

Sculpting the Void



Subtraction, Depth, and Resistance in the Mediterranean

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Candidate: Yasemin Sayin
Student No.: 10746545
Supervisor Prof.: Stamatina Kousidi

Abstract

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This thesis examines subtractive architecture — the organisation of inhabitable space through the removal or displacement of geological or geological-equivalent material — as a distinct spatial intelligence whose persistence across millennia constitutes not a primitive precursor to assembled construction but the most precise available response to a specific set of spatial, environmental, and inhabitation conditions. The research asks how this intelligence is generated, transmitted, and consciously reinterpreted: how the cave produces ritual and domesticity through depth and mass; how embodied and sensory experience is structured by geological enclosure; and what this spatial logic offers to architectural thinking at a moment when the dominant construction culture is organised around placelessness, surface, and mechanical environmental control.

The theoretical framework draws on architectural phenomenology — principally Pallasmaa, Bachelard, Merleau-Ponty, and Norberg-Schulz — to ground the analysis in bodily and sensory experience, alongside Hesong's account of thermal delight, Rudofsky's vernacular studies, Frampton's Critical Regionalism, and Braudel's *longue durée* history of the Mediterranean. The methodological approach combines fieldwork at five primary sites with spatial drawing, section analysis, and a systematic reading of the design decisions through which architects have consciously translated cave logic into constructed form.

The research is structured around three historical and geographic fields: the vernacular Mediterranean cave dwelling, the modern reinterpretations of the mid-twentieth century, and contemporary practice. Chapter One defines the cave as a spatial condition through geology, phenomenology, bodily experience, and thermal performance, arriving at the sculptural void as its primary spatial argument. Chapter Two examines how cave logic operates as a mode of architectural thinking and inhabitation across vernacular Mediterranean settlements. Chapter Three traces the moment at which vernacular necessity became architectural decision, examining how a specific strand of modern architects translated the cave's commitments to depth, mass, and material specificity into consciously resistant built form. Chapter Four examines contemporary practice through an abacus of three degrees of subtraction — literal excavation, earth integration, and autonomous cave logic — across which the same spatial intelligence is being recovered across housing, renovation, and civic programmes.

The thesis concludes that the cave's intelligence is not a formal condition to be preserved but a spatial logic to be continued — one grounded in ritual, domesticity, and the full sensory engagement of the body with geological mass, and one that becomes more rather than less urgent as the ecological and environmental consequences of a construction culture organised around standardised surface grow more acute.

Keywords: subtractive architecture, Mediterranean vernacular, cave dwelling, spatial intelligence, phenomenology, ritual, embodied experience, thermal performance, depth, inhabitation, topography

IT

Questa tesi esamina l'architettura sottrattiva — l'organizzazione dello spazio abitabile attraverso la rimozione o lo spostamento di materiale geologico o geologicamente equivalente — come una distinta intelligenza spaziale la cui persistenza attraverso i millenni non costituisce un precursore primitivo alla costruzione assemblata, bensì la risposta più precisa disponibile a un insieme specifico di condizioni spaziali, ambientali e abitative. La ricerca si chiede come questa intelligenza venga generata, trasmessa e consapevolmente reinterpretata: come la caverna produca rituale e domesticità attraverso profondità e massa; come l'esperienza corporea e sensoriale sia strutturata dall'involucro geologico; e cosa questa logica spaziale offra al pensiero architettonico in un momento in cui la cultura costruttiva dominante è organizzata attorno all'assenza di luogo, alla superficie e al controllo ambientale meccanico.

Il quadro teorico si avvale della fenomenologia architettonica — principalmente Pallasmaa, Bachelard, Merleau-Ponty e Norberg-Schulz — insieme all'analisi del piacere termico di Hesong, agli studi vernacolari di Rudofsky, al Regionalismo Critico di Frampton e alla *longue durée* mediterranea di Braudel. L'approccio metodologico combina il lavoro sul campo in cinque siti principali con il disegno spaziale, l'analisi della sezione e una lettura sistematica delle decisioni progettuali attraverso cui gli architetti hanno tradotto la logica della caverna in forma costruita.

La ricerca è strutturata attorno a tre campi storici e geografici: l'abitazione rupestre vernacolare mediterranea, le reinterpretazioni moderne della metà del Novecento e la pratica contemporanea. Il Capitolo Uno definisce la caverna come condizione spaziale attraverso geologia, fenomenologia, esperienza corporea e prestazione termica, giungendo al vuoto scultoreo come suo principale argomento spaziale. Il Capitolo Due esamina la logica della caverna come modo di pensiero architettonico negli insediamenti vernacolari mediterranei. Il Capitolo Tre traccia il momento in cui la necessità vernacolare è diventata decisione architettonica, esaminando come una specifica corrente di architetti moderni abbia tradotto gli impegni della caverna verso profondità, massa e specificità materiale in forma costruita consapevolmente resistente. Il Capitolo Quattro esamina la pratica contemporanea attraverso un abaco di tre gradi di sottrazione — escavazione diretta, integrazione nella terra e logica autonoma della caverna — applicato all'edilizia residenziale, al restauro e ai programmi civici.

La tesi conclude che l'intelligenza della caverna non è una condizione formale da preservare ma una logica spaziale da continuare — radicata nel rituale, nella domesticità e nel pieno coinvolgimento sensoriale del corpo con la massa geologica — e che diventa più urgente, non meno, man mano che le conseguenze ecologiche di una cultura costruttiva organizzata attorno alla superficie standardizzata si fanno più acute.

Parole chiave: architettura sottrattiva, vernacolo mediterraneo, abitazione rupestre, intelligenza spaziale, fenomenologia, rituale, esperienza corporea, prestazione termica, profondità, abitazione, topografia

Acknowledgements

Some theses begin with a question. This one began with a landscape.
Tunisia in the long afternoon light, pit dwellings carved into the earth of the
Haouz plain. Francesco took me there before I knew I needed to go. I didn't
understand that then. But something had taken root, and I carried it back
without quite knowing what it was.
Professor Stamatina Kousidi deepened this research in ways I couldn't have
anticipated. She taught me more than this thesis could hold. For all of it, I am
grateful.
To my family, who held everything else in place while I disappeared into the
cave, and whose trust I felt even on the days I doubted my own.
To the friends scattered across cities who encountered caves on my behalf
across the world and sent them at unexpected hours, you are dispersed
throughout these pages without knowing it.
The cave, after all, was never solitary. It was always a space for gathering.

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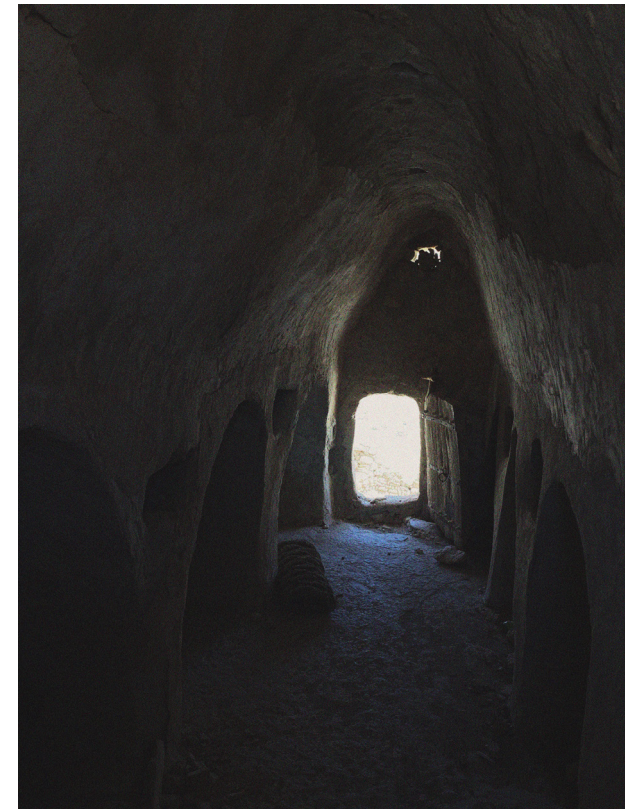
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Chenini, Tunisia, July 2024

Sculpting the Void

There is a moment, crossing the threshold of a carved space, when the body registers something before the mind has named it. At Chenini, in the Tataouine region of southern Tunisia, a narrow opening in the hillside gives way to cool air: the forty-five degree heat of the plateau disappears. The walls are not walls in the usual sense; they are the hillside itself, shaped by the progressive removal of material over generations. The space smells of stone and cool earth. Light enters obliquely, in a single shaft, and the eye adjusts. The architecture does not enclose from the outside, it holds from within. This thesis begins from that experience, from the spatial fact of the carved void, and from the question of what kind of intelligence produced it.

Against the surface-driven logic of contemporary architectural production, which designs buildings for efficiency, lightness, rapid assembly and measures performance by metrics rather than by embodied experience, cave space proposes a radically different spatial intelligence. Architecture does not surround space with positive surfaces, it is cleaved from mass. Thickness defines the void before any facade. The void is activated through removal. Environmental performance, ritual practice, and spatial configuration are not coerced strategies but functions of depth, material continuity, and bodily inhabitation. From earth-carved settlements in North Africa to the hybrid courtyard systems of the Aegean, from the unbuilt spatial propositions of the modernist avant-garde to the autonomous constructions of the contemporary moment, subtractive space recurs as an architectural logic rather than a fixed typology. What connects these examples is not formal similarity but a shared spatial logic: the primacy of mass over surface, of depth over image, of the void as architectural intention rather than residual condition.

Subtraction, Depth, and Resistance in the Mediterranean

0.1 Depth, Displaced

Contemporary architecture operates within an economy of speed. Digital production, standardized systems, and global construction models emphasize efficiency, lightness, and rapid delivery. Buildings are increasingly designed as optimized envelopes in which performance is achieved through mechanical systems rather than spatial mass. The result is the reduction of architectural depth to a thin boundary, and the displacement of environmental control from the building's own body to the technology overlaid upon it. Paul Virilio names the structural condition behind this: **speed, as the organizing instrument of modernity, penetrates not only military and political life but the organization of built space itself.**¹ The city is optimized for movement; the building is optimized for replication. Architecture becomes surface without thickness, enclosure without interiority, space without ground.

A further and less visible consequence is the reduction of the inhabitant to a viewer. Contemporary architecture increasingly produces spaces calibrated for optical consumption: buildings photographed before they are occupied, interiors designed for the image rather than the body, surfaces composed for distant viewing rather than close material encounter. The result is space that can be seen but not properly inhabited, space that addresses the eye while leaving the remaining senses unengaged. This is not a marginal condition but, as Pallasmaa argues, **the defining tendency of a culture that has systematically privileged vision over the full sensory range of embodied experience.**²

The mechanization of environmental comfort has compounded this condition. Modern building culture treats the thermal environment as an engineering problem to be solved by mechanical systems independent of spatial configuration. James Marston Fitch identifies the consequence precisely: **"The technology of heating and cooling aims to achieve a thermal steady-state across time and a thermal equilibrium across space"** — a constant temperature, everywhere, at all times.³ His criticism took place in 1979. Modern day environmental control technologies in buildings have greatly improved since then. Dynamic set point control, demand based ventilation and radiant floor/ceiling systems that create varying temperatures across different zones are all commonplace today for high performance buildings. The thesis does not argue that mechanical comfort systems have stagnated. It argues something different: is that regardless of how advanced these thermal comfort systems become, they still treat thermal comfort as a metric to be evaluated/optimized and not as a physical state to be created. Regardless of how sophisticated the thermal comfort system becomes, it cannot provide an integrated experience of thermal, haptic and visual sensations within a single architectural act like the cave provides by mass and depth alone. The uniformity created eliminates the thermal gradient, the sensory change and the body's ability to adjust itself due to changes in thermal conditions. It eliminates the conditions under which ritual forms around thermal experience: the gathering at the hearth, the migration through the courtyard house following the sun, the coolness of the carved room as a spatial event rather than a

1. Paul Virilio, *Speed and Politics*, trans. Mark Polizzotti (Los Angeles: Semiotext(e), 2006), p. 47.

2. Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*, 3rd ed. (Chichester: Wiley, 2012), p. 19.

3. Lisa Heschong, *Thermal Delight in Architecture* (Cambridge, MA: MIT Press, 1979), p. 30, citing James Marston Fitch.

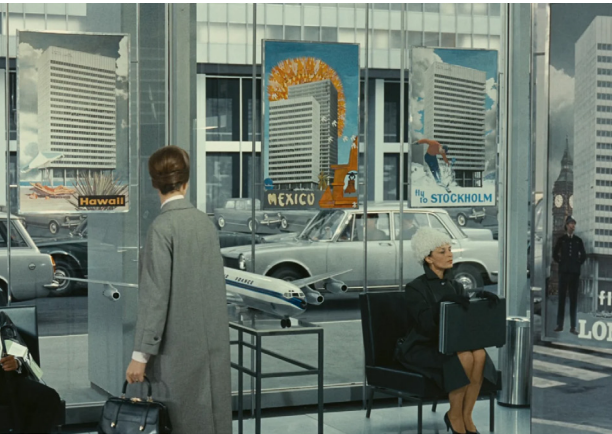
rather than a mechanical output. As Heschong argues, **the thermal sensuality, cultural roles, and symbolism that the standardized comfort zone that the standardized comfort zone designs out of existence.**⁴

Beyond speed and mechanization, there is a third and deeper problem: commodification of the built environment. As Rudofsky observed, **building architecture has ceased to be a human necessity and become a market privilege, and the domestic space of the contemporary Western world has become a collection of elements of the construction industry, assembled according to market logic, identical everywhere.**⁵ The economic implications are spatial as well. Architectural products developed through the logic of the market can be located at any point in space, since they are produced without reference to a particular place, without using local materials, and without being created within a particular lifestyle. It is made from catalogues. More than half a century ago, **Rudofsky called for a different relationship between human beings, their buildings, and their environments.**⁶ What has since become clear is that the homologation he feared is now global. It is to resist this situation that does not involve restoring old forms but instead insists on a different spatial logic. That spatial logic has as its basic tools of architectural design; depth, materiality and physical involvement.

The modernist response to the Mediterranean vernacular did not solve this issue either; in some instances it reproduced it at a much greater scale. When the architects of CIAM IV viewed the Cycladic Islands from the Patris II in 1933, they saw the white-washed cubic houses as a reflection of the ideas they had developed prior to their journey. As Kondylatou documents, most Cycladic houses were not uniformly white — they were stone, ochre, grey, their colours practical rather than aesthetic.⁷ What the modern movement extracted from the Mediterranean vernacular was form without spatial intelligence: the white wall without the thermal mass, the flat roof without the deep shadow, the cubic volume without the geological continuity. The problem of contemporary architecture is not just about speed and market logic but a continuous attempt to extract the legible surface of vernacular intelligence and leave behind its material, climatic and ritual depth.

Jacques Tati made this argument visually in *Playtime* (1967): a travel agency in Paris advertising the USA, Hawaii, Mexico, and Stockholm displays identical glass towers in every poster. The tourists have arrived nowhere in particular. Rudofsky’s fears, expressed half a century ago, have since become certainties. **The homologation he warned against is now global.**⁸

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9. Predrag Matvejevic, quoted in Concetta Tavoletta, 'Luigi Cosenza, Bernard Rudofsky and Gio Ponti and the Secret of the Mediterranean Sea,' ICCAUA 2021 Conference Proceedings, Alanya HEP University, 2021, p. 235.

10. Fernand Braudel, *A History of Civilizations*, trans. Richard Mayne (London: Penguin, 1994), pp. 8–10. On the *longue durée* as a methodological

0.2 The Cave as Spatial Alternative

What all these examples have in common is the absence of depth. The architecture of speed and surface creates areas that may be observed, however they cannot be lived in; that is to say, they lack the thermal body of a space, they lack the feeling of being enclosed by mass, and they lack the depth which defines an enclosure's spatial and psychological reality. It is precisely this aspect of our experience of space that was preserved by the cave and eliminated from contemporary architecture. As such, the cave is emerging as a spatial proposition rather than an historical artifact. The process by which the cave creates space is subtractive: space is created by carving it out of mass, and the thermal and other environmental characteristics of the space are created by using the thickness of the cave wall, its orientation to the sun, and the type of openings to create the desired conditions. Instead of treating the various components of building design — structural system, envelope, mechanical system for environmental control — as separate entities, the cave combines them into a single, continuous material body. The result of this combination are interior environments characterized by shadows, constant temperatures, and smooth transitions; e.g., the transition from the 45-degree plateau to the cool interior of a Tunisian hillside dwelling is not a function of man-made equipment; it is due to the natural geology of the area.

The Mediterranean Sea basin is the geographic context of this thesis as well as its conceptual basis. As Predrag Matvejevic described, it is the Inner Sea where “**Mediterranean appearances are not just appearances. The extension of the space, the peculiarity of the landscape, the compactness of the whole create the impression that the Mediterranean is both a world in itself and the centre of the world: a sea surrounded by lands, a land washed by the sea.**”⁹ It is, in other words, a space defined by the reciprocity of land and water, rock and sky, depth and surface: a geographic condition in which the material characteristics of the ground have always shaped the possibilities of habitation.

Braudel’s account of the Mediterranean as a space of **longue durée** — of spatial and material conditions that persist across millennia of human habitation — provides the intellectual frame for the thesis’s central claim: that the cave is not a primitive stage in the history of shelter but a living spatial condition, continuous across the Neolithic settlements of the Levant, the troglodyte villages of the Mediterranean, the modern reinterpretations, and contemporary works.¹⁰ This continuation is not an act of cultural nostalgia, but rather geology. It was the same geological factors that formed the soft tufa of the hillsides around Matera as well as the volcanic rocks found in the Cycladic Islands which helped shape the spatial intelligence of how one could carve out space from these materials, and how one would understand that the Earth is not merely a solid surface on which to construct structures, but a building block with which to create spaces.

The availability of workable stone as well as the need for protection from extreme heat and high levels of solar radiation provided the impetus for carving. Volcanic tufa, calcareous rock, and clay-gypsum layers were soft enough to be worked with hand tools; strong enough to support a vault without timber; and stable enough to retain their shape over thousands of years of changes in seasonal temperatures. Carving is an expression of an impulse towards creating shadows; seeking shelter through digging down into the earth rather than building structures that block sunlight. The shared material conditions of the basin — calcareous rock, volcanic tufa, compressed earth

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— produced a shared spatial logic: shadow before light, mass before surface, depth before facade. From the carved networks of Tataouine and the Sassi of Matera to the barrel-vaulted dwellings of Santorini and the courtyard settlements of the Aegean islands, subtraction is not absence but spatial intelligence. And this intelligence was recognized — selectively — by the modern movement. When CIAM IV sailed from Marseille to Piraeus in 1933 aboard the Patris II, the architects on board encountered the Cycladic islands and saw in their whitewashed cubic houses a confirmation of modernist principles.¹¹ What they took was form; what they left behind was the spatial intelligence that produced it. The Mediterranean serves here as both geographic context and critical ground: the place where the relationship between subtractive spatial logic and its modern reception can be most precisely examined.

This thesis asks how subtractive architecture in Mediterranean cave dwellings generates rituals of inhabitation and resistance, extending from everyday shelter to practices of silence and contemporary reinterpretations, and what this spatial logic offers to contemporary architectural thinking. The argument is that subtraction, understood as a way of architectural thinking rather than a technique, produces a distinct mode of inhabitation grounded in material depth, material memory, and place. Against the acceleration and placelessness of contemporary building culture, this mode constitutes a form of spatial resistance: not ideological, not nostalgic, but architecturally precise. The thesis does not seek a return to vernacular building. It seeks to understand what is spatially transferable from the carved void, and why that matters now, not only in the political sense of refusing the dominant logics of speed and surface, but in the material sense: the resistance of mass against the body, of depth against image, of geological time against the instant of delivery.

0.3 Ritual and Domesticity

In this thesis ritual is not thought of as a ceremonial exception to everyday life, but rather as a repeated, structured practice through which everyday life is spatially given form and meaning. The anthropologist Arnold van Gennep, whose account of rites of passage established the foundational framework for ritual studies, identified **three phases structuring all ritual transition: separation from the ordinary, a liminal threshold condition, and incorporation into a new state.**¹² These phases are not exclusively symbolic; they are spatial. In cave environments, they are materialized precisely: the threshold narrows the body into the rock, the passage suspends it between exterior and interior, the chamber receives it into stillness. The spatial sequence of the cave is a ritual sequence.

In this framework ritual does not require ceremony. Cooking, storing, praying, bathing, gathering: these repeated acts become, over time, solidified into spatial arrangements. Niches form where objects are habitually placed. Thresholds consolidate where daily passage wears the stone. Courtyards emerge where social rhythms demand light and air. The ritual records itself materially in the thickness of the dwelling.

Aldo van Eyck described this temporal dimension of ritual as “**ritualized time**” — the way repeated spatial practice “**establishes significance in present time by seeing it as a repetition**” of the patterns that have formed across generations.¹³ The niches, the worn thresholds, the hearth positions of vernacular cave dwellings are not decorative; they are the spatial record of

ritualized time, the accumulation of repeated inhabitation decisions into the surface and form of the space itself. The cave contains ritual, but ritual also shapes the cave, which therefore continues to perpetuate ritual.

This thermal inscription is also a social inscription. Heschong observes that places with strong thermal qualities naturally become sites of gathering and ritual: “**Ritualized use can do more than reinforce the affection for a place. Through ritual, the place becomes an essential element in the customs of a people.**”¹⁴ The communal oven, the cool courtyard at noon, the warm upper room in winter: these are thermal anchors around which daily life organizes itself. Architecture, then, is the archival trace of embodied habits. The bread-making ceremony in the Trullo Sovrano in Alberobello, the thermal gradient of a Matmata pit dwelling orienting the body of brightness to coolness: These instances are not arbitrary incidents, however, they represent the continuous acts in which subtractive space is inhabited.

The cave is, at its heart, a domestic space, not one of furnished comfort or stylistic convention, but in the way Corbellini defines the quality modern architecture has lost: a space worn into shape by the repeated acts of everyday life until those acts and the space are inseparable. Corbellini claims that the domestic space of the contemporary Western world is an assemblage of elements of the construction industry, brought together according to the logic of the market. **It is a space occupied, not inhabited, where the relation of the body, its rhythms of everyday life, and material surroundings has been dissolved by standardization.**¹⁵ What subtractive architecture preserves, and what this thesis traces through the ritual argument, is precisely this relationship. The handprint worn into the stone beside the entrance, the smoke-darkened ceiling above the hearth, the doorway whose lintel has been touched by ten thousand departures: these the material record of a life conducted in full bodily contact with its surroundings. Domesticity is not a comfort level but a spatial condition, the condition of a space that has been shaped by living. There is no difference between ritual and domesticity. They are the same, viewed from different perspectives. One is the description of the act, the other the space it produces.

11. On CIAM IV’s encounter with the Cycladic vernacular aboard the Patris II in 1933, see Eric Mumford, *The CIAM Discourse on Urbanism, 1928–1960* (Cambridge, MA: MIT Press, 2000); see also Kondylatou, ‘Traveling to the Cyclades,’ pp. 55–56.
12. Arnold van Gennep, *The Rites of Passage*, trans. Monika B. Vizedom and Gabrielle L. Caffee (Chicago: University of Chicago Press, 1960), pp. 10–11. First published as *Les Rites de Passage*, 1909.
13. Aldo van Eyck, in Peter de Clarke, *The Writings of Aldo van Eyck: A Modernist Sensibility Introduced in Architecture*, PhD dissertation, University of Bristol, Department of Architecture, September 1982, p. 34, citing Van Eyck’s discussion of ‘ritualized time’ (Forum, 1959).

14. Heschong, *Thermal Delight in Architecture*, p. 67.
15. Corbellini, *Domestic Romance*, p. 16.

0.4 Method

This thesis approaches subtractive architecture through three complementary methodological instruments: direct fieldwork at primary sites, spatial drawing and section analysis, and a bibliographical study of existing scholarship and architectural documentation for case studies not directly visited. These three methods are not sequential but overlapping — fieldwork observations shaped the reading of drawings; drawn analysis clarified what to look for in the field; and the bibliographical study provided the critical and historical framework within which both were situated. Together they constitute a methodology organised around spatial reading rather than formal description: the aim in each case is not to catalogue what a building looks like but to understand what spatial conditions it produces, how those conditions are generated by material and topographic decisions, and what they make possible for the body that inhabits them.

The methodological orientation of this thesis was first shaped by Stamatina Kousidi's 'Grotte, cavità e nuvole' (Vesper, no. 8, 2023), whose reading of grotto, cavity, and cloud as spatial figures rather than formal types established the ground from which the theoretical framework developed. The approach to cave space as simultaneously architectural and phenomenological — and the thesis's commitment to reading vernacular intelligence through its spatial rather than stylistic logic — owes its initial direction to this work. The theoretical framework draws on architectural phenomenology, vernacular studies, environmental theory, modern architectural history, and the history and theory of the Modern Movement. Juhani Pallasmaa's account of embodied perception, tactility, and the role of shadow in spatial experience provides the sensory framework for reading carved space. Gaston Bachelard's phenomenology of the inhabited interior grounds the analysis in the poetic and psychological dimensions of enclosure. Christian Norberg-Schulz's concept of genius loci, the spirit of place as a condition that architecture either honours or destroys, connects the phenomenological to the geographical. Maurice Merleau-Ponty's account of the body's spatial intelligence provides the philosophical foundation for the thesis's phenomenological method. Lisa Heschong's Thermal Delight in Architecture provides the framework for reading thermal performance as a spatial and cultural experience rather than an engineering problem. Bernard Rudofsky's writings on Mediterranean vernacular architecture provide the foundational account of climatic intelligence and collective building practice, supported by his own doctoral dissertation on Santorinian construction (TU Wien, 1931). Paul Virilio's analysis of speed as the organising instrument of modernity provides the political framework against which subtractive architecture is read as resistance. Stan Allen's concept of landform building and the research compiled in Dig It! define subtraction as a deliberate architectural gesture, an artificial geology, rather than a primitive technique. Fernand Braudel's long-duration history of the Mediterranean provides the geographic and cultural frame within which the vernacular tradition is situated.

Field Observation

Fieldwork was conducted at four primary sites: Tataouine and Matmata in southern Tunisia; Alberobello in Puglia; the Naples Underground (Napoli Sotterranea) in Campania; and Matera in Basilicata. Additionally, Villa Oro by Rudofsky and Cosenza in Naples was visited as a site of direct relevance to

the modern reinterpretation argument developed in Chapter Three. The fieldwork was guided by consistent criteria across all sites: observations focused on spatial sequence and threshold conditions, the behaviour of light and shadow, material surface and tactile character, the bodily experience of compression and release, and measurable or perceptible environmental performance including thermal gradient and natural ventilation. Field sketches and photographic documentation recorded these conditions directly, prioritising spatial observation over architectural representation.

The findings at each site were specific and shaped the analyses that follow. At Chenini in July 2024, interior temperatures close to room temperature were recorded against an exterior of approximately forty-five degrees — a differential produced by the depth of the carved section alone, without any mechanical system, confirming the thermal argument developed in section 1.4. At Matera in winter, direct observation of December light entering through a single tufa aperture informed the haptic and temporal analysis in section 1.3: the raking light made legible every tool mark and variation in the carved surface in a way that even exposure could not. At the Trullo Sovrano in Alberobello, the discovery of the staircase embedded within the wall thickness confirmed that spatial possibility in subtractive architecture is produced by mass rather than by programme, informing the functional argument in section 1.2. The Napoli Sotterranea visit clarified the distinction between a basement and a cave — the underground chambers are organised internally by the properties of the tufa rather than in relation to the structure above — developed in section 2.4. In Paris, the Appartement-Atelier de Le Corbusier confirmed the cave spatial quality achievable through construction: the depth of the section and the tactile insistence of the concrete surface informed the analysis in Chapter Three. These field observations are the primary source material for the spatial analyses in Chapters 1, 2, and 3.

Bibliographical Study

For case studies not directly visited, the analysis draws on a systematic bibliographical study of existing monographs, critical essays, project documentation, and architectural drawings. This is not a secondary method but an extension of the same spatial reading that fieldwork performs: the aim is to understand, through available documentation, what spatial conditions a project produces and how those conditions relate to the material and topographic decisions of its making. Where possible, multiple sources are cross-referenced to verify spatial readings — a section drawing against a critical description, a photograph against a measured plan — so that the analysis rests on convergent evidence rather than a single account.

Case Study Selection

Case studies are selected according to four criteria. First, each case must demonstrate a distinct degree or mode of subtractive spatial logic, contributing to the analytical framework rather than duplicating an existing category. Second, each case must have a documented and analysable relationship between spatial configuration and environmental or ritual performance. Third, each case must be sufficiently documented through archival material, existing scholarship, or direct fieldwork to support spatial analysis. Fourth, the selection as a whole must represent the geographic and typological scope of the thesis: the vernacular Mediterranean tradition, modern reinterpretations that

engage directly with that tradition, contemporary examples that demonstrate the continuing relevance of subtractive spatial logic, and artistic practices that extend cave logic beyond the boundaries of architecture.

Drawing Methodology

Spatial drawings are the primary analytical instrument of this thesis alongside field observation. Sections are the exclusive drawing type employed, privileged for their capacity to reveal what no other representation can show: the relationship between material thickness and interior volume, the depth of the wall, the compression of the threshold, and the thermal mass surrounding the inhabitable space. Field sketches produced during fieldwork complement the redrawn sections, recording bodily perception, spatial sequence, and the behaviour of light and shadow as directly observed conditions rather than reconstructed ones.

All sections are redrawn at consistent scale and line weight to enable direct visual comparison across case studies and historical periods. The act of redrawing is itself analytical: it requires a spatial decision about what to include and what to abstract, and the resulting drawings carry the thesis's interpretive position rather than simply reproducing existing documentation. Two atlases of sections produced across case studies at comparable scale form the primary visual argument of the thesis: the first, concluding Chapter Three, presents the Mass and Void logic across vernacular and modern case studies; the second, concluding Chapter Four, organises the same comparative reading through the three degrees of subtraction — literal excavation, earth integration, and autonomous cave logic.

Key Terms

Two terms recur throughout the thesis and require precise definition. ***Spatial intelligence***, as defined for the purposes of the study, represents the total of all knowledge related to materials, climate, rituals, and tectonics which are inherent in a building tradition. The transmission of such knowledge occurs via the choices made regarding the physical placement of elements within the construction; this is in opposition to transmitting such knowledge through written works. Therefore, spatial intelligence is based upon the collective's ability to understand how a specific geological formation, climatic conditions, and patterns of settlement result in spatial arrangements that are precise rather than arbitrary. It can be argued that subtractive construction results in a distinct form of spatial intelligence due to the fact that the process of subtracting mass creates a particular relationship among the body of the inhabitant, the materials used in construction, climatic factors, and the community of inhabitants.

Cave logic is the term this thesis uses for the set of spatial commitments that the cave generates and that persist beyond it: the primacy of depth over surface, of mass over lightness, of a building's geological continuity with its ground over its formal autonomy from it, of environmental performance achieved through spatial means rather than mechanical ones. It is not a style nor a formal reference to the shape of a cave. It is a commitment to the specific material of a specific place, to the inhabitation patterns that material makes possible, and to a quality of space defined by the relationship between a body and the depth and mass that surround it. Whether this commitment is present or absent is the central analytical question of the thesis.

0.5 Structure

The thesis is organized in five chapters, each building on the last toward a single argument: that subtractive architecture, understood as an architectural way of thinking and inhabitation rather than a technique, produces a mode of inhabitation grounded in materiality, temporality, and place, and that this mode constitutes a form of resistance against the placelessness of contemporary building culture.

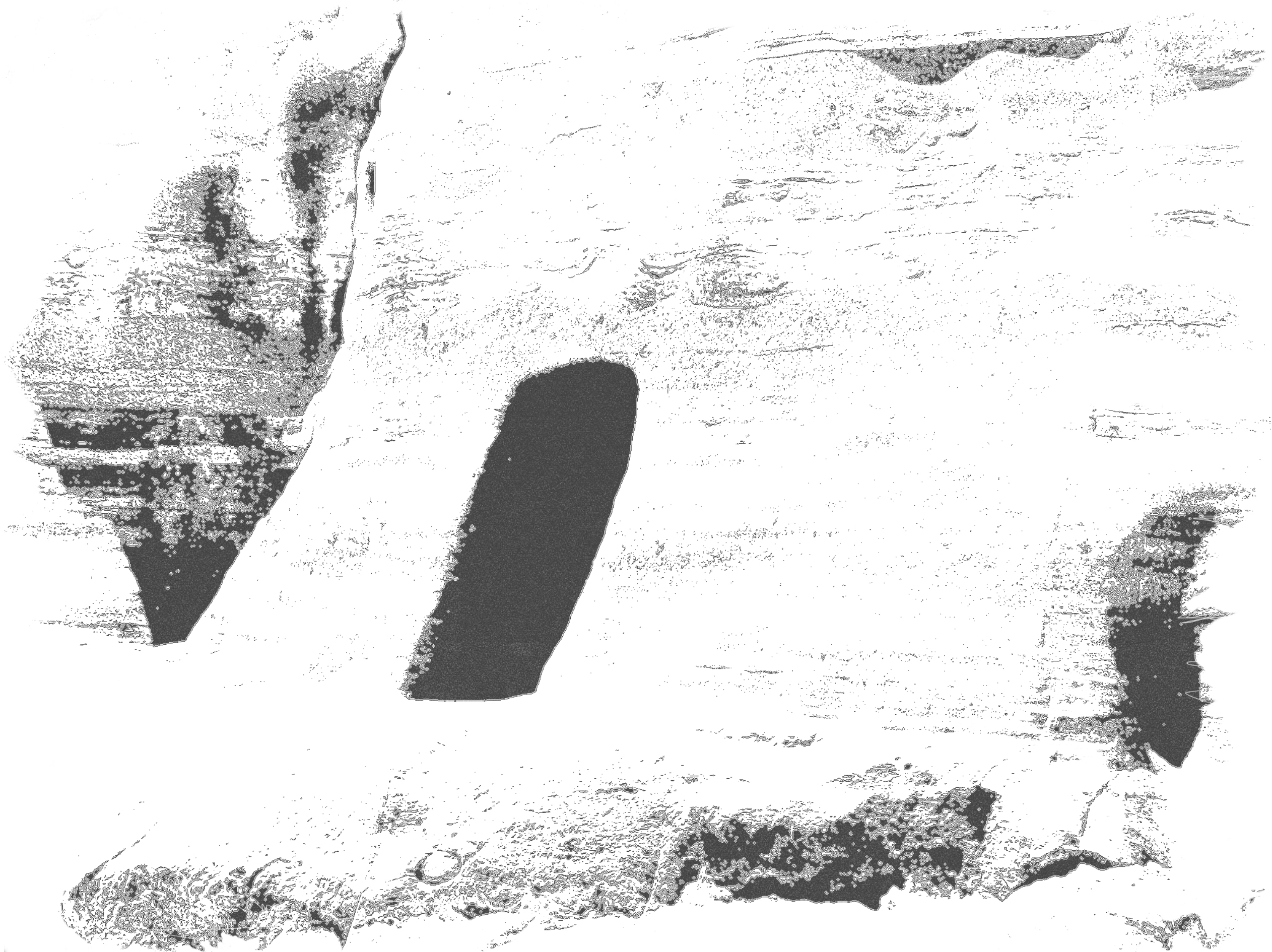
Chapter One establishes the cave as a spatial condition, beginning with the geological claim that subtractive and additive construction operate through fundamentally different logics, and descending through the phenomenological, the environmental, and the bodily to arrive at the sculptural void.

Chapter Two moves from what the cave is to how it is produced, and what kind of architectural thinking and inhabitation such production calls for. This chapter is structured around four aspects — the void, form, environmental intelligence and the settlement figure — and through vernacular building and selected modern reinterpretations, it traces the spatial logic of the cave, arguing that this logic can be transferred across scales, materials and cultural contexts and that it constitutes a form of spatial and political resistance.

Chapter Three develops this argument through the Modern Movement, examining how a specific humanist strand of modernism — working against the dominant machine aesthetic — consciously translated the vernacular cave's spatial intelligence into constructed form. Framed by the motivating frame of resistance, the chapter is arranged around the same four aspects as Chapter Two and argues that the spatial logic of the cave is not a historical condition but an architectural and inhabitation choice.

Chapter Four examines the cave's spatial logic in the contemporary moment, organized around the degree of subtraction axis developed in the abacus. Three housing sections — literal excavation, earth integration, and autonomous constructed cave logic — are followed by a section on renovation and contemporary inhabitation, a demonstration of cave logic across other typologies.

The Conclusion draws the thesis towards its final argument, that the cave is relevant not as a nostalgic model, but as a spatial critique: a way of making architecture that starts with what is already there, and proceeds by revealing what it contains.



Chapter One

The Cave as a Theoretical Tool

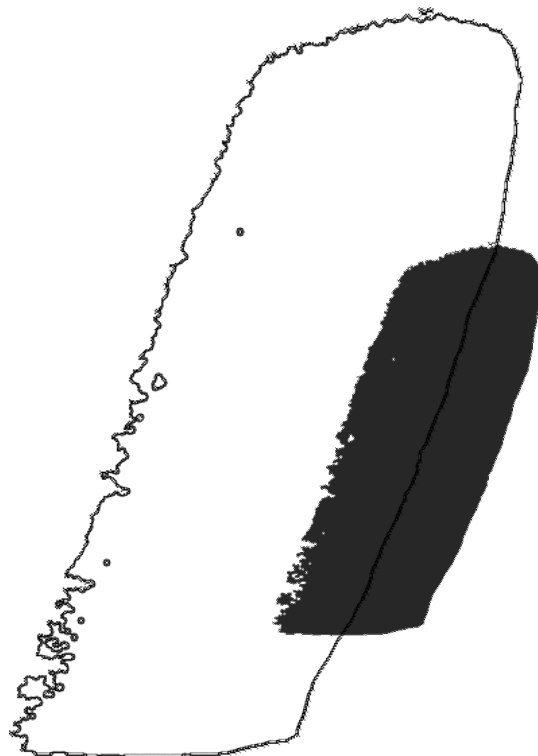
Before the cave can be analysed in terms of climate, ritual, or resistance, it must first be understood as a spatial condition, defined not by its geological origin alone but by what that origin produces: a specific way of structuring perception and organizing inhabited space. The first is geological: that subtractive architecture does not merely sit on its ground but springs from within it, and that the particular geology of the Mediterranean basin both enabled and informed the spatial intelligence that carved it. From this basis, the chapter moves through function, phenomenology and environment to arrive at the sculptural void – the argument that the removal of mass is not a means to an end but the primary act of spatial production. But the cave understood in all five of these dimensions is not a primitive typology. It's an architectural intelligence. And it is, as the following chapters will argue, a mode of architectural thinking and inhabitation, one that has persisted from the Neolithic settlements through the modern reinterpretations of the twentieth century and into the spatial arguments of the present.

1.1 Architecture and Geology

It has been generally accepted that the practice of architecture adds to what exists. That is to say, materials are gathered, transported and then assembled into forms which did not exist before. Whereas the site exists prior to and is an integral part of the ground; the building is seen as something added onto the ground rather than created out of the ground itself. The process of adding is so deeply embedded into the way we think about architecture that removing material to create space is hardly ever viewed as creating. It's viewed as digging into the earth; it's considered to be geology, and in this sense, it's something that came before or created what we know today as architecture.

A cave dwelling carved into the soft rock of volcanic tuff, limestone or the clay-gypsum layers that form the Mediterranean landscape was not an additive process of excavation as much as it was a generative one. The geological character of these formations — workable enough to be cut with simple tools, yet structurally sufficient to hold a vault — made them available for habitation through subtraction rather than construction. It was the specific geological features of the Mediterranean region — its calcareous hillsides, volcanic tuff and compressed earth plateaus created by millions of years of sedimentary deposition — that provided the opportunity for subtractive construction. In subtractive construction the material itself becomes the architecture, rather than serving as merely a backdrop. Subtractive construction is about creating space through carving. Unlike traditional methods of constructing buildings, where space exists prior to enclosing it with walls and roofs, in subtractive construction space is created directly as a result of a spatial operation.

Therefore, a void created through carving is not a void between two separate components of a building, but rather the result of a single spatial operation. Subtractive construction utilizes a completely different logical



1. Bernard Rudofsky, *Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture* (New York: Museum of Modern Art, 1964), p. 1.

approach than additive construction. Neither subtractive nor additive construction are simpler than one another; however, each has a different logical basis.

Rudofsky, in *Architecture Without Architects*, draws attention precisely to this blind spot in architectural culture. **Architecture, it is argued, requires a formal author, engineered structure, and assembled material — a definition that leads us to overlook an immense archive of spatial intelligence embedded in vernacular and subtractive building cultures.**¹ The vernacular form of building is an act of creation in itself. It has its own constructive grammar which is based on the idea that the ground is not a base from which we can construct but rather a medium or material to be constructed into. To carve is to make, as intentionally and as spatially as to assemble.

The architectural distinction of subtractive construction is the relationship it makes between mass and space. In additive building, mass and void are produced separately, then related: walls enclose rooms, columns support slabs, enclosure is the result of accumulation of parts. In the excavated cave, mass and void are united from the very first instant. The act of removal produces at the same time the enclosing wall, the structural body, the thermal mass, and the spatial interior—not as the product of coordinated decisions but as the single consequence of one act of material. Here, geology and architecture are not analogous. It is the carving that makes them indistinguishable. The constructive operation and the geological formation are one and continuous material event.

Bachelard's observation that **intimate space has a certain resistance, that enclosure is experienced as something pushing back against the body**,² is nowhere more literally realized than in the excavated cave. The walls are not constructed surfaces attached to a structure; they are the portion of the original mass that was not removed. Their resistance is not metaphorical but physical. The void is created by the removal of rock. What surrounds the resident is the residue. The residue preserves within itself the memory of its geologic formation through its texture and density. The cave has been formed through man's intervention into nature; therefore, it is nature modified for human use.

Allen and McQuade, in *Landform Building*, write that “**Any work of architecture, before it is an object, is a transformation of the landscape.**”³ In the cases they explore, the boundary between geological feature and architectural element is intentionally dissolved. The building does not rest on the landscape; it flows with it. Although their framework is rooted in contemporary practice, the spatial logic they identify has deep historical precedents. Cave dwellings have always operated this way: their architecture evolves from the geological formations they inhabit, shaped by material properties while adapting to human needs.

2. Gaston Bachelard, *The Poetics of Space*, trans. Maria Jolas (Boston: Beacon Press, 1994), p. 11.

3. Stan Allen and Marc McQuade, eds., *Landform Building: Architecture's New Terrain* (Baden: Lars Müller Publishers, 2011), p. 33.

1 Casa Malaparte, Capo Mas-sullo, Capri, 1938. Aerial view
2 Casa Malaparte Section by the Author.

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When geology and architecture merge in the cave, the standard analytical categories of structure, enclosure, surface, and environment lose their separateness. They give way to a more unified concept: **mass**. This mass, when shaped, deepened, oriented, and opened, becomes simultaneously structure, wall, climate regulator, and spatial interior. This is not a design choice, it is a material consequence. Carving does not create these qualities; it uncovers what was already present in the material, waiting to be revealed.

The cave, understood as an architectural condition, is not defined by being underground. It is defined by the primacy of mass: by the experience of space produced through removal rather than enclosure, and by the sense of being held within something that has geological continuity rather than assembled from parts. A dwelling cut into a Tunisian hillside and a freestanding constructed mass that produces equivalent conditions of compression, depth, and tactile enclosure are not different in kind. They are different in method.

Allen records that when asked whether he had bought his house ready-made or designed it himself, Malaparte replied that **the house had been there, the had designed the landscape**.⁴ Casa Malaparte does not sit on the cliff at Capri, it emerges from it. The staircase is the hillside continued, the rooftop terrace extends the plane of the rock face. Frampton observed the same condition at Fallingwater: **that despite its extensive horizontal glazing, the interior evokes the atmosphere of a furnished cave rather than a house in the traditional sense — nature permeates the structure, yet the occupant remains sheltered within it.**⁵

4. Ibid.

5. Kenneth Frampton, *Modern Architecture: A Critical History*, 4th ed. (London: Thames & Hudson, 2007), p. 189.

Rudofsky and Cosenza's Villa Oro in Naples (1934–37) provides one of the earliest and most precise modern articulations of this logic. Sited on a spur of tufa on the Posillipo hill overlooking the sea, the villa does not sit upon its geological base but emerges from it, its volumes described by Tavoletta as **“an extension of the cliff face between the water and the rock.”**⁶ The building follows the topographic curvatures of the hill, its plan a composition of intersected solids that amplifies rather than contradicts the topography. Corridors are abolished; interior ambiances connect through internal steps that trace the natural gradient of the ground. Rudofsky introduces the project in bodily terms: **“for a long time we have lost contact with the ground,”**⁷ he wrote, describing the liberation of the body that the house proposes — a domestic space oriented toward the freedom of barefoot movement, the flat of the foot against smooth stone. The Villa Oro is not an object placed on a site; it is a transformation of the geological condition from within.

The logic of Villa Mâche on Amorgos (1966–1974) by Xenakis extends this concept from the singular structure to the architectural proposition that it represents in relation to the exterior. Curved walls, bunker windows, and a heavy massing provide the visual cues of the cave's spatial proposition prior to entering the space; a building which will not present itself as an architectural facade, but which appears as a three-dimensional sculpture carved into the topography of its location, controlling the openings to the outside world as tools for manipulation of light and view rather than aesthetic display.⁸ The primary characteristic of the cave — the dominance of mass over surface, and depth over façade — is evident regardless of where one views the structure. Kiesler's Endless House took this idea further, representing the most extreme conceptual form of the cave — a single continuous shell with no separation of floor, wall or ceiling; an internal space that was conceived as a cavernous cavity formed exclusively through use and occupation rather than structural efficiency. While Villa Mâche exemplifies cave logic through its method of construction on a Mediterranean hillside, the Endless House illustrates cave logic as an archetypal model — the cave condition as the ultimate spatial proposition, prior to geological conditions and prior to cultural influences.⁹

What distinguishes spatial intelligence from program-based planning is not that spatial intelligence lacks intent, but where intent originates — spatial potential derived from the logic of mass as opposed to a predetermined plan. When using subtractive construction, architects do not apply a program to an undifferentiated medium. Rather, the program exists within the inherent resistance of the site.

Thus, the cave's logic is a form of spatial intelligence because it uses the physical properties of the site as a starting point to discover what lies beneath the surface. Using this perspective, the cave may be viewed as man-made geology. Working with geological conditions instead of working against those conditions constitutes a spatial position — and later, a political position as demonstrated by the subsequent chapters. The decision to utilize mass instead of surface, to create depth instead of images, and to employ the specific characteristics of the site instead of using the generic site, represents a rejection of the idea that architecture is merely the delivery of objects. This rejection is not an ideological statement. Rather, it is a spatial one. The cave does not represent resistance, it demonstrates resistance by virtue of how it came into existence. It is neither nature converted into shelter nor architecture mimicking the nature. Instead, it is geological material, mass designed and built using geological principles with spatial intent while maintaining its inherent qualities of depth, weight and continuity. Geology becomes architecture when geology is transformed from within.

6. Concetta Tavoletta, 'Luigi Cosenza, Bernard Rudofsky and Gio Ponti and the Secret of the Mediterranean Sea,' ICCAUA 2021 Conference Proceedings, Alanya HEP University, 2021, p. 235.

7. Bernard Rudofsky, cited in *Lessons from Bernard Rudofsky: Life as a Voyage* (Basel: Birkhäuser, 2007), p. 262.

8. Sharon Kanach and David Bergé, in *The Architect is Absent: Approaching the Cycladic Holiday House* (Athens: Kyklada Press, [year]), pp. 19–20, 41–42.

9. Frederick Kiesler, *Inside the Endless House: Art, People and Architecture* (New York: Simon and Schuster, 1966).



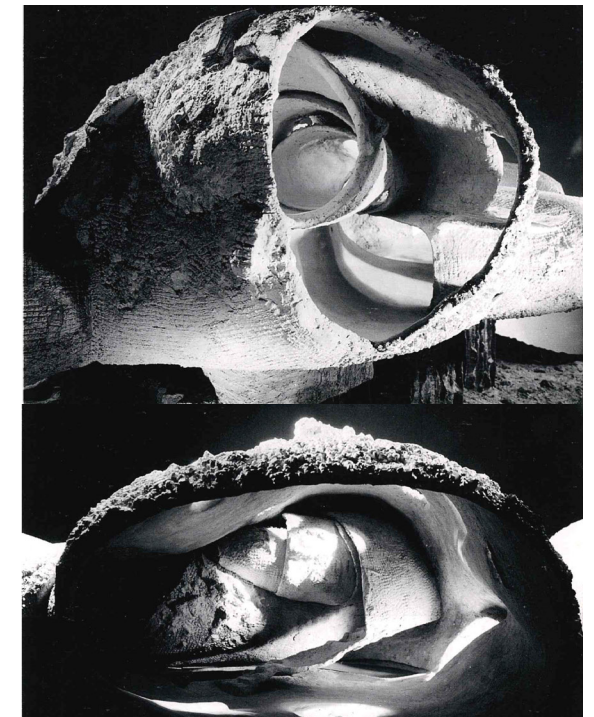
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3 Bernard Rudofsky and Luigi Cosenza,

Villa Oro, Naples, 1935–37

4 Villa Mâche as seen from the

sea, Amorgos Island, 2018

5 View into model for Endless

House, 1959. Wire-mesh,

cement, plexiglass, 96.5 ×

247 × 106.7 cm. Collection of

Whitney Museum of American

Art, New York

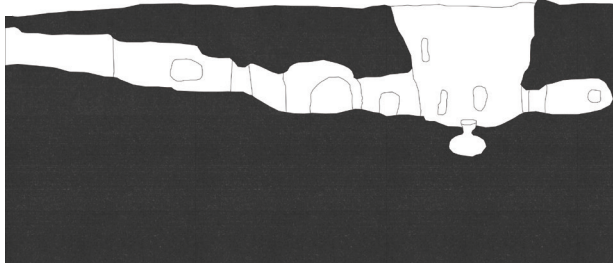
1.2 Function and Use

The cave is not a spatial type but a spatial practice. In subtractive architecture, function is never predetermined — no room announces itself before the body arrives. Instead, space emerges from the ongoing negotiation between the body and the resistance of the material: its weight, its texture, its depth. The space does not precede the life lived within it. The life produces the space.

This distinction — between an occupied space and an inhabited one — is central to Corbellini’s argument on domesticity. **To occupy a space is to be present in that space; to inhabit a space is to have formed that space by the repetition of an act, to have written into its walls, thresholds and surfaces the rhythms of daily life.**¹⁰ Thus the distinction between the two is not stylistic but spatial: an inhabited space bears in its material form the record of its use. The surfaces of a house inscribe its spatial autobiography: in the shift of level where a body has moved over and over again, in the worn edge of a ledge that is used as a seat, in the stain of a wall that has submerged in decades of cooking smoke. These are not accidents of use but a record of a life lived in direct material contact with its environment.

Such an inscription is clearly readable especially in cave environments, because the material is both yielding and permanent. Tufa and limestone bear the mark of use — they can be deepened, widened, shaped further by the body’s repeated encounter — but they also keep it. Here, ritual and domesticity are not separated into different spaces, but ordered across the same surface, the same material stratum, differentiated by depth and orientation rather than by partition. This is not the primitive conflation of categories, but another spatial intelligence, one that understands the dwelling as a continuous field of life and time rather than a collection of separated, purpose-specific enclosures.

Cave dwellings organize function based on thermal and social rhythms instead of formal room hierarchies. Heschong’s description of a typical Tunisian courtyard home illustrates how people move throughout their homes each day in response to temperature changes; from interior ground-floor rooms during hot summer afternoons to open rooftop spaces during cool summer evenings and finally to upper loggia areas during sunny winter days.¹¹ The spatial intelligence at work here is not primitive or deficient, it is the precise exploitation of what the dwelling already offers: the thermal gradient produced by depth, the social differentiation produced by orientation, the calibration of shade and enclosure to the specific requirements of each daily act. At Matmata, the pit dwelling extends this logic to its most complete spatial form. The central courtyard acts as a regulating element for both light and ventilation within the dwelling while simultaneously maintaining stable temperatures. Cooking, storing food, sleeping, and socializing all occur around the pit in relation to their orientation, depth, and ability to be shaded.¹² Function in this context is not a room but a continuum of movement through various environmental conditions provided by the dwelling.



6 Matmata pit dwelling, Tunisia.
7 Matmata pit dwelling Section by the Author

10. cf. Corbellini, *Domestic Romance*, p. 16.
11. Lisa Heschong, *Thermal Delight in Architecture* (Cambridge, MA: MIT Press, 1979), p. 16.
12. Heschong, *Thermal Delight in Architecture*, p. 67.

At the Trullo Sovrano in Alberobello, the thick masonry walls of the dwelling contain within their depth a spatial possibility that would be invisible in thinner construction: a staircase connecting the two floors, embedded between the living room and the kitchen. The wall was thick enough to contain a stair, and so the stair was placed there — a spatial possibility uncovered through the logic of mass rather than imposed upon it.¹³ This is what distinguishes functional thinking in subtractive architecture from programme-based planning: the possible uses of the space are found within the material rather than specified in advance and then provided for. The dwelling’s spatial possibilities emerge from the direct encounter between the body’s needs and the resistance of the material. Function is not assigned, it is excavated.

Functional organization in cave-logic architecture will always be an ongoing negotiation between the body and the material conditions of the ground. Rooms are never abstract receptacles of programmed space; rather they are created as a result of the specific depth, orientation and thermal characteristics of the excavated or constructed mass. The dwelling itself is not a blank canvas on which one can conduct their daily lives; rather it provides a specific set of spatial conditions, and the way in which people live out their lives in the dwelling are formed through the constant interaction with these spatial conditions. It is at this point that we can begin to see the architectural intelligence of the cave: it is not the successful resolution of a pre-determined program, but rather the creation of a spatial field that allows people to find the forms of their own habitation.

13. Trullo Sovrano Casa Museo, exhibition texts and interpretive panels, Alberobello, Italy, field visit and notes, 2025. On internal staircases in larger trulli generally, see ICOMOS, Advisory Body Evaluation No. 787: The Trulli of Alberobello (Paris: UNESCO World Heritage Centre, 1996), p. 55, <https://whc.unesco.org/document/154272>.



8 Trullo Sovrano, Alberobello. Interior staircase, view from below. Photograph by the Author.



1.3 Bodily Experience

From the geological substrate and its living inhabitants there emerges a From the geological foundation and the functional life that inhabits it, a specific perceptual structure emerges — one organized not around vision but around tactility, depth, and the full integration of the senses. To understand the cave as architecture requires recognizing that it is, above all, a field of bodily experience: a space that operates through closeness, shadow, material resistance, and compression rather than through facade, composition, or visual framing. This section examines that experience in two movements: first through tactility, shadow, and the particular quality of light that mass produces; then through the body’s muscular and haptic engagement with carved space.

1.3.1 Tactility, Shadow, and Light

Pallasmaa argues that **architecture is experienced through the body, which serves as the primary instrument of spatial orientation, memory, and understanding.**¹⁴ The body is not a passive receiver of spatial information; it is the organ through which space is sensed, remembered, and internalized. Any architectural condition that prioritizes image over embodiment risks severing this essential relationship. **Modern architectural culture, Pallasmaa observes, has become increasingly vision-centred, reducing spatial experience to optical consumption.**¹⁵ Thickness and interiority are collapsed into façade and surface when architecture is understood primarily as image. The cave opposes this condition. In contrast to this condition, the cave has its characteristics expressed in terms of proximity, shadow, enclosure and resistance of materials rather than through distance or visual arrangement. Thus, the cave cannot be totally perceived visually from a remote location; it can only be accessed and experienced physically by the body.

Merleau-Ponty’s foundational argument in the Phenomenology of Perception is that the body is not an object in space but the very medium through which space is constituted. Space, for Merleau-Ponty, is not a geometric container that things inhabit but a relational condition produced by the body’s engagement with its surroundings. The body does not perceive space from outside; it inhabits it — it orients itself within it through movement, posture, and the felt pressure of nearness and distance. **The body’s spatiality is not a position in space but a way of being in the world, shaped by the specific material conditions it encounters.**¹⁶

The cave realizes this condition with particular intensity. Pallasmaa argues that vision has an intrinsic tactile dimension: **the eye anticipates touch, measuring weight, texture, and depth before the hand confirms them.**¹⁷ A rough stone wall is not perceived as a flat surface but as material resistance. A deep recess suggests coolness before it is felt. In the cave, this fundamental quality of perception is made explicit. Space is read through density, shadow, and material continuity rather than through formal articulation. Where image-driven environments smooth their surfaces, illuminate uniformly, and compose for distant viewing, cave space operates through thickness. Its boundaries are not membranes but mass. The wall is not a partition but depth. Light does not eliminate shadow but reinforces it.

In the cave, shadow is not a lack of light but a tool of space. The winter

14. Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*, 3rd ed. (Chichester: Wiley-Academy, 2012), p. 12.
15. Pallasmaa, *The Eyes of the Skin*, p. 19.
16. Maurice Merleau-Ponty, *Phenomenology of Perception*, trans. Colin Smith (London: Routledge, 1962), p. 101. First published 1945.
17. Pallasmaa, *The Eyes of the Skin*, p. 32.

sun in the Sassi of Matera came through one small opening in the thick tufa wall, sending a shaft of sharp light across the carved interior while the surrounding stone kept its depth in shadow. The effect was not darkness but disclosure. The raking light made legible every tool mark, every hollow, every variation in the surface. These walls would have looked like one plane, evenly lit. The material announced its duration in the contrast of light and shadow. What the roughness of tufa bears is not texture in the decorative sense but the record of its own making, the record of every cut, every season of moisture, every hand that has touched it. In this case, the state is what makes this record visible, shadow.

Worn stone is material memory – the surface legible by duration, each mark the record of a body that passed through the same space before. What gives the density of atmosphere to historic places is not age, but the legibility of time in the surface of the material. Modern building materials – glass, polished metal, smooth concrete – are intended to withstand this kind of reading, manufactured to stay pristine and unmarked by time. The cave works on the reverse principle, its surfaces accumulating the record of the making and inhabitation simultaneously.

Bachelard identifies precisely this condition as **the intimate quality of the shadowed corner: the sense that compressed, partially lit space has a psychological gravity that open, evenly illuminated space does not.**¹⁸ A shadow is not an absence; it is a spatial condition. And in the cave, shadow is produced architecturally by the same mass that provides structure and thermal stability. Although it is not an actual cave, The Pantheon in Rome exemplifies this concept on an architectural level. The oculus allows a singular column of light to enter the building which moves in a slow arc over the course of the day; the path of the light follows the sun's arc across a surface that appears to be unarticulated when lit uniformly. The light is what allows the mass to be read.

The cave alters the relationship between the inhabitant and the space. Total visual control is prevented. The entire space cannot be instantly mapped. Dimness, gradation, and partial concealment deepen spatial awareness. Shadow slows perception and thickens interiority. The inhabitant is not an observer standing outside space but is enveloped within it. The cave is the spatial antithesis of surface-driven architecture: its enclosure-structure continuum produces an interior that is not assembled but uncovered, not composed but inhabited.

This understanding of the cave as a space of tactility and depth, organized around the body rather than the eye, connects directly to Norberg-Schulz's concept of **genius loci, the spirit of place.**¹⁹ Norberg-Schulz argues that a place is defined not by its geometric properties but by its character, the particular quality of atmosphere and material presence that makes it irreducibly itself. Dwelling, in his formulation, means something more than shelter; it implies an existential foothold, **a space where life occurs and through which identity is anchored.**²⁰ The cave possesses genius loci in this fullest sense. Its spirit is not added by decor or style; it is produced by the specific encounter between the body and the geological material of the place. This spirit cannot be replicated, moved, or mass-produced, and it is precisely what is erased by the architecture of acceleration and interchangeable surfaces. The following section examines the bodily dimension of this encounter more closely; the way the cave's spatial conditions of compression, release, and haptic continuity constitute a distinct model of spatial experience organized around the body rather than the eye.

18. Bachelard, *The Poetics of Space*, p. 222. *On the intimate quality of the corner: 'A corner is a refuge that assures us a first value of being: the right not to move.'*

19. Christian Norberg-Schulz, *Genius Loci: Towards a Phenomenology of Architecture* (New York: Rizzoli International Publications, 1980), pp. 5–6.

20. Norberg-Schulz, *Genius Loci*, p. 5: 'Dwelling implies something more than shelter. It implies that spaces where life occurs are places, in the full

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10 Interior view of a dwelling showing the opening and light effect in Sassi, Matera, 2025. Photograph by the Author.

11 Interior view of a dwelling showing the opening and light effect in Sassi, Matera, 2025. Photograph by the Author.

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1.3.2 Compression, Release, and Haptic Space

Unlike additive construction — which begins with a geometric framework — subtractive construction begins with the body. The hollow must accommodate standing, rotation, and shelter. These are not abstract dimensions; they record a specific encounter between a human body and a resistant material.

Where additive construction mediates bodily measure through structural grids and standardized components, subtractive construction eliminates that distance. The carver acts directly on matter. What remains is not a designed object but an index of that action: the height of a chamber corresponds to an upright figure, the curve of a niche to the arc of a reaching arm. In this sense, the morphology of a cave space is the spatial record of the body that produced it.

Pallasmaa introduces the concept of **muscular space** to describe how the body registers spatial qualities through tension, compression, and release.²¹ A low ceiling is not only perceived as low — it registers as pressure. A chamber that opens is not only read as larger — it is felt as release. In this sense, cave space is inherently bodily: its morphology is organized around compression and expansion as spatial experiences, not formal devices. The narrow threshold that deepens into an interior chamber, the constriction of a passage before a room opens, the shift in height between sleeping alcove and communal space — these are not incidental features of cave architecture but constitutive ones. The cave is a body-sized instrument, tuned to the specific dimensions and movements of the body that inhabits it.

This haptic character is reinforced by the material itself. Pallasmaa identifies **hapticity as the property of an environment that activates the body’s sense of touch even without direct physical contact.**²² The cave is haptic by nature: its surfaces are rough, uneven, and thermally active, and its dimensions keep the body within perceptual range of the material. Walls are encountered through touch as much as sight. The ceiling registers as pressure; the floor, through weight. Together, these produce a continuous tactile envelope rather than a geometric container. Bachelard notes that **a corner, a niche, or a recess carries an intimate quality that more open spaces do not — that compressed space invites the body to settle rather than to pass through, producing enclosure felt as security rather than confinement.**²³ The cave exemplifies this: its interior is large enough to be housing yet small enough that the inhabitant maintains continuous sensory contact with the surrounding mass. The space does not offer a neutral container; it registers at bodily scale, pressing its surfaces into the perceptual field of the person within.

The irregular curvature form found within most caves, reinforces the body-centered navigation system. Unlike the right angled or parallel planar forms of orthogonal constructions, caves' carved forms tend to curve along the fracture line of the rock/material and follow the arc of the tool. The curves are not designed, they result from the interaction between the tool, body and mass. In close proximity to curved surfaces, the body has no fixed reference points as it would in rectilinear space. Rather than relying on vision for navigation, the inhabitant relies on feeling the pressure of proximity; rather than using measurement to determine distance between two parallel planes.

Kiesler understood this when he wrote that the *house is not a machine for living but a living organism with a very sensitive nervous system.*²⁴ His Endless House was not a formal experiment in curved geometry but an attempt to produce the spatial conditions of cave-logic through construction:

the continuous shell, the space not boxed into rooms but organized by inhabitation and light. Kiesler traced the lineage directly: primordial man had to kindle a twig and carry it to the shadowy corner of his cave to make out what was in the darkness. The Endless House continued this project by other means, using light to define space through shadow as much as illumination.

Cave space, understood through the body rather than the eye, proposes a spatial model organized not by composition but by inhabitation. Its dimensions are human not because a designer calculated them, but because they were carved by human bodies working against resistant material. Its curves follow fracture lines and tool arcs rather than formal decisions. Its compressions and releases are felt before they are seen. What the preceding sections have established as geological, functional, and phenomenological dimensions of the cave converges here: the space is simultaneously a geological event, a field of accumulated habitation, and a haptic envelope calibrated to the body. This integration — the refusal to separate spatial experience into distinct sensory channels or functional categories — is the cave’s central spatial argument, and it is what the following sections on thermal performance and the sculptural void will carry forward.

1.4 Thermal and Environmental

The spatial logic established in the preceding sections — mass before facade, depth before image, geological continuity before assembled surface — has a direct environmental consequence. Thermal comfort within the cave does not depend on an added architectural system but is generated directly by the arrangement of space. The section functions as an environmental tool. Fieldwork confirmed this realization.

In July 2024, at the cave settlements of Chenini near Tataouine in southern Tunisia, the contradiction was immediate. Outside, on the Saharan plateau, the temperature reached approximately forty-five degrees Celsius. Inside the rock-cut dwellings, the air was cool, fresh, and still. No mechanical system was present: no air conditioning, no ventilation equipment. Only the mass of the rock, the depth of the enclosure, and the calibration of the openings. This encounter challenged one of the fundamental premises of contemporary architectural culture: that environmental comfort must be produced by external technological systems. At Chenini, thermal effectiveness was not superimposed; it was intrinsic. The rock body alone was sufficient.

What distinguishes this spatial model is not thermal stability as an outcome, but the means by which it is achieved. Mechanical systems produce comfort as a binary condition: the system is either on or off, and conditions are either comfortable or not. Caves operate on a gradient, not a switch. The transition from hot exterior to cooler interior does not occur instantly; it unfolds through a sequence of spaces with varying degrees of shading, compression, and depth of shadow, arriving finally at the stable stillness of the interior chamber. Each spatial layer corresponds to a shift in sensory experience: brightness fades, sound softens, temperature drops. The body recalibrates continuously rather than making a single adjustment. Hescong names this quality **thermal delight: the experience of moving through a range of thermal conditions as a richly sensory spatial event rather than an engineering problem to be neutralized.**²⁵

Fathy, writing about the climatic principles underlying vernacular architecture in North Africa and the Middle East, describes how the thick earthen and stone walls of traditional dwellings absorb heat during the day

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21. Pallasmaa, *The Eyes of the Skin*, p. 65.
22. Pallasmaa, *The Eyes of the Skin*, p. 56.
23. Bachelard, *The Poetics of Space*, p. 136.
24. Frederick Kiesler, ‘Frederick Kiesler’s Endless House and Its Psychological Lighting,’ *Interiors*, November 1950; and ‘Notes on Architecture as Sculpture,’ *Art in America*, May–June 1966, pp. 57–68.

25. Lisa Hescong, *Thermal Delight in Architecture* (Cambridge, MA: MIT Press, 1979), p. 17.

and release it gradually at night, producing a lag between interior experience and exterior temperature fluctuation.²⁶ Fathy describes this principle as a **thermal flywheel: the mass does not generate heat but regulates its distribution across time.** This thermal lag, Fathy argues, is the organizing principle of the spatial system — not a passive consequence of heavy construction but the active logic of the plan: the depth of rooms, the thickness of walls, the size of courtyards, and the position of openings are all calibrated to extend and regulate this delay. The building is not designed against climate but through it.

This principle is directly measurable. Field studies of Matmata's troglodyte dwellings confirm that interior temperatures are consistently more comfortable than above-grade houses in the same region throughout the year, with summer temperature differentials between outside and inside reaching up to fifteen degrees Celsius. With approximately seven metres of soil cover from ground level to ceiling, the optimum depth of ten metres identified by researchers is precisely what the first inhabitants of Matmata arrived at empirically through generations of building.²⁷ Amos Rapoport observed that the Matmata pit dwellings, with rooms located under thirty feet of earth, are **"cooler than anything which could be built on the surface"** — a spatial and environmental argument that no mechanical system has since improved upon.^a

The carved structure works precisely as Fathy describes: not as insulation blocking heat transfer, but as a thermal reservoir that absorbs, stores, and releases it across a time delay. The result is an interior whose temperature reflects not a moment in the day but a climatic average over time. The cave does not repel its environment, it absorbs it slowly and returns it transformed.

12



12 Chenini, interior sketch by the Author.

26. Hassan Fathy, *Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates* (Chicago: University of Chicago Press, 1986), p. 48.
27. Moncef Krarti, 'Thermal Performance of Ancient Underground Dwellings in Tunisia,' University of Colorado at Boulder, 1997. Field measurements confirmed temperature differentials of up to 15°C in summer, with optimum dwelling depth of 10 metres.

^a Amos Rapoport, *House Form and Culture* (Englewood Cliffs, NJ: Prentice-Hall, 1969), p. 47.

13



13 Chenini settlement and mosque

The cave is thus a climatic body. Its mass is not an inert support for other systems; it is itself the environmental apparatus. Thermal regulation, structural enclosure, and spatial interior are a single material condition. The same stone that bears weight also slows airflow, stores heat, and controls humidity. Bachelard's insight that **interiority is a bodily experience registered before geometric measurement**²⁸ is confirmed here through temperature: the sense of being inside is inseparable from the coolness, the stillness, and the shadow. Enclosure and environmental comfort are not discrete phenomena; they are experienced concurrently via various senses, created by the same body. Thermal knowledge within a cave functions in both seasonal extremes, which provides an explanation for objections regarding coldness in winter. The objection is based upon a misconception about how thermal mass operates. Earth maintains a relatively consistent temperature — generally ranging from twelve to fifteen degrees Celsius at the depth inhabited in the Mediterranean — regardless of the conditions at the surface. During the summertime, there is a large benefit: the cave will be substantially cooler than the outside temperature — up to fifteen degrees.

However, during the colder months, the consistency of temperature will provide another type of benefit: the interior will remain warmer than the outside air temperature and, most importantly, be protected from wind, rain, and rapid temperature fluctuations that create challenges for heating structures located above ground. Field studies of cave dwellings in Spain found an average year-round interior temperature of approximately twenty degrees Celsius, with only minimal internal heating required to maintain comfort.²⁹

The primary heating instrument in vernacular cave dwellings was the hearth. Hescong traces the hearth as a social and ritual centre precisely because of its thermal function: **a focus of warmth that organizes the daily life of**

28. Bachelard, *The Poetics of Space*, p. 4.

29. Field studies of cave dwellings in the Vinalopó Medio region of Alicante, Spain found an average interior temperature of 20.4°C year-round with only minimal heating required.

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the household around it.³⁰ In the cave, the thick stone walls that absorb and store heat in summer perform the same service in winter: they absorb the warmth generated by the fire and by human bodies, and release it slowly through the night. The thermal lag that makes the cave cool in summer makes it retentive of heat in winter. In the Mediterranean, where winters are mild rather than extreme, this passive thermal capacity has historically been sufficient — supplemented when necessary by the hearth, which in cave dwellings doubles as the spatial centre of domestic life.

This integration — the refusal to separate structure, enclosure, and climate into distinct systems — is what makes the cave spatially significant by contemporary standards. In contrast, modern building culture treats environmental performance as an engineering issue, space as a design issue, and structure as a technical issue. The cave does not treat these issues separately. Instead, the cave creates structure, enclosure, and climate with a single material act. All three of these aspects are created by mass at the same time. The act of subtraction does not provide additional environmental performance to a space. It simply reveals what is inherent within the material itself. This is the environmental argument for the cave's spatial intelligence. This is also the same argument, presented in a slightly different manner, as the geological, functional, and phenomenological arguments discussed in previous sections. The following section develops this argument through the void as primary spatial act — the point at which subtractive logic connects vernacular cave architecture to the broader questions of spatial theory.

1.5 The Sculptural Void

The preceding sections have approached the cave through its geological, functional, phenomenological, and environmental dimensions. What remains is to consider the void itself, not as the outcome of carving but as its primary subject. In cave architecture, space is not the residue of construction. It is the intention behind it. The removal of mass is not a means to an end, it is the end. This inversion connects the spatial logic of the cave to a broader intelligence that extends beyond vernacular building into sculpture, land art, and artistic practice.

Martin Heidegger's observation that **“a boundary is not that at which something stops, but, as the Greeks recognized, the boundary is that from which something begins its presencing”** is nowhere more precisely demonstrated than in the cave.³¹ The rock does not stop at the inhabited void, it begins there. The carved threshold is not a limit but a beginning: the point at which geological mass becomes spatial condition, at which weight becomes shelter, at which the specific resistance of a specific material becomes the definition of an inhabited world.

The void left behind when mass is subtracted from the whole has a different character than the void created through assembly. The edges of the void created by subtraction do not exist as surface applications to form a boundary; rather they are the internal faces of the remaining mass. The form of the void is the inverse image of the mass which has been removed. Bachelard, examining the dialectic of inside and outside, argues that **true interiority is defined not by what a space contains but by the depth of what surrounds it — that the thickness of the boundary is what produces the experience of being inside.**³² The carved void realizes this condition literally. The space exists because mass was removed, and it is the remaining mass — its weight, its texture, its geological continuity — that defines the

interior as an interior.

Eduardo Chillida's unrealised project for Montaña de Tindaya was a huge cubic void to be carved out inside a sacred mountain on the island of Fuerteventura, accessible only by a narrow tunnel and positioned to receive light from above at specific times of the year. The project was conceived specifically as a space completely defined by its surroundings, the weight and geology of the mountain above and around the chamber. Chillida described it as a space belonging to no particular culture but to the shared human experience of enclosure and interiority. **In this formulation the cave is not a historical typology but a spatial archetype: a condition of depth that the body recognizes before culture names it.**³³

Rachel Whiteread's House (1993) makes this logic visible from the opposite direction. By casting the interior void of a demolished Victorian terraced house in concrete, Whiteread solidified domestic void into mass, presenting the shape of inhabited space as a physical object. The result reveals how precisely the character of interior space is determined by the surfaces that once enclosed it. The cast is uncanny because it makes the void legible as form, demonstrating that the space between walls carries a geometry as specific and as spatially charged as the walls themselves. The cave and House arrive at the same understanding from opposite directions: **void is not absence but a shaped condition, and its character is inseparable from the act of its production.**³⁴

Across these examples — the vernacular cave, Chillida's mountain, Whiteread's cast — the same spatial logic is at work: enclosure defined by mass, boundaries that are geological before they are architectural, spatial character inseparable from the act of removal. The spatial intelligence represented by this logic is not simply a style or a period of time, but rather an awareness that the void is not created through forming walls around it; instead, it is created through removing mass from inside of it. The remaining space after removal then becomes both the architecture and the memory of the materials used to create it.

The cave, understood in this way, begins to exceed its own geology. What the carved void produces — the primacy of mass over surface, of depth over image, of duration over speed — constitutes a spatial logic that is transferable beyond literal excavation and beyond the Mediterranean basin. This is the cave as an architectural way of thinking and inhabitation: not a type to be reproduced but a way of thinking that can be recognized wherever a building commits to the same spatial conditions — wherever mass is primary, wherever the void is the intention rather than the residue, wherever the specific resistance of a material and a place is allowed to participate in the decision. The distinction between the physical cave and cave logic is not a weakening of the argument. It is the argument's full scope. With this understanding established, the following chapter turns to the logic by which this void is produced and carried forward: subtraction understood not as technique but as an architectural way of thinking and inhabiting.

30. Heschang, *Thermal Delight in Architecture*, pp. 44–67.
31. Martin Heidegger, 'Building Dwelling Thinking,' in *Poetry, Language, Thought*, trans. Albert Hofstadter (New York: Harper & Row, 1971), p. 154.

32. Bachelard, *The Poetics of Space*, p. 222.
33. Beatriz Matos Castaño, "Eduardo Chillida, arquitecto" (PhD diss., UPM, 2015), <https://doi.org/10.20868/UPM.thesis.39814>.
34. Peter L. Wong, "Casting Call: Spatial Impressions in the Work of Rachel Whiteread," *The Plan Journal* 0, no. 0 (2016): 97–110, <https://doi.org/10.15274/TPJ-2016-10008>.

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14 Eduardo Chillida, *Proyecto Tndaya*, 1995. Interior render
15 Mount Tindaya, Fuerteventura, Canary Islands

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16 Rachel Whiteread casting *Ghost*, 486 Archway Road, London, 1990
15 Rachel Whiteread, *House*, 193 Grove Road, London E3, 1993

Chapter Two

The Cave as Architectural Thinking

Chapter One established the cave as a condition of space: geological before architectural, structured by the body and not only the eye, thermal and seismic in its performance, sculptural in its spatial consequence. This chapter shifts the question. It moves from what the cave is to the kind of thinking it calls as well as what that thinking produces when it is undertaken beyond the vernacular, beyond the Mediterranean, beyond literal excavation.

The cave, understood not as a building type but as a mode of architectural thinking, is characterized by a series of spatial commitments: to the void as a primary act of architecture; to material depth, mass and the readability of making; to environmental conditions as spatial conditions; and to the settlement as the collective realization of the same logic that orders the individual dwelling. These too are commitments about inhabitation: about the kind of daily life the space allows, the rituals it generates, and the collective practices it enables.

These commitments arise from the conditions of carved space itself — from the fact that the act of removal is also the first spatial decision, and every decision that follows is shaped by it. Time is a dimension of the work rather than a constraint on it. To understand the cave as an architectural logic is to understand why this commitment has recurred across history, materials, and practices — not through imitation but because the spatial intelligence of subtraction resolves conditions of dwelling that no other method addresses with the same precision.

The chapter is organized around four aspects through which this thinking operates. The first ***the cave as void*** establishes the conceptual ground: subtraction as an intentional spatial commitment, and not simply a residual condition. The void is not merely what remains after construction, it is the center of organization for the entire design process. This section moves from the most purely conceptual statement of the position back to its architectural formulation in modern and contemporary practice, where subtraction and addition are not opposites but can become two moments of the same spatial operation: the removed material transformed rather than simply absent.

The second ***the cave as form*** addresses the dwelling scale: how the subtractive logic is produced through the encounter between a body and resistant material, how the marks of that encounter are preserved in the finished space, and how the materiality of cave form — its capacity to accumulate time, to carry the record of its making as the space deepens rather than decays — constitutes a distinct spatial argument. This section also introduces the question of preservation: not the arrest of change but the calibration of an ongoing process of material transformation that began with the first act of carving.

The third ***the cave as environmental intelligence*** argues that the thermal and seismic performance of the cave is not a technical bonus added to the spatial experience but an identity: the same act that produces enclosure also produces climate regulation and structural resistance. The aperture, the depth, the mass and the orientation; these are not distinct systems but rather are the spatial conditions of the cave itself. Therefore, these conditions cannot

be separated from the ritualistic practices of inhabitation that they enable to happen.

The fourth *the cave as settlement figure* extends the logic from the dwelling to the collective: the neighbourhood carved from the hillside, the social housing settlement that follows the topographic gradient, the urban infrastructure accumulated through millennia of successive removal. The settlement represents the ultimate manifestation of the cave’s potential. It is the location where the principles of reduction and communal existence converge. A settlement that follows the terrain, that is organized from within the conditions of the specific ground rather than imposed upon them, is autonomous in the same sense that the cave is: it cannot be reproduced elsewhere, because it was produced by a specific encounter between a spatial logic and a particular geology.¹

The chapter moves from the abstract to the concrete: from the conceptual conditions of the void, through the material logic of the individual dwelling, to the environmental intelligence that mass and depth produce as a consequence of their spatial commitments, and finally to the scale at which these decisions accumulate into a collective way of inhabiting the world. The arc — from void to material to environment to settlement — is not an organizational convenience but a reflection of how cave thinking actually operates: it begins with a commitment to the void and arrives, through a series of spatial and material consequences, at a way of living together that could not have been prescribed in advance.

34 1. The concept of the autonomous cave — built form that has internalized the cave’s spatial logic without literal excavation — is introduced here and developed throughout the chapter. It is defined not by material or method but by the spatial commitments it makes: to the void as primary organiser, to mass and depth over surface and image, to the legibility of making in the finished form. The term is developed further in Chapter Four in relation to specific contemporary case studies.

2. The irreversibility of the subtractive act requires qualification. Several contemporary projects — including Herzog & de Meuron’s Ricola Herb Centre (1999) and Stone House (1988) — employ stone gathered from or adjacent to the site, so that removed material is transformed and redeployed as built form. Subtraction and addition are here sequential rather than opposed. The commitment subtraction demands is therefore not to permanence or loss but to spatial intentionality. See also section 2.4.

3. Michael Heizer, *Double Negative*, 1969–70. Land artwork, Virgin River Mesa, Overton, Nevada. 457 × 15 × 9 metres. Museum of Contemporary Art, Los Angeles (gift of Virginia Dwan). See Michael Heizer, *Natural Object / Artificial Object* (New York: Gagosian Gallery, 1977).

2.1 Cave as Void

The conventional story of architectural history is one of addition: materials assembled one after another into shelter and enclosure, mass collected and manipulated into configured space. Subtraction proposes a different opening act — not what to introduce into a site, but what to release from it. In this understanding, the void is not the residue of construction, the space left over once material has been placed. It is the primary intention of the act, the spatial condition that the removal of material was always in the process of producing.

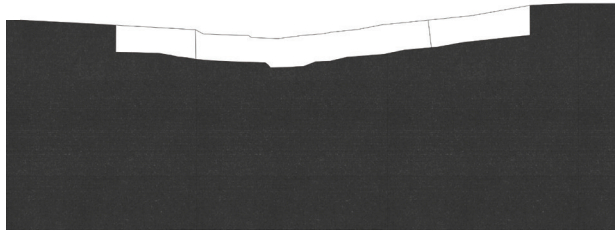
To understand subtraction as a mode of architectural thinking, it is necessary to begin with the act of removal itself — with what it commits the maker to, and with what it leaves behind. Subtraction is the act that decides everything that follows: the dimension of the opening, the weight of the wall, the quality of light admitted and shadow retained, the thermal behaviour of the interior that mass and depth together produce. These are not decisions in addition to a spatial act, they are the spatial act.² The subtraction creates a void which is not the negation of form but its most direct expression, it exists because of what is no longer there.

The clearest artistic formulation of this position is Michael Heizer’s *Double Negative* (1969–70): two trenches cut into the rim of a mesa in the Nevada desert, fifty feet deep, thirty feet wide, fifteen hundred feet in total length, displacing 240,000 tons of rhyolite and sandstone to produce **a void that is itself the work**.³ Nothing to see but absence, the cut in the earth, the missing material piled at the edges, the sky framed by the opening. Heizer gave it a precise name: the negative is not the absence of something positive, but a primary condition in itself. This is the spatial argument that connects the desert trench to the carved Mediterranean hillside: architecture, in both cases, is an act of removal.



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1 Michael Heizer, *Double Negative*, 1969, Mormon Mesa, Overton, Nevada. Aerial view, 2016



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2 Michael Heizer, *Double Negative* section. Drawing by the author

4. Gaston Bachelard, *The Poetics of Space*, trans. Maria Jolas (Boston: Beacon Press, 1994), p. 4: 'For our house is our corner of the world. As has often been said, it is our first universe, a real cosmos in every sense of the word.' On the distinction between spaces given and spaces won, see also pp. 10–12.
5. Le Corbusier and Pierre Jeanneret, *Roq et Rob, Cap Martin, France, 1949 (unbuilt)*. The project is documented in *Le Corbusier, Oeuvre complète*, vol. 5: 1946–52 (Zurich: Girsberger, 1953), pp. 54–59.
6. Kenneth Frampton, *Modern Architecture: A Critical History*, 4th ed. (London: Thames and Hudson, 2007), pp. 224–226, on Le Corbusier's vernacular turn and the shift from the Purist machine aesthetic to the expressive force of geological material and traditional construction.

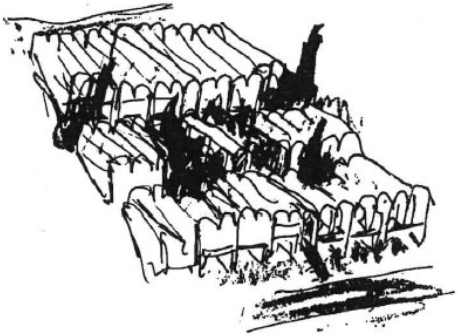
Bachelard draws a distinction that underpins this: the difference between spaces that are given and spaces that are won. The cave belongs decisively to the second category; its void is earned through effort, through the meeting of a body with resistant matter.⁴ This earning is what gives subtractive space its particular authority. The void is not the remainder but the beginning. It was created by an intentional act which carries on its surface a trace of how it was made. The nature of the subtractive process focuses one's gaze in a manner rarely required during construction. In contrast to constructing an assembled wall which could have been clad, corrected or replaced; the carved surface is now the architecture itself.

Le Corbusier's Roq et Rob project for Cap Martin (1949), though never built, makes the void argument with unusual conceptual clarity. The proposal carved stepped housing units directly into the Mediterranean coastline cliff, each unit occupying a terrace excavated from the rock face and oriented toward the sea. The inhabited space is not placed upon the hillside but within it, the cliff is the spatial condition from which the dwelling is produced.⁵ Following Frampton, this project belongs to Le Corbusier's vernacular turn after 1928, in which the Mediterranean landscape ceased to be a view and became a material: something to be worked with, carved into, inhabited from within rather than set against. The geological condition the spatial act from which it begins: a logic that, seven decades later, would be taken to its furthest architectural conclusion on another Mediterranean island.⁶

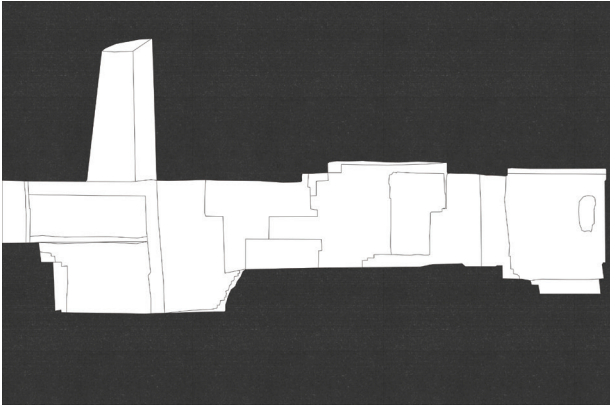
- 3 Le Corbusier, *Roq et Rob, Cap Martin, 1949*. Sketch showing reinterpretation of the weekend house as a housing prototype
- 4 Le Corbusier, *Roq et Rob, Cap Martin section*. Drawing by the author



3



- 5 Ca'n Terra, Menorca. The lone tree within the carved lightwell
- 6 Ca'n Terra, Menorca section. Drawing by the author



6

7. Ensamble Studio (Antón García-Abril and Débora Mesa), *Ca'n Terra, Menorca, 2018–20*. The project is documented in Antón García-Abril, 'Ca'n Terra,' *Architectural Record* (February 2021); and in the Ensamble Studio project archive at ensemble.info. For the broader practice of inhabiting pre-existing geological voids in contemporary architecture see also the discussion of earth integration in section 2.4 of this chapter.
8. The tension between the geological scale of Ca'n Terra and the domestic scale of the cave dwelling is discussed in the context of the project's reception. See also the distinction between inhabitation and encounter in relation to land art and architecture in Rosalind Krauss, 'Sculpture in the Expanded Field,' *October*, vol. 8 (Spring 1979), pp. 30–44.

Ca'n Terra by Ensamble Studio in Menorca (2018–20) is that furthest realization. The project began not with a design but with a discovery: an abandoned Marés stone quarry, excavated industrially over decades, later used as a military depot during the Spanish Civil War, then left to decay. García-Abril and Mesa purchased the site and began the process of making it inhabitable, not by building within it but by revealing what the subtraction had already produced.⁷ The architects entered the quarry with laser scanners rather than drawing boards, mapping the carved interior before any intervention was proposed. Architecture here is discovered within the void. The subtractive act, carried out over decades by industrial quarrying, is the architecture; the design is its inhabitation.⁸ Yet, Ca'n Terra displays a tension the thesis should name: the void was not made for human habitation, but for industrial extraction. Geological in scale not domestic. In every direction its chambers are larger than the human body. This is what makes the project both conceptually radical and spatially ambiguous. It makes the case for the void as primary act with unusual clarity and at the expense of the human scale that makes the cave, in its vernacular form, a place of habitation and ritual rather than of encounter and contemplation.



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What the quarry void, the cliff terrace, and the geology of incision share is neither material nor method but a common spatial commitment: the organization of conditions from within rather than the assembly of enclosure from without, so that the void is the intention rather than the outcome. The three examples also demonstrate different relationships with the body that inhabits them — at Cap Martin the scale of the stepped terraces is calibrated to dwelling, at Ca'n Terra the scale of the quarry exceeds it entirely. The following chapter explores this tension: how the subtractive logic that Heizer states in its most absolute form becomes, in vernacular, modern, and contemporary practice, the condition for a specific and irreplaceable way of living.

2.2 Cave as Form

The void of subtraction is not complete. It is the outcome of a slow process, physical and irreversible. Its surfaces are the record of its making, not as decoration or texture but as a record of space. This is a form, in this very sense, produced by time.

Yvonne Farrell of Grafton Architects states that architecture is **a machine for slowing down time**. At their most powerful, buildings introduce a fourth dimension, not only space but the experience of time moving through space, of light shifting across surfaces, of materials ageing, of the body constantly recalibrating as it moves through changing conditions.⁹ The cave is the most literal expression of this proposition. Its surfaces are the record of time and the condition of it. The cave is temporal not because it is ancient but because it absorbs repetition into form. Every time an act returns to the same threshold, the same niche, the same courtyard, it is a deepening of the definition of that element in space. The space is not fixed at the moment of carving, but still in the process of being produced by the lived life in it.

What makes it different from the prefabricated unit is the cave, not materiality or age, but the legibility of duration. What worn stone keeps is not age but accumulation — the deposited time of ten thousand passages, each one leaving the threshold fractionally more itself. Contemporary building practice moves in the opposite direction: polished metal and glass are designed to resist the effects of time, to remain perpetually unmarked, to refuse the inscription that use would otherwise leave. The cave's form, by contrast, is inseparable from the conditions of its making, and its material surface is inseparable from the history of its inhabitation.

This relationship between form and material is inseparable from the question of preservation. Cave architecture does not deteriorate in the way that constructed architecture does. It does not collapse outward but deepens inward, accumulating the marks of use, weathering, and repair as spatial information rather than damage.¹⁰ The tuff of Matera's Sassi, the volcanic ash of Santorini's caldera, the limestone of Apulia's trulli — each material has a certain logic of ageing. Tuff solidifies by oxidation, producing a protective crust. Cutting exposes new material, which cures in air, resulting in a surface harder than the geologic formation from which it originated. Preservation is not arrest of change, but change of its direction. John Ruskin, writing on the lamp of memory, said that **the marks that time leaves on a building are not imperfections to be corrected, but the building's truest ornament: the evidence of its having been lived in.**¹¹

The making of cave form is a bodily intelligence. Rudofsky observed that the Santorinian barrel vault was not a theoretical principle but a particular

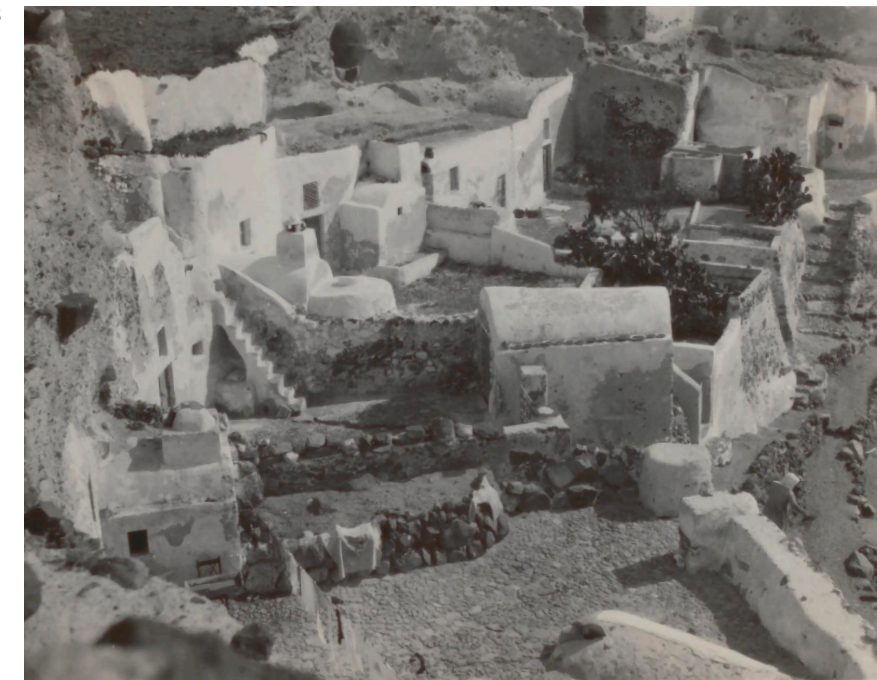
12. Bernard Rudofsky, *Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture* (New York: Museum of Modern Art, 1964), p. 1. On Rudofsky's fieldwork in Santorini and his 1932 Vienna doctoral thesis on Cycladic construction, see Ugo Rossi, 'The Discovery of the Site: Bernard Rudofsky. Mediterranean Architectures,' in *House and Site*: Rudofsky, Lewerentz, Zanuso, Sert, Rainer, ed. Eleonora Mantese (Florence: Alinea, 2014), pp. 52–113.

quality of the island's soft volcanic stone. The repeated application of the hands to material led to this discovery, and over centuries it was refined into a form that was at once structure, enclosure, and climate.¹² This is a haptic knowledge, not expressed in drawings and specifications, but in the incorporation of a tradition into the body of the craftsman. That material itself is part of the decision, it cannot be abstracted away in its entirety. The cave is shaped by this negotiation of body and material, which is always specific to the geology of a given place, and the tools available to a given community.



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7 View from Phira overlooking the marina. Cave dwellings in the sheer cliffs of Klite.

8 "The inhabitants of the villages situated on the slope often live in caves hewn into the somewhat eroded ash deposits, which have only a front wall to enclose them, thus forming rooms and chambers."

9. Yvonne Farrell, quoted in Rory Olcayto, 'Grafton: Every dimension, every niche, every surface in architecture makes a difference,' *The Architects' Journal*, 6 February 2014.

10. On the material logic of tuff and its behaviour under weathering in Matera's Sassi, see Pietro Laureano, *Atlante d'acqua: Conoscenze tradizionali per la lotta alla desertificazione* (Turin: Bollati Boringhieri, 2001). On the preservation of Santorinian volcanic ash construction, see Thanos N. Stasinopoulos, 'The Four Elements of Santorini's Architecture,' in Willi Weber and Simos Yannas, eds., *Lessons from Vernacular Architecture* (London: Routledge, 2014), pp. 11–36.

11. John Ruskin, *The Seven Lamps of Architecture* (London: Smith, Elder & Co., 1849), Chapter VI: 'The Lamp of Memory.'

Le Corbusier's Maisons Jaoul in Paris (1955) produces the same cave spatial quality through construction rather than excavation.¹³ Following Frampton, the project represents the fullest realization of Le Corbusier's vernacular turn: the Catalan vaults, the exposed brickwork, the concrete struck directly from timber shuttering — traditional means applied at a moment when modern architecture was defined by smooth, machine-wrought surfaces. **The narrow openings in the cross-walls, the transverse vaulted bays, the tactile insistence of the material: these produce compression, depth, the sense of being held within mass, the roughness of a surface that registers its own making.**¹⁴ James Stirling described the Maisons Jaoul as retrograde — disturbed that Le Corbusier was building by hand with traditional materials at a moment when modern architecture was defined by smooth prefabricated surfaces. But Stirling's discomfort was precisely the point. The Maisons Jaoul was not making a technical argument but a spatial one: that mass, depth, and the visible trace of making produce a spatial quality that no smooth machine-wrought surface can provide.¹⁵ It is also, and inseparably, a sensory argument. The roughness of brick struck from timber shuttering is not a textural choice but a haptic one: it activates the eye's anticipation of touch, measuring weight and resistance before the hand confirms them — what Pallasmaa identifies as the fundamental tactile dimension of vision. The compression of the vaulted bay registers as pressure before it is read as form. The shadow that gathers in the transverse wall openings deepens the interior not visually but atmospherically, producing the sense of being held within mass rather than enclosed by surface. Stirling was right that this was not progress in the modernist sense. It was a return to the spatial conditions — haptic, thermal, resistant — that the machine aesthetic had eliminated from domestic space, and that the body, given the opportunity, immediately recognises.

13. Le Corbusier and Pierre Jeanneret, *Maisons Jaoul*, Neuilly-sur-Seine, Paris, 1955. See *Le Corbusier, Oeuvre complète*, vol. 6: 1952–57 (Zurich: Girsberger, 1957), pp. 226–235.

14. Kenneth Frampton, *Modern Architecture: A Critical History*, 4th ed. (London: Thames and Hudson, 2007), pp. 225–226.

15. James Stirling, 'Garches to Jaoul: Le Corbusier as Domestic Architect in 1927 and 1953,' *Architectural Review*, September 1955, pp. 145–151, here p. 148.

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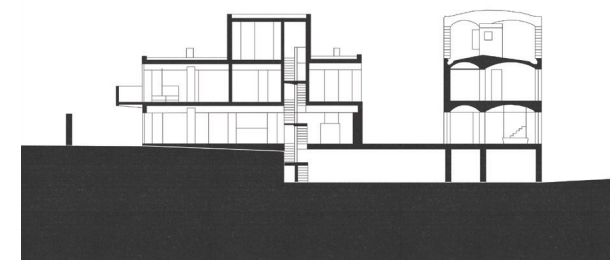


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9 Le Corbusier, *Maisons Jaoul*, Neuilly-sur-Seine, 1954–56. Exterior view



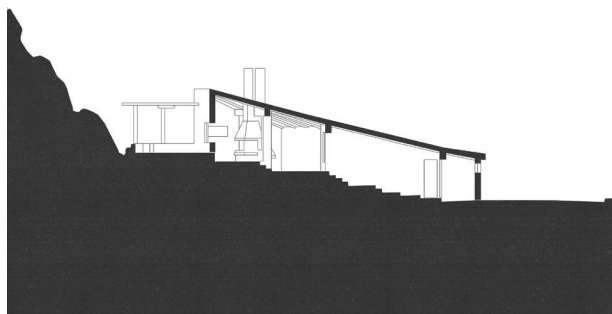
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10 Le Corbusier, *Maisons Jaoul*, Neuilly-sur-Seine, 1954–56. Interior, vaulted ceiling
11 *Maisons Jaoul* section.



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12 Alberto Ponis, *Hartley House, Costa Paradiso, Sardinia, c. 1970. Exterior view*
 13 *Hartley House section. Drawing by the author.*



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16. Alberto Ponis, *Hartley House, Costa Paradiso, Sardinia, c. 1970. See Sebastiano Brandolini, Alberto Ponis: Architettura in Sardegna (Milan: Electa).*

Where Maisons Jaoul achieves cave spatial quality through the density of its construction, Alberto Ponis's Hartley House at Costa Paradiso, Sardinia (c. 1970) does so through a different register: **the direct bodily encounter with the geological ground before a single line is drawn.**¹⁶ The triangular footprint of the house occupies a natural depression between two rock pinnacles, allowing it to sit within the landscape rather than above it. The sail-shaped roofline extends the visual presence of the adjacent formation rather than competing with it, and the stairway to the upper terrace was cut directly from the rock rather than constructed upon it — a distinction that is not merely technical but spatial, locating the threshold of ascent within the material of the site itself.

The design was preceded by sustained site investigation: Ponis walked the terrain extensively, producing numerous sketches of the topography at varying distances and scales. This process was not preparatory in the conventional sense but constitutive of the design — the form of the house emerging from accumulated observation rather than from a geometric intention imposed upon the land. The resulting relationship between house and ground could not have been arrived at without direct, prolonged engagement with the site itself. This engagement is bodily before it is architectural. Ponis did not analyse the site from a distance and then design upon it; he walked it, sketched it, returned to it at different times of day and in different light conditions, accumulating a sensory knowledge of its specific resistances — the angle of the granite formations, the direction of the sea breeze, the way afternoon shadow falls across the depression between the two rock pinnacles — before a single spatial decision was made. What the Hartley House produces as a result is a space whose sensory conditions are inseparable from its topographic ones: the staircase cut directly from the rock places the body in material contact with the geological substance of the site at the moment of ascent; the sail-shaped roofline, following the visual presence of the adjacent formation, frames the sky as the specific sky of this cliff rather than any sky; the interior, compressed between rock and roof, produces the haptic enclosure of the cave without excavation. Ponis understood what the vernacular builders of the Mediterranean had always known: that a dwelling belongs to its ground not when it resembles it formally but when the body, moving through it, feels that it could not be anywhere else.

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14 Alberto Ponis, *Hartley House, Costa Paradiso, Sardinia, c. 1970. Interior view*

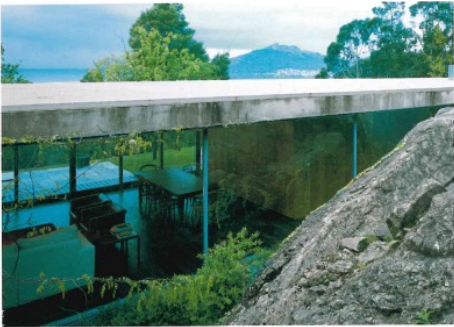
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Eduardo Souto de Moura’s House in Moledo in northern Portugal (1991–98) arrives at a similar spatial commitment through a different material logic. The site was an existing system of dry-stone agricultural terraces cut into a granite hillside over centuries. Rather than clearing them, Souto de Moura inserted the house within and between the terrace walls: the ancient stone retaining structures become the load-bearing elements of the building, the voids between the terraces the inhabited spaces. **A single concrete slab roof sits flush with the hillside surface so that from above the house disappears entirely into the slope.**¹⁷ In Moledo, the materialization of the historical agriculture and the spatial configuration of modern dwellings converge. The construction of the house’s stone walls cannot be distinguished from those of the agricultural walls which surround it. Not as an imitation; rather, as one. What this material continuity produces is a specific sensory experience: the same weight, the same thermal behaviour, the same acoustic density in the walls that have organised this hillside for centuries. The body moving through the House in Moledo does not encounter architecture applied to a landscape but geology continued into dwelling — the haptic character of the granite surface, the coolness of the thick stone walls, the compression of spaces that follow the gradient rather than overriding it, all registering as conditions of inhabitation before they are read as architectural decisions. The form of the building is also a reflection of the landscape. For centuries, the form has been calibrated to the weight, drainage and seismic characteristics of

the granite hillside. In Moledo, the legibility of making becomes visible at its purest level: the surface of the house is literally a geological record of the land upon which it was built.

The recurrence of this spatial logic across different periods and geographies is not coincidental. It is a shared understanding of what architecture owes to the conditions of its making: that the time taken to construct, the material encountered during construction, and the specific resistance of a specific place are not simply constraints to be overcome, but rather the spatial argument itself. The haptic knowledge embedded in Santorinian vernacular construction, the bodily encounter with Sardinian granite, the barrel vault translated from the Mediterranean farm building into Parisian social housing, and the agricultural stone terraces redeployed as the structure of a contemporary Portuguese dwelling do not share a common formal reference or a common material. Rather, they represent a shared understanding of what architecture owes to the conditions of its making.

17. Eduardo Souto de Moura, House in Moledo, Portugal, 1991–98. See *El Croquis* 124: Eduardo Souto de Moura 1995–2005 (Madrid: El Croquis Editorial, 2005); also Eduardo Souto de Moura: *Atlas de Parede, Imagens de Método* (Porto: Dafne Editora, 2011).



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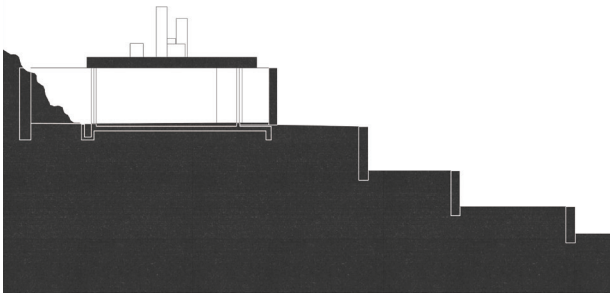
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16 Alberto Ponis, Hartley House, Costa Paradiso, Sardinia, c. 1970. Exterior view
17 Eduardo Souto de Moura, House in Moledo, Portugal, 1991–1998. Exterior view
18 Eduardo Souto de Moura,

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18 Eduardo Souto de Moura, House in Moledo, Portugal, 1991–1998. Interior view through glazed façade
19 House in Moledo section. Drawing by the author.

2.3 Cave as Environmental Intelligence

The cave has been understood in environmental terms as a simple climate control system, as an instance of how traditional building techniques can be adopted by contemporary architects in view of the decreasing availability of energy sources. This view is not wrong, but it is incomplete. The cave doesn't address the thermal and seismic issues with mechanical devices added to a neutral enclosed space. Rather, it addresses these issues as it makes the spaces in which they take place; that is, as it then carves out those spaces from the ground. Mass, depth, orientation, the thickness of the geologic formation around the dwelling are all integral components of the architectural design of the cave. The spatial organization of the dwelling is directly conditioned by its thermal characteristics and seismic stability — these are not separate considerations applied to a prior form, but forces that shape the form itself. To read the cave as a mode of environmental intelligence is to recognize that its spatial and environmental conditions are not parallel systems but a single integrated one: the cave performs because of how it is arranged, and it is arranged the way it is because of how it performs.

Santorini offers the most concentrated instance of this convergence. The excavated dwellings of the caldera cliff — cut into the compressed volcanic ash of the island's inner face — represent, as Stasinopoulos documents, the optimal built response to the specific environmental conditions of the site.¹⁸ The caldera faces southwest, receiving maximum solar radiation in winter when it is most needed and shading itself through the mass of the cliff in summer. The volcanic tufa — technically a compressed ash rather than a stone — absorbs the heat of the day and releases it slowly through the night, producing interior temperatures that remain stable while exterior temperatures swing dramatically between seasons. Field measurements confirm that excavated dwellings maintain interiors consistently more comfortable than above-grade construction throughout the year, with summer temperature differentials between inside and outside reaching up to fifteen degrees Celsius.¹⁹ No mechanical system produces this result. The earth is the climate system, and the act of carving into it is the environmental act.

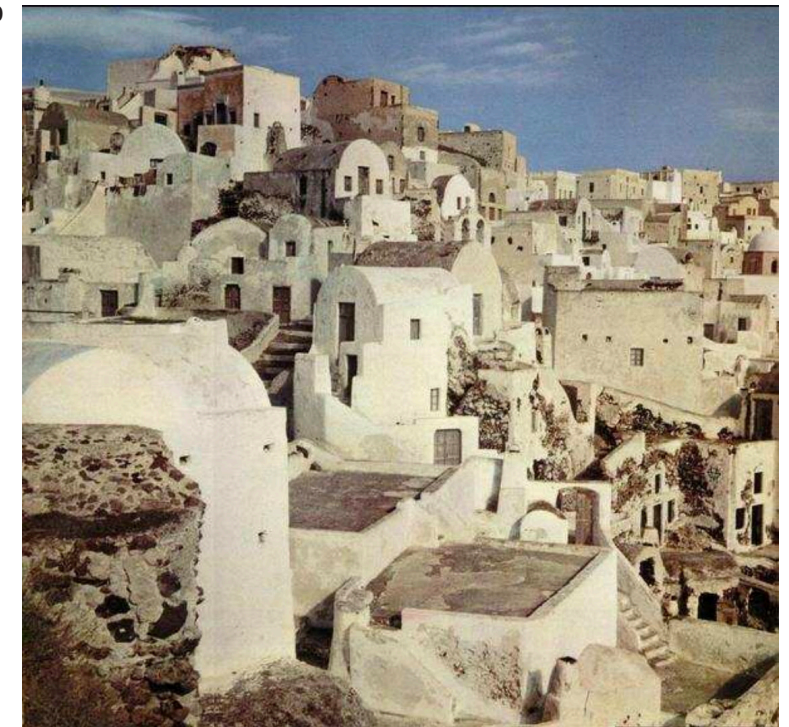
The seismic performance of the Santorinian excavated dwelling is equally direct. The island sits on one of the most seismically active zones in the Mediterranean. The 1956 eruption and earthquake destroyed a significant portion of the above-grade built fabric. The excavated dwellings survived. Stasinopoulos records that aseismic principles shaped every element of the spatial system: thick side walls and thin vaults, buttresses and stone tendons, narrow openings and rigid corners.²⁰ These are not structural elements added to the spatial arrangement; they are the spatial arrangement. The same thick wall that holds the thermal mass of the surrounding earth also distributes seismic force away from the structure. In other words, the cave uses the geology as an environmental response to geological violence. This is possible because the cave is part of the geology and not in opposition to it. Therefore, the spatial intelligence and environmental intelligence of the cave are one and the same.

18. Thanos N. Stasinopoulos, 'The Four Elements of Santorini's Architecture,' in Willi Weber and Simos Yannas, eds., *Lessons from Vernacular Architecture* (London: Routledge, 2014), pp. 11–36. The four elements are: the caldera orientation, the volcanic material, the excavated form, and the aperture system — each simultaneously spatial and environmental.

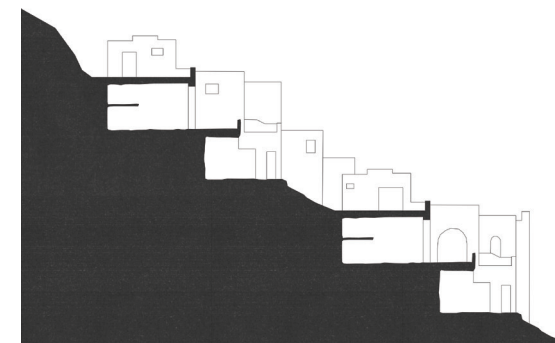
19. Ibid.

20. 'These are the best structures to withstand earthquakes, with the additional benefit of acting as free heating and cooling mechanisms due to the large thermal mass of earth.'

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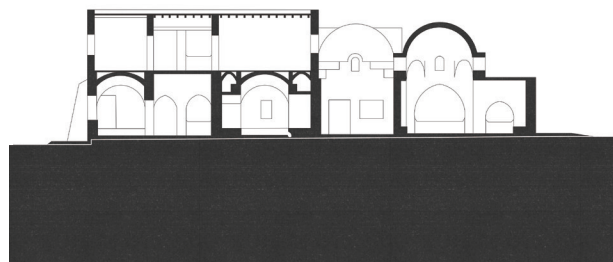
20 Santorini, typical dense architectural formations showing skepastá dwellings carved into the caldera cliff
21 Santorini cave houses section. Drawing by the author.

Lisa Heschong's account of thermal experience in traditional dwellings offers the theoretical framework for understanding what this environmental identity produces in terms of inhabitation. Heschong argues that thermal conditions are not physiological facts to be neutralized but spatial events that structure daily life: the warmth of a hearth, the cool of an interior room in summer heat, the transition between sun and shade produce specific acts, specific gatherings, specific rhythms of movement through the dwelling. The traditional Tunisian courtyard house organizes daily life as a migration through the building according to temperature: the shaded ground-floor room at midday, the upper terrace in the evening breeze, the interior at night.²¹ The dwelling's thermal gradient represents its spatial program and should be seen as part of the organizational process, rather than an additional element.

This is the cave's environmental intelligence: not that it maintains a stable temperature, but that its thermal conditions structure inhabitation. The thermal gradient is also a ritual one. The daily movement through the cave dwelling — from the cool inner chamber where food is stored and the body rests, to the intermediate space where work is done, to the sunlit threshold where social life occurs — is not a sequence an architect designed but one the spatial and thermal conditions of the cave produced. Heschong identifies this as thermal delight precisely because it is inhabited rather than merely experienced: the body's movement through conditions of warmth and coolness, shadow and light, enclosure and threshold, is the spatial substance of daily domestic ritual.²² In the Tunisian dwellings, the transition from interior cave to courtyard to terrace is not a circulation diagram but a daily choreography shaped over generations by the geological processes that formed the thresholds themselves. The movement inward during summer heat, the gathering around a fire in winter, the retreat into the deepest chamber at the height of the day — these are not arbitrary actions but responses to the spatial and thermal conditions of the cave. The cave organizes daily life without prescribing it: it offers conditions, not instructions.

21. Lisa Heschong, *Thermal Delight in Architecture* (Cambridge, MA: MIT Press, 1979), pp. 26–30. Heschong's account of the migration through the traditional Tunisian courtyard house is one of the foundational arguments in the literature on thermal experience as spatial event rather than physiological condition.

22. Lisa Heschong, *Thermal Delight in Architecture* (Cambridge, MA: MIT Press, 1979), pp. 17.



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22 House in New Gurna section. Drawing by the author.

23 Hassan Fathy, *New Gurna, Luxor, Egypt, 1946–52*. Street view

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23. Hassan Fathy, *New Gurna, Luxor, Egypt, 1945–48*.

The project is documented in Fathy's own account: Hassan Fathy, *Architecture for the Poor: An Experiment in Rural Egypt* (Chicago: University of Chicago Press, 1973); and in Hassan Fathy, *Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates* (Chicago: University of Chicago Press, 1986).

24. On the *malqaf*, *qa'a*, and courtyard as integrated thermal systems in Egyptian vernacular architecture see Fathy, *Natural Energy and Vernacular Architecture*, op. cit., Chapters 3–5. Fathy documents each element both as a spatial type and as a climatic instrument, arguing that their separation — the design of space and the design of environmental performance as distinct operations — is precisely what makes modern construction thermally inadequate.

Hassan Fathy's New Gurna project in Luxor, Egypt (1945–48) stands as the clearest modern attempt to carry this environmental logic forward — to translate the spatial intelligence of vernacular thermal architecture into the terms of contemporary social housing.²³ Commissioned to rehouse the inhabitants of the ancient village of Gurna, Fathy refused the concrete block construction standard in Egyptian social housing of the period. Instead he studied the traditional domestic architecture of the Nubian and Upper Egyptian vernacular: the *malqaf*, or wind catcher, which captures prevailing winds and directs cool air into the building's interior; the *qa'a*, the reception hall whose high vault channels warm air upward and out; *the courtyard*, which collects cold night air and releases it slowly through the day, acting as a thermal battery within the built fabric.²⁴ Each spatial element is simultaneously a climatic one. Fathy designed spaces as environmental systems rather than fitting environmental systems to pre-existing forms. He understood that in the vernacular home, spatial organization was the environmental system — that the section of a room, the height of an opening, and the orientation of a courtyard were thermal decisions before they were architectural ones. In this way, Fathy demonstrates how the environmental logic of the cave — the interplay of climatic and spatial reasoning — can be named, understood, and deliberately applied.

In his domestic architecture, Frank Lloyd Wright demonstrates that the same logic of environmental organisation can be achieved through construction rather than excavation, and within a modern rather than a vernacular tradition. In the Prairie houses of the early twentieth century, Wright organised the entire spatial sequence around the central hearth: the chimney mass is the thermal and structural core of the building, from which every room extends outward. The fireplace is not a decorative element but the thermal centre: a mass that absorbs heat and releases it slowly, regulating the interior temperature in the same way that the earth regulates the temperature of the cave. Wright described the hearth as the psychological and physical heart of the house: the point around which domestic life gathers, the threshold between the protected interior and the exterior world. In Fallingwater (1935), this logic reaches its geological conclusion: the hearth is built directly into the rock of the site, the stone ledge of the streambed incorporated into the living room floor, the boundary between the built and the geological dissolved at the building's thermal centre. The cave's environmental intelligence — the organisation of daily life around a thermal anchor, the calibration of mass and opening to the specific conditions of a place — here becomes the organising principle of a modern building in a specific landscape. As Edgar Kaufmann Jr. observed, **"although all of Fallingwater is opened by broad bands of windows, people inside are sheltered as in a deep cave, secure in the sense of the hill behind them."**²⁵

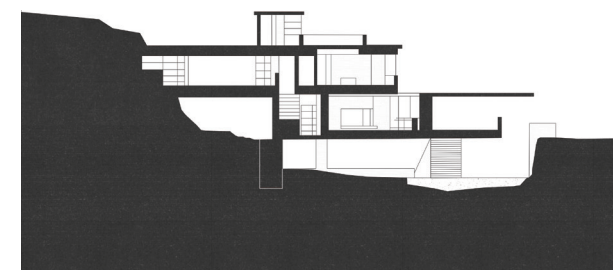
The cave's environmental intelligence requires neither geological material nor literal excavation to operate. A constructed building can achieve the same integration of spatial and environmental act through mass, depth, orientation, and the calibration of aperture — through the same spatial commitments the cave makes, arrived at through construction rather than carving. Fathy's mud-brick vaults with their thick load-bearing walls, the deep-set openings of Wright's thermally-driven interiors: both produce, in different ways, the environmental identity that the excavated cave produces directly. This is the cave as environmental proposition: not a reference to vernacular form, but an autonomous realization of its spatial logic.

25. Edgar Kaufmann Jr., *Fallingwater: A Frank Lloyd Wright Country House* (New York: Abbeville Press, 1986), p. 42.

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24 Frank Lloyd Wright, *Fallingwater*, Mill Run, Pennsylvania, 1936–39. Boulder at hearth, fireplace detail
25 Frank Lloyd Wright, *Fallingwater*, section. Drawing by the author.



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26. On the spatial structure of Matera's Sassi, and on the three-dimensional layering of the settlement, see Pier Luigi Lionetti and Francesco Foschino, *I Sassi di Matera: Abitare la Roccia* (Matera: Antezza Tipografica, 2008); and UNESCO World Heritage Site documentation for the Sassi di Matera (1993). For the relationship between the Santorinian vernacular settlement and the organization of collective life across the slope — directly analogous to the spatial logic of the sassi — see Stamatina Kousidi, 'Through the Lens of Sigfried Giedion: Exploring Modernism and the Greek Vernacular in situ,' *RIHA Journal* 0136 (15 July 2016), URL: www.riha-journal.org/articles/2016/0136_kousidi.

27. Peter Lauritzen, 'The Cave Dwellings of Matera,' in Bernard Rudofsky, *Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture* (New York: Museum of Modern Art, 1964). See also Carlo Levi, *Christ Stopped at Eboli*, trans. Frances Frenaye (New York: Farrar, Straus and Giroux, 1947), for a contemporaneous account of the inhabited Sassi prior to the 1952 evacuation.

28. Christian Norberg-Schulz, *Genius Loci: Towards a Phenomenology of Architecture* (New York: Rizzoli, 1980), pp. 89–102.

26 Sassi of Matera Sketch by the Author
27 Sassi of Matera section. Drawing by the author.

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2.4 Cave as Settlement Figure

The cave as form of dwelling, established at the scale of the body in the previous section, does not end at the physical limits of the individual dwelling. The same logic that carves a niche carves a neighbourhood. The same logic that carves a neighbourhood carves a city. At the scale of settlement, subtraction becomes the organizing principle of collective spatial life: the shared roof, the communal network, the street that is also a threshold. This section follows the figure of the cave through four examples, from the vernacular to the contemporary, and from the neighbourhood to the individual dwelling embedded in its topographic context — arguing at each scale that the subtractive void is not simply a formal device but the spatial condition that makes collective inhabitation possible.

At the neighbourhood scale, Matera's Sassi demonstrate what subtractive logic produces when extended beyond the individual dwelling. The two ravines — Sasso Caveoso and Sasso Barisano — were formed over millennia by the erosion of the limestone plateau of Basilicata. What distinguishes the Sassi spatially is not simply that dwellings were carved from the hillside, but that no clear boundary exists between those carved from the rock and those built upon it — nor between what is underground and what is above. **The roof of one dwelling is the street in front of another; the retaining wall of one courtyard is the facade of the house below.**²⁶ The three-dimensional layering implies that the void is not contained within the limits of individual buildings but is flowing through the whole settlement. The cave here is not a room, but a spatial condition that structures a whole neighborhood, determining how light falls, how air circulates, how water is collected from cisterns carved into the rock below the houses, how social life is distributed across the slope. What Matera makes legible is the relationship between this incremental spatial production and the rituals of collective life that structured it. The roof terrace as street, the common cistern at the bottom of the ravine, the threshold between the private interior of the cave and the collective outdoor space — these are not the addition of spatial features to a settlement but the spatial record of repeated acts of the community. Water collection, food preparation in shared courtyards, the passage of animals along the internal paths of the settlement: the spatial organization of the Sassi is the accumulated imprint of daily rituals performed by specific bodies in specific geological conditions for centuries. The cave shaped the habitation as much as the habitation shaped the cave.

The Sassi were not planned but grew incrementally from the geology itself, each generation carving further into the rock or building up from what the previous had left. Peter Lauritzen, documenting the spatial structure of the settlement, describes how the cave dwelling and the constructed house above it function as a single unit: the cave providing cool storage and sleeping space in summer, the upper room capturing winter sun.²⁷ Christian Norberg-Schulz, writing on the genius loci of Mediterranean settlements, argues that **the specificity of a place is produced not by individual buildings but by the relationship between built form, topography, and the voids between them.**²⁸ In Matera this relationship is literal: the settlement did not adapt to the geology but emerged from it. Rock was cut away where shelter was needed, built up where carving stopped, and left open where light and air were required. The result is a spatial fabric in which subtraction and addition become indistinct — one whose organizing logic is geological rather than architectural.

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At the scale of the modern city, Álvaro Siza's Quinta da Malagueira in Évora, Portugal (1977–2005) demonstrates that the cave figure can operate as an organizing principle for social housing without literal excavation. The interpretation was not derived from an existing written record of the project; however, it was formed through a study of the project itself. In terms of spatial organization, the development functions under a topographic logic prior to being organized by type.²⁹ Commissioned in the aftermath of the 1974 Carnation Revolution, the project proposed 1,200 low-rise courtyard units distributed across 27 hectares of undulating terrain on the outskirts of the ancient walled city. Instead of superimposing a grid, Siza utilized the gradient directly to define the street pattern. He created narrow cobbled streets which followed the slopes of the site; therefore, the settlement appears to have developed organically from the landscape rather than having been positioned on top of it. Each unit is arranged around courtyard voids – negative spaces used to organize household activity, allow natural light and ventilation into each unit, and provide the spatial framework for semi-public interaction on the street.

The project's most powerful element is its infrastructure: a two-storey concrete service conduit that runs through the entire settlement, distributing utilities and simultaneously acting as a spatial landmark – a contemporary reinvention of the sixteenth-century aqueduct that still runs through Évora. Pier Vittorio Aureli has characterised Quinta da Malagueira as “**perhaps the last great social housing project**” – **the last in which formal principles and political intent were fused as a single spatial act.**³⁰ What makes Siza's project relevant here is its spatial intelligence: the refusal of the tabula rasa, the submission of the plan to the topographic reality of the specific ground, the courtyard void as the primary unit of social organization. The settlement grows as a cave settlement grows. What the ground gives here is not only spatial but sensory: the specific warmth of Alentejo stone in afternoon light, the acoustic intimacy of the narrow cobbled street that follows the slope, the compression of the courtyard void that gathers cool air at night and releases it through the day. The body moving through Quinta da Malagueira does not experience a housing settlement but a thermal and haptic choreography organised by topography — the same daily migration through conditions of shade, enclosure, and threshold that the Mediterranean cave dwelling has always produced, here recovered at the scale of the neighbourhood. From the conditions of the place. Following what the ground already gives.

29. Álvaro Siza, *Quinta da Malagueira, Évora, Portugal, 1977–2005*. See Kenneth Frampton, *Álvaro Siza: Complete Works* (London: Phaidon, 2000); also Frampton, *Modern Architecture: A Critical History*, 4th ed. (London: Thames and Hudson, 2007), pp. 314–327.

30. Pier Vittorio Aureli, quoted in Ellis Woodman, 'Quinta da Malagueira,' *The Architectural Review*, 2015. Reprinted at drawingmatter.org.

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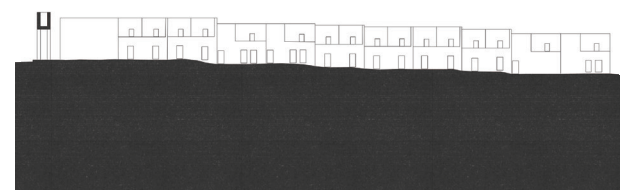
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29 Álvaro Siza, *Quinta da Malagueira, Évora, Portugal, 1977–1997*. Interior street view

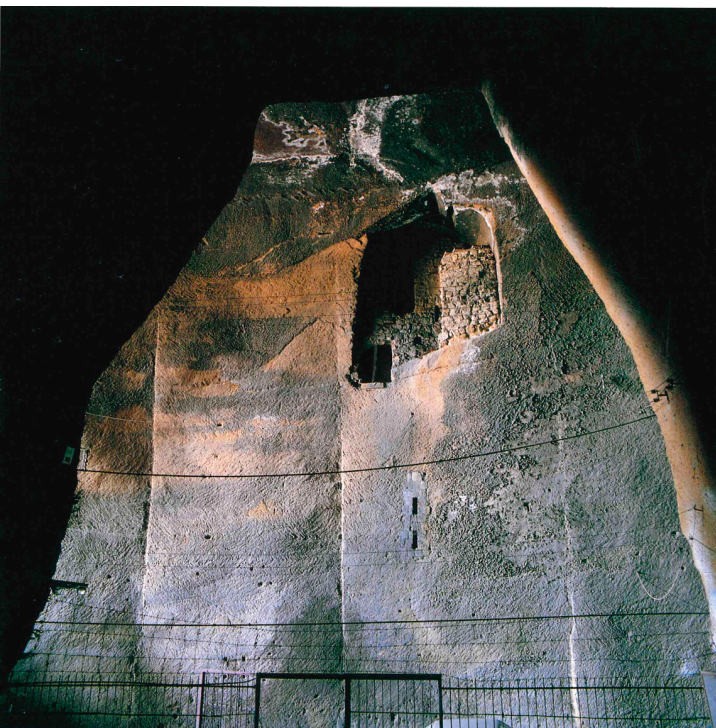
30 Álvaro Siza, *Quinta da Malagueira, Évora, Portugal, 1977–1997*. Roofline and massing

28 Quinta da Malagueira urban section. Drawing by the author.

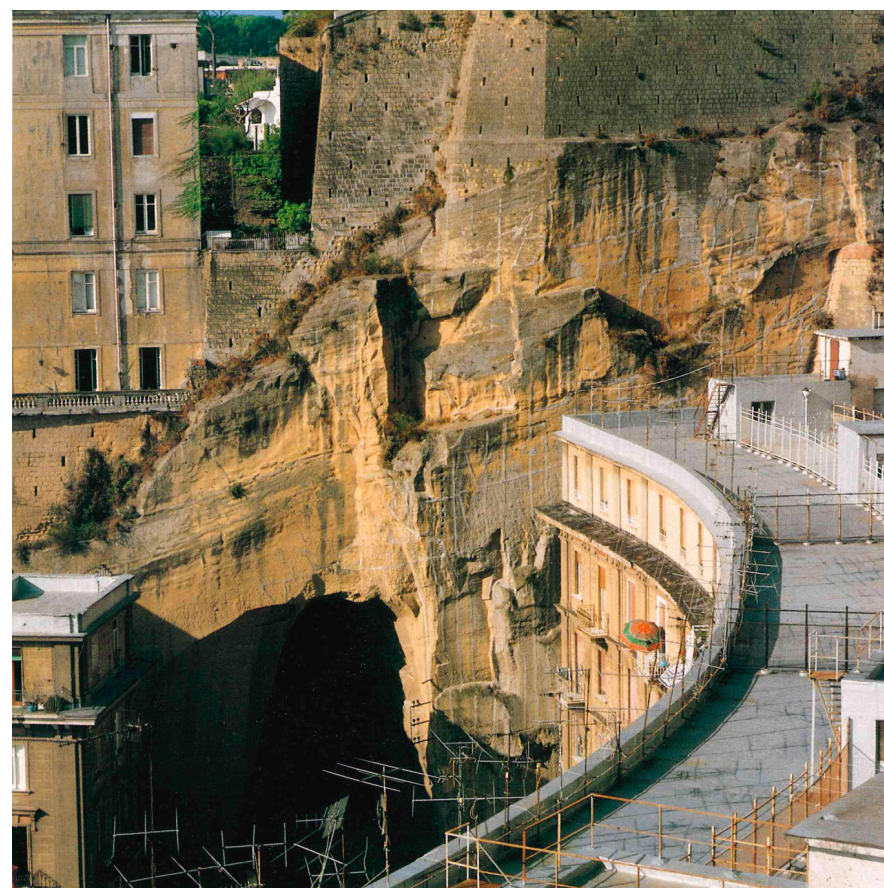


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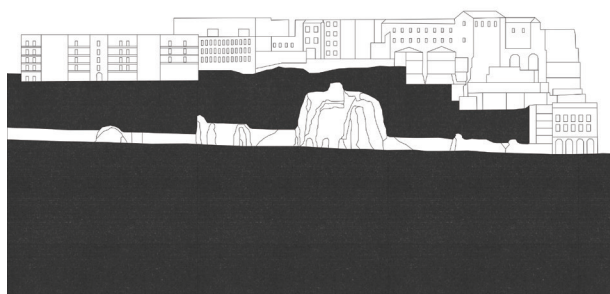
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31 Napoli Sotterranea, interior view showing material texture and surface

32 Napoli Sotterranea, exterior view showing entrance and surrounding urban context

33 Napoli Sotterranea section. Drawing by the author.

31. Napoli Sotterranea. The network extends beneath the historical city from Greek and Roman periods through the Second World War. See Charlotte Berney, ed., *Dig It! The Subterranean Architecture Book* (London: RIBA Publishing, 2021). For the geology and historical accumulation of the tufa substrate see also the documentation at napolisotterranea.org.

32. Mario Botta, in Vittorio Magnago Lampugnani and Paola Antonelli, eds., *Sotto Napoli: Idee per la città sotterranea* (Naples: Electa Napoli, 1988), pp. 80–81.

33. Mimmo Jodice, interview, in Lampugnani and Antonelli, eds.,

Beneath the city of Naples, a different order of subtractive settlement has been accumulating for more than two millennia. Napoli Sotterranea — the continuous underground network extending beneath the historical city — is not a single spatial system but a layered accumulation of successive subtractions: Greek-era aqueducts, Roman cisterns, medieval passageways, wartime shelters, post-war utility tunnels.³¹ The network of spaces in Naples provides evidence that the subtractive urban space, once created, remains viable even after it is no longer used for the purpose it was originally created for. The void will continue to exist; however, as the needs of the population change over time, so too will the uses of this void. It will be re-purposed, expanded upon and linked with other existing voids. People will inhabit these voids in ways their predecessors would never have envisioned. For over 2300 years, the tufa rock beneath the surface of Naples — soft enough to be worked by hand, structurally resistant enough to hold the city above — has been continuously worked and built upon. Over centuries, each generation contributed to a spatial system that was never designed or managed by any single authority. The result is a city beneath a city — one whose organization derives not from a predetermined plan but from the accumulated knowledge of those who removed material from below ground across generations.

The underground system also creates an opportunity to make apparent, a distinction that would otherwise be difficult to perceive at the level of the individual dwelling; namely the distinction between a basement and a cave. A basement is a remnant of a space beneath a structure whose organization is based upon the structure above it. It has its existence in relation to the structure that exists above it. The caves of subterranean architecture are organized internally. They are dimensionally determined by the properties of the tufa, the direction of the flow of water that once passed through them and the needs of those who created them. They have primary organization, not secondary. This distinction — between residual and primary, between that which remains after something has been removed and that which is created — is what distinguishes subtractive urbanism from mere subterranean construction. Architects and critics who initially treated Napoli Sotterranea as an architectural issue recognized this distinction intuitively. Mario Botta, writing in *Sotto Napoli*, observed that **“the sobriety of the vaulted caves is due to the mass and weight of the removed stone”** — naming precisely what distinguishes the underground network from any constructed vault: **not the shape but the origin, the fact that the enclosing surface is not applied but remains.**³² The photographer Mimmo Jodice, who spent years documenting the underground city, described the experience of the tuff chambers in terms of an absolute temporal discontinuity: the underground spaces exist, he wrote, **“beyond time”** — **not in the sense of being ancient, but in the sense that the geological material refuses the logic of the present altogether.**³³ The cave does not behave like a room. It behaves like a geological formation that has been made habitable, and the difference is registered immediately and physically by the body that enters it. What the body registers is precise: the drop in temperature at the threshold, the change in acoustic quality as sound deadens against tufa rather than bouncing from plaster, the narrowing of the passage that forces the shoulders inward,

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the smell of stone and cool earth that precedes any visual reading of the space. These are not atmospheric effects added to an underground room. They are the spatial substance of the cave itself — sensory conditions produced directly by the geological material and the depth of the section, without any architectural mediation.

In all three of these instances — the neighborhood developed on the Basilicata plateau, the social housing development which follows the topographical slope of the land, and the subterranean network built over thousands of years — the cave figure functions as an organizing principle of collective spatial living. The organization is based upon a scalar logic; that is, it moves from the neighborhood to the urban fabric and then to urban infrastructure. Each scale will have different amounts of time in which to remove and accumulate. However, the spatial commitment — the fact that the void has never been simply the byproduct of construction, but rather the central element in organizing the construction process — remains unchanged.

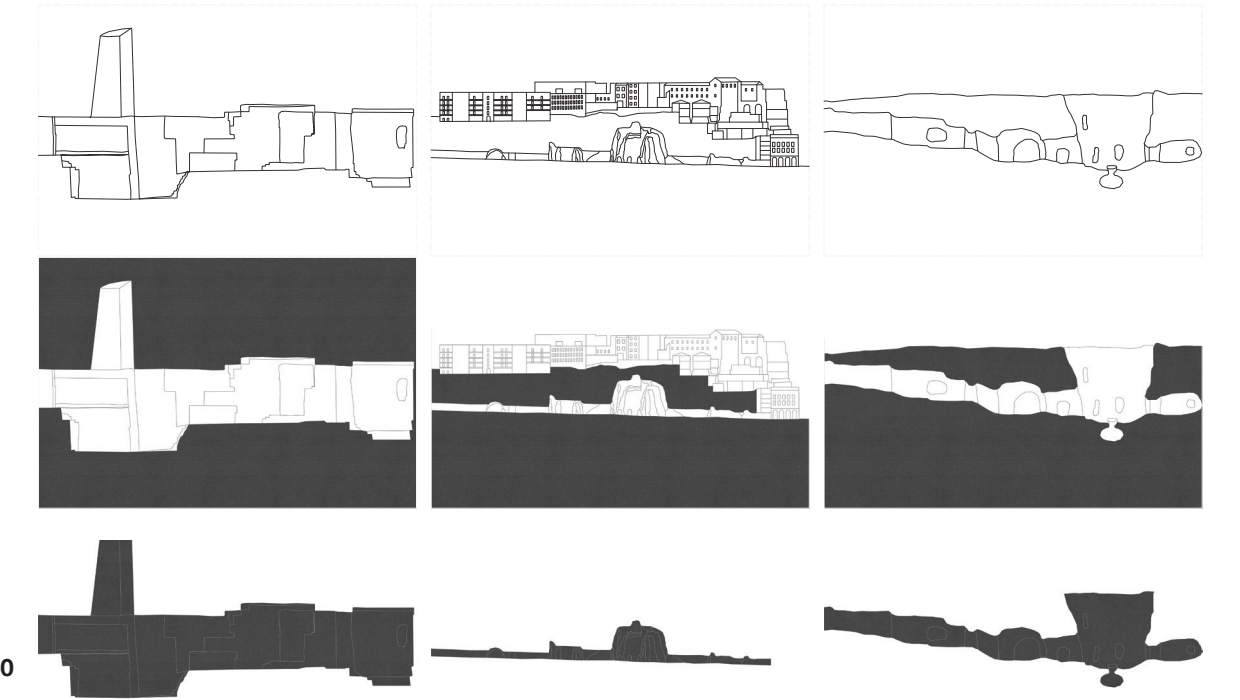
This chapter has investigated the cave as a means of architectural thought and inhabitation, not merely a building type, but rather as a series of spatial principles that appear repeatedly in different forms, materials, periods, and scales because these principles provide solutions to a variety of spatial and inhabitation problems that are best resolved through no other method. The four aspects that were utilized to examine this thinking — the void as the fundamental architectural action, the cave as form, the cave as environmental intelligence, and the cave as settlement — are not distinct categories. Each aspect is a dimension of the same principle: a spatial condition generated from within rather than imposed from without; one in which the void is the intended outcome rather than a residual effect; one in which the material records the process of its making; one in which environmental and spatial conditions are inseparable; and one in which the organization of the settlement is the collective extension of the organization of the individual dwelling. What this investigation produces is not a formal language but a spatial intelligence. The cave does not offer a set of elements to be borrowed — the vault, the thick wall, the recessed opening — but a method for understanding the relationship between a spatial act and the site, material, time, and community in which it occurs. This intelligence is transferable not because the cave can be recreated, but because the reasoning that produced it can be identified and applied: the same logic that generated the excavated dwellings of Santorini from the thermal and seismic properties of volcanic tufa is present in Ponis's sustained site analysis before design, in Souto de Moura's negotiation with existing agricultural terraces, and in Wright's organization of domestic space around the thermal mass of the fireplace.

In addition to examining the concept of spatial intelligence as represented by the cave, this chapter has introduced the concept of the autonomous cave. Autonomous caves represent built forms that have incorporated the spatial logic of the cave without actually excavating or using naturally occurring geologic materials. The autonomous cave is defined by its commitment to certain types of spatial characteristics such as mass and depth versus surface area and visual representation; legibility of creation in the final product; and environmental conditions viewed as spatial conditions. These concepts will be further developed in Chapter Three, where modern architects will be explored as the first individuals to consciously adopt the autonomous cave — translating the spatial commitments of the cave through construction/design rather than excavation, within the specific cultural and historical context of the Modern Movement's quest for a humanistic and site-specific form of

architecture. The chapter closes with the settlement — the scale at which the cave's spatial rationale finds its fullest expression. A settlement constructed from within the physical characteristics of a site, its streets following terrain gradients, its voids organizing collective life, its infrastructure accumulated over centuries rather than imposed at once, demonstrates that the cave's logic of inhabitation extends beyond the individual dwelling to every scale at which humans organize space. The settlement that could only exist in this place, from this material, at this time, is where the cave as a mode of architectural thinking reaches its conclusion. It is also the point toward which this chapter's argument about ritual, depth, and resistance has been tending — and from which Chapter Three begins: asking what it means, within the history of the Modern Movement, to have chosen this spatial position deliberately, against the dominant logics of the century.

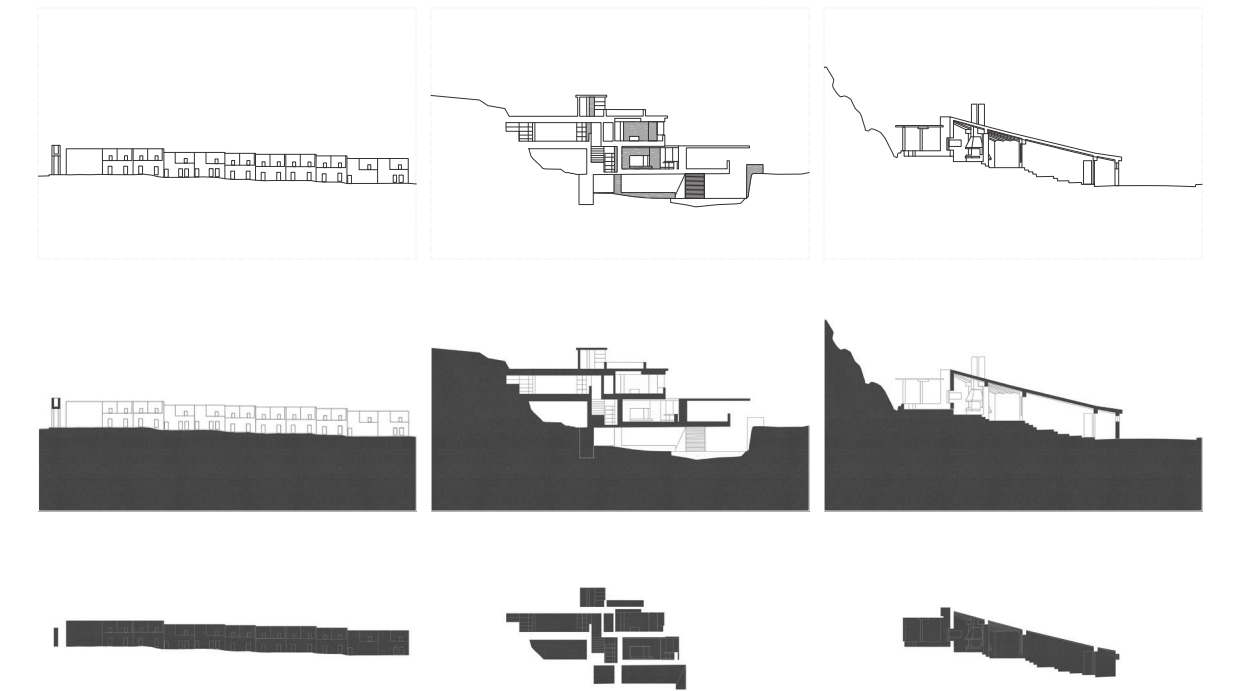
Mass and Void

Ca'n Terra Naples Underground Matmata Dwellings

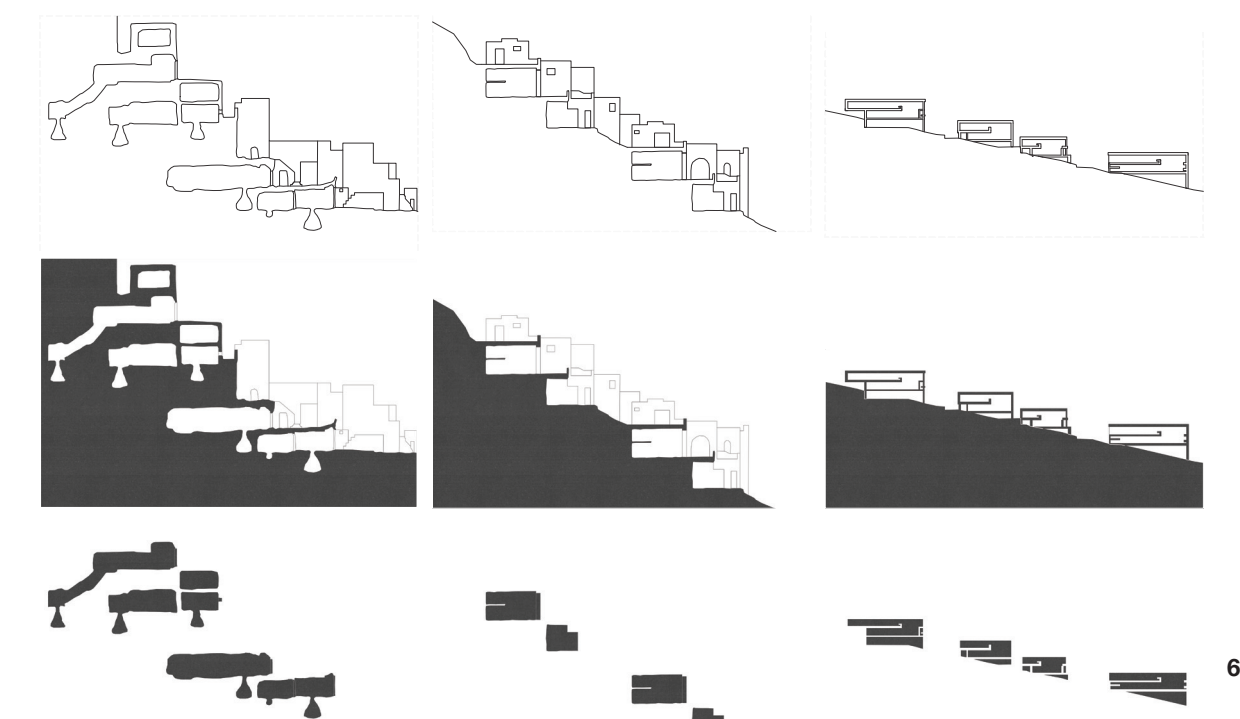


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Quinta da Malagueria Fallingwater Casa Hartkey

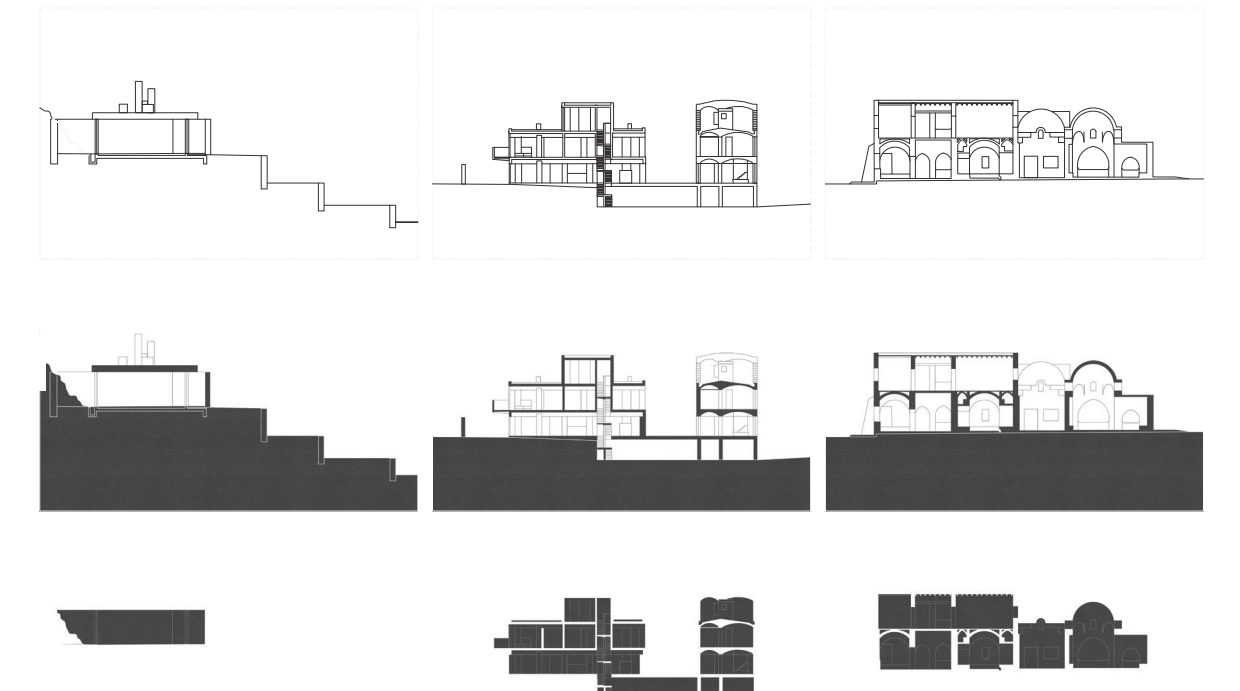


Sassi of Matera Dwellings Santorini Cave Dwellings Roq et Rob



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House in Moledo Maisons Jaoul New Gournia Housing



Chapter Three

The Cave Logic Through the Modern Movement

Chapter Two closed with a question: what does it mean to have chosen the cave's spatial position deliberately, against the dominant logics of a century? The vernacular cave did not choose its logic — it was produced by it. By the specific gravity of a geology, the angle of a sun, the accumulated knowledge of generations who carved and built and carved again until the space and the life within it became indistinguishable. The builders of the Santorinian skepasti or the Materian Sasso did not decide to embed their dwellings in the earth; they could not have built otherwise. What Chapter Three examines is the moment at which necessity became decision: when a identifiable strand of modern architects, working in full awareness of the dominant spatial grammar of their century, recognized in the cave's commitments a spatial intelligence worth recovering, translating, and defending.

That dominant grammar was the machine aesthetic of the early Modern Movement: the smooth surface, the standardized component, the neutral site, the building that could be anywhere. Against this — its reproducibility, its placelessness, its refusal of material specificity and thermal depth — a counter-position emerged. It did not announce itself as such. It formed no school, signed no manifesto. It was expressed instead through specific spatial choices: the decision to follow the gradient rather than flatten it, to expose the texture of a material rather than conceal it behind a finish, to calibrate the aperture to the conditions of a particular hillside rather than to a generalized standard of light and ventilation. Kenneth Frampton would later name this tendency **Critical Regionalism** — an *arrière-garde* position that, as he wrote, “**has the capacity to cultivate a resistant, identity-giving culture while at the same time having discreet recourse to universal technique.**”¹ But the architects who practised it named it through the buildings themselves, before the term existed: in the thick brick vaults pressing against the grain of Purist language; in the curvilinear whitewashed volumes of a house on Amorgos built from Paris by an architect in political exile who could not return to the ground he was designing; in the mud-brick courtyard settlement in Upper Egypt that refused the concrete block standard of postwar social housing in the name of a spatial intelligence three thousand years old.

Viola Bertini has situated this generation of architects within what she calls a “large and heterogeneous family” who, standing “at the edge of modern thinking, have been ignored for long” — a family that includes Dimitris Pikionis, Joze Plecnik, and Louis Barragán, each of whom made of the relationship between architecture and specific place the primary material of the project, and each of whom developed that relationship in direct opposition to the homogenizing logic of international modernism.² The connection between Fathy and Pikionis was not only intellectual but biographical: Fathy spent four years (1957–1961) working with Constantinos Doxiadis in Athens, during which he formed a personal friendship with Pikionis, the architect whose use of

1. Kenneth Frampton, “Towards a Critical Regionalism: Six Points for an Architecture of Resistance,” in Hal Foster, ed., *The Anti-Aesthetic: Essays on Postmodern Culture* (Port Townsend, WA: Bay Press, 1983), p. 20.
2. Viola Bertini, “Hassan Fathy. The Monkeys and the Giraffes,” *FA Magazine*, no. 47 (2018). Available at: famagazine.it. On the Fathy–Pikionis friendship: in February 1958 Pikionis gave Fathy a collection of poems by Cavafy with the dedication “To my dear Hassan Fathy, D. Pikionis and Imo, 20-2-1958.” The book is held at the Rare Book and Special Collection Library of the American University of Cairo.

local limestone and haptic spatial intelligence in the paths around the Acropolis stands as one of the clearest articulations of the same spatial commitment in the Greek context. The convergence is not coincidental. It establishes how a generation of architects understood the connection between architecture and particular material grounds to be the primary focus of their architectural work and rejected the abstraction of place required by the machine aesthetics on that premise.

This counter-position did not emerge in a vacuum. Modernism had always maintained an ambiguous relationship with the Mediterranean — claiming its formal simplicity, its geometric clarity, its apparent whiteness as evidence of a shared spatial ancestry, while simultaneously erasing the specific material, climatic, and inhabitation intelligence that had produced those forms. Le Corbusier, at CIAM 2 in Frankfurt in 1929, had called for the “standardization, industrialization, and Taylorization” of housing production, describing domestic life as “a regular sequence of precise functions” to be calibrated at the “human scale” — a formulation that reduced inhabitation to biology and eliminated from the dwelling any spatial logic rooted in place, material, or cultural memory.³ **The 4th CIAM congress**, held on board the Patris II sailing between Marseille and Piraeus in the summer of 1933, crystallized this ambiguity: the international architectural community encountered the vernacular architecture of the Greek islands and found in it what they had already decided to find — confirmation of the machine aesthetic’s formal preferences, stripped of their geological and climatic origins. As Dimitra Kondylatou has argued, the Cycladic house was appropriated as “**a confirmation of Modernism’s claims and ambitions**” rather than understood on its own spatial terms.⁴ The architects examined in this chapter refused that appropriation. Where the dominant strand of modernism borrowed the Mediterranean’s appearance, they studied its spatial logic. Where CIAM claimed the vernacular as ancestry, these architects treated it as a living body of spatial intelligence — one that required not reproduction but translation, and not aesthetic translation but inhabitation translation: the carrying forward of the specific commitments to depth, mass, climate, and collective spatial life that the Mediterranean vernacular had demonstrated across centuries of building and dwelling.

Aldo van Eyck, writing from within the CIAM structure itself before its dissolution at the 1959 Otterlo congress, named the spatial consequence of this dominant grammar with devastating precision: “**They flattened the womb, expelled all sense of place.**”⁵ The formulation is architectural before it is poetic: to flatten the womb is to erase the spatial condition of enclosure, depth, and thermal protection — the cave’s primary spatial argument — in favour of the neutral platform and the placeless object. It was against this erasure that the architects examined in this chapter positioned themselves. Their resistance was not only spatial and material but sensory: a refusal to accept that architecture could be experienced adequately through the eye alone, and an insistence that depth, mass, and the resistance of material produce a quality of bodily engagement that no smooth, machine-wrought surface can replicate.

What connects the cave-form pressed into a volcanic island hillside to the curvilinear whitewashed volumes distributed across an Aegean slope, the mud-brick courtyard settlement calibrated to desert thermal conditions to the terraced housing complex that follows the topographic grain of a Mediterranean coastline, is not a shared style but a shared refusal: the refusal to treat the site as a neutral surface onto which architecture is placed, and the consequent insistence that the specific conditions of a ground — its material, its

climate, its cultural accumulation — are not constraints to be overcome but the spatial act from which architecture and inhabitation begin.

The chapter is organized around four aspects through which this translation operates. The first ***the chosen void*** establishes the conceptual ground: what it means to commit to the cave’s spatial logic not from geological necessity but from architectural conviction, and what that commitment looks like in the buildings of architects who understood the vernacular cave as a living spatial argument. The second ***the legibility of making*** examines the surface argument that follows from this commitment: the fidelity of the material to the specific ground from which it comes, and the insistence that the building’s surface carries the record of that relationship. The third ***depth as climatic tool*** traces the environmental consequence of choosing mass and depth as primary spatial conditions, and the inhabitation quality that no mechanical system replicates. The fourth ***the collective ground*** extends the cave’s logic from the individual dwelling to the settlement, asking what it means to organize collective life around the void, the threshold, and the shared shade.

Chapter Three traces this translation across these four aspects, asking in each case how the spatial commitments of the cave were consciously transposed into the terms of modern construction. It does not argue that these architects produced replicas of vernacular space, nor that they looked backward in nostalgia toward a pre-industrial building culture. It argues that they understood the cave’s spatial logic precisely enough to produce, through entirely modern means, buildings that think like caves — **buildings organized from within the conditions of their specific ground, whose material carries the record of its making, whose environmental and spatial conditions are identical, whose patterns of inhabitation are structured by the space itself rather than prescribed by a programme, and whose collective form extends the logic of the single dwelling to the scale of the settlement** — all while resisting the placelessness, the smoothness, and the indifference to material and climate that the machine aesthetic had normalized. Chapter Four will then ask what it means, in the contemporary moment, to continue making that translation: when the vernacular tradition has receded still further, when the cave’s spatial logic must be sustained not by cultural memory but by architectural argument alone, and when the question of resistance is more acute than it has ever been.

3. Eric Mumford, *The CIAM Discourse on Urbanism, 1928–1960* (Cambridge, MA: MIT Press, 2000), p. 3.
4. Dimitra Kondylatou, “Travelling to the Cyclades: Modernist Projections,” in *The Architect is Absent: Approaching the Cycladic Holiday House*, 3rd ed. (Athens: kyklàda.press, 2023), p. 52.
5. Peter De Clarke, *The Writings of Aldo Van Eyck: A Modernist Sensibility Introduced in Architecture*, PhD dissertation, University of Bristol, Department of Architecture, September 1982, p. 31.

3.1 The Chosen Void

The ground was a platform; the building descended upon it like a delivered object, complete in itself, indifferent to what was beneath or about it. To insist otherwise, to design from the conditions of a ground rather than upon it, was already a spatial and political refusal. The architects discussed in this section refused that, not programmatically but in a series of spatial decisions: about where to place mass and where to open it, about what the body encounters as it moves through a space calibrated to a particular climate and a particular geology, about what it means to inhabit a dwelling whose depth is not decorative but structural. The resulting inhabited space thinks like a cave, not because it was cut from rock, but because it was organized from within the same commitments — to mass, depth, and the specific resistance of a particular ground — that the cave had evidenced across millennia of Mediterranean inhabitation.

The clearest theoretical articulation of this commitment came not from a manifesto but from a doctoral dissertation. In 1931, Bernard Rudofsky completed *Eine primitive Betonbauweise auf den südlichen Kykladen* at the Technische Universität Wien — a meticulous study of the barrel-vaulted domestic architecture of Santorini, undertaken during his extended stay on the island in 1929. The dissertation is organized around a spatial observation that is also the thesis's central argument: the boundary between cave and constructed house cannot be drawn. “*Die Grenze zwischen Höhle und Haus ist ja nicht scharf zu ziehen*,” Rudofsky wrote, **the line separating the carved void from the assembled room does not exist in the Santorinian building tradition.**⁶ The vault had grown from the island's specific geology: from the softness of volcanic pumice that made excavation possible without timber, and from the continuity between the hollowed-out cave and the free-standing constructed room that the building culture had maintained for centuries. On the opposite island of Therasia, Rudofsky documented a builder who had quarried the pumice around a hillside slope “and left only a free-standing block the size of the house in the natural rock; into this block the new house was then hollowed” — **the transition between cave and construction suspended in a single building act.**⁷ The building tradition, as Peter Meyer wrote in a passage Rudofsky cited, was one in which “*so sehr wächst alles aus dem Boden selber*” — **so completely does everything grow from the soil itself.**⁸

Rudofsky's understanding of this continuity was simultaneously spatial and climatic. After living in a cave dwelling for a month, he recorded the experience directly: “*Das Fehlen von Feuchtigkeit, die angenehme Temperierung zu allen Jahreszeiten, die überraschend gute Belichtung machen die Wohnhöhle zu einem idealen Aufenthalt*” — **the absence of moisture, the pleasant temperature regulation in all seasons, the surprisingly good illumination made the cave an ideal residence.**⁹ Against the Existenzminimum — the minimum unit of measurable, reproducible habitation — this was not a deficient shelter but an optimal one: calibrated by the specific conditions of a specific geology to produce exactly the spatial and climatic qualities that the body required, without mechanical systems, without imported materials, without anything that did not already belong to the ground. “*Ich wüsste keine Bauweise, die in konstruktiver, materialtechnischer und farblicher Hinsicht eine ähnliche Einfachheit erreicht wie diese Wohnzellen*” — **I know of no building method that achieves similar simplicity in structural, material-technical, and color terms**

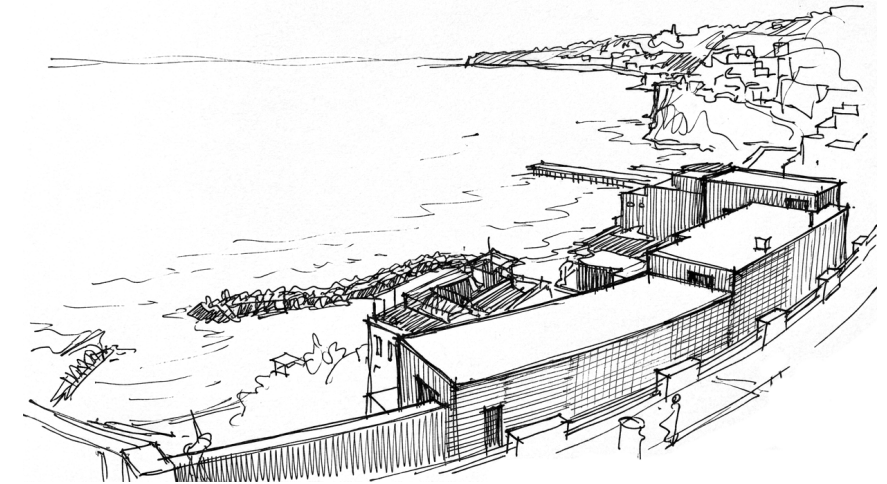
as these dwelling cells.”¹⁰ The comparison with “European wallpaper industries” that follows makes explicit what this simplicity refuses.

Casa Oro is not a synthesis of Mediterranean coastal architecture but something more precise: the retention of everything the specific site already knew about how to inhabit a steep ground. The terrace is the primary unit of outdoor life. The threshold is the spatial event rather than the door. The body's movement through levels is the organizational principle of the dwelling. Gio Ponti understood this precisely: “**The Mediterranean taught Rudofsky, Rudofsky taught me.**”¹¹ What the Mediterranean taught was not a formal vocabulary but a spatial philosophy — that the material of a place is not a constraint to be overcome but the medium through which the dwelling is produced. Casa Oro does not resist its site. It grows from it, and the void it organizes is inseparable from the specific ground from which it was drawn.

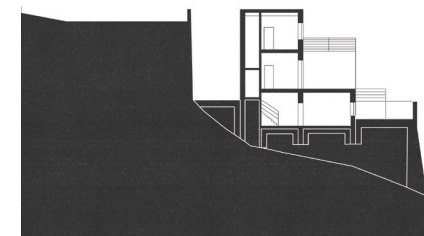
10. *Ibid.*, pp. 25–26.

11 Gio Ponti, ‘Il Mediterraneo ha insegnato a Rudofsky, Rudofsky ha insegnato a me,’ *Aria d'Italia*, VIII (1954), quoted in Rossi, Bernard Rudofsky architetto, p. 9.

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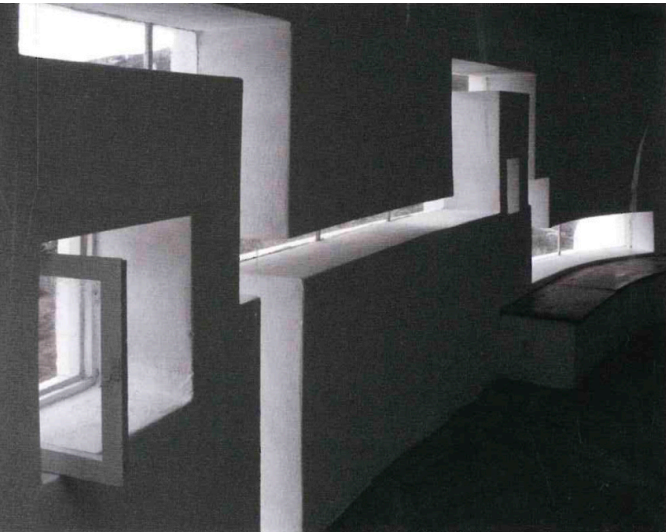
1 Luigi Cosenza and Bernard Rudofsky, Villa Oro. Sketch by the Author
2 Villa Oro section. Drawing by the Author.

6. Bernard Rudofsky, *Eine primitive Betonbauweise auf den südlichen Kykladen nebst dem Versuch einer Datierung derselben*, doctoral dissertation, Technische Universität Wien, 1931, p. 24: “*Die Grenze zwischen Höhle und Haus ist ja nicht scharf zu ziehen. So primitiv der Höhlentypus ist, lässt er Variationen und Zwischenformen zu.*”

7. *Ibid.*, pp. 26–27.

8. *Ibid.*, p. 23.

9. *Ibid.*, p. 27.



3



4

3 Iannis Xenakis, Villa Mâche, Amorgos, 1966–74. Interior view showing openings

4 Villa Mâche under construction, showing base and walls.

5 Iannis Xenakis, Villa Mâche, Amorgos, 1966–74. Interior view.

6 Villa Mâche section. Drawing by the author.



5

12. Sharon Kanach, “Summer Home for François-Bernard Mâche, by Iannis Xenakis, 1966–74,” in *The Architect is Absent: Approaching the Cycladic Holiday House*, 3rd ed. (Athens: kyklâda.press, 2023), p. 19.

13. Elisavet Kiourtsoglou, “Epistolary Architecture: When Writing Letters Created Modern Space. The Case of Iannis Xenakis’s House at Amorgos, Greece,” *TEXT Special Issue 55: Writing | Architecture*, eds. Eleni Bastéa and Patrick West (April 2019), p. 7.

14. David Bergé, “Villa Mâche: a harsh hijack against the space of the sun,” in *The Architect is Absent: Approaching the Cycladic Holiday House*, 3rd ed. (Athens: kyklâda.press, 2023), pp. 41–42. The poem is cited across multiple passages in this section.

15. *Ibid.*, pp. 41–42.

That translation found one of its most precise and most charged expressions in the Villa Mâche, designed by Iannis Xenakis for the French composer François-Bernard Mâche on the island of Amorgos between 1966 and 1974. Xenakis was living in Paris in political exile; he could not enter the country he was designing for. Mâche brought him photographs of the site — of Tyrokomos Bay, of the Panagia Hozoviotissa monastery hanging over a rocky cliff — and from these photographs Xenakis abstracted not the appearance of the Cycladic house but its spatial logic. As Sharon Kanach has described, Xenakis was **“most concerned with creating a general form for the ensemble that would harmonize with the natural contour of the underlying bay”** — a bay that had been terraced for agriculture many years before the house was built, so that the foundations of the structure are as deep as its finished height.¹² The earth was already worked; the house continued its logic. Its three cells — a master suite, a communal living and kitchen space, and a guest area — each grow from the terraced ground rather than being placed upon it.

What the Villa Mâche does not do is reproduce the Cycladic house. It abstracts it. As Kiourtsoglou has argued, the photographs Xenakis worked from could be perceived abstractly — they demonstrate **“geometrical and topological relations”** rather than vernacular forms.¹³ The window openings, cast directly into concrete walls and placed to screen the intense summer sun, accomplish what Kanach calls **“creating openings for indirect zenith light”** — a 40-centimetre path of light splits the living room ceiling, while raised ceilings at intersections produce indirect illumination in all three cells. The apertures are not openings to be looked through. They are calibrated spatial instruments — what David Bergé, in his poem on the house, calls **“a harsh hijack against the space of the sun: / fissures, wounds knifed into whitened concrete / an arrow slit, a loophole, une meurtriére / bunker windows / from which to shoot the enemy — the outside.”**¹⁴ The enemy is light, noise, other people — all the dissipating forces of the surface world against which the cave’s depth is the primary instrument.

Bergé’s poem names the inhabitation programme of the house with remarkable economy: **“five monastic cells to write music, sleep, cook, read, shit.”** The five functions are elemental — stripped of everything that contemporary domestic architecture adds between the body and its basic rhythms. The monastic framing is architecturally precise. A monastery does not contain ritual; it is organized around it. Every spatial element calibrated to the specific requirements of a daily practice, the space inseparable from the act it was built to house. The five cells of the Villa Mâche operate by the same logic: writing music, sleeping, cooking, reading, the most elemental bodily acts assigned to specific spatial conditions of light, enclosure, and depth. This is what distinguishes the Villa Mâche from the holiday house it technically is: the space does not accommodate a generic programme but demands a specific inhabitation, structured by the material conditions of each cell. **“Curves changing into squares according to need a Wnd function,”** Bergé continues, form following the body’s specific requirements rather than a compositional logic imposed from outside. And the spatial consequence: **“an architecture activating its user / not comforting her”; “an architecture imploring the entire body to move.”**¹⁵ This is cave logic as sensory argument: not a space to be seen but bodily inhabited, its enclosure produced by concrete and calibrated shadow rather than geological mass. The cave does not offer neutral accommodation. It demands inhabitation. The Villa Mâche is its modern realization: a void organized around five acts of daily life, calibrated to a specific body on a specific Aegean hillside, refusing every spatial logic that the contemporary moment had normalized.

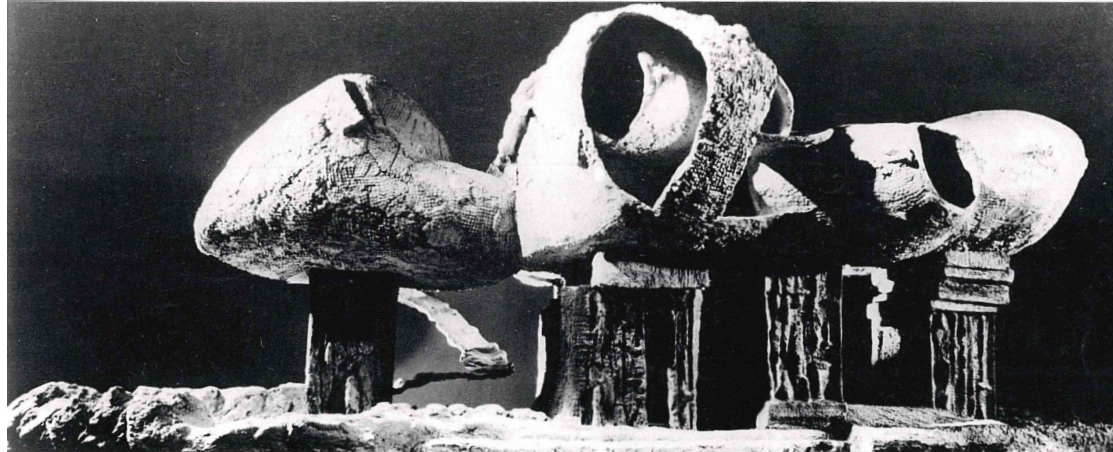
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7 Friedrich Kiesler, model for
Endless House, 1959. Wire-
mesh, cement, plexiglass, 96.5
× 247 × 106.7 cm

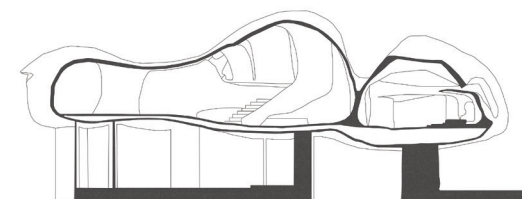
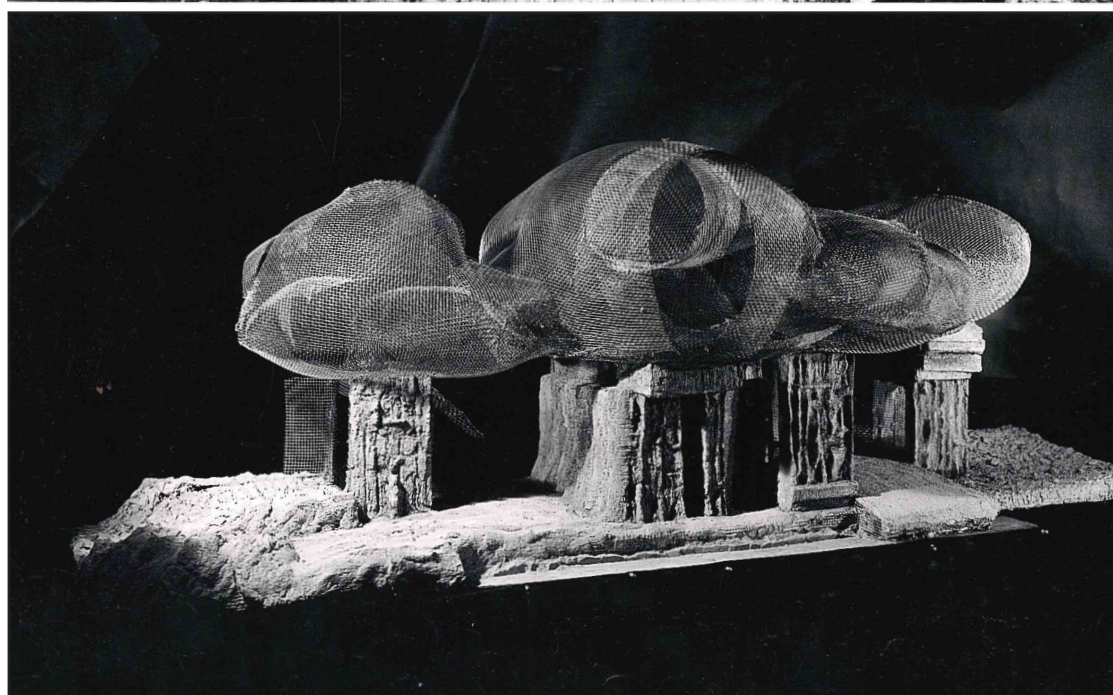
8 Friedrich Kiesler, model for
Endless House, 1959. Working
process

9 Friedrich Kiesler Endless
House section by the Author.

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Alongside these built translations, the period produced one further articulation of the cave's spatial logic, one that was never built but whose theoretical precision makes it essential to this section's argument. Frederick Kiesler's Endless House, developed through the 1950s and realized only as a model and a series of drawings, proposed the inhabited void as a pure spatial proposition: a continuous shell with no distinction between floor, wall, and ceiling, organized entirely around the body's movement through and inhabitation of space rather than around the distribution of rooms according to a functional programme. As the Sotto Napoli essay on the cave's architectural history observes, the Endless House represents the culmination of a long intellectual tradition that traced the cave as the “**anti-model**” to the hut; the spatial condition against which the entire history of constructed form had defined itself, and which Kiesler now proposed not as prehistory but as architecture's most radical spatial proposition.¹⁶ The Endless House was not a cave. But it thought like one: organized from within rather than composed from without, indifferent to the distinction between structure and surface, insisting that the inhabited space and the body within it are not separable dimensions of an architectural problem.

Together, these three positions — Rudofsky's theoretical articulation carried into the built void of Casa Oro, Xenakis's inhabited translation on Amorgos, Kiesler's conceptual proposition — establish what it means to choose the cave's spatial logic within the modern moment. Neither to copy it nor to aestheticize it. In order to comprehend it sufficiently well to transfer its spatial principles into completely different materials and ways of living; against the prevailing architectural culture which has taken the exact opposite position.

The void, however, is never only spatial. The choice to build from within geological and material conditions leaves a surface record that is inseparable from the spatial experience it produces. The following section examines this record: the fidelity of material to specific ground, and the insistence that the building's surface carries the evidence of where it comes from.

3.2 The Legibility of Making

If the previous section established what it means to choose the cave's spatial depth as an inhabitation condition, this section asks what that choice looks like in the surface of the building and its relationship to the specific ground from which it comes. The cave's formal argument is not only about depth; it is about fidelity: the insistence that the material of the building belongs to the specific geological and climatic character of its site, and that the surface carries the record of that belonging. Juhani Pallasmaa has argued that natural materials — stone, brick, and wood — “**allow our vision to penetrate their surfaces and enable us to become convinced of the veracity of matter. Natural materials express their age, as well as the story of their origins and their history of human use.**”¹⁷ The machine aesthetic's defining gesture was precisely the opposite: the smooth, machine-wrought surface that reveals nothing of its origin, nothing of its place, and nothing of its making. In opposition to this, the buildings examined here make the relationship between material, site and the record of making a single spatial argument. Not as decoration or texture but as evidence: that the space was made by particular hands, from particular material, in a particular place, in direct engagement with the conditions of the ground.

16. Vittorio Magnago Lampugnani and Paola Antonelli, eds., *Sotto Napoli: Idee per la città sotterranea* (Naples: Electa Napoli, 1988), pp. 24–37.

17. Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*, 3rd ed. (Chichester: Wiley, 2012), p. 34

Maisons Jaoul, designed by Le Corbusier in Neuilly-sur-Seine (1952–54), expressed this idea of an internal refusal. As discussed in Chapter Two, Maisons Jaoul was designed to show how a building could be made to have a cave-like spatial quality. The use of Catalan vaults; the exposed brickwork; the concrete that had been cast using timber formwork; the compressed and deep spatial qualities which enclosed the user in the mass of the structure all illustrated this. James Stirling, in his 1955 *Architectural Review* article, described the project as disturbing precisely because it represented a regression from the Purist machine of Villa Savoye to something he could not place within the narrative of modernist progress. Le Corbusier, “**who had insisted on the necessity of establishing new architectural habits,**” was now “**building with traditional materials in a manner that is almost peasant-like.**”¹⁸ Stirling’s uneasiness with the Maisons Jaoul was an authentic reflection of his thought. The Maisons Jaoul represented more than just an alternative formal decision; it was a spatial and material counter-argument to the course of modern architecture as Stirling perceived it. The brick vault was not a nostalgic reference but a statement of resistance. As Frampton has observed, **it marks the moment at which Le Corbusier’s vernacular turn became explicit and irreversible, the point at which the material of making became the argument of the building.**¹⁹

Eduardo Souto de Moura’s House in Moledo in northern Portugal (1991–98) continues this argument from the register of construction to the register of site: the material of the building is the material of the ground on which it stands. This house is built into a granite hillside in the Minho valley and its walls are made of the granite excavated during its construction, the same stone brought back to the surface in a different formation. The board-marked concrete that appears next to the granite bears its own history: the timber formwork that pressed its grain into the surface, the pour that is visible in its horizontal register lines. Nothing smooth or finished in the conventional sense. The building’s exterior is a record of its own fabrication, which was inherently intertwined with the specific material circumstances of the site. As *El Croquis* documented, Souto de Moura understood the project as a negotiation between the existing granite walls of old agricultural terraces and the new construction: the house does not replace the vernacular landscape but continues its material logic, using the same stone in the same formation.²⁰ The Moledo house is the legibility of making argument stated at its most literal: the surface of the building is the geological record of the ground it removed.

18. James Stirling, “Garches to Jaoul: Le Corbusier as Domestic Architect in 1927 and 1953,” *Architectural Review*, September 1955, pp. 145–151, here p. 148.

19. Kenneth Frampton, *Modern Architecture: A Critical History*, 4th ed. (London: Thames & Hudson, 2007), pp. 225–226.

20. Eduardo Souto de Moura, *House in Moledo*, documented in *El Croquis* 124: Eduardo Souto de Moura, 1995–2005 (Madrid: El Croquis, 2005). See also Aurora Fontes and Antonio Esposito, *Eduardo Souto de Moura* (Milan: Electa, 2003).

10 Le Corbusier, Maisons Jaoul, Neuilly-sur-Seine, 1954–56. Exterior view showing material texture

11 Eduardo Souto de Moura, House in Moledo, Portugal, 1991–1998. Exterior view showing material texture



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12 Sergison Bates, Casa Voltes. Interior view showing light through opening, new construction
13 Sergison Bates, Casa Voltes. Existing fabric showing original material



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21. Mónica Rivera, “Casa Voltes, Cadaqués,” *Architects’ Journal*, February 2013. Photography: David Grandorge.

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Sergison Bates’s Casa Voltes in Cadaqués (2006) makes the same argument from a different direction: not geological but temporal. The house sits over an 18th-century stone cellar vault that was the sole surviving element of a ruin on the site. Rather than clearing the ruin and beginning again, the architects preserved the vault as the organizing spatial anchor of the new construction, building the contemporary house in dialogue with and above the existing stone. As the project description observes, “**the spatial configuration resists immediate understanding, thus granting spaces the paused, rich quality of old constructions that have been built additively**” — constructions that have accumulated rather than been designed in one gesture.²¹ The new concrete and stone sit alongside the old without imitating it; the vault below is not aestheticized but structurally continued. The house thinks like a cave not because it is subterranean but because it is organized around the logic of additive inhabitation; each layer carrying the record of the previous one, the spatial experience deepening as the body moves through the evidence of accumulated time.

This is what Pallasmaa means by the “**veracity of matter**” — the capacity of a natural or historically worked material to make visible its own time and making. The smooth surface has no time; it exists at the instant of its production and resists all subsequent duration. The brick vault, the granite quarried from the hillside, the preserved stone cellar — these surfaces carry duration as a spatial quality. To inhabit them is to inhabit not only space but the record of how that space came to be. This is the cave’s formal logic translated into contemporary construction: not a reproduction of its shape but an inheritance of its spatial philosophy — that the material of the building and the material of the place are not separate things, and that a surface, honestly made, carries the evidence of both.

The material that carries the record of its making is also the material that regulates the climate of the space it encloses. Thick stone, brick vault, and board-marked concrete are not only formal arguments; they are thermal arguments. The following section examines what it means to choose material depth as an environmental strategy, and what kind of inhabitation that choice makes possible.

3.3 Depth as Climatic Tool

Chapter Two established that the cave’s environmental and spatial conditions are inseparable: the same act that produces enclosure produces climate regulation. Thermal performance is not a system added to the space — it is the space, produced by mass, depth, orientation, and the calibrated aperture. What Chapter Three asks is what it means to choose that integration deliberately, in a modern context where environmental and spatial conditions have been decisively separated — where climate is managed by mechanical systems and space is designed by visual and compositional logic operating independently of the conditions of a place. To choose the cave’s environmental logic in this context is to refuse that separation. It is to insist that the section of a room, the depth of a wall, the position and dimension of an opening are climatic decisions before they are architectural ones — and that making them as such produces a spatial quality no mechanically conditioned space can achieve.



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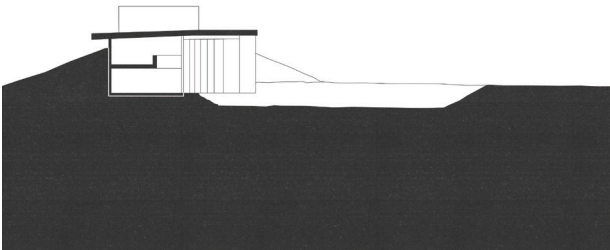
Frank Lloyd Wright's Jacobs House II in Middleton, Wisconsin (1944-1948) demonstrates how the decision to use a passive climate control system can be a very powerful tool when designing for an area with harsh climates. The house is a solar hemicycle: it has a curving shape that hugs the hillside on the northern side, while using floor-to-ceiling glass on the southern side to take full advantage of sunlight. The earth berm on the north wall is used as a thermal instrument, rather than as a landscaping element — it provides insulation from extreme cold during the harsh Wisconsin winters, and the curvilinear glass facade allows for maximal collection of heat from the sun. The plan of the house is designed completely around this climatic logic: the main rooms are located on the south side of the house and have access to the garden; the utility spaces are placed on the north side of the house and are protected by the earth berm. As Frampton argues in **"Towards a Critical Regionalism,"** the act of **"in-laying"** the building into the site carries **"a capacity to embody, in built form, the prehistory of the place, its archeological past and its subsequent cultivation and transformation across time"**²² — a principle Wright enacts not archaeologically but climatically — pressing the house into a specific hillside so that the earth becomes the thermal logic of the section.

The decision is resistant in the precise sense that Frampton has articulated: to terrace the same site, to calibrate the aperture to the local light spectrum, to refuse the standardized section in favour of one that responds to the specific angle of the Wisconsin winter sun — these are choices made against the dominant environmental logic of Wright's moment, which was already moving toward the hermetically sealed, mechanically conditioned building that would define postwar American architecture.²³ In contrast to the notion of air-conditioning the climate away, the Jacobs House II is an example of inhabiting the climate. Daily life is organized within the context of the physical limitations imposed by this geographic location, and a way of living emerges from these limits. A pattern of living based upon the sun's trajectory across the sky, the bulk of the hillside and the winter sunlight coming in from the south through a curved glass wall. In this sense, the Jacobs House II is similar to a cave's environmental awareness; however, instead of absorbing the earth into its vault, it absorbs the hillside into its plan.

22. *Towards a Critical Regionalism: Six Points for an Architecture of Resistance*, in *The Anti-Aesthetic: Essays on Postmodern Culture*, ed. Hal Foster (Port Townsend: Bay Press, 1983), 26.

23. *Towards a Critical Regionalism: Six Points for an Architecture of Resistance*, in *The Anti-Aesthetic: Essays on Postmodern Culture*, ed. Hal Foster (Port Townsend: Bay Press, 1983), 26. Frampton identifies the prioritization of topography and climate as an act of resistance against "the tendency to reduce architecture to a pure product" — a logic that in the postwar American context translated directly into the sealed, mechanically conditioned building.

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14 Jacobs House II section. Drawing by the author.

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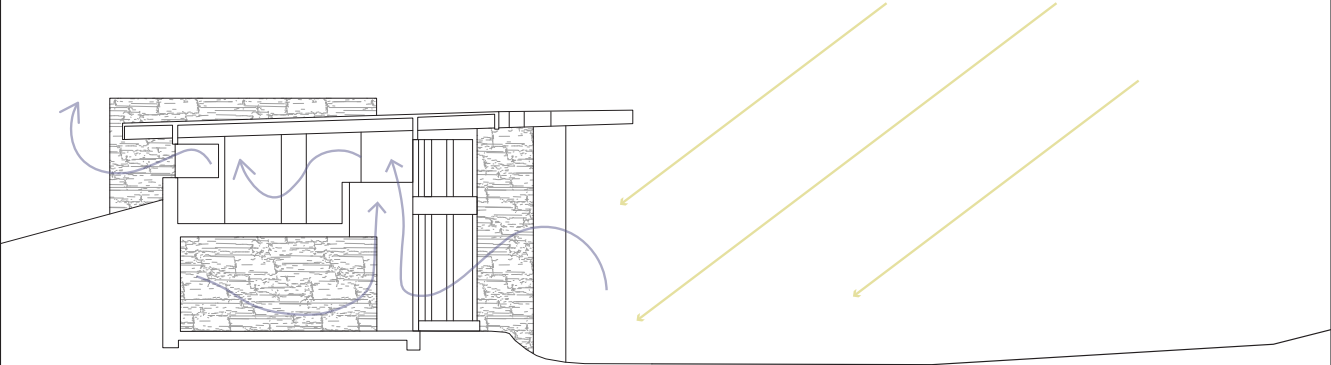


15 Frank Lloyd Wright, Jacobs House II (Solar Hemicycle), Middleton, Wisconsin, 1946-48. South façade

16 Jacobs House II, solar hemicycle section showing passive solar heating and natural ventilation strategy. Drawing by the author.

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17 Hassan Fathy, House in Sidi Krier, Alexandria, Egypt, 1971. Exterior view
18 Earthen mass construction, natural ventilation section. Drawing by the author.



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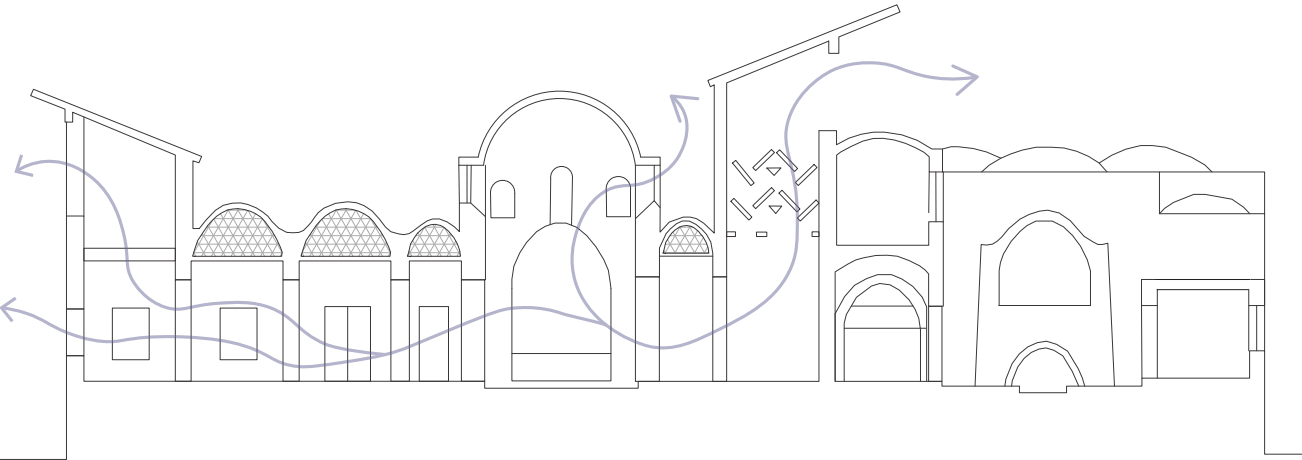
Where Wright arrived at the cave’s environmental logic through a specific northern climate and a constructed material tradition, Hassan Fathy arrived at it through a direct engagement with the vernacular intelligence of a specific culture, and through an explicitly political refusal of the environmental logic that modernization was imposing upon it. Rudofsky had already named this refusal precisely: **“The house has to become again what it was in the past: an instrument for living, instead of a machine for living. This would make all the difference in the way we conduct our lives, like the difference between playing a violin and playing a jukebox.”**²⁴ Fathy did not use this formulation, but he enacted it. His refusal of the concrete block construction standard in Egyptian social housing was a spatial and political act before it was an environmental one: a refusal to accept that the standardized, reproducible, mechanically conditioned unit was an adequate answer to the inhabitation needs of a specific community with a specific climate, a specific building culture, and specific patterns of domestic life accumulated over centuries.

As Viola Bertini has argued, most scholarship on Fathy **“tended to associate his work with the regional or vernacular,”** while **“it’s often absent the attempt to thoroughly investigate Fathy’s work, contextualize it, figure out its reasons and understand, regardless of the stylistic and formal outcomes, its intellectual value, that is its modern character.”**²⁵ The concrete block standard that Fathy refused was not simply a technical choice but an ideological one, the material expression of exactly the homogenizing logic that CIAM had institutionalized as housing. His refusal was therefore simultaneously environmental, spatial, and political. What he recovered in doing so was the ritual dimension of thermal experience that Hescong identifies as the cave’s deepest domestic contribution: the daily migration through the malqaf’s cool draught, the gathering in the shaded qa’a at midday, the warmth of the courtyard stone in the evening — a choreography of bodily movement through thermal conditions that no mechanically conditioned space produces and no prescribed programme replaces.

The environmental intelligence of New Gournia is inseparable from this position. Fathy drew on three integrated spatial-climatic elements of the Egyptian vernacular tradition: the *malqaf* — a wind catcher, a vertical shaft projecting above the roofline to capture the prevailing breeze and direct cool air into the building’s interior; the *qa’a* — the main reception hall, whose high vaulted ceiling channels warm air upward and out through openings at the apex, creating a natural convective cycle; and the courtyard, which collects the cold night air and releases it slowly through the heat of the day, functioning as a thermal battery within the built fabric.²⁶ Each of these elements is simultaneously a spatial element and a climatic one. The malqaf is not a ventilation device installed in a standard section; it is a spatial element that determines the section, the height of the receiving room, the orientation of the building, the relationship between the private courtyard and the street. The qa’a is not a thermal system added to a reception hall; it is the reception hall, the high vault is both the spatial character of the space and its environmental logic. Fathy refused both terms of the separation simultaneously: space without environmental intelligence, and environmental performance without spatial consequence.

His most radical proposition at New Gournia was not environmental but social, and it is this proposition that carries directly to the settlement logic of the following section. Fathy refused to repeat the same unit for every family. Each dwelling was designed in response to the specific inhabitation patterns

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24. Bernard Rudofsky, quoted in *Lessons from Bernard Rudofsky: Life as a Voyage* (Basel: Birkhäuser, 2007), p. 20.
25. Bertini, “Hassan Fathy. The Monkeys and the Giraffes.”
26. Hassan Fathy, *Architecture for the Poor: An Experiment in Rural Egypt* (Chicago: University of Chicago Press, 1973), pp.44

of the family who would live in it: the number of family members, the gender composition of the household, the specific practices of domestic life that required separation or adjacency. As Steele has documented, **“the idea that each of nearly seven thousand people should have a voice in the design of their new community was virtually unheard of at this time.”**²⁷ Fathy described the principle directly: **“unity in variety and not in uniformity”** — the settlement as a collective spatial argument that could only be realized through the specific inhabitation pattern of each individual family, and that collapsed into uniformity the moment the unit became standardized and repeatable.²⁸

What connects the three cases examined in this section is a shared refusal: that the section of a building and the climate it produces are separable conditions. In each case, the section is the environmental instrument — the depth of a wall, the height of a receiving room, the orientation of a courtyard are climatic decisions before they are architectural ones, and making them as such produces a spatial quality no mechanically conditioned space achieves. The cave does not regulate its environment through a system added to the space but through the space itself. This integration — environmental and spatial, inseparable — is what the following section extends to the scale of the settlement: the question of what it means to organize collective life around the same spatial intelligence that organizes the individual dwelling.

3.4 The Collective Ground

The cave’s spatial logic has never been exclusively a logic of the individual dwelling. As Chapter Two established through Matera and the Quinta da Malagueira, the cave figure achieves its fullest collective realization at the scale of the settlement — when the courtyard void becomes the organizing unit of social life, when the single carved room extends to the neighbourhood, when the logic of individual inhabitation becomes a principle of collective spatial organization. The modern architects examined in this section understood this. What distinguishes their work from the vernacular settlements examined in Chapter Two is not the spatial logic itself but its condition of production: they arrived at the cave’s settlement intelligence not through geological necessity but through studied understanding of a specific building tradition, and through the deliberate decision to apply that understanding against the dominant planning logics of their moment.

Van Eyck described the threshold condition that organizes collective inhabitation as the **“in-between”** — the spatial category that neither interior nor exterior logic can account for alone, and whose systematic erasure from modern planning he considered the century’s deepest spatial loss.²⁹ The courtyard, the covered street, the shared shade of the pergola: these are not decorative elements added to a housing programme but the spatial substance of collective inhabitation — **the voids around which daily life organizes itself**. To recover them was, for the architects examined in this section, precisely the spatial argument of their work against the tower in the park and the neutral ground of the modern city.

For Josep Lluís Sert, that understanding began on Ibiza. In 1932, the journal AC — the organ of the GATCPAC, the Catalan rationalist group Sert co-founded — devoted a feature to the vernacular houses of the island. The terms of the analysis were precise: the Ibizan house **“looks eastwards, the best possible orientation, is built according to a human scale, is rational and logical.”**³⁰ The house was understood not as a picturesque regional form but as a spatial and climatic argument — one that happened to share its constants

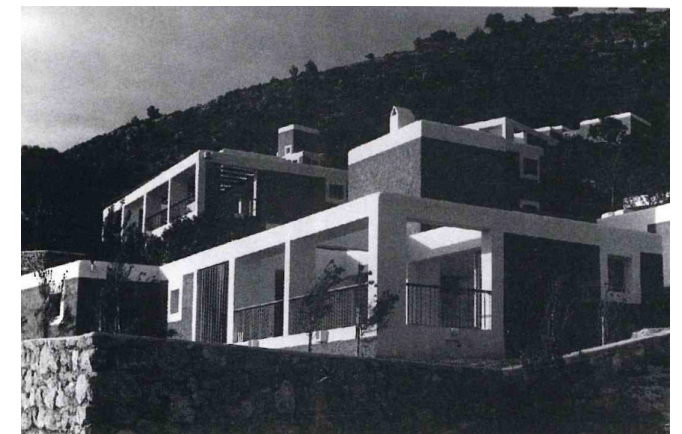
with the ambitions of the modern. In 1935 Sert delivered lectures in which he articulated the position directly: **“architecture will follow the same overall guidelines in all countries. However much regional clothing may be modified, the racial foundations and characteristics of each people will remain... we must defend a Mediterranean spirit of order, of clarity, of respect for millennial constants.”**³⁰ This was not regionalism in the sense of stylistic reproduction. It was the identification of a spatial logic — the orientation toward the sun, the human scale, the courtyard as the primary unit of collective life — that the Mediterranean had demonstrated across centuries of habitation and that modern architecture needed to recover rather than abandon.

Can Pep Simó, the housing complex Sert designed on Ibiza in 1964–69, is the built realization of this understanding at settlement scale. The complex follows the topographic grain of the Ibizan hillside, not as a formal gesture toward the vernacular but as the same spatial decision the vernacular had made for centuries: to work with the gradient rather than flatten it, to terrace rather than level. As Frampton has written, **“the terracing of a site to receive the stepped form of a building is an engagement in the act of cultivating the site”** — an act that produces a specific relationship between the building and its ground, between the private dwelling and the collective topography, that no placed object can replicate.³¹ The patios — organized at three scales, from the private courtyard of the individual dwelling to the shared district space to the public plaza — extend the cave’s courtyard logic to the neighbourhood, producing what Sert called **“scales of privacy”: a spatial system in which each scale of collective life has its own void, its own threshold, its own inhabitation pattern.**

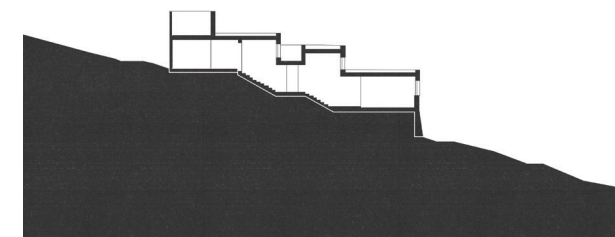
30. “Mediterranean Vernacular Architecture,” AC, no. 18, second quarter 1935. Cited in Antonio Pízza, ed., J. Ll. Sert y el Mediterráneo (Barcelona: Col·legi d’Arquitectes de Catalunya, 1997), p. 65.

31. Sert, lectures 1935, cited in Pízza, J. Ll. Sert y el Mediterráneo, p. 83.

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19 Josep Lluís Sert, Casa Sert, Ibiza, 1968. Exterior view
20 Casa Sert section. Drawing by the author.



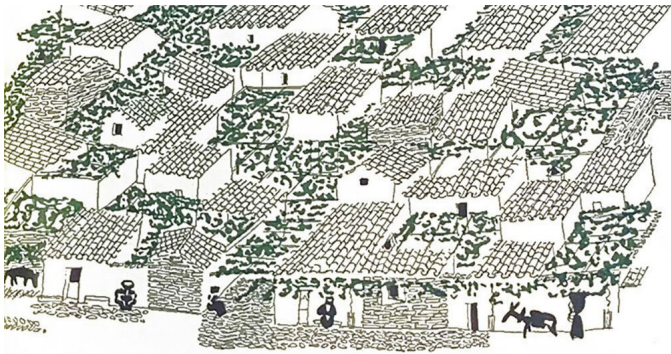
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27. James Steele, Hassan Fathy, *Architectural Monographs 13* (London: Academy Editions, 1988), p. 65.

28. Hassan Fathy, quoted in Ismail Serageldin, in J.M. Richards, Ismail Serageldin, and Darl Rastorfer, Hassan Fathy (Singapore: Concept Media / London: Architectural Press, 1985), p. 93.

29. Peter De Clarke, The Writings of Aldo Van Eyck: A Modernist Sensibility Introduced in Architecture, PhD dissertation, University of Bristol, 1982, p. 34.

The “in-between” as a spatial category was developed by Van Eyck across his editorship of *Forum* (1959–1963) and his contributions to the Team 10 discourse.



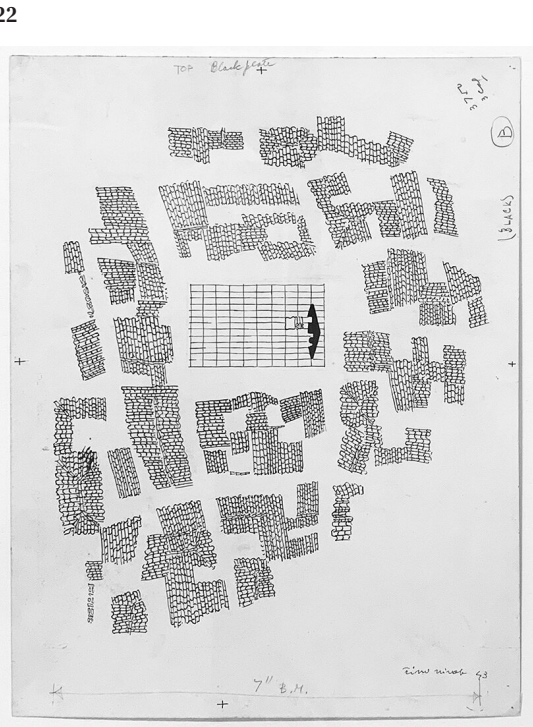
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21 Costantino Nivola, *Vined Orani (with pergolas), Orani, Sardinia. View of the settlement*
22 Costantino Nivola, *Vined Orani. Original drawing*
23 Costantino Nivola, *Vined Orani. Drawing showing Orani seen from above*

What Sert arrived at through the studied understanding of a specific Mediterranean tradition, Costantino Nivola arrived at through a different and more immediate practice — through the act of making rather than the act of analysis. The Pergola Village, first proposed in 1953 and published in *Interiors* magazine in January of that year, is a collective spatial proposal organized around the simplest possible element: **shade**. Nivola proposed a village structure in which the pergola — a frame of climbing vegetationW stretched over a lightweight structure — would constitute the primary communal spatial act. The covered space beneath is neither interior nor exterior; it is a threshold condition, a collective void that organizes social life without enclosing it. In collaboration with Bernard Rudofsky, whose understanding of Mediterranean vernacular spatial intelligence was the deepest of any architect of the period, the Pergola Village proposed a settlement logic derived from the same spatial intelligence that had organized Mediterranean village life for centuries — the agora, the covered street, the shared shade — and translated it into the lightest possible modern form.³² The Pergola Village is not a cave. But it produces the cave’s primary spatial condition: a collective void organized around inhabitation rather than enclosure, in which the body is sheltered without being contained. It thinks like a cave at the scale of the village.

What connects the terraced hillside complex, the pergola village, and the mud-brick courtyard settlement examined in the previous section is not a shared formal language or a shared geography. It is a shared method and a shared conviction. All three began from extended, careful study of a specific vernacular tradition before proposing anything. Fathy spent years documenting Nubian and Upper Egyptian domestic architecture; Sert devoted a decade and a journal to the systematic analysis of Ibizan and Catalan vernacular building; Nivola, working with Rudofsky, drew on a lifetime of Mediterranean spatial experience rooted in his Sardinian origins. What each translated was not the form of the vernacular settlement but its spatial intelligence — the organization of collective life around the void, around shade, around the threshold between private inhabitation and shared ground. This intelligence — the cave’s intelligence extended to the scale of the neighbourhood — is what these buildings propose against the dominant planning logic of their moment: against the tower in the park, against the erasure of topography, against the neutral ground of the modern city that had chosen to forget what the Mediterranean had always known about how to inhabit a specific earth collectively.

The settlements described here show that the spatial intelligence of the cave is not only dependent upon vernacular need and geographic location. The spatial logic of the cave is a transferable logic; it survived the transformation from geologic formation of the cave to man-made construction today. This logic continues to exist where there exists an awareness of the importance of depth, the material qualities of materials used in construction, and how these factors create specific types of inhabitation. Chapter Four asks what that commitment looks like in the contemporary moment — when the vernacular tradition has receded still further, and when the question of resistance is more acute than it has ever been.



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32. Costantino Nivola, *Pergola Village, Interiors, January 1953. See also Museo Nivola, Orani, Sardinia.*

Chapter Four

The Cave Logic
and Its Contemporary
Reinterpretations

4.0 Introduction

Chapter Three concluded by arguing that the spatial logic of the cave survived its geological necessity to become an architectural choice. That is, a recognizable and discrete current of modern architects, working against the grain of their century’s dominant grammar, translated the cave’s commitments to depth, mass, and material specificity into constructed form with a conscious knowledge of the alternatives. Chapter Four explores what happens when that distance is extended: when the vernacular tradition has receded even further, when the Mediterranean building cultures that gave rise to the Santorinian Skepasti and the Materian Sasso are no longer living resources but historical archives, and when the decision to embed a building in its topography, to build with the geological material of a particular ground, must be justified not by cultural inheritance but by architectural argument alone. This chapter focuses on the contemporary period, when, through different routes and different materials, practices have multiplied across the Mediterranean basin and have returned to the same spatial intelligence that the previous chapters have followed from the Neolithic settlement to the modern reinterpretation. It asks what that return looks like, what spatial lessons it produces, and what it means, in the conditions of the present, to choose topography and geological matter as the primary instruments of architectural thought.

The Mediterranean is used throughout this chapter not as a stylistic category or a cultural essence but as a geographical and geological concept. Fernand Braudel, whose *The Mediterranean and the Mediterranean World in the Age of Philip II* established the **longue durée** as the methodological frame for understanding how geological and climatic conditions shape human inhabitation across centuries, defines the Mediterranean not through the political territories that border it but through the material continuities that organize it: **the specific character of its stone, its light, its hillsides, and the relationship between this specific ground and the communities that have built within it.**¹ It is within these material conditions — the specific character of Mediterranean stone, light, and hillside — that the spatial intelligence of the cave developed, and to which, as Chapter Four argues, contemporary practice is returning. Where projects fall outside this precise geography, their inclusion is justified by the explicit analogy of geological and climatic conditions that the Mediterranean shares with adjacent territories: the North African desert plain, the Adriatic cliff, the Atlantic granite coast, the loess plateau.

The main argument of this chapter is that the specific conditions of a specific ground — its topography, its geological material, or both — are the primary generators of the building’s spatial logic. What connects the projects examined here is not, first and foremost, the stone, earth, or tuff from which

1. Fernand Braudel, *A History of Civilizations*, trans. Richard Mayne (London: Penguin, 1994), pp. 8–10. On the *longue durée* as methodological concept: Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II* (1949), trans. Siân Reynolds (New York: Harper & Row, 1972).

they are built, but the decision to make the specific ground of a specific site the generator of the spatial and constructive logic of the building. Kenneth Frampton, in his analysis of tectonic culture, identifies the act of terracing a site as a primary spatial and ethical commitment: “**the terracing of a site to receive the stepped form of a building is an engagement in the act of cultivating the site,**” he writes, “**an act that produces a specific relationship between the building and its ground, between the private dwelling and the collective topography, that no placed object can replicate.**”² This formulation captures the distinction the chapter pursues: between an architecture that places an object on the ground and an architecture that is drawn from the ground itself, between a building that could be anywhere and one that could only be here, in this specific topographic and geological condition. Stan Allen and Marc McQuade, in their framework for landform building, describe this as the dissolution of the conventional boundary between landscape and architecture: **when a building presses into the earth, embeds within the gradient, or is constructed from the material it removes, the distinction between site preparation and architectural production collapses.**³ This collapse is the spatial condition the thesis has traced from the Neolithic cave to the modern reinterpretation. Chapter Four asks where it is happening in the contemporary moment, and what spatial lessons it produces.

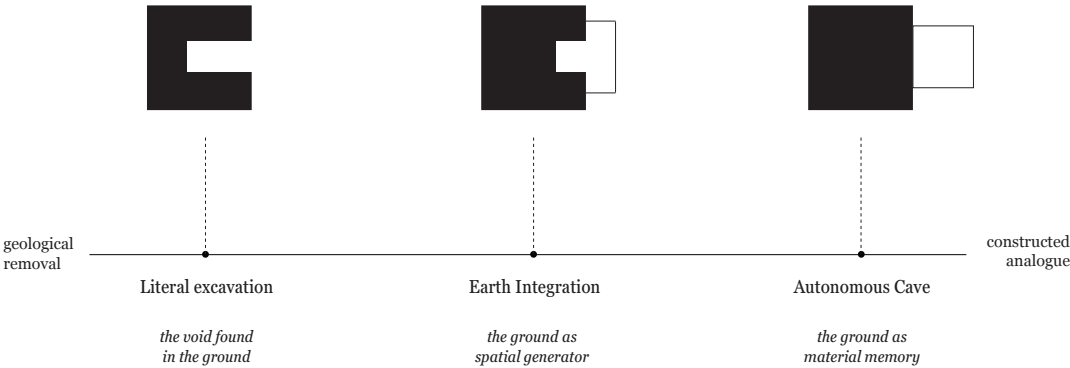
The analytical framework that organizes the chapter’s case studies is the abacus of degrees of subtraction, developed from the spatial intelligence traced across the preceding three chapters. Rudofsky, in his study of Santorini’s barrel-vaulted architecture, identified a spatial continuum “**from caverns carved into the volcanic rock, all the way to thin vaulted ceilings**” — from the directly excavated to the constructed analogue.⁴ This continuum has three principal positions. The first is **literal excavation**: the removal of geological material as the primary spatial act, the building produced by what is taken away rather than by what is assembled. The second is **earth integration**: the building pressed into existing terrain, the topography’s gradient becoming the section’s generator, the geological mass of the hillside functioning as thermal and structural enclosure without being directly carved. The third is **autonomous cave logic**: the building constructed above ground or on a neutral site, but with the mass, depth, material specificity, and inhabitation logic of the cave — what Chapter Three examined in the modern moment, here applied through contemporary practice with contemporary technique. These three degrees are not a hierarchy. They are positions on a spatial axis that the abacus makes visible: the axis from direct geological subtraction to constructed geological analogue, across which the cave’s spatial intelligence operates at different distances from the original material act.

The case studies are selected according to five criteria that together constitute the chapter’s argument. First, **topographic integration**: each project must demonstrate a primary spatial relationship to the specific ground of its site, whether through excavation, embedding, or the construction of geological-equivalent mass. Second, **spatial quality**: the primary building material must be structurally and spatially constitutive, not a cladding or finish applied to an indifferent structural frame. Third, **inhabitation logic**: the spatial conditions produced by the topographic and material decisions must shape the daily life and domestic rhythms of the building’s users, rather than providing a neutral container for a predetermined programme. Fourth, **residential or public typology**: the cases in sections 4.1 through 4.4 are residential, with section 4.5 addressing communal and civic programmes

that demonstrate the spatial logic’s extension beyond housing. Fifth, **the chronological scope**: the chapter’s scope extends from the 1970s to the present, with the primary focus on works completed from 2000 to 2025. The emphasis falls on the contemporary moment. These criteria are applied as an analytical lens: logic is genuinely present in contemporary practice, and distinguish it from the aesthetic reproduction of cave form without the spatial and topographic commitment that generates it.

The chapter is organized around five sections. Sections 4.1 through 4.3 address residential architecture, each corresponding to one of the three degrees of subtraction on the abacus: **literal excavation**, **earth integration**, and **autonomous cave**. Section 4.4 **The Received Cave** examines a fourth and distinct condition: reception. Where the preceding sections ask how cave logic is produced through excavation, embedding, or construction, **reception** asks how an existing spatial intelligence is inhabited, restored, and continued without destroying what makes it architecturally irreplaceable. The cases examined here demonstrate that the most precise act of renovation is also the most restrained. Section 4.5 **The Communal Cave** demonstrates that the same topographic and spatial logic operates across collective, cultural, and civic programmes, extending the argument beyond the domestic dwelling to the shared space of public life. Across all five sections, the chapter returns to the same spatial question that the thesis has posed from the beginning: what does it mean to begin from the specific topographic and material conditions of a specific ground, and to allow those conditions to generate the spatial and inhabitation logic of the building? This question, as the following case studies demonstrate, is not yet settled. It is, in the contemporary moment, more urgent than it has ever been.

2. Kenneth Frampton, “Towards a Critical Regionalism: Six Points for an Architecture of Resistance,” in Hal Foster, ed., *The Anti-Aesthetic: Essays on Postmodern Culture* (Port Townsend, WA: Bay Press, 1983), p. 26.
3. Stan Allen and Marc McQuade, eds., *Landform Building: Architecture’s New Terrain* (Baden: Lars Müller Publishers / Princeton University School of Architecture, 2011), p. 22: ‘any work of architecture, before it is an object, is a transformation of the landscape.’
4. Bernard Rudofsky, *Eine primitive Betonbauweise auf den südlichen Kykladen nebst dem Versuch einer Datierung derselben*, doctoral dissertation, Technische Universität Wien, 1931. p.25.



Degrees of subtraction - from direct geological removal to constructed geological analogue

4.1 Literal Excavation

The most direct contemporary engagement with the cave’s spatial logic is also the most demanding: the decision to drill, cut, or carve into existing geological material as the primary spatial act — not as site preparation before construction begins, but as the construction itself. In literal excavation, the plan is not drawn on a neutral ground and built, it is found in the particular resistance of the material. The resulting void is not designed in the usual sense. It is a product of decisions about what to cut. This distinction is spatially relevant. A space delimited by the inner faces of residual geological mass relates to its site differently than any space with walls of assembled surfaces. Its character is not imposed, it is revealed. The two projects discussed in this section, one on the Atlantic coast of northern Portugal, one on a Cycladic island in the southern Aegean, reach this condition through different geological materials and different formal strategies, but share the same fundamental design decision: that the ground is not the foundation on which the building sits, but the material from which the building is drawn. Though the Portuguese project sits outside the Mediterranean basin as defined in this chapter's introduction, its inclusion is justified by the geological analogy that introduction names explicitly: the specific resistance of Atlantic granite and the thermal logic of its mass are continuous with the spatial intelligence this thesis traces throughout the Mediterranean.

Though the Portuguese project sits outside the Mediterranean basin as defined in this chapter's introduction, its geological condition is continuous with the spatial intelligence the thesis traces throughout: Atlantic granite offers the same primary resistance — the same logic of mass, depth, and thermal inertia — that volcanic tufa offers on Serifos. The theoretical distinction that underlies this section is one Frampton draws in *Studies in Tectonic Culture* between the stereotomic and the tectonic modes of construction. The tectonic is assembling: it works from the element upward, from the component to the structure, from lightness toward enclosure. The stereotomic is carving: it works from the mass downward, from the continuous to the void, from geological weight toward inhabited space. These are not merely different building techniques but different relationships between architecture and ground. Tectonic construction produces a building that sits upon its site; stereotomic construction produces a building that is drawn from within it. As Frampton observes, the stereotomic mode has its origins in the earthwork and the excavation — in the act of cutting into the earth as a primary spatial gesture rather than as preparation for construction.⁵ The most direct of the stereotomic modes is the literal excavation: the material is the ground, the architecture is the removal, and what is left after the cut is at once the structure, the enclosure, and the spatial condition of the dwelling. The two projects presented here meet this condition in different geological materials and on different scales, but both start from the same premise: the specific resistance of a specific geological formation is not a constraint to overcome, but the spatial argument from which the dwelling starts.

House in Ribeira dos Moinhos, completed by João Cepeda in 2024 in Castelo Branco, northern Portugal, occupies a formation of granite cliffs alongside the mountain stream from which it takes its name. It is a site of extreme geological character: massive outcrops of local granite, fractured by time and water into formations that already read as partially inhabited spaces. Cepeda’s design does not import a logic of space into this condition. It recognizes what the cliff already has, and adds to it. As the architect writes,

“once a form and matter were found, the intention was to try to transform it into a newly constructed idea, by dignifying it again, with its new housing use” — giving a “renaissance” to an already existing matter rather than replacing it with a designed object.⁶

The plan is laid with studied economy. In the back, against the back of the cliff, is a private bedroom in the most enclosed and protected spot. As the section continues, the programme expands: a rocky patio serves as a mediator between the private zone and the living room that looks east to the stream and the valley. The bathroom spaces, which the architect calls the “humid” interiors, are placed along the rock face, their enclosure determined by the existing geometry of the granite, rather than by a pre-given room dimension. This sequential organization — private at the rear, collective at the front, services distributed along the geological edge — reads in section as a movement from geological enclosure towards the landscape, each space opening further as it moves away from the cliff face. Depth as the generator of gradients of inhabitation It is precisely the sectional organization of the Matmata pit dwellings or the Santorinian skepasti at a different scale and in a different material.

The material decision is the spatial decision. The large blocks of sawn local granite that frame the house are not cladding. They are the existing geological formation, cut and continued. Interior surfaces reproduce the same stone, the same grain, the same thermal behaviour. The distinction between the rock that was there and the rock that was added in construction is, by design, difficult to locate. Cepeda quotes Herberto Helder in describing the house: “Space does not exist, it is a metaphor for time. This is how this stone house is — just crafted by time — excavated between the rocky cliffs.”⁷ The formulation is exact at the architectural level. The time that builds the space is geological, the slow shaping of the cliff itself, and constructive, the cutting, placing and finishing of what the cliff had already begun.

Thermally the house works through the mass it occupies. The granite formation that makes up its back and side walls acts as a thermal flywheel in exactly the terms Fathy identified in the earthen walls of New Gourna: absorbing the thermal variation of the Beira Interior’s continental climate across the day, and releasing it slowly, the interior temperature reflecting a time-averaged condition rather than the instantaneous state of the exterior. This is of most direct advantage to the humid spaces that lie beside the rock face: their enclosure is geological, their climate generated by the mass that surrounds them. In contrast, the living room opens eastward through glazing to the morning sun, its thermal condition defined by aperture not mass — the two logics of thermal regulation that the cave tradition has always held in tension, calibrated here through the plan. The daily inhabitation that follows from this calibration is precise: the body moves from the geological enclosure of the humid spaces toward the morning light of the living room, a thermal and spatial choreography produced not by programme but by the section itself.

5. Kenneth Frampton, *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture* (Cambridge, MA: MIT Press, 1995), pp. 3–5. On the stereotomic and tectonic distinction: *ibid.*, p. 4: “The stereotomic is the objectification of a mass made up of repetitive units, while the tectonic is the spatial disclosure of a structure made of discrete parts.”

6. João Cepeda, project statement, *House in Ribeira dos Moinhos*, 2024. Quoted in *STIRworld*, October 2024.

7. Herberto Helder, quoted by João Cepeda in the project description for *House in Ribeira dos Moinhos*. *Designboom*, June 2024.

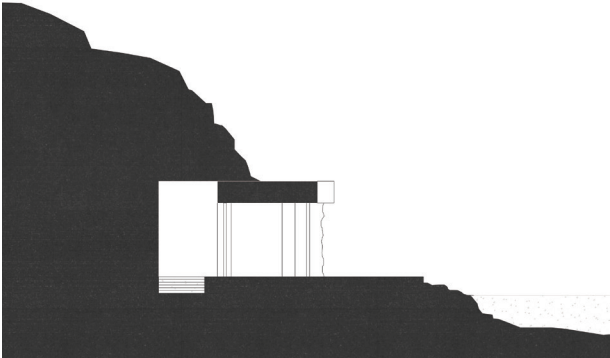


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3 João Cepeda, House in Ribeira dos Moinhos, Portugal. Interior view showing skylight
4 João Cepeda, House in Ribeira dos Moinhos, Portugal, 2023. Exterior view overlooking the river stream



3



2

1 João Cepeda, House in Ribeira dos Moinhos, Portugal, 2023. The living room reconciles with nature
2 House in Ribeira dos Moinhos section. Drawing by the author.

4



NCaved, completed in 2021 by MOLD Architects (Iliana Kerestetzi) on the island of Serifos in the Cyclades, starts from a different question. Where Cepeda found an existing geological formation and completed it, Kerestetzi found a site condition — a small rocky cove exposed to strong northern winds, but with an unobstructed view of the Aegean — and determined that the only adequate spatial response to this condition was to remove the ground, rather than to build upon it. **“The need to create a protected shelter, at a location of disarming view, but openly exposed to strong north winds,” she writes, “led us to the decision to drill the slope, instead of arranging a set of spaces in line at ground level.”**⁸ The decision to excavate is an act of space-making and thus the decision is a spatial argument. A building placed on the surface at this location would be structurally possible but spatially wrong: exposed to the wind that makes the site extreme, standing above a landscape that the cave tradition has always proposed entering rather than overlooking.

The architects applied a rectangular grid to the slope, generating what they describe as a three-dimensional “chessboard” of solids and voids: excavated volumes that become the rooms of the house, and remaining geological masses that separate and insulate them. This grid is the plan. Not a plan drawn in advance and then cut into the ground, but a spatial logic developed specifically in response to the slope’s geometry and the programme’s requirements — bedrooms, living areas, service spaces — distributed across the chessboard as isolated inhabitable units, each enclosed by remaining rock on at least three sides. The plan is a series of excavated chambers stepping down the hillside, each defined, not by its walls but by the mass of what was not removed.

The one significant exception to the grid is precisely where the argument of design is most obvious. The last grid axis is rotated at the living room, the social and collective space of the house. This turning breaks the geometric regularity of the chessboard and opens the living volume to a wider field of vision than any orthogonal alignment could permit. The effect is spatial and perceptual simultaneously: **“shifting the axis intensifies the sense of perspective significantly,”** the architects note, **“and thus the imprint of the residence appears minimized at the conceptual end of the ascent.”**⁹ The visual perspective of the Aegean is exaggerated; the sense of the building’s presence on the landscape is reduced. The rotation is not a formal gesture but a calibration of the relationship between the excavated interior and the exterior horizon — the aperture as a spatial instrument in the precise sense that Bergé identified in the Villa Mâche’s bunker windows. Where those apertures were designed to limit and control the exterior, NCaved’s rotated axis is designed to expand it. The excavation and the view are the same spatial act.

Materially, the house is constructed from the volcanic stone of the Serifos hillside. The lateral limits of the excavated volumes are defined by longitudinal dry-stone walls, a material already present in the Cycladic landscape as a vernacular building element, guiding the inhabitant’s gaze from the interior towards the sea. The transverse limits are glazed and completely openable: the contrast between the solid walls of volcanic stone that run parallel to the slope and the transparent surfaces that cross it is the main spatial argument of the section. Stone is geological permanence. Glass is optical continuity with the Aegean. This contrast is not resolved in this section. The defining spatial experience of the house is the mass of the excavation at the same time as the openness of the view. The planted roof of green makes the building disappear from above, giving back the hillside surface in an unbuilt condition. The building exists only as section — as an organization of volumes in the ground

8. MOLD Architects (Iliana Kerestetzi), project statement, NCaved House, 2021. Published in Arch2O, May 2021; and Domus online, March 2021.
9. Ibid.



5

5 MOLD Architects (Iliana Kerestetzi), NCaved House, Serifos, Greece, 2021. Interior view showing stone walls and aperture towards the Aegean

which has no exterior form when seen from the landscape.

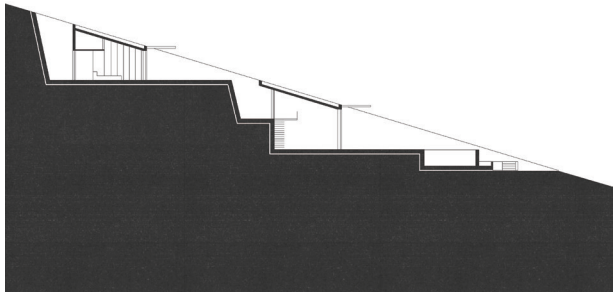
The two projects together show that literal excavation in the contemporary moment is not a reproduction of vernacular necessity nor a formal reference to cave architecture. It is a spatial decision made in full knowledge of the alternatives: both houses could have been built on the surface, with equivalent programme, equivalent cost, equivalent structural logic. To cut into the ground is to argue about the relationship between a dwelling and its specific geology — about what the site already has, and what kind of inhabitation is possible when the plan is organized around what is taken away rather than what is put in. This is the central question of the thesis, asked in its most direct contemporary form: what does it mean to choose the spatial logic of the cave, when geological necessity no longer compels it? Cepeda’s house and NCaved answer it differently, through different materials and different formal strategies, but the spatial intelligence at work in both—section as the primary analytical tool, depth as the generator of inhabitation quality, mass as the source of climatic and acoustic stability—is continuous with the intelligence that produced the Materian *sasso* and the Santorinian *skepasti*. The cave’s logic is the most fitting spatial answer to certain conditions of ground, light, wind and inhabitation in 2021 and 2024. The next section examines what happens when that logic is applied not through the geological excavation, but through the embedding of constructed mass within an existing terrain.



6



8



7

6 NCaved House, Serifos, Greece, 2021. Aerial view showing excavated volumes within the hillside
7 NCaved House section. Drawing by the author.

8 NCaved House, Serifos, Greece, 2021. Aerial view showing the house within its coastal landscape

4.2 — *Earth Integration*

The second degree of subtraction is not the removal of geological material, but the decision to make the existing ground a constitutive element of the spatial and environmental logic of the building. Where a literal excavation makes the void the primary act of spatiality, earth integration begins with the topography that is already there – its gradient, its orientation, its geological character – and allows these to generate the section, plan and pattern of inhabitation of the building. In this degree of subtraction, the section is the primary analytical tool. As Frampton has argued, the terracing of a site to receive a building is not a neutral operation but **“an engagement in the act of cultivating the site”** — an act that produces a specific relationship between building and ground that no placed object can replicate.¹⁰ Allen and McQuade, developing a framework for landform building, identify this condition as the dissolution of the conventional boundary between landscape and architecture: when a building presses into the earth, follows its gradient, or uses the geological mass of the hillside as its thermal and structural enclosure, the distinction between site preparation and architectural production collapses.¹¹ Heschang has shown that the spatial experience of moving through a building whose section is calibrated to the gradient of its terrain produces a range of thermal and atmospheric conditions that she calls thermal delight: inhabitation organized not around a mechanical set point but around the specific climatic character of each position in the topographic sequence.¹² The three projects examined here demonstrate this condition in different scales and different Mediterranean geologies, organized in order of increasing collective ambition: from the single dwelling embedded in its specific Adriatic hillside, to the domestic cluster whose plan recovers an agricultural stone wall tradition, to the 174-unit vacation complex whose settlement presses into and reinforces the geological cracks of a Côte d’Azur cliff face.

Issa Megaron, completed by Proarh (Davor Mateković) in 2016 on the island of Vis, Croatia, names its spatial argument in terms that the preceding chapters of this thesis have established as precise architectural language. The architects describe the house as **“a dug-in volume, a residential pocket between the stretches of space-forming walls, an artificial grotto, a memory of a primitive shelter and a new rural man-made topography, all by using simple construction technologies.”**¹³ The design is conceived through the framework of the Socratic Megaron — which the architects understand as the **“first passive house”**: a single rectangular space whose orientation, enclosure, and relationship to light and air constitute a complete environmental argument without mechanical systems. Two elements generate the design at two different cultural scales: the Megaron at the scale of the Mediterranean spatial tradition, and the ancient local stone drywalls at the scale of the specific island of Vis. The house steps into the hillside through a sequence of successive green terraces, the programme distributed across the gradient according to the specific requirements of each domestic act.

The site on Vis presented a condition of total isolation: no infrastructure existed at the plot. This constraint became the design’s generative condition. The architects describe self-sustainability as “prerogative and the only solution.”¹⁴ The result is a dwelling of 100% energetic autonomy: bioclimatic passive design, buried heat containers, photovoltaic cells, and recycled rainwater through natural filter systems. Each decision is simultaneously environmental and spatial: the bioclimatic orientation determines the section’s exposure; the buried heat containers deepen the relationship between

9 Proarh (Davor Mateković), Issa Megaron, Vis, Croatia, 2016. Exterior view showing stone drywall and landscape



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10. Kenneth Frampton, ‘Towards a Critical Regionalism: Six Points for an Architecture of Resistance,’ in Hal Foster, ed., *The Anti-Aesthetic: Essays on Postmodern Culture* (Port Townsend, WA: Bay Press, 1983), p. 26.

11. Stan Allen and Marc McQuade, eds., *Landform Building: Architecture’s New Terrain* (Baden: Lars Müller Publishers, 2011), p. 22.

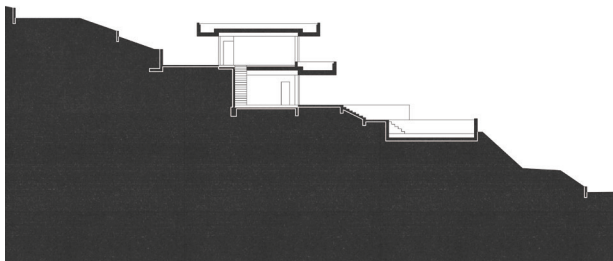
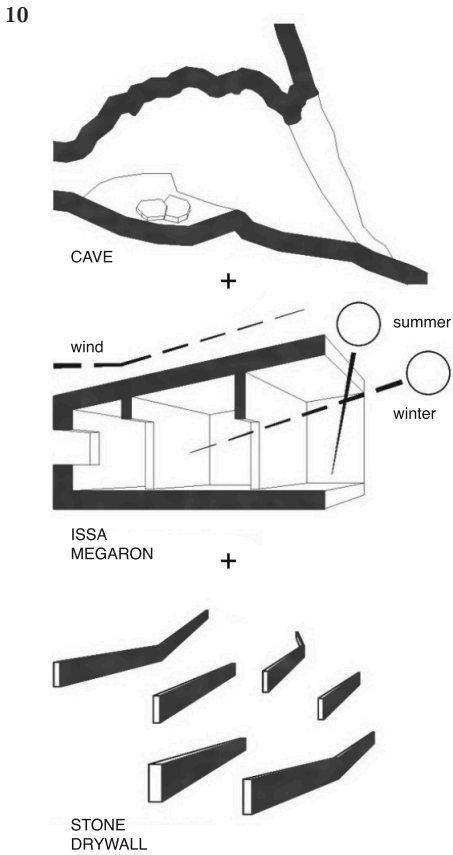
12. Lisa Heschang, *Thermal Delight in Architecture* (Cambridge, MA: MIT Press, 1979), p. 17.

13. Proarh (Davor Mateković), project description, Issa Megaron, 2016. EU Mies Award submission: <https://eumiesawards.com/heritageobject/issa-megaron/>. The Plan Award 2018, Villa category; World Architecture Festival nomination, 2017.

14. Ibid.

the house and its ground. The architects’ observation that the project is **“innovation in architectural design in the sense of reinventing simple traditional construction technologies typical of the Mediterranean, something that is in times of hi-tech architecture forgotten and abandoned, while it completely satisfies the needs of the modern man,”**¹⁵ connects directly to the resistance argument developed across Chapters Two and Three: the specific geological and climatic intelligence of the Mediterranean vernacular applied because it works, because it is available, and because the specific ground from which it comes is the ground on which the building stands.

15. Ibid.



10 Proarh (Davor Mateković),
Issa Megaron, Vis, Croatia,
2016. Conceptual diagram:
cave + Issa Megaron + stone
drywall
11 Issa Megaron section.
Drawing by the author.

12 Issa Megaron, Vis, Croatia,
2016. Exterior view showing
terraced structure
13 Issa Megaron, Vis, Croatia,
2016. Exterior view showing
roof and landscape integration

14



14 DECA Architecture, Aloni, Antiparos, Greece, 2008. Aerial view showing the house within the terraced hillside landscape
 15 DECA Architecture, Aloni, Antiparos, Greece, 2008. Aerial view showing roof and courtyard organisation

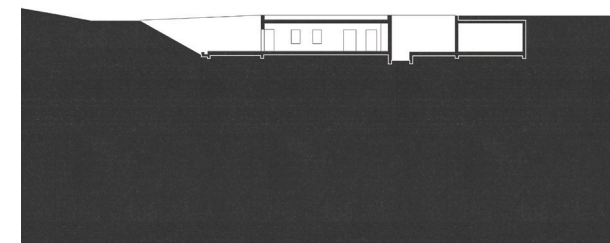
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16. DECA Architecture, project description, Aloni, Antiparos, 2008. In: Jodidio, ed., 100 Contemporary Houses (Cologne: Taschen, 2013), pp. 170–175. Piranesi Award 2009; Hellenic Institute of Architecture Award 2008.
 17. Ibid.
 18. DECA Architecture, Earthworks series, Benaki Museum, Athens, 2009.

Aloni, completed by DECA Architecture in 2008 on the island of Antiparos in the Cyclades, begins from a reading of the site's archaeological agricultural past rather than its geological present. The design is described by the architects as “**a dual response to the particular topography of the site and to the rural domestication techniques that in the past shaped the raw Cycladic island landscape.**”¹⁶ Dry-rubble stone walls domesticated the Cycladic terrain for agricultural purposes, retaining earth and transforming steep topography into a series of arable plateaus. DECA's design continues this logic: the same dry-rubble technique, the same earth-retaining principle, now applied to produce domestic rather than agricultural space. Two long parallel stone walls bridge the hills, allowing the house to nestle within the space between them while the terrain continues over the roof, flowing uninterrupted across the building's upper surface.

The plan organizes the living programme into five interior areas separated by four courtyards carved into the flowing green roof, each one a vertical void admitting light and sky to the interior spaces below. As the architects describe it, “**this simple strategy blurs the edges of the house and makes its mass imperceptible within the broader skyline of the island.**”¹⁷ The section, read from the hillside, is a sequence of embedded volumes and carved voids: stone walls as the primary structural and climatic element, green roof as the landscape's continuation, courtyards as the calibrated apertures through which light and air enter the inhabited depth below. The stone walls provide thermal mass; the buried plan ensures stable temperatures through the Cycladic summer; the four courtyards calibrate natural light and cross-ventilation without mechanical assistance. The four projects of DECA's Earthworks series — of which Aloni was one — were exhibited at the Benaki Museum in Athens in 2009 and subsequently influenced the revision of the Greek building code: in 2012, a committee from the Ministry of the Environment visited the practice to consult on incentives for earth-integrated construction that minimizes visual impact on the landscape.¹⁸



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16 Aloni section. Drawing by the author.

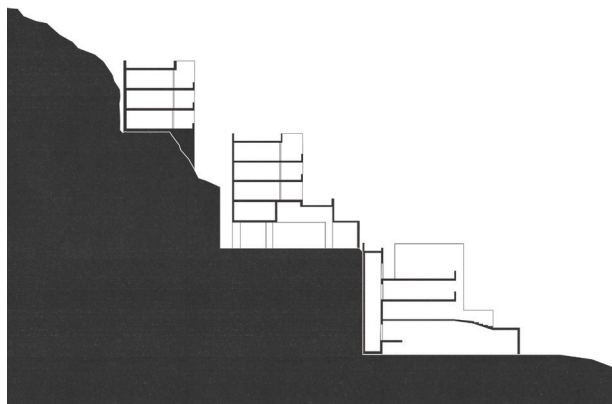
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17 Jean Nouvel (Ateliers Jean Nouvel), *Résidence Pierre et Vacances*, Cap-d'Ail, France, 1988–1991. Exterior view showing integration into the cliff

18 *Résidence Pierre et Vacances*, Cap-d'Ail, France, 1988–1991. View showing terraced facades and landscape

19 *Résidence Pierre et Vacances* section. Drawing by the author.

19. Jean Nouvel (Ateliers Jean Nouvel), project description, *Résidence Pierre et Vacances*, Cap-d'Ail, 1988–1991. 174 vacation homes, 5,860 m².

20. Ibid. Full passage: 'The site? It's steep. Rocky. Partly hollowed out by a quarry. Almost a cliff. Pine trees and agaves cling to its surface between the rocks, on the slope overlooking the sea. Architecture also clings to it. It lodges itself deep down, reinforcing the cracks in the rocks. It is mineral. It is minimal.'

The *Résidence Pierre et Vacances*, completed by Ateliers Jean Nouvel in 1991 at Cap-d'Ail on the Côte d'Azur, is the section's most spatially ambitious case: 174 vacation homes organized across 5,860 square metres of a steep rocky cliff face partly hollowed out by a former quarry, overlooking the Mediterranean between Monaco and Nice. Nouvel's own description, written on completion, positions the project within the thesis's argument with unusual directness: **"The thickness of the medium, the freshness related to its mass and to the depth of space create an impression of architecture engraved in the rock, a recollection, an awareness of what architecture has always been: a shelter, a strategic place from which to face time and the elements."**¹⁹

The site itself arrived with a spatial argument already embedded in it: a former quarry had already begun the work of subtraction, hollowing out the cliff face over decades of stone extraction and leaving behind a geometry of voids and remaining mass that the building would continue rather than override. The site's design title — **"enrollment on the cliff register"** — names the primary spatial decision: the building does not occupy the cliff but joins it, enrolling itself in the geological record of the specific rock face. Architecture **"clings to it,"** Nouvel writes. **"It lodges itself deep down, reinforcing the cracks in the rocks. It is mineral. It is minimal."**²⁰ The settlement's organizational logic follows the cliff's geometry: the 174 units are distributed across the gradient, each one oriented toward the Mediterranean through what Nouvel describes as a **"CinemaScope view of the landscape"** — the panoramic aperture calibrated to the specific angle of each unit's position on the cliff face. This is the aperture argument at the scale of the settlement: 174 individually oriented openings, each the specific product of the specific position of one dwelling within the specific geology of the cliff. The garages are cut out of the rock itself and lit by long horizontal slots — Nouvel describes them as **"crypt-like"**. The spatial character of excavation creates a cave even in the most infrastructural programme of the building.

The three projects examined in this section demonstrate earth integration at different scales and through different relationships to the geological and cultural landscape they inhabit. Issa Megaron reads the geological and climatic conditions of an Adriatic island and translates them directly into a self-sustaining spatial system: the section is the environmental instrument, the stone drywall is the structural and climatic argument, and the daily inhabitation of the house follows the rhythms of the sun, the wind, and the specific topography of the Vis hillside. This is the cave's ritual logic recovered in contemporary construction: the migration through thermal and spatial conditions that the section already contains. Aloni reads the agricultural and topographic history of a Cycladic island and translates it into a domestic spatial logic: the stone retaining wall recovered from its agricultural purpose becomes the structural and climatic enclosure of the house, the landscape continues over the roof, and the four courtyards organize the programme around vertical voids in horizontal mass. *Pierre et Vacances* reads the geological character of a Mediterranean cliff face and organizes 174 inhabited units around its cracks and gradients, demonstrating that the cave's earth integration logic operates at settlement scale with the same spatial precision it brings to the single dwelling. All three provide the same lesson: that the section's intelligence is produced not by design abstraction but by a close reading of the specific topographic, geological, and cultural conditions of a specific ground. The following section examines what happens when this logic is pursued entirely through construction — when no existing terrain assists the decision, and the cave's spatial intelligence must be sustained by material and constructive argument alone.

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4.3 Autonomous Cave

The third degree of subtraction examined in this chapter is the most demanding: it receives no direct geological assistance. Sections 4.1 and 4.2 both describe conditions in which the existing ground participates actively in the spatial logic of the building — through excavation, through embedding, through the terrain's gradient becoming the section's generator. The projects examined here begin from a different condition: a site that could receive any building, and a decision to construct with the material and spatial logic of the cave regardless. The building becomes, through its own material substance and constructive commitment, an extension of the specific geological and topographic character of the ground it occupies. Norberg-Schulz, describing what it means for architecture to belong to its place, argues that a building's "genius loci" is constituted not by stylistic reference but by the specific material and topographic conditions from which it is drawn: **a building belongs to its place when the specific character of the ground — its material, its gradient, its orientation, its climatic exposure — has generated the building's own spatial and material logic.**²¹ Frampton, developing a framework for what he calls the **tectonic culture, identifies the mediation between building and ground as the primary architectural commitment: the manner in which a building meets its topography — whether it is placed upon, pressed into, or constructed from the material of its site — determines the character of the architecture before any formal decision is made.**²² The three projects examined in this section each demonstrate a different expression of this commitment: a house whose perimeter walls are built from the stone extracted during its own garage excavation; a dwelling whose linear plan follows the invisible lines of an ancient irrigation system that has organized the Moroccan plain for centuries; and a social housing complex whose load-bearing masonry recovers a local limestone construction technique abandoned by the industry for thirty years. In each case, the building does not impose a spatial logic onto its ground. It reads what the ground already contains and allows that reading to generate the building's form, material, and inhabitation.

Casa Balma Murada, completed by Mesura Architects in 2025 on the Mediterranean coast of Spain at the edge of a natural reserve, begins with the most fundamental act of topographic reading: attentiveness to the specific character of the ground before any design decision is made. The architects describe the project as **"conceived as an architecture of response rather than imposition,"** beginning from **"a markedly rocky ground, constant exposure to wind, and a building tradition based on the direct use of local resources."**²³ These three conditions — geological, climatic, and cultural — together define the building's spatial logic before a plan is drawn. The rocky ground determines the material. The wind determines the mass and geometry. The local building tradition determines the construction technique.

That character leads directly to stone and to the dry-stone walling technique that has organized the Mediterranean landscape for millennia. The UNESCO inscription of "The Art of Dry-Stone Walling: Knowledge and Techniques" as Intangible Cultural Heritage of Humanity in 2018 — with Spain, Greece, Croatia, Italy, and four other Mediterranean countries as co-nominating parties — recognizes what Mesura's design takes as its starting point: that dry-stone construction is as a living material intelligence, constituted by centuries of accumulated knowledge about how to work the specific stone of a specific landscape without mortar, relying on gravity and the specific weight and fracture pattern of local rock.²⁴ Casa Balma Murada



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20 Mesura, Casa Balma Murada, Spain, 2025. Exterior view showing stone walls and rocky landscape

begins from this intelligence. All perimeter walls are built from the KM0 stone extracted during the excavation of the garage: what is removed from the ground to make space for the building becomes the substance of its construction. As the architects state: **"What is removed from the ground to make space for the building becomes the substance of its construction, reinforcing continuity between land, material, and architecture."**²⁵ The circularity is total: subtraction produces material, material produces enclosure, enclosure produces the inhabitable space, and the space is defined by the same geological substance as the ground from which it was made.

The topographic reading extends into every spatial decision. The façade follows the natural geometry of the topography, adapting to the existing rocks and fragmenting to generate multiple orientations and views. In response to the persistent wind exposure, the house relies on mass, wall thickness, and volumetric geometry rather than conventional insulation. The stone walls provide thermal inertia and climatic protection; the fragmented perimeter breaks the wind's force while encouraging natural air circulation through the sections between volumes. The poet J.V. Foix, who summered on this coast, wrote: *"Allunyeu-me dels vents"* — keep me away from the winds. The building answers this request not through mechanical insulation but through the specific constructive intelligence of Mediterranean stone mass.²⁶ The daily access to the house is organized by the same topographic logic: residents enter each morning through the garage embedded in the ground from which the stone walls were quarried, the subtraction and construction made continuous in the daily ritual of coming home. The spatial lesson of Casa Balma Murada is precisely this: that the most rigorous topographic reading produces a building that belongs to its ground not as an aesthetic gesture but as a material fact.

25. Mesura Architects, *Casa Balma Murada*, 2025. *Op. cit.*
 26. J.V. Foix, quoted in 'Casa Balma Murada,' *Arquitectura Viva* / AV UIA Barcelona.

21. Norberg-Schulz, *Genius Loci* (New York: Rizzoli, 1980), pp. 5–6.

22. Frampton, *Studies in Tectonic Culture* (Cambridge: MIT Press, 1995), pp. 3–5.

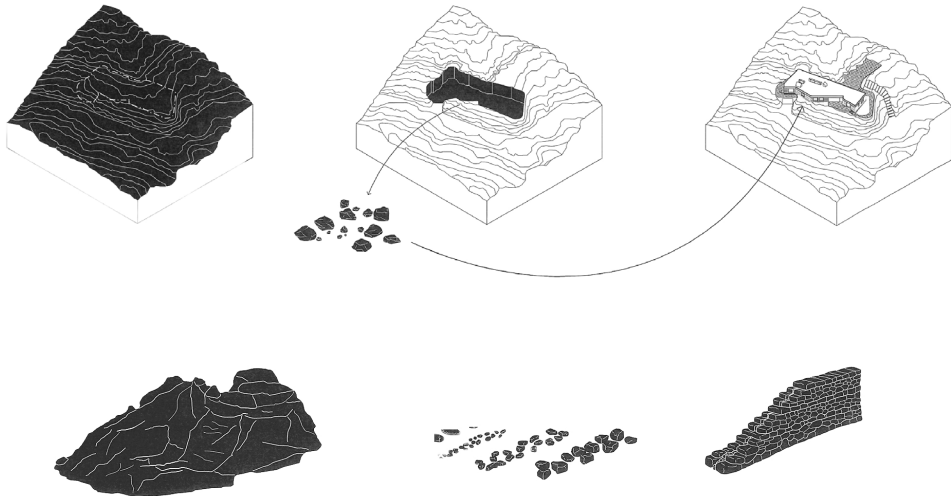
23. Mesura Architects, project description, *Casa Balma Murada*, 2025. Photography: Rory Gardiner.

24. UNESCO, 'The Art of Dry-Stone Walling,' inscribed on the Representative List of the Intangible Cultural Heritage of Humanity, 13th Session, Port Louis, 28 November 2018. Decision 13.COM 10.b.38.



21

23 Casa Balma Murada,
diagram showing stone
extraction from site for use in
construction
24 Casa Balma Murada,
construction diagram
25 Casa Balma Murada,
exterior view showing facade
and natural reserve

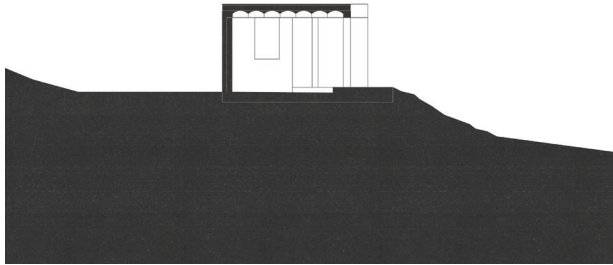


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21 Casa Balma Murada,
physical model
22 Casa Balma Murada

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26 Leopold Banchini Architects and Sana Nabaha, *Dar el Farina*, Morocco, 2024. Construction view showing rammed earth walls
 27 *Dar el Farina*, Morocco, 2024. Interior view showing spatial sequence and skylight
 28 *Dar el Farina*, Morocco, 2024. Exterior view showing the house within the arid landscape
 29 *Dar el Farina* section. Drawing by the author.

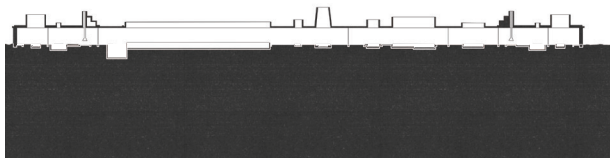
27. Leopold Banchini Architects and Sana Nabaha, project description, *Dar el Farina*, 2024. Photography: Rory Gardiner.
 28. Lightfoot, 'Moroccan khattara,' *Applied Geography*, vol. 16, no. 1 (1996), pp. 21–40.

Dar el Farina, completed by Leopold Banchini Architects in collaboration with Sana Nabaha in 2024 on the Haouz plain of Morocco, demonstrates that topographic reading operates on flat ground as precisely as it does on a slope, that the organization of a landscape can be as generative as its gradient when that organization has been sedimented over centuries of human inhabitation. The site is crossed by two hydraulic infrastructures whose presence in the landscape is almost invisible but whose spatial logic has organized this territory for over a thousand years. The *mesref* is a surface channel used for agricultural irrigation; the *khetara* is an underground draining gallery devised by the Almoravid dynasty in the eleventh century to transport groundwater from the High Atlas Mountains to Marrakesh across the desert.²⁷ These two systems, as the academic literature on Moroccan hydraulic heritage documents, are “**not just irrigation systems but lifelines that have supported generations, enabling communities to thrive in harsh climates and fostering a unique oasis culture deeply connected to water and land.**”²⁸ The house follows the lines of both. Its two parallel rammed earth walls trace the course of the two canals, dividing the property into two distinct landscapes: on the entrance side, the desert remains untouched; on the opposite side, a garden of indigenous plants flourishes, irrigated by these ancient systems. The plan of Dar el Farina is a topographic continuation of what was already there.

The linear section that results from this topographic reading is organized as an enfilade: a succession of rooms, patios, and water basins distributed along the building's length, each space lit from above by what the architects call “*canons à lumière*” — vertical brick shafts descending from the roof to the interior, lined with locally crafted zellige tiles that refract the Moroccan sunlight into coloured patterns across the water surfaces below. The house has no exterior windows. All light enters from above, through precisely calibrated apertures in the compressed earth ceiling — the aperture as a precisely calibrated shaft through thick material, a logic the thesis has traced from the deep-set openings of the Matmata pit dwelling to the bunker windows of the Villa Mâche in Chapter Three. Light in the cave does not come from glazed surfaces. It is produced by the specific geometry of a shaft through thick material. Dar el Farina applies this principle to a flat desert plain, where the mass of the earth roof substitutes for the geological mass of the cave.

The construction logic is entirely site-derived. The outer walls of rammed clay are structurally sufficient to support the concrete roof, the local earth providing both the structural and the thermal argument simultaneously: thick mud walls, calibrated sunlight, water features, and native vegetation combine to create a cool microclimate — a shaded refuge in the desert plain whose environmental logic is identical to the thermal flywheel that Fathy described in the earthen walls of New Gournia and that Chapter One identified in the Matmata pit dwellings. The house is completely off-grid: solar panels, a natural spring, and local material cycles make it entirely self-sufficient. The lesson Dar el Farina provides is spatial and topographic: that on a flat ground, the invisible lines of historical water infrastructure can generate as precise and as site-specific an architecture as any hill or cliff, when the architect is willing to read what the ground already knows.

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Life Reusing Posidonia — fourteen social dwellings in Sant Ferran de ses Roques, Formentera, completed in 2017 by the Instituto Balear de la Vivienda (IBAVI) — is the section's most socially significant case, and in architectural terms the most instructive: a publicly built, publicly funded housing project whose construction logic is derived from a systematic reading of the material landscape of a specific Mediterranean island. The island of Formentera is defined geologically by two primary materials: Marès sandstone, the local limestone quarried from Mallorcan and Balearic deposits since Roman times; and posidonia oceanica, the Mediterranean seagrass that washes ashore on its beaches and was dried and compressed as roof insulation in traditional construction for centuries before the arrival of synthetic materials. Both materials are under threat. The Marès quarries are diminishing; the structural use of load-bearing limestone was abandoned by the construction industry for thirty years in favour of reinforced concrete. The posidonia is collected from beaches in summer and discarded as a nuisance for tourists. IBAVI's project recovers both: the specific material ground of Formentera, read as the most locally available and most climatically adequate construction resource.

The architectural decisions that follow from this reading are structural as much as environmental. Load-bearing walls of non-reinforced Marès limestone, using the same technique the Romans applied in the Balearic Islands, organize the plan of the fourteen dwellings: two bedrooms and a living-dining-kitchen space per unit, arranged in a chequered pattern to maximize cross-ventilation from the dominant north and east sea breezes without mechanical assistance. The section incorporates a thermal chimney in each upper-floor living room: a one-metre ceiling outcrop with a south-facing clerestory window for passive solar heating in winter, shuttered in summer, and a north-facing operable opening for summer ventilation. The plan is the environmental instrument; the section is the climatic argument; the material is the geological substance of the island, recovered from its reduction to cladding and returned to its structural purpose. Architect Carles Oliver describes the guiding principle with precision: “**restrictions stimulate creativity.**”²⁹ The restrictions of Formentera's island context — the limitations of material supply, the cost of transport, the protected ecological status of the posidonia — are the generators of the building's spatial and material intelligence.

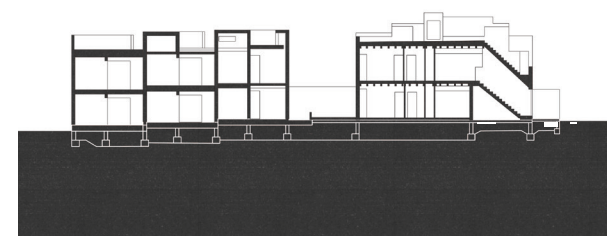
The project took nine years from design to completion, a duration that reflects not only the complexity of the material research but the institutional resistance to construction techniques that fall outside the standard industry palette. That resistance was eventually overcome not by advocacy but by evidence: the buildings have been inhabited since 2017, their residents settled and comfortable, the construction performing as designed. Rafael Gómez-Moriana, writing in the *Architectural Review*, observed that the project “**does not feel the least bit institutional**” — that it possesses a sense of local character that makes it fit within its small-scale, finely grained setting precisely because its materials are those of the place.³⁰ This is the social and spatial lesson IBAVI provides: that the most adequate instrument of social housing is not the standardized unit delivered at minimum cost but the specific material intelligence of a specific place, applied at the collective scale with the rigour that the cave's spatial logic has always required.

The three projects examined in this section each demonstrate a different expression of the same spatial commitment: that the building's material and constructive logic should be drawn from the specific character of the ground it occupies rather than imposed upon it. Casa Balma Murada reads the rocky Mediterranean terrain and quarries its own walls from the stone it removes.

Dar el Farina reads the invisible hydraulic lines of the Moroccan plain and organizes its plan along their course. IBAVI reads the material landscape of a Balearic island and recovers its geological and ecological construction resources from institutional abandonment. The lesson that all three provide — at different scales, in different geographies, through different materials — is the same: that the most precise topographic reading does not stop at the surface of the ground but descends into its specific material character, its historical organization, and its climatic logic. The building that draws its spatial argument from this depth belongs to its place not through formal resemblance but through material continuity. It becomes, in the fullest sense, ground.



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30 Carles Oliver (IBAVI), Social Housing, Formentera, Spain, 2015. Exterior view showing posidonia insulation and stone construction
31 Social Housing, Formentera section. Drawing by the author.

29. Carles Oliver (IBAVI), quoted in Rafael Gómez-Moriana, 'Social Housing, Formentera, Spain, by the Instituto Balear de la Vivienda,' *Architectural Review*, 18 August 2019.

30. Gómez-Moriana, *Architectural Review*, 2019. *Op. cit.*

4.4 The Received Cave

The preceding sections examined the spatial logic of the cave as a chosen condition: the choice to excavate, to embed, to build of the matter of the ground, made in full knowledge of the alternatives. This section examines a fourth and distinct condition: the reception of an existing spatial intelligence rather than its production. It's a different architectural question to renovate and dwell in buildings that already have the cave logic in them, or a real cave structure that is back in use, than to do new construction. It does not ask what material or topographic conditions to use, but how to receive the conditions that are already there without destroying what makes them architecturally irreplaceable. This requires some kind of attention, not design in the traditional sense, but spatial recognition, to know what the existing building or geological structure already contains, and to complete it rather than replace it.

Can Lis, designed and built by Jørn Utzon for his own family on the cliff of Portopetro in southeast Mallorca between 1971 and 1973, is one of the most precise demonstrations in the modern architectural canon of the principle that the cave's spatial intelligence can be pursued through new construction when the commitment to local geological material and topographic condition is complete. The site is a steep cliff above the Mediterranean, narrow between the road and the sea, the geological substrate the warm-gold Balearic marès sandstone — the same material that built the cathedral of Palma de Mallorca and the most humble agricultural field walls of the island, quarried from beds at Santanyi in blocks cut like sugar cubes by a circular saw that first scored a chequerboard of incisions down into the geological formation before a horizontal cut yielded each stone.³¹ Utzon had studied this material and its local constructive tradition carefully before beginning the design. What he found was a system — using local sandstone blocks and brick slabs — that, as the *Arquitectura Viva* documentation notes, “**adapts perfectly well to his building philosophy based on modulation.**”³²

The narrow site prompted the fragmentation of the house into four separate pavilions — bedroom, living room, kitchen and dining room, study — each with its own function, connected not by internal corridors but by transitional courtyards and outdoor paths. This fragmentation is a spatial argument as much as a response to programme: each pavilion is a distinct inhabited enclosure in the cliff, its walls of marès stone thick enough to produce the thermal and acoustic conditions of a carved space without excavation. The living room is the most architecturally explicit: a high-ceilinged space of massive stone walls, with a small opening in the western wall through which a single beam of light descends and moves across the floor as the sun tracks its daily arc.³³ The aperture is calibrated to produce a specific spatial event — not a view, not a window in the conventional sense, but a measured incision in the mass that admits light precisely, selectively, as evidence of the sun's movement against the geological permanence of the stone. This is the cave's aperture logic in built limestone: mass as the spatial argument, the calibrated opening as the instrument of spatial awareness rather than visual transparency.

Utzon himself writes very precisely about his architectural thinking: “**architecture is not an external form: it is primarily the frame that encloses a collection of ritualized events.**”³⁴ The daily life at Can Lis — the movement from pavilion to courtyard to pavilion following the sun's position, the fixed furniture built from the same stone as the floor

and finished with ceramic tile, the specific view of the Mediterranean framed by each opening — is organized by the building's spatial conditions rather than by an abstract programme. This is the thesis's inhabitation argument in a different register: the dwelling does not accommodate a generic way of living; it structures a specific daily choreography around the geological and topographic conditions of the cliff from which it is built. The essay “Platforms and Plateaus,” written by Utzon in 1962 and published a decade before Can Lis was built, had articulated the theoretical ground for this: the platform as the architectural element that establishes a new spatial condition from within the specific topographic character of a site — “**a feeling similar to standing on a large rock,**” he wrote, **the architecture not placed on the land but grown from within it.**³⁵

In 2011, the Utzon Foundation commissioned architect Lise Juel to restore Can Lis and transform it into a contemporary artist's residency. The restoration's approach is described by Juel in terms that are directly relevant to the thesis's renovation argument: “**with the same grid of marès stone and the spatial narrative as a compass, a process of the constant challenge and excavation of ideas and technical solutions took place during the restoration.**”³⁶ The spatial narrative — the specific sequence of threshold, courtyard, pavilion, aperture that Utzon had established from the cliff's own geological logic — is the instrument of the renovation. The marès stone grid is not an aesthetic reference to the original but the structural and climatic logic to which the restoration persists. What Juel received and preserved was not an image but a spatial and material argument. The restoration succeeds because it recognized that argument and declined to substitute for it. This is what renovation of cave-logic architecture demands: not a reproduction of the original's appearance, but a continuation of its spatial intelligence into the conditions of a new use.

32. *Arquitectura Viva*, 'Can Lis, Mallorca — Jørn Utzon,' 2022.

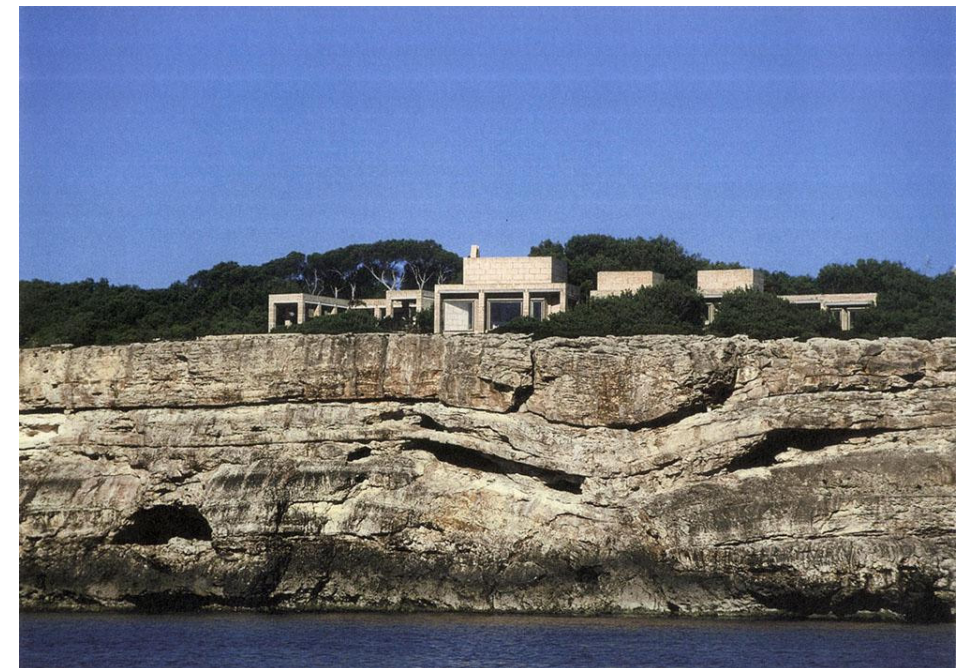
33. RTF / *Rethinking The Future*, 'Can Lis House by Jørn Utzon,' 2021.

34. Utzon, 'La esencia de la arquitectura' (1948), in Puente, ed., *Jørn Utzon: Conversaciones y otros escritos* (Barcelona: Gustavo Gili, 2010), p. 9.

35. Utzon, 'Platforms and Plateaus,' *Zodiac* 10 (1962), pp. 112–140. Reprinted in Puente, ed., *Jørn Utzon: Conversaciones y otros escritos* (Barcelona: Gustavo Gili, 2010).

36. Lise Juel (Utzon Foundation), restoration statement, *Can Lis*, 2011. Quoted in *Designboom*, 2019.

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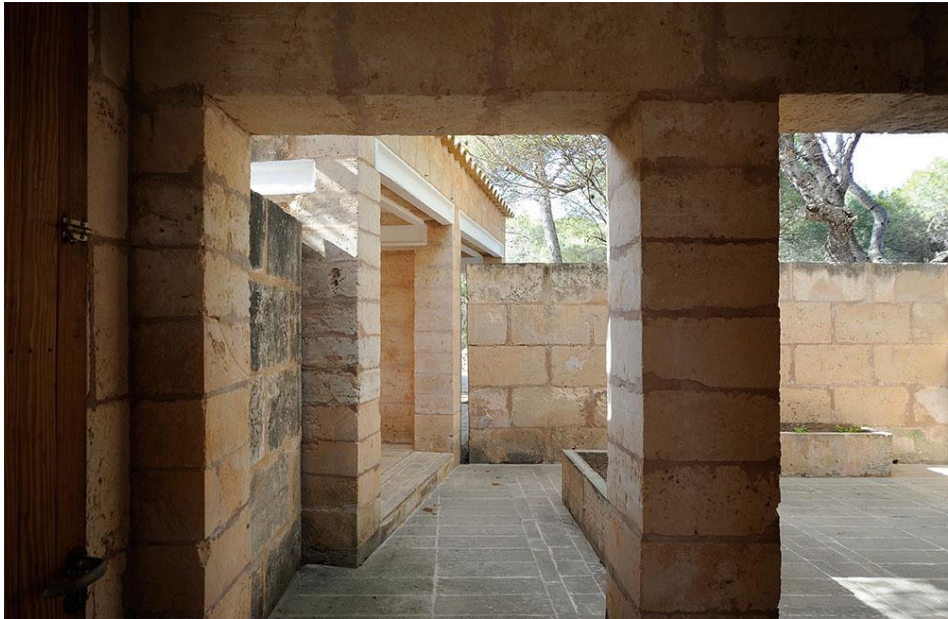
32 Jørn Utzon, *Can Lis*, Porto Petro, Mallorca, 1971–73. Exterior view from the sea showing the house on the cliff

30. Gómez-Moriana, *Architectural Review*, 2019. Op. cit.

31. On *Can Lis marès stone: Architecture Today*, 'Can Lis,' 2020. See also: Aguiló Ribas et al., 'Tourism and Architecture. Jørn Utzon in Majorca: Can Lis,' in *Construction and Building Research* (Dordrecht: Springer, 2014), pp. 305–312. For full documentation: Pardey, *Utzon Logbook Vol. 3: Two Houses on Mallorca* (Hellerup: Edition Bløndal, 2004).

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33 Can Lis, Porto Petro, Mallorca, 1971–73. Interior view showing marès stone walls and apertures

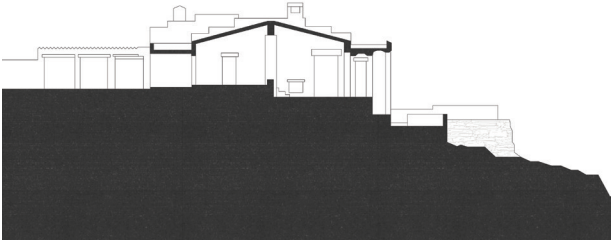


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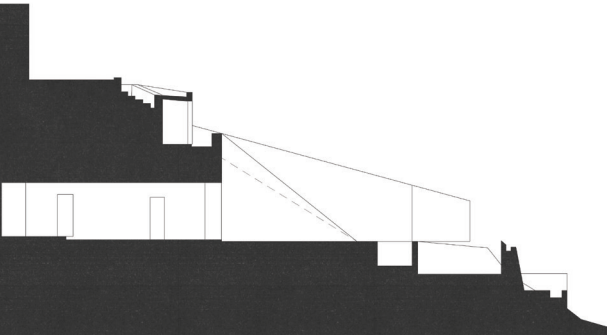
34 Can Lis, Porto Petro, Mallorca, 1971–73. Interior view showing light through stone openings
35 Can Lis section. Drawing by the author.

36 Kapsimalis Architects, Two Holiday Residences in Firostefani, Santorini, Greece, 2016–17. Construction view showing excavation of volcanic tufa
37 Two Holiday Residences in Firostefani, Santorini, Greece, 2016–17. Interior view showing vaulted spaces and apertures towards the caldera
38 Two Holiday Residences in Firostefani section. Drawing by the author.

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The Summer Cave House in Oia, Santorini, completed by Kapsimalis Architects in 2017, brings the section's renovation argument to its most elemental condition: an existing cave-house carved from the volcanic tuff of the Cycladic hillside, received for contemporary domestic inhabitation without losing the spatial conditions that the geological formation already produces. The site is a cave-house embedded in the volcanic earth — not a dwelling designed by an architect but a space shaped over time by the specific softness and carve-ability of Santorinian tuff, the same material that Chapter Two examined as the geological basis of the island's vernacular settlement intelligence.

Its spatial organization begins not from a plan but from a reading: what does this specific geological formation already produce? The vault is soft and continuous, its curves amorphous in the way that carved material is always amorphous — shaped by the resistance of the stone rather than the precision of a drawing. The architects' intervention is precisely calibrated to this condition: cement plaster applied to floor and walls in a continuous surface that "**brings out the plasticity of space**" without flattening the vault's geometry.³⁷ The technique is traditional — the same material logic that the vernacular building culture developed over centuries to finish carved stone without severing the spatial continuity between wall, vault, and floor.

The programme is distributed according to what the geological condition already organizes. This is domesticity in Corbellini's precise sense: not a comfort level but a spatial condition, the condition of a space that has been shaped by the repeated acts of living until those acts and the space are inseparable. The geological vault produces the programme. The spaces closest to the threshold — most open, most lit — receive the social programme: sitting room, kitchen. Moving deeper into the tuff, the enclosure increases and the programme follows: sleeping, bathing, the body's most private rhythms assigned to the cave's most enveloped spatial conditions. At the deepest and most enclosed point, a hammam is placed — the most intimate bodily act located at the maximum geological depth. This is the cave's own spatial logic, read and inhabited. The plan is organized around what the geological vault already produces.

The renovation's lesson is the same as Can Lis's, in a different register: that the most precise act of renovation is also the most restrained — the recognition that the geological condition already organizes the body's inhabitation, and that the architect's role is to complete that organization without substituting another. That this spatial argument now serves Santorini's mass tourism economy is the tension the thesis names honestly rather than resolves. Frampton identified the risk as structural: that the spatial intelligence of vernacular architecture, once made visible to the tourist gaze, risks absorption into what he calls "**scenic regionalism**" — the aesthetic packaging of regional identity as a product of leisure consumption.³⁸ Academic research on the Cyclades has documented this transformation in precise terms: Santorini now operates as simultaneously a living vernacular tradition and one of the Mediterranean's most heavily visited and photographed destinations, its cave architecture functioning as both spatial condition and tourist image.³⁹ The distinction the thesis draws — between the cave's spatial logic preserved and the cave's atmosphere commodified — is not always visible from the outside. The Kapsimalis renovation falls on the genuine side of this line because its spatial decisions follow the geological formation rather than performing it. The thesis's conclusion will return to this distinction at the scale of the field. Section 4.5 examines what happens when the cave's spatial logic is not received from an existing condition but conceived as communal from the outset — when the cave is a collective argument from the beginning rather than a private one adapted to shared use.

37. Kapsimalis Architects, Summer Cave House, Oia, Santorini, 2017. ArchDaily, 11 Sep 2017, [archdaily.com/879339](https://www.archdaily.com/879339).
38. Frampton, 'Towards a Critical Regionalism,' *op. cit.*, p. 21.
39. Sifaki, Varotsis, and Christou, 'Tourism and Cultural Sustainability,' *Sustainability*, vol. 14, no. 1 (2022), article 307.

4.5 The Communal Cave

The cave's communal dimension precedes its domestic one. Lewis-Williams, in his study of Upper Palaeolithic cave art, argues that the painted chambers of Lascaux, Altamira, and Chauvet were produced during collective ritual gatherings — that the cave was the original site of shared cultural production, social differentiation, and communal decision-making before it organized the rhythms of any individual family's daily life.⁴⁰ Mumford, examining the origins of collective human settlement, arrives at the same conclusion from the other direction: the gathering place, the ceremonial space, the site of shared decision-making precedes and generates the private dwelling as the primary spatial act of human culture.⁴¹ The cave was both: the first shelter and the first forum, the first house and the first assembly chamber. Ritual and domesticity, in the cave, were never separate categories — the collective preceded the private, and the spatial intelligence that organised one organised the other. The spatial logic that the preceding sections have traced in residential architecture — depth as protection, mass as climatic regulator, the calibrated threshold between private and collective space — is not a domestic logic. It is a spatial logic that the domestic appropriated. This section restores it to its other dimension.

The preceding sections of this chapter have examined the cave's spatial logic in housing, where the commitment to geological mass, topographic condition, and the calibrated aperture organizes the daily life of individuals and families. This section demonstrates that the same logic operates, with equal spatial precision, in the collective and civic programmes of contemporary design: in a wine bar carved into the Sassi of Matera, and in a former limestone quarry transformed into a performance space in the Veneto. Each case demonstrates that the cave's spatial intelligence — depth as collective enclosure, mass as acoustic and climatic regulator — is not a residential logic but a spatial one, available wherever the commitment to geological or geological-equivalent material is made in the service of public life.

Enoteca Dai Tosi, completed by Architecten De Vylder Vinck Taillieu in 2017 in the Sassi of Matera, is the most intimate case in this section and the most historically embedded: a wine bar occupying three levels of an existing cave in the same geological tuff that Chapter Two examined as the material of a vernacular settlement intelligence spanning two millennia. The architects' competition proposal was distilled to a single formulation: **"The stone for wine will be a stone of Matera."**⁴² The enoteca as a spatial and social institution — the daily gathering place of a community around wine, conversation, and the specific atmosphere of a shared underground space — is here given its most precise spatial argument: the cave is not the setting for the programme but its generator. The cave's tuff regulates the temperature at which the wine is stored and consumed; the cave's depth produces the acoustic intimacy of the space; the cave's geology is the furniture, the wine bottles resting in notches carved directly into the volcanic stone.

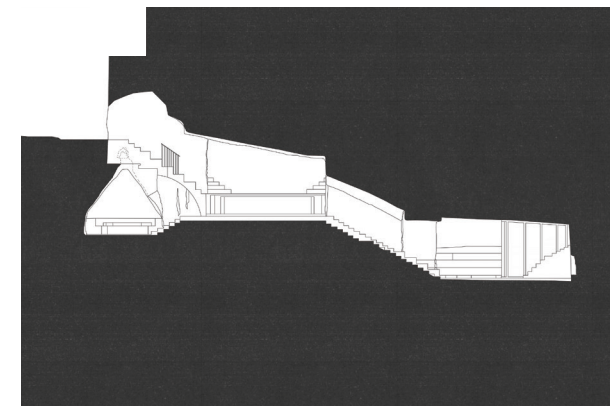
The spatial organization descends through three levels by a large tuff staircase: **"if the vault gives depth, the staircase gives the world — the staircase to the world of Sassi,"** the architects write.⁴³ The collective life of the enoteca is organized by this descent: public and convivial at the upper level, increasingly intimate and enclosed as the visitor moves deeper into the geological mass. The programme is social; the spatial generator is geological. What the cave produces — a collective atmosphere of depth, enclosure, temperature, and the specific acoustic quality of volcanic tuff — is precisely what the enoteca requires, and precisely what no purpose-built bar or restaurant could replicate.

40. Lewis-Williams, *The Mind in the Cave* (London: Thames & Hudson, 2002), pp. 196–210.

41. Mumford, *The City in History* (New York: Harcourt, Brace & World, 1961), pp. 3–10.

42. Architecten De Vylder Vinck Taillieu, competition proposal, *Enoteca Dai Tosi*, Matera, 2016. Photography: Delfino Sisto Legnani.

43. Architecten De Vylder Vinck Taillieu, project text, *Enoteca Dai Tosi*, 2017.



34 Architecten De Vylder Vinck Taillieu, *Enoteca Dai Tosi*, Matera, Italy, 2016. Interior view showing carved tuffa space
35 *Enoteca Dai Tosi* section. Drawing by the author.

34 David Chipperfield Architects, Cava Arcari, Zovencedo, Italy, 2018. Interior view showing the quarry space and new interventions
 35 Cava Arcari section. Drawing by the author.



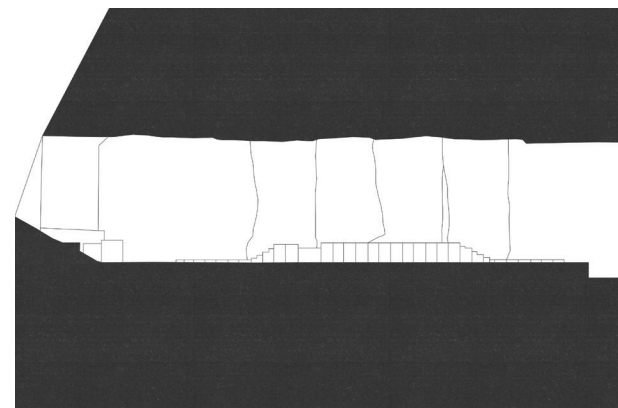
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Cava Arcari, completed by David Chipperfield Architects in collaboration with Laboratorio Morsetto in 2018 in Zovencedo, near Vicenza, is the section's largest case. The site is a former quarry of Pietra di Vicenza — the white limestone that built the Veneto, the villas of Palladio, the pavements of the historic city — whose sixty years of extraction left, when it closed, a cavernous space of irregular massive piers beneath a wooded hill. Chipperfield describes the condition precisely: **“upon entering the caves, it is possible to experience space, material and structure as one unique entity, where nature and architecture seem to imitate each other.”**⁴⁴ The quarry's geometry was not designed, it was the spatial consequence of the extraction process: as stone was removed in horizontal blocks, the remaining mass formed columns and vaults whose structural logic had been determined entirely by geological conditions and the specific angle and rhythm of the saw. The cave produced itself as it was consumed.

Chipperfield's design formalizes the existing condition as a performance space through the Cavea — terraced platforms, steps, and ramps of the same Pietra di Vicenza, added to the cave in the same material extracted from it. As the architects state: **“the stone is both added and subtracted, and the project can be seen as a continuation of the historic quarrying done on the site.”**⁴⁵ What the cave produces as a performance space is inimitable by any constructed theatre: the acoustic character is geological rather than engineered, the lighting shifts with the sun's arc across the quarry's opening rather than with a board operator's cue, and the spatial relationship between audience and performance is organized by geological formations that neither architect nor client designed. The quarry produced the shared built culture of the Veneto from its stone and now hosts, in the void that remains, the collective cultural life of the same community.

The two cases examined in this section demonstrate, at different scales and through different geological formations, that the cave's spatial intelligence is as available to collective life as to domestic inhabitation — and in some respects more precisely fitted to it. The Matera wine bar and the Vicenza quarry are not analogies of the cave. They are its continuation: spaces whose acoustic character, climatic condition, and spatial atmosphere are geological rather than designed, produced by the specific character of volcanic tuff and quarried limestone rather than by formal intention. In both cases the collective programme — the daily gathering around wine and conversation, the seasonal assembly for music and performance — is organized by the geological condition rather than merely accommodated within it. The cave does not provide a setting for the programme; it is the programme's spatial generator. What the vernacular cave demonstrated at the scale of the individual dwelling — that depth, mass, and the calibrated aperture produce a quality of inhabited space that no assembled construction can replicate — is here demonstrated at the scale of the collective gathering. The cave was not first a dwelling. It was first a meeting place. And the spatial intelligence that made it adequate to that original purpose remains available to every collective programme willing to receive what the geological condition already produces.

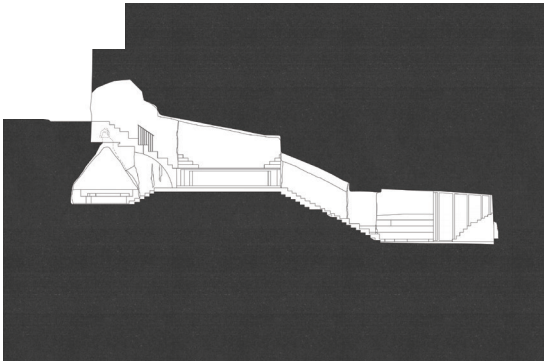
44. David Chipperfield Architects, project description, Cava Arcari, 2018. Photography: Edmund Sumner, Alessandra Chemollo.
 45. Ibid. See also *Arquitettura Viva*, 'Cavea Arcari, Zovencedo,' 2020.



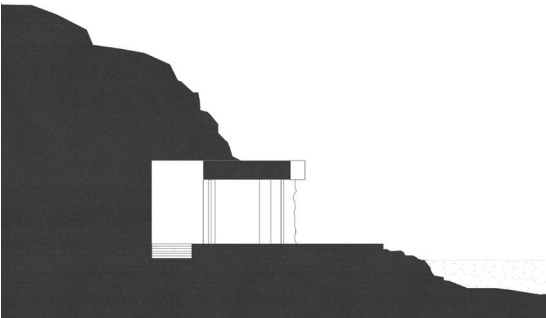
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Degrees of Subtraction

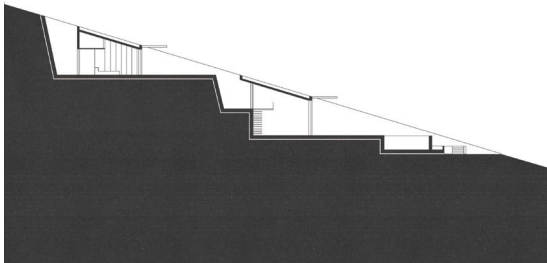
Literal Excavation



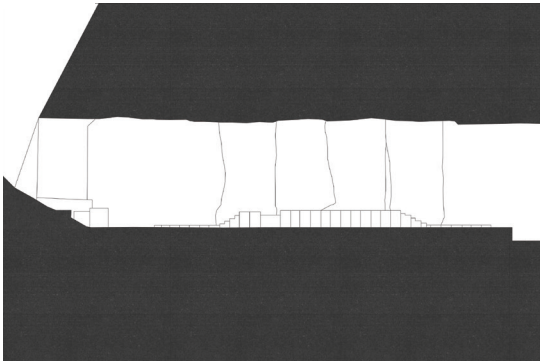
Enoteca Dai Tosi, Architecten De Vyld er Vinck Taillieu
Matera, Italy, 2017



House in Ribeira dos Moinhos, João Cepeda
Portugal, 2023



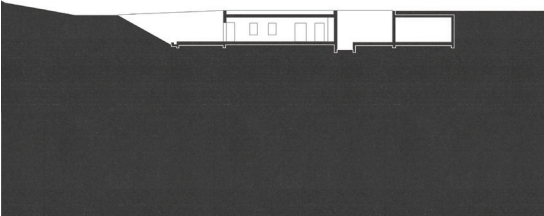
NCaved House, MOLD Architects (Iliana Kerestetzi),
Serifos, Greece, 2021



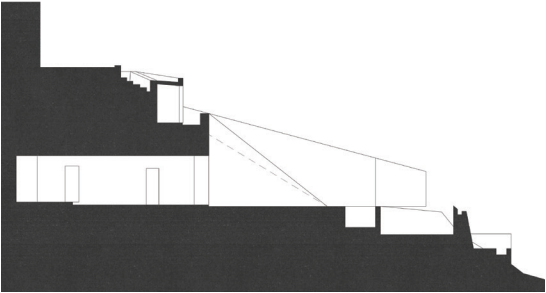
Cava Arcari, David Chipperfield Architects
and Laboratorio Morsetto, Italy, 2018

Earth Integration

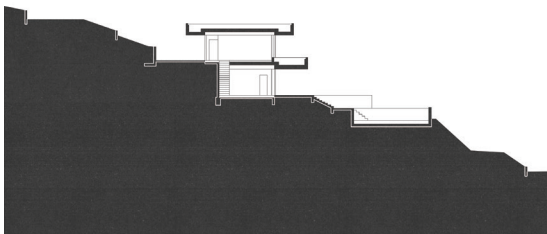
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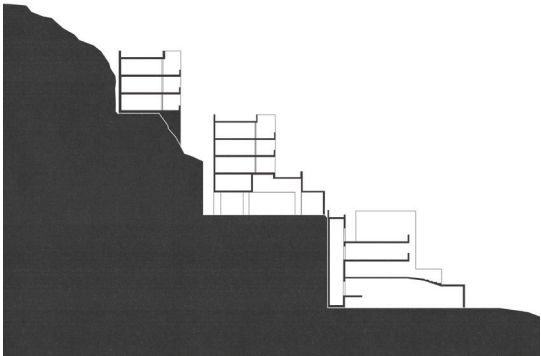
Aloni, DECA Architecture
Antiparos, Greece, 2008



The Summer Cave House, Kapsimalis Architects
Santorini, Greece, 2017



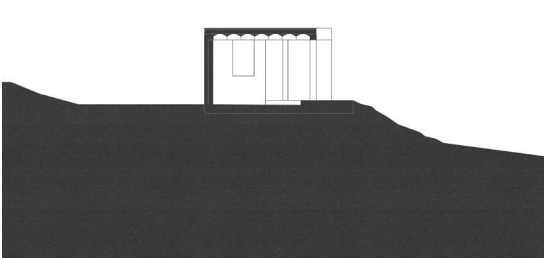
Issa Megaron, Proarh (Davor Mateković)
Vis, Croatia, 2016



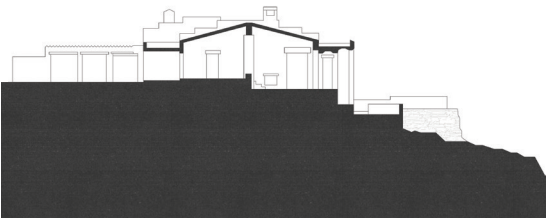
Résidence Pierre et Vacances, Ateliers Jean Nouvel,
Cap-d'Ail, France, 1991

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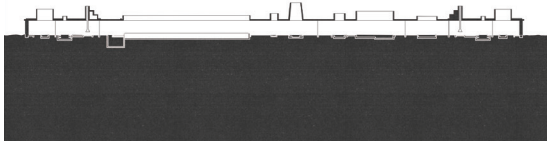
Autonomous Cave



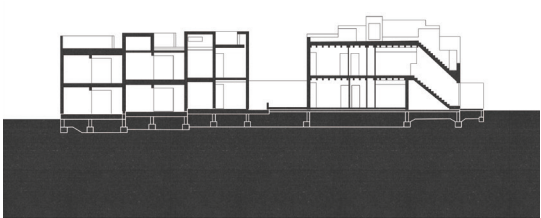
Casa Balma Murada, Mesura
Spain, 2025



Can Lis, Jørn Utzon
Porto Petro, Mallorca, 1973



Dar el Farina, Leopold Banchini Architects
and Sana Nabaha, Morocco, 2024



Social Housing, Carles Oliver (IBAVI)
Formentera, Spain, 2015

Conclusion

This thesis began from a spatial observation and a question. Standing in a carved hillside dwelling in Chenini in July 2024, with forty-five degrees of Saharan heat on the plateau outside and cool stone air within, the observation was immediate and physical: that the removal of mass produces spatial conditions no assembled construction replicates — depth, thermal stability, sensory enclosure, the calibrated aperture that admits light as an event rather than a given. The question that followed has organised the four chapters since: how does subtractive architecture generate rituals of inhabitation and resistance, and what does this spatial logic offer to contemporary architectural thinking at a moment when the dominant construction culture is organised around placelessness, surface, and mechanical environmental control? Four chapters have tested these questions across three historical and geographic fields, and through three analytical lenses that are not stages but aspects of a single argument: subtractive architecture as spatial intelligence, cave dwelling as the demonstration of that intelligence across millennia of Mediterranean inhabitation, and cave logic as a transferable way of architectural thinking that persists wherever the commitment to mass, depth, and material specificity is made — in vernacular stone, in modern brick vault, in contemporary excavated hillside, in a Parisian gallery lined with industrial paint.

The first lens — subtractive architecture as spatial intelligence — reveals what the act of removal produces and why it cannot be replicated by other means. When mass is subtracted rather than assembled, the resulting void carries within it the full spatial argument of the building: structure, enclosure, thermal regulation, and inhabited space are not coordinated decisions but a single material consequence. The cave does not treat these as separate problems. The same stone that bears weight slows airflow, stores heat, and controls humidity. The same depth that produces shadow produces coolness. The same aperture that admits light calibrates the body's awareness of time. What emerges from this integration is a specific quality of sensory and bodily experience — the touch of rough stone, the gradient from heat to cool, the compression of the threshold before the release of the interior chamber — that organises daily life into ritual without prescribing it. Heschong named this thermal delight; van Eyck named it ritualized time; Corbellini named it domesticity. They are all describing the same condition: a space so precisely calibrated to the body and its rhythms that the acts performed within it accumulate, over time, into the spatial record of a life. The bread-making ceremony in the Trullo Sovrano, the midday retreat into the deepest chamber of the Matmata dwelling, the migration through the courtyard house following the sun — these are not incidental practices but the spatial autobiography of inhabited mass. The cave does not merely contain ritual. It produces it — and is in turn produced by it. Every repeated act deepens the niche, wears the threshold, darkens the ceiling above the hearth. The space and the life within it become, over generations, inseparable.

The second lens — cave dwelling as the demonstration of this intelligence across the Mediterranean — shows that what the cave produces is neither accidental nor primitive. The vernacular settlements examined in Chapter Two — the Sassi of Matera, the pit dwellings of Matmata, the excavated cliff faces of Santorini, the courtyard networks of the Aegean — are not survivals of an earlier building culture but precise spatial responses to a specific set of geological and

climatic conditions. The shared material logic of the Mediterranean basin — calcareous rock, volcanic tufa, compressed earth — produced a shared spatial intelligence: shadow before light, mass before surface, depth before facade. What Chapter Three demonstrated is that this intelligence was not extinguished by modernity but translated by it — consciously, against the grain of the dominant machine aesthetic. Rudofsky understood that the line between cave and constructed house could not be drawn. Xenakis, designing from photographs of a Cycladic bay he could not visit, abstracted not the appearance of the vernacular but its spatial commitments. Fathy refused the concrete block standard not on stylistic grounds but on spatial ones: the malqaf, the qa'a, the courtyard are not references to the vernacular but reinventions of its environmental and social logic in the terms of contemporary need. These architects share neither a formal vocabulary nor a geographic origin. What they hold in common is a spatial conviction — that the ground is not a neutral surface on which to place a building but a material condition from which architecture is drawn, and that the specific resistance of a specific place is not a constraint to overcome but the argument from which dwelling begins.

The third lens — cave logic as a transferable way of architectural thinking — is where the thesis's argument reaches its fullest scope and its most urgent contemporary application. Cave logic, as this thesis has defined it, is not a style, not a regional tradition, and not a historical condition. It is a commitment: to the void as the primary spatial act, to the legibility of making in the finished surface, to environmental conditions understood as spatial conditions rather than engineering problems, and to the organisation of collective life around depth, threshold, and shared enclosure. This commitment is present wherever a building grows from its hillside rather than sitting upon it, wherever the material of construction carries the record of its specific ground rather than arriving from a catalogue, wherever load-bearing stone or rammed earth or excavated granite performs simultaneously as structure, climate regulator, and inhabited space. Casa Balma Murada quarries its own walls from the stone it removes. Dar el Farina follows the invisible hydraulic lines of an eleventh-century irrigation system across a flat Moroccan plain. NCaved drills into a Cycladic hillside not from necessity but from the spatial conviction that to build on the surface would be spatially wrong. IBAVI recovers a limestone construction technique abandoned by the industry for thirty years because it is the most climatically adequate response to the specific material ground of Formentera. These are not nostalgic gestures. They are architectural arguments — precise, informed, and made in full knowledge of the alternatives.

The question of resistance, which the thesis names in its subtitle and traces across all four chapters, is not a rhetorical position. It is a spatial one. To resist, in the sense the thesis develops, is to refuse the dominant spatial logic of contemporary construction — the thin envelope, the mechanical comfort system, the building that could be anywhere — by making an architecture that could only be here, from this material, in this ground. The urgency of this refusal has only increased. The construction economy organised around standardisation and surface is also the economy that has produced the largest share of global carbon emissions and the most acute crisis of inhabitation quality in the modern period. When Aziza Chaouni redesigns compressed earth construction for seismic resistance in the Haouz plain after the 2023

earthquake, the same decision Fathy made at New Gourni in 1945 is being made again — not from cultural inheritance but from architectural argument: that the specific material intelligence of a specific place is the most adequate response to a specific human need.¹ The cave's thermal and material logic is not a premodern condition to be archived. It is a spatial proposition whose ecological adequacy becomes more rather than less apparent as the consequences of a construction culture organised around placelessness grow more acute. The thesis does not propose that every building should be a cave. It proposes that every building should ask the question the cave has always answered: what does the specific topographic and material character of this place make possible, and what kind of inhabitation does that possibility open? This question opens in at least three directions that the thesis has been able to trace only at its edges. Toward the political: subtractive architecture as collective self-determination, where communities build with and from the material of their own ground rather than receiving standardised units from an indifferent industry — a practice Fathy pointed toward at New Gourni and that earthen construction movements across the contemporary Mediterranean are pursuing under conditions of far greater urgency. Toward the ecological: the full reckoning with what cave logic offers a construction culture whose carbon consequences are now existential — mass over lightness, geological material over manufactured surface, thermal inertia over mechanical conditioning. And toward the speculative: what cave logic becomes when pursued not through stone or earth but through biological or fabricated materials that share the cave's spatial commitments without its geology. These are not conclusions. They are the directions in which the cave's spatial intelligence is already moving.

This question has no final answer. It has only demonstrations. And among the most precise and most unexpected is a space constructed in Paris in 1958 by the Situationist artist Pinot Gallizio: the Caverna dell'Antimateria, a gallery entirely lined with rolls of industrial painting, its surfaces dense with pigment and resin and aromatic compounds, its tunnel perspective drawing the body forward into enclosure, its ceiling pressing down, its walls closing in.² No geological material. No hillside. No tufa, no granite, no volcanic ash. Only the spatial logic of the cave — depth, enclosure, the calibrated aperture, the body surrounded by material on every side — produced entirely through painting, in a space that was its own anti-world. Gallizio understood something the thesis has tried to argue across four chapters: that the cave is not a place. It is a way of making space that the body recognises before culture names it, and that persists wherever a maker commits to the primacy of the void, the resistance of material, and the depth that makes inhabitation possible. The cave was the first answer. What follows is the continuity of the question.

1



1. Aziza Chaouni Projects, *Anziza Chaouni Projects, Anti-Seismic Earth Brick House*, Taalat N'Yacoub, Haouz, Morocco, 2024. <https://www.azizachaouniprojects.com/haouz-house>.
2. Pinot Gallizio, *Caverna dell'Antimateria*, Galerie René Drouin, Paris, 1958–59. On the project see Claudia D'Angelo, 'Il Situazionismo dimenticato,' *Intrecci d'arte*, no. 2 (2013), pp. 118–126; and Letizia Goretti, 'Costruzione di un ambiente: dalla Caverna dell'Antimateria a Die Welt als Labyrinth,' in *Abitare. Terre Identità Relazioni* (Rome: UniversItalia, 2020), pp. 127–137.

1 Pinot Gallizio, *Une caverne de l'anti-matière*, 1958–59.

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2. Redrawn by the author.

3. Bernard Rudofsky and Luigi Cosenza, Villa Oro, Naples, 1935–37. Research Library, The Getty Research Institute, Los Angeles (920004). Published in Lessons from Bernard Rudofsky: Life as a Voyage. Basel: Birkhäuser, 2007.

4. Villa Mâche as seen from the sea, Amorgos Island, 2018. Published in The Architect is Absent: Approaching the Cycladic Holiday House. Athens: Kyklada Press, 2020. Photographer not credited.

5. View into model for Endless House, 1959. Wire-mesh, cement, plexiglass, 96.5 × 247 × 106.7 cm. Collection of Whitney Museum of American Art, New York. Published in Friedrich Kiesler 1890–1965: Inside the Endless House. Vienna: Böhlau, 1997.

6. Matmata pit dwelling, Tunisia. Photo: Son Tung Tran (CC BY).

7. Redrawn by the author.

8–9. Trullo Sovrano Casa Museo, Alberobello, Italy. Photographs by the author, 2025.

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14. Eduardo Chillida, Proyecto Tindaya, 1995. © Sucesión Eduardo Chillida. Via eduardochillida.com. Reproduced for academic purposes only.

15. Mount Tindaya, Fuerteventura, Canary Islands. Photo: Arup. Via daydreamtourist.com. Reproduced for academic purposes only.

16. Rachel Whiteread casting Ghost, 486 Archway Road, London, 1990. Courtesy of the artist. Via [Artsy.net](https://artsy.net). Reproduced for academic purposes only.

17. Rachel Whiteread, House, 193 Grove Road, London E3, 1993. Photo: Sue Omerod. © Rachel Whiteread. Courtesy of the artist and Gagosian. Via [Artsy.net](https://artsy.net). Reproduced for academic purposes only.

Chapter 2

1. Michael Heizer, Double Negative, 1969, Mormon Mesa, Overton, Nevada. Aerial photograph, 15 September 2016. Photo: Michael Quine / Las Vegas Review-Journal. Reproduced for academic purposes only.

2. Redrawn by the author.

3. Le Corbusier, Roq et Rob, Cap Martin, 1949. In: Kenneth Frampton, Modern Architecture: A Critical History, 4th ed. London: Thames and Hudson, 2007, p. 226, fig. 215. © FLC/ADAGP. Reproduced for academic purposes only.

4. Le Corbusier, Roq et Rob section. Redrawn by the author

5. Ensamble Studio (Antón García-Abril, Debora Mesa Molina), Ca'n Terra, Menorca, Spain, 2018–2020. The lone tree fell dramatically into the house during the construction of the carved lightwell. Photo: Iwan Baan. Via yellowtrace.com.au. Reproduced for academic purposes only.

6. Ca'n Terra, Menorca. Redrawn by the author.

7-8. Bernard Rudofsky, *Bemerkungen zum Thema Treppe* [doctoral dissertation]. Vienna: Technische Hochschule Wien, 1931. Reproduced for academic purposes only.

9-10. Le Corbusier, *Maisons Jaoul*, Neuilly-sur-Seine, 1954–56. © FLC/ADAGP. Via fondationlecorbusier.fr. Reproduced for academic purposes only.

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12. Alberto Ponis, *Hartley House*, Sardinia. Photo: Alberto Ponis. In: Sebastiano Brandolini, Alberto Ponis: *Architettura in Sardegna*, ed. Luca Molinari (Milan: Skira, 2006), p. 23. © Alberto Ponis. Via hiddenarchitecture.net. Reproduced for academic purposes only.

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15-18. Eduardo Souto de Moura, *House in Moledo*, Portugal, 1991–1998. In: Antonio Esposito and Giovanni Leoni, *Eduardo Souto de Moura: Tutte le opere*, expanded ed. (Milan: Electa, 2012), pp. 137, 139. © Eduardo Souto de Moura. Reproduced for academic purposes only.

19. Redrawn by the author.

20. Typical dense architectural formations in Santorini. Source: L. Papadopoulos collection. Published in: Katerina Ritzouli, 'Evolution of the Structural Systems of Vernacular Buildings in Santorini in Southern Greece,' *ISVS e-Journal*, vol. 5, no. 1 (December 2017), fig. 2. Reproduced for academic purposes only.

21. Redrawn by the author.

22. Redrawn by the author.

23. Hassan Fathy, *New Gourna*, Luxor, Egypt, 1946–52. Street view. Photo: Roger Viollet. © All rights reserved. Via architectureindevelopment.org. Reproduced for academic purposes only.

24. Frank Lloyd Wright, *Fallingwater*, Mill Run, Pennsylvania, 1936–39. Boulder at hearth. Photo: Ezra Stoller © Esto. In: *Fallingwater: Frank Lloyd Wright's Romance with Nature*. New York: Universe / Fallingwater–Western Pennsylvania Conservancy, 1996, p. 60, fig. 53. Reproduced for academic purposes only.

25. Redrawn by the author.

26. Sketch by the author.

27. Redrawn by the author.

28–29. Álvaro Siza, *Quinta da Malagueira*, Évora, Portugal, 1977–1997. Photographs by the author, 2024

30. Redrawn by the author.

31–32. In: *Sotto Napoli: idee per la città sotterranea*. Naples: Electa Napoli, 1988, pp. 46, 44. Reproduced for academic purposes only.

33. Redrawn by the author.

p.60–62 *Mass and Void Abacus*. Sections redrawn by the author at comparative scale.

Chapter 3

1. Sketch by the author.

2. Redrawn by the author.

3-4. Photo: Elina Loukou. In: *The Architect is Absent: Approaching the Cycladic*

Holiday House. Athens: Kyklada Press, 2020, pp. 36-37. Reproduced for academic purposes only.

5. Lia Bellou and Grigoris Diamantopoulos *devant le grand coffrage*. Archives Mâche. In: Lucile Arnoux-Farnoux, ed., *Le double voyage: Paris–Athènes (1945–1975)*. Athens: École française d'Athènes, 2021. Reproduced for academic purposes only.

6. Redrawn by the author.

7. Friedrich Kiesler, *Model for Endless House*, 1959. Wire-mesh, cement, plexiglass, 96.5 × 247 × 106.7 cm. Collection of Whitney Museum of American Art, New York. Gift of Lillian Kiesler (98.8). In: *Friedrich Kiesler 1890–1965: Inside the Endless House*. Vienna: Böhlau, 1997, p. 139, fig. 154. Reproduced for academic purposes only.

8. Friedrich Kiesler, *Model for Endless House*, 1959. Wire-mesh, cement, working process. In: *Friedrich Kiesler 1890–1965: Inside the Endless House*. Vienna: Böhlau, 1997, p. 139, fig. 155. Reproduced for academic purposes only.

9. Redrawn by the author.

10. Le Corbusier, *Maisons Jaoul*, Neuilly-sur-Seine, 1954–56. Photo: a+t research group, October 2018. Via aplust.net. Reproduced for academic purposes only.

11. Eduardo Souto de Moura, *House in Moledo*, Portugal, 1991–1998. Photo: Hisao Suzuki. Via arquitecturaviva.com. Reproduced for academic purposes only.

12–13. Sergison Bates, *Casa Voltes*. Photo: David Grandorge. Via *The Architects' Journal*, architectsjournal.co.uk. Reproduced for academic purposes only.

14. Redrawn by the author.

15. Frank Lloyd Wright, *Jacobs House II (Solar Hemicycle)*, Middleton, Wisconsin, 1946–48. South façade. Photo: Ezra Stoller © Esto. Via DASH, journals.open.tudelft.nl. Reproduced for academic purposes only.

16. Redrawn by the author.

17. Hassan Fathy, *House in Sidi Krier*, Alexandria, Egypt, 1971. Photo: © Christopher Little, Chant Avedissian. Courtesy Aga Khan Trust for Culture. Via ofhouses.com. Reproduced for academic purposes only.

18. Redrawn by the author.

19. Josep Lluís Sert, *Casa Sert*, Ibiza, 1968. Zalewski and Sert houses, overall view. Photo: F. Català Roca (AF). In: Josep M. Rovira i Gimeno, José Luis Sert (1901–1983). Milan: Electa, 2000, p. 120. Reproduced for academic purposes only.

20. Redrawn by the author.

21–23. Costantino Nivola, *Vined Orani*, Orani, Sardinia. Courtesy Museo Nivola. Via designboom.com. Reproduced for academic purposes only.

Chapter 4

p.87 – Degrees of Subtraction Diagram

1. João Cepeda, *House in Ribeira dos Moinhos*, Portugal, 2023. The living room reconciles with nature. Photography: Rendergram. Via joaocepeda.com. Reproduced for academic purposes only.

2. João Cepeda, *House in Ribeira dos Moinhos*, Portugal, 2023. Interior view showing skylight. Photography: Rendergram. Via joaocepeda.com. Reproduced for academic purposes only.

3. *House in Ribeira dos Moinhos* section. Drawing by the author.

4. João Cepeda, *House in Ribeira dos Moinhos*, Portugal, 2023. Exterior view overlooking the river stream. Photography: Rendergram. Via joaocepeda.com. Reproduced for academic purposes only.

5. MOLD Architects (Iliana Kerestetzi), *NCaved House*, Serifos, Greece, 2021. Interior view showing stone walls and aperture towards the Aegean. Photo: Yiorgis Yerolymbos and Panagiotis Voumvakis. Via moldarchitects.com. Reproduced for academic purposes only.

6. MOLD Architects (Wiliama Kerestetzi), *NCaved House*, Serifos, Greece, 2021. Aerial

view showing excavated volumes within the hillside. Photo: Yiorgis Yerolymbos and Panagiotis Voumvakis. Via moldarchitects.com. Reproduced for academic purposes only.

7. NCaved House section. Redrawn by the author.

8. MOLD Architects (Iliana Kerestetzi), NCaved House, Serifos, Greece, 2021. Aerial view showing the house within its coastal landscape. Photo: Yiorgis Yerolymbos and Panagiotis Voumvakis. Via moldarchitects.com. Reproduced for academic purposes only.

9. Proarh (Davor Mateković), Issa Megaron, Vis, Croatia, 2016. Exterior view showing stone drywall and landscape. Via archisearch.gr. Reproduced for academic purposes only.

10. Proarh (Davor Mateković), Issa Megaron, Vis, Croatia, 2016. Conceptual diagram: cave + Issa Megaron + stone drywall. Via archisearch.gr. Reproduced for academic purposes only.

11. Issa Megaron section. Redrawn by the author.

12. Proarh (Davor Mateković), Issa Megaron, Vis, Croatia, 2016. Exterior view showing terraced structure. Photo: Miljenko Bernfest, Damir Fabijanić. Via proarh.hr. Reproduced for academic purposes only.

13. Proarh (Davor Mateković), Issa Megaron, Vis, Croatia, 2016. Exterior view showing roof and landscape integration. Photo: Miljenko Bernfest, Damir Fabijanić. Via proarh.hr. Reproduced for academic purposes only.

14. DECA Architecture, Aloni, Antiparos, Greece, 2008. Aerial view showing the house within the terraced hillside landscape. Photo: Julia Klimi and Erieta Attali. Via deca.gr. Reproduced for academic purposes only.

15. DECA Architecture, Aloni, Antiparos, Greece, 2008. Aerial view showing roof and courtyard organisation. Photo: Julia Klimi and Erieta Attali. Via deca.gr. Reproduced for academic purposes only.

16. Aloni section. Redrawn by the author.

17. Jean Nouvel (Ateliers Jean Nouvel), Résidence Pierre et Vacances, Cap-d'Ail, France, 1988–1991. Exterior view showing integration into the cliff. Via jeannouvel.com. Reproduced for academic purposes only.

18. Jean Nouvel (Ateliers Jean Nouvel), Résidence Pierre et Vacances, Cap-d'Ail, France, 1988–1991. View showing terraced facades and landscape. Via jeannouvel.com. Reproduced for academic purposes only.

19. Résidence Pierre et Vacances section. Redrawn by the author.

20. Mesura, Casa Balma Murada, Mediterranean Coast, 2025. Exterior view showing stone walls and rocky landscape. Photo: Rory Gardiner. Via misura.eu. Reproduced for academic purposes only.

21. Casa Balma Murada, physical model. Photo: Rory Gardiner. Via misura.eu. Reproduced for academic purposes only.

22. Casa Balma Murada section. Drawing by the author.

23. Mesura, Casa Balma Murada, 2025. Diagram showing stone extraction from site for use in construction. Via misura.eu. Reproduced for academic purposes only.

24. Mesura, Casa Balma Murada, 2025. Construction diagram. Via misura.eu. Reproduced for academic purposes only.

25. Mesura, Casa Balma Murada, Mediterranean Coast, 2025. Exterior view showing facade and natural reserve. Photo: Rory Gardiner. Via misura.eu. Reproduced for academic purposes only.

26. Leopold Banchini Architects and Sana Nabaha, Dar el Farina, Morocco, 2024. Construction view showing rammed earth walls. Photo: Rory Gardiner. Via divisare.com. Reproduced for academic purposes only.

27. Leopold Banchini Architects and Sana Nabaha, Dar el Farina, Morocco, 2024. Interior view showing spatial sequence and skylight. Photo: Rory Gardiner. Via divisare.com. Reproduced for academic purposes only.

28. Leopold Banchini Architects and Sana Nabaha, Dar el Farina, Morocco, 2024. Exterior view showing the house within the arid landscape. Photo: Rory Gardiner. Via divisare.com. Reproduced for academic purposes only.

29. Dar el Farina section. Redrawn by the author.

30. Carles Oliver (IBAVI), Social Housing, Formentera, Spain, 2015. Exterior view

showing posidonia insulation and stone construction. Photo: José Hevia. Courtesy of IBAVI (Instituto Balear de la Vivienda). Via cinecine.europa.eu. Reproduced for academic purposes only.

31. Social Housing, Formentera section. Redrawn by the author.

32. Jørn Utzon, Can Lis, Porto Petro, Mallorca, 1971–73. Exterior view from the sea showing the house on the cliff. Photo: © Henning Larsen. Via divisare.com. Reproduced for academic purposes only.

33. Jørn Utzon, Can Lis, Porto Petro, Mallorca, 1971–73. Interior view showing marès stone walls and apertures. Photo: Chen Hao. Via divisare.com. Reproduced for academic purposes only.

34. Jørn Utzon, Can Lis, Porto Petro, Mallorca, 1971–73. Interior view showing light through stone openings. Photo: Torben Eskerod and Bent Ryberg. Via architecturaviva.com. Reproduced for academic purposes only.

35. Can Lis section. Redrawn by the author.

36. Kapsimalis Architects, Two Holiday Residences in Firotstefani, Santorini, Greece, 2016–17. Construction view showing excavation of volcanic tufa. Photo: Yiorgos Kordakis. Via kapsimalisarchitects.com. Reproduced for academic purposes only.

37. Kapsimalis Architects, Two Holiday Residences in Firotstefani, Santorini, Greece, 2016–17. Interior view showing vaulted spaces and apertures towards the caldera. Photo: Yiorgos Kordakis. Via kapsimalisarchitects.com. Reproduced for academic purposes only.

38. Two Holiday Residences in Firotstefani section. Redrawn by the author.

39. Architecten De Vylder Vinck Taillieu, Enoteca Dai Tosi, Matera, Italy, 2016. Interior view showing carved tufa space. Photo: Delfino Sisto Legnani. Via divisare.com. Reproduced for academic purposes only.

40. Enoteca Dai Tosi section. Redrawn by the author.

41. David Chipperfield Architects, Cava Arcari, Zovencedo, Italy, 2018. Interior view showing the quarry space and new interventions. Photo: Alessandra Chemollo, Simon Menges. Via davidchipperfield.com. Reproduced for academic purposes only.

42. Cava Arcari section. Redrawn by the author.

p.122 –123 Degrees of Subtraction abacus. Sections redrawn by the author at comparative scale.

Conclusion

1. Pinot Gallizio (Giuseppe Gallizio), assisted by Giors Melanotte (Piergiorgio Gallizio), Une caverne de l'anti-matière, 1958–59. © Galleria Nazionale d'Arte Moderna e Contemporanea, Roma, inv. 18125. Photo: MCBA, Etienne Malapert. Via Il Giornale dell'Arte, ilgiornaledellarte.com. Reproduced for academic purposes only.

