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Introduction to 'natural stones and cultural heritage promotion and preservation'

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Resources Policy

Introduction to 'Natural Stones and Cultural Heritage promotion and preservation' --Manuscript Draft--

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Abstract:	Introduction paper of the 'Natural Stones and Cultural Heritage promotion and preservation' special issue containing selected papers from the II Heritage Stones Workshop, held in Torino in October 2021, organised by Politecnico di Torino, together with the University of Torino and ANIM association, and supported by the IGCP-637 HerStones project. The articles aim to promote natural stone sustainable use, detail the geological and technological properties of known and unknown heritage stones, and deal with the different challenges and perspectives for natural stones concerning their cultural value as composing elements of heritage sites.

- Selected papers from the II Heritage Stones Workshop, held in Torino in October 2021.
- Geological and technological properties of heritage stones.
- Challenges and perspectives on valorising source quarries
- Geotouristic possibilities of heritage stones.

Introduction to 'Natural Stones and Cultural Heritage promotion and preservation'

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Introduction to 'Natural Stones and Cultural Heritage promotion and preservation'

Natural stones (also referred as dimension and ornamental stones) are closely connected with cultural heritage. Stones are the most ancient non-renewable natural resources exploited by humans. From the prehistorical period of the Stone Age, they have been used and transformed to serve as tools, vessels, artwork, and building materials. Which stones were employed and how they were manipulated depended on several factors, linked primarily to geographical and climatological issues, societal values, and acquired technical knowledge. As natural stones are durable, remaining parts or whole works allow us to understand different population poles' way of life, beliefs, and values. From this perspective, natural stones can be intended not just as geological resources but as cultural ones.

Despite natural stones' durability, they are not eternal and deteriorate with time at higher rates out of their natural environment. For that reason, research on stone conservation in heritage sites has grown since the 19th century, though scientific investigations on building stones' properties had already been developed before that (Freire-Lista, 2021).

Although many intertwined factors affect the durability of the natural stone, the intrinsic characteristics of those resources must constitute the baseline for any conservation work where natural stones are present (Winkler, 1997). It is necessary to identify the rock type and provenance, studying its technological properties, deterioration patterns and conservation issues. Moreover, the stone's availability for replacement must also be studied, avoiding the sterilisation of the source quarries when possible. All this together, when given publicity, can help to keep alive the memory of heritage sites or objects, which is the primary goal of the 'Global Heritage Stone Resource' Designation - GHSR (Pereira et al. 2015a).

The GHSR designation, instituted by the Heritage Stones Subcommittee (HSS) of the International Union of Geological Sciences-International Commission on Geoheritage (IUGS/ICG), can be given to natural stones that are significant to human culture and whose geological framework, characteristics, source quarries, and cultural values are scientifically documented (Cooper et al., 2013; Kaur et al., 2021). The HSS also established the designation of 'Global Heritage Stone Province' – GHSP, for geographical areas with several heritage stones (Pereira and Cooper, 2014).

The GHSR initiative has successfully given visibility to such important natural resources so far. From its formal establishment and with IGCP-UNESCO support, twenty-two stones were designated, and researchers from different countries revealed many others in scientific meetings and publications (Pereira, 2020).

As most of the designated GHSRs are European, the HSS commission broadened the geographical participation to include medium and low-income countries. Promoting heritage stones research in emerging countries and capacity building for young scientists is the focus of the IGCP-UNESCO project HerStones - Heritage Stones Recognition: a step forward (<http://www.herstones.eu/>).

Consequently, the heritage stones research community has been studying natural stones' relationship with their cultural values and history, sometimes 'discovering' local

stones and their provenance, other times 'rediscovering' them by learning other values they possess.

Scientific papers about stones from many countries have been published in the *IUGS-Episodes*, *Geoheritage*, *Geosciences*, *Geosciences Canada*, *Sustainability* (see Pereira, 2020). Several books have also been published on this matter: two on the Special Publications of the Geological Society of London (Pereira et al. 2015b; Hannibal et al., 2020), four of a series on Natural Stones and World Heritage of Taylor&Francis (Pereira, 2018; Kaur et al., 2020; Ehling et al., 2021; Siddall, 2021), one in Japan (Kato et al., 2016), one in Brazil (Del Lama, 2021), and a book chapter in Colombia (Becerra and Pulido, 2019).

This special issue contains selected papers from the II Heritage Stones Workshop, held in Torino in October 2021, organised by Politecnico di Torino, together with the University of Torino and ANIM association, and supported by the IGCP-637 HerStones project. The articles aim to promote natural stone sustainable use, detail the geological and technological properties of known and unknown heritage stones, and deal with the different challenges and perspectives for natural stones concerning their cultural value as composing elements of heritage sites.

Without a doubt, divulging knowledge about the natural stones that compose monuments, buildings and infrastructures around us enriches the experience of visiting touristic points, provides tools for the local community to learn and care for their history and culture, and gives a simple walk a whole different perspective. It also helps to understand the link between the natural and built environment, our planet's geological evolution, and how rocks have been formed and transformed over time. Moreover, the deterioration patterns on stones as a function of the several factors affecting their decay state prove unequivocally that our planet Earth is a system where everything is connected.

Geological information adds scientific or educational value to heritage sites, enhancing their economic valorisation more frequently through responsible and sustainable tourism. Stones in monuments are already part of urban geotouristic routes in several countries, some of them with interactive maps available to the public, i.e. the TourInStones app in Turin (Gambino et al., 2019) or the geological walks of Zagreb, Croatia (Fio Firi, & Maričić, 2020) and São Paulo, Brazil (Del Lama et al., 2015). Also, some old quarries, especially the ancient ones, receive many tourists.

Within this issue, Careddu et al. (2021) alert about the current production decay of Sardinian granites, which have been exploited and applied as building materials in Italy and abroad for four thousand years. To acknowledge those natural stones' socio-economic and cultural impacts, the authors suggest creating geotouristic routes through monuments and quarries of Sardinia and propose the island as a Global Heritage Stone Province.

A geomathic archaeological tour in the Roman Amphitheater of Eporedia, in Ivrea, Italy, is the approach for the valorisation of the Apuan stones identified within that heritage site by Storta et al. (2022). The article details the different lithotypes found at the site and the process of constructing that virtual tour by photogrammetry, 3D modelling and geo-referencing.

Also, a combined quarry-monuments geotouristic route in Vila Real, Portugal, is proposed by Freire et al. (2022). The authors' proposal aims to promote geotourism, cultural tourism and the sustainable use of the old quarry of Pena Granite, enhancing the socio-economic development of the local community.

Sustainable use of natural resources is addressed too by Bobrowska et al. (2022) for the Miocene Limestones of Nowe Brusno, Poland, a heritage stone with many functions (grinding stone, carving stone, building stone) since the 15th century in the region, and currently also as agricultural fertiliser. The authors study that stone's geomechanical and thermal properties for its use as aggregate in roads, aiming to reduce quarry wastes and substitute artificial materials with natural ones in road engineering. Due to the area's climatic conditions, with seasonal freezing, the thermal behaviour of Nowe Bruno limestone is fundamental for that possible use and the paper's focus, which also increases the knowledge of this stone as an insulating material for other uses.

Knowing the geological characteristics of natural stones can help conservators to follow the best practices in restoration works, extending the stones' life and avoiding or delaying replacement. In this publication, the serpentinites and opicalcites of eastern Liguria, Italy, including the world-known 'Rosso Levanto', their historical use and conservation issues, are detailed by Fratini et al. (2022). The versatility of the serpentinites of Valdemanco, also in Italy, with many different uses along their almost one thousand years of exploitation and new applications in several countries, is discussed by Cavallo (2022). From Rio de Janeiro, Brazil, Castro et al. (2022) reveal a locally unnoticed, though widely applied, from the 16th to the 20th centuries, Neoproterozoic metamorphic rock, the 'Leptinito gneiss'.

When it is unavoidable the replacement of missing or too decayed parts that menace the monument's integrity, the identification and protection, when possible, of their provenance deposits (original quarries), is of utmost importance. The re-opening of old quarries, on the other hand, may not be possible for economic, environmental, or land-use reasons, which can be addressed by finding compatible lithotypes (Prykryl and Török, 2010). In such matters, Luodes et al. (2022) carried out a study on two Rapakivi granites that have been utilised in St Petersburg since the 1760s but originate from south-eastern Finland, with the aim to assess the needs for restoration of stones utilised in constructions and to establish databases of stones utilised in historical buildings and of the original and alternative quarries. Chemical analysis with a handheld XRF instrument was found to be the most promising approach when combined with multivariate mathematical tools. Navarro et al. (2022) present the current situation of old Spanish quarries linked to ten of Unesco's World Heritage Sites - WHS, such as the Alhambra and the Segovia Aqueduct. The authors show the uneven status of both the knowledge and the reach of this information among the general public and, more importantly, the authorities. They warn about the necessity of emphasising the cultural value of natural stones as building materials, promoting research on old quarries linking them to the monuments they are part of, and reaching the proper instances to obtain the quarries' legal protection for their future use to maintain the WHS.

Stone heritage conservation also faces the challenge of the progressive replacement of traditional handwork by using technology. That is addressed by Merico et al. (2022), who evaluate the new trend to use Itria Valley limestones with sawn finishing instead of the

traditional rough one of the "Trulli" constructions of Apulia, a World Heritage. The authors assess the mechanical performance and durability of those heritage stones' different finishes, making observations based on fossils' quantity and dimensions, and correlating technological properties.

The proper characterisation of heritage stones following the geological standard established by the HSS, no matter if they will be GHSR candidates, elevates national studies to an international level. The addressed stones gain a global status, which is also a way to promote research cooperation and the use and proper maintenance of natural stones by acknowledging the cultural values of local resources. Including the quarries in the visitation, virtual or not, to heritage sites built with natural stones is interesting from different points of view: disseminating the Earth sciences to the general public, promoting the sustainable use of active and abandoned quarries, and broadening and enriching the cultural meaning and touristic offers.

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References

Becerra, J. E., Pulido, O., 2019. Rocas ornamentales. In: Prieto R., G., Guatame, C. L., Cárdenas, S. C. (comps). Recursos minerales de Colombia, vol. 1. Bogotá: Servicio Geológico, 95-125. (In Spanish).

Bobrowska, A., Jagoda, E., Domonik, A., Ryżyński, G., 2022. Thermomechanical properties of detrital limestone from the Nowe Brusno town (Poland). *Resour. Policy*, 77, 102698. <https://doi.org/10.1016/j.resourpol.2022.102698>.

Careddu, N., Cuccuru, S., Grillo, S. M., 2021. Sardinian granitoids: 4000 years of geoheritage and dimension stones. *Resour. Policy*, 74, 102339. <https://doi.org/10.1016/j.resourpol.2021.102339>.

Castro, N. F., Mozer, A. G. S., Pinto, A. C. R., Felix, C. C., Mansur, K. L., Coppedê Silva, R. E., Ribeiro, R. C. C., 2022. Leptinito gneiss: The heritage stone of the old town, Rio de Janeiro, Brazil. *Resour. Policy*, 75, 102493. <https://doi.org/10.1016/j.resourpol.2021.102493>.

Cavallo, A., 2022. "Serpentino della Valmalenco" (Central Alps, Northern Italy): A green dimension stone with outstanding properties. *Resour. Policy*, 75, 102467. <https://doi.org/10.1016/j.resourpol.2021.102467>.

Cooper, B.J., Marker, B.R., Thomas, I., 2013. Towards international designation of a heritage dimension stone. *Key Eng. Mater*, 548, 329–335.

Del Lama, E.A., 2021. Patrimônio em Pedra (ed). Instituto de Geociências, Universidade de São Paulo, São Paulo (In Portuguese).

Del Lama, E. A., Bacci, D.C., Martins, L., Garcia, M.G.M., Dehira, L.K., 2015. Urban Geotourism and the Old Centre of São Paulo City, Brazil. *Geoheritage*, 7, 147-164.

Ehling, A., Häfner, F., Siedel, H., 2021. *Natural Stone and World Heritage: UNESCO Sites in Germany*. CRC Press, Taylor and Francis Group, 166 p.

Fratini, F., Rescic, S., Pittaluga, D., 2022. Serpentine and opicalcite in the architecture of eastern Liguria and as decoration of Tuscan religious buildings. *Resour. Policy*, 75, 102505. <https://doi.org/10.1016/j.resourpol.2021.102505>.

Freire-Lista, D. M., 2021. The forerunners on heritage stones investigation: Historical synthesis and evolution. *Heritage*, 4(3), 1228–1268. <https://doi.org/10.3390/heritage4030068>.

Freire-Lista, D. M., Becerra Becerra, J. E., Simões de Abreu, M., 2022. The historical quarry of pena (Vila Real, north of Portugal): Associated cultural heritage and reuse as a geotourism resource. *Resour. Policy*, 75, 102528. <https://doi.org/10.1016/j.resourpol.2021.102528>.

Fio Firi, K., Maričić, A., 2020. Usage of the Natural Stones in the City of Zagreb (Croatia) and Its Geotouristical Aspect. *Geoheritage*, 12:62. <https://doi.org/10.1007/s12371-020-00488-x>.

Gambino, F., Borghi, A., d'Atri, A. et al., 2019. TOURinSTONES: a Free Mobile Application for Promoting Geological Heritage in the City of Torino (NW Italy). *Geoheritage*, 11, 3–17.

Hannibal, J. T., Kramar, S., Cooper, B. J. (eds), 2020. *Global Heritage Stone: Worldwide Examples of Heritage Stones*. Geological Society, London, Spec. Pub., 486, <https://doi.org/10.1144/SP486>.

Kato, H., Shimazaki, Y., Reedman, A. (eds), 2016. *Stone Heritage of East and Southeast Asia*. Geological Survey of Japan (GSJ)-CCOP, 234 p.

Kaur, B.G., Frascá, M.H.B.O., Pereira, D., 2021. Natural Stones: architectonic heritage and its global relevance. *Episodes*, 44:1-2. <https://doi.org/10.18814/epiiugs/2020/0200s15>.

Kaur, G., Singh, S.N., Ahuja, A., Singh, N.D., 2020. *Natural Stone and World Heritage: Delhi-Agra, India*. CRC Press, Taylor and Francis Group, 186 p.

Luodes, N., Sihvonen, T., Panova, E., Paakkunainen, M., Härmä, P., Reinikainen, S.P., 2022. Study supporting restoration of rapakivi granite in St. Petersburg. *Resour. Policy*, 77, 102713. <https://doi.org/10.1016/j.resourpol.2022.102713>.

Merico, A., Bellopede, R., Fiorucci, A., Marini, P., 2022. Itria Valley (Apulia, Italy): Comparison of limestones for the construction and restoration of "Trulli" roofing. *Resour. Policy*, 76, 102630. <https://doi.org/10.1016/j.resourpol.2022.102630>.

Navarro, R., Martínez-Martínez, J., Suárez, J. F., Álvarez-Arecas, E., Baltuille, J. M., 2022. Comparative analysis of the current uneven situation of historical quarries

associated with the UNESCO world heritage sites in Spain. *Resour. Policy*, 75, 102471. <https://doi.org/10.1016/j.resourpol.2021.102471>.

Pereira, D., 2018. *Natural Stone and World Heritage: Salamanca, Spain*. CRC Press, Taylor and Francis Group, 116 p.

Pereira D., 2020. Final report of IGCP-637: a project linking researchers and heritage stones from around the world. *Episodes*, 44(1):75–80.

Pereira, D., Cooper, B.J., 2014. A global heritage stone province in association with the UNESCO world heritage city of Salamanca, Spain. In: Lollino, G., Manconi, A., Guzzetti, F., Culshaw, M., Bobrowsky, P., Luino, F. (Eds.). *Engineering Geology for Society and Territory - Volume 5*. Springer.

Pereira, D., Kramar, S., Cooper, B. J. (eds), 2015a. *Global Heritage Stone Resource: An Update*. *Episodes*, 38, 78-131.

Pereira D., Marker B.R., Kramar S., Cooper B.J., Schouenborg B.E. (eds), 2015b. *Global heritage stone: towards international recognition of building and ornamental stones*. Geological Society, London, Spec. Pub., 407. <https://doi.org/10.1144/SP407.0>.

Prikri, R., Török, A., 2010. Natural stones for monuments: their availability for restoration and evaluation. Geological Society, London, Spec. Pub., 333, 1 – 9. doi: 10.1144/SP333.1.

Siddall, R., 2021. *Natural Stone and World Heritage: The Castles and Town Walls of King Edward in Gwynedd*. CRC Press, Taylor and Francis Group, 324 p.

Storta, E., Borghi, A., Perotti, L., Palomba, M., Deodato, A., 2022. Minero-petrographic characterisation of stone materials used for the roman amphitheater of Eporedia (Ivrea, To): A scientific-dissemination proposal in the Cultural Heritage. *Resour. Policy*, 77, 102668. <https://doi.org/10.1016/j.resourpol.2022.102668>.

Winkler, E. M., 1997. *Stone in Architecture. Properties, durability* (3rd ed.). Springer-Verlag, Berlin Heidelberg. <https://doi.org/10.1007/978-3-662-10070-7>.