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Inhabiting the quarry. Strategies for recovery. Projects for Cutrofiano

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Abstract

The research adopts an interdisciplinary approach to the recovery and adaptive reuse of extractive landscapes, with a specific focus on the quarry system of Cutro-fiano, in the Salento area (Southern Italy). The work operates within a theoretical and operational framework that interweaves architecture, geology, ecology, and anthro-pology, aiming to define strategies and tools for the sustainable transformation of disused quarry sites into ecological, cultural, and energy infrastructures. The thesis is based on the assumption that the quarry represents a radical form of landscape, where the matter of the earth and the form of the project meet, offering a reflection on contemporary ways of inhabiting the world. The research reconstructs a critical framework on the meaning of the “quarry landscape” where nature and artifice, economy and morphology overlap. Through the phenomenology of space, the quarry is interpreted as a form of knowledge, an archive of relations, and a generative device. It constitutes the negative of the city and its ontological counterpart, in a reciprocity that unites the constructive and geological dimensions of the territory. The thesis defines an interdisciplinary method of interpretation. The multicriteria analysis developed for the case of Cutrofiano made it possible to identify areas of vulnerability and potential transformation, assessing the stability of the quarry fronts, the environmental characteristics, and the prospects for accessibility and reuse. The methodology, conceived as an open and transferable matrix, proposes a replicable model applicable to other Mediterranean contexts characterized by similar morphological and socio-economic conditions. On the operational level, the research materializes in the regeneration project articulated into three complementary strategies: the transformation of the quarry into a flood-control basin, conceived as an instrument for risk mitigation and sustainable water management; the conversion of the quarry floor into an energy park; and the design of cultural spaces intended for collective use and for the enhancement of the territory’s identity and heritage.

Cover: Cutrofiano Quarry - view from inside a tunnel toward the quarry floor. Drawing by the author.

Angelo Ganazzoli

02 Inhabiting the Quarry. Strategies for Recovery | Projects for Cutrofiano

D.R.S.A.T.E.

Doctor in Risk And Environmental, Territorial and Building Development

Coordinator: Prof. Francesco Fiorito

XXXVIII CYCLE
Curriculum: CEAR-09/A, GEOS-02/B

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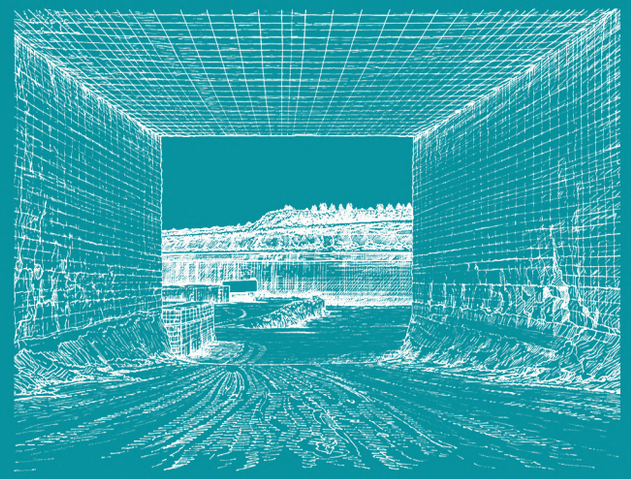

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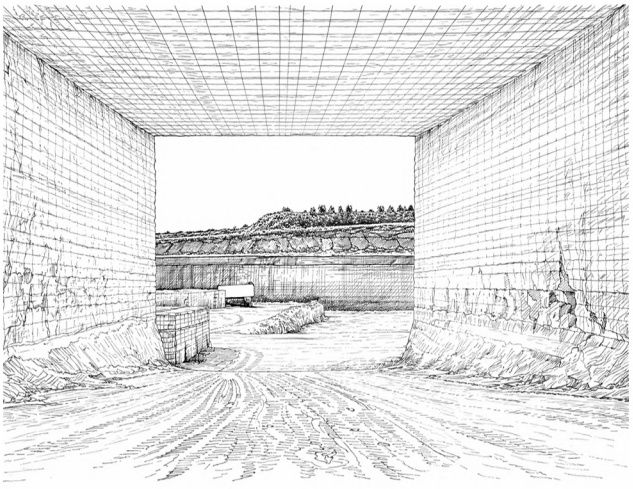

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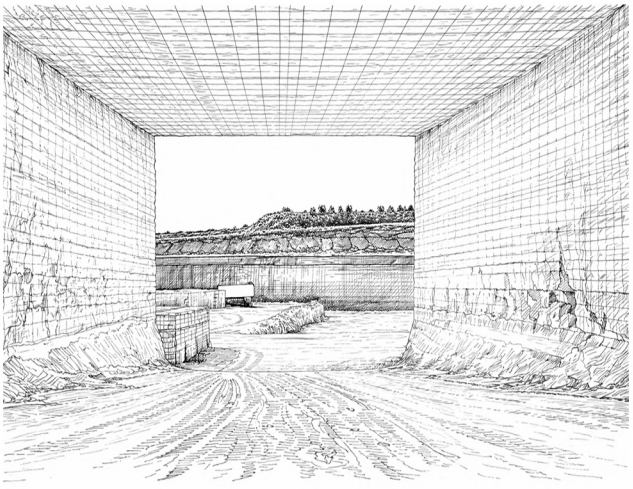

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Abitare la Cava. Strategie per il Recupero Progetti per Cutrofiano

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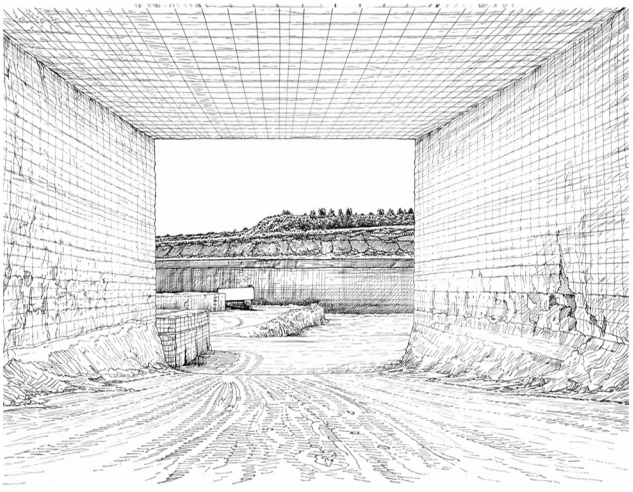

EXTENDED ABSTRACT *(eng)*

The research adopts an interdisciplinary approach to the recovery and adaptive reuse of extractive landscapes, with a specific focus on the quarry system of Cutrofiano, in the Salento area (Southern Italy). The work operates within a theoretical and operational framework that interweaves architecture, geology, ecology, and anthropology, aiming to define strategies and tools for the sustainable transformation of disused quarry sites into ecological, cultural, and energy infrastructures. The thesis is based on the assumption that the quarry – a space of subtraction, labor, and memory – represents a radical form of landscape, where the matter of the earth and the form of the project meet, offering a reflection on contemporary ways of inhabiting the world. The investigation unfolds across three complementary levels: theoretical, analytical, and design-oriented. On the theoretical level, the research reconstructs a critical framework on the meaning of the "quarry landscape" as both a material and symbolic construct, where nature and artifice, economy and morphology overlap. Through a dialogue with the philosophy of landscape, the phenomenology of space, and the Italian tradition of territorial design, the quarry is interpreted as a form of knowledge, an archive of relations, and a generative device. It constitutes the "negative" of the city and its ontological counterpart, in a reciprocity that unites the constructive and geological dimensions of the territory.

On the analytical level, the thesis defines an interdisciplinary method of interpretation. The multi-criteria analysis developed for the case of Cutrofiano made it possible to identify areas of vulnerability and potential transformation, assessing the stability of the quarry fronts, the environmental characteristics, and the prospects for accessibili-

ty and reuse. The result is a complex mapping that restitutes the quarry as an organism in dynamic equilibrium between natural processes and human interventions. The methodology, conceived as an open and transferable matrix, proposes a replicable model applicable to other Mediterranean contexts characterized by similar morphological and socio-economic conditions.

On the operational level, the research materializes in the regeneration project of the V.F. CAVE s.r.l. site, articulated into three complementary strategies: the transformation of the open-pit quarry into a flood-control basin, conceived as an instrument for risk mitigation and sustainable water management; the conversion of the quarry floor into an energy park; and the design of cultural spaces intended for collective use and for the enhancement of the territory's identity and heritage. These interventions do not represent separate solutions but rather the outcomes of a single design logic: the modelling of the ground as a practice of recomposition, the restitution of the void as an active spatial element, and the reconciliation between the natural and the artificial dimensions.

The thesis thus contributes to redefining the contemporary meaning of the extractive landscape, transforming it from a space of loss into a heritage of design, from a territorial wound into an infrastructure for future inhabitation. In this perspective, Cutrofiano becomes a paradigm of a renewed alliance between humankind and the earth, in which scientific knowledge, cultural memory, and architectural design merge to generate new scenarios of coexistence and care. The project does not merely intervene on a specific site but proposes a model of reading, interpretation, and transformation of the landscape that restores value to the excavated matter, reintroducing it into the vital cycle of territory and culture.

Keywords

Quarry landscape; Ground architecture; Extraction basins; Matter; Memory

EXTENDED ABSTRACT *(ita)*

La ricerca affronta in modo interdisciplinare il tema del recupero e della rifunzionalizzazione dei paesaggi estrattivi, con particolare riferimento al sistema di cave di Cutrofiano, nel Salento. Il lavoro si colloca in un ambito di indagine teorico e operativo che intreccia architettura, geologia, ecologia e antropologia, con l'obiettivo di definire strategie e strumenti per la trasformazione sostenibile dei siti di cava dismessi in infrastrutture ecologiche, culturali ed energetiche. La tesi assume come presupposto che la cava – spazio della sottrazione, del lavoro e della memoria – rappresenti una forma radicale di paesaggio, in cui la materia della terra e la forma del progetto si incontrano, restituendo una riflessione sull'abitare contemporaneo.

L'indagine si articola in tre livelli complementari: teorico, analitico e progettuale. Sul piano teorico, la ricerca ricostruisce un quadro critico sul significato del "paesaggio di cava" come costruzione materiale e simbolica, in cui si sovrappongono natura e artificio, economia e morfologia. Attraverso un dialogo con la filosofia del paesaggio, la fenomenologia dello spazio e la tradizione italiana del progetto di territorio, la cava viene interpretata come forma di conoscenza, archivio di relazioni e dispositivo generativo. Essa costituisce il "negativo" della città e il suo completamento ontologico, in una reciprocità che unisce la dimensione costruttiva e quella geologica del territorio. Sul piano analitico, la tesi definisce un metodo di lettura interdisciplinare. L'analisi multicriteriale sviluppata per il caso di Cutrofiano ha consentito di individuare le aree di vulnerabilità e di potenziale trasformazione, valutando la stabilità dei fronti, le caratteristiche ambientali e le prospettive di fruibilità. Il risultato è una mappatura complessa, che restituisce la cava come organismo in equilibrio dinamico tra proces-

si naturali e azioni antropiche. La metodologia, concepita come matrice aperta e trasferibile, propone un modello replicabile in altri contesti mediterranei caratterizzati da analoghe condizioni morfologiche e socio-economiche. Sul piano operativo, la ricerca si concretizza nel progetto di rigenerazione del sito V.F. CAVE s.r.l., articolato in tre strategie complementari: la trasformazione della cava a fossa in bacino di laminazione, dispositivo per la mitigazione del rischio e la gestione sostenibile delle acque; la riconversione del piano di cava in parco energetico; e la progettazione di spazi culturali destinati alla fruizione collettiva e alla valorizzazione identitaria del territorio. Questi interventi non rappresentano soluzioni separate, ma esiti di una medesima logica: la modellazione del suolo come pratica di ricomposizione, la restituzione del vuoto come spazio attivo e la riconciliazione tra la dimensione naturale e quella artificiale.

La tesi contribuisce così a ridefinire il significato contemporaneo del paesaggio estrattivo, trasformandolo da spazio di perdita a patrimonio di progetto, da ferita territoriale a infrastruttura per l'abitare futuro. Cutrofiano, in questa prospettiva, diventa un paradigma della possibilità di una nuova alleanza tra l'uomo e la terra, in cui la conoscenza scientifica, la memoria culturale e il disegno architettonico si fondono per generare scenari di coesistenza e di cura. Il progetto non si limita a intervenire sul luogo, ma propone un modello di lettura, interpretazione e trasformazione del paesaggio che restituisce valore alla materia scavata, restituendola al ciclo vitale del territorio e della cultura.

Keywords

Paesaggio di cava; Architettura di suolo; Bacini di estrazione; Materia; Memoria

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INTRODUCTION

The quarry, in its deepest ontology, represents the point where human action penetrates the Earth's material, carving it, hollowing it out, and shaping it according to a logic of habitation, production, and technical mastery. It exists, simultaneously, in the dichotomy between above and below ground, a place of extraction and subtraction, of construction and loss. Within the quarry, a double metamorphosis occurs: that of the stone, which becomes the material for building architecture, and that of the landscape, which, altered and marked by stone extraction, acquires a new morphological and, yet, symbolic configuration. It is in this ambiguity – between artifice and nature, between use and abandonment, between resource and wound – that the theme of this research is rooted: recognizing and reinterpreting the quarry landscape as a habitable form, as an ecological and cultural infrastructure of the contemporary territory. In recent decades, the end of many extractive activities in Italy and Europe has left a constellation of voids in the landscape: suspended spaces, uncertain margins, geographical shadow cones in which the memory of labor and the materiality of the earth intertwine in a state of latency. These legacies (or waste) of modernity – to use an expression dear to Georges Didi-Huberman[1] – today offer themselves as archives of as yet unexpressed possibilities. No longer just places of material production, but fields of experimentation for a new way of conceiving the relationship between nature, technology, and design. As Georg Simmel already intuited in his famous essay “Die Ruine” (1911)[2], although referring to different assumptions, but reaching conclusions that are appropriate to the theme under examination, when the work of man and that of nature overlap, a third landscape is born, charged with aesthetic and cognitive tension. The quarry, although not a constructed architecture, but rather a post-productive state, belongs to the category theorized by the German philosopher of "active ruins", configuring itself not so much as the carcass of a historical, political, and cultural testimony, but rather as a generative space.

The research is therefore based on a threefold hypothesis. First, that the quarry landscape can be considered a heritage not only for its geological, historical, or cultural value, but as a complex spatial structure capable of accommodating new

forms of habitation, energy, and knowledge. Second, that architectural design – understood as a critical form of territorial interpretation – can operate within these voids not as a simple operation of recovery or repurposing, but as an act of morphological and poetic retranslation. Finally, that the act of inhabiting the quarry qualifies as a paradigmatic tool for engaging with a radical condition of being[3]: a dwelling "in negative", excavated, removed from direct light, yet capable of revealing an archaic and cosmogonic dimension of the relationship between humanity and the land it inhabits. "Inhabiting the quarry", therefore, becomes a metaphor as well as a strategic direction: a metaphor for the reconciliation between the *pars construens,* which pertains to the structuring of urban spaces, and the *pars destruens,* which refers to natural places, between the phenomenology of technology and the resilient component of natural places. It manifests itself as a design strategy for the sustainable transformation of abandoned landscapes, consistent with the principles of the European Green Deal and the New European Bauhaus, which promote an aesthetic of ecology, regeneration, and enduring beauty. The underlying question that drives the research concerns how design can restore meaning and form to what remains: how can architecture inhabit the void, give measure to absent matter, and bring out the memory of stone without replicating the extractive logic that generated it? In the specific case of Cutrofiano, in the heart of Salento, which represents a case study and experiment, the research is rooted in a context where stone and man have for centuries enjoyed a symbiotic relationship of production and identity. The ancient "tajate" (stone quarries) demonstrate the continuity between the agricultural surface and the cultivated subsoil, between the Mediterranean light and the mineral shadows cast by excavation. The progressive decommissioning of the quarries has created a system of voids that today constitutes a potential network of landscapes to be reinhabited, according to the principles of environmental mitigation, cultural valorization, and energy innovation. Cutrofiano thus becomes an emblematic laboratory for a widespread problem, offering opportunities for reflection and exploration on how to transform the landscape of extraction into a landscape of care.

In this sense, the thesis has a dual objective: on the one hand, it intends to construct a theoretical and critical framework for the meaning of dwelling in relation to – or by virtue of – the cavity created by the removed material, through a dialogical approach with the disciplines of geology, landscape, geography, architecture, and environmental aesthetics (from Heidegger to Norberg-Schulz, from Berque to Augé)[4]; on the other, it intends to formulate verifiable design strategies for the recovery and regeneration of the abandoned Cutrofiano quarries, hybridizing contemporary architectural practices with geological knowledge and multi-criteria analysis tools placed at the service of a multi-inter-transdisciplinary method of inquiry. The research therefore moves between two complementary extremes: the theory of the void and the practice of design, in the belief that only through design – understood as an act of knowledge – is it possible to transform the wound into form, the removal into a resource, the cavity into material to be inhabited.

Thus conceived, the thesis is situated within a broad disciplinary framework, in which architecture engages with geology, ecology, the philosophy of technology, and landscape anthropology. It aims not only to provide a practical contribution to the regeneration of quarry sites, but also to propose a more general reflection on the fate of vulnerable territories in the Anthropocene: on how, in an era marked by resource depletion and changing natural and climatic conditions, design can become an act of restitution and reconciliation between humanity and the earth.

In these terms, and in relation to the object of this research, the Salento landscape represents one of the most emblematic expressions of the relationship between geology and Mediterranean habitation. It is a territory where the geolithological structure, in addition to manifesting itself as a complex and multilayered physical substrate, is a generative engine of forms[5], settlements, and building languages. The calcarenite slab that emerges in the countryside of Melpignano, Cursi, Martano, and Cutrofiano has for centuries provided the raw material for the architecture of Lecce, delineating an anthropogeographic model of significant interest, where the practices of dwelling, building, and farming interpenetrate in a continuity of gestures, rituals, and knowledge. As Paul Vidal de la Blache observed, each region defines itself as a

«physiognomy of the relationship between man and the land»[6] – and Salento, more than any other part of Italy, embodies this physiognomy in a tangible and manifest way. The karst and stratified morphology of the Salento peninsula has created a sequence of landscapes that alternate the hardness of compact stones with the evanescence of soft sands and calcarenites. The latter, locally known as Lecce stones or tuffs, have generated a widespread economy of small-scale extraction, intimately connected to rural self-construction and stone crafts. Over the centuries, Salento has developed a veritable ecosystem of stone working, based on short cycles, local materials, and excavation techniques adapted to the coexistence of built and vegetated terrain above ground. Therefore, the quarries, often hidden among olive groves or concealed beneath farmhouses, create an invisible geography – that of emptiness – that overlaps – or is subsumed – by – the agricultural one, like an underground network of artificial spaces.

It is within this dialectic between surface and depth that the territory of Cutrofiano is located, a hub of a geomorphological system that embraces the western edge of the Serra di Supersano and extends towards the Galatina plain. Here, the land is composed of alternating calcarenites and clays, whose workability has favored both ceramic production – documented since the 16th century – and the development of systematic mining activity in the 19th and 20th centuries[7]. During this period, the Cutrofiano quarries took on the form of pits or underground chambers, creating spaces excavated with rigor and precision, combining production efficiency and artisanal sensitivity, and generating places and environments of remarkable spatiality. Their presence has profoundly impacted the configuration of the landscape and local identity, defining a stratified cultural landscape, in which the memory of the land ends up coinciding with the memory of man's tenacious work, yet which abandonment has obliterated. From a geographical perspective, Cutrofiano today represents a paradigmatic case for the analysis and design experimentation of abandoned mining landscapes. Unlike other Italian districts (such as the Carrara marble quarries or the basalt basins of Mount Etna), here the phenomenon takes on a minute, diffuse, and capillary scale: a constellation of cave systems scattered throughout the agricultural

and peri-urban fabric, often near or adjacent to housing. This proximity between productive space and residential space makes the Cutrofiano case particularly fertile for contemporary reflection on the regeneration of vulnerable territories, defining an opportunity that is not episodic, but rather programmatic: a process of systemic reconnection capable of combining, in the practice of the project, geological protection, hydrogeological mitigation, and social valorization. The investigation conducted in the Salento context thus takes on transferable methodological value, considering the settlement logic and morphology of the Cutrofiano sites as an exemplary laboratory for addressing issues common to other Mediterranean regions characterized by calcarenite or soft stone quarries, such as southern Sicily, coastal Tunisia, Greece, and part of Atlantic Portugal. In these territories, the extraction of local stone materials has created threshold landscapes, suspended between erosion and sedimentation, which today require a new design paradigm. Indeed, the approach developed in the research – based on the integrated reading of geotechnical data, historical maps, and spatial interpretations – aims to define replicable tools for the ecological and cultural regeneration of quarried voids, adaptable to diverse contexts yet sharing similar geolithological and socioeconomic conditions.

On a theoretical level, the Salento case offers the opportunity to rethink the relationship between place and project according to the perspective of "constructive geography" proposed by Augustin Berque, for whom the landscape is «an ontological intermediary between being and the environment»[8]. In the Cutrofiano quarries, this mediation is tangible: the excavated space is not merely the result of a technical gesture, but the material manifestation of an anthropological relationship with the land, a *mésocosme* in Berque's sense, where culture and the geological substratum coexist in a fragile equilibrium. The transferability of the model lies, therefore, not in the mere formal or functional replication of an intervention, but in the ability to recognize the common grammar of Mediterranean quarry landscapes: the coexistence of light and shadow, solids and voids, worked surfaces and silent depths. This implies an "ecotopian" approach – to use a term by Yi-Fu Tuan – that considers each quarry as a microcosm of environmental, social, and symbolic relationships[9]. From this perspective,

the Cutrofiano project does not limit itself to intervening on a specific site, but proposes a method of interpreting and transforming the exportable landscape, based on knowledge, measure, and care. In these terms, southern Puglia and inland Salento emerge as a study site, as well as an epistemological device that allows us to interrogate the nature of the contemporary landscape and its potential for regeneration. Through Cutrofiano, the thesis explores the possibility that a new life cycle can emerge from a state of exhaustion, and that stone, once removed and then abandoned, can once again become a source of form, energy, and meaning for future habitation.

Over the past thirty years, the topic of reclamation and repurposing of quarry sites has gained increasing prominence in architectural and environmental debate, both nationally and internationally, to the point of becoming one of the most fertile fields of experimentation for contemporary research. The intensification of this debate over the past decade is a direct reflection of a structural shift in the perception of quarry landscapes: from a place of productive exploitation and land consumption to a potential ecological and cultural infrastructure. This paradigm shift has resulted in the progressive development of guidelines and regulatory frameworks, which have attempted to reconcile the objectives of environmental safety with the more recent objectives of valorization and sustainable regeneration. However, most current regulations – both at the European and national levels – continue to favor a conservative and technical approach, limited to securing sites and mitigating hydrogeological risks, without providing for recontextualization strategies or long-term landscape integration programs. In this scenario, the main European regulatory framework is Directive 85/337/EEC (now incorporated into Directive 2011/92/EU and subsequent amendments, including 2014/52/EU), which regulates the environmental impact assessment (EIA) for public and private projects with significant environmental impacts, including mining activities. It requires Member States to provide compensation and environmental restoration measures for abandoned sites, encouraging the return of land to compatible and sustainable uses. At the national level, however, the regulatory framework remains fragmented and inconsistent. Royal Decree no. 1443 of 1927, still formally in force, defines the general regulation of mines and quarries, but is limited to

regulating the granting of licenses and exploitation rights, without providing for post-extractive recovery procedures. Only with Presidential Decree no. 616, administrative powers over extractive activities were transferred to the Regions, resulting in a local articulation of sector policies which, while allowing for greater adherence to territorial specificities, has generated significant regulatory inconsistency. Some Regions (such as Lombardy, Veneto, Emilia-Romagna, and Tuscany) have introduced sector plans and specific regulations for the management and redevelopment of quarries, while in other areas – particularly in Southern Italy – regulation lag, a lack of controls, and the absence of effective planning tools persist. Italy is therefore lagging behind in implementing the strategic guidelines of the European Biodiversity Strategy 2030 and the European Green Deal, which promote the transition to circular economy models, zero land consumption, and the ecological reconversion of degraded landscapes. The environmental redevelopment obligation imposed by the European directive applies in Italy only to quarries exceeding 20 hectares, effectively excluding most of the small and medium-sized sites that dot the country. According to ISTAT data (2021), in Italy there are 4,168 authorised quarries and over 14,000 disused or abandoned ones, with an uneven distribution that sees Puglia (388 active, 2,552 disused) and Sicily (442 active, 254 disused) as the regions with the highest levels of criticality in terms of land consumption, morphological alteration and landscape aggression. Although in both cases the Regional Extractive Activities Plans (PRAE) provide for the contextual recovery of active quarries, a unified system for the redevelopment of abandoned quarries and integrated strategic planning capable of linking ecological, economic and cultural dimensions is still lacking.

In contemporary Europe, a progressive shift from reactive to proactive management of the post-industrial landscape can be observed. Numerous member countries have developed guidelines that consider abandoned quarries as regenerative territorial infrastructures, designed to host public, ecosystemic, and cultural functions. In France, for example, the "Carrières et Paysages" program promoted by the Ministry of Ecological Transition has introduced integrated quarry reuse methodologies based on multilevel landscape plans and participatory processes. In the United Kingdom, the

Mineral Extraction and Restoration Strategy (DEFRA, 2018) promotes the conversion of extraction sites into natural habitats and public areas, with a strong focus on ecological restoration. In Germany, the strategy of the " Bundesamt für Naturschutz" has for years recognized quarry sites as "compensatory biotopes", that is, places where human intervention becomes an opportunity for the spontaneous regeneration of biodiversity. Spain, too, through the experiences of Castilla-La Mancha and Andalusia, has experimented with the revitalization of limestone quarries as cultural and environmental education spaces, networking local authorities, universities, and mining companies. This European framework also includes the European Commission's recent Guidelines (2020) for the promotion of the *Nature Restoration Law*, which includes abandoned mining areas among the priority objectives of renaturalization, and the New European Bauhaus program, which encourages the interaction between sustainability, aesthetics, and inclusion in territorial regeneration processes.

Compared to this international scenario, the Italian context remains fragmented, with a clear separation between environmental, urban planning, and cultural responsibilities. Quarry management policies have historically focused on the productive dimension, neglecting the spatial and social potential of excavation voids. Only recently, thanks to funding programs under the PNRR (Mission 2 "Green Revolution and Ecological Transition") and the action lines of the National Plan for Adaptation to Climate Change (PNACC), has a greater awareness emerged of the need to integrate environmental mitigation with landscape and cultural regeneration. The objective, in line with the Green Deal, is to foster the creation of sustainable productive landscapes, based on principles of ecological resilience and resilience. However, the lack of an updated national regulatory framework and unified institutional direction continues to limit the effectiveness of recovery policies. From this perspective, Italy – due to its cultural stratification, geological variety, and the density of historic quarrying sites – represents a privileged territory for investigating the relationship between architecture and geology, between the excavated landscape and the built city. Understanding the relationships between quarries and urban or rural contexts reveals the peri-urban and interstitial nature of many extractive systems, located in marginal positions, yet ca-

pable of constituting new ecological and functional hinges between city and countryside. The quarry, understood as the negative of architecture, represents a counterform of the city, its subterranean projection: what the construction elevates, the excavation sinks; what the city aggregates, the quarry disintegrates. This duality, far from being oppositional, takes the form of a mutual belonging, in which subtraction becomes a tool of knowledge and the void a new form of public space.

In recent years, design reflection on quarry landscapes has intertwined with academic and scientific research in the architectural, geotechnical, and environmental fields, generating a body of experience demonstrating how integrated design can drive territorial regeneration. Architectural experimentation has helped redefine the very meaning of reclamation: no longer merely repairing damage, but rather an active transformation that restores functional, cultural, and ecological value to the excavated material. Within this context, numerous internationally significant examples testify to contemporary architecture's growing attention to quarry sites as design spaces, and these will be analyzed in the body of this paper. These experiences, while different in scale, context, and purpose, share a common methodological tension: the assumption of the quarry landscape as a device for measuring time and form, as a field of interaction between nature and culture, between geological energy and human design. This orientation, today more than ever, is connected with the principles promoted by European programs for the green and digital transition, offering architecture the possibility of acting as a mediator between ecology and technology, between memory and innovation. The research methodology is grounded in an interdisciplinary epistemological framework, which considers the quarry – and more generally the subtracted landscape – as a complex cognitive device, in which geological, architectural, ecological, anthropological, and cultural dimensions intersect and mutually regenerate each other.

The approach adopted does not proceed through disciplinary silos, but through osmosis between fields of knowledge, constructing a field of investigation in which the morphological interpretation of the soil intertwines with architectural theory,

geotechnical characterization engages with the cultural history of the sites, and environmental analysis translates into design prefiguration. The starting assumption is that understanding a subtracted landscape cannot be entrusted to a single interpretative category, but requires a relational method capable of combining empirical and symbolic measurement, objective data and the layers of meaning that the material preserves. In this sense, research is configured as a methodological laboratory in which architecture is not only an outcome, but a tool for scientific investigation, capable of transforming observation into interpretation, and interpretation into design.

The research process unfolds through a sequence of integrated and retroactive actions: a cognitive survey, based on topographic, photogrammetric, and autoptic surveys, and the development of three-dimensional digital terrain models, aimed at reconstructing the morphological and structural features of the quarry landscape; a critical and phenomenological analysis, which combines geotechnical data with environmental, ecological, and anthropological data to create a comprehensive framework in which the quarry material is interpreted as a living, layered organism, in constant interaction with natural and cultural processes; and a design synthesis, understood as a cognitive rather than an operational act, in which the project becomes a heuristic and prefigurative device, capable of making the site's latent potential visible and translatable. The research is distinguished by its consistent integration of disciplines, combining engineering and geological knowledge with the tools of architecture, urban planning, and landscape theory. Geotechnical and structural investigations – aimed at understanding the mechanical behavior of the rock bed and the stability of the tunnels – were complemented by in-depth historical, documentary, and cartographic research, necessary to reconstruct the cultural genealogy of the landscape and the millennia-old relationship between quarrying and architectural construction. In parallel, environmental and hydrological analyses allowed us to interpret the site as a complex ecological system, in which percolation processes, spontaneous vegetation, and microclimatic variations become design elements for a new balance between nature and artifice. In this sense, the methodology does not separate the geological from the design dimension, but rather affirms their structural complementarity.

The research methodology is therefore systemic and transdisciplinary, considering the quarry landscape as a cognitive infrastructure, where mineral and cultural matter meet. It is based on the idea that architecture can constitute a common language between heterogeneous disciplines, defining a polysemantic territory of translation. The quarry, as a complex organism, thus becomes the point of convergence of a method that unites the precision and scope of the relevant sciences, configuring an approach capable of simultaneously addressing the physical, environmental, and spatial dimensions of the landscape. The proposed methodology views the act of design as an opportunity capable of activating or directing regeneration interests and policies, and strategies for adapting to climate change. Interdisciplinarity, in this sense, is an epistemic necessity: only through the interaction between geology and architecture, ecology and culture, technology and design, can extractive landscapes be restored to their former status as ecological and cultural infrastructures of the future.

1. THE QUARRY LANDSCAPE

Observing a quarry means looking at the landscape from its reverse. It is as if the familiar image of the earth, expansive and solid, were turned on itself, revealing its inner depth, its intimate internal composition, its fragility and its memory. In that hollowed-out void, the landscape manifests its nature as both a material and cultural construction. The quarry landscape is, in fact, a complex device: the result of a superposition of geological forms, technical gestures, and economic practices, which over the centuries have defined humanity's relationship with the earth's materiality. If the agricultural landscape represents the image of use, the extractive landscape is its complementary negation: a landscape of removal, of hollows, of irreversible transformation. Such a landscape, thus defined, contributes to the delineation of a "topography of absence", that is, a punctuation of places where human action does not add, but subtracts, shaping the land's shape by difference. This condition makes it one of the most radical fields of investigation for landscape design, because it expresses the categories of space, matter, time, and limit in extreme ways. Each quarry is both a section and a story: a cut in the soil that makes geological history legible, and also a testimony to the tenacity of human labor and its economies. In this sense, as Kenneth Frampton observes in outlining a "tactic of resistance" to the loss of place identity, knowledge of the landscape must begin with the material, with its physical and cultural depth[10].

The quarry landscape thus becomes an atlas of relationships between the land and the forms of civilization. This perspective implies a fundamental shift in the perspective through which it is analyzed: the quarry is no longer simply a site of exploitation, nor a relic to be reclaimed; it is established as a living, multiple, and evolving territorial structure, capable of generating new ecological and social cycles for the redemption of the reviled context in which it stands. In the post-extraction phases, when production stops, the site transitions into a state of "spontaneous morphogenesis"[11]: water, whether meteoric or spring, stagnates, collected within the basins; pioneer species, both animal and plant, colonize the faces; light transforms the walls into



Fig.1 – Quarry landscape between artifice and nature. Limestone quarry, Derbyshire. Unknown artist, late 1700s

surfaces of iridescent reflection; and the void becomes an ecosystem. The quarry, in this sense, is a laboratory for the coexistence of entropy and design, a place where matter demonstrates its capacity for reorganization, and architecture can grapple with the notion of duration rather than form.

Likewise, studying the quarry landscape also means reading a history of techniques: each type of quarry – open-pit, pit, chamber, stepped, or underground – corresponds to a different way of interpreting geology and translating it into economics. The cutting methods, the sequence of layers, the morphology of the faces are traces of a material knowledge transmitted over time. The quarry is therefore also an archive: of tools, gestures, memories, and geometries; the implicit rules of construction emerge in the stone: proportions, resistance, the rhythm of empty and full spaces. In this sense, the quarry landscape presents itself as an anticipated form of de-



Fig. 2 – Mirny diamond mine, located in the remote region of Eastern Siberia, Russia. Igor Dvurekov, CC BY-SA 3.0



Fig. 3 - Former asbestos mine in Balangero and Corio, Piedmont. RSA Archives

sign, an unconscious design – compared to the space conceived for habitation – yet rigorous, generated by necessity and refined by experience. It is precisely from this awareness that the research aims to recover the quarry as a formative and founding matrix, just as it is understood as part of a landscape in which the geometry of extraction is reversed, declining into the grammar of habitation.

From a disciplinary perspective, the quarry landscape intersects with multiple fields: geology, soil ecology, the history of techniques, architectural morphology, and the philosophy of matter. In all these fields, a single question emerges: how can the earth, once carved, still be a place? The fracture produced by extraction is not only physical, but epistemic: it interrupts the continuity of the soil and, at the same time, that of meaning, imposing an interpretative task on the project.

Following the lesson of Merleau-Ponty, who saw in the landscape "a flesh shared between man and the world"[12], the quarry appears as an extreme manifestation of this reciprocity: man cuts into the earth, but the earth in turn cuts into man, shaping his perception and culture.

The following sections explore the quarry landscape along three complementary lines: the first reflects on the quarry as a place situated between artifice and nature, yet dominated by them, where the cultural dimension of the landscape intersects with the protection of fragile territories, and the project becomes an act of mediation rather than transformation; the second addresses the relationship between caves and civilization, that is, the way in which cities and territories have developed in relation to quarrying spaces, intertwining economies, infrastructures, and architecture; the third concerns the morphology, material, and extraction techniques, the spatial logic of voids and fronts, and the processes that have shaped the different types of quarries over time.Together, these three lenses contribute to constructing an integrated reading of the extractive landscape as a form of knowledge: a field in which matter becomes language, and the earth can heal the lacerations of its disembowelment.

1.1. Place between artifice and nature

As the practice of extraction carves into the Earth's material, what was once substance transforms into form, and the landscape – in the original sense of "pays agé", inhabited and perceived territory – becomes the field where artifice and nature interpenetrate. Quarry sites, moreover, represent one of the clearest manifestations of the relationship between humanity and nature, between productive activity and landscape transformation; in them, the Earth's surface has been continually reshaped by labor, extraction, and technology, but also by time, vegetation, and natural processes of recomposition. Quarries thus manifest themselves as interfaces: contact zones where natural and artificial logics are not opposed, but overlap, giving shape to a hybrid territory. This permeability is what allows us to understand the diffusion of quarry systems across the country and testifies to a continuity between the construction of civilization and the exploitation of mineral resources. In fact, every era has shaped the soil according to its own needs: from the stone of ancient cities to the building materials of the modern age, up to the conglomerates of contemporary industry and artificial stone materials.

Moreover, as Vitruvius recalls (De Architectura, II, 1), knowledge of the nature of stones and the places from which they are quarried is the foundation of the art of building[13], and the specificity of Italian geology, with its variety of limestones, basalts, gypsums, and tuffs, determined not only the wealth of available materials but also the diversity of architectural, economic, and territorial languages. The system of quarries, distributed across hilly and coastal areas, thus accompanied the formation and expansion of settlements, influencing their location, infrastructure, and trade networks. In many cases, the quarry precedes the city: it provides the raw materials that make its construction possible. As Lewis Mumford observed (The City in History, 1961) , the city always arises in relation to a resource, and quarries, therefore, cannot be considered as spaces separate from the urban fabric, but as structural components of its economic and morphological metabolism, effectively constituting the negative of architectural construction: while the city elevates and aggregates buildings

and living systems, the quarry excavates and disperses the materials for their construction, producing two complementary forms of the same process of territorial transformation. This operation, however, has left an indelible mark on the landscape. This is due to the intensification of excavation rates, which has occurred particularly in the last two centuries, and which has led to increasing land consumption and a series of irreversible alterations: depressions, slopes, accumulations of debris, water pollution, and loss of ecological continuity. Today, abandoned quarries constitute a constellation of voids, often perceived as degraded, marginal, or waste spaces, awaiting redemption or for nature to reclaim what has been stolen from it: «it moves, adapts, reclaims what man abandons» this is what Gilles Clément wrote when imagining a garden in motion (1991)[14], and it is thus that within many abandoned quarries spontaneous processes of renaturalization can be observed: vegetation colonizes the excavated surfaces, water stagnates in the basins, fauna reclaims the spaces; what was once production infrastructure becomes habitat, and the open wound appears as a healed lesion.

These seemingly random phenomena are examples of ecological substitutes, that is, functional replacements of native ecosystems with new biotic and abiotic arrangements, generated by the specific conditions of the extraction site. In the literature, these dynamics are described as "secondary successions" or "anthropogenic successions": colonization sequences in which pioneer species, often resistant to drought and poor soils, prepare the ground for more stable communities. In calcarenite quarries, for example, the first plant forms are mosses, lichens, and rock plants; in deeper quarries or tunnels, communities adapted to shade and humidity develop. The result is a new biodiversity, non-native but nonetheless significant, demonstrating the self-organizing capacity of the ecological system. These processes challenge the traditional idea of an antithesis and a boundary between the natural and the artificial, as well as the contemporary idea of reclaiming quarry sites through revegetation as the exclusive strategic direction for environmental protection. They offer projects new opportunities to envision new models and principles for inhabiting the landscape, while also intervening to dissolve the boundaries between the urban and natural contexts

and bridging the gap between the two for territorial reorganization. It is precisely here that the complexities and critical issues of quarry design lie, namely the formulation of new relationships and orders to redefine integrated landscape management. From this perspective, Italy, due to the density of its quarry heritage, represents an ideal territory for exploring the relationships between the built city and the quarried landscape. As Bernardo Secchi writes (The City of the Twentieth Century, 2005), «the form of the city dissolves in the territories of production, and urban design must recognize the continuity between the margins and the center»[15]. This reciprocity is also manifested on the territorial level due to the fact that quarry systems are often located in marginal positions, between the city and the countryside, along transport routes , rivers, and ridges, defining spaces of transition and permeability, where urban and rural functions intermingle and where they can become reconnecting devices, capable of reestablishing a link between environmental and human systems, between the city and its supply territories. Considering the quarry as part of the urban landscape means recognizing the landscape as a dynamic system of relationships, becoming a laboratory for experimenting with forms of spatial sustainability, in which resource management is combined with the construction of new meanings.

The most recent European policies – from the Green Deal to the New European Bauhaus – clearly point to this direction: the regeneration of productive landscapes as a tool for ecological and cultural transition. Disused quarries, in particular, can be interpreted as spaces for "retro-innovation", where the legacy of the past meets contemporary technologies. The reconstruction of the fronts, controlled renaturalization, the valorization of industrial heritage, and even more so the creation of new public uses, represent the most effective strategies today for restoring vitality to these areas, while also laying the foundation for ethical speculation: that of responsibility for artifice. Every extractive activity involves extraction and alteration, but also the possibility of restitution, since designing in disused quarries means confronting the history of territorial transformations and the need to restore balance to compromised ecosystems.

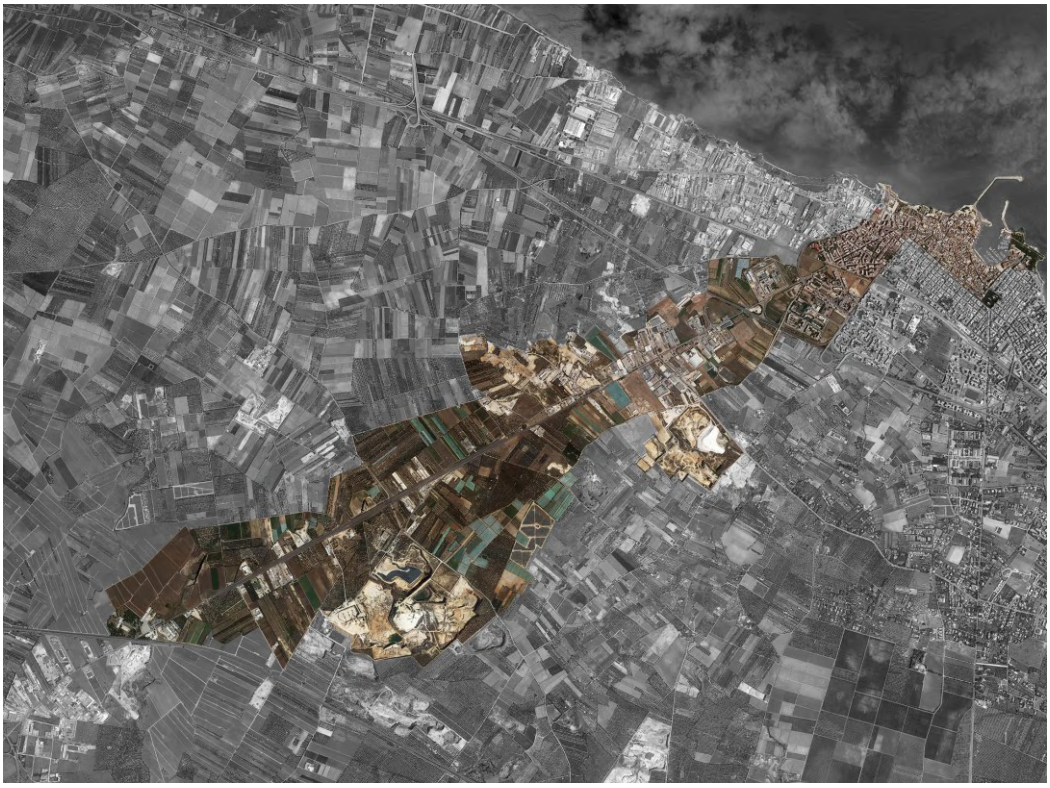

Fig. 4 – Quarry of S. Chiara, Trani. Anthropic development in mineral and vegetal territoy. Image from the author

Contemporary landscape design must therefore act as a mediating tool: not erasing the traces of mining activity, but integrating them into the life cycle of the

landscape, transforming the signs of loss into new forms of habitability. Recognizing the quarry as a landscape therefore means acknowledging the design's ability to regenerate, rather than erase, the traces of human labor in the land.

Finally, quarries represent a great opportunity to rethink the relationship between center and margin in contemporary territory. Where once perceived as residual or marginal spaces, they can now play a central role in building new ecological and cultural networks. Many recent experiences – from European mining parks to projects to reclaim abandoned quarries in Italy – demonstrate how the regeneration of these spaces can contribute not only to environmental protection but also to the con-

struction of new territorial identities. Recognizing quarries as contemporary landscapes means accepting that the project is not also a cultural gesture: caring for these spaces requires an interdisciplinary and collective approach, capable of transforming the voids of production into new hermeneutics of coexistence between humanity and the environment.

1.2. Cavitas et civitas

Every historic city is founded on the balance between two primary systems: water and stone. Since antiquity, water basins and lithological features have determined not only the location of settlements, but also their form, the structure of production networks, and the configuration of the urban landscape. Water enables life, communication, and movement; stone provides the material of permanence. Together, they define the physical and symbolic framework of habitation. If the first system regulated the relationship between the city and the fertility of the soil, the second conditioned its material construction, influencing the morphology, building typology, and the very scale of the urban landscape. From this perspective, the *cavitas* and the *civitas* do not represent two opposing realities, but two manifestations of a single territorial process. The city is built where the earth offers the possibility of being cut, extracted, and transformed in a constructive order. Every ancient city was born where the soil was both fertile and stony, where the availability of water and materials coincided with the intensity of human labor.

Italian territorial theory, from Muratori to Gregotti, has clearly interpreted this continuity. For Muratori, urban form is not an abstract composition but the sedimentation of a "working history" in which the construction process develops in direct dependence on the material and productive conditions of the site[17]. The organization of urban fabric and building types reflects the economy of materials and the proximity of quarries, and the evolution of the city is inscribed within this chain that links extraction, processing, and construction. Aldo Rossi, continuing this approach, recognizes in the urban character the permanence of types and structures that resist time, but observes that such permanence is based on a material concreteness[18]: stone, its

workability, its dimensions, and its ability to be transported. With Gregotti, the argument becomes explicit: the territory of architecture is the material extension of the project[19], and the relationship between resources and built forms is one of the keys to understanding the profound meaning of the settlement. The *cave* thus becomes the operational field within which the *civitas* recognizes and measures itself for the construction of the *urbs*, and the choice of material, its extraction, and its logistics participate directly in the construction of the urban identity. In this sense, every historic city is a lithological organism, a structure that appropriates its own mining landscape to translate it into architectural language. Quarries have been not marginal but fundamental places since antiquity because they provide not only the material but also the rule, since the format, resistance, and chroma of the stone determine the construction modules, the scale of solids and voids, the proportion of the orders, and the overall *facies* of the urban environment. The color of the city, its texture, and its compactness are the result of a constructed geology, of a technical knowledge that translates the conditions of the soil into figurative culture. Stone, even before being a symbol, is, as previously specified, structure and rule, and the connection between lithological quality, format, and transport constitutes the physical basis of the *imago urbis*. Stone resists or wears away, smoothes or crumbles, and the very form of the city depends on these characteristics: thick or thin walls, large or small openings, orders modulated according to the specific weight and strength of the materials. The size of the quarried block, its weight, and its ability to be lifted or hauled also influence the construction geometry, determining proportions and rhythms. Finally, the modes of transportation – by land, by water, or, in modern times, by rail – define the scale of construction and, in many cases, the very position of monumental areas in relation to ports or rivers.In Gregotti's interpretation, the city is not simply a collection of buildings, but the result of a series of operations that connect the territory and the architectural form. The quarry, in this sense, is not an element extraneous to the urban project, but its generative principle. It represents the primary infrastructure, both material and cultural, from which the coherence of the settlement derives. Benevolo, in his “History of the City”[20], had already highlighted how every civilization constructs its

image through the translation of matter into urban order: the "form of the city" is also the form of its materials, and every technological transformation in the field of extraction or processing has an impact on the urban morphology.

Rome is the paradigmatic example of this alliance. From its origins, the city has interpreted the geography of Lazio's lithological basins, laying its foundations on Alban and Fidenian tuff, building with peperino and Tiburtine travertine, and shaping its image on the mechanical and chromatic qualities of these stones. The *imago urbis* of Republican Rome was shaped by local materials, available in abundance and transportable by water. The introduction, during the Imperial Age, of Luni marble and oriental stone did not erase this geological foundation, but rather amplified it, enhancing through diversity and juxtaposition the stone that built the city's identity, both physically and intangibly, and through materiality also defining the social, political, and civilizational paradigms of Roman civilization. Rome became the capital of the Mediterranean lithological basins: a hub coordinating quarries, ports, and construction sites, a center of consumption reflected in the monumentality of its forums and basilicas. As Carandini has pointed out, the topography of the ancient city is inseparable from its supply networks: the consular roads and ports on the Tiber served not only the circulation of goods, but also the distribution of building materials[21]. Coarelli, Gnoli, and Lazzarini have precisely documented this relationship, demonstrating how the marbles of Carrara, Proconnesus, and Aswan, arriving via Ostia, introduced a representative language that overlapped with the tuff and travertine character of the Republican era. Roman monumentality thus arose from a balance between proximity and distance, between the economics and politics of material.

On the other hand, this same principle, which finds its highest exemplification in Roman civilization and recurs as a synecdoche for all other Mediterranean civilizations, is also reflected in the urban imagery of many other grandiose cities that have shaped European history. Among these, Athens built its identity on Pentelic marble, whose homogeneity and brilliance enabled a stereotomic perfection that influenced the Doric and Ionic grammar. Pharaonic Egypt founded its monumentality on Aswan granite, whose hardness was redeemed by the ease of transport along the Nile: here,

river logistics became a natural extension of the quarry. The cities of the Italian Renaissance reinterpreted this alliance in a local context: Florence organized its language around the alternation between *pietra forte* and *pietra serena*, transforming the lithological difference into a principle of architectural order; Venice based its material on Istrian stone, compact, impermeable, and salt-resistant, and constructed its image as a city suspended on the continuity between stone and water. Similarly, in the South, Lecce stone shapes the Baroque plasticity of the Salento city, while in Sicily, calcarenites and Iblean limestones define a widespread identity, based on a short and coherent supply chain, in which extraction, construction site, and landscape coincide. In any case, the quality of the stone and the distance from the quarry regulate the scale of the city, its compactness, and its ability to endure over time.

Yet, the characteristics of stone outlived civilization, continuing to construct the urban identities of future cities and civilizations. Indeed, the evolution of the relationship between cities and quarries can be interpreted as a long-term sequence. Initially, cities formed near resources, building with local stone and defining a unified language, consistent with the landscape. With the expansion of trade and the formation of empires, supply networks expanded and materials diversified: the chromatic variety of marble became a sign of power and universality. In the Middle Ages, the rarefaction of mining activities and the habit of reuse transformed cities into quarries of themselves: the practice of spoliation represented a form of material continuity between eras. With the Renaissance, local supply chains were reactivated and stone once again became a civic symbol, subject to regulations and controls that established the material identity of cities. The industrial age ushered in a period of alienation: the railway and mechanization dissolved local dependencies, replacing natural stone with artificial materials, until contemporary globalization made stone a ubiquitous and often anonymous material. Today, within the framework of the ecological transition, reflections on the "short supply chain" and the circularity of materials bring the question of territorial relevance back to the forefront, reestablishing a direct relationship between city and quarry, between material and identity.

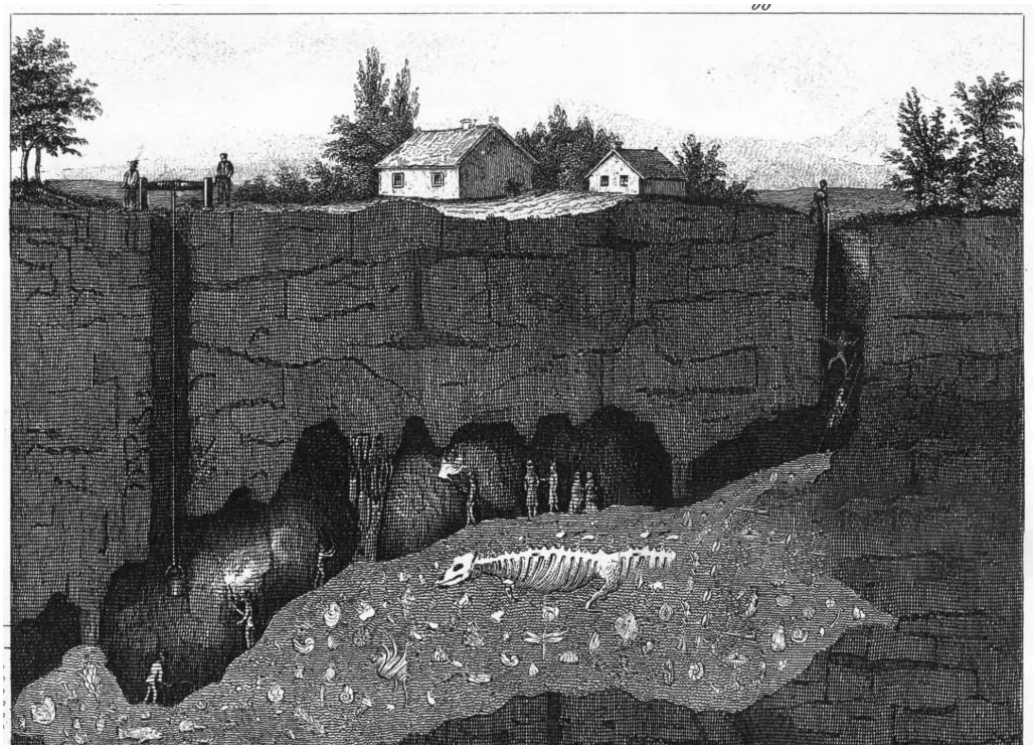

Fig. 5 – Proximity between Buildings and underground quarries. In the image, section of the cave in the Dream lead mine near Wirksworth, Derbyshire, 1822. Drawn by T. Webster from a sketch by Prof. Buckland. Wellcome Collection 42479i

Understanding the relationship between *cavitas* and *civitas* therefore means reading the city as a cultural projection of geology. Stone is the primary measure of architecture: it contains the rhythm of cutting, the repetition of the module, and the time of labor. The city is the continuation of this gesture on a larger scale, the translation of the quarry's rhythm into the urban rhythm. When the relationship between quarry and city is broken, the city loses part of its identity and its material "voice" becomes uniform. Bringing contemporary design back to an awareness of this genealogy means not only pursuing a principle of sustainability, but also reconstructing the continuity between territory, material, and form.

In this sense, quarries belong not only to the past but also to the future of architecture and landscape. They are the places where one can still discern the original measure of construction, the point of contact between nature and civilization. Rethinking the city starting from its own stones – recognizing lithological basins as cultural infrastructures as much as watersheds – means restoring to design the ability to interpret the earth as a resource and a material for relationships. The *civitas* is, ultimately, the conscious form of the *cavitas*: what nature offers in power, the city returns in construction, memory, and responsibility.

1.3. Morphology: materials, techniques, extraction procedures

Every quarry is a trace of knowledge inscribed in the Earth's material, and the moment its surface is carved, a principle of order and knowledge emerges: the resulting form is never spontaneous, but a direct consequence of the geological qualities of the material, the extraction techniques employed, and the economic and cultural purposes that guided its excavation. In this sense, the morphology of quarries does not belong exclusively to the realm of technology, but constitutes a form of territorial writing, defining a language through which societies deposit their intentions, their tools, and their concept of measure in the soil.

Since ancient times, the relationship between the hardness of the material and human technical skill has shaped profoundly diverse spatial configurations. The quarries of soft stone – especially calcarenite, tuff, clay, or gypsum – were traditionally excavated with manual tools, following slow, progressive processes that favored direct penetration into the material and the deliberate use of tools specifically designed for this activity. These techniques resulted in intimate spaces, underground sequences, chambers, and rooms modulated by the rhythm of the blow and the blade. The manual action, repeated for centuries and passed down through the generations, produced morphologies of great plastic continuity: low vaults, pillars left "in reserve", surfaces marked by the natural curvature of the gesture. In these places, the quarry behaves like an organism formed by erosion.

A different logic governs the extraction of harder materials – such as limestone, marble, basalt, and granite – where the stone's resistance requires fracture and

separation procedures. Here, form arises from division, from clean cuts, and, more recently, from controlled explosions. The morphologies are structured through steps, vertical fronts, terraces, and work surfaces, where the regularity of the module corresponds to the need to optimize the block and reduce waste. The historical evolution of quarrying techniques is, ultimately, the story of humanity's progressive emancipation from the limits imposed by matter. From the first Neolithic quarries – where flint and obsidian were extracted through abrasion and natural detachment – to the large Roman quarries, equipped with drainage systems and wooden joints, the ability to understand and appropriate stone has translated into increasingly complex spatial phenomena[21]. Throughout the Middle Ages and the modern era, the use of levers, moistened wedges to exploit the increase in volume, and hammers continued to define a quarrying landscape composed of cyclical and continuous movements, marked by their rituality, in which each block was slowly separated, following directions that respected the structure and directionality of the bench, visible on the front. The quarry, in this sense, was marked by anthropometry, and the spaces created were a projection of the human body and the gestures it performed: the space was shaped according to the scale and strength of the worker.

With the Industrial Revolution, and particularly from the 19th century onwards, mechanization ushered in an irreversible transformation. The use of explosives, wire saws, pneumatic hammers, and later, chain and diamond-blade machines profoundly altered extraction procedures, affecting not only productivity but also the products, and thus the very shape of the quarry basins. Surfaces became more uniform, faces more regular, and the scale of intervention expanded. The material lost some of its original resistance in the face of the power of the machine, and technology imposed a new order of precision and efficiency, pursuing the logic of increased productivity, reduced extraction times, and reduced waste. Furthermore, it marked a clear shift in scale and a significant change in the morphology of the quarries themselves; ultimately, writing – and sometimes overwriting – a new narrative about the text contained within the earth, relating to a new epic of the anthropization of natural places.

Therefore, if in ancient quarries, form was the result of a dialogic tension between gesture and resistance, or between the tenacity of human work and the incorruptibility of stone material, in modern quarries it tends to be the effect of a geometric prefiguration of an industrial nature: the excavation project precedes the quarry itself, and the stone becomes the materialization of a calculated resource, losing the characteristics of discovery from when it was extracted from the earth's surface.

As Françoise Choay noted, the industrialization of materials entails a «semantic stripping of the place»: extraction is no longer an interpretative act of the landscape culminating in the opening of a new quarry[22], but a process of serial production that tends to erase its intrinsic and extrinsic differences. Furthermore, the need for rapid procurement of stone resources to meet the new demands of contemporary life and the increase in construction in the decades following the 1950s and continuing until the 1990s led to the rapid attack on lithological basins – especially by means of modern and invasive tools and techniques – resulting in a rapid transformation that failed to respect the natural recomposition of the static and ecosystemic balances of the environment, in which the variable of time plays a fundamental role. This, following abandonment and the abandonment of care, caused risks and damage, not only to the affected rock surface and the landscape, but also to environmental safety and to the life of the natural systems and ecosystems that exist in the vicinity of the quarries. Yet quarries, even contemporary ones, retain a profound fascination, especially when different extraction systems coexist within the same site. That is, when the signs of previous techniques persist, visible on the quarry faces, forming a palimpsest of symbolic testimonies that define a tangible and intangible human heritage. Each extraction phase leaves a grammar of traces: cutting lines, blast holes, water channels, crane supports, and inclined planes for transporting blocks.

The "remaining rock" thus acts as a temporal cross-section of human labor: it shows the succession of techniques, the pauses, the interruptions in extraction lines, as well as the errors committed and the attempts to adapt to the lithological configuration. In many cases, the surfaces still bear the imprint of the cutting modules used: squares, parallelepipeds, corresponding to the imprint of blocks of constant size

which, like a gigantic negative, reflect the inverse image of the architectural construction. The quarry thus becomes an archive of operational morphologies, a place where technological time is deposited on the stratigraphy, made visible, of the eras of nature, overwriting them with the contents of the Anthropocene.

Contemporary techniques, based on computerized cutting systems and the use of high-precision diamond wires, have introduced a new type of sign: polished, almost abstract surfaces, cuts measuring just a few millimeters, perfectly orthogonal geometries that eliminate any trace of randomness. The quarry tends to take on the appearance of a three-dimensional laboratory, governed by Cartesian coordinates and performance algorithms. This exaggerated precision, while ensuring greater control over the material and reducing waste, produces an unmistakable spatial paradox: the loss of the experiential dimension of emptiness. Where ancient extraction generated spaces of relation – caverns, passages, bottlenecks, corridors, walkways, habitable spaces – the new extraction produces a total excavation, resulting in isolated, metaphysical, and difficult-to-access mineral surfaces, whose scale is conceived for machines rather than humans. It is in this sense that some scholars, such as Mbembe, speak of a "necropolitics of extraction"[23]: the progressive disappearance of the body and of sensitive experience from the production process, replaced by a regime of abstract and remote visibility.

The morphological transformation of quarries is therefore inseparable from the epistemological one: what changes is not only the way stone is cut, but the way of conceiving the relationship between space, residence, technology, and territory. In the pre-industrial tradition, technology was an integral part of the environment and respected its limits; in the contemporary world, it tends to operate through abstraction and detachment, reducing the land to a pure resource, measurable and computable in terms of dismemberment, removal, use, and profit. However, it is precisely in the distance between these antithetical polarities placed in dichotomous pairings – the gesture and the machine, the soft and the hard stone, the surface and the cavity – that the aim and the instrument of the project can be found, today more than ever: to restore a morphological awareness of the quarry, understood not as a sore, a wound,

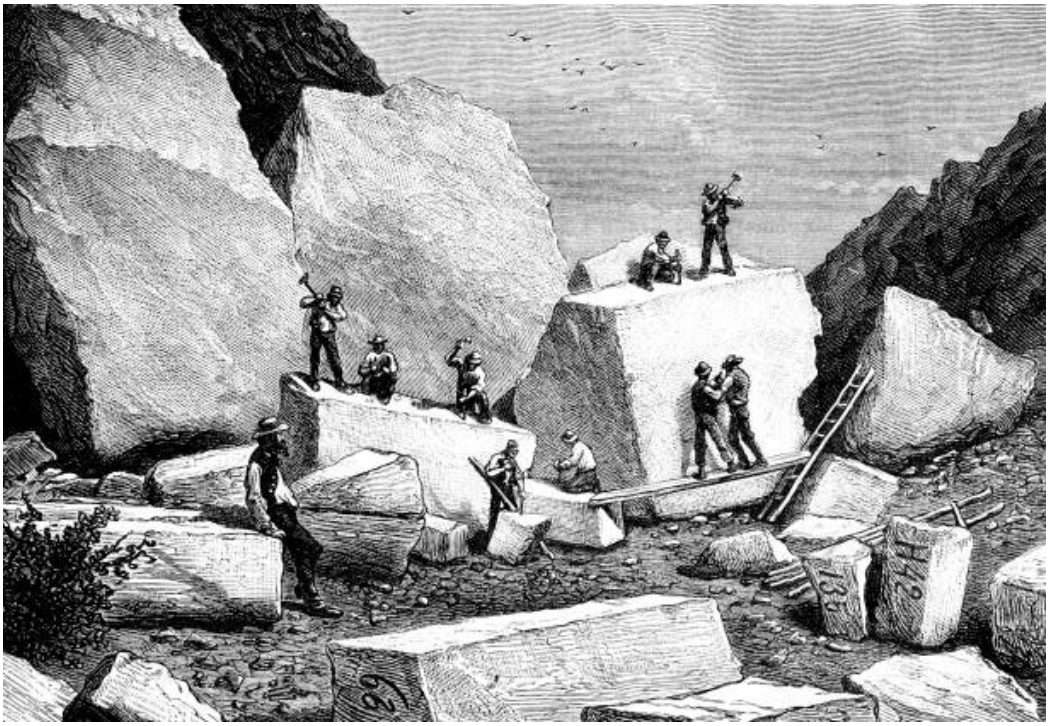

Fig. 6 – Mormons carving granite for the temple. Engraving from a drawing by J. Ferat, to illustrate the story "The White Conquest," by William Hepworth Dixon, 1875, published in “Le tour du monde”, 1876, edited by Edouard Charton, edition H

or a carcass, nor even as a relic of a productive event, but as a living structure, capable of narrating through its forms the material and cultural history of its transformation. In reading the facades of contemporary quarries, including their language, every discontinuity reveals an economic or environmental transformation. The morphology of the quarry landscape is therefore a lexicon that evolves alongside the tools, energies, and ideas for development. Understanding this lexicon means recognizing that the quarry is not merely the product of a practice, but a form of understanding and knowledge of the material world, and that its spaces – sometimes grandiose, sometimes residual – constitute one of the most profound testimonies to human constructive intelligence.

The forms of the spatial figures generated by man on rock banks are, as illustrated so far, the result of a mutual interaction between the reasons of geology and those of human industry: they respond to laws of gravity, resistance, drainage, and equilibrium, but also to cultural conventions and the stratification of knowledge, skills, and innovations. Moreover, as Vitruvius already stated in De Architectura, in a phrase that seals the principle that runs through the entire history of extraction: «the nature of quarries differs according to the constitution of the places; some are more tenacious, others more fragile, and man's judgment must adapt to their quality» (II, 7, 1)[24].

The distinction between typologies, therefore, does not arise from a classificatory order, but from a diversity of relationships with the earth. Each quarry represents a different measure of the relationship between depth and horizontality, between light and shadow, between continuity and cut. The open-cast quarries, with their stepped progression, are the result of a direct engagement with gravity and the scale of the landscape; the pit and chamber quarries, on the other hand, belong to a more intimate horizon, in which the act of excavating coincides with the experience of interior space, of an almost architectural nature; the slope or tunnel quarries, finally, respond to the need to pursue a mineral vein, a vein of material, and reveal the continuity and pursuit of the reason behind the stone.

In the 16th century, in De Re Metallica (1556), Georgius Agricola[25] described in detail the different “forms of the earth's workshops”: open-cast quarries, deep mines, shafts, cultivation chambers, furnaces. He noted how «the site and the nature of the deposit dictate the miner's art»[26], and how the arrangement of the fronts and walkways had to follow the logic of the vein, «not according to the will of man, but according to the will of the stone»[27]. This empirical awareness, which brings together observation and practice while establishing a hierarchical order, introduces a principle that remains valid even today: the shape of the quarry is an induced form, an expression of what the material allows. Over the centuries, this principle has been interpreted in different ways, oscillating between organicity and mechanism.

In the pre-industrial world, the quarry developed through adaptation: its geometry was born from a tactile progression, in which each extracted block determined

the next. In modern and contemporary ages, however, mechanization introduced a prefigured and abstract model of extraction, in which space is first designed and then excavated. As Lewis Mumford observes in "Technics and Civilization" (1934), «the machine has replaced the rhythm of the hand with the rhythm of the engine, imposing on matter a regularity that does not belong to it».[28] Yet, even in its most artificial forms, the quarry retains a cognitive dimension that distinguishes it from other productive infrastructures. As Gaston Bachelard writes in "La terre et les rêveries de la volonté" (1948), «digging is an active reverie; it is the will that becomes geometry, the dream that translates into an inclined plane, a wall, a tunnel»[29]. In other words, the act of extraction retains a symbolic and revelatory power: excavating means bringing to light a hidden order, bringing to light an invisible structure. Each type of quarry, therefore, is a revealed form of the subsoil, a portion of landscape eviscerated by human hands. From this perspective, the classification of quarries is not a descriptive exercise, nor a purely scientific cataloging operation, but an attempt to understand the modalities of the aforementioned revelation.

In light of this, and reiterating the typological grouping and differentiation presented above, it can also be summarized as follows: open-cast quarries represent the extensive form of extraction; they unfold horizontally, interact with the landscape, and generate new artificial topographies; pit quarries, on the other hand, focus on the verticality of the cut, on the descent into the earth, and translate the idea of the threshold, and in particular the threshold towards the abyss, into a figure; while chamber quarries are places of particular interiority, spatial matrices that prefigure underground architecture, in which the rhythm of pillars and roof planes arises from a static balance between what is removed and what is left.

This morphological variety also reflects what Gilbert Simondon would have called the «mode of existence of technical objects»[30]: each technique generates its own space, its own time, and its own degree of individuation. The quarry, as a territorial technical object, therefore possesses a principle of morphological individuation: it is constituted at the intersection of the logic of the mineral and the logic of human action. It is not a designed form, but a form that occurs through the repetition of gestu-

res and forces, until a balance is established between solids and voids, between resistance and desire. It goes without saying that the contemporary interpretation of quarry typologies cannot ignore this dual legacy: the quarry as a technical construction and the quarry as a phenomenological experience. In the first sense, its form responds to functional rules of cultivation and safety; but in the second, it becomes a perceived space, a place of light and shadow, of echo and silence, where the human body measures the depths of the earth: it is at this intersection that the extractive landscape acquires aesthetic and cultural value, not just as a production backdrop.

Each type of quarry, in the pages that follow, will therefore be analyzed both as the result of technical provisions and as an expression of spatial thought, a concrete form of the way in which civilizations have known – or wanted, or even been able – to dialogue with matter.

1.3.1. Open-air and stepped quarries

Open-cast quarries are inscribed in the landscape as topographies of cutting and gravity, in which the production of space coincides with the process of removal. Excavation proceeds along successive horizontal planes, which gradually recede into the ground, generating a system of steps or terraces that function to stabilize the fronts and move the material. The resulting overall form – a series of concentric or parallel wings – is the result of a constructive balance between safety, economy and control of the mass. Referring to De Re Metallica (1556), Georgius Agricola observed that «the miner, when he removes the earth in layers, leaves a sufficient margin at each level, so that nature does not fall on itself»[31], formulating a precise description of the extractive logic that proceeds on steps: an architecture of stability that allows the interpretation of the geological stratification, but at the same time transforms it into an artificial construction.

Open-pit quarries are typical of hard or compact materials – limestone, basalt, granite, marble – that preclude underground excavation and avoid structural risks. Their morphology is therefore extroverted, expansive, and tends to construct new and inverse slopes. In the Apuan marble quarries, for example, the relationship between solid and void takes on an almost monumental character where the stepped facade

visually expresses the stone's intrinsic qualities of hardness and compactness[32]. The fragment of landscape of the open quarry is, in this sense, the very image of mining modernity: a place where nature and its endogenous issues are made

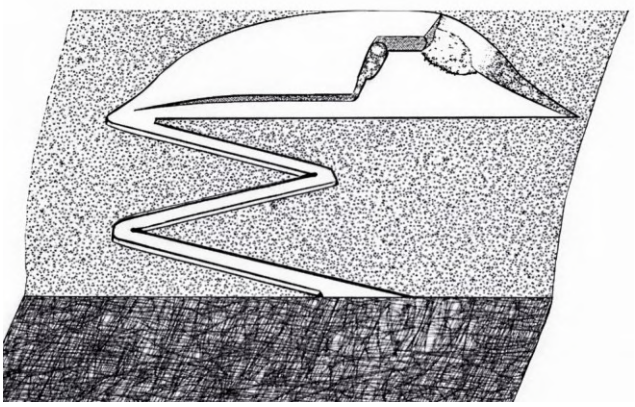

Fig. 7 – Oper-air quarry. Methods and schemes for the implementation of cultivation projects, as well as for the recovery. Provincial Administration of Pesaro and Urbino

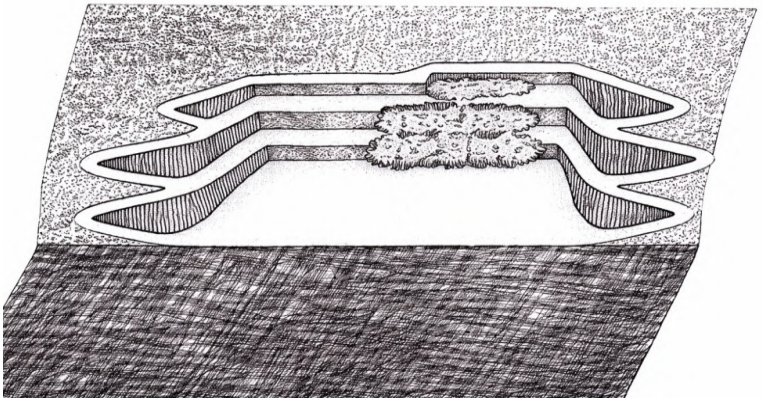

Fig. 8 – Stepped quarry. Methods and schemes for the implementation of cultivation projects, as well as for the recovery. Provincial Administration of Pesaro and Urbino

legible through the rule and modular reiteration of extraction techniques: if the material resists, the technique responds with geometric seriality.

The historical evolution of open-pit quarries parallels the advancement of cutting and lifting tools: in ancient times, mining proceeded along irregular levels, created with chisels and wooden wedges that, swelling with water, separated the blocks from the bed, and along low, if not minimal, steps, often adapted to the natural structure of the stratification. With the Renaissance and the modern age, the spread of pulleys, winches, and hoists ushered in a progressive geometric rationalization that culminated in the 19th century with the advent of mechanization, first with band saws, then with helical wire saws, which, due to the sheer size of the quarry and the scale of the quarry, imposed a leap in scale on the landscape. Spatially, the stepped quarry generates an ambivalent perception: on the one hand, its monumentality and the purity of its cuts give it an abstract character – superimposed planes, constant proportions, and a rhythm of solids and voids reminiscent of ancient theaters or amphitheaters – on the other, its scale and openness produce a sense of suspension: the person entering loses measure, the terraces become wings, the quarry paths transform into ramps leading down to a dimension where the earth is no longer a horizon, but a wall, revealing an inverted landscape.

1.3.2. Pit quarries

While open-pit quarries expand horizontally, pit quarries – one of the oldest and most significant forms of mining – develop in depth in a centripetal movement that concentrates space around a vertical void. The genesis of the latter is linked to the need to reach layers of soft material – calcarenite, tuff, clay, porous travertine – that extend steadily and for many meters below ground level and cannot be mined simply by surfacing. The pit thus becomes a descending architecture, a controlled crater in which section prevails over plan, and verticality becomes a constructive principle. In his work, Agricola describes the "foveae" as cultivation wells that «man opens in the earth's womb to extract what is hidden, leaving walls around them that support each other like limbs of a body»[33].

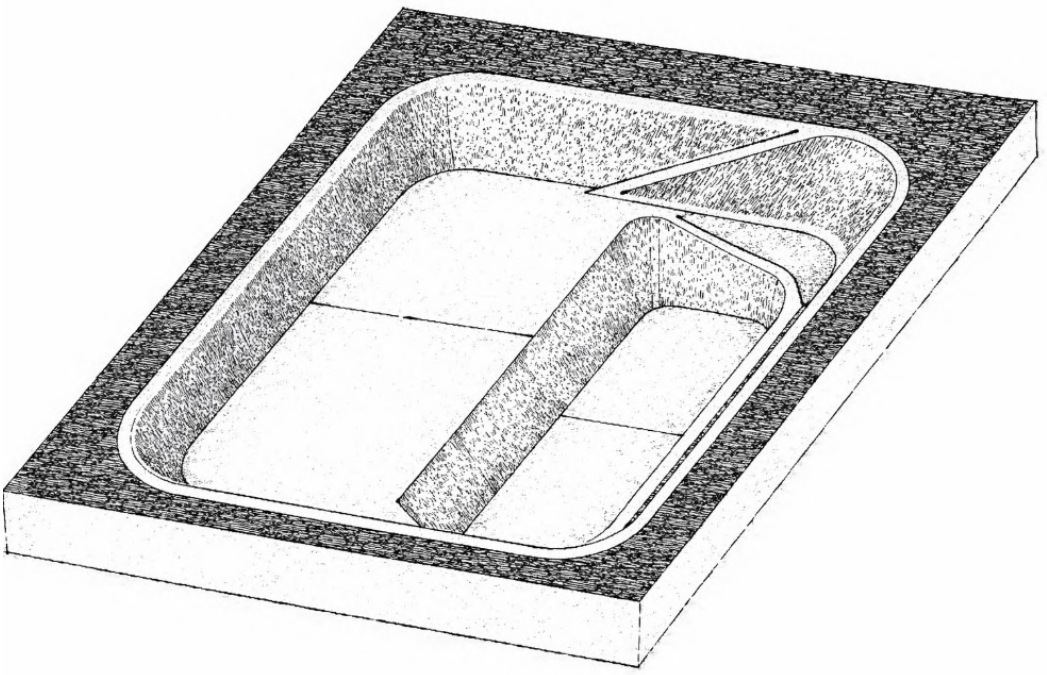

Fig. 9 – Pit quarry, Methods and schemes for the implementation of cultivation projects, as well as for the recovery. Provincial Administration of Pesaro and Urbino

In this image, the pit already appears as a structural organism, where solids and voids cooperate to maintain the balance of mass and geometry: the pit – square, circular, oval – derives from the relationship between the mechanical properties of the rock and the available excavation techniques: in soft materials, the cross-section tends toward roundness, as erosion and subsidence are counteracted by the curvilinear profile; in more cohesive materials, the pit takes on a prismatic shape, reflecting the order of the cut. From a morphological point of view, it is possible to interpret the pit quarry as an introverted landscape in which the light penetrates from above, drawing a blade that decreases in intensity until the bottom, where the cutting and extraction activity is concentrated: as Gaston Bachelard observes in Poétique de l'espace (1957), «descend into the earth is an act of material imagination: every step do-

wnwards is a step towards interiority, a return to the hidden core of things»[34], and the pit quarry, more than any other, embodies this condition.

In Mediterranean regions – particularly in Southern Italy and the Levant – pit quarries became widespread due to their energy efficiency and microclimate: their depth provides shade, constant humidity, and protection from the wind, making these spaces surprisingly habitable. In many cases, after mining operations ended, the pits were reused as storage facilities, cisterns, or places of worship, transforming into underground refuges. This reversibility is one of the most fascinating characteristics of this type of quarry, as the quarry does not end with production, but rather already contains the principle of reuse, since its void, protected and delimited, is predisposed to reappropriation. As Annette Béguin notes, «the pit is the matrix of reuse: its closed and enclosed form invites new meanings, as if the earth were lending itself to a second act, this time cultural»[35].

Even for this type of cave, technical evolution has profoundly altered the nature of these cavities. Until the 19th century, excavation was conducted manually with pickaxes, chisels, and saws, leaving regular, oblique marks on the face; the walls were often articulated with safety steps, while the access ramps – sculpted into the rock – constituted veritable spatial devices created from the same material that defines the cave. With the introduction of machinery and lifting equipment, the scale of the pits expanded, the faces became smoother and more vertical, and the human scale gave way to the industrial one. Modern pit quarries, visible in many calcarenite extraction areas of the Mediterranean, today take on a conical or cylindrical morphology, the result of excavation with mechanical shovels and continuous-wire saws, which prioritize speed and geometric regularity, also resulting in a transformation of the perceptual dimension. The experience of the contemporary pit quarry is often one of a total lack of orientation: the sky appears like a distant disk, the light becomes vertical and immobile. It is an almost metaphysical landscape, evoking – as Augustin Berque writes – «the conversion of the territory into the cosmos»[36], that is, the transformation of a productive space into a place of contemplation. The symbolic power of this typology derives precisely from its liminal nature: it no longer belongs to the

surface, but is not yet subterranean; it appears as a threshold between the earth and its negation, between human activity and its fading absence.

1.3.3. Slope or continuous face quarries

Slope quarries develop along the natural slopes of mountains, following the line of the rock bed or mineral vein. These quarries do not dig deep, but hollow out the mountain laterally, creating a continuous face, often visible from a great distance. Their shape is derived from the superposition of successive cuts on the same inclined plane: a series of regular removals that create a horizontal pattern on the wall, almost like a text engraved in the rock. From a historical perspective, slope quarries represented a significant evolution compared to pit quarries: the transition from centripetal mining to linear mining, which was more efficient and easily accessible. Agricola, as early as the 16th century, observed that «the prudent miner follows the vein as the painter fol-

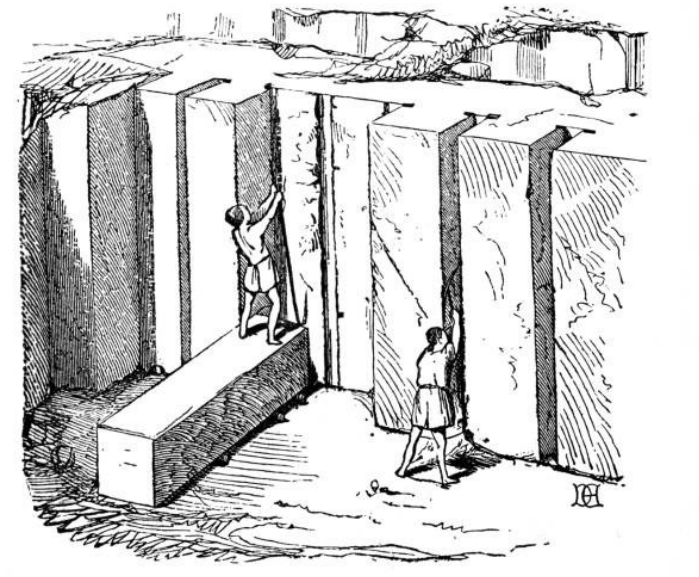

Fig. 10 – Continous face quarry, author unknown

lows the line of a drawing»[37], referring to the open-face mining method.

This approach, based on adherence to the topography and structure of the rock, implies a morphological understanding of the territory: the quarry does not impose a geometry, but reads the mountain, following its slope and direction. The result is a landscape poised between artifice and revelation, in which the boundary between the natural and the technical becomes indistinguishable. As Augustin Berque writes, «to inhabit the world is to understand its inclination»[38] ("Écoumène", 2000): in slope quarries, this inclination is both literal and symbolic, since working obliquely translates gravity into design.

From a construction standpoint, slope quarries are primarily used for stratified materials – limestone, sandstone, basalt, marl – occurring in inclined or alternating beds. Excavation proceeds through horizontal cuts, often multiple, separated by safety benches; each face can reach considerable heights, transforming into an architectural wall. In Sicily, Puglia, Tuscany, and throughout southern Europe, these quarries have shaped entire hilly landscapes, creating morphologies of elevations and terraces that today blend into the natural structure of the terrain. The extraction process, repeated over time, has generated a "topographic parallelism" effect: the quarry floors ideally continue the contour lines, making the geological inclination visible.

Perceptually, the slope quarry is a cross-section of architecture. Those who observe it from below see a succession of overlapping planes, joining lines, shadows, and reflections. From above, however, it appears like a crack in the ground, an oblique cut that reveals the hidden depths of the bank. In both cases, the landscape takes on a scenographic dimension: the face becomes a visual palimpsest, a mineral backdrop that offers itself as an iconography of the open land. As Gilles Clément wrote, «the wound is a form of landscape when it accepts its own scar»[39] ("Le jardin en mouvement", 1991): in the slope quarry, the scar becomes language, a permanent sign that narrates the encounter between geological and human time.

The continuous-face mining approach also requires specific management of rainwater and the risk of collapse: natural slopes promote drainage, but expose the face to erosion and instability. Consequently, the quarry transforms into a system of

hydrogeological and structural balances, where attention to water, slope, and light control transforms the slope quarry into a complex territorial machine, where natural and artificial components seamlessly coexist. The aesthetic power of this typology lies in its perceptual ambiguity: the quarry face is simultaneously wall and mountain, section and surface, wound and foundation.

1.3.4. Underground chamber quarries

Chamber quarries represent the most complex form of extraction: a system of internal spaces in which material and light, technique and perception, enter into an intimate and reciprocal relationship. These cavities are dug entirely below ground level, either continuously or at depth with respect to a vertical or inclined access, and supported by pillars left in reserve, which serve as natural load-bearing elements. The logic that governs them is not that of pure subtraction, but of balance: each extracted volume corresponds to a volume left behind, in a subtle balance between solid and void. In these quarries, the technical gesture translates into architecture, as the form of the space derives directly from a static principle.

In De Re Metallica, Georgius Agricola distinguishes "cavernae subterraneae" from shaft or open-pit mines, emphasizing how the miner «leaves columns of the stone itself to support the vault, so that the work does not fall on itself»[40]. The image is one of extraordinary architectural precision: the space is generated by a structural logic, in which the extraction itself becomes the load-bearing structure. This principle is found in all ancient chamber quarries – from the Apulian calcarenites to the Roman catacombs, from the Emilian gypsum to the Campanian tuff – where the cavity is divided into serial spaces punctuated by pillars, substructures, arches, and lowered vaults. The arrangement of the extracted solids and voids follows the pattern of the geological bed, revealing an implicit geometry of the stone, composed of fracture planes, cutting directions, and resistance veins.

From the point of view of the experience of space, it is no longer defined by the horizon line, but by the density of darkness and the way in which the light passing through artificial openings is reflected on the stone surfaces and draws their limits.

As Gaston Bachelard wrote in 1957, «the deep interior is never dark: it is a habitable penumbra, an intimacy that breathes slowly»[41]. The underground quarry belongs to this poetic category of the interior: a place of suspension, where silence and darkness are matter, and perception relies on echo and temperature rather than sight. It is here that the most radical, yet primordial, dimension of terrestrial habitation is measured: not above the earth, but within it. From a technical standpoint, the chamber quarry is only possible with soft or moderately coherent materials – calcareous, tuff, gypsum, marl – which allow for the excavation of large volumes while maintaining the stability of the walls, where excessive hardness would make advancement impracticable, while absolute friability would cause collapse. In this balance between compactness and workability, the sequence of load-bearing pillars appears as a monolithic framework, and the surfaces, left rough or marked by the pickaxe, reveal the continuity of the manual gesture. In modern quarries, the use of mechanical saws, pneumatic hammers, and diamond wires has replaced the hand, but has not erased the original structural principle: the need to alternate solids and voids, as in a great underground nave.

The spatial organization of the chamber quarries often takes on a surprising regularity: orthogonal meshes, repeated modules, constant heights: an architecture in which geometric precision is designed starting from the logic of use and prudence: as Eugène Viollet-le-Duc notes in the “Dictionnaire raisonné de l'architecture française” (1858), «the logic of construction manifests itself where the structure coincides with necessity; the quarryman, in leaving a pillar, performs an architectural act without knowing it»[42]. The underground quarries are therefore the paradigm of an introverted architecture, in which the art of building coincides with that of subtracting.

From a perceptual and phenomenological perspective, darkness and silence amplify the perception of the body, while the repetition of the pillars produces a rhythm that also orients those who walk along it. As Georges Didi-Huberman wrote, «void is the form that remains after the hand's contact with matter»[43] (“Ce que nous voyons, ce qui nous regarde, 1992”): in the underground quarries, that void becomes presence, a volume inhabited by the absence of stone. The visitor perceives not the

object, but its subtraction; not the built, but the unbuilt, which nevertheless possesses form, mass, and measure. Over the course of the 20th century, many chamber quarries were abandoned and converted into spaces for conservation or culture. Their thermal and acoustic continuity – constant temperature, controlled humidity, and soundproofing – made them suitable for new contemporary uses: cellars, archives, galleries, and theaters. This adaptability testifies to the underground quarry's ontological flexibility: not a relic, but a void ready for habitation. From this perspective, chamber quarries represent, if you will, an archetype of sustainability *ante litteram*, a way of building by subtraction and inhabiting the interior as a resource.

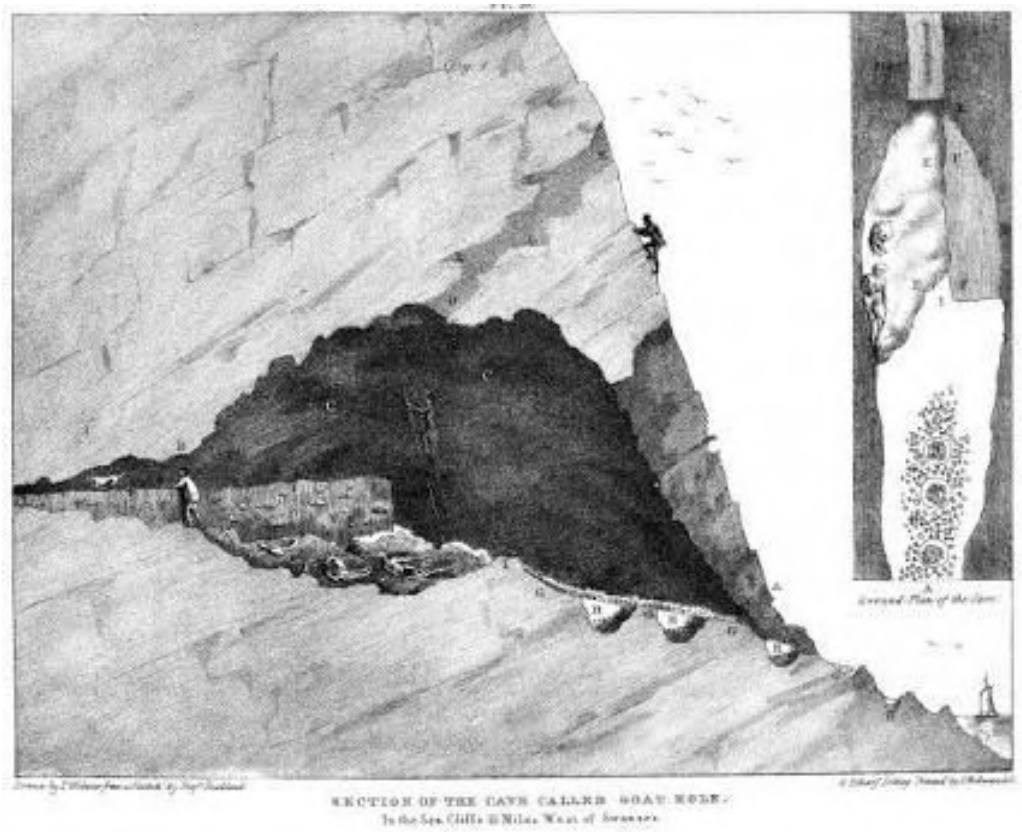

Fig. 11 – Underground chamber quarry. Section of Paviland Cave (Wellcome Trust)

1.3.5. Quarries in tunnels or with controlled underground development

Tunnel quarries represent the most introspective and technologically sophisticated form of extraction. Unlike open-pit or pit quarries, which develop vertically, they advance horizontally, following the mineral vein along an axis internal to the mountain. Their morphology arises from the balance between two opposing needs: penetration into depth and the need to ensure the stability of the massif. In this sense, the tunnel space is therefore an inhabitable form of pressure, a hollow volume that must exist in equilibrium with the forces surrounding it.

Once again, in De Re Metallica (1556), Georgius Agricola describes with extraordinary precision the logic of tunnel quarries: «arteries of the earth, through which man proceeds, measuring the health of the mountain with sound and flame»[44], representing the quarry as a living organism, endowed with respiration, heat, and sound. «One proceeds horizontally, leaving side walls and ceilings that support the entire mountain, like the ribs of a body»[45], Agricola adds, revealing an anatomical conception of the territory, in which the quarryman is seen as someone who understands its physiology, in a metaphorical delineation whereby the tunnel quarry is the fruit of a knowledge that we might currently define as geotechnically advanced, capable of detecting the stresses of the stone and translating them into geometry.

From a morphological perspective, tunnel quarries generate linear or reticular spaces, with variable cross-sections depending on the nature of the material and the excavation method. In manual or semi-mechanical extraction, the tunnels assumed elliptical or low-vaulted profiles, according to the logic of compression; in modern systems, the cross-section tends to become rectangular or trapezoidal, adapted to the cutting machines, as well as to the space and maneuvering space of transport vehicles. The transition from manual to machine-operated action is particularly evident here: the precision of mechanized cutting erases the spontaneity of the path, replacing it with the algorithmic logic of efficiency. The tunnel experience is one of a gradual transition from open air to opacity, from dispersed sound to absolute silence. Yet, it is precisely this invisibility that gives the tunnel quarries a particular aura: they constitute a moving internal landscape, with almost kinesthetic characteristics, where

perception is constructed along a narrative axis – the entrance, the path, the threshold of light, the extraction area, the terminal chamber.

As Gaston Bachelard writes in “La Terre et les rêveries du repos” (1948), «the horizontality of the underground is a dream of balance; man seeks peace in the belly of the earth, like a return to the undifferentiated»[46]: from this perspective, the tunnel is not only a technical device, but a symbolic figure of the return, a path towards the interior, where matter becomes a psychic, meditative and tactile experience.

Historically, tunnel quarries emerged more recently than other types, when the knowledge needed to ensure continuous ventilation and drainage allowed for deep-seated work without compromising the stability of the mountain. In the limestone and

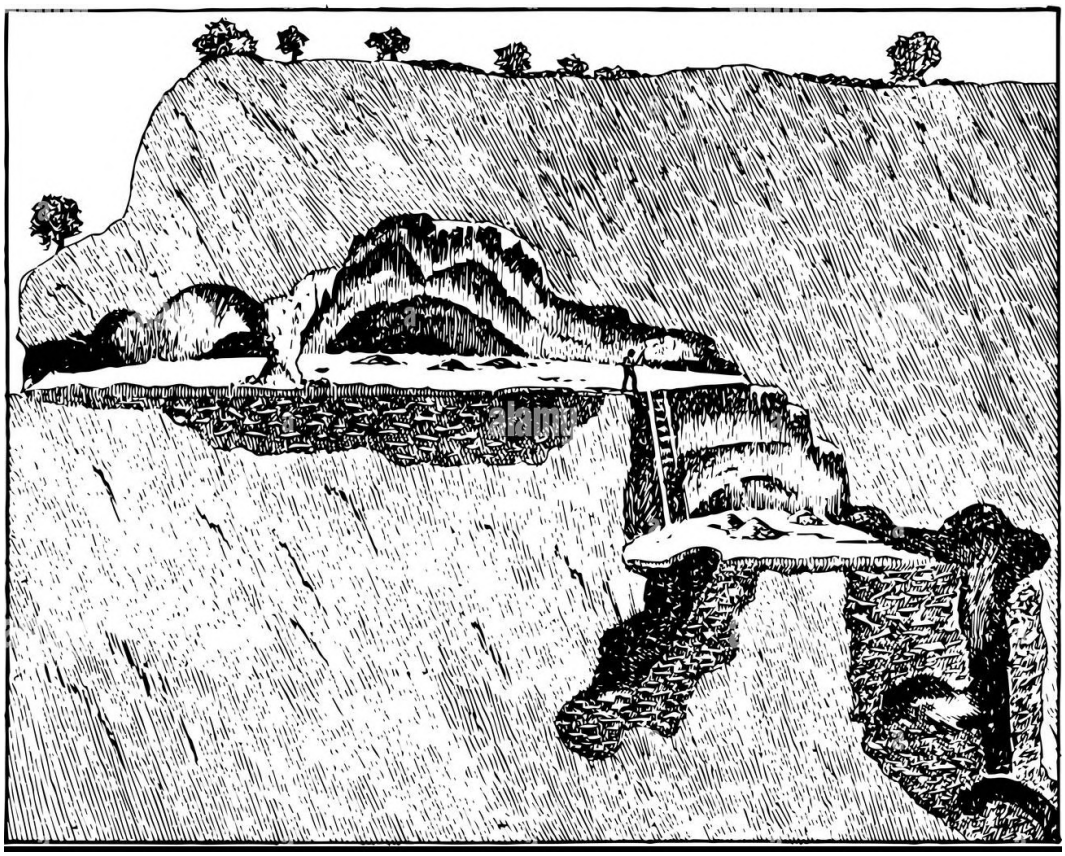

Fig. 12 – Quarry with controlled underground development. Webster, Hutton Storia antica (Boston, MA: DC Heath & Co., 1913)

tuff regions of the Mediterranean – especially on the Ionian and Tyrrhenian sides of the Italian peninsula, but extending along the Balkans to the Attic mountains – they allowed the exploitation of otherwise inaccessible deposits, reducing the visual impact on the surface. This "disappearance", or, to put it another way, this "concealment" of the quarry from the landscape's epiphenomenon, marks a conceptual shift: the void is no longer visible, but latent, like a buried memory that continues to operate beneath the skin of the land.

In the twentieth century, the spread of mechanical drilling technologies, diamond wires, and automated excavators transformed these cavities into complex underground networks, where the design coincides with the technical section. The contemporary tunnel is no longer simply a place of extraction, but a flow infrastructure: a space for the transit of air, water, and energy. Yet, in historic quarries, the tunnel was often also an extension of the dwelling. Many communities lived near or within these spaces, transforming the entrances into courtyards, the ramps into connecting roads, the terminal chambers into storage areas or places of worship. Numerous ancient underground quarries throughout the Mediterranean still show traces of architectural adaptation, featuring sequences of steps, niches, inclined surfaces for water drainage, and the persistence of spaces connecting the interior and exterior.

As Christian Norberg-Schulz writes in "Genius Loci" (1979), «every construction in the earth is an act of reconciliation with the origin»[47], and the quarry in the tunnel embodies precisely this reconciliation: the technological gesture which, penetrating the soil, rediscovers the measure of the limit, transforming the mountain from an obstacle into a dwelling, and the depth into a place of knowledge.

2. THE HERITAGE RECOGNITION OF QUARRY SITES

If in the previous chapter the relationship between *cavitas* and *civitas* demonstrated how cities are founded on a relationship of continuity with lithological basins, here the reflection expands to include the quarry no longer simply as a matrix of construction, but as an object of patrimonial recognition, as a place that preserves and represents the joint history of the Earth and the civilizations that have inhabited it.

Every form of civilization is the result of an unstable balance between the earth and its representation. What we call landscape is, in reality, a cultural construction that emerges from the dialogue between geological laws and human intentions, between the stratifications of matter and the symbolic forms grafted upon it. The act of quarrying, in this sense, belongs not only to the sphere of technology or economics, but is a cognitive act, a way of interpreting the deep structure of the soil and translating it into architecture, cities, and memory. The heritage recognition of quarry sites is, in fact, situated within a complex perspective that intertwines geology, anthropology, and cultural politics. Every quarry, even the most remote or most anonymous, bears witness to a moment of encounter between natural processes shaping the earth's crust and historical processes of organizing labor and space. It is, simultaneously, a geological and a cultural document. On the one hand, its stratigraphy encapsulates the memory of geological eras, sedimentations, pressures, and chemical changes; On the other hand, it preserves the signs of human labor: traces of tools, production waste, regular cuts or sudden fractures that reveal the techniques and times of an era. In this sense, the quarry is not just a place of extraction, but a lithic archive: an open section of the Earth, a palimpsest that allows us to read, in the same material, the continuity between natural and cultural history.

The word “geology”, from the Greek γῆ (earth) and *λόγος* (discourse), originally meant "the story of the earth". But this story is never neutral: every excavation, every cut, every removal transforms geology into history, as humans, by intervening on the material, interrupt its silence and reactivate its language. Quarries are therefore "speaking places”, in which the Earth becomes text and human labor becomes its syntax. The quarried stone is not simply an inert artifact, but a bearer of meaning: its

grain, its color, its fractures constitute expressive elements that have guided, over time, architectural and symbolic languages.



Fig.13 – Cusa ancient quarries. Source: https://parchiarcheologici.regione.sicilia.it/



Fig.14 – View taken in the Campo Bello quarries near Selinunte, Saint-Non Jean-Claude Richard

However, this dual nature – natural and cultural – complicates the recognition of quarry sites as heritage sites. Unlike architectural monuments or agricultural landscapes, they do not originate with a representative purpose, but as productive devices, often marked by a high degree of transformation and a destiny of abandonment. Only recently have design culture and reflections on heritage begun to consider

them as "hybrid" cultural assets, situated on the boundary between nature and artifice, between geological memory and social memory. In Italy, the slow pace with which this awareness has emerged reflects the difficulty of recognizing as "heritage" that which pertains to the dimension of labor and production, rather than that of representation. While the mines and industrial districts of Northern Europe have long been included in UNESCO lists as examples of industrial archaeology and cultural landscapes, the Italian quarry system remains largely devoid of a specific regulatory framework and full cultural valorization. Yet, Italy is one of the most densely populated

regions in the world for traces of extraction. The peninsula's geological diversity – from Alpine dolomites to Apuan limestones, from Etna basalts to Apulian calcarenites – is reflected in the diversity of landscapes and the architectural languages that have resulted. In every region, there is a direct link between the quality of the stone and the form of the building: the quarries of Carrara and Custonaci, Trani and Lecce, Ragusa, Valpolicella, and Verona have generated not only building materials, but entire figurative models, construction techniques, and local economies. They represent a widespread, often invisible, heritage that spans the territory like a network of underground geographies, intertwining natural history with social and productive history. Understanding the quarry as a heritage means, therefore, restoring its cultural dignity: recognizing that the aesthetic value of the landscape lies not only in its integrity or balance, but also in its ability to reveal the processes, fractures, and wounds that created it.From a methodological perspective, recognizing quarry sites as heritage sites requires a paradigm shift: from the logic of conservation to the logic of understanding, from the idea of protection as passive protection to that of protection as active interpretation. This requires an interdisciplinary approach, capable of connecting earth science with design science. Geology, in this context, is no longer a supporting discipline, but a constitutive principle for understanding the territory. Understanding the "reason of the earth" means interpreting the morphogenesis of the soil as an integral part of the history of habitation. From the history of the Earth to the history of humanity, a line of continuity emerges that contemporary design must learn to recognize and represent. Every lithological basin is both a place of resources and a narrative: a geological form that has shaped the evolution of civilizations. The cities of stone – from Matera to Agrigento, from Ragusa to Ostuni – testify to the possibility of coexistence between extraction and habitation, between excavation and construction. In them, rock is not merely a foundation, but a living part of the architecture and landscape: the cavity and the construction coincide, and the material of the soil becomes the material of habitation. This awareness restores to quarries a value that goes beyond their original function: they are places of memory and design, natural archives in which the geological, historical, and anthropic dimensions intertwine. Recognizing this value

means assuming the responsibility of a protection capable of integrating scientific knowledge with cultural sensitivity. Heritage is not an objective fact, but an act of collective interpretation: it arises when a community decides to recognize, in the material that surrounds it, a reflection of its own identity.

The heritage recognition of quarries is therefore not an administrative gesture, but an epistemological shift. It invites us to rethink the very notion of landscape, which must be explored in its depth and preserves within its depth the traces of the coexistence between nature and culture. The quarry landscape, in this vision, is not simply a disfigured landscape, but is expressed in the qualities of a revealed landscape: a place where the earth reveals its structure and its "stone nature", its history, and where contemporary design can recognize the measure of limits, the responsibility of transformation, and the profound sense of time.

2.1. Γεωλογία: the reasons of the earth

The Earth is a great living rock. A slowly moving mass, an organism that breathes through its fractures, expanding and contracting according to the invisible rhythm of internal forces. In its apparent immobility, it holds a profound dynamism, a vital tension that for billions of years has shaped mountains, opened fissures, deposited sediments, and solidified matter. Each layer, each vein, each crystal is the result of a fragile, millennia-old balance. When humans carve into the Earth's crust, as in the ancient practice of quarrying, they perform more than a technical act: they lay bare the planet's intimate nature, penetrate its anatomy, and reveal its secret structure. The quarry, in this sense, is a cognitive act: a section of the Earth that allows us to read its body, understand its internal logic, and symbolically appropriate it. Geology – Γεωλογία, Geōlogía – is, etymologically, the discourse of the earth, the word that man utters to understand what sustains him. But it is also, conversely, the voice of the earth manifested through its forms, its materials, and its metamorphoses. The Earth's crust, in its variety, is a complex grammar of substances and processes, a mineral syntax that has provided humanity with the physical and conceptual founda-

tions for building its history. Stones, marbles, metals, minerals, gems – all the lithological products that derive from the bowels of the planet – are not simple resources, but mediators between nature and culture, tools through which civilization has constructed not only its architecture, but also its cosmologies.

Humans learned early to distinguish the qualities of matter, to recognize the measure of their own gesture in the hardness or brittleness of rock. From the chipped stone of the Paleolithic to bronze, from iron to modern alloys, every technical transition corresponds to a threshold of awareness in the relationship with the earth. The history of civilization can be read as a long mining education: a process of refinement of geological knowledge translated into material culture. In this sense, Γεωλογία, the "reason of the earth", is not merely a science, but an original principle of construction. Architecture, even before being an art or technique, arises as a continuation of geology: the same forces that in nature determine the resistance and cohesion of matter are translated, by human intervention, into rules of balance and spatial order.

The variety of lithological products that the Earth offers – stones, marbles, metals, minerals, gems – has accompanied and defined the history of civilizations. Each possesses a specific geography and temporality, and their distribution has shaped the form of human settlement, the birth of trade, the symbolism of power, and the construction of collective images. Cut stone and marble constitute the foundational material of habitation: temples, walls, and cities were built with them. Metals have made possible the tool, the machine, and the weapon, that is, the functional extensions of the human body. Minerals have provided pigments, fuels, and substances for the alchemy of production. Finally, gems have embodied the symbolic and sacred



Fig.15 – Fossils. Mollusca. Cephalopoda. Tetrabranchiata, 1879–1901.Padua, University of Padua, Library of Geosciences

dimension, the idea that the Earth, deep within, contains a form of perfection. This diversification is the result of the planet's long geological history, its constitutive instability. Different pressures and temperatures, chemical transformations, and metamorphic processes have generated a multitude of materials and forms, each with its own physical and chromatic identity. Civilizations have constructed themselves by recognizing and selecting these qualities: the compactness of Egyptian granite, the translucency of alabaster, the finesse of Pentelic marble, the ductility of bronze, the hardness of iron, the luster of gold and silver. The choice of these materials reflects a specific vision of the world. Stone represents stability and durability, metal power and transformation, gems rarity and light. Each era, therefore, has based its aesthetic and symbolic identity on a specific relationship with geological matter, elevating it to the image of its own idea of order and beauty.

The distinction between quarries and mines, often confused in everyday language, takes on a crucial meaning here. Both belong to the realm of extraction, but respond to different logics and imaginations. Quarries are places where stone material is extracted: stone, limestone, marble, travertine, tuff, basalt. They operate primarily on the surface or in the immediate subsurface, using excavation processes that maintain a visual and topographical relationship with the landscape. Mines, on the other hand, delve deep underground in search of non-stone materials: metals, coal, salts, useful minerals. Their principle is penetration, not subtraction; their geography is subterranean, invisible. If the quarry opens the Earth to reveal its structure, the mine perforates it to extract its energy. Quarries belong to the sphere of architecture and construction, mines to that of industry and transformation. This difference also gives rise to a different aesthetic perception: the quarry is a wound that becomes a landscape, the mine a womb that closes behind itself. Geology, as the science of the Earth's forms, thus presents itself as a science of origins, a discipline that not only describes physical processes but also illuminates the connections between natural structure and culture. Geological knowledge is not neutral: every rock classification, every stratigraphic or geomorphological map is a way of representing the Earth as a whole, of translating its complexity into language. The geologist, like the architect, works in

sections and planes, interpreting the relationships between layers and interpreting discontinuities as clues to a deeper order. The quarry section, in this sense, is not simply a void, but a diagram of Earth's life. It exposes the continuity between geological and human time, between nature and design. For this reason, geological value must be considered not only as a natural heritage, but as a structural cultural heritage, on a par with art or architecture. Recognizing geological value as the foundation of territorial identity means accepting that the culture of habitation arises from a reading of the Earth. The lithological differences – the solid white of Carrara marble, the pink of Veronese limestone, the gray of Neapolitan tuff, the golden Lecce stone – are not simply aesthetic variations, but expressions of a geological rootedness that has guided languages, techniques, and sensibilities. As Gregotti reminded us, «the territory of architecture is the architecture of the territory»[48]: there is no project without knowledge of the material, and there is no identity without the memory of the land from which it comes. The contemporary notion of geodiversity arises precisely from this awareness. It refers to the variety of geological forms, structures, and processes that compose the planet, analogous to the biodiversity that characterizes the living world. Geodiversity includes rocks, minerals, soils, fossils, reliefs, cavities, rivers, and coastlines: everything that contributes to the Earth's morphology. But, unlike biodiversity, its cultural perception is still recent. For centuries, the Earth was conceived as a backdrop or resource, not as a living system with its own formal autonomy. Only in the twentieth century, with the rise of modern physical geography and environmental awareness, was geodiversity recognized as a value, a necessary condition for ecological stability and for understanding the landscape.

In Italy, attention to geodiversity has taken on increasing importance in recent decades, thanks to European environmental protection policies and the establishment of UNESCO-recognized geological parks and geoparks. However, the full valorization of geological heritage remains a work in progress, often confined to naturalistic disciplines and poorly integrated into planning and design practices. Yet, geodiversity represents a dynamic archive of forms that continuously narrates the transition from natural to human history. Every quarry, every abandoned mine, every exposed rock

face can be read as a document in this archive, as a fragment of the great geological narrative from which civilization has drawn its substance. In the contemporary context, characterized by the progressive depletion of resources and accelerating processes of transformation, geodiversity takes on an ethical as well as scientific value. It calls humanity to measure, to take responsibility, to the awareness that matter is finite and that every intervention on Earth alters a complex and fragile equilibrium. Quarries, in this sense, once again become emblematic places: spaces where the power of nature and the will of man meet, producing forms that are simultaneously wounds and knowledge. Geology is no longer simply the discipline that describes the Earth, but becomes a principle of design: a way of thinking that recognizes matter not as a simple resource, but as a living presence, bearer of history, identity, and meaning. Thus, the discourse on the Earth – the *loghìa* of the *ghè* – reveals itself as the most ancient of narratives, the one that precedes all others, because it is the Earth itself that tells, through its folds and cavities, its own genealogy. Humans, by carving into the Earth's crust, merely continue this tale: their work, their architecture, their cities are the forms through which geology becomes history. Understanding the Earth's reasons, then, means recognizing that every culture, every civilization, every project is born from a profound pact with the matter of the world. Stone, in its mute duration, preserves the very principle of dwelling: it is the memory of the Earth and, at the same time, the condition of our permanence.

2.2. From the history of the Earth to the history of mankind

At the dawn of human civilization, the Earth was not a resource, but a divinity. Humans called her Gaia, Tellus, Cybele: the universal Mother, fertile and terrible, who generates and destroys, welcomes and consumes. All archaic cultures recognized in her the vital principle from which every form descends and to which every form returns. The earth was the womb of origin and the abode of return; digging, carving, or extracting stone from it meant touching the body of the divinity, violating its skin, but also establishing a relationship of trust and knowledge with it. Ancient man lived in a state of ontological symbiosis with the soil that hosted him: matter was not distinct

from spirit, rock was not separate from the sky. In this symbolic context, the first idea of geology was born, not as a science, but as ritual and myth: the attempt to explain the profound unity between human life and the Earth.

The myth of Deucalion and Pyrrha, narrated by Hesiod and then by Ovid in the Metamorphoses (I, 313 – 415)[49], emblematically represents this archaic perception. After the universal flood, the two survivors, by the will of the gods, throw behind their shoulders the "bones of the Great Mother" – the stones of the earth – and from them new men are born. In this reading, all humanity is a second generation of the stone, a direct emanation of the mineral body of the world. Humans do not come from the earth metaphorically, but by filiation. Stone is not inert: it contains a vital spark that, when touched by a sacred gesture, transforms into flesh. It is the same intuition that runs through, with varying accents, the cosmogonies of many civilizations. In the Judeo-Christian tradition, man is fashioned from clay: «Formavit igitur Dominus Deus hominem de limo terrae»[50] (Genesis 2:7). In Mesopotamian mythology, Enki and Ninhursag also mold man from the mud of the Tigris; in Egyptian theogony, Khnum forges the human body on the potter's wheel with clay from the Nile. In all these narratives, the act of creation coincides with the act of shaping: the divinity shapes the earthly matter, and man, in turn, inherits this creative faculty. The technical act and the divine act coincide, and the earth becomes the intermediary between the divine and the human. This genealogy of mud and stone establishes a conception of man as a "geological" being, made of the same matter he inhabits, participating in the earth's matter and subject to its laws. In Greek philosophy, the connection between body and earth translates into an organic vision of the cosmos. Aristotle, in Meteorologica (II, 8, 369b – 370a), distinguishes between animate and "semi-animate" beings, generated by the earth itself. He interprets fossils not as the remains of living organisms, but as figurae naturae, potentially vital forms, not yet fully developed: «ἐν τοῖς λίθοις π ολλάκις φαίνονται ἰδέαι ζῴων καὶ φυτῶν, ὥσ π ερ ἡ φύσις ἐ π εχείρησεν ἐν αὐτοῖς γεννᾶν, ἀλλ᾽ οὐκ ἐτελείωσεν»[51] ("In stones one often sees the forms of animals and plants, as if nature had attempted to generate them, but had not brought them to completion")[52]. Stone thus becomes the threshold between life and matter,

the place where nature attempts generation but stops short of the soul. This conception, although scientifically erroneous, reveals a profound intuition: the earth as a vital forge, as an organism capable of expressing the forms of life even in its mineral state. In Aristotelian thought, the Earth is an active principle, animated by a breath that flows through it. Its bowels are traversed by warm and humid "spirits" that determine its transformations: the action of heat and humidity generates metals and minerals, and the entire geology is assimilated to a natural physiology. This vision will be taken up and transformed in the following centuries by Christian philosophy and medieval scholasticism. Thomas Aquinas, in Summa Theologiae (I, q. 70 – 71), re-elaborates Aristotelian cosmology in light of the theology of creation: the earth, although not endowed with a soul, participates in the divine order, and its fecundity is a sign of the goodness of creation. Fossils, for Thomas, are not "errors of nature" nor simulacra, but effects of the hidden virtues of matter, generated by internal heat or the influence of the stars. In them, the divine nature manifests itself. A formative *virtue* that comes from God through the secondary causes of nature. This idea of the earth as a body endowed with powers, although subordinated to theology, introduces a dynamic vision of matter, which anticipates the modern notion of geological process[53].

During the Renaissance and the seventeenth century, reflection on the Earth gradually emancipated itself from myth and theology to take on a cognitive dimension. Leonardo da Vinci, observing marine fossils in the Alps, intuited that the Earth's crust was a constantly changing palimpsest. In his notebooks, he wrote: «The bowels of the Earth are full of infinite living things»[54]. He recognized that sediments and petrified shells testify to ancient seabeds, and that mountains are not static, but the result of slow uplift. With Leonardo, geology became empirical experience: the Earth was no longer merely a mother, but a knowable organism.

In the seventeenth century, authors such as Niels Stensen, in his "De solido intra solidum naturaliter contento" (1669), founded modern stratigraphy. He argued that each layer of rock represents a phase in time, and that fossils are the remains of living beings embedded in matter. With him, the Earth acquires a measurable time, a history[54]. The idea of instantaneous creation gives way to the notion of duration. Sto-

ne becomes an archive, the quarry a book. At the same time, philosophical thought began to question the temporal depth of the world. Francis Bacon and then Descartes, in the "Discours de la méthode"[55] and in the "Principia Philosophiae"[56], described the Earth as a system governed by mechanical laws: mountains, rivers, volcanoes become the results of physical processes, not divine manifestations. But it was in the eighteenth century, with Buffon and James Hutton, that geology found its own epistemological autonomy. Buffon, in the "Époques de la Nature" (1778), hypothesized an age of the Earth of millions of years and interpreted its transformations as stages of a natural history[57]; Hutton, in 1788, stated: «We find no vestige of a beginning, no prospect of an end»[58]. With these words, The Earth definitively becomes a temporal organism, endowed with cycles, metamorphosis, and memory. The history of the Earth and the history of humanity merge into a single history of living matter.

From this point on, geology will no longer be a simple knowledge of stones, but the science that establishes the planet's profound time. It reflects the same tension that animates civilization: the search for origins, the desire for understanding, the awareness of limits. Human history is but one episode in the long chronology of minerals. From this perspective, every quarry, every excavation face, every cut in the Earth's crust is a window onto time: not an act of domination, but an act of knowledge. "Geology" once again takes on the meaning, in its fullest sense, of a discourse on the Earth: a language that unites science, philosophy, and art. As Humboldt wrote in the early nineteenth century, «mountains are the great chronicles of the Earth, and their language is universal»[59]. They speak the language of form and time, the same language that humanity, for millennia, has sought to translate into architecture and cities. The history of geology, therefore, is also the history of humanity learning to listen to the Earth. From the mythology of mineral generation to stratigraphic knowledge, from symbolic creation to scientific analysis, the common thread remains the same deference to matter: the recognition that every stone on Earth is inscribed in a genealogy that concerns us all. The act of shaping clay, sculpting rock, or extracting minerals is not simply a gesture of production: it is an act of memory and belonging.

2.2.1. Man and Stone

The connection between architecture and stone, therefore, is as old as human history, and this connection is also expressed linguistically and historically, with the two historical segments relating to the evolution of human civilization being designated "Paleolithic" (of the old stone) and "Neolithic" (of the new stone). It is clear, therefore, how much the development of civilization is linked to the wisdom in the use and processing of stone, in order to obtain tools and materials that benefit humans in their essential life activities, such as food procurement, hunting, building shelters and enclosures, and housing. During the first period, related to homo's aptitude for hunting and gathering, and characterized by a nomadic nature due to the need to follow the herds and the ripening times of berries and fruit, the use of stone was of three types: primary, that is, the use of stones and pebbles for splitting and grinding; Secondary, or rather, the use of one stone to strike another to chip it and make it sharp and cutting; and composite, or rather, the use of a worked tool to craft another tool. Stone tools such as knives, spear and arrowheads, mortars, and axes date back to this period. The second period, however (for simplicity's sake, reference to the middle period, the Mesolithic, will be avoided in this discussion), relating to the practice of agriculture, weighing, and livestock farming, is characterized by the production of smoothed – or even polished – stone tools and the creation of objects for decorative, symbolic, or representative purposes. This period also includes archaeological evidence of the production of the first ceramic objects (now classified as artificial stone).

Each of the historical phases of human civilization briefly described above corresponds to different housing models, stemming from different lifestyles. Indeed, while in the Paleolithic, as mentioned, the attitude was that of hunter-gatherer, housing solutions were temporary and of two types: one relating to the construction of temporary shelters, such as wooden huts or huts with wooden supports and tanned hides; and one relating to occasional shelters, such as caves and cavities. The use of stone as a building material dates back to the Neolithic phase, responding to the need for continuous permanence, linked to the principal activities in which man engaged, for the construction of fences, ditches, and stone bases for buildings intended for

residential and ritual purposes. This is why the German philosopher Heidegger, referring to the birth of culture, refers to the invention of the sheepfold[60].

Although these practices – and the associated constructions – characterized human culture until recently, the profound connection humans established with stone, even before responding to their need for seclusion, should not be overlooked. Indeed, it was precisely in the Paleolithic era that humans first established relationships with rock, referring to caves and grottos. Moreover, the most fascinating archaeological discoveries relating to the use of underground environments can be traced back to this period. Examples include the caves of Lascaux, Cosquer, and Chauvet (in France), the caves of Altamira, Hornos de la Peña, and Chufín (in Spain), the Grotta dei Cervi in Porto Badisco, the Grotta del Genovese, and the Grotta dell'Arco (in Italy).



Fig.16 – Rock paintings in prehistoric caves. Source: http://www.lascaux.culture.fr

Furthermore, although each of these was known due to the extremely suggestive painted rock art, they are evidence, as some recent studies demonstrate, of a much more striking fact: in addition to the representations of animal characters and of the usual life in the tribal organizations of the time, there are some signs - up to a certain point considered exclusively decorative - including dots (“.“), lines (“|”) and forks (“Y”), which would refer to an attempt at calendaring, whereby the lines and dots would mark months and lunar phases, while the “Y”s would refer to the periods in which the beasts that primitive man fed on give birth[61]. This, using the internal shell of the cave – which constitutes a *single entity* without any interruptions or distinctions between walls, ceiling, and floor – and represented directly on the rocky nature, would constitute the first form of representation of time through space, or rather one of the greatest intellectual inventions of man, which are still the subject of his current productions in all its declinations (zeroing, contemporaneity, co-presence, dilation, alteration, detachment…).

In the subsequent era, which saw the first megalithic constructions, including menhirs, dolmens, and cromlechs (shown here in their punctual, trilithic, and spatial configurations), rather than dwelling within the rock, humans felt the need to compose (from the Latin cum-ponere: to put together) portions of stone from the same rock they once inhabited. Beyond a symbolic and abstract representation, in which matter becomes form – and no longer matter decorated with shapes – anchored to the ground and rising toward the sky, it appears to be a method of construction that defines spaces. This is the case with the menhirs, which define walls and roofs, and which were also covered with clods of earth on which grass would later grow; and the Cromlechs, which, in the majority of cases that have reached us, are arranged in a circular pattern and which, according to our current state of knowledge, were intended to follow the cycle of the sun and the stars and to connect the perishable matter of man with the eternal matter of the sky. In this sense, it seems that this latter type of configuration is not so dissimilar from the practice of engraving or painting signs on cave walls in order to dominate the temporal component of human life. This appears

even more convincing if one considers the formal correspondence between the circular configuration of these places and the form that derives from the geometric abstraction of the space of a cave. Furthermore, given the technical means available to prehistoric man, the size of the stone blocks used could indicate that extension of continuous rocky material was present inside the cave, and which man did not give up for reasons of transportability. The connection between architecture and stone continued in later eras, with a progressive increase in the size of the ashlars used in masonry. It appears that the advancement of quarrying techniques corresponded to a reduction in the size of the blocks, which, from cyclopean in shape, reached the size of bricks, in a continuous and progressive process of abstraction of the material in function of the formal structure of the architecture, which at the same time became increasingly structured. This was not least in contemporary times, with the use of concrete conglomerates and the invention of reinforced concrete – with the resulting methods of application – whereby the stone material was crushed and even pulverized. Since humans abandoned caves – which did not consume any land – they have continually returned to the bowels of the earth and its rocky ridges, no longer to inhabit them, but to procure building materials. They recreate, above ground and above ground, the environments they inhabited millennia ago, without abandoning their anthropological connection to stone, which guaranteed solidity, hardness, and durability to compensate for the fragility, precariousness, and temporary nature of their existence. Furthermore, the current global architectural interest in underground spaces (whether projects for the redevelopment and conversion of quarry sites or underground architecture excavated directly from the ground – also deriving advantages in terms of insulation, cooling, and energy efficiency) reveals a certain need, beyond caring for the vulnerable landscape, to also return to that engagement with the stone materiality from which humans originate.

2.2.2. Birth and burial of the quarry

In ancient civilizations, the opening of a quarry was never a purely technical gesture. Before being a productive act, it was a ritual gesture that implied contact with the Earth's profound forces. Cutting rock was not just a removal of material, but a vio-

lation of the body of the earth's deity, and therefore required propitiatory ceremonies. In the Greek world, λατομία, or the art of quarrying, was often accompanied by sacrifices dedicated to chthonic deities – Plouton, Gaea, Demeter, Kore – so that the earth would "grant" its substance without unleashing catastrophes. As Pausanias (De lapidibus, IX, 39)[62] and Theophrastus (De Lapidibus, chap. 6)[63] recall, before beginning excavation, offerings of wine or milk were made on the first cracks in the stone, a rite of pacification with the soil. The quarry, like the mine, was considered a dangerous threshold between the world of the living and that of the subterranean gods: a gateway to the unknown, to the invisible.

Even in Rome, the opening of a quarry took place on days considered auspicious and under the authority of the magistrates, who symbolically consecrated it to *Tellus Mater* or to *Silvanus*. According to Varro (De Lingua Latina, V, 74)[64] and Pliny (Naturalis Historia, XXXVI, 42 – 47)[65], travertine quarries were often marked by votive shrines or inscriptions bearing the name of the local tutelary deity. In this way, the act of quarrying also became a civic act: the material that founded the city was taken from soil that had first been made sacred. Similarly, the closure or decommissioning of a quarry was accompanied by rituals of restitution. The Earth, stripped of its material, had to be "reconciled". In many cultures, the void left by excavation became a burial or cult space. In the pre-classical Mediterranean, hypogea and rock tombs were often excavated in the areas of ancient quarries, as in the necropolis of Pantalica in Sicily (12th – 8th centuries BC), studied by G. Voza ("Pantalica. The Necropolis and the Inhabited Area", 1996).

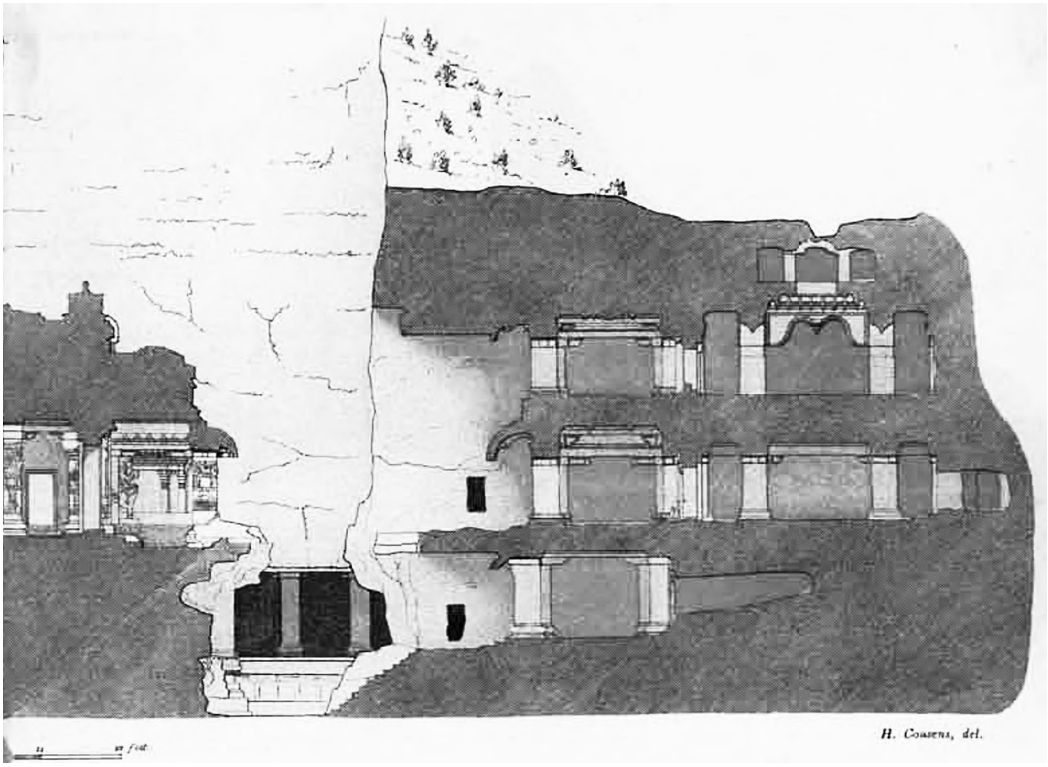

Fig. 17 - Transverse section of the Kailasha Temple (Cave 16) at Ellora, illustrating the rock-cut structure carved from top to bottom, with three levels of sanctuaries and pillared halls integrated into the monolithic mass. J. Burgess (1883)

Here, the limestone, already cut and quarried for construction, became funerary material, transforming the act of extraction into the act of burial[66]. Similarly, in the Etruscan tombs of Cerveteri and Tarquinia, dug into tuff beds[67], the structure of the quarry is still visible in the flat ceilings and the pillars left to support the vault: the world of the dead reproduces the home of the living, but within the body of the earth. In the Roman world, this relationship of continuity between quarry and tomb was further developed with Christianity. The catacombs of Rome – San Sebastiano, Domitilla, San Callisto – are largely located within ancient pozzolana and tuff quarries[68]. The tunnels originally intended for excavation were reused as funerary galleries and oratories: the place of material production became a place of spiritual salvation. In Chri-

stian topography, the subsoil was transformed into a place of refuge and hope, a symbol of descent and resurrection. The same phenomenon is found in other cave civilizations, where the relationship between quarry and habitation became structural. In Cappadocia, Anatolia, ancient volcanic tuff quarries, already exploited in the Hittite and Roman eras, were transformed into troglodyte dwellings and rock-hewn churches[69]. Villages like Göreme, Derinkuyu, and Kaymaklı still form a "negative" landscape today, where the quarry coincides with the city. Here, excavation does not destroy but constructs: the house is carved out, not built. The same occurs in the Sassi of Matera, where, as Pietro Laureano recalls[70], the tradition of quarrying calcarenite has generated a *continuum* between natural and constructed space. The stone, excavated and reinhabited, becomes living architecture: the "wound" is transformed into form.

In the modern world, the symbolic and functional transformation of the quarries continues, adapting to new historical conditions. In Paris, the large *limestone quarries*, used for centuries to build the city, were converted in the 18th century into public catacombs, a vast ossuary housing the remains of over six million people. As Philippe Artières writes, the city built above and the city of the dead below represent two faces of the same urban organism: the quarry is not only the source of material, but also the site of collective memory[70].

In Naples, the network of yellow tuff quarries, extending beneath the city, has been reused over the centuries as cisterns, air raid shelters, and storage facilities, and today as museum spaces and tourist routes[71]. In this case, the functional continuity between the quarry and the city is almost organic: the underground becomes a second urban level, a parallel and protective architecture. The idea of the quarry as a sacred threshold or the womb of the earth survives even in modern and Romantic sensibilities. In the 18th and 19th centuries, abandoned quarries were often reinterpreted as landscape elements or as places of meditation on nature and time. The quarries of Tivoli and Guidonia, from which travertine was quarried for Rome, were included in the pictorial circuits of the Grand Tour and depicted by Piranesi and Turner as "natural ruins", where the action of human labor merges with that of geological[72]. Similarly, in the nineteenth century, the pietra serena quarries of Fiesole and Settigna-

no, places where Michelangelo and the master Tuscan stonemasons trained, were reinterpreted as spaces of the memory of the craft[73].

This long history reveals that every quarry, once exhausted, tended to be re-signified: inhabited, sacralized, musealized, theatricalized; and that the practice of abandonment is a characteristic of the contemporary era, stemming from the cultural degeneration of human positivistic domination over the world, which has led to the disfigurement of the place we inhabit. The abandoned quarry thus becomes, and must return to being, the symbol of a return to habitation: what was taken from the earth is returned as architecture, as worship, or as memory.

Today, contemporary reuse practices – from the mining parks of Tuscany to the *Carrières de Lumières* in Baux-de-Provence, where limestone walls become surfaces for immersive art projections – continue this tradition, which has emerged as a millennia-old continuity. As Anne-Marie Sankovitch observes «the quarry is not just a scar, but a wound that heals by producing culture»[74].

2.3. Protection measures: gaps and opportunities

Throughout history, as mentioned, the opening and closing of quarries has been accompanied by practices of signification: ritual, cultic, or aesthetic. They mark the transition between the history of the Earth and that of humanity, between matter and memory. Opening a quarry meant establishing a dialogue with the telluric deity; closing it meant giving it back its voice, offering its voids a new purpose. Thus, the quarry, from a wound, becomes a refuge: a place of passage and revelation, where the Earth and humanity continue to negotiate their balance. However, this negotiation is an ontological, ethical, and consubstantial transition that contemporary times have forgotten.

In the global landscape, there are places where morphology, signs of human settlement, and territorial transformations tell a story closely connected to that of humanity, to economic, social, anthropological, and architectural events. This is the case with quarries and the systems of cultivation and extraction of mineral resources essential to the growth of human society. Indeed, the system of quarries present

throughout the country, especially in Italy, provides us with evidence of a historical past and a contemporary era that provides insights into the historical phases of civilization, as well as into architecture, art, urban planning, the creation and transformation of cities, the rural environment, and the landscape. The diverse orographic, geological, and mineral composition of the territory has contributed, throughout its historical vicissitudes, to its economic, political, and artistic growth and wealth.

Below are some examples of quarries that have played a significant role in the history of Italian art and contributed to the creation of works and phenomena of great historical and cultural value: the Botticino Quarries in Lombardy are famous for their Botticino marble, widely used in architecture and sculpture in Italy and abroad; the Carrara Quarries provided the white marbles that were a key element of the Tuscan Renaissance; the Tivoli Travertine Quarries, located near Rome, provided the stone for numerous Roman architectural works, including the Colosseum, the Arch of Constantine, and St. Peter's Basilica; the Trani Quarries in Puglia are known for their high-quality calcarenite stone used in the construction of outstanding Romanesque buildings, including Trani Cathedral; The quarries of Lipari, in the Aeolian Islands, from which pumice stone and obsidian were extracted, both used since ancient times for various purposes, including the construction of buildings and artifacts linked to the islands' traditions, as well as the production of hunting tools and being the object of exchange in the first forms of trade.

However, as a counterweight to the social, economic, and cultural development of civilization, quarrying activities, especially stone quarries, have led to land consumption and an indelible imprint on the landscape. This, particularly when the resources contained therein have been exhausted, has left scar-like incisions on the landscape, resulting in a considerably high environmental impact. Furthermore, the rapid quarrying and extraction of stone resources – especially using modern and invasive tools and techniques – entails rapid transformation that fails to respect the natural recomposition of the static and mechanical balances of the environment, in which time plays a fundamental role. This creates risks and damage, not only to the affected rock surface and the landscape, but also to the environmental safety and life

of the natural systems and ecosystems that exist in the vicinity of the quarries. Therefore, the urgency of regulating quarrying activities goes hand in hand with the need to redevelop abandoned quarries.

Over the past thirty years, this topic has been the subject of a national and international debate that has intensified in the last decade and has led to the formulation of general guidelines, which constitute the basis for the definition of regulations and laws. However, in many cases, these guidelines are aimed exclusively at securing the affected sites without defining a program for their re-contextualization and re-functionalization with a strategic vision for the sustainable development of the relevant municipalities, or in dialogue with the contemporary landscape. In the contemporary international and more specifically European landscape, it is clear that some cities, together with local governments, are undergoing an economic transition with a sustainable and eco-friendly vision. This transition aims to define a society and a political system more sensitive to environmental issues, with a view to economic and cultural innovation. Education and scientific research play a key role in protecting landscape assets and environmental resources. This is in an emerging cultural context where architecture can significantly contribute to design through a dialogic approach that integrates the urban context, the rural environment, and the productive system with which it interacts, intersecting and intertwining. Architecture acts as a guide and measure of transformation (or, more precisely, of re-transformation and systemic reintegration), and furthermore acts as a driver of social, economic, and cultural development, as well as of tourist attraction. In this context of sustainable regeneration, cultural and cave heritage represents an ideal territory for investigating the relationships between environmental contingencies and specificities, and architectural strategies for territorial reconnection, both generally and specifically, for the protection, preservation, and recomposition of the margins carved into the landscape at the margins of the urban context, which have nevertheless interacted or are interacting with the latter in historical, anthropological, social, and cultural terms.

The issue of protecting quarry landscapes lies at the threshold between environmental protection, cultural heritage valorization, and land-use planning. Quarries, a

site of production and transformation, have rarely been interpreted as heritage; yet they constitute one of the most explicit manifestations of the historical relationship between humanity and the Earth. If, as Salvatore Settis writes, «there is no protection without recognition»[75], the primary challenge lies precisely in recognizing the cultural, ecological, and identity-building value of quarry sites, beyond their productive function or their perception as scars on the landscape.

The Italian legislative framework regarding the protection of quarry landscapes is complex and multilayered, and the relevant body of legislation is inadequate and fragmented. Royal Decree No. 1443 of July 29, 1927, "Legislative provisions to regulate the exploration and exploitation of mines in the Kingdom", represents the first comprehensive text of unified mining legislation in Italy, still largely in force today, although profoundly modified by subsequent reforms76. It was enacted at a time when the fascist regime's industrial policy aimed to reaffirm state control over subsoil re-



Fig. 18 – Aerial view of a large calcarenite quarry in southern Italy, showing extraction benches, processing facilities, and the surrounding agricultural landscape. Image courtesy of A. Reina

sources, conceived as strategic assets of the nation. The *rationale* of the decree is already contained in Article 1, according to which "mines belong to the State", while private individuals are granted only the right to explore and exploit them, subject to administrative concession. The founding principle, originating in the 19th century but reinterpreted in an authoritarian manner, is that of the legal separation between ownership of the land and ownership of the subsoil. Land, in its mineral dimension, is no longer a private domain, but part of the economic body of the State. The decree is the first act to clearly distinguish between mines and quarries, establishing two different legal regimes: mines (Articles 1 – 3) include deposits of metallic substances, fuels, salts, and minerals of significant economic value, and fall under state jurisdiction; quarries, on the other hand, which involve the extraction of construction materials (ornamental stone, limestone, clay, sand, etc.), remain private property and are subject to less stringent regulations, based on local authorization. This distinction, born of production needs, has had profound consequences for the perception and management of extractive landscapes. Mines, considered strategic, have been the subject of census, protection, and safety policies since their inception; quarries, on the other hand, have long remained marginalized by public planning, viewed as economic activities of local interest rather than as structural components of the national landscape. The approach of Royal Decree 1443/27, while reflecting the logic of the times, introduced a dichotomy destined to endure: that between economic resources and territorial assets. While the law implicitly recognizes the need for public oversight of non-renewable resources, it also reduces their cultural and landscape dimension, confining them to the realm of production. Significantly, the entire text lacks any reference to environmental impact, ecological safety, or soil reconstitution: the Earth is still understood as a "body to be exploited", not an "environment to be protected".

After the Second World War, the Italian Constitution (Articles 9 and 117) and subsequent regional legislation profoundly changed the context, establishing landscape and environmental protection as primary values[77]. However, Royal Decree 1443/27 remained the legal framework for classifying minerals and assigning responsibilities, and was further referenced in Presidential Decree 616/1977[78] and Legislative Decree

112/1998[79]. In this sense, the 1997 law represents a sort of archaeological foundation for modern mining regulations: a text that, although conceived from an industrial and centralist perspective, defined the coordinates of a system that is still in force today, albeit outdated and highly inadequate to the changing needs of contemporary society. On a cultural level, the decree also marks the end of an era in which the relationship with the land was mediated by local and customary practices. The nationalization of the subsoil marks the transition from a proximity economy to an extraction economy: the quarry, from a place of territorial knowledge, becomes a cog in a national production system. As Vittorio D'Angelis observes, «the Royal Decree of 1927 is the first legal manifestation of the modern idea of land as state infrastructure, not as community landscape»[80].

Since Law 431/1985 – the so-called Galasso Law – the principle has been established that areas of landscape and environmental interest must be subject to restrictions and integrated planning. However, the law does not explicitly mention quarry sites, which are generically classified as "landscape assets" and "areas of particular geological or geomorphological interest"[81].

Only with Legislative Decree 42/2004, the Cultural Heritage and Landscape Code, did the notion of landscape expand beyond the aesthetic dimension to include "the identity aspects deriving from the natural, historical, and morphological characteristics of the territory" (Article 131)[82]. This definition paves the way for the recognition of production landscapes, but in administrative practice, quarries remain excluded from direct protection categories, except as "geomorphological assets" or "abandoned areas of naturalistic or archaeological value". In Italy, jurisdiction over mining activities is entrusted to the Regions, by virtue of Presidential Decree 616/1977[83] and the subsequent Legislative Decree 112/1998[84], which transferred the management of mineral resources to local authorities. This has led to considerable regulatory fragmentation: each Region has its own laws and regulations, often oriented more toward economic planning than landscape protection.

The Puglia Region, for example, implemented the state mandate with Regional Law 37/1985 (Regulations for the regulation of extractive activities), but did not fully

contextualize quarry management within the landscape framework defined by the Regional Territorial Landscape Plan (PPTR, 2015)[85]. The plan recognizes "geomorphological and lithological systems" as landscape components, but does not translate this recognition into active protection tools for abandoned or depleted quarries.

Consequently, in the absence of national coordination, the protection of extractive landscapes in Italy remains episodic, entrusted to individual initiatives by local authorities, parks, or cultural institutions. This highlights the lack of national coordination regulating extractive activities, the accuracy of deposit plans, and the requirements for landscape restoration and care.

At the international level, attention to geological and mining sites as cultural heritage is more advanced. UNESCO, with its Global Geoparks programme (2001), introduced an integrated vision of geological heritage as an educational, touristic, and environmental system. Italy, with eleven recognised geoparks, has partially embraced this perspective, but such recognitions rarely include former quarries or historic extraction sites, except as marginal elements. Similarly, the European Landscape Convention (Florence, 2000) and the Syracuse Charter on Biodiversity (2010) have promoted a concept of protection extended to all landscapes, including "ordinary and degraded" landscapes. However, the concrete application of these principles remains weak, especially in areas where quarries are no longer productive but not yet regenerated. This regulatory vacuum is not only administrative, but cultural. Italian landscape thinking – from Rosario Assunto to Saverio Muratori, from Cesare Brandi to Bernardo Secchi – has recognized that protection cannot be limited to the conservation of what already exists, but must extend to the recognition of forms of change. The quarry, as a space of transformation, belongs precisely to this category. It is a landscape in motion, where human intervention and natural processes interact dynamically. As Alberto Magnaghi writes, protection is not the arrest of transformation, but the knowledge of its codes and the ability to manage it sustainably[86]. This approach implies a redefinition of the very concept of protection, no longer understood as a prohibition or constraint, but as a project of co-evolution between humanity and nature.

Disused quarries today represent a critical frontier for conservation policy. They encompass three interdependent dimensions: the historical memory of production, environmental vulnerability, and planning potential. However, current legislation continues to treat them according to sectoral rationales – environmental, mining, or urban planning – without a unified framework.

European legislation offers tools that could fill these gaps – from the Habitats Directive 92/43/EEC[87] to the Green Deal (2019)[88] and the New European Bauhaus (2020)[89] – but their implementation requires a conceptual leap: recognizing quarries as cultural ecosystems, not simply remediation sites. The ISPRA strategy for the "renaturalization of abandoned quarries" (2021 Guidelines) goes in this direction, proposing an integrated approach that combines ecology, geology, and culture. However, its implementation is still experimental and fragmented. From an operational standpoint, the main protection gaps in Italy concern: the lack of a specific category of landscape asset for quarry sites, recognizing their historical, geological, and anthropological value; the absence of national guidelines for post-extractive management and landscape restoration from a heritage perspective; the weak integration between economic planning tools (quarry plans) and landscape planning tools (territorial plans and PPR).

The recent attention to "production landscapes"[90] and "work heritage"[91] opens up new possibilities for interpreting quarry sites. The quarry, far from being a fracture, can become a place of mediation between environment and culture, a space for geological education, public art, and sustainable reuse. European experiences of mining geoparks (such as the *Parque Minero de Riotinto* in Spain or *the Great Orme Mine* in Wales) demonstrate that protection does not imply immobility, but conscious transformation. In Italy, virtuous experiences can be found in Carrara, where the Fondazione Marmo and the Tuscany Region have promoted the cultural valorization of historic quarries, and in Custonaci, Sicily, where the Cusa quarry, an ancient source of the temples of Selinunte, is now a protected archaeological and landscape area. Protection, from this perspective, is no longer the opposite of transformation, but its completion. It coincides with the awareness that geological and extractive heritage is

an integral part of collective identity. As Cesare Brandi writes in “Teoria del restauro”, the material of the work is its history, and its history is in the material[92]. Similarly, the quarry is not a void to be filled, but a material of history to be interpreted.

The issues to be resolved in the contemporary era, then, consist of moving from "protection" to "protection planning" and defining a model in which regulatory mechanisms are not barriers, but tools for regenerating relationships between the natural, cultural, and productive components of the territory. This model also addresses the issue whereby measures to protect quarry landscapes in Italy still reflect an asymmetry between theoretical awareness and administrative practice. But precisely in this gap, opportunities for a new paradigm arise: a regulatory system capable of recognizing geodiversity as a cultural heritage and transforming the history of extraction into a resource for ecological transition. Protection, then, will no longer be merely a defense of the landscape, but a care for its evolution, recognizing stone not as the source of the wound, but as the condition for its healing. And in this scenario, the architectural design tool becomes the rule and measure of transformation, reestablishing connections with the spatial matrices and the intrinsic and extrinsic qualities of the material with which it interacts.

3. SOME SPATIAL ISSUES

In quarry structures, the form of knowledge and ability to interpret the landscape is manifested through the experience of space, which here is not constructed, but subtracted; it is not generated by addition, but by removal. The quarry landscape is the tangible demonstration that architecture does not coincide with solidity, but rather with the relationship between solid and void, between matter and absence, between light and shadow. For the culture of design, quarries represent one of the highest metaphors of space as an event that reveals the form already inscribed within the mass. Reflection on space, since the origins of Western thought, has been pervaded by a tension between the solid and the hollow, between the *Platonic chôra* – the receptacle, the matrix of forms – and the ἐντελέχεια *(Aristotelian entelécheia)*, the realization of power in matter. In the quarry, this opposition finds its most concrete representation: rock becomes space, depth becomes form. As Gaston Bachelard writes «every excavation is a return to the cradle of matter; the underground refuge is the primordial form of dwelling»[93]. In this sense, the quarry is therefore an anthropological figure of dwelling – an original gesture in which man confronts the earth to rediscover his own dimension.

If the history of geology recounts the evolution of the Earth, the history of architecture recounts the evolution of its space. The two dimensions coincide in quarry sites, where the technical and the poetic are intertwined. Cutting a rock produces a section, and the section – as Aldo Rossi recalls in his “Autobiografia scientifica" – is the purest form of architectural knowledge: «The section is the measure of reality, it is what allows us to understand construction, the way things are»[95], and this is also evident in the hollow section of quarry sites.

In architecture, emptiness is not a lack, but a structuring presence. Louis Kahn defined it as «the will to nothingness that generates form»[95], and this definition perfectly reflects the essence of quarry space: a void filled with energy, charged with tension, in which the surrounding material becomes a frame and measure. The spatial dimension of the quarry is also a temporal dimension: the quarry is an "inverted con-

struction site", where the excavation phases correspond to the plans of an invisible building, whose architecture coincides with the memory of its making. As Giorgio Grassi observes, «architecture is never creation from nothing, but an act of recognition of what already exists»[95]. In the quarry, this principle becomes literal: the act of excavation does not produce the new, but reveals the old, freeing the space contained within the material.

From a perceptual perspective, the quarry space is a liminal experience between interior and exterior. Unlike traditional construction, which separates the interior from the landscape, the quarry creates continuity between them: the inside arises from the outside, and its form depends on the consistency of the rock, the light, the temperature, the humidity. And at the same time, it is a space that thrives on gravitation, weight, and pressure. Where traditional architecture constructs the surface, the quarry constructs depth. It is both landscape and a section of the landscape; it does not represent nature, but reveals its structure. The relationship between quarry and architecture thus becomes a problem of scale and perception. The person entering the quarry experiences disproportion: the expanse of the void, the verticality of the cuts, the density of the stone. It is a primordial, almost mythical experience, which harks back to the origins of dwelling. In Genius Loci, Christian Norberg-Schulz reminds us that «to dwell means to belong to a place that possesses a center and a depth»[96]. The quarry is, in this sense, a radical form of dwelling: a center that coincides with absence, a depth that becomes refuge. It constitutes the reverse of the urban landscape, yet retains the same spatial logic. The relationship between below, inside, and above – which will be analyzed in the following paragraphs – pervades the entire history of human culture.

Every civilization has constructed its own spatial order based on these three symbolic planes: the sky as the dimension of the invisible, the earth as the horizon of action, the subsoil as the place of origin and return. In the quarries, these planes touch. The sky penetrates the earth through the light that falls from the vertical cuts; the ground opens up in depth; and the space "in between" becomes the theater of human presence.



Fig. 19 – Aerial view of the Apricena quarries (Apulia, Italy), one of the largest extractive districts in southern Europe, showing the extensive system of open-pit calcarenite and limestone excavations integrated into the agricultural plateau. Image courtesy of A. Reina

In this sense, the quarry is not a marginal place, but a cosmic threshold, a point of contact between elements. Even matter, from this perspective, takes on a spatial function. Stone becomes a formal principle: that which defines the measure, density, and temperature of space. As Merleau-Ponty writes «matter is not an obstacle to form, but the condition of its visibility»[97]. The quarry makes this truth visible: here, matter becomes space, and space, matter.

From this awareness arises the concept of negative architecture, which will be developed in the third section. The quarry is, in effect, a model for thinking of architecture not as a sum of volumes, but as the intelligence of emptiness. Construction and subtraction become two mirrored acts: one builds by addition, the other by removal. Both are forms of design, but only the second restores the profound measure of the relationship between humanity and the Earth. Thus, speaking of "spatial questions" means interrogating the very categories of architecture: the below, the inside, the void, or the ontological conditions of space, all simultaneously contained within the space of the quarry: it is below because it excavates the Earth's crust; it is inside because it envelops the body and modifies its perception; it is empty because its form is determined by absence. In this sense, it constitutes a paradigm of primary space, a laboratory for rethinking the relationship between construction and excavation, between time and matter, between nature and design.

As Italo Calvino writes in “Le città invisibili”, «the city is built with stones, but it is their arrangement that makes it live»[98]. Similarly, the quarry does not live in the stone it removes, but in the space it leaves, in that interval that separates and unites, like a deep breath of the Earth.

3.1. Below, inside, between sky and earth

In Heidegger's reflection on building and dwelling, we encounter one of the most essential formulations of the human condition in space. In “Bauen Wohnen Denken”, Heidegger states:

«Man dwells as a mortal. He dwells to the extent that he saves the Earth, welcomes Heaven, awaits the Divine, and accompanies mortals. These four, Earth and Heaven, the Divine and Mortals, belong in a mutual unity. Building is properly dwelling, and dwelling is the way in which mortals are on Earth»[99]

It is in this passage, perhaps more than any other, that the notion of "the squaring of the world" manifests itself, in which the position of man is not a simple physical location in space, but an ontological tension between the elements that constitute it: the low and the high, the finite and the infinite, matter and spirit. Man therefore lives suspended between the ground and the sky, rooted and reaching out, confined and open to the transcendent. Dwelling, from this perspective, is not a matter of location, but a form of relationship: a way of belonging to the Earth and, at the same time, of existing "under the sky". The human being, says Heidegger, is "he who dwells", and dwelling is what distinguishes him from the simple occupation of a place. Dwelling is the symbolic form through which man recognizes his own limit and transforms it into a world.

Transferred to the question of quarries, this concept takes on a particularly intense meaning. The quarry represents the point where the Heideggerian position of man – between Earth and Heaven – is reversed and deepened. If traditional dwelling is situated on the surface, in the measure of soil and breath, quarry dwelling is situated beneath the Earth, within matter, yet between Earth and Heaven, in the intermediate zone where light penetrates and gravity still dominates. The worker, the architect, or the inhabitant who enters the quarry space does not look at the sky from above, but from below: he perceives it as a distant opening, a luminous interstice. His relationship with the Earth is not one of possession, but of immersion; it is not domination, but recognition. The quarry is, in this sense, an inverse figure of Heideggerian dwelling: a topology of interiority.

If on the surface, humans experience Earth as foundation and Heaven as measure, underground they discover Earth as envelope and Heaven as distance. The space beneath the Earth is not an absence of world, but another modality of the world, a threshold where gravity becomes a tangible presence, and light a rare and precious event. In the quarry, matter itself becomes the horizon. Where built architecture tends to mediate between Earth and Heaven through verticality, excavated architecture – like quarry architecture – replaces verticality with depth. It does not rise, but retreats; it does not conquer space, but welcomes it.

As Merleau-Ponty notes «to see is to enter a universe of beings that reveal themselves»[100], but what reveals itself, in the cavities of the Earth, is the very substance of being: the thickness of the matter that supports the visible world. The quarry reminds us that space is not a neutral extension, but a body endowed with density and memory, and that descending beneath the earth means traversing time and space in a single gesture: each meter of depth corresponds to millions of years of sedimentation, a stratification of geological and human events: architecture that grapples with this depth cannot help but become, in turn, an act of knowledge. The quarry thus becomes a privileged place to rethink the relationship between design and environment, because in it the ground is not simply a support, but an interlocutor. The condition of "being beneath" is epistemological: it means accepting the minority position of human action in the face of the power of the soil, recognizing that every project is first and foremost a reading of the Earth, a translation of its profound logic. The act of excavating reveals a spatial knowledge older than construction itself: the knowledge of limits, of resistance, of gravity, and it is in this understanding of depth that contemporary design seems to have lost in its tension toward surface and lightness. To this experiential dimension, another is added: that of the "inside". Being inside the earth means being welcomed into a body, whereas the underground space is a uterine environment, where sound is muffled, light rarefied, and temperature constant: conditions that overturn the sensorial parameters of external architecture and require a new way of thinking about light, breath, and the perception of boundaries. In these conditions, design can no longer simply construct forms, but must orchestrate balances: between air and stone, between shadow and luminosity, between weight and silence. The architect, in this context, has the responsibility of dealing with an atmospheric condition, a balance between forces that oppose and interact.

Finally, the dimension of the "between" – between heaven and earth – introduces the theme of the threshold. The quarry is a place where the "between" materializes: a gap where the technical and the natural meet. It makes visible the continuity between the natural and the constructed world, and forces the project to

confront the precariousness of this relationship. The space "between" is, in reality, the authentic locus of architecture, because it is the space of inhabitation: not the totally natural, nor the completely artificial, but the one born from the interaction and resolution of the tensions that exist between the two. The quarry project – intended not merely as recovery or reuse, but as a form of interpretation – must therefore operate within this gap, accepting that its form is never autonomous, but the consequence of a dialogue. In it, "building" once again coincides with "dwelling", because both are based on a relationship of belonging and not of domination, further adhering to the paradigm outlined by Heidegger, who does not distinguish between building and dwelling because both conditions pertain to the same experience of the world: that of being in the middle, between what supports and what transcends, between the Earth that welcomes and the sky that calls. In the quarry landscape, this condition manifests itself in a concrete form: man truly finds himself beneath the Earth, immersed in his body; within the Earth, enveloped in its silence; and between heaven and earth, at the point where matter opens to the light.

Any project that engages with such spaces cannot help but begin with this triple tension, which is both ontological and design-related. Architecture, here, does not construct a place, but reveals it: it does not create space, but experiences it. And perhaps, precisely in this inversion of the architectural gesture – from building to understanding, from elevating to penetrating – lies the possibility of a new foundation for dwelling: a dwelling that seeks not to dominate the Earth, but to save it; that seeks not to affirm form, but to comprehend it. The quarries, in their capacity as wounds and refuges at the same time, represent one of the few places where this ancient truth can once again be experienced: places where the earth is not merely matter, but a dwelling place; and where man, standing between heaven and earth, rediscovers the measure of his own being.

3.2. Matter and Void

The architecture of the quarries, generated by subtraction rather than accumulation, makes visible the original relationship between matter and void: a relationship that is not oppositional, but dialectical, and which determines the very

possibility of space. In the quarry, form does not impose itself on matter, but springs from it; geometry does not organize the stone, but follows its structure. Where the cut occurs, the void becomes shape, and matter reveals itself in its most intimate degree of resistance and light. The quarried landscape testifies that space is not an abstract entity, but the result of tension: it is the measure that emerges when matter yields, when the Earth allows itself to be wounded and a habitable cavity opens within its body. In “El vacío. Reflexiones sobre el espacio en la arquitectura” Fernando Espuelas writes: «The void is not a gap between things, but the condition that makes them possible. Without the void, matter would have no form; without matter, the void would have no measure. Architecture is the art of maintaining this duplicity in balance, of giving order to the tension between that which weighs and that which is unseen»[101]. This statement summarizes the core of a theory that restores matter to its ontological value and the void to its generative dimension. For Espuelas, the void is not the negation of matter but its necessary correlate: it is the “invisible part of matter”, that which supports and reveals it. In this vision, the quarry becomes the paradigmatic place where this relationship finds a concrete form: space is born from excavation, and excavation is an act of knowledge, a way of measuring the earth through loss. Espuelas describes the void as a perceptual substance, as the dimension in which material transforms into language. «The void is what allows light to enter and matter to speak. It is the condition of architecture's breath. Its meaning does not reside in absence, but in availability, in the suspension that precedes every form»[102]. This definition recognizes an affinity with the spatiality of quarries: in quarries, in fact, the void is never pure: it is always a void inhabited by gravity, by stratifications, and by the traces of human labor. In his second text, "Madre Materia", Espuelas further elaborates on this vision: «Matter is the principle of all architecture, not as substance, but as a memory of forces. It bears the laws of its formation, and the architect cannot help but follow them if he wants the work to endure. The void, in this sense, is the reverse of matter: its visible interiority, the proof of its willingness to become world»[103]. Matter thus becomes the mother of all construction, not in the physical sense of heaviness, but in the ontological sense of generation.

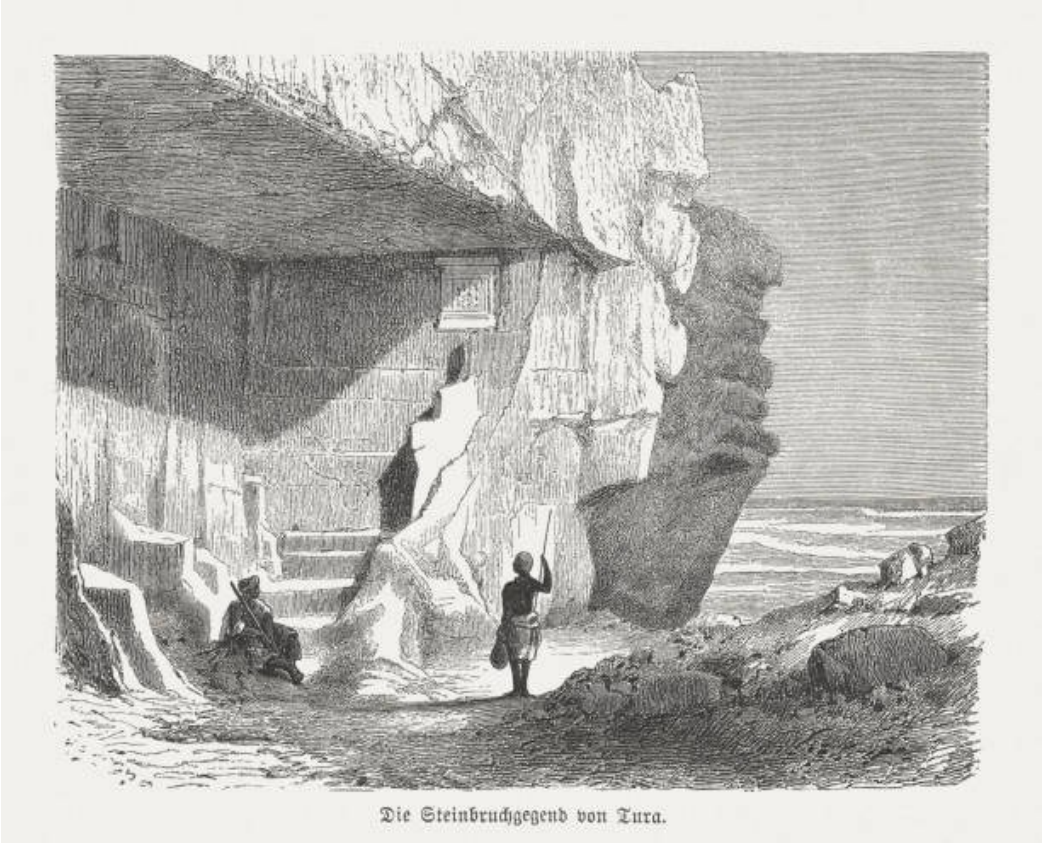

Fig. 20 – The limestone quarries of Tura, Egypt. The engraving highlights the interplay between matter and void: the rock's mass, shaped by human excavation, becomes architecture itself, revealing the spatial tension between the carved surface and the hollowed interior. K. R. Lepsius, "Memphis, à l'ombre des pyramides", jean capart, 1930

Quarry architecture, excavated, carved, and sculpted, bears witness to this motherhood of the Earth: rock is not an obstacle, but a womb. The resulting void is not a neutral space, but the vital residue of an original gesture that laid bare the very structure of reality. Rafael Moneo's thought, while moving in a more theoretical register, finds a profound affinity with this theme. «Building always means establishing an order in matter. But this order is not imposed, it is discovered. Architectural form is not the result of an abstract idea, but rather the manifestation of a desire for permanence that matter embraces and resists. The architect does not

create from nothing: he organizes the void that matter allows him»[104]. This "strategy of the void" coincides with Espuelas's intuition: the material does not allow itself to be possessed, but rather yields according to rules that the project must interpret. In the quarry, this interpretation becomes a tangible action: the project does not build against the stone, but from it; it does not invent space, but measures it. Moneo continues in “La vida de los edificios”: «Every architecture, however abstract, is based on an experience of matter. It gives us back a sense of reality through resistance. Matter limits and opens at the same time, because it is only in the limit that place manifests itself. And place is, ultimately, the configuration of emptiness»[105]. Place is therefore not a pre-existing entity, but an event that occurs in the interaction between matter and emptiness. The quarry, in its physical form, makes this condition visible: place is not given, but produced by the tension between what is removed and what remains. From this perspective, the contemporary project that engages with the quarry landscape cannot help but assume matter as its beginning and emptiness as its end. The former offers the memory of the gesture, the latter the possibility of form. Matter carries within itself geological time, emptiness introduces human time. As Espuelas states, «matter is never immobile; it always tends to make space for itself, and architecture is the place where this tendency finds its measure»[106]. The responsibility of the project lies in this measure: every intervention on the quarry must be an act of restitution, not of appropriation; it must recognize that the material, in becoming empty, has already built. Moneo's and Espuelas's reflections, therefore, converge on one essential point: architecture is not born from form, but from the relationship between what remains and what is missing. Emptiness is a consequence of matter, not its negation; it is the hidden face of construction. Every quarry, once abandoned, becomes, beyond the project, a sort of relic of the making: a space in which the wounded material continues to speak through silence. In this idea, which is linked to an ancient yet very modern sensibility, we can read the essence of a new building ethic: the recognition that the Earth is not just matter to be shaped, but a body to be cared for.

3.3. Negative Architecture

Architecture, in addition to identifying a logical, ontological, and chronological presupposition in the quarry, also articulates its connections in terms of mutual belonging to it and the formal phenomena that can be traced in the stone walls, identifying not only the traces of the extraction gestures, but also the testimonies of the forms that remain in the stone not yet quarried.

The constructed form presupposes its reverse, a hidden counterpart that preserves its origin: the place where the material, before being shaped, resisted; and quarries reveal this origin directly, because in them, architecture reveals itself through contrast – not as presence, but as the potential of the material. The quarry, in its essence, is architecture in negative: not an emptied building, but the place where construction announces itself without yet happening.

The implicit design of every future construction can be read in the quarry facades, and their spatiality is not so much the outcome of extraction as the primary condition of all architecture. It is in this sense that Cesare Brandi can be remembered when he wrote that «every work that survives time bears within itself the gap as a sign of truth»[107]: in the same way, every quarry demonstrates the truth of construction as a process of loss: form is born where matter retreats. The idea of "negativity" as a form of knowledge also pertains to the thought of Giorgio Grassi, for whom design is not invention but recognition. In "La costruzione logica dell'architettura", he states that architecture invents nothing, but reorders the world that already exists.[108] The quarry can therefore be understood as the prefiguration of the building, the negative of the city; and what remains in the facades is the primary writing of the architectural form.

This "reverse design" is particularly evident in some exemplary locations in the Mediterranean and European quarrying landscape.



Fig. 21 – Negative of architecture: friezes carved directly into the quarry wall. Prun quarries, Verona area, where ornamental details emerge not as added elements but as excavated matter, revealing the direct dialogue between stone, craft, and void. Photo by the author

In the Prun quarries, on the Veronese plateau, the soft stone bed was excavated underground, in chambers or galleries, revealing actual architectural walls, on which appear the remains of cornices, moldings, friezes, and rough-hewn recesses: elements not yet quarried, but already carved into the parent rock. There, architecture manifests itself in its embryonic state, held within the material, like a figure still imprisoned in its block. The quarry face thus becomes an archive of intentions: an archaeological survey of suspended forms, of works that have never left the stone. A similar phenomenon is observed in the Osuna quarries, near Seville, where the sandstone, similar to that of Lecce or Noto, was quarried in such a way as to leave the exact imprints of the ashlars destined for the cathedral on the wall, as well as friezes, carved entablatures, and entire sculptural groups. The void, in this case, repeats the solid: each removed ashlar left a cast, a negative form that recounts the geometry of the building to which it belonged. These surfaces, punctuated by regular shadows, constitute a sort of "inverted facade", a catalog of inverted architectural elements, in which the building reveals its opposite.

Where in the city stone becomes order and a façade, in the quarry it preserves the memory of its dispersion and origin. But perhaps the most emblematic case remains that of the Cusa quarries, near Campobello di Mazara, Sicily: a complex of Greek-era where extraction was suddenly interrupted, leaving behind in the rock column drums, drums, bases, and barely hewn capitals, some still attached to the stone bench, as if time had crystallized in the act of cutting. Those blocks are not archaeology in the traditional sense of disintegrated architecture composing ruins, but "unborn architecture": potential figures that testify to the continuity between matter and form. In them we recognize an ancestral relationship that defines architecture and its negative: that which exists in the place where it should have disappeared. The ontological paradox is evident: the column, intended to support the temple, sits here beneath the temple, still in the earth, like an echo of the construction that never happened, revealing a certain oxymoronic coincidence between the not yet and the no longer. In all these cases, the quarry face becomes a phenomenological document: a natural relief that preserves the imprints of human endeavor and its interruption. What

is revealed on the wall is not so much the completed work, but its intention; not the architecture, but its promise.

As Peter Zumthor writes: «I seek an architecture that not only displays the finished form, but also allows us to glimpse the hand and time that created it»[109]. Negative architecture is not a linguistic category, but a condition of the world: in this logic, emptiness is not lack but outcome; the negative is not only the reverse, but also the foundation. The quarry faces, with their regular cuts, their supporting planes, and the pillars left in place to support the vault, constitute the most eloquent repertoire of "unintentional" typologies: forms that anticipate the architectural language of epigean construction; in them one can read the genealogy of construction: the entablature in the structure of the superimposed planes, the column in the pillar left in place, the cornice in the horizontal sign of the cut. When Grassi observed that «architecture is always already written in reality; it only needs to be recognized»[110], perhaps he was also unconsciously referring to the genealogy that it profoundly establishes with the land from which it came, so that the signs left on the quarry faces, the unreleased figures, the retained sketches, constitute a testimony to this profound continuity between man and the earth: an uninterrupted dialogue between the technical gesture and the destiny of the form.



Fig. 22 – Canteras de la Sierra de San Cristobal. The site contains numerous underground quarry basins from which the stones for the construction of Seville Cathedral were extracted. Satellite view



Fig. 23 – A commemorative engraving (probably for an Andalusian quarryman) on the quarry entrance to a tunnel. Photo by the author



Fig. 24 – Extractive hypogeum in the quarries of Sierra de San Cristobal. Photo by the author



Fig. 25 – An ancient mining cave transformed into a military base during World War II. Photo by P. M. Millàn Millàn



Fig. 26 – An ancient mining cave transformed into a military base during World War II. The structure features a plastered wall that delimits the space of the underground chamber where explosive material was stored. Section. Rendering by the author



Fig. 27 – El Coto de la canteras. The quarry site is located in the immediate vicinity of the neighboring town of Osuna, in a tension between city and emptiness. Satellite view



Fig. 28 – Entrance to El Coto. The friezes are the result of stratifications of uses of the quarry basin over time, including for non-extractive purposes. Rendering by the author



Fig. 29 – Negative of architecture: Osuna Caves, dug by ancient Iberian peoples about 2500 years ago. Photo by the author



Fig. 30 – the lithological block was eroded both in the tunnel and in the open air, isolating the rock which emerges like an island in a desert. Photo by the author

4. THE WHITE STONE FROM LECCE

In the Salento landscape, stone is not just matter, but a principle of order. Everything built, from the dry stone wall to the baroque façade, descends from the same substance: a soft, sedimentary rock, formed by the ancient sea that once covered the plateau and which, retreating, left its body. Lecce stone – a compact, light-colored, malleable, and porous Miocene calcarenite – has over time become the defining characteristic of the city and its territory, a material that has shaped not only architecture, but the imagination of an entire civilization. As Cesare Brandi writes in "Pellegrino di Puglia", «In Lecce, stone does not support, it flourishes. The entire city is a stone garden that sprouts in the light. There is no wall that does not become a figure, no figure that does not dissolve in the sun.



Fig. 31 – Blocks of Pietra Leccese, a fine-grained biocalcarenite typical of the Salento region (Apulia, Italy), characterized by its warm white tone and workability, historically used in Baroque architecture and contemporary stone design

Lecce stone does not build, but blossoms»[111]. This statement, which has the force of a poetic and phenomenological synthesis, encapsulates the deepest meaning of a relationship between material and landscape that transcends the technical dimension to become language. The white stone of Salento constitutes a geological foundation that has shaped the settlement culture and the human landscape. The stone is cut and carved as if it were mineral wood, allowing the development of sculptural structures that are modeled directly on the face or block, as occurred in the quarries of Cursi or Melpignano. This direct relationship between quarry and architecture – between raw material and sculpted form – explains the continuity that links the language of construction to the decorative tradition, and that transforms the working of stone itself into a widespread artistic knowledge. In the work of Bruno Zevi, Lecce stone becomes the example of a "Mediterranean material", capable of merging light and gravity. Zevi writes: «The stone of Lecce, kneaded by sea and sun, allows light to be sculpted as if it were matter. Southern Baroque was born from this optical miracle: sculpture becomes architecture, the façade dissolves into light»[112]. This ability to "sculpt light" is what gives the city its visual unity, its almost mineral image. It's not just a local material, but a cornerstone of identity that has shaped the entire Salento region over time. Lecce stone, due to its porosity and calcareous nature, lends itself to an intimacy with light unlike other Mediterranean materials. Its whiteness is never dazzling: it absorbs and reflects light with a diffuse, modulated vibration, transforming the surface into an atmospheric field. Its mechanical weakness – which elsewhere would be a flaw – here becomes poetic, allowing the material to become a mark, to be worked to the point of erosion.

4.1. Extraction basins

The Lecce stone quarrying area constitutes one of the most extensive and coherent stone districts in the Mediterranean, a geological and productive system that extends across the central Salento region, spanning the municipalities of Lecce, Cavallino, Cursi, Melpignano, Martano, Zollino, and Maglie. From a geomorphological

perspective, it is a Miocene calcarenite formation belonging to the Calabrian sedimentary cycle, deposited in a shallow marine environment during the Late Miocene (approximately 10 – 5 million years ago). The stone, composed of cemented carbonate sands, has a fine and compact texture, medium-high porosity, and a color ranging from white to golden yellow, with occasional ochre veining due to the oxidation of ferrous compounds. This lithological structure, determined by a combined action of diagenetic physicochemical processes and bioclastic sedimentation, gives the material great workability, a quality that has guided the location of quarries since ancient times in the most homogeneous and regular beds.

The main extraction basins – identifiable according to the Geological Map of Italy (Sheet 223 "Lecce" and 224 "Otranto") – are articulated along a northwest/southeast axis, following the direction of the ancient fault lines of the Salento plateau. The Cursi quarries represent the most significant nucleus of the system: a district of approximately 500 hectares comprising over forty sites, some active and some abandoned. Here, the Lecce stone emerges in beds 3 to 10 meters thick, with subhorizontal stratification and varying levels of compactness. The traditional extraction system involved removing the overburden (average thickness 1.5 – 2 m), tracing the bed with chisels and iron mallets, and then subdividing it into blocks using moistened wooden wedges, capable of generating expansion fractures. The quarry, therefore, was not a simple functional void, but a true open-air workshop, in which the sequence of manual operations shaped the landscape.

The Melpignano district stands out for the quality of its stone, which is more compact and less porous, and is primarily used in the structural parts of buildings (architraves, cornices, and load-bearing elements). Here, the quarries feature sub-vertical sections and regular facades, often arranged in steps, with still visible traces of hand cuts and extraction holes, testifying to the gradual transition – between the late 19th and early 20th centuries – from manual extraction to light mechanization. The Martano and Zollino quarries, on the other hand, produce softer and more uniform stones, primarily used for decorative elements, moldings, and the sculpted surfaces of the Lecce Baroque period. Their lighter color and fine grain size allowed

for precision workmanship, making them a favored material for Lecce's stonemasonry workshops between the 17th and 18th centuries.

However, Lecce stone is not homogeneous: stratigraphic and compositional differences distinguish different locally recognised “types”. At least three main varieties can be identified: the compact Lecce stone (Cursi, Melpignano), with low porosity and good mechanical behaviour; the soft Lecce stone (Martano, Zollino), more porous and easier to sculpt; the hard Lecce stone (Cavallino, Lequile), suitable for load-bearing structures and exposed elements. These varieties, although belonging to the same geological formation, define a complex lithological geography, in which the aesthetic and technical qualities of the material influence the settlement morphology and construction choices. Historically, the first evidence of organized extraction dates back to the late Middle Ages, with documentation of stonecutters (lapidarii) in the 15th-century tax records of Terra d'Otranto. However, it was in the 17th century – the era of maximum expansion of the Baroque construction industry – that the quarry system reached a proto-industrial scale: the Cursi, Cavallino, and Melpignano basins fueled the construction of the great churches and noble palaces of Lecce, Galatina, and Nardò. The workers organized themselves into lapidary guilds that passed down cutting and sculpting techniques, generating a specific material culture founded on the unity of design, gesture, and material. The proximity between the extraction sites and urban centers fostered a direct relationship between quarry and city, giving the territory a polycentric structure: each major center had its own extraction basin, functionally integrated into the production and commercial network.

With the advent of modern mechanization in the 20th century – particularly with the introduction of band saws, diamond wire saws, and pneumatic hammers – the morphology of quarries underwent a radical transformation. The excavation faces, once low and sloping, became vertical and deep; the natural rhythm of extraction, marked by manual labor, accelerated, irreversibly altering the landscape. Quarries expanded and deepened, sometimes reaching depths of 15 – 20 meters, resulting in an increased risk of slope instability and groundwater contamination. The management of mining activities is now regulated by the Puglia Region's Regional

Plan for Mining Activities (PRAE), adopted in 2006, which establishes the delimitation of quarry areas and environmental remediation procedures for abandoned sites. In particular, the PRAE recognizes the Lecce district's value as a landscape and productive heritage, requiring monitoring, reuse, and reconversion strategies that preserve its geomorphological identity.

The Cursi and Melpignano quarries today constitute a complex cultural landscape: places where geological stratification intertwines with historical stratification, and where the notion of "heritage" extends from material to process. Their walls, still marked by the parallel cuts of mechanical saws, testify to a temporality distinct from that of the built environment: a time of subtraction, in which every cubic meter removed corresponds to a portion of the city's history. The landscape, interpreted through quarry mapping, reveals itself as a mosaic of productive spaces and potential voids, where mining has defined not only an economy, but a structured landscape of edges, ramps, steps, and basins. The abandoned quarries, numerous between Cursi and Maglie, are now undergoing a process of cultural reappropriation: some have been converted into event spaces, sculpture parks, or controlled renaturalization basins. This continuity between extraction and regeneration reveals the profound logic of Lecce stone: a material that, even when removed, remains a constitutive element of the territory.

The system of Salento's quarry basins, in its complexity, thus constitutes a geography of production and perception. The quarries are not merely economic infrastructures, but spatial devices that have helped define the morphology of the territory and the image of the city. Studying the quarry basins means understanding the genesis of the built landscape, recognizing in the sequence of solids and voids the geological fabric of a stone civilization. It is in this direct, immediate relationship between the soil and the work that Lecce stone continues to establish its value: a value that is both material and symbolic, technical and defining.

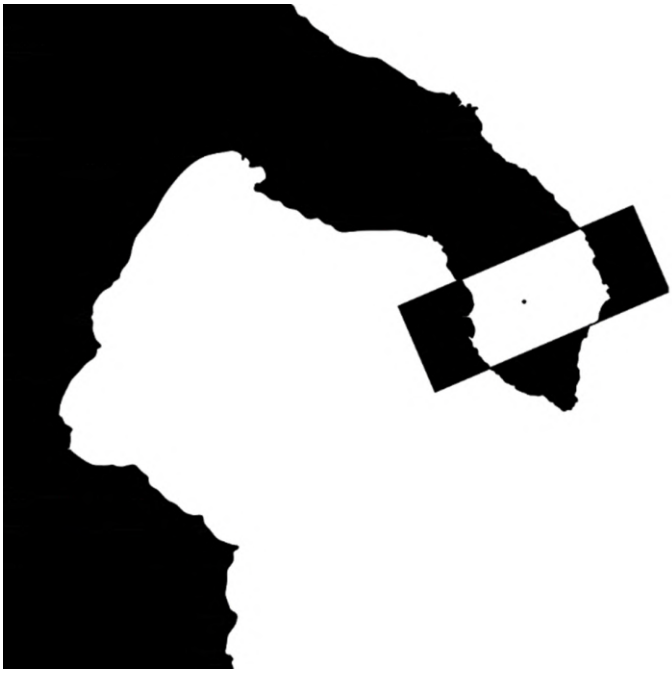

Fig. 32 – Diagram relating to the territorial framework of extraction basins. Rendering by the author.

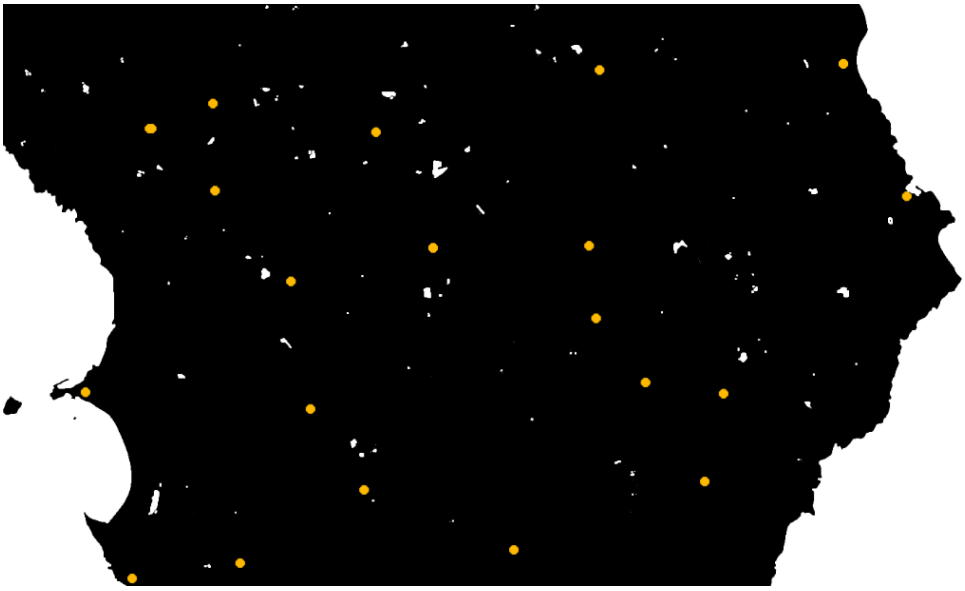

Fig. 33 – Diagram showing the distribution of extraction basins in Salento (in white) related to the lay-out of towns (in yellow). Rendering by the author.

4.2. Litho-stratigraphic characteristics

From a geological perspective, Lecce stone belongs to the large Late Miocene calcarenite formation that forms the central portion of the Salento plateau. It is arranged in subhorizontal beds varying in thickness from 3 to 12 meters, separated by thin layers of clay or marl, remnants of phases of marine deposition alternating with periods of regression. Its origin can be traced to the sedimentary processes that, during the Tortonian and Messinian periods, affected the Ionian-Adriatic basin, when a vast carbonate platform developed in a shallow marine environment, subject to intense current dynamics and bioclastic deposits. These events combined to produce a porous carbonate rock composed of a micritic matrix with fragments of fossil organisms (bryozoans, foraminifera, mollusks) cemented by microcrystalline calcite. It is precisely the prevalence of this micritic matrix, combined with the fine grain size and low degree of crystallization, that gives the material its peculiar softness and homogeneity, which has determined its success in the construction and artistic fields. Mineralogical analyses conducted by CNR-IGAG (2007) indicate an average composition of approximately 92 – 94% calcium carbonate ($CaCO_3$), with traces of dolomite, quartz, and clay minerals. The iron and manganese oxide content, although minimal (<1%), is responsible for the chromatic variations ranging from ivory-white to straw-yellow and, in the most oxidized levels, to golden beige.

The bulk density is around 1.8 – 2.0 g/cm^3, while the total porosity varies from 25 to 35%, values that place it among the medium-soft calcarenites with high breathability. The simple compressive strength, measured on dry samples, averages between 5 and 12 MPa, but can drop below 4 MPa in softer or water-saturated layers. These apparently modest mechanical parameters are, however, compensated by a remarkable textural homogeneity and an isotropic behavior that guarantees volumetric stability and ease of cutting into regular blocks.

The Geological Map of Italy, Sheet 223 "Lecce" and 224 "Otranto", classifies the formation as the Lecce Calcarenite, distinguishing several stratigraphic horizons within it. The basal level, more compact and rich in cemented bioclasts, outcrops in the Cavallino and Lequile areas; the intermediate level, softer and finer-grained,

characterizes the Martano and Zollino area; while the upper level, with greater porosity, is typical of the Cursi basin. This vertical and lateral variation in lithology explains the diversification of architectural uses: the more resistant material from the lower levels was used for foundations and load-bearing structures, while the softer material from the middle and upper levels was used for sculpted surfaces, capitals, and decorations. The stratigraphic interpretation, therefore, coincides with a functional hierarchy of construction, in which the nature of the bedrock determined the intended use of the architectural element. Petrographically, Lecce stone appears as a micritic biocalcarenite with calcitic cement, with fossils clearly visible to the naked eye. The high original organic content has favored, over millennia, a slow oxidation that has consolidated the rock without altering its fineness. Unlike carparo (coarser) or yellow tuff (more friable), Lecce stone displays a compact and regular structure, with very small pore diameters and limited connectivity, which reduces its capillary action but increases its heat exchange capacity. From a degradation perspective, Lecce stone exhibits a vulnerability typical of calcarenites: the combined action of acid rain, marine aerosols, and temperature-hygrometric fluctuations produces granular disintegration, differential erosion, and the formation of black crusts due to the precipitation of calcium sulfates. In urban environments, the main weathering mechanisms are carbonate dissolution and saline recrystallization, which lead to a loss of surface cohesion and swelling.

The litho-stratigraphic characteristics of Lecce stone thus determine a specific building morphology, reflected in both historical techniques and contemporary practices. The availability of extensive benches, ease of cutting, and relative lightness have favored, since the 17th century, the spread of highly plastic architecture, in which the distinction between structure and decoration tends to dissolve. The Baroque Lecce architecture, with its perforated façades, spiral capitals, and sculpted trabeations, is directly dependent on the qualities of the stone: a material that allows for the transformation of mass into light. But the same lightness that favors sculpture also entails an intrinsic fragility, necessitating constant maintenance and today directing research toward more sophisticated consolidation and protection

strategies. From a contemporary perspective, petrographic and stratigraphic knowledge of the material is not merely a technical requirement, but a prerequisite for the project: understanding the stone means understanding the territory that generates it. Finally, Lecce stone should be considered not as an isolated material, but as part of a larger geological sequence, which also includes the contemporary Carparo and Gravina calcarenite formations. This lithostratigraphic system, which extends from the Murgia to lower Salento, testifies to the geological unity of the Apulian landscape and its productive continuity: a single body of stone that, gradually changing in composition, connects the history of the Earth to that of cities. From this perspective, Lecce stone appears as a threshold – between geology and architecture, between matter and image – and its lithostratigraphic study becomes the prerequisite for any reflection on the relationship between construction and the quarried landscape.

4.3. Use in historical and contemporary architecture

The use of Lecce stone in the construction of Salento's architectural landscape has been a long-standing constant, spanning the centuries from the medieval foundation of the first monastic buildings to the most recent experiences of contemporary design. In this continuity, stone does not play a purely technical or ornamental role, but becomes a principle of collective identity, a constructive language capable of translating geology into civilization. As Aldo De Giorgi observed in his study "La pietra di Lecce e la città di luce", «stone is the language with which Lecce speaks to the landscape, a language that is not limited to the Baroque lexicon, but continues to reinvent itself in its relationship with light and time»[113]. This principle of dynamic continuity – between matter, light, and form – is the common thread that allows us to read the architecture of the past and that of the present as variations on the same grammar. The first evidence of the systematic use of Lecce stone dates back to the Romanesque period in Puglia (11th – 13th centuries), when the spread of stone-carving skills between the Terra d'Otranto and Terra di Bari regions led to the definition of a construction language based on the balance between mass and excavation, between light and shadow. The Cathedral of

Otranto (begun in 1088) and the Basilica of Santa Caterina d'Alessandria in Galatina (late 14th century) represent the early stages of a tradition in which the local stone was shaped into regular ashlars, with smooth surfaces and thin joints that convey a uniform luminous quality. The stone's lightness, ease of carving, and its pale hue favored the use of widespread sculptural elements – rose windows, archivolts, zoomorphic decorations – which, despite their Romanesque sobriety, anticipated the plastic freedom of subsequent centuries. In these works, the material is never neutral,



Fig. 34 – Example of Lecce Baroque architecture, characterized by the sculptural plasticity of Pietra Leccese, elaborate decorative motifs, and dynamic compositions that merge architecture and sculpture into a unified stone façade

and its optical behavior allows for the definition of the very space of the visual experience, a condition that will become a hallmark of the Lecce Baroque.

In the 17th century, Lecce became a laboratory for an unparalleled plastic language. Lecce stone, thanks to its ductility, allowed for a degree of formal freedom

that would be unthinkable elsewhere. The facades of the Basilica of Santa Croce (1549 – 1695), the Cathedral of Lecce (1659 – 70), and the Palazzo dei Celestini (1659 – 70) are the most accomplished expression of this alliance between matter and light. The sculptures and friezes seem to emerge directly from the quarry, as if the entire city had been carved from the same calcarenite mass from which it originated. The plasticity of the stone allowed for a modeling that eliminated the boundary between structure and ornamentation: columns, entablatures, and cornices dissolve into a decorative *continuum* that enhances the reflective power of the material. In this phase, Lecce stone became not only representative of the city, but the material of its image, a “mineral skin” that fuses sky and ground in the same chromatic vibration. With the 19th century and the early modern era, the use of Lecce stone gradually declined in favor of new industrial materials, such as bricks, concrete conglomerates, and compact stones foreign to the context. However, it did not disappear, remaining used in restorations, cladding, public paving, and civil architecture as an element of continuity and recognizability.

In the post-war period, interest in local materials was rekindled within the Italian architectural culture that was more attentive to the *genius loci*, from Giuseppe Samonà to Saverio Muratori, and found an echo in the reflections of Aldo Rossi, who in “L’architettura della città” recognised local stone as an archive of the territory, capable of giving form to the urban identity[114].

In Salento, this awareness translates into a new attention to stone as a principle of measurement and memory. One of the most evocative interpretations of Lecce stone in contemporary times is Mimmo Paladino's Benevento Garden (2004 – 2008), created in San Cesario di Lecce for the Biscozzi-Rimbaud Foundation. Here, the artist transforms stone into a narrative device: blocks of calcarenite, recovered from abandoned quarries, are arranged in the garden like archaic, almost archaeological presences, arranged like monoliths engraved with primary signs, symbols, and totemic figures. The garden thus becomes a "map of memory”, in which the stone becomes the subject, a body that preserves the stratification of time. In the Benevento Garden, the architectural and sculptural dimensions merge: the

constructed space is enclosed by a fence that takes the form of a sequence of white thresholds. The stone, eroded and excavated, harks back to the original quarries, evoking the transition from extraction to contemplation, from the wound to the garden. Álvaro Siza Vieira worked similarly for the Parco delle Cave di Marco Vito (Lecce, 2003 – 2009), also known as the "mineral garden". In addition to the project for the use and protection of the quarry site, he placed a sculptural polyptych on the quarry floor, giving the material a new expressive capacity: a formal tension, undoubtedly achieved through new stone processing techniques, which allows him to overcome the ductility and fragility of Lecce stone and to define the quarry space by measuring the human figure placed there for use. This design act represents a turning point in contemporary reflection on the relationship between stone, landscape, and architecture.

The project, located in an area of abandoned quarries on the southern outskirts of the city, is based on the principle of restoring emptiness: here the architect does not build upon the wound, but transforms it into a place of measure and silence. Siza uses Lecce stone not simply as a material, but as a conceptual matrix: the surfaces of the walkway and the steps that delineate the garden are composed of irregular blocks of local calcarenite, recovered directly from the quarry and arranged according to logics of balance, tension, and suspension. The stone absorbs and reflects light in a shifting manner, creating a landscape where the material vibrates and the context resonates with it. As Siza himself stated in a recent interview at the park's inauguration: «I didn't want to impose an architectural mark on the quarry, but rather to listen to its form. The stone, already excavated, knows the measure of silence better than any project»[115]. In this sense, the mineral garden is an act of reconciliation, an attempt to restore to the stone the right to be space, even in its absence, in the void, in subtraction. The project, due to its sobriety and the delicacy of the intervention, therefore presents itself as a paradigm of subtractive architecture: the stone, instead of being extracted, returns to its place, and the landscape is transformed into a unitary organism of matter and light.

Another significant example of a contemporary reinterpretation of Lecce stone is Torre 67 in Alezio, designed by Aires Mateus & Associados (2016 – 2020). Conceived as a residence and meditation space, the building is nestled into a rural landscape dominated by olive groves and dry stone walls. The construction is entirely clad in blocks of bush-hammered Lecce stone, laid in staggered horizontal courses, giving the surface a vibrant and tactile effect. The twenty-meter-high tower presents itself as a monolithic and silent volume, positioned in linguistic contrast with its context, devoid of visible openings, hollowed out internally by a system of patios that filter zenithal light. In this case, the stone, alternating between the two phases of construction and reinterpretation, becomes a material of perception: the surface becomes a diaphragm between interior and exterior, between time and light. As Aires Mateus explains in the project's presentation, «Lecce stone allows you to build with air. It is a material that breathes and wears away, as if the house were a mineral organism that lives over time»[116]. The architecture is thus reduced to its geological essence: a void carved into the stone, a return to the logic of ancient quarries and latomies, where form is born through subtraction. And indeed, the tower, set like a parallelepiped monolith in the rural landscape, takes on the appearance of a gigantic ashlar, quarried and abandoned. The project is completed with the imposition of two other geometric figures that systematize the architectural and landscape scales: a quadrangular swimming pool, also white, and an olive grove enclosed within a dry-stone wall enclosure, also quadrangular in shape, which contains the trees. Here the layout and arrangement of the plant species become the regulating grid of the geometries of the countryside, of the architecture, of rural life, and here the garden proposes a grandiose comparison between plant and mineral: the trees seem to float on a white plane of gravel derived from the sfabbricidi produced during the construction of the architectural intervention.

Given this, it can be said that, from medieval basilicas to contemporary architectural works, the use of Lecce stone defines a material and meaning continuity that spans the history of the Salento region, defining new approaches to restoring new meanings to the stone material, reinterpreted in each era according to the

sensibilities of those who used it: the Romanesque masters as a stone of order, the Baroque as a stone of light, contemporary artists and architects as a stone of memory. In all cases, its principal quality remains the same: the ability to combine the gravity of the earth with the lightness of light. Lecce stone, by its nature soft and luminous, is the testimony of a geology that becomes language, of a material that, far from being exhausted by use, continues to generate forms, spaces, and meanings, reflecting in its porous whiteness the very history of Salento: a land that, by excavating itself, has built its own image.



Fig. 35 – Tower 67 in Alezio, designed by Aires Mateus, aerial photo. Source: https://domusweb.it



Fig. 36 – Tower 67 in Alezio, designed by Aires Mateus. Source: https://domusweb.it



Fig. 37 – Hortus conclusus, Benevento. Source: Mic_Censimento delle architetture italiane dal 1945 ad oggi

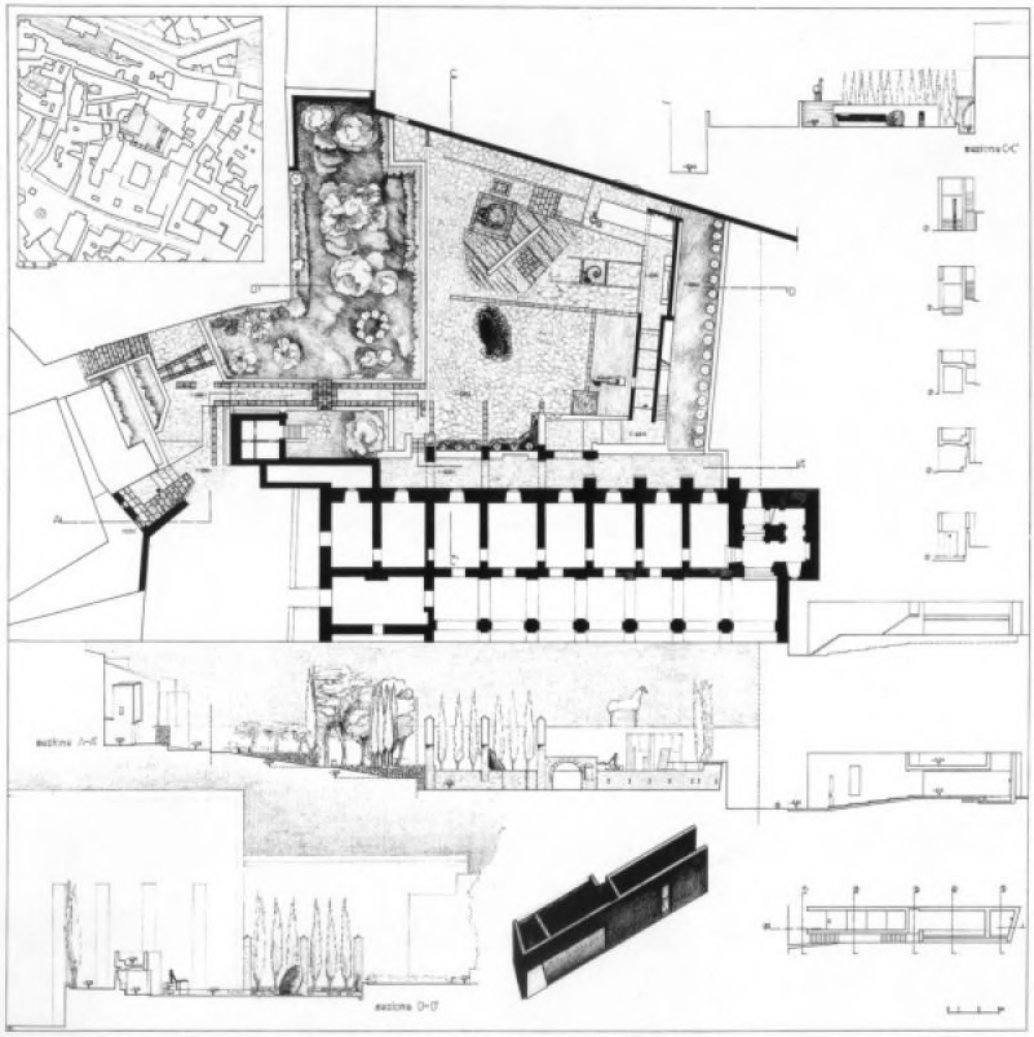

Fig. 38 – Hortus conclusus, Benevento, plan. Source: Mic_Censimento delle architetture italiane dal 1945 ad oggi

5. THE PROJECT IN THE QUARRY. CASE STUDIES

Born from a technical gesture and a productive necessity, the exhausted quarry offers itself to time as a space open to transformation, an unfinished organism awaiting new meaning. Indeed, when the work of extraction ends, the work of interpretation begins, in which the architect becomes the reader of a material already written, a text engraved in the geological material, in which the history of the Earth and that of humanity coincide. The quarry is therefore the point of contact between natural and cultural space, between the genesis of the soil and the form of the built environment, establishing a new syllogism according to which, if the time of extraction is that of loss,



Fig. 39 – View of the "Giardino dell'Impossibile" in Favignana, a monumental garden carved into ancient tufa quarries where vegetation and stone coexist in a profound dialogue between natural regeneration and human excavation

the time of the project is that of restitution – not as reconstruction or repair, but as an act of recognition. From this perspective, the architecture born in quarry sites does not simply occupy a void, but takes on its ontological character: they are constructions that contend with gravity, with grazing light, with the boundary between surface and depth.

The projects collected here – from the latomie of Syracuse to the quarries of Minorca, from the Chinese landscapes of Xu Tiantien to the Mediterranean echoes of Souto de Moura, Siza, Chipperfield, Latina, Campo, and Cusenza – outline a journey through ten variations of the same archetype in which the quarry becomes a generative figure of the architectural project, and in which each of the case studies represents a different way of interpreting the relationship between matter and space, between subtraction and construction, between memory and design, forming, together, an ideal topography of emptiness: an atlas of places where architecture does not impose itself on the landscape but extends its logic and translates it into language.

In this grammar, the first hub of the journey is occupied by the latomie of Syracuse, ancient sandstone quarries excavated in Neapolis, which represent the original paradigm of this relationship: the place where the practice of extraction gives way to the generative practice of vegetation. As Giovanni Battista Vaccarini, who studied their proportions in the eighteenth century, observed, "the latomie are not artificial spaces, but wounds that nature has healed, transforming them into gardens". They embody the theme of the paradeseion, the underground garden, a place of isolation and contemplation, which even today continues to suggest the possibility of a vegetal architecture in which the memory of subtraction is converted into abundance and lushness.

The Scirocco Room in Fondo Micciulla, Palermo, is another example of this dialectic between necessity and invention. Conceived as an underground system of natural ventilation, it transforms the logic of the quarry into architecture for well-being: a bioclimatic machine ahead of its time, carved into the calcarenite rock and governed by the principles of natural thermoregulation. Its space, entirely carved into

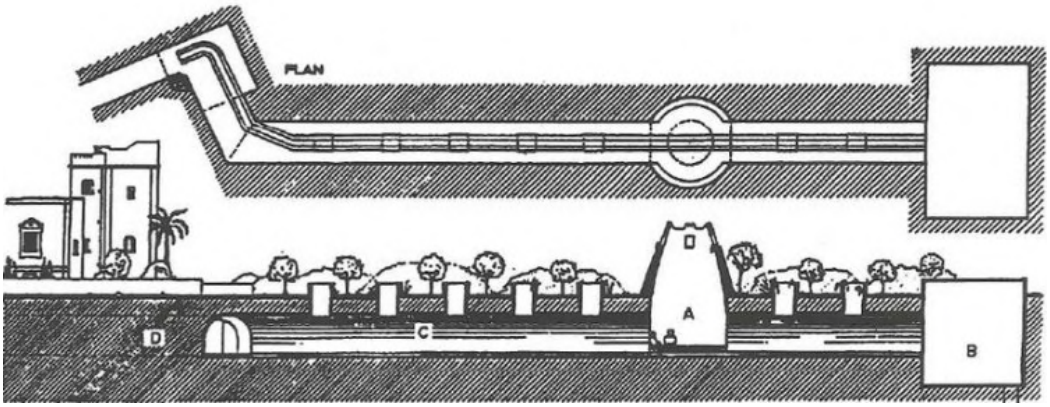

Fig. 40 – Diagram of a “scirocco room” in Palermo — a traditional underground structure designed to provide natural cooling through air circulation and humidity control, connected to qanat tunnels and garden ponds. Pietro Todaro, 1984



Fig. 41 – Interior of a “scirocco room” in Palermo — a hypogean cooling space carved into calcarenite, where natural ventilation and underground humidity create a refreshing microclimate connected to qanat tunnels and garden systems. Source: https://cittametropolitana.pa.it

the calcarenite rock, reveals an empirical understanding of underground living that anticipates many contemporary reflections on environmental sustainability.

Xu Tiantien's intervention in the abandoned quarries of Jinyun County, China, reframes the relationship between man and matter according to a principle of traversal. Here, the project does not simply recompose a void, but constructs a network of paths, walkways, and suspension bridges that reconnect the landscape's lesions. The architect's gesture is not reparative but cognitive: the quarry becomes the device through which the community rediscovers its perception of its territory. Here, the void is traversed, experienced, transformed into a space for relationships.

Different, yet complementary, is Eduardo Souto de Moura's project for the Braga Stadium (2003), which establishes a meaningful dialogue between the quarry's mineral face and the building's material, intervening with the creation of a new architectural front, a double resemblance that translates the sense of subtraction into the language of the built environment. The rugged stone of Monte Castro becomes the stage for the sporting activities performed there. The Braga Stadium is not a building within the landscape, but a landscape that has become a building, an architecture that restores the quarry to its dignity as a finished work.

In David Chipperfield's project for the Arcari Quarries in Zovencedo (Vicenza), limestone is transformed into a mirror: the quarry, excavated to extract Istrian stone, becomes an exhibition and contemplative space, where polished vertical surfaces and a cleverly placed pool of water reflect natural light, amplifying its depth. The project is therefore based on a principle of perceptual suspension: stone is not merely material but image, and the void becomes a mental space. The Arcari Quarries thus represent the possibility of an architecture that adds virtually nothing to the place it interacts with, but rather reveals its invisible density.

The Marco Vito Quarry Park, designed by Álvaro Siza Vieira in Lecce, takes up this logic as a gesture of descent, transforming the quarry edge into a path, the step into a threshold, the stone into a surface for meditation. The project returns architecture to its telluric origins, restoring the quarry's value as a public space, where the descent into the ground becomes a spatial experience of interintimate

space, and the stone returns to being what it has always been – the measure of the boundary between earth and sky.

In Vincenzo Latina's project for the Teatro della Cava in Lampedusa (2006 – 2010), the void becomes a plaza: a community space generated through absence. The project is located in a disused calcarenite quarry, which the architect transformed into a cavea, leaving the exposed sections intact and integrating a few steel and wood elements. Here, the material is inhabited, the stone becomes steps, and the void is transformed into an agora. The work demonstrates how the public dimension can be reborn in places of subtraction. Similarly, the idea of public enjoyment is extolled in Menorca, where landscape designer Laetitia Sauleau has transformed the ancient marés quarries into a mineral garden (Líthica, Pedreres de s'Hostal). Here, nature and geometry coexist in dynamic equilibrium: the quarries, excavated since the 19th century, are reinterpreted as open-air rooms, vegetable gardens, water features, and a stone labyrinth spanning the entire quarry floor.

Instead, in Maria Gabriella Campo's Garden of the Impossible, created in 1990 in the sandstone quarries of Favignana, vegetation becomes material, and the stone welcomes a forest within: the void is filled with vegetation, absence becomes living matter. Campo works with the slowness of a gardener and the precision of a designer, constructing a landscape of thresholds, ramps, and niches that evoke the geometry of quarrying. The work, awarded a prize at the 1992 Florence Biennale, is one of the finest expressions of Italian thought on reversible landscape.

If the Garden of the Impossible is the home of trees, Ca'n Terra by Ensamble Studio (Minorque, 2019) is the home of men: here, the quarry becomes home. Architect Antón García-Abril discovers an abandoned marés quarry and, without modifying it, transforms it into a home. The walls sculpted by hand become walls, the void becomes a room, natural light penetrates as a constructive element. In this case, dwelling is not building but recognizing: the project is reduced to an act of reading, a poetic interpretation of the material. As the authors state, "Ca'n Terra is the house found, not built. The quarry was already architecture, we simply brought light". It is

the culmination of a process that, from the latomie of Syracuse, reaches all the way to contemporary architecture in which the absence of stone is inhabited.

The exhibition concludes with Giuseppe Cusenza's Hotel Cave Bianche (2001 – 2015), built in a disused calcarenite quarry on Favignana, translating the quarried landscape into habitable architecture. The project, preceded by environmental restoration and consolidation of façades up to 12 meters high, extends entirely within the quarry's perimeter, where new volumes in squared calcarenite alternate with Mediterranean gardens. The facades, vibrant with light and etched with deep cuts, echo the texture of the original rock. The building does not adhere to the façades but faces them, creating tall shaded tunnels that promote natural ventilation and passive cooling. The wall, defined by Purini as the project's "thematic center", connects and separates the spaces, extending the site's geometry. Quarrying and inhabiting become complementary actions, grounded in the same material and in the continuity between excavated nature and built form.

The projects presented here represent a form of interpretation, understanding, and reappropriation of marginal or discarded places, outlining a concrete possibility of inhabiting the boundary between visible and invisible, between construction and excavation. Each intervention, despite the diversity of context and language, responds to a common need: to rediscover the principle of habitation in matter. From silence to the garden, from well-being to crossing, from the double to the mirror, from the descent to the square, to the forest and the house, the quarry project is always an act of reconciliation, as can be seen in the selection of relevant architectural projects listed below.

5.1. The Double | Braga Municipal Stadium, Eduardo Souto de Moura, Braga 2003

The Braga Municipal Stadium, designed by Eduardo Souto de Moura and inaugurated in 2003 for the 2004 European Football Championship, is one of the most significant contemporary examples of architecture inserted into a quarry landscape. The project is located within the ancient Dume granite quarry, along the northern slope of Monte Castro, on the outskirts of the city of Braga, in northern

Portugal. The site, already subject to mining, presented an imposing morphological configuration: a large open-air basin, with vertical walls and a quarry face carved by decades of excavation. Souto de Moura, winner of the 2011 Pritzker Prize, interprets this limitation not as a constraint but as a design material, transforming the quarry wound into a structured space. The founding idea is to use the void as an architectural matrix: the stadium is not built over the quarry, but within it, establishing continuity with the natural relief and the history of the site.

The facility is developed according to a principle of controlled asymmetry: only two main stands, arranged on the long sides of the playing field, face the rock wall left in place and the opening towards the Cávado River valley. This choice reverses the traditional typology of the stadium closed on four sides, creating an "incomplete" structure that complements the surrounding landscape. On the east side, the quarry face becomes a natural backdrop for the competitions, while on the west side, a panoramic view opens up towards the city and the surrounding mountains. The project, as stated by the architect himself, was born from the idea of "cutting into the mountain" rather than building on it: «I didn't want to impose a form on the place, but rather let it express itself through the cut. The architecture is already contained in the stone; you just need to know how to read it»[117]. The load-bearing structure is made entirely of exposed reinforced concrete, crafted with an almost stone-like precision, as if to extend the language of the quarry. The stands, each capable of seating approximately 15,000 spectators, are composed of a succession of inclined partitions and beams, defining a rigorous grid of solids and voids. The interior spaces, consisting of galleries and distribution ramps, are structured like cavities carved into the compact volume of the structure, while the stairways and rectilinear openings allow for a direct connection with the exterior. The morphology of the site guided every design decision: the north stand rests against the mountainside, almost embedded in the rock, while the south stand juts out into the void, suspended on a system of independent partitions and beams. This balance between support and suspension conveys the image of a construction that belongs to the ground yet retains its telluric memory.



Fig. 42 – Topographic plan of the Municipal Stadium of Braga, Portugal, designed by Eduardo Souto de Moura (2003). The project is carved directly into the granite of an abandoned quarry, integrating the natural relief into the architectural composition. E. S. De Moura, in “Casa da Arquitectura”, Electa, Milano 2022

The roof is one of the most innovative elements of the project: it is composed of a series of pre-tensioned steel cables, arranged parallel between the two stands Fig. 43 –



Fig. 43 – Municipal Stadium of Braga, designed by Eduardo Souto de Moura (2003). The structure is embedded within a former granite quarry, with one grandstand carved into the rock and the opposite side open to the valley, connected by suspended steel cables. E. S. De Moura, in “Casa da Arquitectura”, Electa, Milano 2022

and anchored independently to their respective structures. The cables support lightweight panels and act as both a structural and visual system: a suspended "weave" that filters light and lightens the concrete mass. The result is an optical suspension effect, where light acts like a building material. The quarry, now inactive and marginal to the urban fabric, is being reimagined as a public sports park, with a system of accesses and pathways reconnecting the area to Monte Castro and Braga's road network. The granite surfaces remain exposed, while the smaller excavation areas have been converted into parking lots and pedestrian walkways. In this sense, the project acts as a territorial regeneration device: it transforms a disused infrastructure into a collective space, without obscuring its original nature. The stadium's value also lies in the material and conceptual coherence that links it to the

quarry. Indeed, concrete, as an artificial stone, establishes a chromatic and tactile continuity with the local granite; the cuts, shadows, and surfaces exposed to direct light extend the grammar of the quarrying process. The work thus takes on a dual dimension: on the one hand a functional sports facility, on the other a geological monument, and it is in this ambiguity that the strength of the project lies, for which the stadium is not a foreign body, but an architectural transcription of the mining site in which the void generated by extraction becomes form, and the form restores meaning to the void. International architectural critics have recognized this project as one of the finest examples of contemporary topographical architecture. As Joseph Rykwert observes, «The project is an act of mimesis, a way of making the land speak the language of construction»[118]. In 2004, the Braga Stadium received the Secil Prize for engineering and in 2005 the Venice Biennale Prize for Architecture, as an "example of balance between strength, measure and memory". Furthermore, the stadium is a prototype of inverted extractive architecture: not a landmark added to the landscape, but a device that translates the logic of the quarry into a constructive and perceptual system, in which the playing field, the stands, the voids, the cables, and the rock interact according to a principle of structural and symbolic continuity. Souto de Moura's intervention demonstrates that quarry design belongs not only to the sphere of environmental redevelopment, but also to that of cultural recomposition: a way to reconcile the construction with its foundations.

5.2. The Mirror | Cave Arcari, David Chipperfield, Zovencedo 2010

The Arcari Quarry, located in Zovencedo in the province of Vicenza, is one of David Chipperfield Architects' most iconic projects in the field of quarrying redevelopment. The project, developed between 2010 and 2018, involves the transformation of a Vicenza stone quarry – a light-colored calcareous material used for centuries in Venetian architecture – into a complex of spaces for operational, exhibition, and cultural purposes. For over sixty years, the site was exploited for stone

extraction, resulting in a vast underground system of rooms and galleries supported by regular pillars, with an extension that made it a veritable subterranean architecture. When the quarrying ceased, the site appeared as an imposing stone void, already endowed with autonomous spatial and material qualities. The project arose from the need to restore a contemporary function to the site, safeguarding its integrity while promoting the culture of the local material. As the project briefs emphasize[119], the goal was not to introduce a new language, but to work toward continuity, valorizing geology as a constructive and cultural matrix. The quarry thus becomes a place where productive memory and civil use overlap, where stonework is combined with functions of representation, display, and encounter. Chipperfield's design strategy is based on a logic of minimal interference: interventions are limited to the introduction of a few essential elements – platforms, seats, ramps, and stairs – made from the same local stone and designed to integrate with the site's original geometry. These linear, compact devices allow for movement and use of the underground spaces, ensuring safety and accessibility without altering the overall perception of the space, which is instead enhanced. The surfaces of the new elements are smoothly finished, joints are minimized, and the entire structure follows a principle of geometric precision that reflects the rationality of Chipperfield's architectural language. The project is a continuation of the extractive logic: the orthogonal cuts, vertical façades, and the regular proportions of the pillars are taken as the ordering modules of the architectural composition. From a material perspective, Vicenza stone becomes the sole construction and stylistic material. Its chromatic homogeneity allows for visual and tactile continuity between the built and the excavated, blurring the line between intervention and pre-existing elements. The natural surfaces of the quarry, marked by time and humidity, interact with the worked surfaces of the new volumes, generating a balanced relationship between roughness and smoothness. The overall language remains faithful to the principles of disciplined modernism that distinguish Chipperfield's work: elementary forms, clean lines, and controlled proportions. Light, filtering through the upper openings and reflecting off the wet surfaces, creates an ever-changing visual landscape.

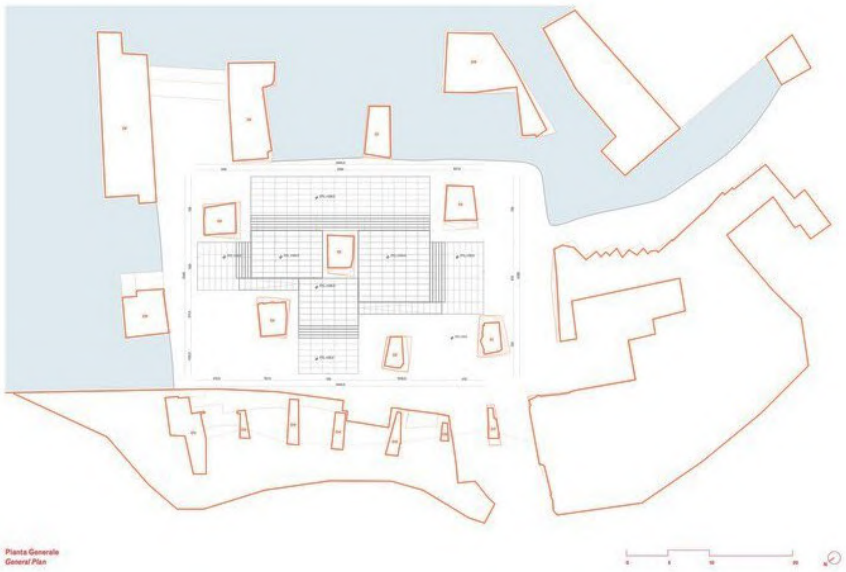

Fig. 44 – General plan of the Arcari Quarry in Zovencedo (Vicenza, Italy), by David Chipperfield Architects. Source: https://davidchipperfield.com

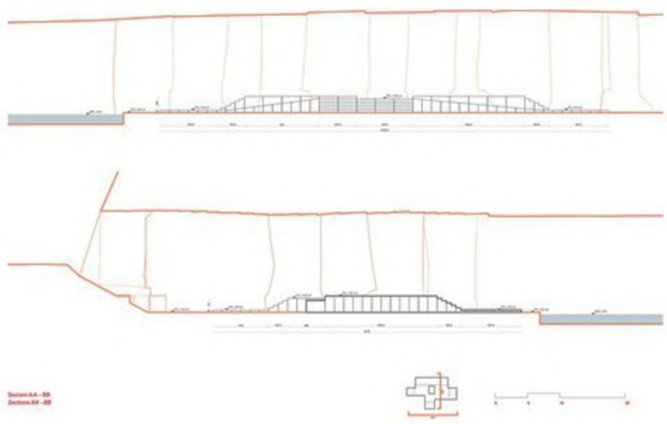

Fig. 45 – Section of Arcari Quarry. Source: https://davidchipperfield.com

Another central element of the project is the presence of water, which filters naturally from the rock bed and collects in the lower level of the quarry in a basin that aligns the quarry's geometry, forming a reflective mirror. Water amplifies the perception of space, visually duplicating the walls and platforms, and introducing a dynamic, constantly shifting dimension. The mirror theme is therefore not a metaphor, but a physical condition of the place: the stone finds a second image in its reflection, and the architecture becomes an optical device for its perception: as Chipperfield observes, «light and water are the tools that complete the stone»[118]. The interiors of the quarry house a variety of functional spaces: rooms for processing and displaying the stone, offices, reception areas, and rooms for small events or concerts. Here, the layout follows the original logic of the extraction chambers, which become usable volumes without substantial modifications. Particular attention was paid to environmental and sustainability aspects. The project considers the ecological impact of the project through strategies for recovering and reusing local resources: the reused stone comes from the same excavation areas, the finishing materials are natural and reversible, the lighting is controlled by occupancy sensors to minimize consumption, water management is entrusted to a drainage system that channels and purifies the filtered water, while the stable internal temperature reduces energy requirements. The quarry, thus, transforms from an extractive infrastructure into a self-sufficient and regenerative system, capable of producing cultural and environmental value. From this perspective, the Cava Arcari becomes a place of synthesis between architecture, industry, and landscape, an example of how discipline can operate within matter, restoring meaning and function to a void created by human labor.



Fig. 46 – The project reinterprets the disused stone quarry as a civic and cultural landscape, integrating new structures within the geometric traces of the excavation grid. Source: https://davidchipperfield.com



Fig. 47 – Internal view of the water channels. Source: https://davidchipperfield.com

5.3. La casa | Ca'n Terra, Ensamble Studio, Minorca 2019

Ca'n Terra, winner of the 2019 Charles Jencks Prize awarded by the RIBA (Royal Institute of British Architects), is a project by the Spanish firm Ensamble Studio (Antón García-Abril and Débora Mesa) located within a former marés quarry on the Balearic island of Menorca. The title itself establishes a dual semantic level: on the one hand, it recalls the Spanish word *cantera* – "quarry" – and on the other, it literally means "house in the earth". This dual linguistic meaning summarizes the nature of the project: a reflection on living underground and a contemporary reinterpretation of the quarried material as a domestic space.



Fig. 48 – Ca'n Terra, a former sandstone quarry transformed by Ensamble Studio into a spatial sequence of chambers and voids, where excavation becomes architecture and light defines the inhabitable landscape. Drawing by the author

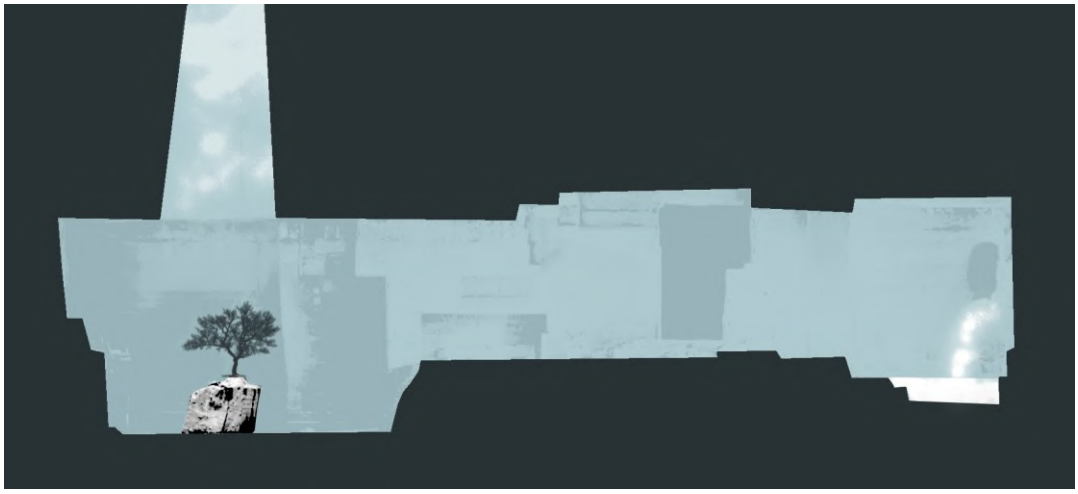

Fig. 49 – Section, Ca'n Terra. Drawing by the author



Fig. 50 – Interior of "Ca'n Terra" Sant Llorenç d'Hortons, Spain — Ensamble Studio transforms a disused sandstone quarry into an inhabitable cave, where the carved geometry, natural light, and raw materiality define a new domestic landscape. Source: https://www.ensamble.info

The original site is a quarry of marés, a local calcarenite stone, soft, homogeneous, and characterized by high hygroscopic properties. The mining activity, abandoned for decades, had left a sequence of vaulted and hollowed-out rooms with irregular sections, with chisel-cut walls and an undulating floor, the result of the various phases of extraction. Ensamble Studio intervened with the aim of reinterpreting the void as a habitable space, maintaining the form and material of the site almost unchanged. The project eschews any attempt at superimposition: the architectural gesture is reduced to a series of operations involving cleaning, consolidation, and minimal infrastructure, aimed at making living within a pre-existing void possible. The architectural interventions are homothetically related and coherent with the original quarrying logic. The first step involves perforating the rock covering with three skylights of calibrated diameter, excavated in the darkest areas. These devices ensure natural ventilation and controlled overhead lighting, restoring the functional distinction between daytime and nighttime zones in the underground spaces. An olive tree is placed at the central core, which coincides less with a geometric center than with the distributive and symbolic center of the house – the hearth, now reinterpreted as a work, study, and meditation area. This vegetal element, in addition to fulfilling microclimatic functions, establishes a direct connection with the surrounding natural landscape and the island's agricultural heritage. Its inclusion harks back to Mediterranean vernacular typologies, where the coexistence of nature and architecture is not ornamental but constitutive. Local materials are also reused in the creation of new construction elements. The floors and partitions introduced to delimit spaces and integrate utilities are made of concrete conglomerates that include the same marés stone dust resulting from the cleaning process, ensuring material and chromatic continuity between the existing structure and the new addition. This choice evokes the logic of ancient Mediterranean underground dwellings, where the excavated material was immediately reused in the construction, reducing the waste cycle to zero. In this way, the overall effect is that of a self-generated architecture, in which the distinction between soil, structure, and cladding is eliminated. The vertical enclosures – doors, windows, and internal partitions – are instead designed with

lightweight, pre-assembled, industrial materials, intentionally ephemeral. Aluminum, polycarbonate, and translucent fabrics replace the masonry, restoring the space to a state of precariousness and reversibility. These elements do not contribute to the mineral continuity of the quarry, but rather allow it to be perceived in its entirety: the material remains the protagonist, while the technological language is reduced to the bare minimum. The stone surfaces are cleaned and consolidated, but not polished: the traces of excavation, the marks of tools, and the salt layers remain legible, constituting a sort of visual memory of the extraction process. The site, in fact, characterized by rising water and rainwater infiltration, is equipped with a collection and filtration system that allows the resource to be reused for domestic purposes and for the creation of small pools for relaxation and contemplation. Water, as in the tradition of underground dwellings in the Mediterranean and the Middle East, becomes both a climatic and symbolic element: it participates in thermal regulation and introduces a principle of visual reflection that amplifies the perception of the volume. The house's technological systems are completely concealed within the walls and floors, following an off-grid approach. Electricity is provided by integrated photovoltaic systems, while ventilation is provided by skylights and pressure differences between the rooms. In this way, Ca'n Terra operates as an autonomous system, without direct connections to infrastructure networks, consistent with the idea of self-sufficient and reversible architecture. The project, despite its small size, takes on an experimental and theoretical significance. As García-Abril and Mesa (Ensamble Studio: Architecture of the Earth, 2020) emphasize, «the quarry is not a void to be filled, but a space to be discovered. Inhabiting the earth means returning architecture to its original state, when building was excavating and inhabiting was adapting to the shape of the ground»[120]. Ca'n Terra thus emerges as a manifesto for contemporary underground living, in which the project operates through minimal modification and maximum material awareness. Architecture is reduced to an act of interpretation: stone becomes structure, wall, ceiling, and memory, while light, filtered by skylights, reveals its natural plasticity.



Fig. 51 – Interior of “Can Terra” Sant Llorenç d’Hortons, Spain — Ensamble Studio transforms a disused sandstone quarry into an inhabitable cave, where the carved geometry, natural light, and raw materiality define a new domestic landscape. Source: https://www.ensamble.info

5.4. The Stone Garden | Líthica, Laetitia Sauleau, Minorca 1994-2014

The Pedreres de s'Hostal, located approximately one kilometer from the city of Ciutadella de Menorca, along the ancient Camí Vell, is one of the most significant examples of contemporary repurposing of the Mediterranean quarrying landscape.
The complex, spanning approximately seven hectares, represents a material and temporal stratification that allows us to understand the entire historical trajectory model for heritage restoration and landscape regeneration of quarry sites. Líthica is structured as a scenic and plant-based complex, a complex sequence of gardens, labyrinths, and stone theaters that explore the relationship between art, nature, and productive memory. The site can be reached from the Ronda Sud, near the monumental sculpture known as Porta del Mar, which symbolically marks the entrance to a threshold landscape, suspended between the visible and the invisible. Líthica is not offered solely as an open-air museum, but as a perceptive and sensorial experience: an immersive place where visitors confront the scale of the void and the living substance of stone. In this sense, it represents a true mineral epiphany, where human intervention and the passage of time overlap, generating forms of dynamic equilibrium between culture and nature. Among the project's most significant features are the two labyrinths: one vegetal and one mineral. of the quarrying of marés stone, the porous, golden limestone that for centuries was the raw material for the island's buildings. In the oldest part of the site, dating back to the 19th and 20th centuries, the stone was cut by hand using a slow chisel; in the more recent portion, in use until 1994, quarrying was carried out mechanically, marking the transition from an artisanal economy to an industrial process. Quarrying ceased in the spring of 1994, leaving behind a collection of chambers, screens, and vertical walls of exceptional monumentality.



Fig. 52 – Night light in Líthica, by Laetitia Sauleau, Minorca. Source: https://lithica.es/en

The Mediterranean light amplifies their perceptual qualities, enhancing vibrant surfaces and natural acoustic cavities. As a result of the 1983 law, which required operators to redevelop abandoned quarries through partial backfilling and reforestation, many of these structures were filled with waste materials or other types of waste. The regulatory framework, while conceived with a view to environmental restoration, had nevertheless led to the obliteration of the heritage to which the quarry site testified. It was at this critical juncture that, in 1994, Laetitia Sauleau (born Laetitia Lara), a French architect and sculptor, conceived the Líthica project – from the Greek líthos, meaning stone – as an act of cultural and environmental resistance. The redevelopment began with the aim of saving the s'Hostal quarries from destruction, transforming them into a laboratory of landscape, art, and education. The chronological coincidence between the cessation of mining activity and the Declaration of Menorca as a UNESCO Biosphere Reserve (1993) marked the beginning of a new environmental awareness on the island, fostering the emergence of initiatives geared toward sustainability and the valorization of material heritage. The Líthica project is therefore not a simple restoration, enhancement, or museum project, but a complex cultural operation, capable of combining ecological, aesthetic, and social dimensions. Sauleau conceived the project as a palingenesis of stone: a process of liberation and rediscovery of pre-existing forms, where architecture serves the material and memory. The guiding principle lies in the desire to restore the quarry's dignity as a human landscape, recognizing that mining culture is an essential component of the island's identity. The Pedreres de s'Hostal, listed in the Bé d'Interès Etnològic heritage register and subsequently in the Patrimoni Històric de Menorca catalogue (2017), are now recognized by Hispania Nostra as a reference.

The vegetal labyrinth, located in the ancient quarries, is inspired by Cretan tradition and the classical unidirectional spiral model. Composed of seven sections paved with marés (a type of limestone) alternating with seven aromatic hedges – rosemary, lavender, santolina, mint, and other Mediterranean species – it is a path of approximately 150 meters, intended for meditation and listening.



Fig. 53 – Musical events in Líthica, by Laetitia Sauleau, Minorca. Source: https://lithica.es/en

The circular and centripetal design evokes a ritual procession rather than a functional path: the visitor, following the path, performs an act of internalization of space and time, rediscovering the contemplative dimension of the landscape. The mineral labyrinth, built in 2014, explicitly references the myth of the Minotaur and is symbolically located in the machine-dug section of the quarry. It is arranged along a square plan and a multi-track path, organized into seven concentric rings of marés blocks laid dry, following the island's ancient construction technique. At the center is a small body of water naturally filtered by aquatic plants, introducing a reflective and symbolic dimension: the return of matter to the primordial element. Each block, over three thousand in total, has been adopted by citizens, artists, and visitors in a participatory gesture that overturns the paradigm of extraction – taking away – into an act of collective restitution, returning its tangible and intangible heritage to the community.



Fig. 54 – The stone labyrinth inside the mineral garden of Lithica, by Laetitia Sauleau, Minorca. Source: https://lithica.es/en



Fig. 55 – Plan of Lithica, by Laetitia Sauleau, Minorca. Source: https://lithica.es/en

Added to these two features is the medieval garden, conceived according to the model of monastic cloisters: a square proportioned to the other geometric shapes that organize the complex, crisscrossed by gravel paths that delimit flowerbeds planted with ancient roses, medicinal plants, and vegetables. At the center, a fountain collects and redistributes water, organizing the space according to a principle of symmetrical and symbolic balance. The entire garden is designed as a space of quiet and contemplation, where the senses are progressively reactivated: the touch of stone, the smell of aromas, the sound of water, the sight of chiaroscuro on the quarry walls, generating a synesthetic experience that refocuses the body and perception, recalling the ancient principle that knowledge of the world comes through direct experience of matter.

Finally, the quarries themselves constitute a large stage space, the nucleus of a renewed public vocation. The ancient Naranjos quarry and the medieval garden host the *Quietud Musical en el Jardín Medieval festival*, while the modern quarry becomes the venue for the *Fosquets Líthica Festival*, held annually during the summer months. During the *fosquet* – the time of day when the light fades and the sky changes color – the stone walls transform into a natural amphitheater for music, theater, and dance. In this way, the quarry landscape is returned to the community as a cultural asset to be inhabited, a place of connection and shared experience.

5.5. The Square | Quarry Theatre and Migration Memorial, Vincenzo Latina, Lampedusa 2019

Vincenzo Latina's project on the island of Lampedusa, comprised of the dual components of the Quarry Theatre and the Migration Memorial, is part of a reflection that unites environmental restoration, territorial regeneration, and the symbolic construction of collective memory. The work is located in a disused quarry at Punta Sottile, the southernmost tip of Italy, where the land dissolves into the sea and the jagged, golden calcarenite bed bears the marks of ancient mining. Here, in this archaic landscape, where human hands have carved the rock to create a mystical

and primordial void, Latina conceives an architecture that bridges geological and human history, nature and tragedy, stone and memory.

The project stems from a long and complex administrative process. In 2005, the municipal administration of Lampedusa approved a plan to enhance the island's natural beauty, envisioning the reclamation of several marginal areas and their return to the community. Only in 2019, after a series of suspensions and reschedulings, was the project definitively reassigned to Vincenzo Latina. The aim was to transform a degraded area, marked by accumulations of waste and debris, into a place of encounter and reflection, where architecture could act as a gesture of moral and landscape reparation. The chosen site features a morphological configuration similar to a small natural amphitheater. The quarry incision, slightly lower than the ground level, opens southward toward the sea, creating a natural scenic backdrop. Latina, seizing the site's acoustic and spatial potential, developed a project that transforms the quarry cavity into an open-air theater, conceived as a public space and a simulacrum of memory. As he himself observes, «From inside the quarry, one cannot look beyond the wall, but one can sense the elements of nature: the sound and smell of the sea, an infinity of sensations and emotions, even to the point of disorientation»[121]. The project thus evokes the tension between limit and limitlessness, between the closure of the wall and the openness of the sea: the quarry as a place where man, facing the stone, perceives the vastness of the world. The theater stalls, capable of seating up to five hundred spectators, are constructed using a kerbstone structure filled with concrete mixed with aggregates and pigments sourced from the quarry itself, ensuring material and chromatic continuity with the context. The project discreetly integrates into the existing morphology, without altering the original layout, but rather enhancing its acoustic and lighting characteristics. The sea, visible in the background, becomes a backdrop and a reverse shot, establishing a direct relationship between stage and landscape. The theater, in its formal simplicity, is configured as a stone plaza, a collective space where the community can gather to listen, perform, and commemorate. Closely connected to it, on the southern edge of the quarry, is the Memorial of Migrations, a

memorial of great sobriety and intensity. The work consists of 368 circular cavities carved into the rock, varying in diameter from 50 to 100 millimeters: one hole for each of the victims of the shipwreck of October 3, 2013, off the coast of Lampedusa. These holes, arranged in a pattern reminiscent of a constellation, remain in shadow throughout the year, but are illuminated annually on the anniversary of the tragedy, with a similar number of lights transforming the wall into a memorial firmament, superimposing the mineral writing with that of the recent history of the Mediterranean. The engraved rock thus becomes an archive of memory, a secular altar, where individual pain is transfigured into a clear collective sign. Completing the composition, a boat salvaged from the sea is placed on the southeast wall of the quarry, treated according to the Japanese technique of *shō sugi ban* (or yakisugi), which involves the surface charring of the wood as a method of preservation and protection. The wreck, blackened by fire, takes on an archetypal significance: a fossil of the present, a metaphor for all journeys, a universal symbol of travel and survival. The boat, resting on the stone, presents itself as an image suspended between shipwreck and resurrection, between destruction and permanence.



Fig. 56 – Vincenzo Latina, Memorial, Lampedusa, Section. Source: https://www.espazium.ch



Fig. 57 – Vincenzo Latina, Memorial, Lampedusa, view. Source: https://www.espazium.ch

Latina describes its intent through a threefold interpretation: the project seeks to synthesize the island's tourist and cultural vocation, the tragic memory of migration, and the extraordinary natural beauty of the site. These components intertwine in a balanced composition, where the architecture does not impose forms but listens to them: «The project chooses the path of silence»[122], explains the designer. «It listens, it does not speak. A few sparse, laconic signs guarantee access, accessibility, and services»[123]. The architectural language is thus reduced to the essential: a system of thresholds, paths, and steps that accompany the visitor through different levels of depth, from ground level to the underground dimension of memory. At the lowest point of the excavation, where the light becomes rarefied and the staircase narrows, one enters a space intended for meditation and prayer. Here, the silent monumentality and the use of light as a metaphysical element lend the memorial a suspended, abstract quality. Proceeding south, however, the excavation becomes lighter, the walls thin out, and the line of the sea horizon reappears: the space of memory transforms into a space of performance, a natural theater open to the sea. The sea and the sky, merging at sunset, become an integral part of the scene, a shifting

backdrop for concerts, ceremonies, and performances. The Migration Memorial thus becomes an architectural metaphor for the island itself: an outpost of Europe, a threshold between continents, a place of arrival and loss, a landing place and a tomb, life and death intertwined in the same topography. Lampedusa, «land that becomes sea»[124], as Sciascia wrote, becomes through this project a device of collective memory, in which the material of the stone and the light of the Mediterranean come together to give form to pain.

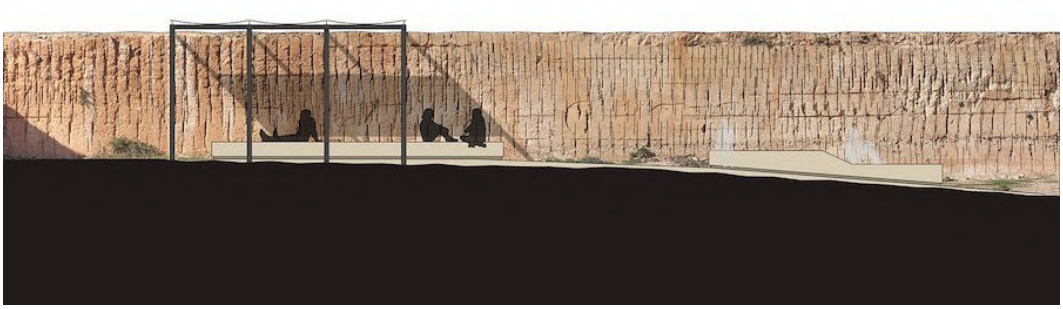

Fig. 58 – Vincenzo Latina, Memorial, Lampedusa, Section. Source: https://www.espazium.ch



Fig. 59 – Vincenzo Latina, Memorial, Lampedusa, View. Source: https://www.espazium.ch

5.6. The Path | The Quarries in Xiandu Valley, Xu Tiantian, Lishui 2021

The regeneration of the quarries near Lishui, in Jinyun County, Zhejiang Province, represents one of the most significant contemporary projects in China for the reinterpretation of the mining landscape from a cultural and community perspective. The project, conceived and coordinated by architect Xu Tiantian with the firm DnA_Design and Architecture, is based on a principle of restraint and discretion, aimed at restoring vitality and a sense of community to a territory marked by the decommissioning and progressive abandonment of mining activities. In an area where over three thousand small quarries, opened over the centuries for the manual extraction of natural stone, dot the Xiandu Valley, Xu Tiantian's project selects nine test sites to experiment with new uses compatible with the landscape, memory, and material culture of the place. The mountainous morphology of the Jinyun region, characterized by a complex articulation of reliefs, cliffs, and volcanic formations, testifies to a long process of interaction between geological nature and human activity. The mining tradition, handed down for generations, had progressively carved out the mountain, leaving behind a fabric of chambers, cavities, and vertical spaces of surprising monumentality. With the cessation of operations, these voids – some as high as thirty-eight meters – were left as relics of a vanished economy, places suspended between ruin and memory.

The project, promoted by local authorities in 2021, is part of a broader national policy to enhance rural areas and small-scale cultural infrastructures, and continues the regeneration process initiated by Xu Tiantian in the nearby Songyang district, where the architect had already experimented with models of micro-architecture spread across mountainous contexts. The design strategy adopted for Jinyun is based on the principle of minimal intervention. The new architectures, conceived as mediators between geological material and contemporary use, do not overlap with the existing voids, but interpret them and make them accessible again.



Fig. 60 – The project by DnA_Design and Architecture transforms an abandoned stone quarry into a reflective cultural space, where water, light, and the monumental rock walls redefine the relationship between nature and architecture. Source: https://www.domusweb.it

The structures introduced are lightweight, reversible, and often made of steel and bamboo, materials that belong both to the Chinese construction tradition and to the logic of contemporary sustainability. These elements, assembled dry or with metal joints, do not alter the static equilibrium of the cavities but rather enhance their perception, discreetly emphasizing the spatial qualities of the cuts, rough edges, and shadows. Particularly exemplary of the nine regenerated quarries are Quarries 10, 9, and 8, which epitomize the variety of themes addressed in the project. Quarry 10, characterized by a rectangular plan and a wide opening to the sky, was conceived as a place for demonstration and education. Inside, the memory of manual labor is evoked through public performances in which ancient stonemasons demonstrate extraction techniques, making tangible the continuity between technical knowledge and cultural heritage. Quarry 9, on the other hand, features an inverted funnel cross-section: the converging walls and open top allow light to penetrate vertically and rainwater to flow into the lower basin, which transforms into a temporary pool when needed. The extraordinary acoustics, resulting from the unique stone geometry, have prompted the space to be used for concerts, conferences, and performances. Finally, Quarry 8 houses a subterranean library, organized across five overlapping levels, connected by walkways and platforms that create a refined three-dimensional layout. In this case, overhead lighting and the transparency of the metal structures create a suspended atmosphere that encourages reading and concentration, giving the hollowed-out space the intimate quality of a domestic interior. All the interventions are interconnected via a system of paths and stairs that follows the natural contours of the valley, connecting the various quarries along a roughly one-kilometer route. This pedestrian network, conceived as a minimal infrastructure, serves a dual purpose: on the one hand, it allows for tourist use of the complex, and on the other, it reintegrates the quarries into the local and social fabric, returning them to the local community. At the center of the valley, near a small rural village, an information center is planned, housing educational spaces, a restaurant, and a stone-working training laboratory. The project thus takes on socioeconomic as well as architectural value: it reactivates artisanal skills, promotes new forms of

cultural economy, and creates job opportunities in a context marked by depopulation and obsolete production. From a theoretical perspective, Xu Tiantian's work stands out for its critical approach to the notion of "rural romanticization". Opposing the widespread trend in many areas of China to transform historic villages into tourist destinations, the architect proposes a model of authentic regeneration, based on the recognition of the landscape as an archive of work and not as an aestheticized image. Stone, from this perspective, is not an ornamental material but a testament to human energy, a palimpsest of gestures, tools, and stratifications. Quarries thus become tools for territorial narration, where the form of emptiness is no longer a sign of exhaustion, but a condition of potential. As Xu Tiantian states, «emptiness does not represent absence, but the space where life can be reborn" (DnA Studio, Jinyun Quarries, 2021)»[125].

The nine quarries now constitute a pilot project for the sustainable regeneration of China's rural areas: a territorial laboratory where ecology, economy, and culture converge. The resulting spatial experience – a sequence of amorphous interiors, illuminated by natural fissures, where sound and light modulate perception – restores to the visitor the awareness of being in a landscape inhabited by memory. The excavated material thus becomes the matrix of a new form of community, where architecture does not simply construct, but recomposes. In Xu Tiantian's project, the Jinyun quarries are no longer places of extraction, but chambers of the future, where the tradition of manual labor and contemporary ecological sensitivity find a rare and necessary balance.



Fig. 61 – Quarries of Jinyun, DnA Design, Plan. Source: https://www.domusweb.it

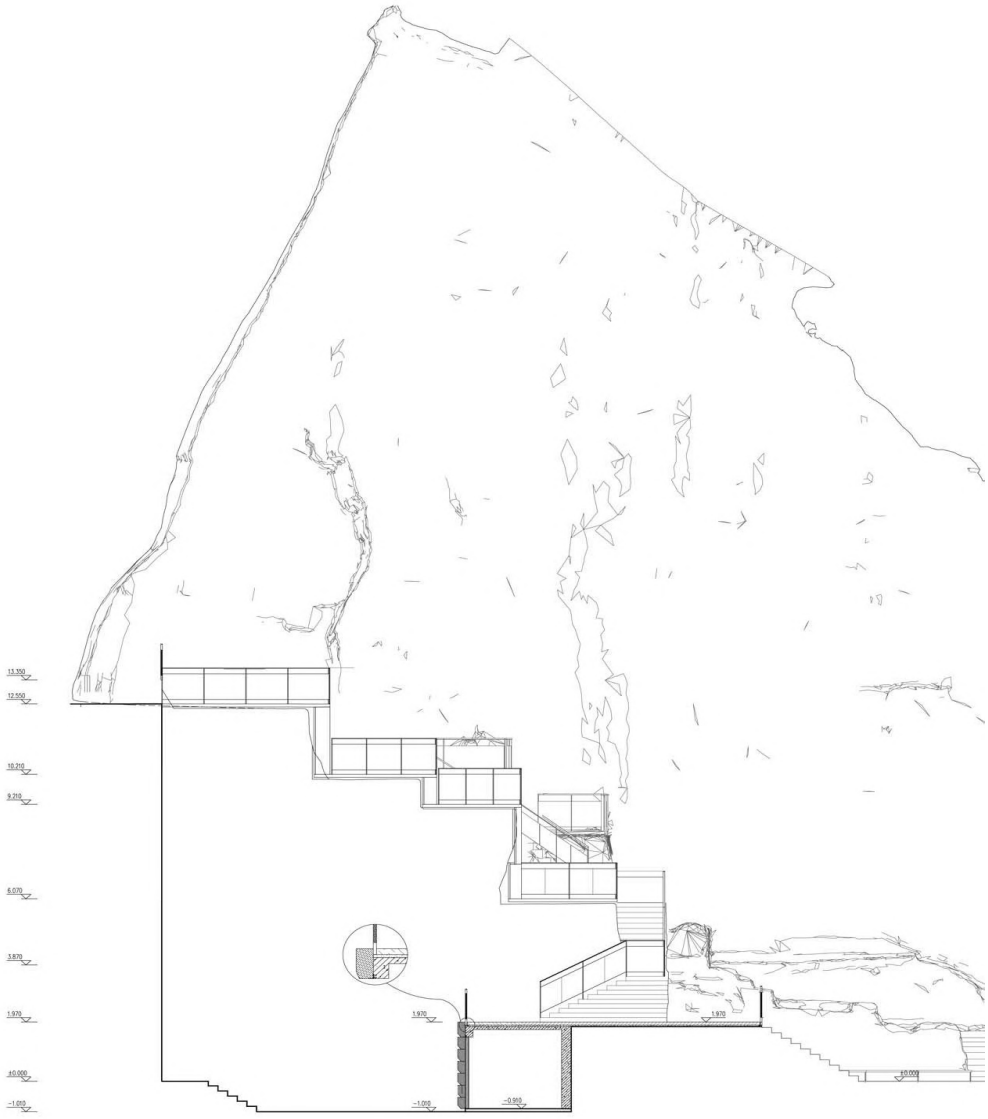

Fig. 62 – Quarries of Jinyun, DnA Design, Section. Source: https://www.domusweb.it

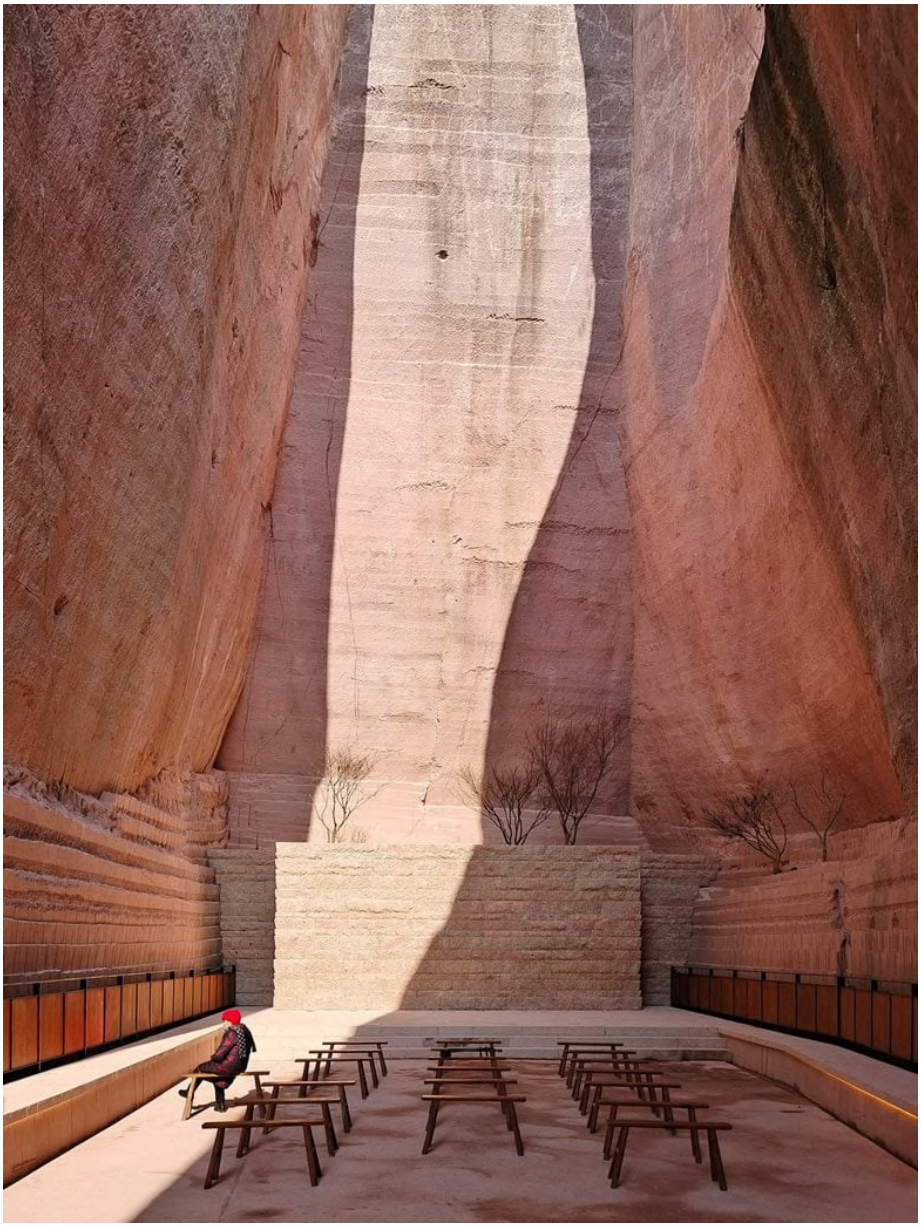

Fig. 63 – Quarries of Jinyun, DnA Design. Photo by Wang Ziling

5.7. The Descent | Marco Vito Quarry Park, Álvaro Siza Vieira, Lecce, 2009

Marco Vito's Quarry Park, inaugurated in Lecce following an international competition announced by the City in 2009 and won by Álvaro Siza, is a landscape-urban regeneration project that uses the abandoned quarry as the project's morphological, environmental, and cultural matrix. The area, located south of the historic center and close to the train station, covers approximately seven hectares and had been the site of Lecce stone extraction for decades. Following its abandonment, it was reduced to a dumping ground and decay. The project reinterprets the site as a continuous public infrastructure, where the quarry section becomes, above all, a form of collective space. The development strategy proceeds through the typological reuse of the existing natural setting: the rocky faces – on which the carvings of the "zocco", the iron tool used until the mid-20th century, are still visible – are recognized as the structural and perceptual backdrop for the new park. The design follows the original topography with pedestrian paths in stabilized soil (approximately 800 linear meters), dry stone walls defining the edges of the waterfalls, large expanses of grassland and native Mediterranean vegetation (approximately 100 holm oaks and carob trees, prickly pears, pomegranates, figs, capers, and shrubs) that, in addition to ensuring ecological continuity and microclimate control, create a green safety barrier along the fronts. The choice of materials and techniques – from soil treatment to extensive maintenance of the greenery – orients the park toward a sustainable management regime, consistent with the site's pedological and climatic identity.

The transversal continuity of the entire area, historically interrupted by Via del Ninfeo, is restored by the Bridge, a pivotal element both functionally and metaphorically: the elevated crossing connects the two portions of the park, allowing for vehicular and pedestrian passage, and simultaneously establishes a *link* between the quarrying memory and the new urban centrality attributed to the southern sector. In the long run, the project integrates with the station's revitalization program, which includes a new access point on Via del Ninfeo, the redevelopment of the railway building's exterior and interior spaces, the elimination of architectural barriers, and the

provision of new services: a transformation that relocates the city's functional center of gravity and consolidates the park as a connecting device.

The park's perimeter includes the 16th-century Masseria Tagliatelle – a name that harks back to the "tajate" (cuts) of the quarry – a three-story structure rising to the south, centered around a central courtyard. It has been restored as a hub with a café, co-working space, a hostel, spaces for non-profit organizations, cultural workshops, and artistic residences. While not architecturally significant, the complex houses the Nymphaeum of the Fairies, a Renaissance underground structure later converted into an olive oil mill, restored by the Nicolì company. The entrance, marked by an architrave with Roman inscriptions, leads to a rectangular chamber with twelve niches (six on each side) housing six life-size sculptures arranged symmetrically around the fountain. A passageway leads to a circular space with a false dome and a summit oculus, surrounded by a stone bench. The property, reopened for use, defines the park as an integrated system of underground heritage and open space. Consistent with Siza's approach, which during preliminary visits emphasized that the quarries are already a beautiful natural park and that the project should enhance their beauty, the construction grammar is deliberately essential: local stone furnishings obtained by clean excavation of blocks left rough on three sides, minimal edge devices and steps, and selective insertions where safety and accessibility required. The acoustic study of the façades identified two performance areas (to the northwest, adjacent to the soon-to-open café; and at Masseria Tagliatelle), verifying the reflective effectiveness of the limestone walls and the containment of sound dispersion towards the residential edges. From a historical-geological perspective, the park makes explicit the city's morphological dependence on the quarry: the Miocene bedrock on which the excavation fronts are based is the same one that provided the material used to build the churches, palaces, and houses of the historic center; the city, in building itself, created its own negative on the outskirts, leaving a subtractive imprint that the project now translates into a public form. The operation does not simulate a natural landscape, but adopts the artificial nature of the section as a compositional rule and an educational device: the legibility of the cultivation cuts, maintained and secured, is treated

as a technical and cultural document offered to the citizens. The park is also part of Lecce's network of urban green spaces, distinguishing itself for its unique quarry setting and its emerging metropolitan function, linked to the station-Via del Ninfeo axis. The works as a whole achieve a complex regeneration: environmental, through reclamation and controlled renaturalization; social, through the creation of new meeting places, services, and culture; economic, through the activation of local maintenance chains, stone crafts, and micro-enterprises linked to the park's uses; and infrastructural, through the reconnection of walkways and new accessibility. Therefore, Siza's project does not simply "park" a residual void, but establishes an urban device in which geological section, productive memory, and contemporary use are integrated: the facades remain the protagonists as structural and acoustic backdrops; the paths, calibrated to the natural slope, ensure a slow and inclusive use; the Masseria Tagliatelle and the Ninfeo reconnect the work to the long historical duration of the site; The bridge heals a morphological fracture and anticipates the reconfiguration of the railway access; the stone furnishings and native vegetation consolidate a language consistent with the site's materials. The result is a quarry park that is simultaneously a public space, a material archive, and an infrastructural threshold of the contemporary city, an operational paradigm for the redevelopment of quarry landscapes in Southern Italy.

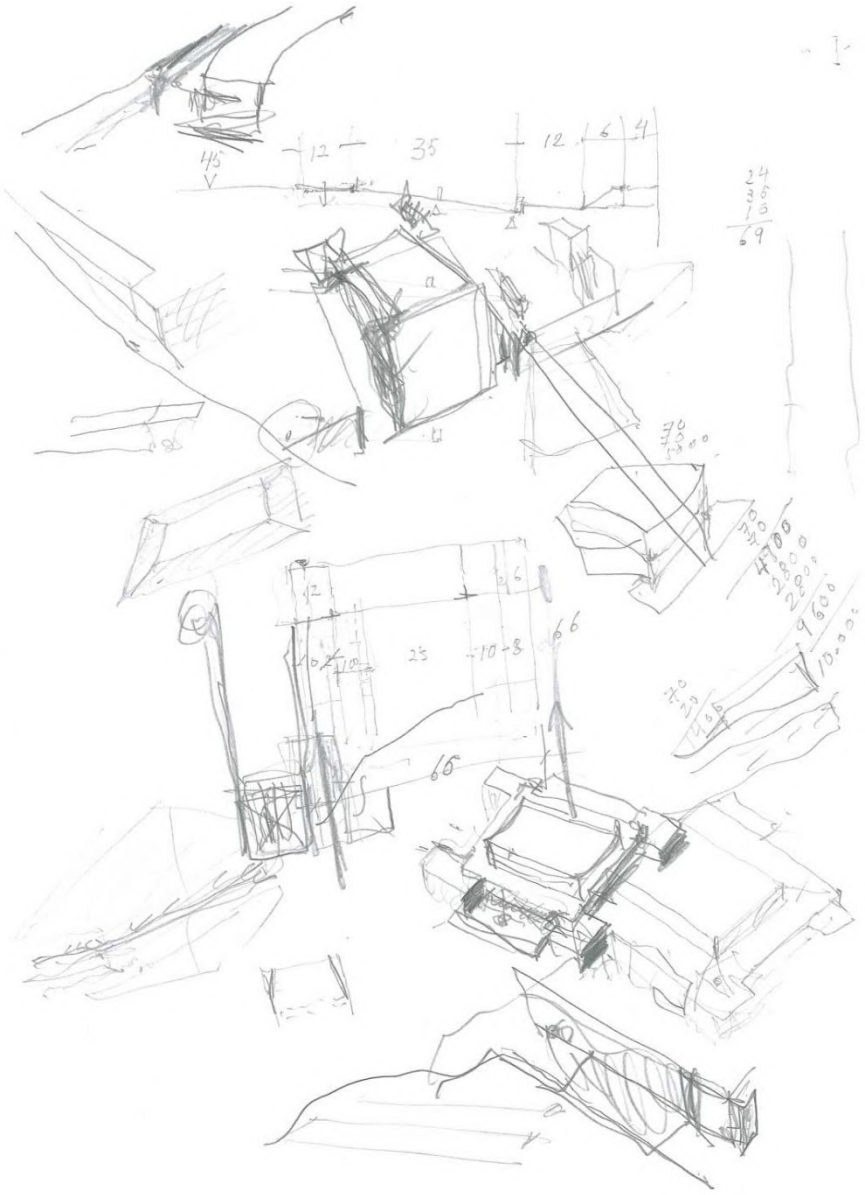

Fig. 64 – Siza project for Marco Vito's quarry. Drawing. Source: https://www.comune.lecce.it



Fig. 65 – Siza project for Marco Vito's quarry. Source: https://www.comune.lecce.it



Fig. 66 – Siza project for Marco Vito's quarry. Source: https://www.comune.lecce.it

6. CUTROFIANO

In the heart of the Salento peninsula, in an area between the Serre and the Ionian plain, Cutrofiano represents a significant area for exploring the interrelationship between geology, settlement, and material culture. Its urban and territorial identity is inextricably linked to the earth's materiality, to the quarrying and manufacturing traditions that have shaped both the topography and the physiognomy of the town over time. The landscape of Cutrofiano is thus the product of a geological transformation that has become anthropological: stone, initially a natural matrix, has become a building language, an economic tool, and a symbol of identity. Beginning in the 17th century, quarrying and processing activities have fueled a widespread economy that has become part of the system of artisanal centers in Salento, making Cutrofiano one of the main centers for the production of stone and ceramic materials. Quarry soil and clay, corresponding to two different lithological levels of the subsoil, have generated two complementary vocations – that of the builder and that of the potter – which still today constitute the dual face of its territorial identity. The dialectic between these two elements, stone and plastic, solid and malleable, epitomizes the profound relationship between the mineral and cultural dimensions of the place.

The system of quarries extending south and west of the town presents a widespread extractive morphology, marked by large basins, vertical cuts, and cultivated surfaces that, over the centuries, have redefined the topography and perception of the urban edge. These depressions, partly still visible as open wounds and partly recolonized by spontaneous vegetation or secondary uses, today constitute a complex geocultural heritage, in which nature and artifice overlap in an unstable equilibrium. The progressive abandonment of excavation activities, beginning in the second half of the twentieth century, has left behind a mosaic of interstitial spaces, poised between decay and potential, which require a new design interpretation based on an understanding of their spatial and environmental qualities.

Analyzing the Cutrofiano quarries therefore means interpreting a long-term process, in which geomorphological and urban planning knowledge intertwines with

socioeconomic history and the dynamics of landscape perception. Each quarry, in its specific morphology, is the result of an act of excavation repeated over time, which has progressively constructed a negative landscape: an inverted geography, where depth replaces height, and where future planning can only arise from an understanding of past stratifications. From this perspective, the regeneration of abandoned quarries is not simply a matter of functional or environmental recovery, but a cultural operation aimed at restoring meaning and continuity to a system of voids that belong to the community's collective memory.

This chapter approaches the Cutrofiano area from a dual perspective: on the one hand, geomorphological and urban planning, necessary to understand the structural relationships between land, city, and mining activities; on the other, planning and regulatory approaches, aimed at defining guidelines for the redevelopment and enhancement of quarry landscapes. The goal is to provide a comprehensive picture of the historical, spatial, and environmental transformations that have affected the area, identifying the possibilities for a new balance between memory and design, between conservation and innovation, between the depths of the earth and the horizons of contemporary living.

6.1. Geomorphological and urban analysis

The Cutrofiano area, located in the central-southern part of the province of Lecce, lies within the Serre Salentine carbonate platform, in the transition zone between the inland hills and the Ionian plain. It is an area of extraordinary geological interest, whose predominantly gentle and undulating morphology reveals the long-standing effects of marine sedimentation and subsequent karst erosion. From a lithostratigraphic perspective, the substratum consists of a succession of Miocene-age calcareous and calcarenitic rocks – specifically the Gallipoli Calcarenites and the Andrano Calcarenites – overlying Pliocene clay and marl layers, with sandy interbeds and fossiliferous layers of notable paleontological interest (ISPRA, Geological Map of Italy, Sheet 223 "Galatina", scale 1:50.000)[126]. The geological structure is the result of



Fig. 67 – Depth of the water table during floods. Municipality of Cutrofiano, Geological Analysis of the Territory for Municipal Planning, Table 3

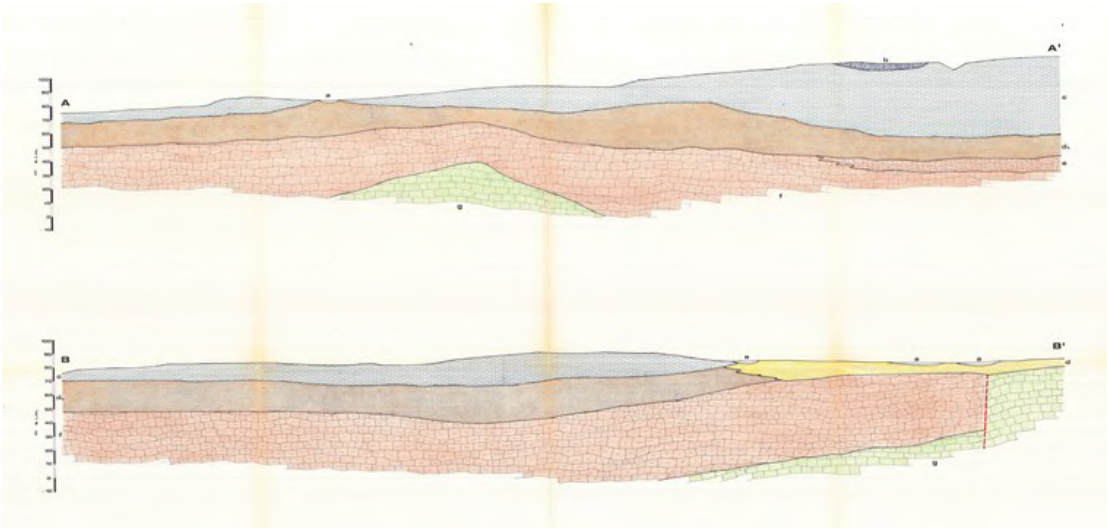

Fig. 68 – Geological section and constitutive stratigraphy. Municipality of Cutrofiano, Geological Analysis of the Territory for Municipal Planning, Table 8

a complex history of marine transgressions and regressions, during which the stone beds that constitute the area's principal lithic resource were deposited. These calcarenite horizons, with fine and medium grain sizes, variable cementation, and clay content often less than 10%, have favored open-pit quarrying over the centuries, thanks to their average compactness and ease of cutting. The current landscape thus reflects a delicate balance between natural processes and anthropogenic modifications, where quarry morphology is a structural element, not an exception. The excavated faces, cultivation levels, and residual basins, sometimes transformed into water collection basins or peri-urban vegetable gardens, define a complex topography, in which the altitudinal discontinuities and the chromatic variations of the rock surfaces become identifying features.

From a hydromorphological perspective, the land surface is organized according to an ephemeral drainage system, influenced by the low permeability of the underlying clay layers and the presence of superficial karst fractures. Disused quarries, due to their concave shape and impermeability from processing residues, act as mi-

cro-basins for seasonal water accumulation, locally influencing soil moisture and plant recolonization. This phenomenon, documented in numerous quarry areas in Salento (Puglia Region, Landscape Atlas, 2016), highlights the ecological role these depressions can play in a highly anthropized context, serving as temporary reservoirs for regulating rainwater and as habitats for native plant and animal species.

The origins of the town of Cutrofiano are closely linked to the presence of these lithic resources. The first permanent settlements, attested from the late Middle Ages onwards, were located along the boundaries between the quarrying areas and the agricultural lands, midway between the freshwater springs and the ridge roads that connected the towns of Galatina, Aradeo, Supersano, and Maglie. The urban organization follows the typical model of medieval Salento towns, with a radial grid centered on the mother church and a system of courtyards and alleys that cluster within the walled core, progressively surrounded by productive zones: kilns, artisan workshops, and, beyond that, the first quarry fronts. Already in the 1820 Land Registry (Lecce State Archives, Provisional Land Registry Fund)[127], a clear distinction can be observed between the compact residential area and the quarrying zones, located in continuity with the farm routes. Throughout the 19th century and the first half of the 20th, urban growth developed centrifugally, gradually incorporating the margins of production[128]. The quarries closest to residential areas, abandoned due to exhaustion or safety limitations, were gradually reoccupied with mixed uses – agricultural, artisanal, and sometimes residential – resulting in the gradual absorption of the quarried landscape into the urban fabric. This process, while on the one hand resulting in a loss of legibility of the original morphologies, on the other hand produced a particular state of interpenetration between built and excavated space: a threshold, rather than a border, where the city seems to infiltrate the voids of the earth, and the earth, in turn, persists as a subsoil structure and material memory.

A comparative analysis of historical maps (IGM 1888, 1954, 1980)[129] and regional orthophotos (AGEA 2006, 2021)[130] highlights how the main quarry areas – those of Contrada Matine, Via Aradeo, Via Supersano, and San Giuseppe – have progressively merged with the urban expansion of the late twentieth century, to the point

of constituting actual residential areas, often lacking specific urban planning regulations. The current Cutrofiano master plan (approved with Regional Government Decree no. 2683/2005)[131] only partially addresses the complexity of these areas, classifying them as areas for transformation or compatible reuse, without, however, providing a coherent morphological design or an ecosystemic vision integrated with the landscape.

Perceptually, the quarries constitute a system of spaces with a strong visual and identity-building value. The rocky faces, sometimes over ten meters high, define an introverted and shaded space, contrasting with the blinding light of the surrounding Salento landscape. The calcareous nature of the material gives the cuts an iridescent hue – from yellow ochre to ivory white – that varies with the incidence of sunlight and air humidity, generating remarkably intense perceptual effects. These characteristics, combined with the stratification of excavation techniques (manual block cutting, mechanical helical wire cutting, and continuous cutting), make the Cutrofiano quarries a palimpsest of forms that documents not only a technological evolution, but a true history of work and material.

In urban context, the interaction between soil, excavation, and construction translates into a hybrid settlement structure, in which the contemporary city – despite its apparent regularity of plan – preserves underground the memory of a now-abandoned production system, yet one that is still visible in topographical discontinuities and land anomalies. Indeed, over time, quarries have created a micro-grid of routes – access paths, ramps, loading bays – that now overlap with the minor road network, giving it an irregular and asymmetrical layout, resulting not from a plan but from an accumulation of practices and needs. The relationship between city and quarry thus manifests itself not as juxtaposition, but as genetic continuity, in which the built-up area derives directly from the extractive logic that preceded it. This integrated reading of the Cutrofiano landscape – based on geomorphological analysis, historical cartography, and perceptual interpretation – reveals the image of a territory in which the excavated void represents not a negation of space, but rather its origin. The quarries, far from being relics of an industrial past, constitute a spatial and morphological

heritage that can be reactivated as environmental, cultural, and social infrastructure, capable of redefining the city's edges and proposing a different idea of continuity between nature and artifice.

6.2. Transformations of historic quarries

The history of quarrying in Cutrofiano is a long and complex stratification of technical practices, production structures, and morphological transformations, through which a palimpsest of relationships between man and the geological substratum of Salento has gradually developed. The evolution of the quarry system, from underground pillar quarrying to later open-pit quarries, reflects not only the advancement of tools and extraction methods, but also a profound shift in the perceptual and spatial relationship with the earth: from working *within* the rock to working *against* it, from the intimacy of underground rock to the monumentality of the open face. From a geological perspective, the formations affected by mining belong to the Andrano Calcarenites and, above all, the Gallipoli Calcarenites, lithostratigraphic units of Pliocene and Pleistocene age that outcrop in the Cutrofiano area in a continuous sequence. The typical succession of the area shows at its base a series of sands and coarse calcarenites, locally rich in fossiliferous fragments and cetacean remains, overlain by finer and well-cemented bioclastic calcarenites, alternating with marly and sandy levels. The genesis of these formations is attributed to an internal marine platform environment, subject to cyclical transgressions and regressions that have determined a wide grain size variability and a peculiar lithological inhomogeneity, from which the different technical qualities of the extracted material derive. This stratigraphic richness gives the Cutrofiano subsoil a geological and landscape complexity: a sort of archive of paleoenvironmental transitions inscribed in the stone itself. According to land registry sources and oral testimonies, the first phases of exploitation of the calcarenite bed date back to the 17th century, but it was between the second half of the 19th century and the first decades of the 20th century that the technique of underground pillar mining became systematically widespread, destined to dominate local production until the post-World War II period. In this phase, quarrying took place entirely below ground level, through the opening of vertical access shafts – the so-called " *quarry*

eyes" – from which branched off a series of tunnels and extraction chambers organized according to an orthogonal grid, supported by pillars left in place. These pillars, of square or rectangular cross-section (generally 3-4 meters long on each side), ensured the stability of the vault and the reduction of the risk of collapse, maintaining a ratio of approximately 1:1 between the excavated volume and that left in place.

The underground quarries of Cutrofiano, now largely hidden or collapsed, extended mainly to the northwest of the town, in the Matine district and along the roads of Via Supersano and Via Aradeo, where the calcarenite bed was more homogeneous and compact. Some of them reached considerable extensions, spread over multiple levels and with depths varying between 6 and 12 meters. The work was carried out with manual tools – the *baseboard* and the *mallet* – and required careful planning of the cuts to maximize the extraction of regular ashlars (carrots or pieces), intended for building construction. The underground spaces, despite having no architectural purpose, took on a clear spatial quality: the modular repetition of the pillars, the light filtered through the vertical accesses, the constant temperature and the horizontal section of the vaults created an internal landscape of extraordinary charm, which local memory has handed down as "the city beneath the city". On an urban level, the presence of an extensive network of underground cavities has significantly influenced the settlement evolution of Cutrofiano. The areas above the ancient quarries, often incorrectly surveyed, are still characterized by geotechnical stability issues, with differential subsidence and the risk of collapse. Studies conducted by the Regional Geological Survey and ISPRA (Map of Artificial Cavities of Puglia, 2018)[132] highlight the need for constant monitoring of these voids, many of which are located within the consolidated urban fabric. However, these underground spaces, in addition to constituting a safety issue, also represent a resource of exceptional historical and cultural value, comparable in morphological characteristics to the underground quarries of Melpignano, Cursi, and Martano, with which they share the same calcarenite matrix and regular pillar structure. Beginning in the 1950s, with the introduction of mechanical machinery and the resulting increased productivity, underground mining was gradually abandoned in favor of the open-pit system, which allowed for large-scale extraction and

the creation of higher, more continuous faces. This transition marked a profound change in the landscape: the discrete and invisible underground cavities gave way to vast excavated basins, clearly visible in the Salento countryside. The quarries of Contrada San Giuseppe, Tagliate, and Marco Vito developed according to this new logic, with quarry faces over 100 meters wide and 15 – 18 meters deep, creating a striking visual and morphological impact. The extraction, mechanized using band saws and helical wire, produced a regular geometry of the faces and a system of ramps and yards that still form a visible pattern on cartography today. The transition from underground to open-pit mining also had significant consequences for the local economy. Increased production and the standardization of the material led to a period of growth, but also a progressive impoverishment of the qualitative relationship with stone. While underground quarries were places of artisanal knowledge and measurement, open-air quarries became industrial spaces of exploitation, geared towards quantity. The subsequent crisis in the construction sector and the depletion of the best-quality beds led, between the 1980s and 1990s, to the progressive decommissioning of mining activities, leaving a vast system of abandoned areas, often used as landfills or filled with waste material, in the absence of any environmental recovery plan.

Despite the loss of productive functionality, the landscape of the Cutrofiano quarries maintains an extraordinary morphological coherence, which still allows us to read the cutting sequences, the signs of excavation, the areas of the fronts, like a large palimpsest of human gestures imprinted in the stone. Some areas, such as those of *Contrada Matine* and *San Giuseppe*, present conditions of natural equilibrium with forms of spontaneous plant colonization; others, such as *via Supersano* and *Tagliate*, show phenomena of degradation or burial, but also potential for re-functionalization from an environmental or cultural perspective. In some cases, the quarry voids have favored the formation of humid micro-ecosystems, with the presence of species typical of temporary Mediterranean biotopes, such as the *Hydrocharis morsus-ranae* and the *Tamarix africana*, documented in the *PPTR Puglia* (2015)[133]. From an anthropological and urban point of view, the quarries have taken on new social functions over time: places of storage, grazing, play, but also spaces of collective memory, associa-

ted with the work and toil of the quarrymen. Oral memory still preserves the names of several large quarries – Masseria Duca, Cava Minonna, Cava Lazzari – which constituted a true regional production system, with access roads, warehouses, and workshops. Today, their physical and perceptual survival is linked to the possibility of reinterpreting them as cultural landscapes capable of revealing the profound structure of the territory. Geological investigations have revealed that the subsoil of Cutrofiano holds not only a lithological heritage but also exceptional paleontological evidence, including remains of Miocene and Pliocene cetaceans (whales and delphinids), associated with marine fossil layers of great scientific importance. These discoveries reinforce the idea of a possible connection between geological and architectural enhancement, where knowledge of deep stratifications becomes the foundation for reuse or protection projects. The ancient underground quarries, if adequately consolidated and monitored, can be reintegrated into the area's cultural enjoyment system as museum spaces or educational itineraries, similar to the experiences of Melpignano or Cursi, where restoration projects for exhibition purposes have been initiated.

The historical transformation of the Cutrofiano quarries cannot therefore be interpreted as a simple sequence of production phases, but as the visible manifestation of a continuous and dialectical relationship between matter and form, nature and culture, economy and landscape. From the intimacy of the underground chambers to the spectacularity of the open fronts, the territory has built its identity on a constant act of excavation and modeling, today called upon to renew itself through regeneration strategies aware of its historical depth. In this sense, the quarries are active forms of territorial memory, potentially capable of generating new urban and cultural centers. They represent, in architectural and environmental terms, a privileged laboratory for reflecting on the dialectic between *cavitas* and *civitas*, between excavated space and constructed space, according to the morphological continuity that still today defines the most authentic essence of the Cutrofiano landscape.

6.3. Abandoned quarries and spatial assessments

The progressive decommissioning of the Cutrofiano quarries, which began in the 1980s, represents the current state of these spaces – suspended between abandonment and potential – and requires a more complex interpretation that transcends the purely environmental dimension to address spatial, urban, and identity issues. The abandoned quarries constitute a widespread morphological system, a network of deep voids that delineate, underground and in the countryside, a counter-territory: an "inverse infrastructure". The main extraction areas of Cutrofiano are concentrated along the western and southern edges of the town, and where activities abruptly ceased, the faces still show traces of mechanical cutting, defining regular surfaces with architectural significance, upon which natural time has grafted new forms of biological colonization. In other cases, such as the San Giuseppe quarries, the surfaces have been partially obliterated by haphazard fill, construction site aggregates, and various types of waste, altering the original perception of the excavated space. The contrast between the geometric precision of the cut and the spontaneity of the reconquest of vegetation generates an ambiguous condition: a landscape precariously balanced between artifice and nature, between permanence and dissolution. This ambiguity, far from being a limitation, today represents the interpretative key for the definition of new uses, in which the very morphology of the quarry – its concave shape, its shadow, its acoustic resonance – becomes design material. The underground chambers still display the regular grid of pillars, with surfaces smoothed by chisels and large, low vaults; in some cases, the cavities feature horizontal connections that suggest an original production continuity, subsequently fragmented by urban transformations. These underground chambers, due to their environmental characteristics (constant temperature, controlled humidity, and soundproofing), could be repurposed as museum spaces, educational tours, or underground laboratories, subject to consolidation and monitoring.



Fig. 69 – The underground quarries of Cutrofiano. Photo by the author

The experience of Cursi, where part of the ancient underground quarries have been integrated into museum tours of Lecce stone, demonstrates the potential to transform these sites from risk zones into highly valuable cultural assets. The spatial assessment of abandoned quarries, therefore, cannot ignore an integrated ecological approach, which considers the quarry voids as nodes in the regional green-blue network, potentially functional for rainwater drainage, climate mitigation, and the environmental connection between agricultural areas and urban margins. From this perspective, residual depressions, if appropriately restored, can take on the role of natural retention basins, reducing hydraulic risk in urbanized areas and contributing to the improvement of the local microclimate, in analogy with the Nature-Based Solutions strategies envisaged by European Directive 2021/741[134].

From a settlement perspective, the disused quarries of Cutrofiano represent an interstitial spatial system, located between the compact city and the agricultural countryside, in a position of "active margin". However, their very liminal location gives these places extraordinary potential as ecological and cultural bridges between the residential area and the surrounding countryside. The current General Regulatory Plan (DGR 2683/2005)[135] has not yet incorporated specific legislation for the protection or enhancement of quarry areas, generically classifying them as "transformation zones" or "disused production areas". This regulatory gap highlights the need to update the plan in line with the guidelines of the Regional Territorial Landscape Plan (PPTR)[136], which includes disused quarries among "production landscapes" and recommends restoration interventions "aimed at ecosystem reintegration and the recognition of their testimonial and morphological value" (PPTR, Table 4.1.2, 2015)[137].

Spatial assessments conducted through direct surveys and photointerpretation highlight how the quarries' form constitutes a still-legible matrix: enclosed, introverted spaces, delimited by rocky backdrops, which lend themselves to controlled collective uses, such as parks, themed gardens, natural amphitheaters, or research spaces. These voids possess qualities that contemporary urban planning often artifi-

cially seeks: temperate microclimates, acoustic insulation, natural shading, and material continuity with the context. Within the framework of European strategies for the regeneration of abandoned industrial landscapes, the Cutrofiano quarries offer a privileged testing ground. The heritage and morphological value of these sites, combined with their widespread distribution and proximity to the town center, allows us to envision an integrated system of underground and open-air public spaces, connected by passageways, capable of reconstructing the relationship between city and land. The concept of a "quarry network", already introduced in similar experiences in Catalonia and Provence, could constitute an effective strategy for Cutrofiano: a unified landscape system that enhances each quarry according to its specific characteristics – ecological, historical, or perceptual – while ensuring their spatial and functional connection. Within this framework, the spatial assessment of abandoned quarries cannot be reduced to mere cartographic delineation: it requires a broad, informed, and holistic approach, capable of interpreting depth, orientation, light, acoustic resonance, humidity, permeability, and ecological balance. These parameters, if appropriately translated into design guidelines, can guide future reuse interventions, defining criteria for the inclusion of new, low-impact architectural or infrastructural devices. The redevelopment of the Cutrofiano quarries, therefore, is not merely about environmental restoration, but involves a semantic reactivation: from the place of extraction to the place of restitution, from the void of subtraction to the space of possibility. As Andrea Branzi writes: «Every abandoned place is already a project, since it holds within itself the memory of a bygone energy and the promise of a new form of life»[138]. From this perspective, quarry voids are not margins but matrices: structures of meaning and form, from which to rethink the city and the contemporary landscape.

7. THE PROJECT FOR THE UNDERGROUND QUARRY OF CUTROFIANO

The study area covered in this chapter represents one of the most recent and significant opportunities for design reflection within the Cutrofiano mining district, in the heart of the Salento peninsula. The site, now owned by V.F. CAVE s.r.l., represents a point of convergence between different periods of local mining history: a modern mining pit system that, during clearing operations, intercepted an older network of underground galleries dating back to the pre-industrial phase of quarrying. This hybrid condition – a spatial short circuit between the archaeological depth of the underground landscape and the infrastructural scale of the contemporary quarry – has laid the foundation for a redevelopment project that, within the framework of the doctoral research in Environmental, Territorial, and Building Risk and Development (DICATECh – Polytechnic University of Bari), embraces the dimension of the anthropic void as a generative and cognitive device.

The project is part of a complex territorial context, marked by a variety of environmental, geotechnical, and landscape issues, yet also characterized by significant morphological and identity-building value. The coexistence of underground quarries, open-pit quarry depressions, and landfill areas has over time created a layered landscape, in which forms of subtraction overlap with those of abandonment. In this context, the V.F. CAVE s.r.l. quarry serves as a laboratory for applied experimentation, where surveying, analysis, and design practices contribute to the definition of an integrated operating model aimed at reconciling environmental, energy, and cultural needs. The site's redevelopment is based on three complementary strategic directions, each addressing a different level of the relationship between soil and project. The first, hydrogeological in nature, aims to create a retention basin to collect and regulate rainwater, in order to mitigate runoff and flooding that affect the surrounding catchment area. The second, energy-related, proposes the installation of a photovoltaic park integrated into the quarry's morphological system, conceived as a reversible, low-impact production infrastructure. The third, cultural and social in nature, identifies

the underground complex and the quarry floor as potential venues for cultural, musical, and educational promotion, where the geological memory and acoustic quality of the void become resources for architectural and performative experimentation.

These three interrelated and synergistic lines of action define a framework for intervention based on the concept of adaptive transformation, in which knowledge of the site – both its surface and subsurface dimensions – is the methodological basis of the project. The approach adopted is based on an integrated digital survey system, based on photogrammetric techniques, laser scanning, and three-dimensional modeling, aimed at building an accurate spatial archive of the complex's morphological and structural conditions. This knowledge-gathering tool is not limited to mere documentation, but becomes an integral part of the design process, allowing for the evaluation of the relationships between the quarry structures, the lithological discontinuities, and the site's environmental components. From this perspective, the Cutrofiano quarry project is an interpretative and operational tool that establishes a dialogue between nature and artifice, soil and infrastructure, memory and innovation. The ultimate goal is to restore meaning to a marginal place, reintegrating it into the territorial system as a spatial and cultural infrastructure capable of producing energy, managing water resources, and generating collective experiences.

7.1. Site transformations

The V.F. CAVE s.r.l. quarry, located in the southern part of the municipality of Cutrofiano Located between provincial roads 362 and 198, it condenses the overlap between more recent pit mining practices and the complex legacy of underground cultivation that has characterized the area since the 19th century. Human intervention, repeated over time, has generated a complex morphology in which different levels of excavation, lithological fractures, and underground voids intertwine in a three-dimensional stratigraphy of human labor in the material. The site's current configuration is the result of a dual process: the transformation of the rock bed for the industrial

extraction of calcarenite and, simultaneously, the spontaneous metamorphosis of the landscape resulting from the partial decommissioning of production activities.

Modern excavation, conducted with helical wire and band saw machinery, has created a large, sub-rectangular pit, delimited by vertical walls up to 14 meters high and lateral access ramps connecting the quarry floor to the ground level. Excavation operations, begun in the second decade of the 21st century, have led to the progressive interception of a pre-existing underground system, consisting of galleries with pillars left in place, located on average at a depth of 7 – 8 meters below the original level.



Fig. 70 – Excavation work that intercepted the ancient tunnels excavated by the Cavamonti. Image courtesy of V.F. CAVE s.r.l.

The overlap between the underground and pit morphologies constitutes the most complex and delicate aspect of the site. In some central sections, the new quarry floor has literally broken through the vaults of the ancient tunnels, producing large collapses and areas of geotechnical instability, while in others the interface between the two systems has remained intact, delineating a complex "double cavity" relationship that today appears as a material palimpsest of the quarry's production. The re-

search and recovery project began precisely from this condition of interference, viewing the stratification not as a critical issue but as a cognitive tool: the possibility of studying, in cross-section, the continuity between the ancient and modern quarry, between the manual and mechanical gestures, between the cutting of the pickaxe and that of the industrial blade. The survey conducted between 2022 and 2024, using aerial and terrestrial photogrammetry, laser scanning, and 3D rendering in a BIM environment, allowed for the precise reconstruction of the void's morphology and the quantification of the extracted volumes, excavation depths, and intersections between the different levels.



Fig. 71 – Excavation work that intercepted the ancient tunnels excavated by the Cavamonti. Image courtesy of V.F. CAVE s.r.l.

The modeling highlighted a complex hydraulic relationship between the main pit and the underlying tunnels, which currently act as drainage basins and temporary reservoirs for rainwater collection. Infiltration, concentrated in the most permeable areas, has favored the formation of small wet depressions and stagnant areas. These phenomena, while increasing the risk of instability, also confer a latent ecological value to the site, potentially attributable to the functions of a natural retention basin.

The result is a picture in which recent extraction of carbonate stone material using modern tools and techniques, during the clearing phase, which intercepted the ancient tunnels extending underground, has created an exceptional condition in which, on the quarry fronts, large portals stand out, giving access to underground passages, once accessible only through descents. The extraction basin in question is located at the end of the relevant depositional level and requires a recovery and conversion plan. On a perceptual and landscape level, the quarry manifests a dual identity. On the one hand, the imposing open-air void, punctuated by the clean cuts of the blades and the pale hues of the calcarenite, conveys a strongly horizontal spatiality, dominated by light and silence. On the other, the underground network of tunnels – latent – suggests a depth that transcends the visual scale, evoking the dimension of an interior landscape, carved into the material. This dual nature of the void – horizontal and vertical, visible and hidden – has become the starting point for design hypotheses, aimed at reintegrating the site into the territorial system through water regulation, energy production, and cultural enhancement. The site's transformations are not limited to its physical dimension. They involve the collective perception of the place, which tends to reconfigure itself from a marginal productive space into an environmental and cultural infrastructure. The presence of the underground galleries, once hidden and feared, now becomes a source of valorization: their regular geometry and structural stability allow them to be reinterpreted as an integral part of the project, capable of hosting support functions or user paths linked to the memory of labor and stone. At the same time, the main pit – with its involuntary monumentality – lends itself to new architectural interpretations as a natural amphitheater, ecological basin,

or energy platform.From an operational perspective, the transformations already initiated by the owners in recent years, in accordance with the guidelines of the Puglia Regional Quarry Plan (updated 2020), have included safety measures along the quarry fronts, water management, and the creation of a collection system for hydrogeological control. However, the design approach adopted here departs from the logic of mere morphological restoration: it aims to enhance the existing morphology as an active structure, not to be erased but integrated into a new life cycle of the site. In this sense, the quarry becomes a laboratory for reflection on the relationship between geology and architecture, in which the shape of the earth and the form of the project overlap until they coincide. The transformations observed in the V.F. CAVE s.r.l. quarry represent not just a local episode, but a territorial paradigm. They demonstrate how, within the Salento quarry system, the progressive overlapping of excavation techniques and times has generated a landscape of depth, in which the city and the subsoil dialogue through an invisible thread. Cutrofiano, in this sense, is the synthesis of a mining genealogy that is renewed in the project: the extracted material becomes material of knowledge, and the transformation of the void becomes an opportunity to re-establish a balanced relationship between human activity and the shape of the earth.



Fig. 72 – The underground quarries of Cutrofiano. Photo by the author



Fig. 73 – A tunnel in the underground quarries of Cutrofiano. Photo by the author

7.2. Detection techniques

Knowledge of the extraction system at the V.F. CAVE s.r.l. quarry was based on an integrated survey combining photogrammetric methodologies, laser scanning, topographic surveying, and 3D modeling. The goal was to build a precise knowledge base of the quarry's morphologies, the intercepted underground tunnels, and the geotechnical and hydraulic relationships between the two excavation levels. The survey was conceived as an operational and interpretative tool, useful for both morphological analysis and the definition of design strategies. The approach adopted allowed for the merging of the territorial and subterranean scales, providing a coherent 3D model of the entire complex. Photogrammetric documentation was carried out using multirotor UAV drones and high-resolution digital cameras, with *Structure from Motion (SfM) technology*. The flight missions produced a georeferenced point cloud with a planimetric accuracy of ±2 cm and an altimetric accuracy of ±3 cm. From this, the digital terrain model (DTM), the digital surface model (DSM), and orthophotometric data were derived, used to map the quarry faces and calculate the extracted volumes. Multispectral imaging allowed us to identify wetlands and spontaneous vegetation, useful information for defining the areas of greatest permeability and for planning the future retention basin. The underground tunnels, discovered during mining activities, were surveyed with 3D time-of-flight laser scanning technology, with millimetric precision. The scans, taken from multiple station points, produced a cloud of over 250 million points, fully describing the underground volumes, pillars, and vaults. The processing, conducted in *Autodesk Recap* and *CloudCompare*, allowed the underground scans to be integrated with the photogrammetric survey of the open-pit quarry, resulting in a single continuous model. This model highlighted the contact points between the modern pit and the ancient tunnels, the collapse zones, and potentially unstable areas, providing a solid basis for subsequent morphological and safety assessments.

In this way, modeling is not just representation, but a project anticipatory act, capable of predicting transformation scenarios through the dynamic overlay of metric, environmental, and functional data. Three-dimensional analysis also allows for the establishment of a direct relationship between physical parameters (depth, slope, ex-

posure, accessibility) and reuse potential, translating technical knowledge into an operational design tool.



Fig. 74 – Digital model obtained by combining the point cloud. Modeling by the author



Fig. 75 – Photogrammetric survey of underground tunnels. On-site acquisition.

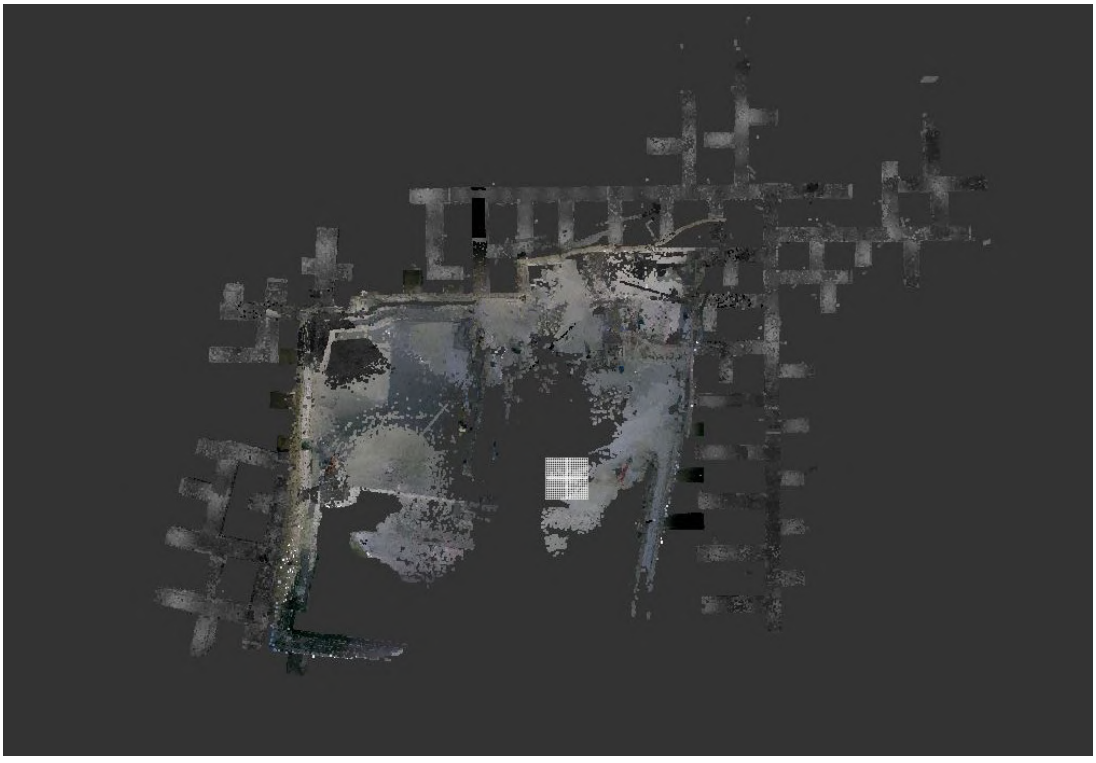

Fig. 76 – Photogrammetric survey of underground tunnels. On-site acquisition

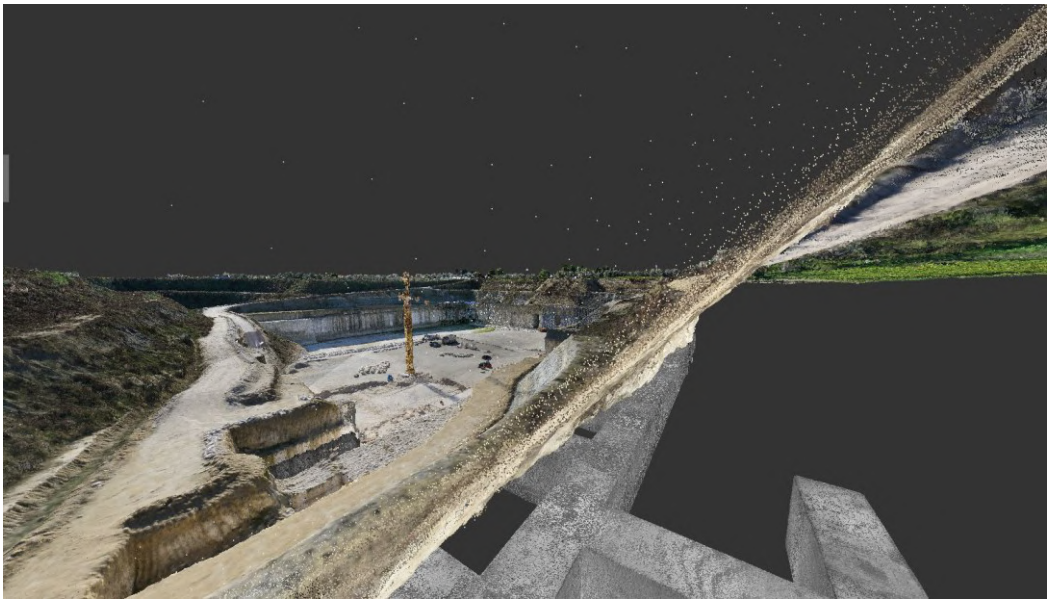

Fig. 77 – Digital model obtained by combining the point cloud. In this image you can see the quarry floor and galleries simultaneously Modeling by the author

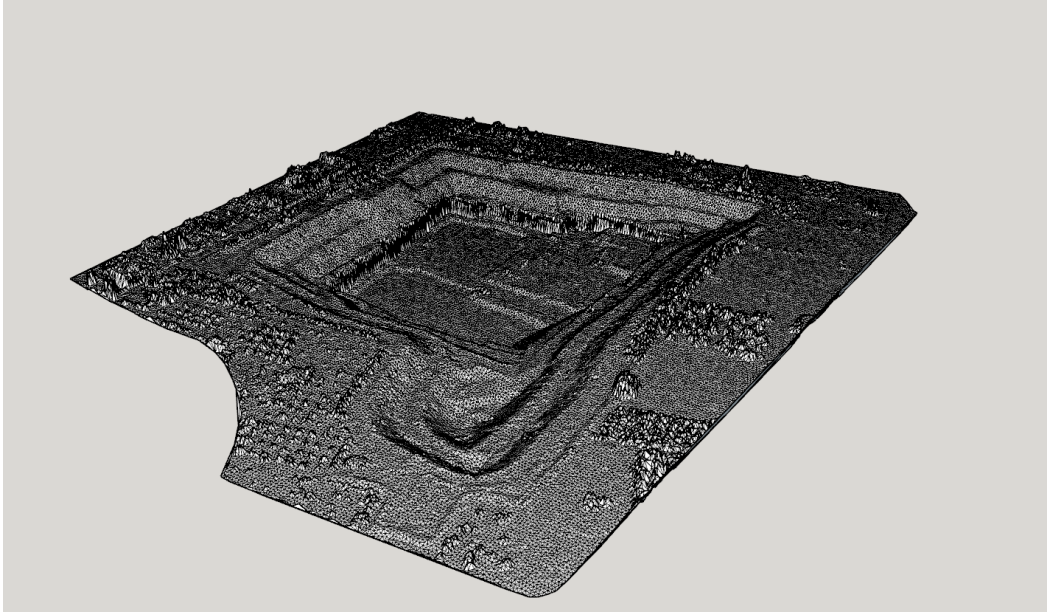

Fig. 78 – Digital model of the Quarry. Modeling by the author

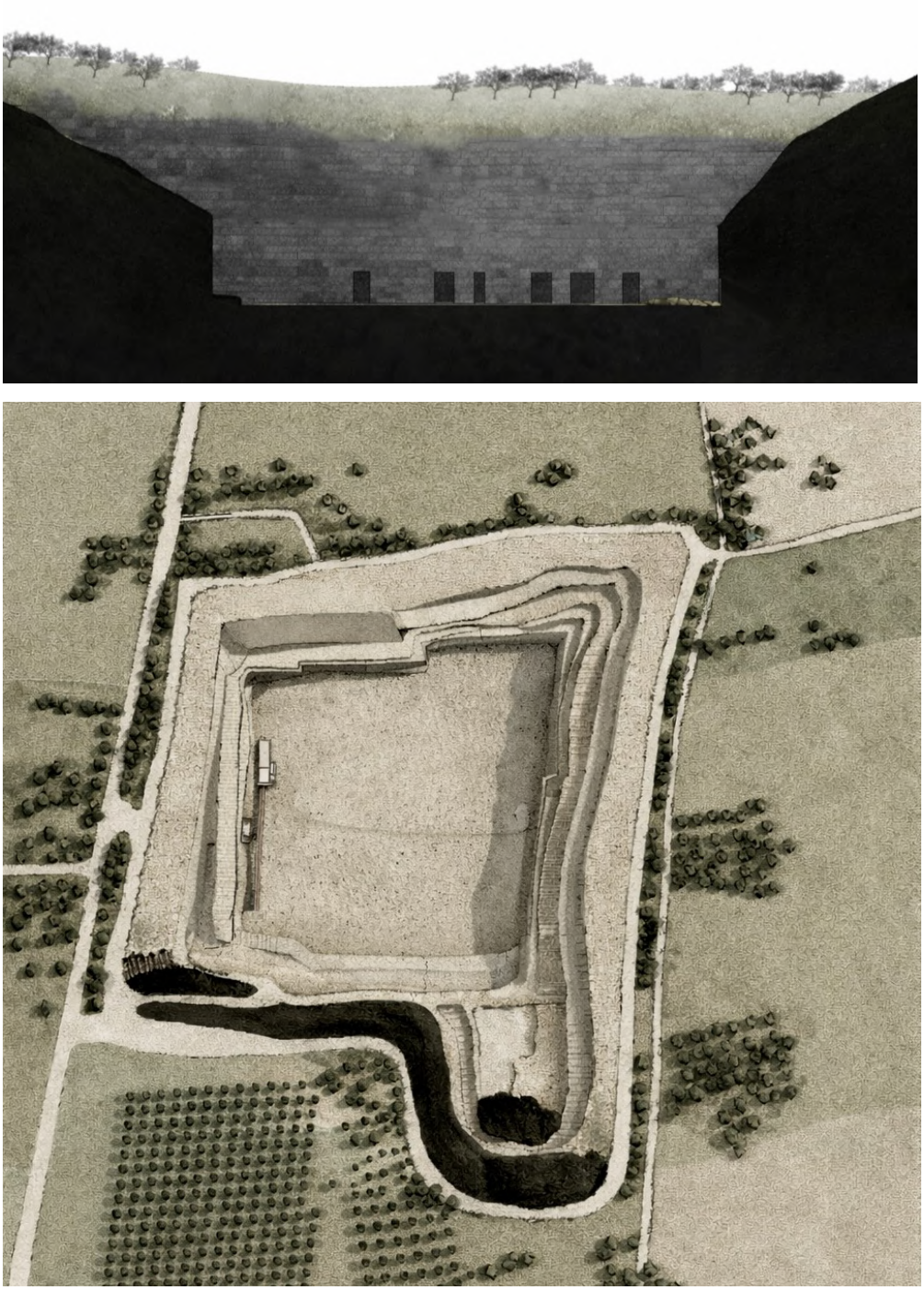

Fig. 79 – Current state drawings. General plan and longitudinal section. Rendering by the author

7.3. Site interpretation and multi-criteria analysis

In-situ autopsy surveys allowed for a highly precise definition of the morphology and geological structure of the quarry system, offering an in-depth understanding not only of the spatial configuration but also of the static and mechanical behavior of the constituent materials. Direct knowledge of the site, combined with morphometric and three-dimensional analyses, allowed for the identification of the construction logic and geotechnical quality of the subsoil, clarifying the mechanisms that allowed the coexistence of pit and underground quarrying.On the main face of the quarry, a clear and orderly stratigraphy is visible, divided into three main levels: a surface layer of soft clays, with silty fractions and discrete organic veins; a middle layer of compact, more cohesive and homogeneous clays; and a lower bed consisting of a mass of compact calcarenite, belonging to the Gallipoli Formation, ivory-yellow in color and medium-fine grained. This latter bed, due to its compressive strength and good workability, was historically used for underground excavation by quarrymen, known locally as "cavamonti"[139], who constructed the tunnels on a system of regularly spaced, square-section pillars left in place. The regular texture of the bed, combined with the presence of well-distributed natural contraction joints, ensured the stability of the vaults and their preservation over time.

Visual inspections and three-dimensional surveys confirm the absence of significant damage or plastic deformations; neither keystone crushing nor perimeter subsidence were observed. The nearly flat vaults and the absence of deflections demonstrate the structural integrity of the underground system, aided by the lithological continuity of the bedrock and the absence of significant infiltration in the central portions of the tunnels. The only fragile conditions observed concern the connection points between the surface and the underground, corresponding to the ancient descents. These tunnels, once used for access and transport of material, open outward in a truncated cone shape and are now partially collapsed. The collapse of the top ashlars has caused the progressive erosion of the overlying clay, allowing rainwater to infiltrate the tunnels and percolate along the faces. In these areas, characterized by localized imbibition phenomena, limited surface instability has been observed, wi-

thout, however, compromising the overall stability of the cavities. The safety and morphological reconstruction of the access passages therefore constitute the starting point of the project: their stabilization and waterproofing will guarantee the usability of the underground passages, preventing further infiltration and allowing safe access to future visiting and study spaces. The site's interpretation required an integrated assessment based on a multi-criteria analysis that simultaneously considered morphological, geotechnical, hydraulic, ecological, and perceptual aspects. This analysis aimed to identify critical areas and, at the same time, those with the greatest potential for transformation, thus rigorously guiding the design interventions. From a morphological and structural perspective, the three-dimensional analysis conducted on the pit quarry and the underground tunnel system revealed an average elevation difference of 8-9 meters between the various levels, for a total average elevation difference of 28 meters, and a natural slope of the fronts between seventy and eighty-five degrees.



Fig. 80 – Zinital view and territorial framework that highlights the proximity relationship between the inhabited center of the municipality of Cutrofiano and the extraction basin under study. Graphic rendering by the author



Fig. 81 – Synoptic map of the spatial and geomorphological conditions of the territory surrounding the quarry under study, obtained by superimposing different maps. Graphic rendering by the author

The regularity of the cut surfaces and the lithological continuity of the limestone bed confirm the overall stability of the complex, which therefore lends itself to being interpreted as a potential active geotechnical infrastructure, capable of accommodating new uses without compromising the structural equilibrium of the site. From a geotechnical and hydraulic perspective, the pit-like shape of the extraction area favors the natural flow of rainwater toward the quarry floor. Digital terrain models and two-dimensional hydraulic simulations have demonstrated the potential for water storage in some low-lying areas, with a potential capacity of over ten thousand cubic meters, sufficient to ensure the effectiveness of a future retention basin. The presence of underground tunnels, which intercept part of the infiltration water, allows for the creation of a natural drainage network capable of facilitating the overall water management of the system. However, in the entrance areas of the descents, where imbibition and ru-

noff are concentrated, it will be necessary to provide sealing with drainage materials and the construction of surface collection channels to mitigate the risk of uncontrolled infiltration. From an ecological and environmental perspective, direct observations and drone analyses have documented the spontaneous establishment of pioneer plant species, such as *Atriplex halimus, Cistus monspeliensis,* and *Euphorbia dendroides*, which attest to the habitat's progressive regeneration capacity. The presence of these species, adapted to poor soils and conditions of strong radiation, suggests the possibility of implementing low-impact renaturalization strategies based on the enhancement of native vegetation. Furthermore, the underground galleries feature stable microclimatic conditions – with temperatures between 16 and 18°C and an average humidity of 85% – which make the underground spaces particularly suitable for low-energy functions, such as exhibition spaces, research laboratories, or places for artistic and musical experimentation. This relationship, interpreted as a narrative device for the project, allows for the restoration of symbolic and identity-building value to the excavated landscape, transforming it from a wound in the territory into an archive of material memories and a cultural infrastructure. Finally, the analysis of accessibility and usability identified the pre-existing network of quarry ramps and paths as a logistical base already prepared for subsequent transformation. The access routes, sized for the passage of technical vehicles, can now be converted into differentiated routes for pedestrian traffic, maintenance, and inspection operations. The regular morphology of the underground corridors, with an average width of three and a half meters and a nearly horizontal floor, facilitates compliance with safety and universal accessibility standards. The access shafts, which have been reconstructed and consolidated, will be integrated into the access system, ensuring controlled and safe access to the underground spaces without altering the original morphology. Overall, the multicriteria analysis provides a picture of overall stability and internal coherence of the quarry system, in which critical issues are limited and circumscribed, while the potential for reuse is high and compatible with the site's geological identity. The Cutrofiano quarry, far from being a risk site, can therefore be interpreted as a consolidated infrastructure, capable of safely accommodating new environmental, energy, and cultural functions,

positioning itself as a strategic hub for territorial regeneration based on the re-signification of the excavated landscape.





Fig. 82 – Areas at Potentially Significant Flood Risk (APSF) and Floods – Risk Classes (PGRA 2021). Source: National Geoportal; elaboration by the authors. Source: National Geoportal; elaborated by the author

7.4. Project strategies

The combination of morphological, geotechnical, and environmental analyses has allowed us to define a sufficiently robust knowledge framework to guide intervention strategies for the regeneration of the V.F. CAVE s.r.l. quarry system. The very structure of the site – determined by the interaction between the pit excavation and the underground tunnel system – offers a spatial duality that becomes the foundation of the project: the surface area, open and permeable, is designed to accommodate hydraulic, ecological, and energy functions; the underground area, dense and protected, hosts cultural functions and the valorization of the material heritage. The overall objective is to transform a recent quarry site, still recognizable as an industrial site, into a complex environmental infrastructure capable of combining hydrogeological safety, energy production, and cultural enjoyment, according to the principles of sustainability and the circular regeneration of the excavated landscape.

The project thus takes the form of a territorial device structured around three interdependent strategic directions. The first concerns the creation of a retention basin integrated with the local hydrographic system, capable of simultaneously fulfilling hydraulic safety and ecological rebalancing functions. The second involves the development of an energy park, which will exploit the quarry's extensive surface area and its exposure to host renewable energy production technologies. Finally, the third concerns the conversion of the underground spaces into venues for cultural and musical promotion, conceived as a simultaneous continuation of the memory of underground work and living. The three strategies, while differing in objectives and operational methods, contribute to a single project framework, in which each intervention is conceived as part of an integrated ecological and cultural system. The retention basin ensures the area's hydraulic resilience; the energy park guarantees its self-sufficiency; the underground spaces consolidate its memory and symbolic dimension. The result is a model for regenerating the quarry landscape that goes beyond environmental restoration, defining a new form of coexistence between natural processes, technical infrastructure, and human activities. The project, conceived as the outcome of a process

of understanding and listening to the material, restores the quarry's dignity as a living space, transforming it into a place of balance between nature and artifice, economy and culture, memory and project

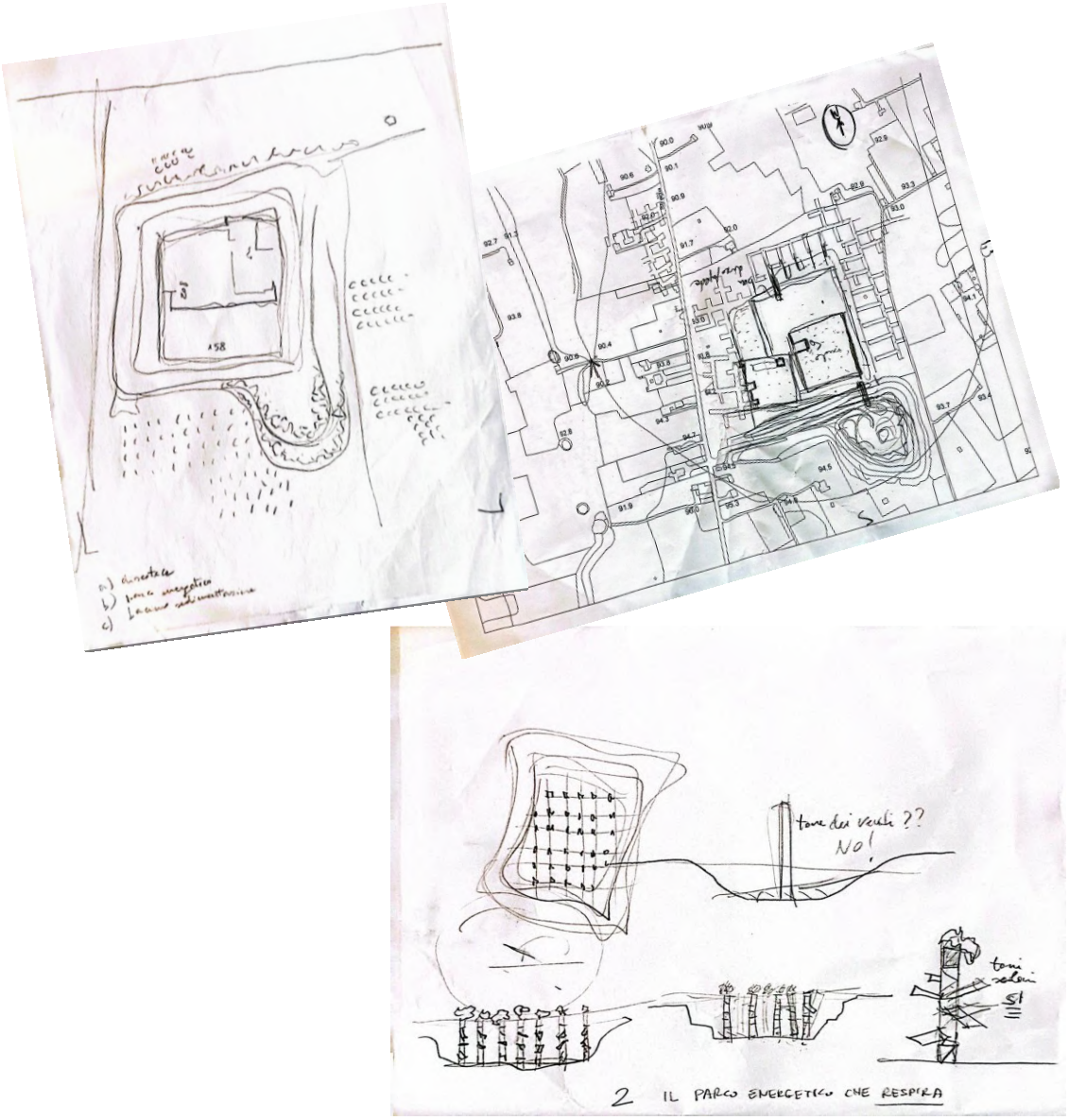

Fig. 83 – Project sketches. Drawing by the author

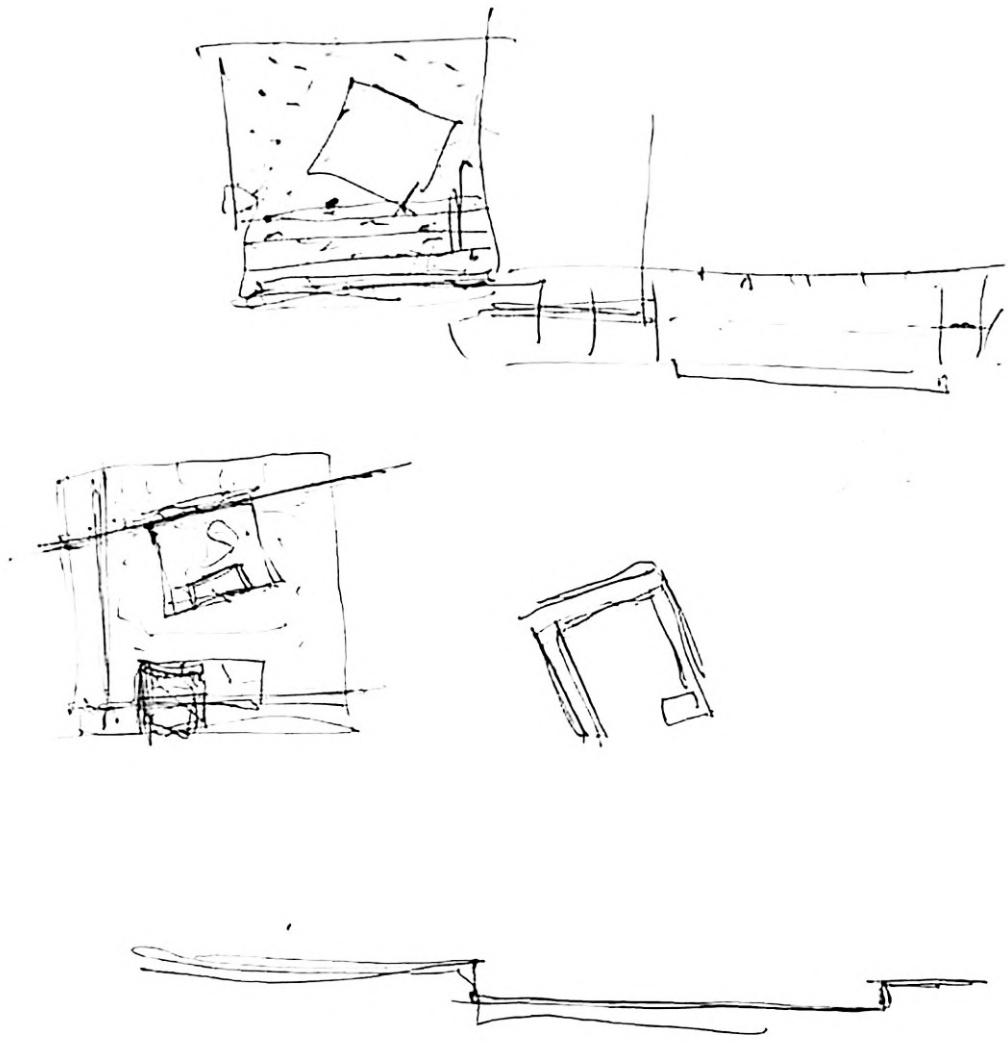

Fig. 84 – Project sketches. Drawing by the author

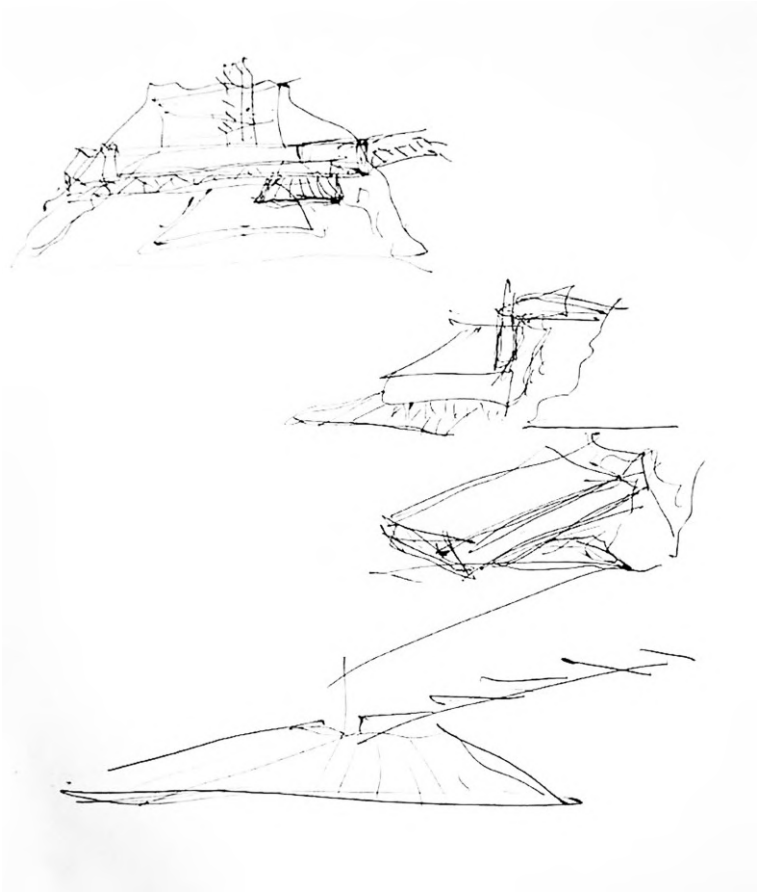

Fig. 85 – Project sketches. Drawing by the author

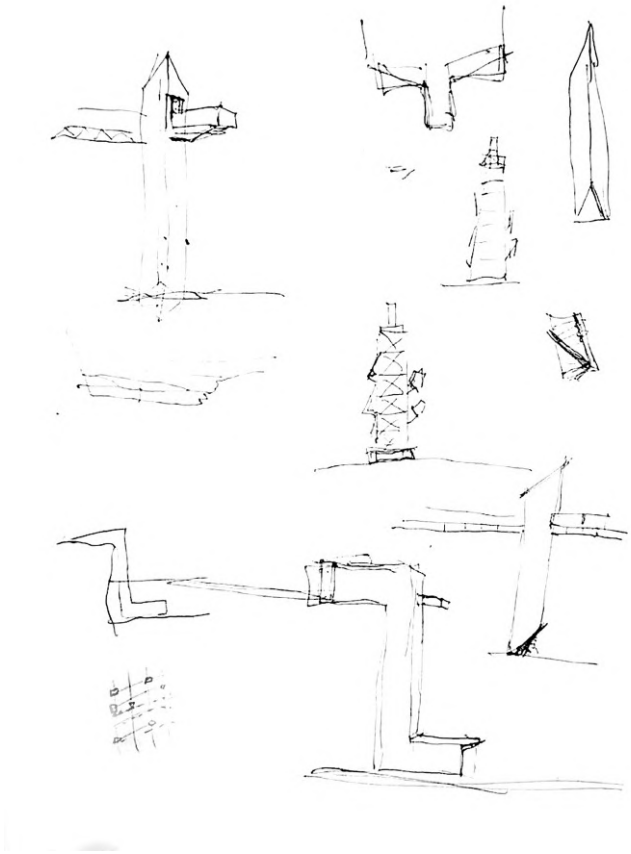

Fig. 86 – Project sketches. Drawing by the author

7.4.1. The containment basin

The first project, dedicated to the hydraulic and morphological reconfiguration of the quarry, involves its conversion into a retention basin, transforming it into a large infrastructure for regulating surface water and, at the same time, a device for measuring and perceiving the landscape. This is a soil modeling project achieved through subtraction, in which the logic of excavation is reinterpreted for design and environmental purposes. The excavation of a portion of the bedrock and the controlled redefinition of the faces aim not only to consolidate and stabilize the rock surfaces but also to restore an orderly morphology capable of accommodating water and making its behavior visible. The quarry, from an extraction void, thus becomes a measurable hydraulic basin, whose cross-section, calibrated at different altimetric levels, allows for immediate identification of the height reached by the water during extreme weather events. Each flood level corresponds to a material reference plane, like a scale of values engraved in the rock, capable of recording hydrological variations over time and restoring their physical memory. In this way, the quarry becomes a tool for interpreting and monitoring the territory, as well as a water supply basin useful for the adjacent city and the surrounding countryside. The proposed modeling does not aim to erase traces of the mining past, but rather to establish a dialectical dialogue between the spontaneous forms of mining and those of conscious design. The distinction between random excavation, generated by the mechanical action of production, and intentional excavation, governed by design, translates into a visual and spatial comparison that articulates the surface and reveals its different layers of time.

The design approach introduces a principle of measure and rhythm into a seemingly amorphous morphological organism: the shadows cast by the new, regularized facades emphasize the verticality of the walls, while the variations in depth and access thresholds redefine the perception of the void, transforming it into an architecture of earth and water.

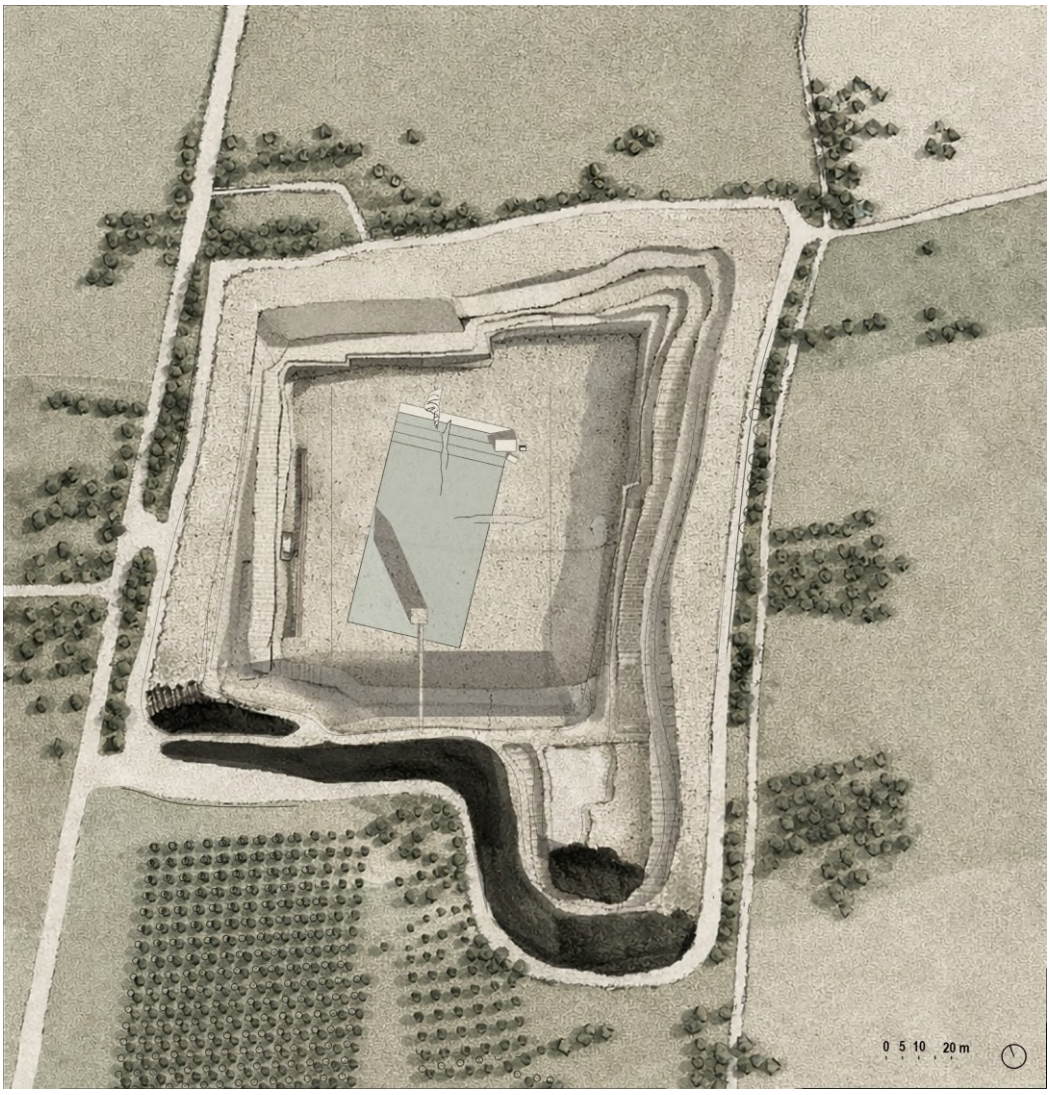

Fig. 87 – The containment basin. General plan

The slope redevelopment project is not limited to consolidation, but is an integrated process, in which slope stabilization is accompanied by a carefully planned morphological reshaping. Structural and hydraulic simulations have demonstrated that the slope geometry, inclined at safety angles between 60° and 70°, reduces the horizontal pressure exerted by water and ensures the stability of the system even during floods.

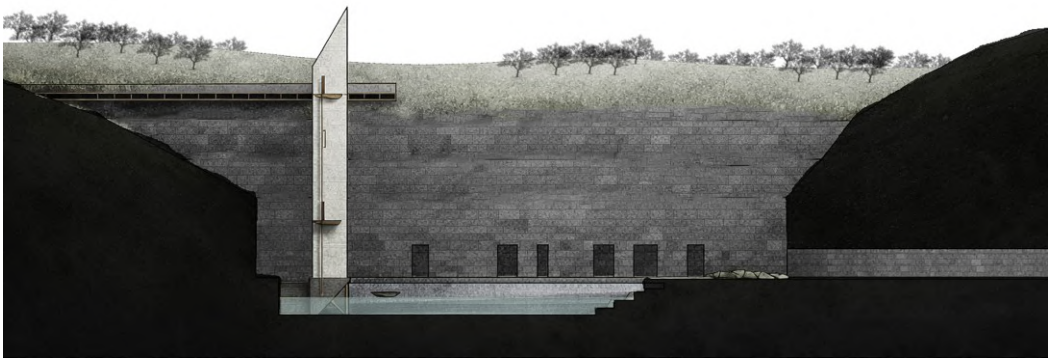

Fig. 88 – The containment basin. Section

The quarry floor, lowered at strategic points, is designed to facilitate the flow and controlled accumulation of water, with a usable volume exceeding ten thousand cubic meters. Runoff water is conveyed through a system of perimeter channels and constructed wetlands, ensuring a natural oxygenation and filtration process. The combination of hydraulic and modeling works transforms the quarry into an ecological lamination infrastructure, capable of mitigating the effects of intense rainfall and restoring balance to the local water cycle. On a perceptual and correspondence level, the project engages with the relationship between soil and water, between the mineral mass and the fluid surface. The void now becomes a space for accumulation and reflection, capable of reflecting light and image. The introduction of a permanent or temporary body of water allows for a continuous interplay of reflections and transparencies, making the quarry a mirror of the sky and the earth, visually conveying the idea of nature regenerated through artifice. The walls sculpted by the excavation are reflected in the liquid surface, producing an inverted perception of the landscape,

where low and high, matter and light, past and present overlap. A key element of this composition is the access and descent tower to the mineral level, rising from the bottom as a vertical sign and technical device. Its presence, legible on a landscape scale, serves as a visual and structural reference point, defining the entrance to the new basin and containing within it a mechanical lifting system based on pulleys and tie rods.

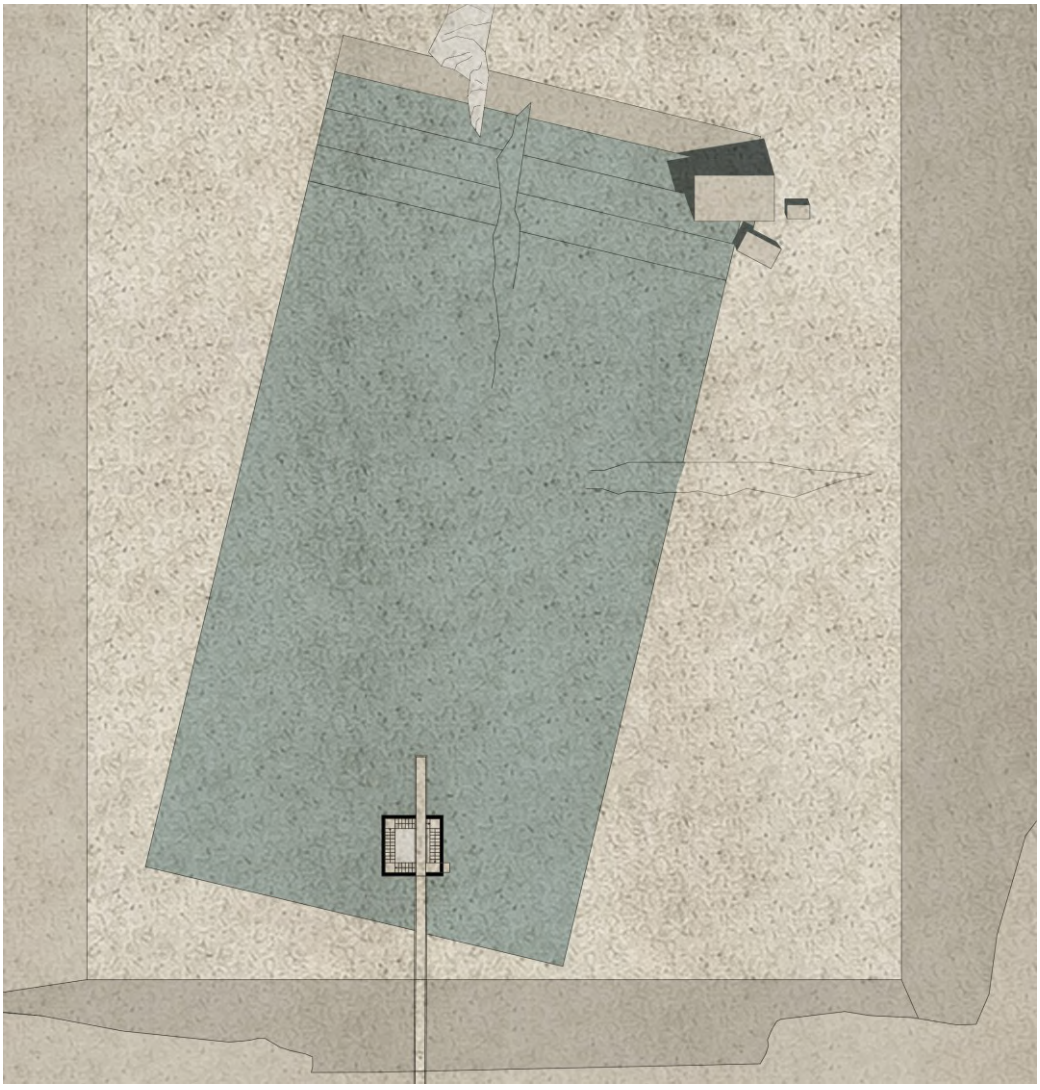

Fig. 89 – The containment basin. Plan

This mechanism allows the keels of small vessels to be lowered directly onto the water's surface, enabling controlled exploration of the basin via guided tours. The idea of internal navigation, evoked as a slow and contemplative gesture of traversal, amplifies the museum-like dimension of the site: the quarry becomes a museum of itself, a constantly transforming space, progressively revealed according to the water level and the light. The tower, both infrastructure and signal, also takes on a measuring function, becoming a modern, monumental hydrometer. Its height, marked by notches and indicators, allows the water level to be visually recorded, transforming scientific observation into an aesthetic experience. The tower's verticality, contrasting with the horizontality of the water's surface and the depth of the basin, creates a spatial device that connects the three fundamental elements of the excavated landscape: earth, water, and sky. The retention basin project does not simply resolve a hydraulic issue, but introduces a new morphological grammar for the site, in which architectural composition and geological knowledge merge into a single design. The excavation process, once a productive and destructive act, is transformed into a tool for redemption and knowledge: the void, once the result of subtraction, becomes a measure and memory of time, an integral part of a natural and cultural cycle that restores meaning to the landscape.



Fig. 90 – The containment basin. View



Fig. 91 – The containment basin. View

7.4.2. The energy park

The second design approach involves converting the quarry site into an energy park, configuring the quarry as a sustainable production infrastructure integrated into the agricultural landscape. This strategy is part of regional and municipal policies for ecological transition, which recognize abandoned quarry sites as a prime opportunity to test low-impact energy production systems, capable of contributing to the decarbonization of the region and the valorization of otherwise marginal areas. The choice to implement this type of intervention on the site in question responds to two criteria: on the one hand, the presence of large horizontal surfaces and stable fronts, and on the other, its strategic position with respect to the infrastructure network and the surrounding agricultural landscape. The goal is to establish a relationship of continuity and formal coherence between the new technological system and the natural order of the landscape, avoiding any clash between artifice and nature. The park's composition is based on a careful reading of the agricultural geometries surrounding the site. The rows of trees, planted across the farmland with a regular pace and consistent direction, define the geometric matrix of the project. This framework is based on a modular grid that determines the rhythm and arrangement of the solar towers on the quarry floor. The design does not introduce elements foreign to the context, but simply translates the morphological regularity of the rural landscape into technical and construction language. Thus, nature – although already transformed by man through cultivation and land management – becomes the matrix of the architectural form and the organizing principle of the project. The artifice, far from being an imposition, manifests itself as a continuation of the logic of the site, transforming the geometry of the agricultural layout into an energy grid. A series of solar towers are positioned on the hollow slab, conceived as vertical collection devices, constructed using metal lattice structures covered with photovoltaic panels. Each tower is a modular and reversible system, based on the principle of lightness and visual permeability, capable of reducing the system's perceptual impact on the landscape. The towers are not identical: their height increases progressively from south to north, optimizing exposure to solar radiation and reducing mutual shading. This variation, achieved through careful study

of the average solar angle at different seasonal latitudes, allows each module to maintain two permanently illuminated faces throughout the day, ensuring constant and uniform energy output.



Fig. 92 – The energy park. General plan

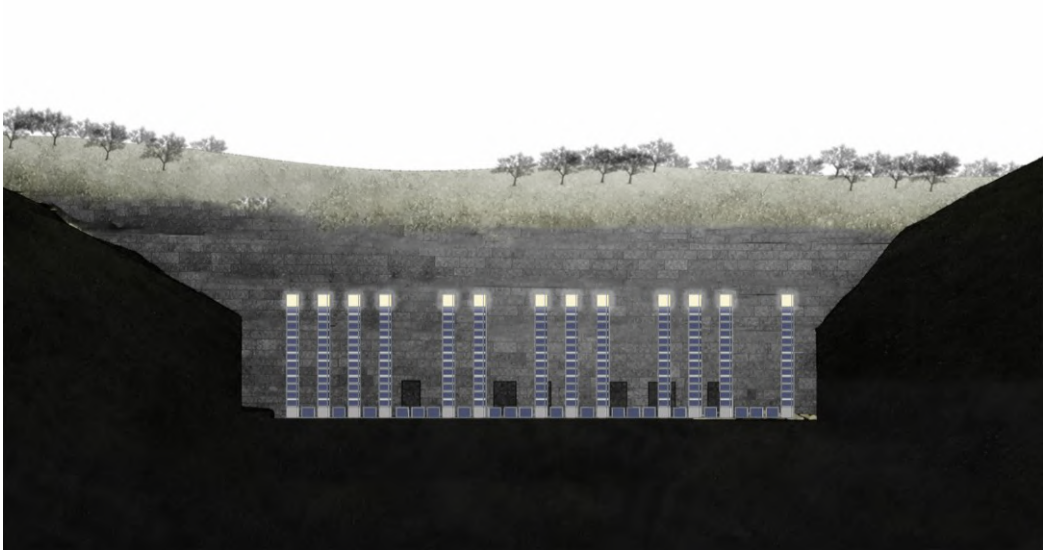

Fig. 93 – The energy park. Section

The tower's cross-section, rotated with respect to its main axis, was designed to ensure a balance between solar collection and natural ventilation, reducing panel overheating and improving efficiency. The photovoltaic modules covering the vertical surfaces are tilting and mechanized, capable of adjusting their inclination based on the position of the sun and the season. This dynamic orientation system, managed by a centralized controller, maximizes electricity production while simultaneously reducing the visual impact of the system during off-peak hours, when the panels close, restoring the towers' geometric purity. The slow and calibrated movement of the panels introduces a kinetic and temporal component that transforms the landscape into a light-sensitive machine, in which technology becomes part of the natural phenomenon. From a construction standpoint, the towers rest on lightweight, removable foundations, consisting of precast concrete bases or helical micropiles anchored to the compact layers of the rock bed. This solution allows us to avoid invasive works and

maintain the reversibility of the intervention, ensuring that the site can be returned to new functions in the future.

The energy park's planimetric configuration, arranged in a regular pattern yet sensitive to the terrain's unevenness, generates a spatial texture that reflects the site's dual nature: mining and agriculture. The towers rise like artificial extensions of the trees, translating the horizontal rhythm of the rural landscape into a vertical one. During the central hours of the day, the light reflected by the panels produces a diffuse vibration, similar to that of treetops blowing in the wind; at sunset, the photovoltaic surfaces take on the warm hues of stone and earth, revealing the visual continuity between the quarry and the countryside. The energy park thus becomes a technological landscape, but not by contrast: a new productive horizon that renews the tradition of labor and extraction, transforming it into the production of energy and knowledge.

Functionally, the generation system is connected to a local microgrid, capable of managing the self-consumption of the energy produced and feeding the surplus into the public grid. This configuration allows for the direct powering of the project's functions – lighting, ventilation, monitoring systems, and multimedia devices in the underground tunnels – ensuring the entire complex's energy self-sufficiency. Looking ahead, the quarry can become a permanent laboratory for testing renewable technologies, hosting research and training activities in collaboration with universities and regional technical institutes. The plant, in fact, is not designed as a closed installation, but as an open system, capable of evolving and adapting over time to innovations in the energy sector. Perceptually, the energy park project reimagines the quarry void. The towers, seemingly repetitive, generate an orderly yet ever-changing pattern, punctuated by the rhythm of light and the movement of the panels. The quarry, which once represented an act of subtraction, now becomes a field of accumulation and production: from a place of absence to a place of energy. The project, despite its infrastructural dimension, does not impose itself on the landscape, but complements it, rewriting the relationships between nature, technology, the memory of production activities, and a response to the new energy needs dictated by contemporary times.

In this sense, the energy park is a territorial device that embodies the principle of restitution: the act of extraction is performed again, but this time in reverse, no longer taking away but adding, no longer digging but building. The quarry, from a mutilated body, transforms into an organism that mutates, moves, and "breathes", capable of producing resources and generating the future.



Fig. 94 – The energy park. View



Fig. 95 – The energy park. View

7.4.3. A place for cultural promotion

The third option for repurposing the quarry complex is based on the desire to restore the site's social and cultural function, transforming the former production space into a contemporary hub for sharing, creativity, and memory. The project is in line with the needs expressed by the local community, which recognizes these marginal spaces as a potential hub for social gatherings, musical and artistic expression, and the valorization of the intangible heritage associated with stoneworking. The project, as a whole, is not intended to superimpose itself on the existing landscape, but rather to sculpt itself within it, respecting its mineral nature and reactivating the dialogue between matter and form that gave rise to the site. The main idea is embodied in the creation of a covered space for musical performances, conceived as a monolithic and compact block, carved from the rock but not yet quarried: a mass that symbolically detaches itself from the southern face of the quarry, as if emerging from the stone bed that generated it. This volume, suspended between extraction and permanence, houses the spaces for cultural and recreational activities, as well as the technical and logistical services necessary for their operation. The choice of an isolated building, detached from the face but made of the same material, stems from the principle of structural mimesis that governs the entire project: the architecture does not add to the site, but rather extends its meaning and internal logic. The platform, redesigned according to the "second ground" principle, constitutes the new threshold of

the relationship between the artificial landscape of the quarry and the natural landscape of the countryside. It is not a neutral surface, but rather a carved slab, a sculpted topography that adopts the same material grammar as the stone bench. The artificial ground thus becomes a mediating plane, a device that allows the visitor to perceive the relationship between the excavation process and the construction of the landscape. Through slight variations in elevation, cuts, and cracks, the new ground establishes a continuous dialogue with the original stone ground, revealing the differences in density, light, and temperature that characterize the excavated landscape.

The project's volumetric composition revolves around the theme of emptiness, conceived not as absence but as a full, solid entity capable of determining and

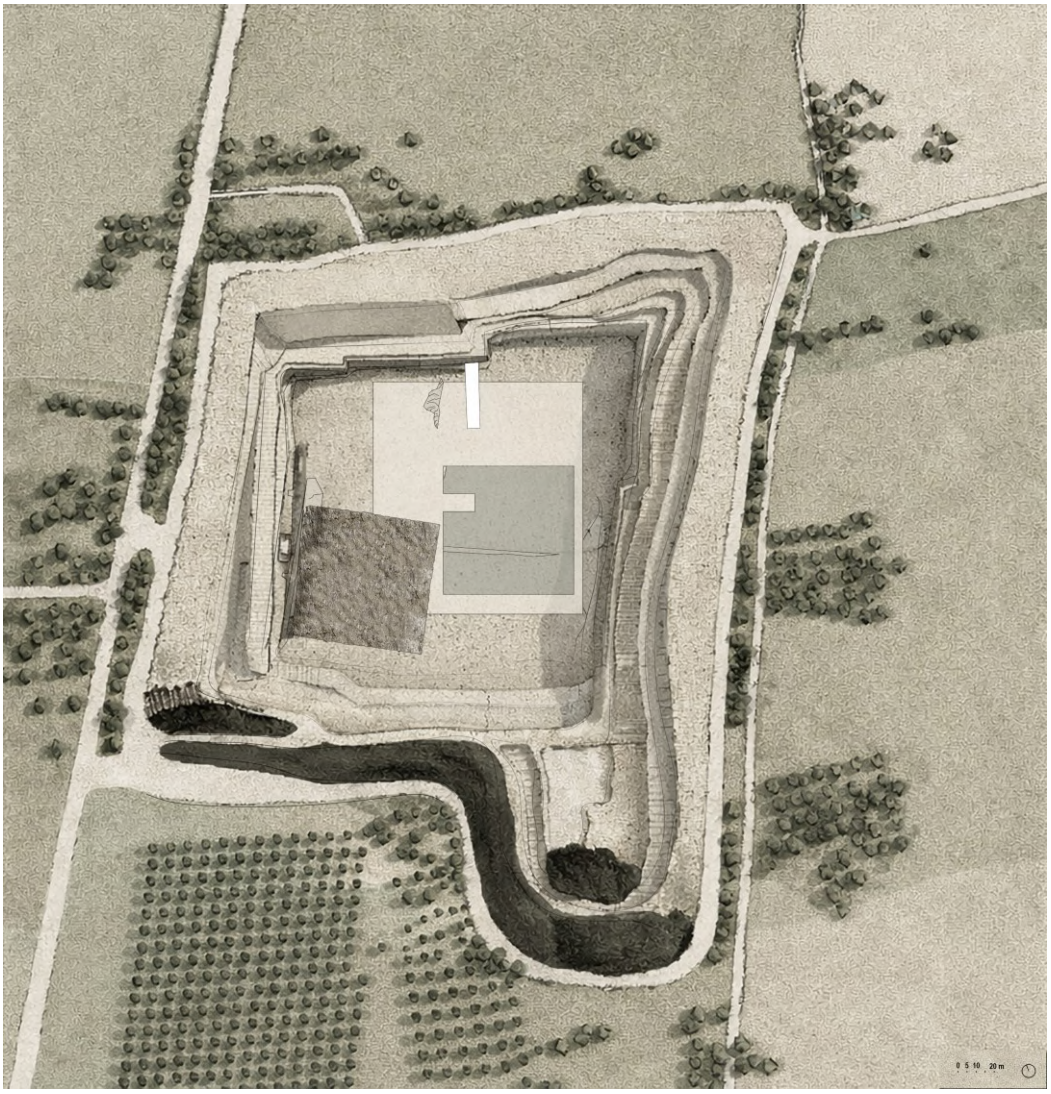

Fig. 96 – A place for cultural promotion. General plan

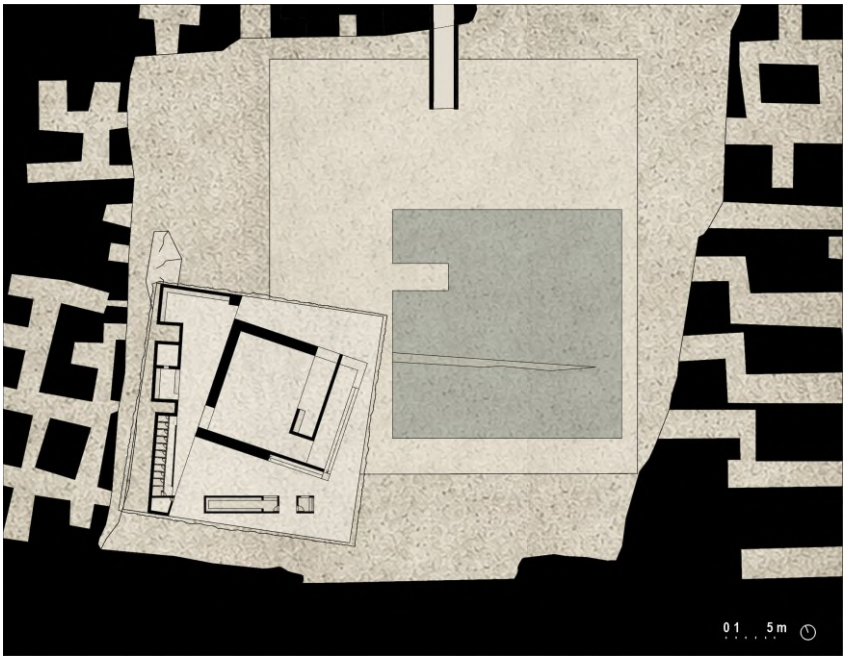

Fig. 97 – A place for cultural promotion. Plan 1

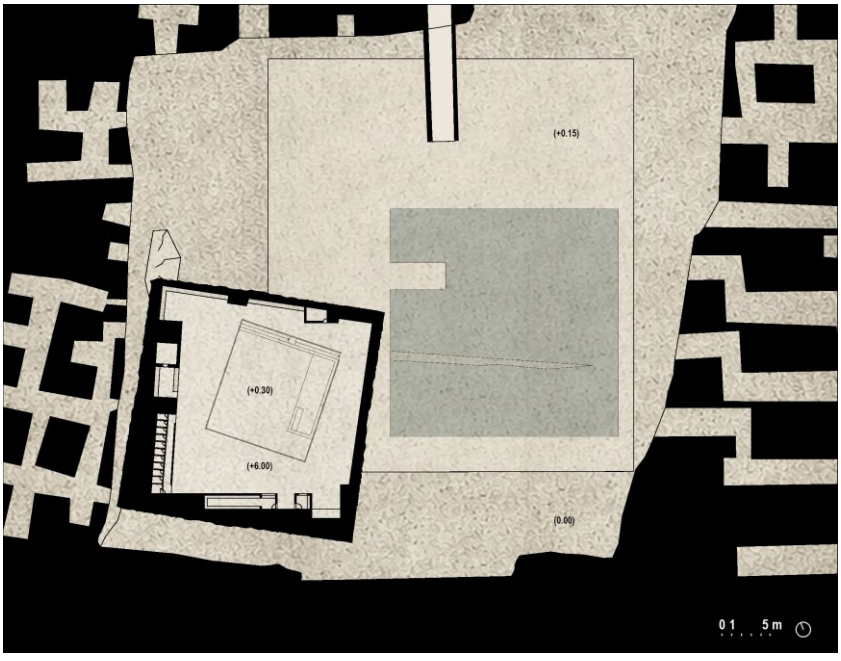

Fig. 98 – A place for cultural promotion. Plan 2



Fig. 99 – A place for cultural promotion. Section

measuring presences. The void here becomes a sculptural body, a "negative solid" that interacts with the new volumes constructed in a dialectic of contrasts and correspondences. This interaction generates interstitial spaces – passages, cavities, cracks – that become places of transit and sensory perception. Light, filtering through these interstices, shapes the surfaces and marks the rhythm of the experience, restoring to the visitor a perception of the quarry's depth and time. The intervention thus presents itself as an act of revelation: a device capable of revealing what the quarrying activity had erased or rendered indecipherable, recovering the directionality of the tunnels obliterated by the demolition and restoring continuity to the internal logic of the underground system. The architectural language adopted does not seek literal mimesis, but rather a continuity of matter and principle. The materials employed – fiber-reinforced concrete mixed with local stone dust, exposed metal reinforcement elements, and recomposed stone finishing surfaces – maintain a chromatic and tacti-

le coherence with the parent rock. This continuity is not decorative, but serves as a tool for interpreting the relationship between the natural and the artificial, between geological time and the human time of the project. The openings, small and oriented according to the incidence of light, produce luminous slits that emphasize the geometry of the cavity and create a controlled visual and acoustic experience. The interior of the monolithic space, designed to host concerts and performances, exploits the acoustic qualities of stone and its capacity for diffuse sound absorption, configuring itself as a form of sonic architecture, where the material actively participates in the propagation and modulation of acoustic waves. The design process appropriates the grammar of the extractive space – its section, its light, its density – to translate it into a cultural and community language. This third hypothesis thus presents itself as a symbolic synthesis of the previous two: if the retention basin resolves the relationship with water and the energy park with light, the cultural center addresses the theme of matter and sound, restoring a human and sensitive dimension to the entire quarry system. The three strategies, in their complementarity, construct a complete cycle of regeneration: water that balances, energy that generates, culture that interprets. More broadly, the project is an act of identity restoration: the site of toil and extraction becomes a place of sharing and representation. The mineral material, enduring and immutable, engages with the vegetal and ever-changing dimension of the Lecce countryside, amplifying the dichotomy between permanent and ephemeral, full and empty, silence and sound. The quarry, thus reinterpreted, is no longer a margin, but a new center of gravity for the community to experience the permanence and simultaneous coexistence of nature and artifice, memory and design, light and depth.



Fig. 100 – A place for cultural promotion. View

8. EVALUATION OF THE EFFECTS

The set of strategies developed for the Cutrofiano quarry forms a unified transformation system that transcends the scale of architectural intervention to embrace that of territorial redevelopment. The impact assessment is based on an integrated approach that jointly considers geotechnical, hydraulic, ecological, energy, and economic dimensions, viewing the quarry as an experimental laboratory for risk mitigation, sustainable resource production, and environmental regeneration. Each of the design actions developed and presented in the previous chapter responds to a different need of the territorial system and contributes to the same objective of transforming abandoned land into an infrastructure for environmental, social, and economic regeneration.

8.1 Risk mitigation

The first and most immediate impact of the project is the reduction of hydrogeological and geotechnical risks, through the transformation of the quarry into a retention basin and the safety of the faces. The site, originally characterized by a pit morphology and a complex system of underground tunnels, was experiencing localized degradation at the entrances to the descents, where the collapse of the ashlars and the erosion of the clay had favored imbibition processes and micro-landslides. The project intervention, in this phase, included a selective consolidation program, conducted through the use of compatible materials – pozzolanic mortars and low-pressure injections – and the restoration of the natural slopes, with the partial closure of unstable openings. Static simulations and numerical analyses conducted during the three-dimensional survey (integration of drone photogrammetric surveys and direct autopsy) showed an average safety factor greater than 1.5, confirming the overall stability of the face and the underground cavities. The lithological continuity of the calcarenite bed, combined with the presence of regular pillars and intact vaults, allowed the original spatiality to be preserved without resorting to invasive interventions.

The creation of a retention basin in the central part of the quarry is the main measure to mitigate the hydraulic risk. The natural morphology of the site, with a slope converging toward the bottom, facilitates the conveyance of rainwater and allows for the collection of a significant volume of water. The basin acts as a compensation device in the event of exceptional rainfall events, reducing surface runoff and limiting the risk of flooding in the downstream areas. The accumulated water can also be reused for agricultural purposes and for irrigating the renaturalized green belts, constituting a strategic water reserve for the area. In this way, the project transforms risk into a resource, restoring a function of balance and continuity to the natural water cycle.

From a microclimatic perspective, the presence of the basin and the surrounding vegetation contribute to the site's thermal regulation: solar reflection on the water surfaces and controlled evaporation lower the average air temperature during the hottest hours of the day, reducing heat island effects and promoting the well-being of users and wildlife. The water consolidation and management project, therefore, not only ensures the stability of the quarry system but also produces positive ecological and environmental effects, constituting a true infrastructure of territorial resilience capable of dynamically adapting to climate change.

8.2 Energy and economic impact assessment

The second evaluation dimension concerns the project's energy capacity and economic sustainability. The transformation of the quarry into an energy park has allowed the introduction of a new renewable energy production infrastructure into the local area, in line with regional policies on ecological transition and the energy self-sufficiency of small towns. The system of solar towers installed on the quarry floor represents a widespread and scalable generation model. The system, consisting of photovoltaic modules integrated into lightweight metal lattice structures, was designed according to a passive solar orientation logic, with the sections rotated and height varied to avoid mutual shading. Simulations conducted with local irradiance models (latitude 40°05' N) indicate an average annual energy yield of approximately 450 – 500 MWh, equivalent to covering the electricity needs of over 100 homes. This

production is sufficient to ensure the complex's complete self-sufficiency – including its cultural, exhibition, and underground lighting functions – and to feed excess energy into the public grid. From an economic sustainability perspective, the project is based on a hybrid public-private management model, involving V.F. CAVE s.r.l. as the promoter and manager of the energy plant, in collaboration with the municipal administration and local cultural associations. Revenue from photovoltaic energy production (estimated at over €70,000/year) contributes to the financing of maintenance activities, cultural initiatives hosted at the center, and park management costs, generating a circular economic cycle that reinvests production profits in the local area. The depleted quarry, on the verge of becoming an unproductive and marginalized space, thus becomes a hub of attraction and innovation, capable of generating jobs and skills. The local stone supply chain – artisans, restoration companies, technicians, and environmental workers – is involved in the restoration, management, and development phases, fueling a virtuous process of economic regeneration. Added to this are the indirect benefits linked to tourism and educational promotion: the quarry is intended to host educational visits, university workshops, and artistic residencies, contributing to the construction of a new model of local economy based on knowledge, culture, and sustainability. From an energy perspective, the facility operates as a closed and self-sufficient system, capable of managing the complete cycle of energy production, storage, and distribution. The photovoltaic towers feed a local microgrid equipped with storage and intelligent control systems, which regulates distribution based on the actual needs of the various areas (outdoor areas, underground spaces, cultural center). This smart energy district model applied to a quarry site represents a pilot case at the regional level, demonstrating how extraction landscapes can become sustainable production landscapes.

8.3 Environmental redevelopment

The third area of evaluation concerns ecological and landscape redevelopment, which represents the most visible and long-lasting outcome of the project. The intervention is not limited to visual mitigation, but promotes a complex process of

controlled renaturalization capable of restoring ecological balance to a compromised environment. The construction of the retention basin has generated a new wetland ecosystem, where the constant presence of water favors the establishment of hygrophilous species (*Juncus acutus, Typha latifolia, Phragmites australis*) and the emergence of amphibians and avians. This microhabitat constitutes a biological compensation zone, connected to the local ecological network and adjacent agricultural areas. On the progressively renaturalized quarry fronts, the spontaneous colonization of rock-dwelling and pioneer plants – *Cistus monspeliensis, Atriplex halimus, Euphorbia dendroides, Helichrysum italicum* – can be accompanied by a planting program of native tree species (holm oaks, carob trees, almond trees, and mastic trees), with the aim of restoring vegetation continuity with the surrounding Mediterranean landscape.

At the same time, the presence of energy and cultural infrastructure has been calibrated to minimize climate impact. The photovoltaic towers blend into the landscape as elements that rest on the quarry bed, interpreting the geometric regularity of the crops. The walking surfaces and pedestrian paths are made of draining materials, which allow for natural water infiltration and prevent runoff. The central platform, transformed into a public space, takes on an educational and landscape function: a place for rest, observation, and interpretation, where information panels and interactive systems recount the quarry's geological and human history, the extraction processes, and regeneration strategies.

The project's environmental value is measured not only in terms of biodiversity or reduced environmental impact, but above all in its ability to restore meaning to the excavated landscape. The quarry is not erased, but reinterpreted as an active memory, a geological and cultural palimpsest. The intervention connects the long timescales of nature with the short timescales of human labor, restoring a complex landscape where the traces of labor and extraction intertwine with new forms of plant life and human presence.

8.4 Interpretative synthesis

The three lines of action – risk mitigation, energy production, and renaturalization – define an operational model that can serve as a prototype for the integrated management of extractive landscapes. The Cutrofiano quarry project demonstrates that it is possible to transform a geological void into a complex device, capable of combining stability and innovation, production and contemplation, technology and nature. The result is not merely risk reduction or environmental compensation, but the construction of a new form of landscape habitability, in which the material itself becomes an ecological, energy, and cultural infrastructure. The quarry, once a symbol of subtraction, becomes an emblem of restitution: of water to the soil, of energy to the community, of meaning to the territory. It condenses the potential of a replicable model, grounded in a profound understanding of the context and the design's ability to read and reinterpret the geometries, materials, and memories of the land.

Fig. 101 – Three perspective views (on the next page) relating to the three design solutions proposed







CONCLUSIONS

The research conducted in this doctoral thesis aimed to investigate the quarry as a complex figure in the contemporary landscape, a place where the original tension between the material of the Earth and the form of the project, between the logics of production and restitution, manifests itself. From the genealogy of quarried landscapes to the design experiments conducted at the Cutrofiano site, the journey took the form of a multilevel journey – theoretical, historical, technical, and operational – aimed at constructing an interpretative and methodological model capable of restoring meaning, value, and function to those spaces of subtraction that, for centuries, have fueled the construction of civilizations. From the earliest reflections, the thesis identified the dialectic between *cavitas* and *civitas* as the most fertile key to understanding the structural relationship between the built world and the excavated world. The city, to build itself, has always had to understand the geology that supports it, comprehend the nature of its materials, and establish a necessary relationship with the Earth. From this perspective, the quarry is never an elsewhere of architecture, but rather its ontological negative: that which precedes and establishes it, that which preserves its profound memory. The transition from material to design – from extraction to construction – represents not a fracture, but a continuity, a form of landscape writing that alternates solids and voids, volumes and depressions, in a constructive rhythm inherent in the longevity of civilizations.

The investigation has shown how the quarry landscape is not merely a geological document or an anthropic wound, but an active archive of human cultural and material history, a matrix condensing technical knowledge, symbolic rituals, economies, and forms of habitation. From the quarries of Syracuse to the Osuna fronts, from the quarries of Cusa to the caves of Matera, human labor has sedimented in the stone, leaving traces that reveal a primordial spatial knowledge: the ability to extract from the excavation not only building materials, but also order, measure, and orientation. This awareness, already present in the Mediterranean tradition, has today become an operational perspective: understanding the quarry as a space for design, as an

environmental and cultural infrastructure, as a place to experiment with new models of the relationship between artifice and nature. Methodologically, the thesis proposed a redefinition of the concept of extractive landscape, interpreting it no longer as the degraded outcome of a production practice, but as a dynamic system of relationships, subject to processes of transformation, renaturalization, and reinvention. Through the progressive systematization of analytical categories – geology, extraction typologies, decommissioning processes, protection and enhancement tools – a theoretical framework was constructed that connects the territorial and architectural scales. The shift from heritage recognition to design experimentation allowed for the definition of an integrated intervention methodology based on three key principles: in-depth knowledge of the site, geotechnical and environmental compatibility, and the functional redefinition of the void as a spatial and symbolic resource.

From this perspective, the case of Cutrofiano has taken on a paradigmatic role. Located in the heart of Salento, the system of underground and pit quarries at Cutrofiano constitutes one of the most significant testimonies to the Mediterranean mining tradition, where soil morphology and labor culture merge into a single spatial organism. Morphological and photogrammetric investigations, integrated with autoptic surveys and geognostic analyses, have allowed for a precise understanding of the site's stratigraphy: layers of soft and compact clay resting on a massive lithic bedrock, the site of the underground excavation. The stability of the vaults, the absence of deformations, and the structural continuity of the tunnels have confirmed the system's construction quality, the fruit of the excavators' empirical intelligence, capable of translating their tactile experience of the material into refined structural knowledge. Design activity is grafted onto this morphological and symbolic heritage, understood not as alteration or overwriting, but as an act of interpretation and extension of the stone material itself, so that it becomes context and stage, and the void becomes the material with which architecture is tasked. The composition of volumes, the design of pathways, the interplay between light and shadow construct a grammar of measured gestures, in which the project becomes an act of care and re-signification.

The Cutrofiano case allowed us to experiment with a multi-criteria analysis process, integrating morphological, geotechnical, hydraulic, ecological, and perceptual criteria. This interdisciplinary approach, which combines advanced survey tools with qualitative assessments of perception and use, represents one of the most innovative elements of the work. The thesis demonstrates that only the combination of scientific data and phenomenological interpretations can provide an authentic understanding of quarry sites, where visible form is always an expression of profound geological and cultural forces. In this sense, the project serves as a mediating tool between knowledge and action, capable of translating the site's complexity into precise and measurable operational strategies. From a broader research perspective, the thesis's original contribution lies in the definition of a design paradigm for the regeneration of Mediterranean mining landscapes, based on three fundamental principles: the transformation of risk into a resource, through the conversion of quarry voids into water basins, energy systems, and public spaces; the integration of ecological and cultural dimensions, in an approach that recognizes the value of matter as both a document and an infrastructure; and the continuity between scientific research and architectural design, understood not as an application but as the production of knowledge. Thus, the thesis is positioned within contemporary reflections on design as a cognitive tool, in dialogue with the Italian tradition that, from Gregotti to Secchi, from Purini to Venice, has understood architecture as a critical form of reality. The quarry landscape thus becomes a field of theoretical and experimental testing, where the design's ability to restore meaning to environmental and social transformations is measured, to reinterpret the Earth's long history as the living material of design. Moreover, as Fernando Espuelas wrote, «material is not a simple support, but the very condition of form; the void that passes through it is what gives it meaning»[139]. The thesis embraces this lesson, demonstrating how the practice of design can become a tool for understanding matter and territory. Reflection on the heritage and identity value of quarries takes on central importance in this context. Recognizing the quarry as a cultural asset does not mean musealizing it or freezing it, but rather restoring its active role in the local environment. Quarries are devices of collective memory, material

archives of human labor, but also potential generators of new sustainable economies. The shift from protection to valorization requires a redefinition of public policies, a new alliance between local authorities, mining companies, and local communities. In this direction, the Cutrofiano project represents an operational prototype, capable of guiding future experiments in regional and transnational contexts.

Finally, on the broader plane of future prospects, the thesis suggests a reflection on the future of quarry landscapes as ecological and cultural infrastructure. The global challenges of climate change, energy transition, and territorial regeneration require new models of thought and action, capable of combining technical expertise, ecological sensitivity, and aesthetic vision. The quarry, in this scenario, offers a powerful paradigm: a place that unites the geological depths of time with the possibility of new ways of experiencing and inhabiting the landscape. Repurposing a quarry entails mending a broken relationship between people and the land, between the city and its material origins. The future of this research therefore lies in its ability to propose a transferable model: a scientific and design method replicable in other extractive contexts, capable of generating local economies, promoting environmental education, and restoring spaces of identity to the community. In this sense, the Cutrofiano case does not represent an isolated episode, but a methodological matrix: a laboratory in which a new alliance between nature and culture, technology and memory, science and design is being tested. The thesis demonstrates that the quarry landscape can become one of the most advanced paradigms of contemporary regeneration: through the project, the space of subtraction is transformed into a space of relationship, the wound into a threshold, the void into a reservoir and concentration of meaning. The quarry thus becomes a metaphor and instrument for a new way of inhabiting the Earth: no longer domination or extraction, but knowledge, measurement, and care.

NOTES

1. Georges Didi-Huberman, 2000. p. 336.

2. Georg Simmel, 1911. pp. 125 – 131.

3. Martin Heidegger, 1927. p. 87.

4. The theoretical reflection on the relationship between time, ruin, and presence is rooted in a philosophical tradition that—from Simmel to Heidegger to Didi-Huberman—has explored how matter preserves the traces of becoming and how memory inscribes itself within form. Georg Simmel, in "Die Ruine" (1911), interprets the ruin as the aesthetic outcome of the encounter between human construction and natural decay, where constructive and destructive forces achieve a temporal equilibrium. Martin Heidegger, in "Sein und Zeit" (Being and Time, 1927), conceives Dasein as the temporal openness of meaning, grounding human existence in the interplay between being, world, and time. Georges Didi-Huberman, in "Devant le temps. Histoire de l'art et anachronisme des images" (2000), re-elaborates this legacy through a visual and phenomenological lens, reading the image as a stratified field of temporality—where past and present overlap in a productive anachronism.

5. Aristotele, IV sec. a.C. *Metafisica*, trad. e cura di G. Reale, p. 148.

6. Paul Vidal de la Blache, 1922. *Principi di geografia umana*, trad. di G. Barbieri, p. 288.

7. N. Caldarulo, S. Margiotta, L. Pennetta, M. Zingaro, 2014. *Le argille e le calcareniti del Salento: aspetti geologici e risorse del sottosuolo*, p. 215.

8. Cfr. Augustin Berque, 1994. *Cinq propositions pour une théorie du paysage*, p. 141.

9. Cfr. Yi-Fu Tuan, 1974. *Topophilia: A Study of Environmental Perception*, Attitudes, and Values, p. 260.

10. As Kenneth Frampton observes in *Studies in Tectonic Culture* (1995, p. 430), the poetics of construction reveals the ethical dimension of architecture, where material, structure, and place converge to express a tectonic consciousness rooted in

the culture of making. Cfr. Kenneth Frampton, 1995. *Studies in Tectonic Culture*: The Poetics of Construction in Nineteenth and Twentieth Century Architecture, p. 430.

11. Cfr. Gilles Deleuze, 1968. *Différence et répétition*, p. 415.

12. Cfr. Maurice Merleau-Ponty, 1964. *Le visible et l'invisible*, p. 370.

13. Cfr. Vitruvio Pollione Marco, 15 a.C*. De Architectura*, ed. Pierre Gros, 2 voll., p. 871.

14. Lewis Mumford, 1967. *La città nella storia. Le sue origini, le sue trasformazioni, le sue prospettive*, trad. di M. L. De Angelis, p. 898.

15. Gilles Clément, 1991. *Le Jardin en Mouvement: de la Vallée au Jardin planétair*e, p. 160.

16. Bernardo Secchi, 2013. *Progetto di suolo*, p. 112.

17. Saverio Muratori, 1960. *Civiltà e territorio*, p. 198.

18. Aldo Rossi, 1966. *L'architettura della città*, p. 215.

19. As Vittorio Gregotti argues in *Il territorio dell'architettura* (1966, p. 189), architecture must be understood as a process of transformation of the territory itself — an act that interprets and reorganizes the material and morphological conditions of the landscape rather than merely occupying it. Cfr. Vittorio Gregotti, 1966. *Il territorio dell'architettura*, p. 189.

20. Leonardo Benevolo, 1975. *Storia della città*, p. 616.

21. Andrea Carandini, 2012. *Roma. Il primo giorno*, p. 184.

22. Paul T. Craddock, 1995. *Early Metal Mining and Production*, p. 32.

23. Françoise Choay, 1992. *L'allégorie du patrimoine*, p. 141.

24. Achille Mbembe, 2019. *Necropolitica*, p. 67.

25. Vitruvio Pollione Marco, 15 a.C*. De Architectura*, ed. Pierre Gros, 2 voll., p. 871.

26. As Georgius Agricola notes in *De Re Meta*llica (1556, p. 32), the act of mining reveals the intimate correspondence between human technique and the hidden structure of the earth, turning excavation into both a scientific and a cultural operation. Cfr. Georgius Agricola, 1556. *De Re Metallica Libri XII*, trad. ingl. di Herbert Clark Hoover e Lou Henry Hoover, p. 32.

27. Ibidem.

28. Ibidem.

29. Ibidem.

30. Lewis Mumford, 1934. p. 14.

31. Gaston Bachelard, 1948. p. 123.

32. Gilbert Simondon, 1958. p. 9.

33. Georgius Agricola, 1556. p. 47.

34. Michele Gambi, 2002. p. 87.

35. Georgius Agricola, 1556. p. 52.

36. Gaston Bachelard, 1957. p. 61.

37. Annette Béguin, 1993. p. 142.

38. Augustin Berque, 1995. p. 47.

39. Georgius Agricola, 1556. p. 41.

40. Augustin Berque, 2000. p. 132.

41. Gilles Clément, 1991. p. 82.

42. Georgius Agricola, 1556. p. 46.

43. Gaston Bachelard, 1957. p. 209.

44. As Georges Didi-Huberman suggests (1992, p. 45), seeing is never a neutral act but a process of unveiling and resistance, in which the visible and the invisible confront one another to disclose the material depth of perception. Cfr. Georges Didi-Huberman, 1992. p. 45.

45. Georgius Agricola, 1556. p. 52.

46. Ibidem.

47. Gaston Bachelard, 1989. p. 178.

48. Christian Norberg-Schulz, 1979. *Genius Loci*. pp. 34-37.

49. Vittorio Gregotti, 1966. p. 74.

50. Publio Ovidio Nasone, 8 d.C. *Le metamorfosi*. p. 45.

51. Biblia Sacra Vulgata, ca. 405 d.C. p. 13.

52. Aristotele, ca. 340 a.C. *Meteorologica*. p. 195.

53. Traditional Latin translation: “In lapidibus saepe apparent imagines animalium et plantarum, quasi natura ibi conata sit generate, sed defecerit” – used by Aristotle's medieval commentators, by Albertus Magnus and by Thomas Aquinas.

54. As Thomas Aquinas reflects in the *Summa Theologiae* (ca. 1274, pp. 321 – 324), the order of creation manifests a correspondence between material form and divine intelligibility, where the substance of matter participates in a higher metaphysical design. Cfr. Thomas Aquinas, ca. 1274. p. 321 – 324.

55. As Leonardo da Vinci observes in the *Quaderni d’Anatomia e del Diluvio* (ca. 1508, p. 314), the motions of water and earth obey analogous principles of structure and transformation, revealing the dynamic morphology that unites natural and architectural processes. Cfr. Leonardo da Vinci, ca. 1508*. Quaderni d’Anatomia e del Diluvio*. p. 314.

56. Niels Stensen, 1669. p. 12 – 16.

57. Francis Bacon, 1620. *Novum Organum*. p. 112 – 118.

58. René Descartes, 1644. p. 201 – 210.

59. Georges-Louis Leclerc de Buffon, 1778. *Époques de la Nature*. p. 47 – 58.

60. James Hutton, 1788. *Theory of the Earth*. p. 209 – 304.

61. Alexander von Humboldt, 1849. p. 62 – 63.

62. Martin Heidegger, 1951. *Costruire, abitare, pensare*. p. 107 – 126.

63. Genevieve von Petzinger, 2016. p. 214 – 221.

64. Pausanias, II sec. d.C*. Periegesi della Grecia*. p. 39.

65. Theophrastus, IV sec. a.C. p. 12 – 14.

66. Cfr. Marcus Terentius Varro, I sec. a.C. *De Lingua Latina*. p. 74.

67. Pliny the Elder, 77 – 79 d.C. p. 42 – 47.

68. In many cultures, the void left by excavation became a burial or cult space. In the pre-classical Mediterranean, hypogea and rock-cut tombs were frequently excavated in the vicinity of ancient quarries, where the act of hollowing the earth assumed both a symbolic and functional meaning. The necropolis of Pantalica in Sicily (12th – 8th centuries BC) constitutes a paradigmatic example: carved into the lime-

stone cliffs of the Anapo Valley, it reveals the profound relationship between geological morphology and funerary architecture. As G. Voza demonstrated in his seminal study (1996), the site exemplifies how ancient quarrying techniques and ritual practices converged into a unified spatial conception, transforming the landscape of production into a landscape of memory. Cfr. Giuseppe Voza, 1996. *Pantalica. The Necropolis and the Inhabited Area*. Palermo: Arnaldo Lombardi Editore, 1996, p. 47 – 63.

69. Mauro Bartoloni, 2003. p. 37 – 52.

70. Pasquale Testini, 1980. *Le catacombe romane*. p. 64 – 89.

71. Guillaume de Jerphanion, 1925 – 1942. p. 113 – 147.

72. Pietro Laureano, 1993. *Giardini di pietra*. p. 215.

73. Philippe Artières, 2016. p. 47.

74. AA.VV., 2010. *Napoli sotterranea*. p. 132.

75. Roberto Pane, 1967. p. 72.

76. Cesare Brandi, 1963. *Teoria del restauro*. p. 57.

77. Anne-Marie Sankovitch, 2014. p. 119.

78. Salvatore Settis, 2010*. Paesaggio, Costituzione, Cemento*. p. 34.

79. Regio Decreto n. 1443 del 29 luglio 1927. p. 4257 – 4274.

80. Costituzione della Repubblica Italiana, 1948. p. 5422 – 5423.

81. Presidente della Repubblica Italiana, 1977. Decreto del Presidente della Repubblica 24 luglio 1977, n. 616. p. 5631 – 5702.

82. Repubblica Italiana, 1998. Decreto Legislativo 31 marzo 1998, n. 112. p. 23 – 89.

83. Vittorio D'Angelis, 1998. p. 57.

84. Repubblica Italiana, 1985. Legge 8 agosto 1985, n. 431. p. 3 – 1.

85. Repubblica Italiana, 2004. Decreto Legislativo 22 gennaio 2004, n. 42. p. 4 – 94.

86. Repubblica Italiana, 1977. p. 5 – 78.

87. Repubblica Italiana, 1998. Decreto Legislativo 31 marzo 1998, n. 112. p. 3 – 118.

88. Regione Puglia, 1985. Legge Regionale 22 maggio 1985, n. 37. p. 1757 – 1768.

89. Alberto Magnaghi, 2000. *Il progetto locale*. p. 57.

90. European Union, 1992. p. 7 – 50.

91. European Commission, 2019. The European Green Deal. p. 1 – 24.

92. European Commission, 2020. New European Bauhaus. p. 1 – 18.

93. Salvatore Settis, 2010. p. 142.

94. Riccardo Dalla Negra, 2018. *Il patrimonio industriale e il progetto del paesaggio*. p. 63.

95. Cesare Brandi, 1963. p. 37.

96. Gaston Bachelard, 1957. *La poétique de l'espace*. p. 209.

97. Aldo Rossi, 1981, p.54.

98. Louis Khan, 1969, p. 27.

99. Christian Norberg-Schulz, 1979. p 84.

100. Maurice Merleau-Ponty, 1945. p. 121.

101. Italo Calvino, 1972. *Le città invisibili*. p. 89.

102. Maurice Merleau-Ponty, 1945. p. 235.

103. Martin Heidegger, 1951. *Bauen Wohnen Denken*. p. 145.

104. Cfr. Fernando Espuelas, 1995. p. 37.

105. Cfr. Fernando Espuelas, 1995. El vacío. p. 41.

106. Cfr. Fernando Espuelas, 2007. p. 103.

107. As Rafael Moneo observes in *Inquietud teórica y estrategia proyectual*, every architectural work arises from the tension between theory and practice — a reflective unrest that transforms construction into an act of thought. Cfr. Rafael Moneo, 2004. *Inquietud teórica y estrategia proyectual*. p. 15.

108. Rafael Moneo, 2017. p. 105.

109. Fernando Espuelas, 1995. *El vacío*. p. 32.

110. Cesare Brandi, 1963*. Teoria del restauro*. p. 56.

111. Giorgio Grassi, 1967. p. 108.

112. As Peter Zumthor writes in *Thinking Architecture* (1999), architecture acquires meaning through the tactile and atmospheric presence of materials, where construction becomes an experience of memory, perception, and silence. Cfr. Peter Zumthor, 1999. *Thinking Architecture*. p. 44.

113. Giorgio Grassi, 1967. *La costruzione logica dell'architettura*. p. 97.

114. Cesare Brandi, 1971. p. 111.

115. Bruno Zevi, 1948. *Saper vedere l'architettura*. p. 137.

116. Servizio Geologico d'Italia, 1970. p. 1:100.000.

117. Aldo De Giorgi, 1998. *La Pietra di Lecce e la città della luce*. p. 113.

118. Aldo Rossi, 1966. p. 45.

119. Álvaro Siza Vieira, 2023*. Il Parco delle Cave*. p. 27.

120. Manuel Aires Mateus, 2024. *An ancient tower in Salento*. p. 112 – 119.

121. Eduardo Souto de Moura, 2004. p. 117.

122. Joseph Rykwert, 2005. *The Idea of a Town*. p. 214.

123. David Chipperfield Architects, 2018. p. 56.

124. Ibidem.

125. Antón García-Abril e Débora Mesa, 2020. *Ensamble Studio: Architecture of the Earth*. p. 87.

126. Leonardo Sciascia, 1979. p. 112.

127. Xu Tiantian, 2021. *Jinyun Quarries*. p. 23.

128. ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale, 2009. Geological Map of Italy. scala 1:50.000.

129. Archivio di Stato di Lecce, 1820. p. 47.

130. Istituto Geografico Militare (IGM), 1888 – 1980. *Carte Topografiche d'Italia*. p. 52.

131. AGEA – Agenzia per le Erogazioni in Agricoltura, 2006 – 2021. p. 129.

132. ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale, 2018. p. 132.

133. Regione Puglia, 2015. Piano Paesaggistico Territoriale Regionale (PPTR). p. 23.

134. The European Directive 2021/741 establishes the regulatory framework for the reuse of treated urban wastewater, promoting circular resource management and sustainable water cycles in line with the goals of the European Green Deal and climate adaptation strategies.

135. Regione Puglia, 2015. Piano Paesaggistico Territoriale Regionale (PPTR). p. 31.

136. Ibidem.

137. Ibidem.

138. Andrea Branzi, 2006. p. 97.

139. Michele Mainardi, 1999. *Cave e cavamonti*. p. 36.

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CURRICULUM



ANGELO GANAZZOLI
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EDUCATION

- PhD in Environmental, Territorial and Building Risk and Development (DRSATE), Politecnico di Bari, 2023 – ongoing (38th Cycle) Research: “Inhabiting the Quarry. Strategies for Recovery | Projects for Cutrofiano”. Supervisors: Prof. E. Tarantino, Prof. A. Reina, Prof. A. Margagliotta.
- Master in Applied Architecture and Digital Innovation, MArch Valencia – Arquitectura y Diseño, Spain, 2021.
- MSc in Building Engineering – Architecture (LM-4), University of Palermo, 2021. Thesis: “Urban Park within the Cave System of Cappuccini in Alcamo”.
- Classical High School Diploma (International Programme), Liceo Classico ‘G. Meli’, Palermo.

PROFESSIONAL EXPERIENCE

- Studio AGS, Palermo – Architect & Designer.
- Artètika Gallery, Palermo – Exhibition Designer.
- Rock10elode Association, Palermo – Cultural Projects Coordinator & Architect.

SELECTED PROJECTS & COMPETITIONS

- Biennale Architettura Venezia 2025, “Palermotuttaporto”.
- Port Authority of Western Sicily, ‘Isole’ Competition, 2024.
- PROARCH ‘Studium 2030’, project ‘Attraverso l’esistente’, 2024.
- New European Bauhaus Festival, ‘The Music We Live In’, 2022 (Italian Winner).

ACADEMIC AND RESEARCH EXPERIENCE

- Teaching Collaborator, University of Palermo – Dept. of Architecture / Engineering (2021 – present): Courses in Architectural Design, Rural Architecture, Adaptive Reuse, and Heritage Enhancement.
- PhD Research Activities: field research and publications on underground heritage, quarry landscapes, and adaptive reuse; organization of doctoral seminars and exhibitions.

PUBLICATIONS (SELECTION)

- A. Reina, A. Ganazzoli, M. Mastracci “Abitare sotto la linea di terra. Progetti per il recupero del patrimonio caveale”, in P. A. Cruz Franco e A. Rueda Màrquez de la Plata (a cura di), Los cuadernos del ReUSO, Dykinson, Madrid 2023, pp. 174-186;
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- A. Anello, A. Ganazzoli, E. Richiusa, “Pratica e didattica dell’architettura. La lezione di Marcella Aprile”, in C. Tantillo, L. A. Scuderi, S. Gervasio, M. Lo Re (a cura di), Donne e progetto. Figure dell’architettura e del design nell’Italia contemporanea, Quodlibet, Macerata, 2025, pp. 236 – 241, ISBN: 9788822923387.
- A. Reina, A. Ganazzoli, “Paesaggio scavato. Le cave in sotterraneo di Cutrofiano come infrastruttura geologica e culturale / Excavated Landscape: Subterranean Quarries in Cutrofiano as a Geological and Cultural Framework”, in Geologia dell’Ambiente, periodico trimestrale della SIGEA – Società Italiana di Geologia Ambientale APS, 2025, Supplemento al n. 4/2025, ISSN: 1591-5352.
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ANNEXES

The following sections present the geological survey tables prepared for the territorial planning framework of the Municipality of Cutrofiano. For clarity and consistency, the tables are organized and presented in the following order:

1. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 1.A | Carta geolitologica (Geological analysis for municipal planning. Municipality of Cutrofiano. PLATE 1.A | Geolithological map)

2. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 1.B | Sezioni geolitologiche (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 1.B | Geolithological sections)

3. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 1 | Corografia del territorio (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 1 | Chorography of the territory)

4. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 2 | Carta geomorfologica (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 2 | Geomorphological map)

5. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 3.A | Isofreatiche in periodo di piena (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 3.A | Isophreatic flows during floods

6. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 3.B | Isofreatiche in periodo di piena (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 3.B | Isophreatic flows during floods)

7. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 3.C | Profondità della superficie freatica in periodo di piena (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 3.C | Depth of the water table during floods)

8. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 3.D | Carta delle escursioni della superficie freatica (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 3.D | Water table excursion map)

9. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 4 | Distrubuzione delle cave ipogee (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 4 | Distribution of underground quarries)

10. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 5 | Carta clivometrica (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 5 | Slope map)

11. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 6 | Carta della stabilità dei versanti (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 6 | Slope stability map)

12. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 7 | Carta litologica di orientamento geotecnico (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 7 | Lithological map for geotechnical orientation)

13. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 8 | Uso attuale del suolo (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 8 | Current land use)

14. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 9 | Carta delle caratteristiche chimico-fisiche dei suoli (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 9 | Map of the chemical-physical characteristics of the soil)

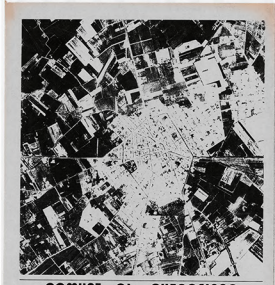
15. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 9.A | Carta del contenuto in potassio (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 9.A | Potassium content map)

16. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 9.B | Carta del contenuto in fosforo (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 9.B | Phosphorus content map)

17. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 10 | Carta delle capacità d'uso dei suoli (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 9.B | Phosphorus content map)

18. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 11 | Zonazione geologico-tecnica delle aree urbanizzate e da urbanizzare (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 11 | Geological-technical zoning of urbanized and to-be-urbanized areas)

19. – Analisi geologica per la pianificazione comunale. Comune di Cutrofiano. TAV. 12 | Carta di documentazione (Geological analysis for municipal planning. Municipality of Cutrofiano. TABLE 12 | Documentation map)



COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. LA — CARTA GEOLITOLOGICA

/CALB 1:10.000

DOTT. GEOLOGO GIUSEPPE LEGNA

LEGENDA

UNITÀ GEOLITOLOGICHE

a — Depositi colluviali. Deposito incoerente formato da "terra rossa" con sabbie calcaree, provenienti dal dilavamento dei calcari e delle calcareniti, da sabbie siltose, argilla e limo da dilavamento. Lo spessore non supera 8 m. OLOCENE.

b — Calcareniti ed arenarie ben cementate. Rocce coerenti a stratificazione centimetrica poggianti su roccia incoerente (sabbie) a pseudo coerente (argille). Gli strati sono costituiti da calcareniti per lo più grossolane, da arenarie ben cementate e da "panchine" compattissime. Lo spessore massimo riconosciuto è di circa 7 m; l'unità appartiene alla Formazione di Gallipoli. PORTOLANIANO (?)

c — Sabbie argillose giallastre passanti inferiormente a marne argillose grigio-azzurrastre. Roccia incoerente (sabbie e sabbie limo-argillose solitamente poco addensate) di spessore variabile ma non superiore a 5 m, poggiante su roccia pseudo-coerente (argille e argille limose) che talvolta presenta spessore superiore a 40 m. La stratificazione è assente. L'unità appartiene alla Formazione di Gallipoli. CALABRIANO.

d — Calcareniti. Roccia semicoerente (calcareniti costituite da sabbioni calcarei poco diagenizzati con intercalazioni di roccia coerente (calcari grossolani tipo "panchina"). L'unità non supera lo spessore di 15 m; appartiene alle Calcareniti del Salento. PLIOCENE.

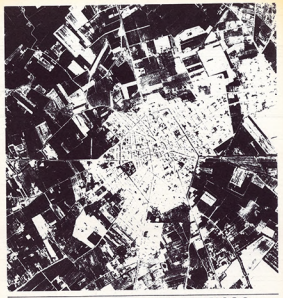
d_1 — Calcareniti. Roccia coerente massiccia o a stratificazione indistinta costituita da calcareniti ben diagenizzate, nel passato è stata utilizzata come materiale da costruzione. Lo spessore massimo riconosciuto è di circa 20 m. L'unità appartiene alle Calcareniti del Salento. PLIOCENE.

Linee delle unità geolitologiche

A — A' Traccia di sezione

Pozzi di cui è nota la stratigrafia

S.E.V.



COMUNE DI CUTROFIANO

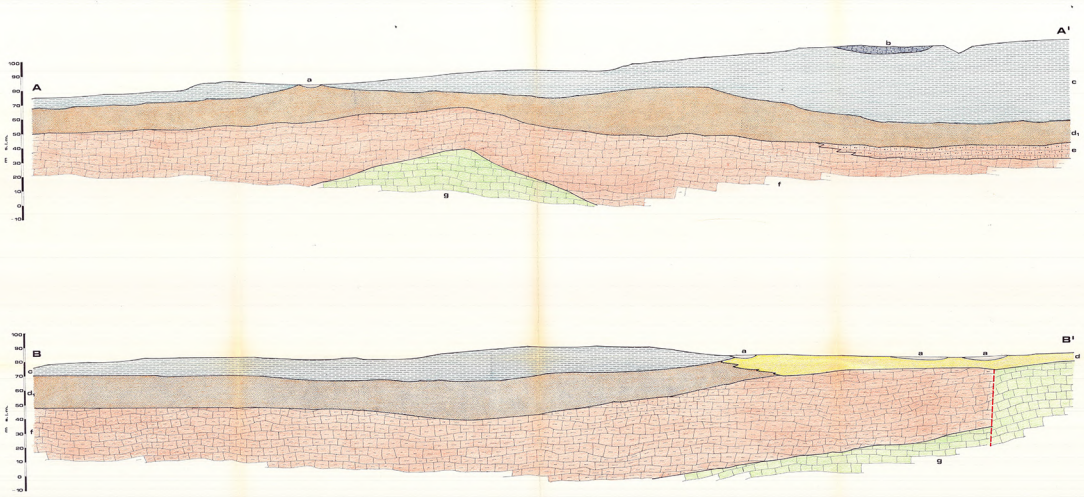
ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. I.8

SEZIONI GEOLITOLOGICHE

SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE LAGNA



LEGENDA

UNITÀ GEOLITOLOGICHE

a — **Depositi colluviali.** Deposito incoerente formato da "terra rossa" e sabbie calcaree, provenienti dal dilavamento dei calcari e delle calcareniti, da sabbie silicee, argille e limo da dilavamento. Lo spessore non supera i 4 m. OLOCENE.

b — **Calcareniti ad arenarie ben cementate.** Rocce coerenti a stratificazione centimetrica poggianti su roccia incoerente (sabbie) o pseudo coerente (argille). Gli strati sono costituiti da calcareniti per lo più grossolane, da arenarie ben cementate e da "panchine" compattissime. Lo spessore massimo riscontrato è di circa 7 m. L'unità appartiene alla formazione di Gallipoli. POSTCALABRIANO (?)

c — **Sabbie argillose giallastre passanti inferiormente a marne argillose grigio-azzurrastre.** Roccia incoerente (sabbie e sabbie limo-argillose solitamente poco addensate) di spessore variabile da non superiore a 6 m, poggiante su roccia pseudocoerente (argille e argille limose) che talvolta presenta spessore superiore a 40 m. La stratificazione è assente. L'unità appartiene alla formazione di Gallipoli. CALABRIANO.

d — **Calcareniti.** Roccia semicoerente (calcareniti costituite da sabbioni calcarei poco diagenizzati) con intercalazioni di roccia coerente (calcari grossolani tipo "panchine"). L'unità non supera lo spessore di 15 m; appartiene alle Calcareniti del Salento. PLIOCENE.

d1 — **Calcareniti.** Roccia coerente massiccia o a stratificazione indistinta costituita da calcareniti ben diagenizzate. Nel passato è stata utilizzata come materiale da costruzione. Lo spessore massimo riscontrato è di circa 20 m. L'unità appartiene alle Calcareniti del Salento. PLIOCENE.

e — **Calcari detritici porosi e calcareniti marnose.** Roccia coerente massiccia, talvolta stratificata con potenza media degli strati sui 40 cm; è costituita da un'alternanza di calcari detritici biancastri, vacuolati, calcareniti biancastre fossilifere e calcareniti marnose. Lo spessore può raggiungere i 40 m. L'unità appartiene alle Calcareniti di Andrano. MIOCENE (Langhiano-Messiniano).

f — **Calcareniti marnose.** Roccia coerente massiccia, talvolta pseudocoerente per elevata percentuale di argilla. Il tipo litologico prevalente è dato da una calcarenite marnosa a grana grossolana, compatta, generalmente porosa, di colore giallo-paglierino. Alla base della formazione, a contatto con il calcare cretacico, sono stati segnalati banchi di bauxite ("bolo"). Lo potenza massimo riscontrata nella perforazione di pozzi è di circa 50 m. L'unità appartiene alla "Pietra leccese". MIOCENE (Tortoniano-Langhiano).

g — **Calcari, calcari dolomitici e dolomie.** Roccia coerente costituita da più tipi litologici rappresentati da calcari, calcari dolomitici e dolomie di colore variabile dal grigio al nocciola per i termini dolomitici fino al bianco per quelli francamente calcarei. L'unità appartiene alle Dolomie di Galatina -CRETACICO (Cenomaniano-Turoniano)- o ai più recenti "Calcari di Melissano" -CRETACICO (Cenomaniano-Turoniano)-.

Faglia presunta



COMUNE DI CUTROFIANO

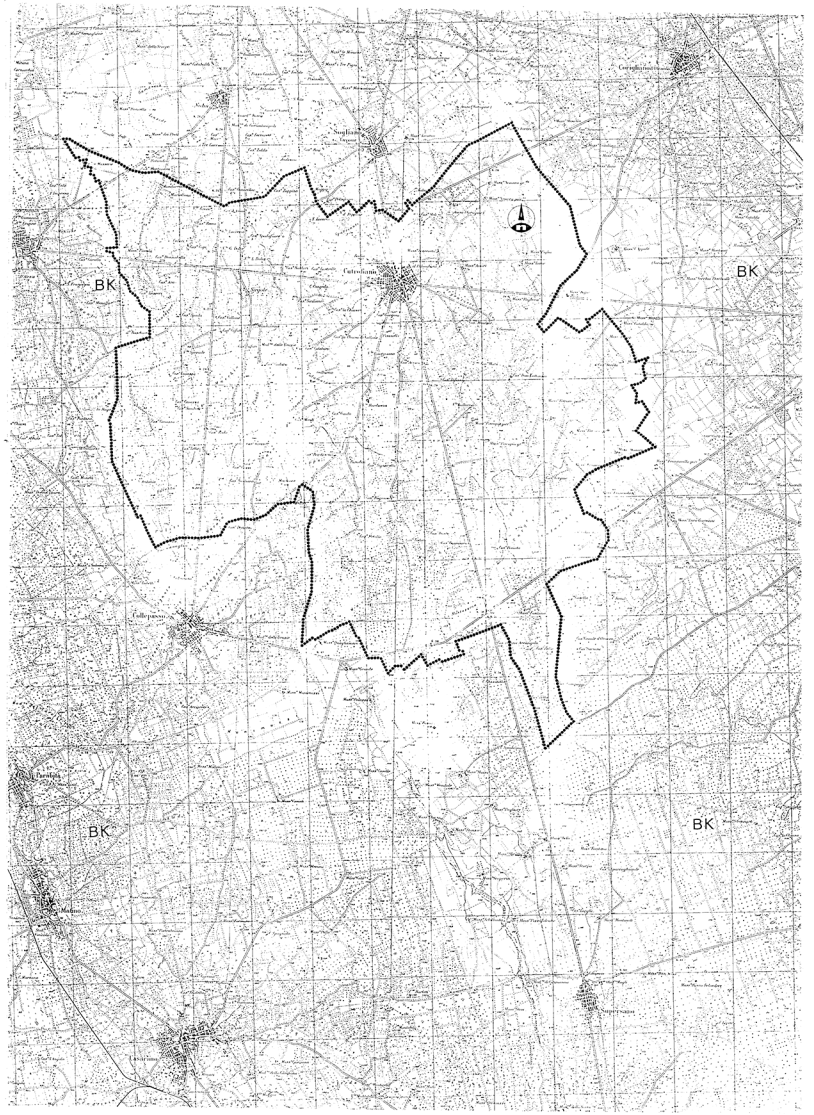
ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. I	COROGRAFIA DEL TERRITORIO

SCALA 1:25.000

DOTT. GEOLOGO GIUSEPPE LAGAR

Confini comunali





COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 2

CARTA GEOMORFOLOGICA

SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE LEONA

LEGENDA

LITOLOGIA DEL SUBSTRATO

- Calcarenitti ed arenarie ben cementate (Calabriano)
- Sabbie argillose pesanti inferiormente ad argille (Calabriano)
- Calcarenitti (Plio-pleistocene)

FORME, DEPOSITI E PROCESSI DOVUTI ALL'AZIONE DELLE ACQUE

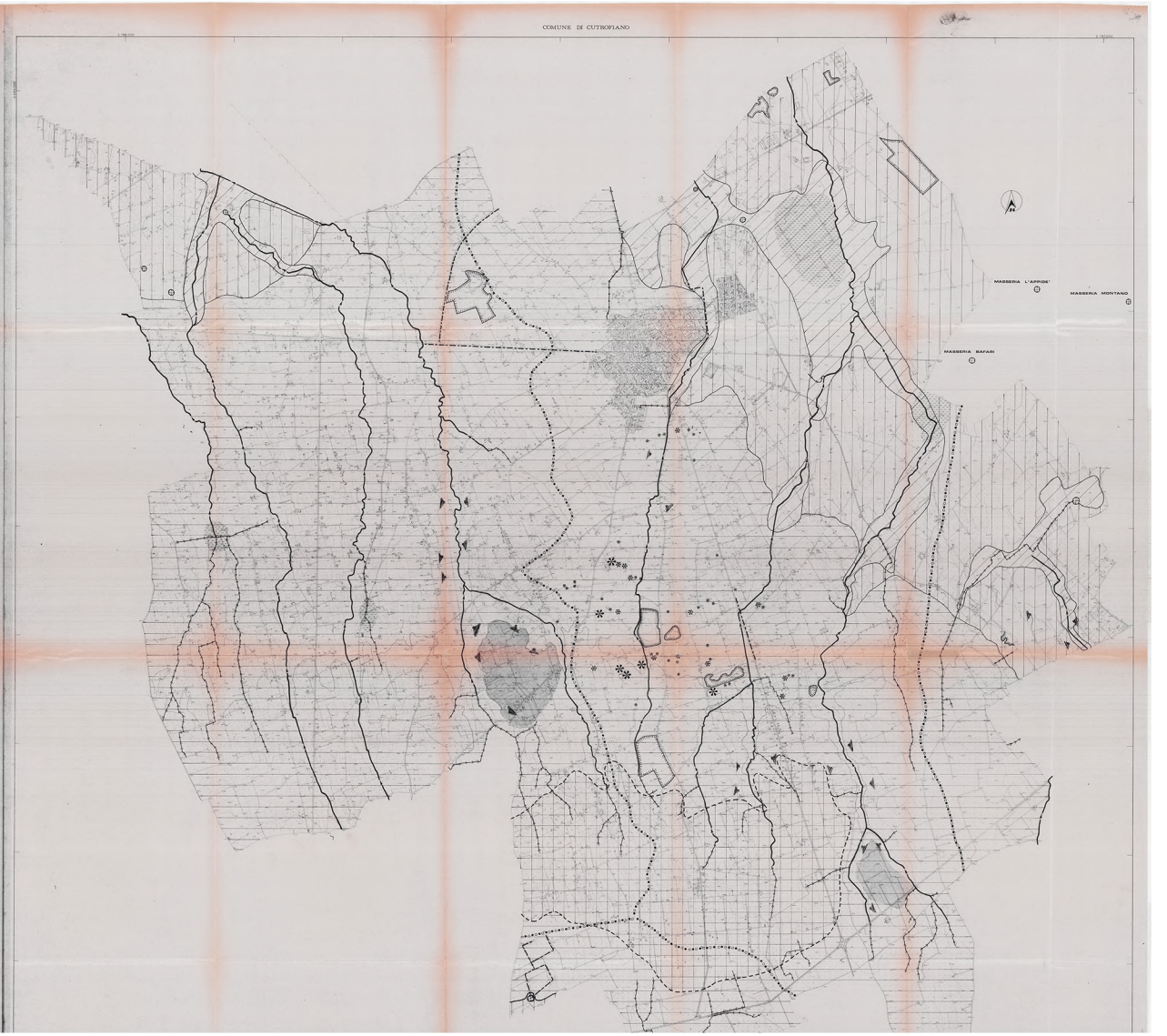
- Ripiano di erosione torrentizia
- Depositi colluviali dovuti a ruscellamento e/o scoscendimento
- Area interessata eccezionalmente da scoscendimento
- Ruscellamento diffuso
- Fosso di erosione concentrata
- Apparato carsico assorbente

IDROGRAFIA

- Reticolo idrografico
- Spartiacque

FORME ANTROPICHE

- Cava
- Sprofondamenti ed avvallamenti superficiali per crolle di gallerie e/o pozzi connessi ad attività estrattive (pegno)
- Canale artificiale





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ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 3.A — **ISOFREATICHE IN PERIODO DI PIENA**

SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE LEGRA

LEGENDA

- Isofreatiche al 22 marzo 1988 (m. s.l.m.)
- Pozzi della rete di osservazione freatimetrica
- Direzione di flusso della falda.
- Spartiacque sotterraneo
- Asse di drenaggio preferenziale
- Area dove è accertata la presenza della falda superficiale





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ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 3.6 — **ISOFREATICHE IN PERIODO DI MAGRA**

SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE LAGNA

LEGENDA

84 — Isofreatiche al 27 agosto 1988 (m. s.l.m.)

•115 Pozzi della rete di osservazione freatimetrica





COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 3.C | **PROFONDITA' DELLA SUPERFICIE FREATICA IN PERIODO DI PIENA**

SCALA 1:10000

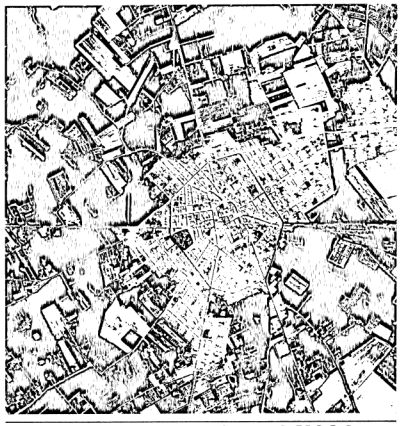
DOTT. GEOLOGO GIUSEPPE LAGNA



LEGENDA

3 — Isobata al 22 marzo 1988 (m. dal p.c.)

1.3 — livello freatico (m. dal p.c.)



COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 3.D — **CARTA DELLE ESCURSIONI DELLA SUPERFICIE FREATICA**

SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE LAGNA

LEGENDA

2 — Linee di ugual valore di escursione in m calcolata fra il periodo di piena (22/3/88) e di magra (27/8/88).

15 — Pozzi della rete di osservazione freatimetrica.

1 2 3 4 5





COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 4 — **DISTRIBUZIONE DELLE CAVE IPOGEE**

/CARTA 1:10000

DOTT. GEOLOGO GIUSEPPE LEGGIERI

LEGENDA

- Area di cave inattive interessate da gallerie di coltivazione
- Area di cave in esercizio
- Pozzi di estrazione di cave inattive delle quali non è nota la planimetria





COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 5 — CARTA CLIVOMETRICA

/SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE LEGRA

LEGENDA

Classi dell'acclività

- < 2%
- 2 - 5%
- 5 - 10%
- 10 - 20%
- > 20%



COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 6	CARTA DELLA STABILITA' DEI VERSANTI	SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE LEGGE

LEGENDA

CLASSI DI STABILITA'

- Instabilità forte
- Instabilità media
- Instabilità limitata
- Situazione stabile

COMUNE DI CUTROFIANO

N



COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 7 | **CARTA LITOLOGICA AD ORIENTAMENTO GEOTECNICO**

/CALB 1:5000

DOTT. GEOLOGO GIS/EPPI LAURA

LEGENDA

UNITA' 1

Depositi colluviali prevalentemente incoerenti di natura sabbiosa, con locali arricchimenti in ciottoli, in limosi ed argillosi. Sono presenti anche livelli di argilla limo-sabbiosa dell'ordine di centimetri, quando i sedimenti poggiano sulle calcareniti la circolazione idrica è limitata alla infiltrazione e percolazione delle acque meteoriche.

UNITA' 2

Sabbie limose e limi sabbioso-argillosi (a) dalla tinta giallastra e giallo-ocracea passanti inferiormente ad argille e argille limose torbifere (b). Sono frequenti livelli di ghiaie poligeniche, ciottoli e blocchi calcarei di cantra calcareo a grana medio-fine, più o meno arrotondati ed a luoghi parzialmente cementate. Lo spessore massimo del pacco è di circa 20 m. I termini a granulometria più fine rivestono valori, caratteristici da terreni mediamente consistenti, mentre i livelli più profondamente impermeabili i termini argillosi, ovvero le argille torbifere sono permeabili per fessurazione, da poco a sostanzialmente permeabili i terreni limi e sabbia che ospitano una falda freatica.

UNITA' 3

Calcareniti eterogranose a grana generalmente medio-grossolana e a diverso grado di cementazione, mostrano con colori tipo "panchina". Spessore dell'ordine dei 5-10 m. La permeabilità è diversa e la circolazione idrica è limitata, sulle aree di affioramento, alla infiltrazione e percolazione delle acque meteoriche. Parametri geotecnici: peso di volume 1.7-1.9 gr/cm³; grado di cementazione 0.15<D<1 ; resistenza a compressione 10-130 Kg/cmq.

■ 3 Perforazione di sondaggio

PROSPETTO DELLE CARATTERISTICHE FISICO-MECCANICHE

CARATTERISTICHE FISICO-MECCANICHE DEI TERRENI		UNITA' LITOLOGICHE	1	2
CARATTERISTICHE IDROLOGICHE	Umidità naturale	w (%)	15.4	21.3-28.3	21.3-27.8
	Peso specifico dei grani	γ_s (g/cm³)	2.65	2.62-2.71	2.68-2.76
	Peso specif. in condizioni	γ (g/cm³)	1.5	1.67-2.11	1.98-2.08
	Porosità	n (%)	50.3	36.5-50.3	36.5-51.2
	Indice dei vuoti	e	1.06	0.58-0.68	0.43-0.45
CARATTERISTICHE GRANULOMETRICHE	Grado di saturazione	Sr (%)	57	100	100
	Argilla	(%)	27	35-36	45-50
	Limo	(%)	15	45-60	36-45
	Sabbia	(%)	62	15-25	5-15
CARATTERISTICHE DI CONSISTENZA	Limite di liquidità	wl (%)	34.7	32.4-35.1	31.5-34.7
	Limite di plasticità	wP (%)	24.6	24.5-25.4	25.1-26.7
	Limite di ritiro	wr (%)	21.2	20.8-24.7	17.5-19.8
	Indice di plasticità	IP	10.1	10.0-11.8	8.1-29.1
	Indice di consistenza	Ic	1.26	0.85-1.02	0.94-1.35
CARATTERISTICHE MECCANICHE	Attività	A	1.2	0.3-0.7	0.1-0.5
	Coesione non drenata	c_u (kg/cm²)	/	1.0-1.5	1.0-1.5
	Coesione drenata	c' (kg/cm²)	0.18	0.15-0.35	0.14-0.28
	Angolo di attrito	ϕ' (grad)	34	29-37	23-28
	Indice di compressib.	Cc (cm²/kg)	1.24	0.10-0.18	0.07-0.19
	Modulo edometrico	Ed (kg/cm²)	30	28-45	20-35
	Modulo elastico	Es (kg/cm²)	80	68-72	61-134

CARATTERISTICHE FISICO-MECCANICHE DEI TERRENI LAPIDEI

		UNITA' LITOLOGICHE	3
CARATTERISTICHE IDROLOGICHE	Peso specifico dei grani	γ_s (g/cm³)	2.66-2.72
	Peso specif. in condizioni	γ (g/cm³)	1.5-1.9
	Coeff. di permeabilità		0.2-0.3
	Coeff. di porosità		5.10-6.44
	Grado di saturazione		0.34-0.74
	Resistenza a compressione	(kg/cm²)	10-120

UNITÀ LITOLOGICHE

1 - SABBIE ARGILLOSE E/O LIMOSE , COLLUVIALI

2a - LIMI SABBIOSO-ARGILLOSI

2b - ARGILLE LIMOSE

3 - CALCARENITI



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TAV. 8 — **USO ATTUALE DEL SUOLO**

/CRIB 1:10.000

DOTT. GEOLOGO GIUSEPPE LEGRA

LEGENDA

- Aree urbanizzate
- Zone per attrezzature sportive o ricreative
- Attività commerciali varie ubicate in aree non urbanizzate
- Strutture di igiene ambientale: impianto di depurazione (D), discarica rifiuti solidi urbani (R), cimitero (C), metallaia (M).
- Aree incolte
- Seminativo
- Vigneto
- Colture varie
- Uliveto
- Superfici boscate soggette a vincolo ai sensi della Legge 1497/1939 per effetto del D.M. 21.5.84
- Verde privato
- Attività estrattive epigee attive (E$_a$) o inattive (E$_i$).



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ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 9 — **CARTA DELLE CARATTERISTICHE CHIMICO-FISICHE DEI SUOLI**

SCALA 1:10.000

DOTT. GEOLOGO GIUSEPPE LAGBA

LEGENDA

TESSITURA

A = Argilloso
AL = Argilloso-limoso
AS = Argilloso-sabbioso
L = Limoso
LA = Limoso-argilloso
LS = Limoso-sabbioso
S = Sabbioso
SA = Sabbioso-argilloso
SL = Sabbioso-limoso
RZ = Medio impasto

PROFONDITA' (cm)

0-20 = PP
20-40 = P
> -40 = MP

CAPACITA' DI SCAMBIO CATIONICO (meq/%)

0-10 = CSC_1
10-20 = CSC_2

AZOTO (%)

< 0.5 = R_1
0.5÷1.0 = R_2
> 1.0 = R_3

pH

< 6.5 = AH
6.5÷7.5 = AB
> 7.5 = BOH

K (p.p.m. di K_2O)

100 = K_1
100÷150 = K_2
150÷200 = K_3
200 = K_4

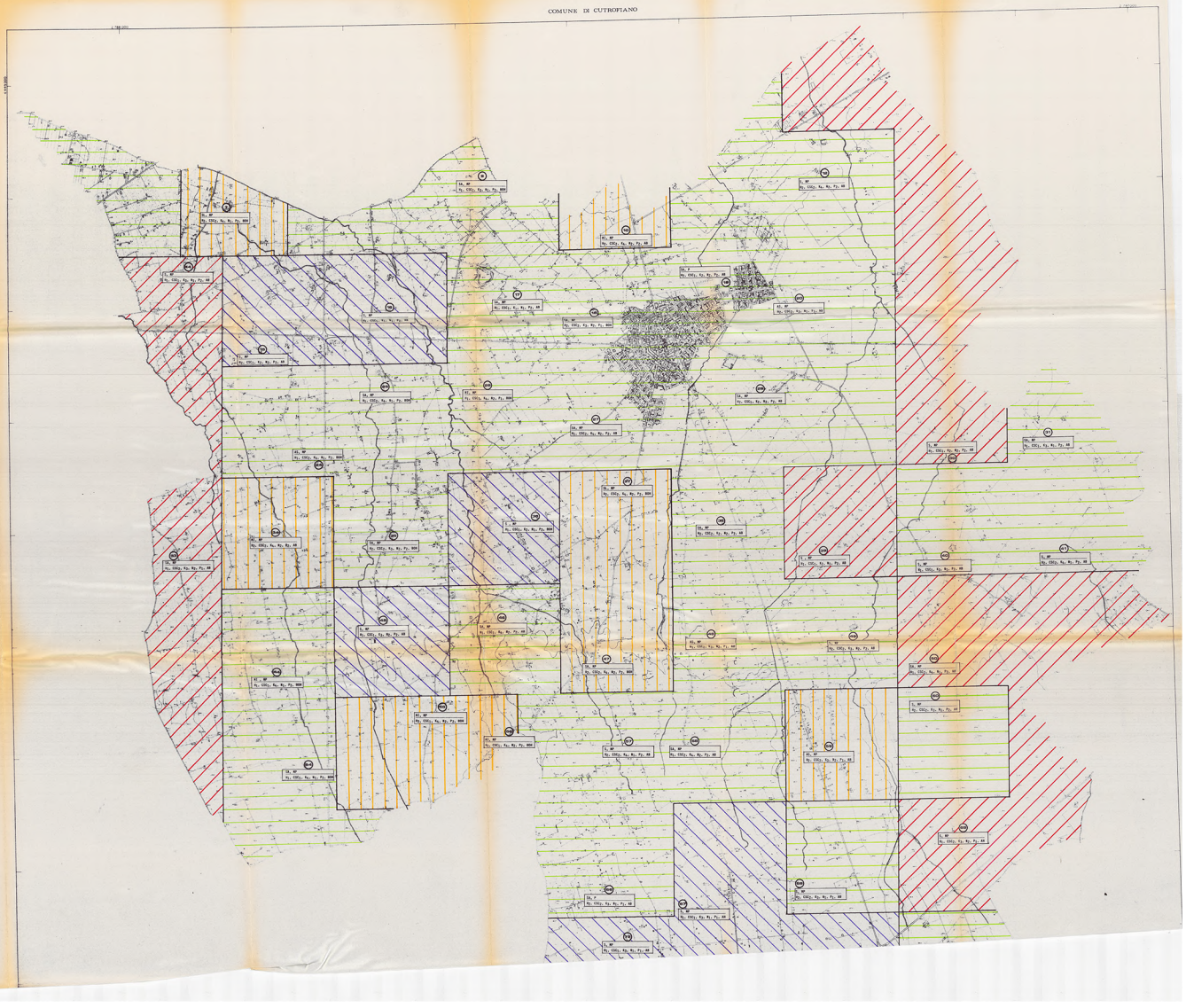
S.O. (%)

0-1 = R_1
1-2 = R_2

P (p.p.m. di P_2O_5)

< 40 = P_1
> 40 = P_2

(Ubicazione e numero dei campioni analizzati)





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ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 9.A — **CARTA DEL CONTENUTO IN POTASSIO**

SCALA 1:10.000

DOTT. GEOLOGO GIUSEPPE LAGANÀ

LEGENDA

- < 100 p.p.m. K_2O
- 100÷150 "
- 150÷200 "
- > 200 "
- (10) Ubicazione e numero dei campioni analizzati



COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. 9.8

CARTA DEL CONTENUTO IN FOSFORO

SCALA 1:10.000

DOTT. GEOLOGO GIUSEPPE LEGRA

COMUNE DI CUTROFIANO

LEGENDA

< 40 p.p.m. P_2O_5

≥ 40 "

Ubicazione e numero dei campioni analizzati



COMUNE DI CUTROFIANO

ANALISI GEOLOGICA DEL TERRITORIO PER LA PIANIFICAZIONE COMUNALE

TAV. IO — **CARTA DELLE CAPACITA' D'USO DEI SUOLI**

SCALA 1:10.000

DOTT. GEOLOGO GIBISEPPE LAGNA

COMUNE DI CUTROFIANO

LEGENDA

CLASSE I

Terreni privi di limitazioni nelle caratteristiche chimico-fisiche; idonei, con modesti costi di produzione, per quasi tutte le colture.
Capacità produttiva buona.

CLASSE II

Terreni con alcune limitazioni nelle caratteristiche chimiche (N, S.O.) o parzialmente in quelle fisiche (tessitu, limi), che richiedono la scelta delle colture e richiedono medi costi di produzione.
Capacità produttiva media.

CLASSE III

Terreni con limitazioni nei più importanti parametri chimici e fisici che limitano la scelta delle colture e che richiedono adeguate pratiche culturali con alti costi di produzione.
Capacità produttiva medio-bassa.

CLASSE IV

Terreni con forti limitazioni nei più importanti parametri chimici e fisici da cui derivano severe limitazioni nella scelta delle colture e che richiedono pratiche culturali molto accurate con alti costi di produzione.
Capacità produttiva bassa.

(T8) Ubicazione e numero dei campioni analizzati.



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TAV. II — **ZONAZIONE GEOLOGICO-TECNICA DELLE AREE URBANIZZATE E DA URBANIZZARE**

SCALA 1:5000

DOTT. GEOLOGO GIUSEPPE LEGGE

LEGENDA

ZONA B_1.
Calcareniti affioranti o con copertura di spessore esiguo. Eventuali nuovi costruzioni possono essere eseguite attraverso fondazioni superficiali previo rilievo, in sito, della reale consistenza e caratteristiche della roccia in modo da non sottostimare gli effetti e risultati di precedenti indagini di carattere geologico-tecnico eseguite nelle aree vicine o nei quali possa ragionevolmente essere basata la progettazione. Per le costruzione di edifici che richiedono in modo rilevante sul terreno di fondazione è obbligatoria l'indagine geologica e geotecnica.

ZONA B_2.
Substrato calcarenitico subtrattato a sabbie di tra 5 e 10 m di profondità con copertura costituita da depositi continentali colluviali e marini continentali. In questa zona si potranno adottare fondazioni superficiali che raggiungano il substrato calcarenitico non alterato. Indagini geologico-tecniche come per B_1.

ZONA B_3.
Situazione litologica come in B_2con possibilità di esondazione, allivionamento e ristagno delle acque dei canali. Per la difficoltà nell'individuazione la sistemazione dei canali mediante opportune opere che evitino la semplice deriva delle acque. Indagini geologico-tecniche come per B_1.

ZONA B_4.
Substrato calcarenitico in genere compreso tra 5 e 10 m di profondità con copertura costituita da depositi continentali colluviali e marini continentali. Substrato costituito da depositi continentali colluviali. Falda idrica, ove presente, a profondità superiore a 2,5 m. Obbligo di indagini geologico-tecniche estese alla parte di ottomando influenzata, direttamente o indirettamente, dalla costruzione. Si consiglia di adottare per i nuovi edifici di almeno sei piani possibile l'adozione di fondazioni superficiali, mentre per quelli che lucciono in modo rilevante sul terreno di fondazione sarà inoltre necessario eseguire fondazioni su pali di diametro e tipo da stabilirsi caso per caso.

ZONA B_5.
Substrato calcarenitico a profondità superiore ai 5 m costituito da depositi continentali colluviali e marini continentali intercalati ad argille. Falda idrica a profondità superiore a 2,5 m. Obbligo di indagini geologico-tecniche estese alla parte di ottomando influenzata, direttamente o indirettamente, dalla costruzione. Si consiglia di adottare per i nuovi edifici di almeno sei piani possibile l'adozione di fondazioni superficiali, mentre per quelli che lucciono in modo rilevante sul terreno di fondazione sarà inoltre necessario eseguire fondazioni su pali di diametro e tipo da stabilirsi caso per caso di realizzazione delle strutture fondali.

ZONA B_6.
Situazione litologica come in B_5. Falda idrica a profondità inferiore a 2,5 m. Particolarità di insediamenti civili subordinate alla realizzazione della pubblica fognatura a cause delle restrizioni imposte dal Regolamento Regionale 20/3/1990, n.1. Prescrizioni di tipo geologico-tecnico come in B_5.

ZONA C_1.
Zona di edificabilità subordinata all'accertamento, mediante sondaggi effettuati, dell'assenza di vuoti sotterranei dovuti all'attività estrattiva. Indagini geologico-tecniche estese alla parte di ottomando influenzata, dal medesimi vuoti. Le indagini geologico-tecniche e le strutture fondali saranno commisurate alla presenza della copertura secondo quanto stabilito nelle zone B_1 e B_2.

ZONA C_2.
Zona di edificabilità subordinata all'accertamento, mediante sondaggi effettuati, dell'assenza di vuoti sotterranei dovuti all'attività estrattiva ipogea, ed alla realizzazione della pubblica fognatura per restrizioni imposte dalla falda idrica superficiale a 2,5 m. Prescrizioni di tipo geologico-tecnico come a B_5.

N



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TAV. 12 — CARTA DI DOCUMENTAZIONE

SCALA 1:10000

DOTT. GEOLOGO GIUSEPPE IRRERA

LEGENDA

- Perforazione di sondaggio
- Prova penetrometrica dinamica
- Sondaggio elettrico verticale
- Pozzo per acqua con stratigrafia nota

COMUNE DI CUTROFIANO

