



CRAterre

INTERNATIONAL CENTRE FOR EARTH CONSTRUCTION

MATERIALS UNIT





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CONTACT

PRESENTATION

Since 1979, CRAterre, International Centre for Earth Construction, has been working to promote the recognition of earth as a material and more widely the local building cultures in order to address challenges related to the environment, cultural diversity and the fight against inequalities.

It was in the post-1968 French context, marked by the emergence of environmentalism and alternative movements, that a small group of students from the Unité Pédagogique d'Architecture de Grenoble discovered earth as a building material, widely used in the region's vernacular architecture and known as pisé (rammed earth). The idea of building with 'what is under our feet' emerged as a response to a fundamental question: **how can humans better produce their own housing by taking advantage of local resources?**

This is how, in the seventies, the first researches and experiments were carried out enabling to regain the knowledge and the know-how which had almost disappeared during the twentieth century.

Based on the results of these researches, the founders engaged in a research and action strategy by creating CRAterre association in 1979.

Simultaneously, numerous studies, notably conducted by international organisations (UNCHS-Habitat, PNUD, ONUDI, BIRD), have

shown that a large part of the world population used local materials for building and especially earth. These findings have led to the elaboration of strategies in favor of the modernization of the traditional techniques.

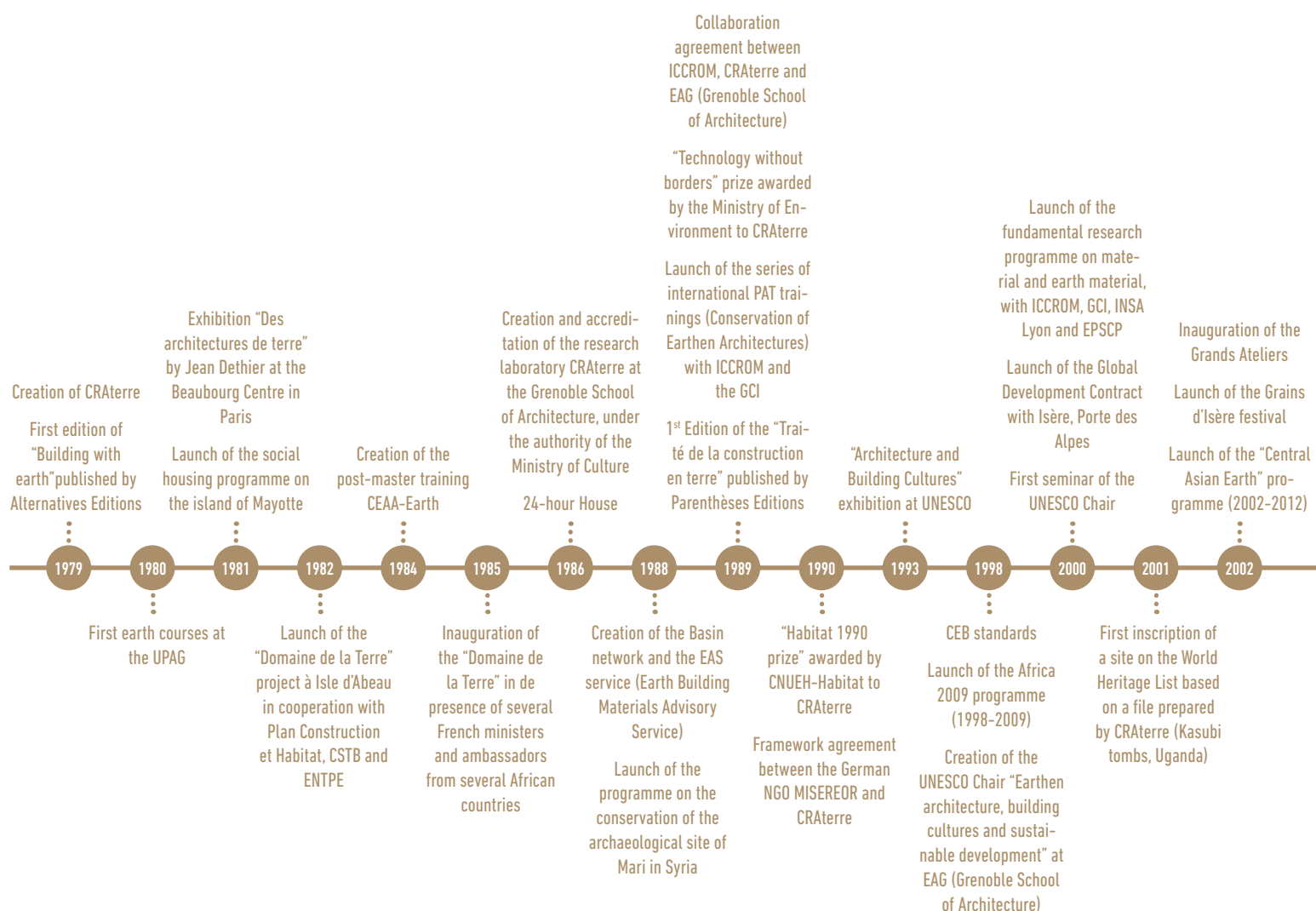
As an extension of these initiatives, CRAterre is responsible, since 1980, for launching a sector for stabilized compressed earth blocs in Mayotte, and to assist various actors to realize the Domaine de la Terre, a programme of 64 housings in Villefontaine (France).

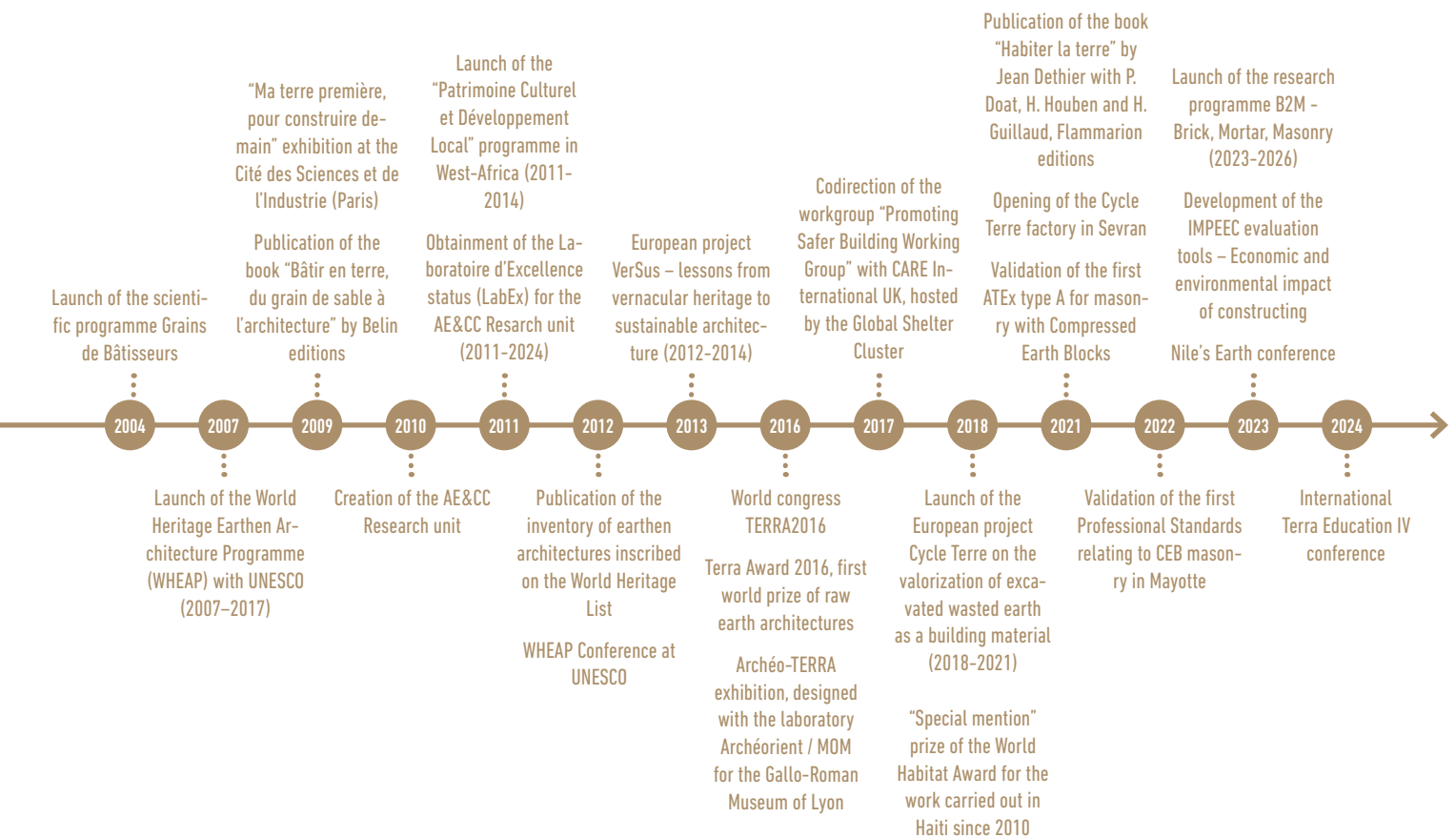
These successfully carried out operations led to the creation of a specialized training at the Grenoble School for Architecture, and later of an eponymous research laboratory. These two structures, the association and the research laboratory, still remain complementary in their activities closely combining research and training with a strong presence in the field, in France and in the world. This allows them to propose relevant answers for the production of ecofriendly habitats and living environments, responding in an effective way to the challenges of sustainability, climate changes, cultural diversity and the fight against inequalities.



HISTORICAL LANDMARKS

On February 6, 1979, Patrice DOAT, Alain HAYS, Hugo HOUBEN, Silvia MATUK and François VITOUX founded CRAterre Association, acronym for “Centre de Recherche et d’Application Terre”, a name that has evolved to “Centre international de la construction en terre” at the end of the eighties. In 1986, the relevance of the researches and action led to the habilitation of an eponymous research laboratory at the Grenoble School for Architecture (CRAterre-EAG). Further to these two major dates, several facts or important projects have marked the journey of CRAterre.





OBJECTIVES

While remaining faithful to the principles that led to its creation, CRAterre renews constantly its objectives, enriched by the permanent interactions between researches and field experiences carried out with various partners. Nowadays, the main objectives are to:

- Contribute to the autonomy and emancipation of the populations facing environmental and societal pressures.
- Promote social and gender equity in the field of construction and habitat.
- Contribute to a lasting and sustainable local economy.
- Limit the impact of building by reducing its ecological footprint and mitigate the impact of climate change on populations and their built habitats.
- Propose architectural solutions and accompany the adaptation to societal and environmental mutations (climate, migrations, natural risks, limited materials, conflicts, humanitarian crises and disasters).
- Promote ecological, local, organic or geosourced materials and their performances, and the applicability of the concept of circularity to the production of habitat and the conservation of earthen architectures.
- Promote the scientific research on raw earth, material, production techniques, heritage conservation and modern architecture.
- Contribute to remove regulatory barriers, adapt the standards to earth material and its constructive uses and update the charters and the conservation approaches.
- Widely disseminate the essential basics of knowledges and know-how to the construction and the conservation of earthen buildings (design principles, constructive provisions, implementation, control methods on the material and its implementation).
- Enhance the cultural diversities and their tangible and intangible heritages.
- Learn lessons from the earthen built heritage applicable to its conservation and to the modern ecoresponsible architectural production, on the technical, environmental, cultural, social and economic level as well as in terms of the global governance of a territory.
- Reinforce the local skills and support the establishment of new training institutions for the conservation of earthen architectures worldwide, notably through onsite projects, educational or participatory construction sites.
- Participate to the implementation of a network of actors, notably by creating bridges between curators, designers and materials producers in order to consolidate the regional know-how linked to the use of available natural materials.

VALUES

For each action (training, research, application, dissemination), CRAterre association brings to the fore the respect of the living beings and the natural, cultural, social and economic contexts in which they evolve.

We adopt an attitude respecting the skills and the know-how of our partners and of the populations for which we intervene and with which we work, with the objective to reinforce their dignity and their autonomy regarding encountered problems.

However, our approaches are intended to be innovative, creative, in order to provide relevant answers to the often complex requests and issues of a rapidly expanding world with very various impacts depending on local, geographical or cultural specificities.

The scientific rigor of the undertaken studies and the researches to ensure the efficiency of the actions, demand responsiveness, adaptability and a capacity to progress and to constantly improve. Moreover, we recognize the need of a diversity of skills for the realization of each project, which commits us to develop interdisciplinary methods encouraging comparative views and open-mindedness.

This work ethic is also applied internally. More particular, the relations between the members of the association and its collaborators are based on respect, confidence and mutual recognition, equity and solidarity. The search for the balance between personal accomplishment (individual) and collective interest (group) guide the decisions taken by the board of directors as well as the attitude of each person towards the others. This is encouraged by mutual listening and dialogue, the sharing of knowledges, friendliness and mutual help, personal and collective valuation, accompagnement and transmission.

In logical continuity of CRAterre's history, many members of the association participate closely in the research works carried out within the Research Unit AE&CC of the Grenoble School for Architecture (ENSAG) within the framework of their recognized status of associated member.



ACTION THEMES

CRAterre association deploys its activities in 3 main areas.

MATERIALS

Enabling raw earth construction within contemporary regulatory frameworks.

Three themes:

- Characterization of raw materials and building components,
- Construction systems, production methods and innovation,
- Evolution of the regulatory framework.

HABITAT

Building today for tomorrow. Improving access to high-quality environmental and cultural housing.

Three themes:

- Crisis preparedness and response,
- Innovative buildings, reasonable architectures,
- Precarious urban areas / housing for the most disadvantaged.

HERITAGE

Promoting cultural diversity by enhancing architectural heritage.

Four themes:

- Heritage conservation,
- Archaeology and conservation,
- World heritage,
- Heritage and development.





EARTHEN ARCHITECTURE

Since eleven millennia, humanity demonstrates an astonishing capacity to build with earth, either simple dwellings, palaces or entire cities. Nowadays, in very various contexts and territories, this building material still remains widely used as it is present in more than 150 countries. Earthen architectures witness of a quality of daily life and of a technical innovation closely mixing know-how and ingenuity.

SOCIAL AND ENVIRONMENTAL ASSETS OF EARTH

Qualities of the earth material

- An abundant, local and infinitely renewable resource.
- Favors the constructive intelligence thanks to its diversity of techniques.
- Adapts to constructive modern innovations (prefabrication, 3D printing).
- Provides good acoustic isolation by its mass.
- Non-combustible, it constitutes a natural barrier against fire.

Flexibility of the implementation

- Reduces inconveniences linked to the construction site (limited noise pollution, low mechanization).
- Generates little waste on the production site.
- Compatible with the manual techniques and participative projects.

- Encourages the transmission of the traditional craftsmanship and vernacular practices.
- Adapted to projects of all sizes, from individual habitats to public facilities and urban planning.

Comfort and well-being

- Regulates naturally the humidity and the interior temperature (thermal inertia, hygrothermal comfort).
- A healthy material for its constructors and for its users.
- Contributes to the reduction of heat islands regulating naturally the thermal exchange with the environment.

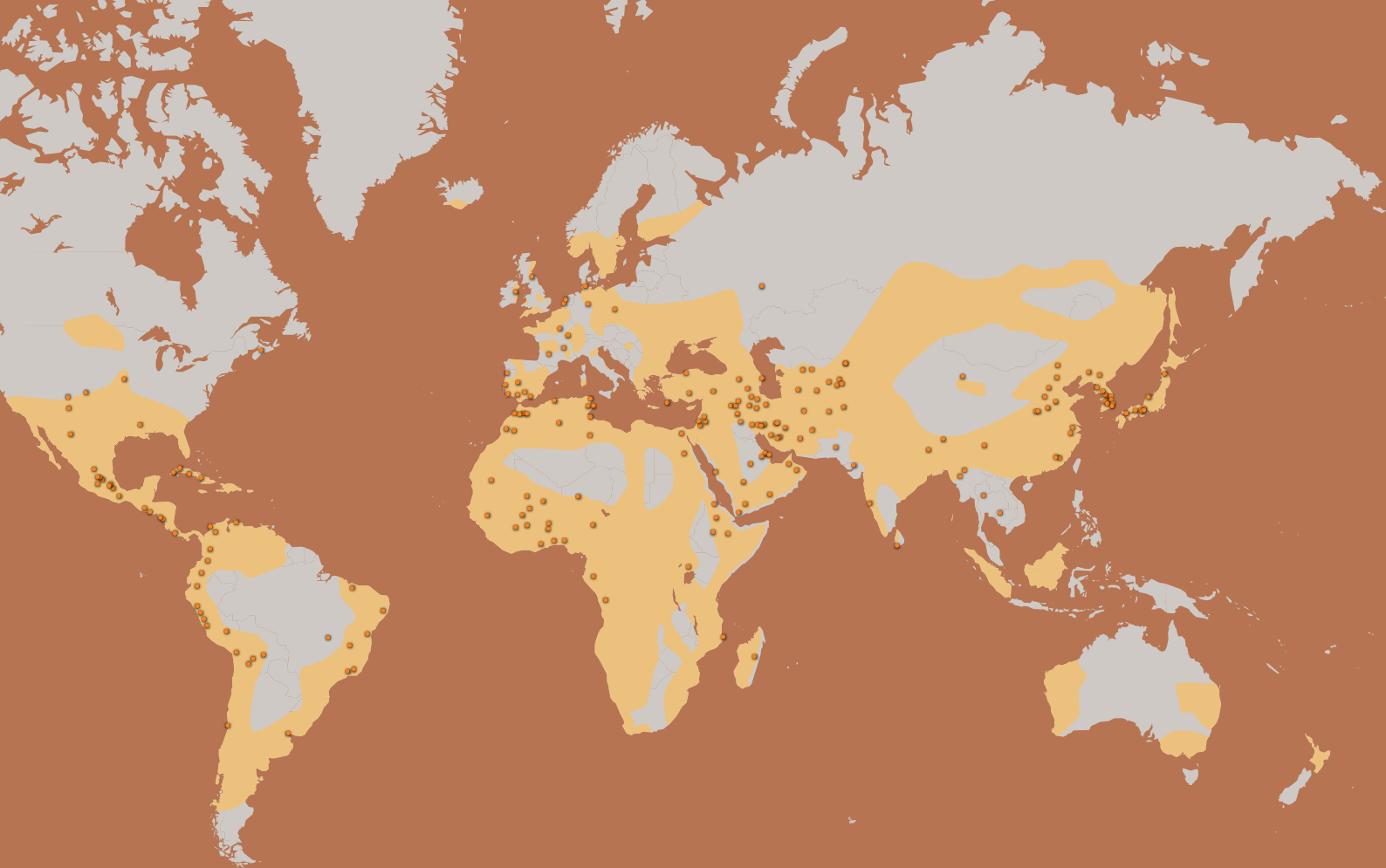
Architectural qualities

- Enables the creation of organic shapes and unique architectural styles.
- Combines easily with other local complementary materials (wood, stone, bamboo...).
- Facilitates extensions and rehabilitation thanks to a modifiable structure.



Energy performance

- Low grey energy (extraction, transformation, transport).
- Good performances in use phase (reduction of heating and air condition needs).
- Compatible with low-carbon approaches and the actual environmental benchmarks (HQE, RE2020, etc.).





EARTHEN ARCHITECTURES IN THE WORLD

-  World Heritage sites with raw earth buildings
-  Distribution of earthen architectures in the world

Social impact

- Reinforces the social cohesion through the collective participation to construction.
- Creates intergenerational solidarity and transmission of knowledge dynamics.
- Favors community involvement and neighborhood ties.

Local economic dynamics

- Generates local sustainable employment and values craft skills.
- Reduces the costs of building in contexts where industrial imported materials are expensive.
- Favors the self-sufficiency and the economic resilience of the territories.

Territorial and environmental integration

- Adapts to the bioclimatic and landscape characteristics of the site.
- Respects the local ecosystems and preserves the biodiversity.
- Maintains the identity of the cultural landscapes and values the local specificities.

Cultural and heritage value

- Reinforces the collective identity being part of the continuity of traditional know-how.
- Favors a sensitive and historical understanding of the inhabited territories.
- Supports creativity and artistic expression.

Responsible life cycle

- Recyclable, biodegradable and reusable material without heavy processing.
- Easy maintenance and simple repairs.
- Global reduction of the pollution and construction waste.

PROJECTS

Since its creation, the association has conducted and capitalized on field experiences in more than 100 countries across all continents on projects of different sizes and of different natures: expertise, technical support, training, etc.

CRAterre has developed programmes in partnership with international and national institutions and non-governmental organizations.

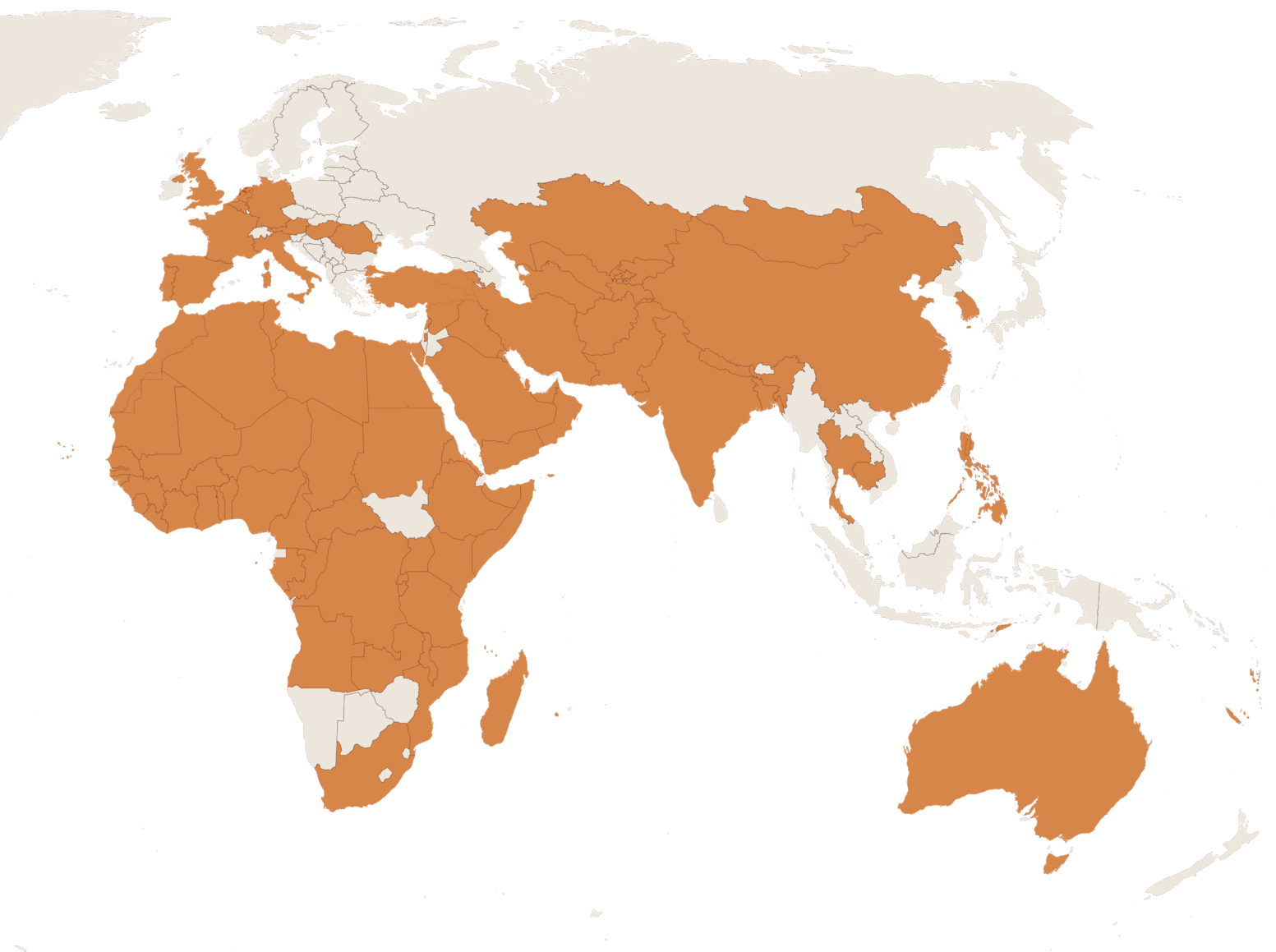
Since its creation, CRAterre has been recognized by numerous institutions:

- United Nations organizations (UNESCO, UN-Habitat, UNHCR, UNEP, IOM, etc.),
- Financial institutions and partners recognized for their action in the field of habitat and heritage conservation (International Federation of Red Cross and Red Crescent Societies (IFRC), Misereor, Fondation pour le Logement des Défavorisés, Caritas Internationalis, Catholic Relief Services, Fondation de France, French Ministry of Culture, IC-CROM, ALIPH, AIMF, etc.)..

CRAterre association collaborates with several networks (UNESCO Chair "Earthen architecture, building cultures and sustainable development", ICOMOS France, ICOMOS ISCEAH, Coordination Sud, Groupe Initiatives, Global Shelter Cluster, Partenariat français pour les villes et territoires, Association française du génie parasismique, etc.) with which actions and reflections are carried out aiming to improve the sectors contribution to achieve the United Nations Sustainable Development Goals.

COUNTRIES OF INTERVENTION

- | | |
|------------------------------|--------------------------------------|
| 1. Afghanistan | 20. Chile |
| 2. Algeria | 21. China |
| 3. Angola | 22. Colombia |
| 4. Argentina | 23. Comoros |
| 5. Armenia | 24. Congo |
| 6. Australia | 25. Cuba |
| 7. Austria | 26. Democratic Republic of the Congo |
| 8. Bangladesh | 27. Ecuador |
| 9. Belgium | 28. Egypt |
| 10. Benin | 29. El Salvador |
| 11. Bolivia | 30. Eritrea |
| 12. Brazil | 31. Ethiopia |
| 13. Burkina Faso | 32. Fiji |
| 14. Burundi | 33. France |
| 15. Cambodia | 34. Gabon |
| 16. Cameroon | 35. Gambia |
| 17. Cape Verde | 36. Germany |
| 18. Central African Republic | 37. Ghana |
| 19. Chad | 38. Guatemala |



- | | | | |
|-------------------|-------------------|---------------------------|---------------------------|
| 39. Guinea | 59. Madagascar | 79. Philippines | 98. Tonga |
| 40. Guinea-Bissau | 60. Malawi | 80. Portugal | 99. Tunisia |
| 41. Guyana | 61. Mali | 81. Romania | 100. Turkey |
| 42. Haiti | 62. Martinique | 82. Rwanda | 101. Turkmenistan |
| 43. Honduras | 63. Mauritania | 83. Sao Tome and Principe | 102. Uganda |
| 44. Hungary | 64. Mexico | 84. Saudi Arabia | 103. United Arab Emirates |
| 45. India | 65. Mongolia | 85. Senegal | 104. United Kingdom |
| 46. Indonesia | 66. Morocco | 86. Sierra Leone | 105. United States |
| 47. Iran | 67. Mozambique | 87. Somalia | 106. United States |
| 48. Iraq | 68. Nepal | 88. South Africa | 107. Uzbekistan |
| 49. Israel | 69. Netherlands | 89. South Korea | 108. Vanuatu |
| 50. Italy | 70. New Caledonia | 90. Spain | 109. Venezuela |
| 51. Ivory Coast | 71. Nicaragua | 91. Sudan | 110. Yemen |
| 52. Kazakhstan | 72. Niger | 92. Syria | 111. Zambia |
| 53. Kenya | 73. Nigeria | 93. Tajikistan | |
| 54. Kuwait | 74. Oman | 94. Tanzania | |
| 55. Kyrgyzstan | 75. Pakistan | 95. Thailand | |
| 56. Lebanon | 76. Palestine | 96. Timor-Leste | |
| 57. Liberia | 77. Panama | 97. Togo | |
| 58. Libya | 78. Peru | | |

DISSEMINATION

In order to respect its fixed objectives, CRAterre association works on the dissemination of the knowledge to a wide audience using different mediums.

THE DOCUMENTATION CENTRE

The management of the documentation centre has been assured alternately by the association and the laboratory. Its documentary collection, constituted since the seventies by the founders of CRAterre, has over time been enriched with scientific and technical productions of the members of the research team and the association as well as by new acquisitions and donations of partners.

This collection indeed gathers nearly 20 000 documents in the fields of earthen architecture and local building cultures as well as other linked themes as for example vernacular architecture, building techniques with natural materials,

improvement of the habitat, reduction of natural risks, archaeology, heritage conservation, world heritage, ecology, climate change, project planning and management, etc.

The documentation centre receives and accompanies every year visitors from all over the world (researchers, students, professionals and general public).

CRAterre documentation at the ENSAG © Audrey Carbonnelle



KEY FIGURES

- 20 000 documents
- 80 000 slides
- +500 000 photos
- 300 VHS tapes/DVDs
- 150 countries covered
- 25 languages

World Heritage Exhibition, 1992-2012 © Sébastien Moriset
 Large audience workshop, Grains d'Isère Festival © Patrice Doat
 ArchéoTerra Exhibition © Sébastien Moriset
 Pedagogical kit ÉlémentTerre © Audrey Carbonnelle

MEDIATION ACTIVITIES

For 45 years, the members of CRAterre have been working for the dissemination of science, technology, art and culture as a way to act with the young generations and the general public. The aim is to allow them to discover new horizons, to deepen their knowledge in specific fields and to provide them with the necessary tools to observe, understand and analyze the world surrounding them. The objective is also to encourage the public to explore new ways of interacting with the material, the living and the Earth.

With this aim in mind, CRAterre has developed original and innovative pedagogical tools like the pedagogical kit ÉlémentTerre, the Plané'Terre programme, the artistic workshop Matter & Emotions and a pedagogical kit on seismic risks.

In addition to these tools, CRAterre regularly designs exhibitions mixing informative textual supports and interactive activities, allowing visitors to explore the themes in a pedagogical and playful way. These exhibitions aim to stimulate the curiosity of the participants by inviting them to experiment and to meditate on the challenges linked to our environment.

Thanks to the support of IDEX UGA, a permanent pedagogical workshop has been installed at the Grenoble School for Architecture (ENSAG) allowing to receive, on request, small groups of students but also the general public.



DISSEMINATION

CRATERRE EDITIONS

Since 1987, CRAterre Editions are dedicated to the valorization of the heritage and the local building cultures, emphasizing in particular the use of earth as a construction material. This publishing house commits itself to promote works exploring traditional and modern building and rehabilitation techniques with earth, offering consequently valuable resources to professionals, students and all sustainable architecture lovers.

CRAterre Editions also publish proceedings of congresses allowing to disseminate the results of the latest researches and innovations in the field, as well as pedagogical material to raise awareness and train on issues related to the use of earth and local materials.

These publications are **freely downloadable online** in order to promote the dissemination of knowledge.

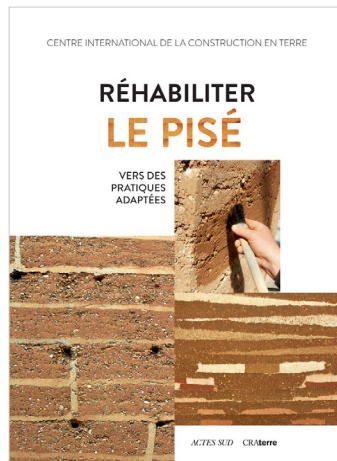
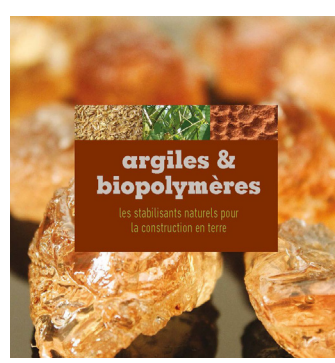
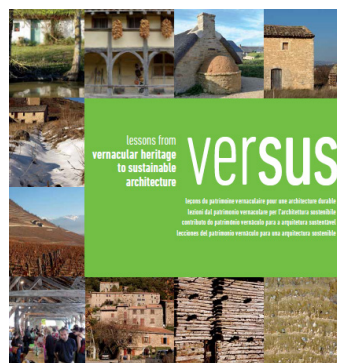
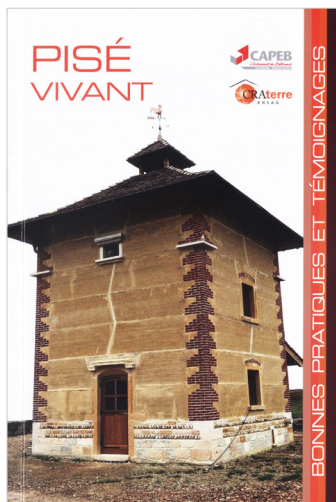
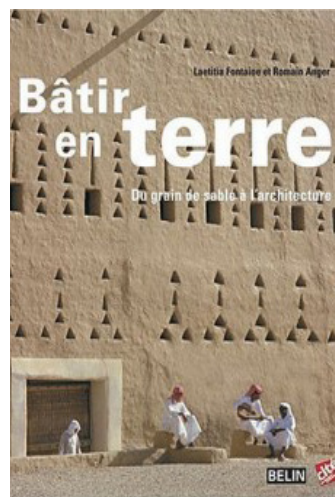
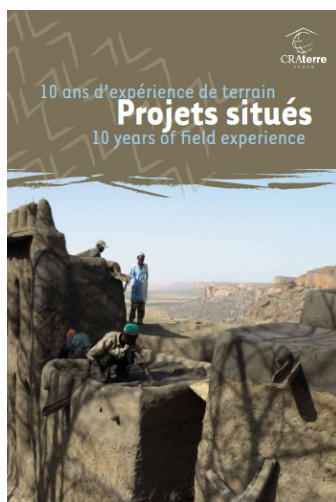
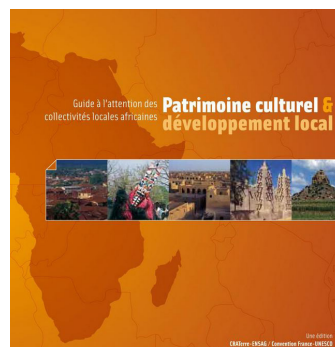
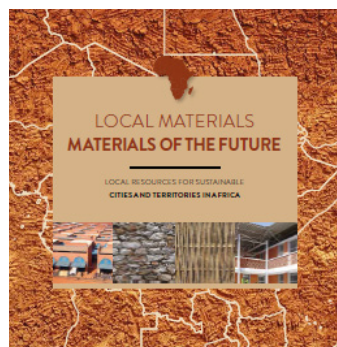
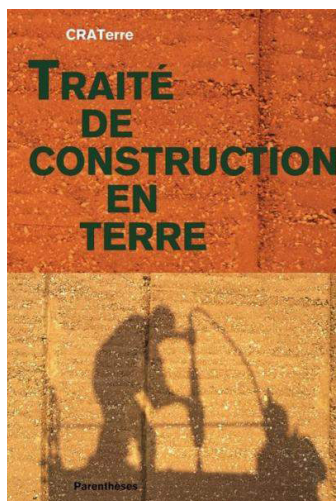
OTHER PUBLICATIONS

The members of CRAterre also contribute to the production of literature with other recognized publishing houses like Actes Sud, Le Moniteur, Flammarion or national and international magazines like Heritage, Built Heritage, Engineering Structures or Les Cahiers de la recherche architecturale, urbaine et paysagère. This testifies of their commitment to enrich the editorial landscape around the themes linked to earth and constructive cultures.

Moreover, CRAterre's expertise is often requested in the framework of the participation to scientific committees of national and international events (colloquia, seminars, conferences, congresses).



View team members' publications online for free at <https://craterre.hypotheses.org/>



WHO ARE WE?

In order to implement its mandate, CRAterre cooperates with about one hundred persons from different nationalities and disciplines with a more particularly active core team of about 40 persons. In 2024, activities have been implemented:

WITH THE DIRECT IMPLICATION OF THE MEMBERS AND THE EMPLOYEES:

ANGULO Dario, architect

BARDAGOT Anne-Monique, ethnologist

BELINGA NKO'O Christian, architect

BERTAGNIN Mauro, architect

BOIVIN Elisabeth, tourist interpreter guide

CARAZAS AEDO Wilfredo, architect

CARBONNELLE Audrey, manager of the administrative and mediation

CARIGNANO Leandro, manager of the administrative and financial unit

CARRILLO Elena, architect

CAUDERAY Elsa, architect

CHANSAVANG Quentin, architect

CHAMODOT Mathilde, architect

CHAUVIN Christèle, accountant

CRETE Eugénie, engineer*

DALI, Amdjed Islam, architect

DAVIS Lara, architect

DAYRE Michel, engineer*

DEJEANT Florie, engineer

DE LA RICA EXTREMIANA Jon, architect

DOAT Patrice, architect

d'ORNANO Sébastien, agricultural engineer

DOULINE Alexandre, building technician

ENCISO BENITES Liz, archaeologist

ESTEBAN AVALOS Héctor, architect

ESTEVE Josep, architect

FERREIRA MENDES Miguel, architect

GALER Titane, manager and archivist

GANDREAU David, archaeologist*

GANDUGLIA Mauricio, architect

GARCIA Carolyn, architect

GARNIER Philippe, architect*

GASNIER Hugo, architect

GUEGUEN-PERRIN Anaïs, architect

GUILLAUD Hubert, architect

HAJMIRBABA Majid, engineer

HENNOUS Mourad, architect

HOLST Jean-Paul, architect

HOSTA Julien, architect

HUBERT Alix, architect*

LE TIEC Jean-Marie, architect*

LIPPE Heiner, architect

MAINI Serge, architect

MISSE Arnaud, architect*

MOLES Olivier, master's degree in local development engineering, Civil engineering technician*

MORISSET Sébastien, architect*

NOUWENS Bregje, secretary

OLIVER David, architect

PACCOUD Grégoire, architect

RAKOTOMAMONJY Bakonirina, architect*

RAMIREZ Beatriz, architect and conservator

RIVERO OLMOS Alba, architect

RUIZ Eric, town planner architecte*

SADOZAI Chamsia, archaeologist

SANCHEZ MUNOZ Nuria, architect

SEVILLANO GUTIERREZ Enrique, architect

TRABANINO Juan, architecte

TRAPPENIERS Marina, engineer architect*

VIEUX-CHAMPAGNE Florent, engineer

VOLHARD Franz, architect



**WITH COMPLEMENTARY
CONTRIBUTIONS OF:**

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FREITAS Sébastien
JOFFROY Thierry
KHALILI Sayed
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MAMA AWAL Halimatou
MAZEL Yvan
MILLE Emmanuel
NOURDIN Julien
PLATTARD Odile
POINTET Martin
RAKOTONIRINA Mampionona
SALERNO Claude
SOARES RODRIGUES David
TOUZARD Inès
ZAWITOWSKI Marie
ZAWITOWSKI Keith



5. Introduction

1.1. Soil
Soil is a natural body of loose material consisting of particles of mineral and organic matter, which is capable of supporting plant life. It is the result of weathering of primary and secondary minerals, and the accumulation of organic matter from plants and animals.

1.2. Soil Structure
Soil structure is the arrangement of soil particles and the spaces between them. It is determined by the size, shape, and distribution of soil particles, and the amount of water and air in the soil. Soil structure affects the rate at which water and nutrients move through the soil, and the ability of plants to grow.



MATERIALS UNIT

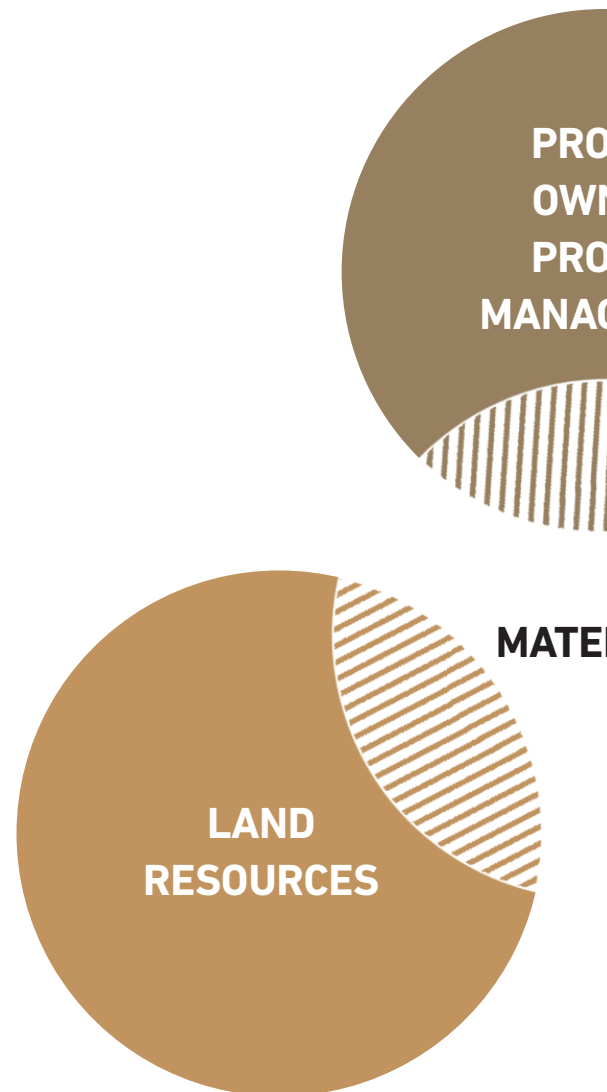
THE MATERIALS UNIT

Given today's environmental challenges and the impact of construction, materials selection at the outset of an architectural project is a critical decision.

In our effort to promote local building practices, reduce environmental impact, and favour short supply chains, our team works alongside all project stakeholders to facilitate the use of raw earth materials.

We share our expertise with all parties involved to collaboratively address the specific challenges linked to the use of these still largely non-standardised materials.

The Materials Unit serves as a bridge between materials and architecture. We consider the full scope of the construction process—from assessing the potential of a territory to the successive stages of material production, structural design, and building implementation. Each project becomes an opportunity to reinforce the building culture of a territory and empower its stakeholders.



On-site rammed earth construction © Jérémie Basset
CEB Production © Alix Hubert
On-site rammed earth construction © Hugo Gasnier
CEES of Orléans © Paul Kozlowski

PROJECT
OWNER /
PROJECT
MANAGEMENT

MATERIALS

COMPANY



FIELDS OF ACTION

From raw materials to architecture: supporting the implementation of raw earth construction projects.

The Materials Unit is dedicated to advancing the use of raw earth in the construction sector. It supports stakeholders throughout all phases of their projects involving this material, in particular by:

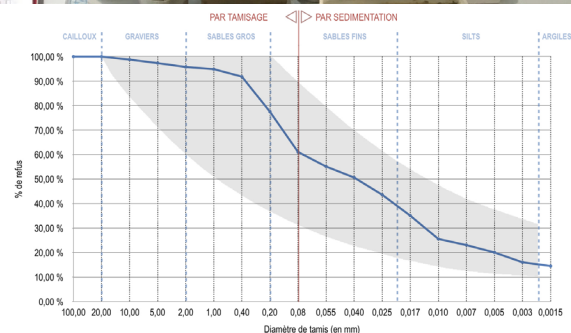
- assisting project owners, designers, and construction companies from design to completion,
- providing technical validation of raw earth structures and contributing to the drafting of normative documents,
- assisting to structure production chains for raw earth-based materials,
- characterising soils and raw earth materials.

Materials is a unit within the CRATERre association that provides expertise to the Heritage and Habitat units. The unit's field projects and the research conducted by the CRATERre laboratory team enrich each other, fostering close links between fieldwork, laboratory research and teaching.

OPERATIONAL AND EDUCATIONAL RESEARCH AND EXPERIMENTATION



© Inès Touzard



© Cycle Terre Project

AN ITERATIVE PROCESS

OPERATIONAL AND EDUCATIONAL RESEARCH AND EXPERIMENTATION



© Alizée Cugney



© Alix Hubert

OPERATIONAL CONSTRUCTION SITES



© Jérémie Basset



© Jean-Marie Le Tiec

SKILLS AND SERVICES

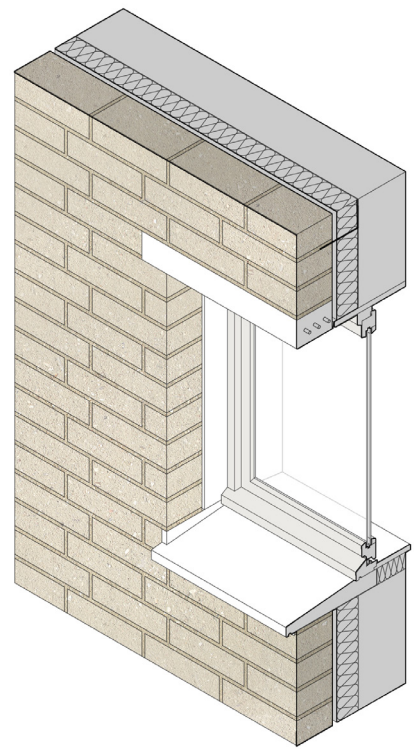
The Materials Unit provides expertise in the following areas:

SUPPORT FOR PROJECT MANAGEMENT AND PROJECT OWNERS

1. Project Assessment and Planning
 - Understanding the project context (location, scale, technology, goals),
 - Providing support during the planning phase.
2. Context (heritage, available raw materials, and local know-how) and Feasibility Studies
 - Identification and analysis of local soils,
 - Guidance in selecting the appropriate raw earth construction technique,
 - Material formulation and, if needed, laboratory characterisation,
 - Overall feasibility analysis (technical, economic, logistical, etc.).
3. Support for architectural design
 - Development of raw earth construction details and interfaces with other materials,
 - Structural calculation notes in collaboration with structural engineering consultants,
 - Assistance with drafting technical specifications and defining the implementation schedule.

4. Technical Justification for Raw Earth Construction
 - Strategy development for technical justification,
 - Coordination of testing campaigns,
 - Preparation of technical approval files (e.g., ATEX-type documentation in France).
5. Assistance with Contractor Selection and Tendering
 - Support in identifying qualified companies and awarding contracts for raw earth works.
6. Support During Construction and Delivery
 - Assistance with site supervision and handover of raw earth structures.

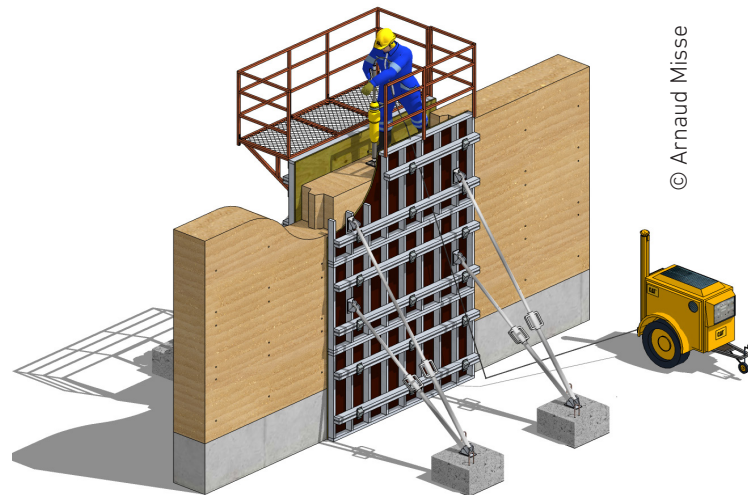
Our support can be provided throughout the entire project lifecycle or focused on specific phases. However, we strongly recommend involving us from the design stage to ensure compatibility with raw earth construction techniques.



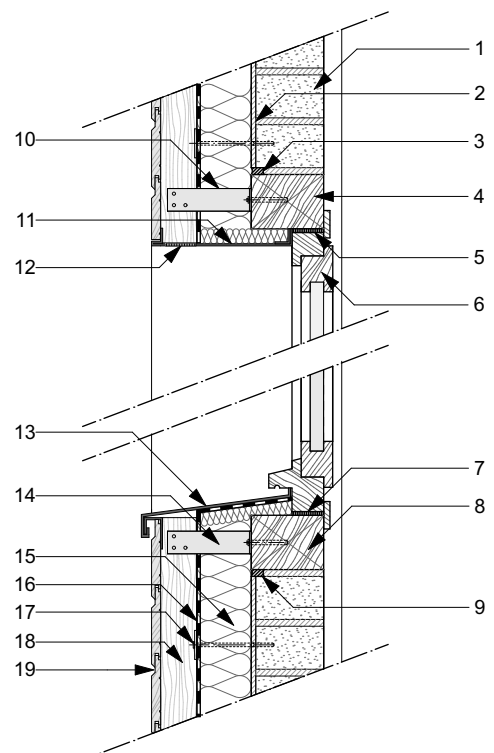
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SUPPORT FOR CONSTRUCTION COMPANIES

1. Project feasibility assessment (structural, economic, planning, etc.),
2. Support with tender preparation and cost estimation for raw earth work packages,
3. Analysis of on-site soils and exploration of nearby quarries to identify suitable materials,
4. Material formulation,
5. Guidance in selecting a structural engineering firm (execution plans and structural calculations),
6. Assistance in planning and carrying out test campaigns, and in preparing certification files (e.g., ATEEx-type approvals in France),
7. Training of construction teams through the building of prototype walls,
8. Support in setting up material production and implementing quality control procedures,
9. Assistance in developing specific tools and equipment adapted to the chosen construction technique and scale of the project.



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SKILLS AND SERVICES

STRUCTURING RAW EARTH MATERIAL SUPPLY CHAINS FOR CONSTRUCTION

1. Feasibility analysis for establishing a raw earth production unit
 - Assessment of the territory and local context in relation to the development of a raw earth sector, including market analysis,
 - Resource evaluation and support in selecting materials for production,
 - Comparative study of the environmental impacts of different materials and production methods,
 - Initial technical, logistical and economic guidelines,
 - Development of a risk management strategy for the project.
2. Design of the production unit
 - Analysis of soil sourcing and preparation processes,
 - Material formulation and characterization,
 - Research and development for material implementation, including prototype construction,
 - Design of production lines and associated R&D activities,
 - Comprehensive project assessment to ensure alignment between technical plans, financial investment, available land and project timeline,
 - Drafting of technical specifications for the installation of production lines.
3. Support for Production Unit Implementation
 - Management of soil supply logistics,
 - Assistance with equipment selection, procurement and installation,
 - Coordination of material testing and characterisation campaigns,
 - Development of technical documentation and user guides,
 - Technical support for marketing,
 - Organisation of demonstration construction sites,
 - Support in setting up quality control processes,
 - Guidance on equipment maintenance.

TECHNICAL AND REGULATORY VALIDATION

- Support in defining a technical and regulatory validation strategy, including risk management,
- Participation in the development of normative documents, technical dossiers, and certification files (e.g., ATEX, professional guidelines, standards),
- Organisation of testing campaigns, analysis of results, and characterisation of materials and structural elements.



SELECTED REFERENCES

ONGOING AMATECO - Mahoran Workshop for Earth-Based Construction Materials: Structuring a low-carbon production supply chain on the island of Mayotte - Project Lead: ART.Terre Mayotte

ONGOING B2M – Research Project: Mechanical, fire, and hygrothermal characterisation of various raw earth masonry types - In partnership with AE&CC, 3SR, CSTB, and CTMNC <https://aecc.hypotheses.org/6250>

ONGOING Henri Becquerel General and Technological High School, Nangis (77): Training in raw earth masonry (BTCS and BTE certifications) - Company: CRUARD Charpente / COFIBAT SAS

ONGOING Henri Becquerel General and Technological High School, Nangis (77): Support in drafting an ATEx B - Design Team: COSA / Client: Île-de-France Region / Contractor: CRUARD Charpente

ONGOING Technical support for the validation of raw earth structures (submission of an ATEx B or alternative process) within the OPHROM project in Martinique – Design Team: MEAT Architecture – BIM Caraïbes / Client: OZANAM – Action Logement Group

ONGOING Design assistance for the integration of raw earth walls in the Guipry-Messac Cinema (35) - Design Team: Linéaire A – OTE Ingénierie

ONGOING Tani Malandi High School, Chirongui - Mayotte: Design assistance for raw earth block masonry (CEB) - Design Team: FBAA Architects + Dietrich | Untertrifaller Architectes SARL / Client: Rectorate of Mayotte

2024 Development of the IMPEEC decision support tool (Assessment of environmental and economic impacts of construction) - Partners: French Development Agency (AFD) and Foundation for Housing for the Disadvantaged

2024 Environmental assessment of various temporary shelter solutions in Somalia - Client: International Organization for Migration (IOM)

2023 Feasibility study for establishing a raw earth material production facility in Martinique - Client: KEMET Bâisseurs Association

2023 Rehabilitation of a former sanatorium into a hospitality complex in Dreux (28) - Design assistance - Design Team: VP & Green Engineering

2022 Longoni Vocational High School for Building Trades, Mayotte - ATEx B - Support to engineering firm Vessières – Design Team: EH archi + COarchitectes / Client: Rectorate of Mayotte

2022 Development of Professional Guidelines for CEB in Mayotte - Development of Professional Guidelines for CEB in Mayotte

2022 Assessment of technical requirements for the evaluation of CEB(S) masonry in the context of the French Overseas Departments (DROM) - Study commissioned by CSTB and carried out in partnership with CTMNC

Cinéma Guipry Messac - Lineaire A + OTE Ingénierie
 Lycée Tani Malandi Chirongui - Mayotte - FBAA
 Lycée des métiers du bâtiments de Longoni - Mayotte - EH
 Réhabilitation du sanatorium à Dreux - VP & Green Engineering



2021 Standard XP P13-901, Member of the editorial committee - Project coordinator: CTMNC

2021 Emma Block – ZAC Flaubert, Grenoble - Client advisory support during the competition phase – Client: SEM Innovia

2018-2021 CYCLE TERRE, Sevrans - Involvement in setting up processes and the production line, securing three ATEx A certifications, material testing, and training - A European project for the development of raw earth construction material supply chains using excavated soil from the Grand Paris project. 13 partner organisations

2020 Le Foyer (Siorac de Ribérac) - Technical support for the raw earth work package - Design Team: Dauphins Architectes / MEP & Cost Consultancy: OVERDRIVE / Environmental Consultant: 180° / Structural Engineer: IBC / Landscape: Plain Air Client: Community Council (CC) + MFR du Pays Ribéracois

2020 University Institute of Technology (IUT) of Tarbes - Technical support for the raw earth work package - Design Team: Mil'Lieux Architectes + GP Architectes / Structural Engineer: TPFI / MEP: TPFI / Acoustics: TISSEYRE Client: Occitanie Region / Delegated Client: SPL Midi Pyrénées



SELECTED REFERENCES

2019 Electrical Transformer Station, Lyon - Technical support for raw earth work - Design Team: Tectoniques Architectes / Structural Engineer: Tectoniques / Client: Enedis

2019 ATEx A CEB in French Guiana - Coordination and implementation - Project lead and funding: DEAL Guyane

2018 ATEx A CEB in Mayotte - Coordination and implementation - Project lead: ART. Terre Mayotte / Funding: DEAL Mayotte

2018 Electrical Substation, Tolbiac, Paris XII^e - Pre-feasibility study and client advisory (competition phase) - Client: RTE (Réseau de Transport d'Électricité)

2016 School Complex, Nanterre (ZAC des Provinces Françaises) - Support for contractor in drafting an ATEx B for rammed earth structures - Client: City of Nanterre / Sustainable Construction Advisor: LesEnR / Design Team: TOA Architectes Associés, INCET, RFR Éléments, PEUTZ & Associés, DBG Paysagistes

2016 LE CAP Business Incubator, Saint-Clair-de-la-Tour (Isère, France) - Client advisory for raw earth construction - Design Team: P. Reach + Hors les Murs / MEP: AKOE / Quantity Surveyor: Biming / Structural Engineer: Vessière / Client: CC Les Vallons de la Tour

2015 Ré-inventer Paris Gare Massena - Technical support for raw earth work - Design Team: Joly Loiret / MEP: AI ENVIRONNEMENT / Quantity Surveyor: PASTIER / Structural Engineer: AR-C / Client: URBEM - *Project not selected*

2015 Ré-inventer Paris TERRACARE (Paris) - Technical support for raw earth work - Design Team: Katja Pargger & Catinca Popovici / Health Programming: IPSO Santé / Raw Earth Engineering: Vessière / Client: Kalelithos - *Project not selected*

2014 Païamboué Middle School, Koné, New Caledonia - Technical support for raw earth construction - Design Team: K'aDH + Berthier & Frassanito / Structural Engineers: BECIB – BEGN / Client: Province Nord / Delegated Client: SAEML VKP / Contractor (earth): Alternative Construction

2014 Guest House, Hangzhou, China - Assistance Maitrise d'œuvre lot terre - Technical support for raw earth construction and setup of an on-site earth lab - Design Team: Wang Shu, Amateur Studio / Client: Hangzhou University

2014 Observation Tower, Dilsen-Stokkem - Technical assistance for raw earth construction - Design Team: De Gouden Liniaal Architecten / Client: Province House Restructuring Committee – L'espace Directorate

Païamboué Middle School - K'aDH + Berthier & Frassanito
 Le Foyer, Siorac de Ribérac - Dauphins architectes
 CEES, Orléans - D&A+NAMA
 Guest House Hangzhou - Wang Shu / amateur studio



2014 Bamyan Hospital, Bamyan, Afghanistan.
Technical support for the raw earth work package - Design Team: ARCOP, Karachi /
 Client: Aga Khan Foundation

2012 European Soil Sample Conservatory (Orléans) - Technical support for the raw earth work package - Design Team: Design & Architecture + NAMA Architecture / Raw Earth Engineering: Vessière / Client: INRA Orléans / Raw Earth Contractors: Caracol + Héliopsis

A FEW NOTABLE EARLY PROJECTS :

1999 Architectural design support for the Société Immobilière de Mayotte (SIM) -
 Assistance with quality control and regulatory compliance

1986 Construction of two prototype housing units in CEB in Kourou, French Guiana -
 Client: SIMKO

1983 Le Domaine de la terre - 65 earth-built housing units, Villefontaine, Isère -
Technical support for the raw earth work package - Client: OPAC 38

1982 Construction of low-cost housing, pilot operations in Passamainty, Mayotte -
 Support in setting up local brickyards, quarry identification, and construction of prototypes - Client: SIM



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