TRACHYANDESITE: A RESOURCE FOR THE FUTURE OF OLD BUILDINGS

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Abstract: *The aim of this action research project is to (re)define and (re)get to know the material trachyandesite. A magmatic rock that has contributed to the identity of the Massif Central region, through the construction of towns since the 15th century, its exploitation has accelerated with industrial growth. Its presence grew and its uses spread throughout France. If this stone confers a specific and visual identity, it is today one of the components of the built heritage of a French region, at one with the landscape because it is at its heart. Understanding the materiality of this stone and its many characteristics is a key factor in the restoration of old buildings. Could knowledge of the qualities of trachyandesite (refractory stone, high pyroscopic resistance) as a local, low-carbon-emission material enhance the value of constructions and/or restorations that could be described as geosourced?*
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Introduction

If the notions of "architectural heritage" and "contemporary architecture" seem at first sight to be opposed, defining them proves to be a complex exercise. Their semantic contours fluctuate according to each person's outlook, background and training, but also according to cultural identities and the temporality of their definition. The notion of architectural heritage seems intrinsically linked to the notion of identity and culture of a region and/or a country [1-3]. As a result, the article presented here will find its limits in the historical and heritage culture of French training and outlook.

At a time of energy crises and global warming, building on what already exists requires us to confront the polysemy of the term "heritage". It also requires us to question the substrate - the existing - with/on which the architect intervenes within the framework of the project: whether it's a construction *a novo*, a restoration or a rehabilitation.

The Anthropocene era is prompting us to rethink environmental issues and think about energy transitions on an international scale. In this context, we believe it's essential to work with materials already in use, identifying them as a "resource". Preserving what has been identified and described as "architectural heritage" should be in keeping with the global challenges of preserving the planet. Can reuse be a first solution to our questions? Can the choice of an old, local material provide some answers?

Our questioning stems from a general observation, based on discussions with consulting architects: many homeowners wish to thermally insulate their building or house. However, not all buildings are eligible for external insulation: this is particularly true of many French historic centers. French legislation, which protects the historic and artistic values of its old town centers [4], does not allow for the alteration of facades and buildings whose age is an integral part of their heritage [5].

Energy-efficient renovation of old town centers cannot therefore always involve thermal insulation from the outside, and alternative solutions must be found. In addition, the small size of older homes means that they cannot always be insulated from the inside. Entire neighborhoods are in a state of disrepair due to the lack of thermal insulation. Many architects and town planners point to this alarming situation, which makes it hard to reconcile "heritage" and "energy renovation", precisely at a time when the impact of global warming no longer

needs to be demonstrated. What are the solutions for sustainable environmental design can we propose to this kind of heritage?

France's national schools of architecture: training for existing buildings

On October 20th, 2015, the French Minister of Culture, Fleur Pellerin, announced a list of 30 measures to be implemented - organized around six axes - as part of the National Strategy for Architecture[1].

Starting from the observation that "architecture is of general interest and concerns all citizens. In addition to emblematic and representative places, [it] must take charge of ordinary, everyday places"[2]. This architecture must therefore take into account the daily lives of citizens, as well as their concerns for the future, such as the many needs they express in terms of thermal comfort.

In the case of town centers, the challenge of architecture in line with sustainable development is a major concern. Dealing with what already exists, the "déjà-là" cannot be reduced to buildings described as "heritage". All architects now have to deal with the context in which they work, which is often marked by the legacy of more recent buildings (post-war, or more broadly 20th century).

The second theme of the National Strategy for Architecture, entitled "Taking into account the architectural heritage of the 20th and 21st centuries and developing architectural intervention to enhance and transform the existing built environment", proposes, in its seventh point to *Strengthening the initial and ongoing training of architects in intervention on the existing environment*. Since the publication of this report, France's national schools of architecture have been working to develop training courses in working with what's already there.

The territorial roots of architecture schools, and the expertise that their teacher-researchers can bring on this same territory, seem to be an indispensable resource in the training of young architects: how can an architectural project be conceived without understanding the historical depth of a site, without knowing the local materials and how they are (and were) used?

This National Strategy for Architecture is the subject of reflections for improvement within the Architecture Department of the French Ministry of Culture. The aim is to take better account of the challenges of ecological transition, the diversification of architectural professions and the rehabilitation of existing buildings, while restoring contemporary architectural creation to its rightful place.

The points of this National Strategy for Architecture, entitled *Strengthening the scientific and economic anchoring of schools at territorial level* [3]; *Fostering architectural quality, creation and innovation or Experimenting with the "permis de faire"* [4] encourage ENSAs in their role of territorial training and research. With research through experimentation, through action research, or through other schemes, they have clear objectives to achieve here. We would now like to turn our attention to a concrete example.

Local materials: the example of trachyandesite

Trachyandesite is a magmatic rock found in large quantities in the Massif Central (France). Its petrochemical composition must be distinguished from other, more common volcanic rocks (such as basalt, trachyte or andesite).

[1] https://www.culture.gouv.fr/Espace-documentation/Rapports/Strategie-nationale-pour-l-architecture consulted on September 25, 2023.

[2] https://www.amc-archi.com/article/les-30-mesures-de-la-strategie-nationale-pour-l-architecture,6375 consulted on September 2, 2023.

[3] 12th point, included in the 3rd axis: «Articulate training-research-trades and bring together the professional worlds of architecture, construction and the living environment».

[4] Respectively points 29 and 30 of the 6th and last axis of the national strategy for architecture: "Supporting the experimental approach and its cultural value".

There are several Auvergne trachyandesite flows, originating from different magmatic chambers, but the three main ones that are and have been particularly exploited are located in the Puy-de-Dôme[5] (Auvergne department, France): a quarry at Mazayes, where the "Chambois lava" is found [6]; another flow located in the Monts Dore massif; and the wellknown quarries in the town of Volvic [7]. Although other trachyandesite flows are mined, the name "Volvic stone" has become generic [8]. On the one hand, this testifies to the expansion and diffusion of the material from the Volvic quarries [9], but it also reflects the extent of ignorance about the material.

It has to be said that, scientifically speaking, little is known about this material at present: neither university research nor restorers specializing in this type of rock exist in France. Only a few geologists, quarrymen and craftsmen working exclusively with this material seem to know much about it. The challenge here is to bring together craftsmanship and technique, on the one hand, with scientific, academic, historical and museum knowledge, on the other[6].

To develop our knowledge of the material, we are currently working on joint research projects with public institutions such as the Institut National du Patrimoine (INP), the Laboratoire de Recherche des Monuments Historiques (LRMH), the Musée Lecoq (a museum located in Auvergne), university research laboratories and architectural history students.

Following our initial research[7,8], some characteristics of this magmatic rock have enabled us to understand its advantages for both ancient and modern construction. Trachyandesite is a compact, vacuolated rock with a hardness ranging from marble to granite (depending on the sample). Among other things, its bubbly composition makes it resistant to gelifraction, which gives it great constructive qualities in its area of use in the Massif Central: a mid-mountain region. Described as an "inalterable rock" in the 19th century, it is highly weather-resistant, watertight from 12cm upwards, has a low coefficient of expansion[9], a rare pyroscopic resistance[10] (enabling it to be glazed) and good resistance to traction, flexion, compression and crushing, whether cold or hot. Finally, it is resistant to most acids, which is why it is still used in the chemical industry. Trachyandesite can therefore be used for a wide range of applications, whether in industry, construction or restoration.

With its many advantages, not least its ability to adapt to thermal changes, trachyandesite has played a key role in the identity of the Massif Central region, in the construction of towns and cities since the 15th century. Its use accelerated with industrial growth, and its presence expanded throughout France as its uses declined and its qualities became appreciated.

But in the 21st century, what do we retain of this material? Why not make the most of its thermal properties, particularly its insulating qualities, for a refractory stone?

In the age of the Anthropocene and global questions about environmental issues and energy transitions, it is time to take a serious look at this material - trachyandesite - as a resource. Is trachyandesite exhaustible? What about its accessibility and possible conflicts of use?

Although quarries are currently shrinking (due to a lack of men and women wishing to work in the stone industry, and the difficulty, harshness and demanding nature of such a profession), the fact remains that the puys chain is a sleeping chain, not an extinct one. So, is the material renewable on a human scale?

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[5] Puy-de-Dôme departmental archives, fonds Brosson-Baudusson, ratings 2 S 64 to 2 S 83.

[6] J.-B Roger, Mémoire sur l'emploi des produits volcaniques dans les arts, read in académie des sciences, belles - lettres et arts de Clermont-Ferrand, july 1827

[7] Exhibition "Enamelled lava techniques", June-September 2022, Musée Sahut, Volvic; J.-P. Naud, Chabrol de Volvic (1773-1843) – Bicentenaire de l'école d'Architecture, Volvic, 2021; Various information gathered from the Institut des Métiers d'Art de la Pierre et de la Construction (IMAPEC, Volvic) and from Mr. Simon Laroche, student restorer at the Institut National du Patrimoine, Paris.

[8] Museum Sahut, "Bicentenary of the Volvic School of Architecture", curated by G. Gayet-Kerguiduff, Volvic, 2021.

[9] Less than 7 per 1000, at 1000°C.

[10] Heat-resistant, the rock melts and becomes lava between 1.200 and 1.800°C.

The *Magmas et Volcans* university laboratory has no doubt that the next eruption will take place (insofar as a chamber of magma is still active beneath the puys chain), without being able to say where, when or in what form. So, what about trachyandesite? Geosourced material, source and resource for decades to come?

A number of obstacles remain to be overcome: the stone trades are less attractive and there are fewer applicants for training[11]. The result is the loss of traditional, often local, human know-how. Regional, national and even European policies are likely to investigate the possibility of creating funding for this type of local employment, thus preserving the memory of traditional techniques, or promoting a short supply chain for carbon footprint reasons. Of course, quarries are finite and it can take a long time to obtain materials. But aren't there alternative solutions that take into account and combine the technical qualities of stone with current and, above all, future environmental needs? There is still a lot of thinking to be done on this rock, such as the possibility of composing an "insulating concrete from trachyandesite" from its cutting waste.

Food for thought: an insulating concrete from trachyandesite?

Insulating concrete, which is generally made from clay, shale or pumice aggregates, could be augmented or enhanced in its composition by pozzolan, or trachyandesite aggregates. Various types of concrete are dedicated to thermal insulation, and the possibility of composing a new type of concrete using trachyandesite is not a completely new idea. In fact, several attempts to combine looted trachyandesite with clay and a flux were already made in the 19th century[12]. These experiments enabled the creation of stone casts for fireplaces and mantelpieces, for example.

Aggregates (combined with sand and cement) are the main components of today's insulating concrete, and determine its thermal conductivity. However, the vacuolar composition of pozzolan - or of certain samples of trachyandesite - would enable concrete to intervene in the thermal regulation of the building. What's more, the aforementioned qualities of magmatic material (resistance to acids, weathering, thermal amplitudes, good compressive strength, low coefficient of expansion, etc.) would make it possible both to develop a building's thermal qualities and to control its aesthetics through molding. The mechanical performance combined with the recyclable and geosourced qualities of such a material could facilitate its use in heritage areas.

The advantages of insulating concrete made from trachyandesite could be studied in greater depth. As an eco-responsible material that can be reused and recycled, it could offer very interesting constructive and thermal characteristics for the future of both heritage and contemporary architecture. Despite its higher cost compared with traditional concretes, this choice would combine new technologies for architecture (whether intervention on existing structures or construction from scratch), with a deliberate posture of using local, geosourced, recyclable materials, to design the future in a responsible and sustainable way.

Conclusion

In this National Strategy for Architecture, we would like to emphasize the desire for a territorial scientific anchoring, as well as the encouragement for a "right to make". Encouraging experimentation to combine current construction techniques with local materials is likely to yield satisfactory results.

However, over and above ministerial encouragement and guidance, and over and above the lack of knowledge about many materials, we must stress the lack of financial support or experimental programs for this type of research. Let's hope that they will develop in the years to come.

Insulating concrete made from reused or waste trachyandesite aggregates could provide a range of solutions, depending on the proportions used. The rehabilitation of existing buildings, the restoration of

[11] La pierre dans l'architecture: conservation, restauration, création, Revue Monumental, Ed. du patrimoine, CMN, 1 | 2019.

[12] For his final dissertation, Simon Laroche, a student in the Master of Restoration program (specializing in the art of fire and ceramics) at the Institut National du Patrimoine in Paris, chose as his subject a masterpiece conserved at the Musée d'Orsay made from Volvic enamelled lava. According to his initial bibliographical and archival research, the material is probably crushed trachyandesite mixed with clay and flux.

heritage buildings in Auvergne's town centers, or a simple local implementation resulting from a constructive posture, could make it possible to think cohesively and concomitantly about existing (heritage or not), contemporary and future architecture.

Conflict of interest

The author declares that there is no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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