high-confidence recording windows — Cussac (~3,000 cal years), Ojo Guareña (~15,000 years), Tuc d'Audoubert (~700 cal years) — between one and four visits are documented. Most caves record a single visit event.

Preservation asymmetry:

Footprints survive in deep, undisturbed zones. Zones of sustained occupation destroy footprint evidence (demonstrated at Fontanet where Zone 2 lost prints to runoff while deeper Zone 1 preserved 69+ prints).

No elderly in deep zones:

Consistent across all nine sites. May reflect demographic patterns or physical demands of access.

> Group compositions across all nine sites are inferred from foot morphology and stature estimation — methods that distinguish children from adults with reasonable confidence but that may not reliably separate elderly individuals from younger adults on morphometric grounds alone. The consistent absence of elderly-attributed prints in deep zones is therefore compatible with two explanations: it may reflect an actual demographic pattern in which older individuals did not undertake deep cave excursions, or it may reflect a methodological limitation in which elderly prints are present but undetectable as a distinct age category.

Table 1. Sealed caves — 9 sites

Cave	Location	Date (approx.)	Who	Recorded Behaviours
Chauvet	Ardèche, France	~36,000–26,000 BP (Aurignacian / Gravettian)	1 boy (~8 yrs)	Solo movement through deep cave; stops to clean torch (charcoal dated ~26,000 BP); art-making in deep chambers; footprints cross bear and wolf tracks (Garcia 1999).

Cave	Location	Date (approx.)	Who	Recorded Behaviours
Pech-Merle	Lot, France	~25,000 BP	5 individuals; 17 footprints: 2 men, 2 women, 1 boy (~9–10 yrs)	Transit corridor (Pastoors et al. 2016). Four moving west; one woman moving east carrying load. Boy steers away from drop-off. All passed through once. Rejects Lemozi's 1929 "priestess and child" interpretation.
Cussac	Dordogne, France	28–31 ka cal BP (Middle Gravettian)	7 footprints; adults wearing soft leather footwear	Only cave where people wore shoes — moccasins (Ledoux et al. 2021). 1.6 km gallery with engravings; human remains in bear hibernation nests. Footwear protective or symbolic/social marker unknown.
Ojo Guareña	Burgos, Spain	~19 ka BP – ~4.3 ka BP; 4 episodes / ~15,000 yrs	9–11 individuals (Chalcolithic); 1,200+ prints	Round-trips documented; one individual inspects side passage; 4 separate visits across ~15,000 years; no association with symbolic spaces in deep sector.
Tuc d'Audoubert	Ariège, France	17,200–16,500 cal BP (Magdalenian)	14 subjects (max 5 visits, 2–6 per visit). Adult male-female core pair; children in separate gallery	Couple traverses 10 locations; male handles bear bones; children in Galerie des Petits Pieds; clay bison in deepest chamber; fully structured spatial use.
Basura	Liguria, Italy	~12,340 BP	~30 prints; 3 juveniles in Sala dei Misteri: ~3 yrs, ~6 yrs, ~12–13 yrs	Crawling on all fours; morphometric reanalysis (Citton et al. 2017) — all juvenile, no adults in this room. Clay balls = children's activity, not ritual.
Niaux	Ariège, France	~13,000 BP (Magdalenian)	Two girls (~9 and ~12 yrs)	Movement through Diverticule des Empreintes; San trackers read as two children moving, not ritual dance.
Fontanet	Ariège, France	12,770 ± 420 BP (Magdalenian IV)	69+ prints; predominantly juveniles (statures 114–142 cm); 1 adult	Zone 1 (deep): children's play, sliding, clay-throwing. Zone 2 (near entrance): art, hearths — prints lost to runoff (Ledoux 2019). Exceptional preservation: fingerprints, skin creases, fingernails. Canid tracks recorded alongside human prints. San trackers identified 13 individuals; morphometric count 2–6 — discrepancy unresolved; an open methodological question about the two approaches.
Aldène	Hérault, France	Mesolithic (~10,000–7,000 BP)	Family group; 400+ prints over 50m	Torch management documented; planned speleological exploration with anticipated return.

Table 1. Sealed caves: 9 sites in chronological order. All data from Pastoors and Lenssen-Erz (2021) unless otherwise cited.

Chapter references: Cussac: Ch. 4 + Ledoux et al. (2021) + Ledoux (2019). Basura: Ch. 14 + Citton et al. (2017). Pech-Merle/Niaux/Fontanet: Ch. 6 + Pastoors et al. (2016) + Ledoux (2019). Aldène: Ch. 15. Chauvet: Garcia (1999). Tuc d'Audoubert: Ch. 13. Ojo Guareña: Ch. 17.

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Part 2: Comparative dataset — 6 unsealed sites in open or eroding environments

The following sites fall outside the geographic and temporal scope of the primary dataset but are included as comparative context — they demonstrate what happens to footprint evidence in unsealed environments across a broader range of periods and locations. Trachilos (Crete, ~6 Ma) and Quesang (Tibet, ~169–226 ka) extend the record deep into pre-*Homo sapiens* time; Happisburgh (Norfolk, ~850–950 ka) documents the oldest known hominin footprints outside Africa. Together with the Upper Paleolithic and Mesolithic sites, they confirm that the preservation asymmetry identified in the sealed-cave dataset is not period- or region-specific: without geological sealing, footprint evidence is lost regardless of age, climate, or location.

Part 1 documents caves where footprints survived because the environment was sealed. This section documents the opposite: sites where footprints were found in caves or surfaces that were never sealed — open to visitors, weather, tides, or theft. In most cases, significant evidence was damaged or destroyed. Where prints survived unsealed, it was through unusual luck — ash cover at Theopetra, mineralization at Quesang. The pattern is consistent: without sealing, footprints are lost.

Site	Region	Date (approx.)	Who	Status	What Happened
Trachilos	Crete, Greece	~6.05 Ma (Miocene)	29 tracks; hominin (species debated)	Vandalized & stolen	Oldest known hominin footprints in Europe. 4–5 prints chiseled out and stolen 2017 (recovered). Others spray-painted. 3D-scanned before theft. Site buried for protection (Gierliński et al. 2017).
Quesang	Tibet, China	~169–226 ka BP	5 handprints + 5 footprints; 2 children (~7 and ~12 yrs)	Exposed, intact	Children pressed into soft travertine at hot spring, hardened to limestone. Open-air at 4,200 m. Possibly oldest parietal art. Earliest hominins on Tibetan Plateau (Zhang et al. 2021).
Theopetra Cave	Thessaly, Greece	~135,000 BP	3–4 prints; Neanderthal children (~2–7 yrs)	Survived (open)	Cave never sealed — occupied 130,000 years. Children walked on fire ashes. Among oldest Homo footprints in Europe. Managed archaeological site.
Vârtop Cave	Apuseni Mts., Romania	~62–68 ka BP	Originally 3 prints; 1 survives. Neanderthal	2/3 stolen	Discovered 1974 in moonmilk. Two prints stolen after discovery. First recognised Neanderthal footprint (Onac et al. 2005).
Ciur-Izbuc	Romania	~36,500 BP	Originally ~400; <100 survive. 6–7 individuals	75%+ lost	Open to tourists since 1965. 300+ prints destroyed by foot traffic. Re-evaluated 2012 with 3D mapping.
Happisburgh	Norfolk	~850–950 ka BP	≥5 individuals; adults + children; possibly H. antecessor	Destroyed (2 wks)	Oldest hominin footprints outside Africa. Exposed May 2013, destroyed within two weeks. 3D photogrammetry captured before loss (Ashton et al. 2014).

Table — Unsealed sites: 6 comparative sites. Red = catastrophic loss; amber = survived or eroding.

Summary: Of 6 unsealed sites, 4 suffered catastrophic loss (theft, destruction, or 75%+ damage). The 2 survivors owe their preservation to unusual geology — not human protection. This confirms the preservation asymmetry identified in the sealed-cave dataset: footprints survive only where geological accident sealed or protected them, biasing the record toward deep, undisturbed zones.

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Abstract

This paper synthesises footprint data from nine naturally sealed caves documented in Pastoors and Lenssen-Erz (2021), supplemented by five post-publication studies. The footprint record shows that cave visitors frequently comprised multi-generational groups including small children, with direct evidence of child play at multiple sites. Behavioural patterns are consistent across caves spanning from the Aurignacian through the Mesolithic: small groups, children present in deep zones, spatially structured activity, and rare visitation. At sites where recording windows can be estimated, the evidence records between one and four visits across periods ranging from 700 to 15,000 years — with Ojo Guareña returning four visits across ~15,000 years of continuous accessibility. A preservation asymmetry is identified: footprints survive preferentially in deep, undisturbed zones where transient and exploratory activity occurred, while zones of sustained occupation tend to destroy footprint evidence.

Keywords: cave ichnology; Upper Palaeolithic; prehistoric footprints; behavioral archaeology; preservation asymmetry; indigenous tracking

1. Introduction

The use of caves by Palaeolithic humans has attracted sustained and growing scholarly interest across archaeology, palaeoanthropology, and cognitive science. Caves are among the most intensively studied contexts in prehistory — as sites of art-making, burial, symbolic behaviour, and habitation — and the evidence they contain has fundamentally shaped understanding of early human cognition, social organisation, and ritual life. Yet most of this interpretive tradition has rested on material culture: pigment on walls, ochre, carved bone, lithic assemblages. The direct record of human bodies moving through these spaces has until recently received far less systematic attention.

Footprint evidence offers something the art and artefact record cannot: a record of specific individuals — their age, sex, gait, group size, and movement trajectories — at a particular moment in time. Since the 1960s, ichnological studies have produced a direct record of who was physically present in these spaces, how many people entered, what they did while inside, and — in combination with radiocarbon dating and stratigraphic evidence — how often caves were visited (Pales 1976; Duday and Garcia 1985; Garcia 1999; Pastoors et al. 2015, 2016; Ledoux 2019; Citton et al. 2017). This evidence body is of considerable value for understanding Palaeolithic cave use, and it has been substantially enriched by two recent developments: the application of high-resolution 3D photogrammetry to footprint documentation, and the integration of indigenous tracking expertise — particularly from San ichnologists — into the reading of prehistoric prints.

This paper synthesises the available footprint evidence from nine naturally sealed caves in northwestern Eurasia, drawing on the landmark synthetic volume of Pastoors and Lenssen-Erz (2021) and five post-publication studies that revise or extend its findings. A comparative dataset of six unsealed sites is examined to establish what happens to footprint evidence in the absence of geological sealing. Together, these datasets support a coherent account of Upper Palaeolithic sealed-cave use and identify a structural bias in the preserved record that has implications for how this evidence is interpreted.

2. The Dataset: Nine Sealed Caves

The dataset comprises nine caves in which human footprints have been preserved by natural sealing mechanisms — entrance collapse, stalagmite growth, or restricted passage access — preventing subsequent disturbance. All nine are documented in Pastoors and Lenssen-Erz (2021). Five entries have been supplemented by post-publication studies that revised key identifications or added new data.

A note on dating: no footprints in this dataset are directly dated. All dates derive from associated materials — charcoal, bone, cultural diagnostics — and attribute the footprints to the same period by spatial and stratigraphic association. The dates mix uncalibrated radiocarbon years (BP) and calibrated dates (cal BP) as given in the source publications. Where uncalibrated dates are used, the actual calendar age is older, in some cases substantially.

Six of the nine caves are located in southwestern France, concentrated in the Ariège and Périgord regions. This geographic clustering reflects the intersection of two conditions necessary for footprint preservation — cave formation in limestone karst geology and natural sealing events — rather than any underlying pattern of prehistoric cave use.

The temporal range extends from the Aurignacian (Chauvet, ~36,000 uncalibrated BP) through the Mesolithic (Aldène, attributed to ~10,000–7,000 BP), encompassing the Gravettian, Solutrean, Magdalenian, and post-glacial periods. The dates are of varying quality and should not be treated as a uniform timescale. Nevertheless, the dataset spans periods with markedly different demographic conditions — from the Aurignacian, when the entire European metapopulation may have numbered in the low thousands (Bocquet-Appel et al. 2005), through the Late Glacial population expansion.

3. Family Groups and Child Activity

The most consistent feature of the footprint record is the presence of children, including very young children, across the majority of sites. Seven of the nine caves record children among the visitors.

At Basura, a morphometric reanalysis by Citton et al. (2017) revised the original interpretation of the Sala dei Misteri from five individuals of mixed ages (following Blanc 1960) to three juveniles with no adults present in that specific chamber. The youngest was approximately three years old and moved through the chamber on all fours. Clay balls found adhering to the chamber walls, originally interpreted by Blanc as ritual deposits, are now understood as the product of children's activity.

At Fontanet, Ledoux (2019) documented 69 or more footprints dominated by juvenile trackmakers, with estimated statures ranging from 114 to 142 cm. The footprint evidence records children moving in multiple directions under low ceilings, sliding on clay surfaces, and throwing clay — sustained play behaviour rather than directed transit or ceremonial activity.

At Chauvet, a single child of approximately eight years moved alone through deep chambers, stopping to clean a torch whose charcoal has been dated to approximately 26,000 BP (Garcia 1999). At Pech-Merle, San trackers working with Pastoors et al. (2016) identified five individuals from 17 footprints, including a boy of nine to ten years steering away from a drop-off. The trackers also identified a woman carrying a load moving in the opposite direction — a transit corridor rather than a ceremonial space. This revised Lemozi's (1929) reading of the same prints as a "priestess and child."

The identifications at Pech-Merle were produced by the Tracking in Caves project, which brought three ǂKhomani and Ju|'hoansi San trackers — Tsamgao Ciqae, /Ui Kxunta, and Thui Thao, all CyberTracker-certified Master Trackers — into European cave sites to read prehistoric footprints. The method is designed to isolate indigenous tracking expertise from researcher expectation: trackers examine footprints independently, discuss their readings in Ju|'hoansi, and reach consensus before presenting findings to the research team, who maintain silence throughout the analysis phase (Biesele 2021). The epistemological basis for treating these readings as scientific evidence was established by Liebenberg (1990), who demonstrated that indigenous tracking employs both systematic tracking (inductive-deductive reasoning from physical evidence) and speculative tracking (hypothetico-deductive or abductive reasoning from environmental context), making it epistemologically equivalent to scientific method (Lenssen-Erz and Pastoors, in Pastoors and Lenssen-Erz 2021, Ch. 6). Beyond Pech-Merle, where the trackers identified five individuals from 17 prints — including the woman-carrying-a-load reading that overturned Lemozi's (1929) ceremonial interpretation — the project contributed revised or new readings at Tuc d'Audoubert, Niaux, Fontanet, and Bàsura (Lenssen-Erz et al. 2018; Pastoors et al. 2015).

At Niaux, two girls of approximately nine and twelve years moved through the Diverticule des Empreintes. At Tuc d'Audoubert, younger children were segregated in the Galerie des Petits Pieds while adults conducted structured activities elsewhere. At Aldène, the group composition has been described as consistent with a

family undertaking a planned speleological exploration with anticipated return.

Groups are small, typically fewer than 15 individuals. Age ranges are mixed. At Tuc d'Audoubert, the core group includes a male-female pair who traverse ten locations together. At Cussac, adults wore soft leather moccasins while moving through a 1.6 km gallery containing human remains in bear nests and extensive engravings (Ledoux et al. 2021). The footwear is the single clearest marker of intentional social preparation for a cave visit in the dataset. No site records elderly individuals in deep or difficult zones.

4. Consistent Patterns of Use

Six behavioural patterns recur across the nine-site dataset with sufficient consistency to be considered characteristic of Upper Palaeolithic sealed-cave use in northwestern Eurasia.

Small, specific groups. No cave records anything resembling a crowd. The largest documented group is 14 individuals at Tuc d'Audoubert, distributed across multiple visits and chambers. Most sites record fewer than six individuals per visit event.

Children in deep zones. Children — including very young children — are present in the deepest accessible areas at seven of nine sites. This is the single most consistent feature of the dataset.

Spatial structuring of activity. At every site where sufficient data permits assessment, different activities occur in different parts of the cave. At Fontanet, Zone 1 (deeper, no art) preserves children's play activity, while Zone 2 (closer to the prehistoric entrance) contained hearths, occupation evidence, and art — but lost its footprints to runoff (Ledoux 2019).

Deepest points for the most significant activities. Clay bison modelling at Tuc d'Audoubert, engravings and funerary deposits at Cussac, art-making at Chauvet — all at the deepest or most difficult-to-reach points.

Rare visitation. Where stratigraphic or dating evidence permits assessment, visits were rare and episodic. Only Ojo Guareña documents multiple distinct visits — four episodes across approximately 15,000 years. Most caves record a single visit event.

No elderly in deep zones. No site records elderly individuals in the deepest or most physically demanding cave zones. This pattern is consistent across all nine sites. Group compositions are inferred from foot morphology and stature estimation — methods that distinguish children from adults with reasonable confidence but that may not reliably separate elderly individuals from younger adults on morphometric grounds alone. The consistent absence is therefore compatible with two explanations: an actual demographic pattern in which older individuals did not undertake deep cave excursions, or a methodological limitation in which elderly prints are present but undetectable as a distinct age category.

5. Depth, Activity, and Preservation

Footprints are preserved in deep cave zones because deep zones are more likely to remain undisturbed — they are beyond casual access, beyond flooding patterns, and beyond later occupation. The Fontanet case demonstrates this directly: Zone 2, which was closer to the prehistoric entrance and showed evidence of hearths, occupation, and art-making, lost its footprints to water runoff, while Zone 1, deeper and without occupation evidence, preserved 69 or more prints in exceptional detail, including fingerprints and fingernails (Ledoux 2019).

This creates a preservation asymmetry. The places people lived and worked — the zones of sustained, repeated activity — tend to destroy footprint evidence. The places people explored, played, or passed through — zones of transient, non-habitation activity — tend to preserve it. The sealed-cave dataset is therefore structurally biased toward recording exploratory and play behaviour rather than whatever may have occurred in entrance zones, occupation areas, or repeatedly visited chambers.

Table 2. Depth, activity, and preservation.

Cave	Depth	Activities recorded	Preservation
Chauvet	Deep (~150 m+)	Solo child, torch, art chambers	Rockfall sealed entrance
Pech-Merle	Mid-depth	Transit corridor	Entrance collapse

Cave	Depth	Activities recorded	Preservation
Cussac	Deep (1.6 km gallery)	Shod adults, engravings, burials	Entrance sealed
Ojo Guareña	Very deep	Exploration, round-trips	Restricted deep access
Tuc d'Audoubert	Deep (10 locations)	Structured pair, clay bison, children's gallery	Entrance collapse
Niaux	Deep	Two children moving	Sealed passage
Basura	Mid-depth	Children crawling, clay balls	Stalagmite growth
Fontanet	Mid (Z1) to deep (Z2)	Z1: children's play; Z2: art/hearths (prints lost)	Entrance collapse
Aldène	Mid-depth	Family exploration, torch management	Sealed

6. Recording Windows

The rarity of cave visits can be assessed by examining the temporal window during which each cave could record footprints — the period between the earliest dated footprint (or associated evidence) and the sealing event (or latest dated evidence).

Table 3. Recording windows and visit counts.

Cave	Earliest	Latest / sealing	Window	Visits	Confidence
Chauvet	~36 ka BP (art, uncal.)	~26 ka BP (torch, uncal.)	~10,000 ^{14}C yrs	1–2	MEDIUM
Pech-Merle	~25 ka BP (art, uncal.)	Unknown	Unknown	≥1	LOW
Cussac	~31 ka cal BP (bone)	~28 ka cal BP (bone)	~3,000 cal yrs	1	HIGH
Ojo Guareña	~19 ka BP (UP)	~4.3 ka BP (Chalcol.)	~15,000 yrs	4	HIGH
Tuc d'Audoubert	~17.2 ka cal BP	~16.5 ka cal BP	~700 cal yrs	1–2	HIGH
Niaux	~13 ka BP (cultural)	Unknown	Unknown	≥1	LOW
Basura	~12,340 BP (uncal.)	~12,340 BP	Unknown	≥1	MEDIUM
Fontanet	12,770 ± 420 BP (uncal.)	Unknown	Unknown	≥1	MEDIUM
Aldène	~10 ka BP (cultural)	~7 ka BP (cultural)	~3,000 yrs	1	LOW

Only three caves — Cussac, Ojo Guareña, and Tuc d'Audoubert — have recording windows based on calibrated radiocarbon dates with direct association to the footprint contexts. Chauvet has two radiocarbon dates but in uncalibrated years, and the relationship between the art (36 ka) and the child's torch (26 ka) is ambiguous: they may represent two visits separated by millennia, or the dates may bracket a single period of accessibility. For the remaining five caves, no recording window can be estimated — only a minimum of one visit is established.

The three high-confidence cases show: Cussac, one visit across ~3,000 calibrated years. Ojo Guareña, four visits across ~15,000 years — notably, the cave's continuous accessibility across this period is itself evidence of non-use: a site that remained open and visitable for fifteen millennia was entered only four times. Tuc d'Audoubert, one to two visits across ~700 calibrated years. These are the figures on which the frequency analysis rests. The remaining caves are consistent with rare visitation but do not independently establish it.

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