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of the mortar can be important also to identify a general technological marker characteristic of each historical period. This would be a useful tool for future characterization of this particular artificial material often difficult to date.

The "red marbles" of Santa Maria del Fiore Cathedral (Florence-Italy)

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KEYWORDS: Florence Cathedral, red marbles, quarries

Santa Maria del Fiore Cathedral in Florence is characterised by a tri-colour cladding realized with white Carrara marble, Green of Prato serpentinite and "red marbles". The purpose of this communication is to discuss about the different red lithotypes that occur both in the sides (dating back to the XIV century) and in the façade (second half of XIX century) of the construction taking into account particularly archive documents. Agostino Del Riccio, Giorgio Vasari and Cesare Guasti indicates Cintoia and Monsummano as areas of provenance of the liver red lithotype present in the sides. Petrographical studies [Vannucci et al., Kermes, 1997; Fazzuoli et al, Pacini Ed., 79-90] evidenced that this material is a calcareous marl belonging to the Marne Sugame lithofacies of the Scaglia Toscana (not metamorphic Tuscan Succession). Concerning the liver red lithotypes present in the façade, Settesoldi [Settesoldi, Alinea Ed., 1987] reports that De Fabris, the architect who designed the cladding, took personal interest in the supplying materials, utilizing mainly the red marly limestone of Montieri (yet belonging to the Marne Sugame lithofacies) but a similar material came also from the Monte Malbe near Perugia, belonging to the Red Scaglia of the Umbrian Sequence. Beside also a red nodular limestone can be recognized which probably comes from Gerfalco where an outcrop of Ammonitic Red of the Tuscan Sequence is present. This lithotype was widely utilised in the Senese architecture. Another red lithotype originally present in the façade is the so-called "Garfagnana Red", at present known as "Rosso Collemantina", a slightly marly limestone belonging to a lithofacies without nodules of the Ammonitic Red. The brick-red hue makes it easily distinguishable from the "Red" of the Marne Sugame. This material is still quarried and is now utilised in the Cathedral for substitutions.

A multimethod approach to pinpoint the origin of white marbles

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KEYWORDS: keywords: marble provenance, inclusion fluid analysis, trace element chemistry

The topic of this paper is to present an overview of the methods to pinpoint the origin of white marbles and to discuss the progress made in this field during the last years. To pinpoint the place of origin of the marble to an area or even to a special quarry may be of appreciable importance in investigating ancient trading routes and trade relations. A material-specific classification can be conducive to understand if the workshops of

an area used marbles of acceptable quality from a local quarry or quarrying areas or if they used imported marbles in or without combination with local ones. Furthermore during restoration activities the knowledge of the origin of the marbles used in architecture may be of importance for supplying more or less original types of marbles. It may also be of interest for evaluating the authenticity of artefact information on the provenance of the used material. Lepsius was the first who successfully used petrographic investigations to discriminate between marbles from classical Greek quarries from the mainland as well as from the islands. Some decades later instrumental chemical analyses, especially the analysis of trace elements, were used to find new criteria for ascribing a marble to a specific source. With the advent of stable isotope analysis of carbonate rocks, a new method seemed to be at the archaeologists' hand to assign a marble sample precisely to its origin. After the pioneering work of Craig and Craig in 1972 on the classical marbles of the Greek islands, legions of papers have been published on this topic. However, with the rapidly increasing number of historical marble quarrying sites and with the increasing number of analyzed samples in general, the compositional fields in the isotope diagram became larger and many classical marbles showed relatively large ranges of overlap. Additionally to the conventional methods we apply the chemical investigation of inclusion fluids for the discrimination of the marbles. To demonstrate the usability of this method additionally used to conventional methods several case studies will be presented: Different types of marbles were mined in the area of Ephesus, and this region had a special importance for ancient marble tading. Examples from the Achaean to the byzantine period will be presented. Further case studies concern architectural marbles used in the Balkans from Hellenistic to Byzantine times. Architecture from the Episcopal centre of Stobi and a series of sculptures found in Macedonia were investigated. Furthermore investigation of marble artefacts and presently found marble quarries in the Balkans will be presented. The application of the above-explained combination of methods for the determination of the provenance of marbles finally will be demonstrated by examples of sculptures of white marbles like the Pergamene Dedication (Capitoline and Ludovisi Gauls etc.) and elaborate Roman sarcophagi.

Experimental tests on clay-based plasters used for undercoating in green building practices

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KEYWORDS: geomaterials, clay-based plasters, green building

Three pre-mixed powdered clay-based (earthen) plasters produced in Europe and specifically designed for wall undercoating were analysed in this paper. These materials are commercially available and successfully employed in green building practices in several European countries. Their compositional and textural characteristics as well as plastic behaviour were investigated through a multi-analytical approach: X-ray powder diffraction (XRPD), polarized light microscopy (PLM), X-ray fluorescence spectrometry (XRFS), scanning electron microscopy equipped with an energy dispersive spectrometer (SEM-EDS), mercury intrusion porosimetry (MIP), grain-size distribution (GSD) and semi-empirical tests (Atterberg Limits, Linear Shrinkage). A natural earth (a Terra Rossa red soil sampled in north-western Sicily), theoretically appropriate for the production of earthen plaster, was also subjected to the same

analytical routine and compared with the three commercially available pre-mixed products. In addition, humidity control capacity (equilibrium moisture content determination) and acoustical properties (sound absorption coefficient, α) of these "green" building materials were tested according to UNI 11086:2003 and UNI EN ISO 10534-1, respectively. The achieved results allowed individuating the compositional and textural features that primarily influence the performances of the studied earthen plasters. The obtained data are expected to be also useful in directing the selection of raw materials for local manufacture of specifically designed innovative products.

Provenance study of marbles used in the sculptures and architectural elements from the "Villa dei Quintili site" (Rome, Italy)

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KEYWORDS: White marble, Provenance, Stable isotopes

The present work is addressed to the study of the provenance of marbles from a Roman archaeological site, known as Villa dei Quintili, a monumental villa located in the south-eastern area of Rome (Italy). The study was carried out on twenty white marble specimens belonging to statues, covering slabs and architectural elements of the villa. Different analytical techniques, including polarized optical microscopy, carbon and oxygen stable isotope ratios along with X-ray diffractometry, were used to identify the marble sources. Microscopic observations were also conducted in order to study the weathering of superficial layer. All these methods provide a set of diagnostic parameters that allow to identify the marbles provenance. For this purpose, results were compared with existing databases of white marbles commonly used in antiquity, especially in the Mediterranean area. Results show that several precious marbles from the Mediterranean area were used confirming the importance of the archaeological site.

Diagnostic analysis aimed to the conservation of some rupestrian churches in Cappadocia Region (Turkey)

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KEYWORDS: Cappadocia, ignimbrite, rupestrian churches

The Cappadocia Region is an important part of Turkey's heritage; in fact many sites as Göreme National Park were included in the UNESCO World Heritage List in 1985. Rupestrian churches were excavated in neogenic ignimbrites outcropping in the area and changed in earth pyramids called "fairy chimneys" by weathering phenomena as erosion, cracking and exfoliation that now threat the conservation of the churches and the precious wall paintings inside. In fact, the Cappadocian ignimbrites were classified as rock characterized by a poor to very poor durability from a

physical point of view. In rupestrian churches wall paintings are deeply linked to the rock substrate so the study of the stone materials is strictly connected with the plan of conservation of the wall paintings that is going to be developed in Cappadocia in order to carry out the future and most suitable interventions. For this purpose this work deals with the petro-mineralogical and physical characterization of the stone materials coming from some rock-hewn churches located in Göreme Open Air Museum and Şahinefendi village. In particular analysis as optical microscopy, XRPD, porosimetric and water absorption tests were carried out on rock samples; whereas petrographic and SEM-EDS analysis were conducted on mortars taken from the Forty Martyrs Church in Şahinefendi to evaluate their conservation state. The studies were carried out within the research project "Rock paintings in Cappadocia. For a project of knowledge, conservation and valorization of the church of the Forty Martyrs at Şahinefendi and its territory" that is a part of the biggest project called "For a data bank of wall paintings and mosaics of Asia Minor (4th-15th centuries: images, materials, techniques of execution".

Evaluation of lime nanoparticles for the restoration of salt weathered rocks

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KEYWORDS: Nanolime; salt weathering; consolidation; stone restoration; limestone

Salt crystallisation phenomena is considered to be one of the most powerful weathering agents in stone materials, especially in the coastal areas, where sea-spray transports large amount of salts on the stone surface. From a macroscopic viewpoint, such a kind of degradation process produces extremely aggressive damages such as erosion, loss of material, flaking and exfoliation and, in some cases, even the complete disaggregation of the material. The consolidation of such degraded stone material represents a critical issue in the field of restoration of Cultural Heritage. In this work, it has been assessed the nanolime consolidation behaviour in limestone degraded by salt crystallization. The use of nanolime for stone consolidation was one of earlier application of nano-technologies to Cultural Heritage. $\text{Ca}(\text{OH})_2$ particles with submicrometric dimensions allow to obviate to the traditional lime treatments limitations, although a deeper understanding of the interactions between product and substrate should be achieved. For this purpose a stone material taken from a Sicilian historical quarry and widely used in the eastern Sicilian Baroque architecture, has been artificially degraded by salt crystallization test. Then, degraded samples have been treated with NanoRestore®, a suspension of nanolime in isopropyl alcohol. To evaluate the consolidating effectiveness, peeling test or the so called "Scotch tape test" (STT) and point load test were performed. Moreover, mercury intrusion porosimetry has been performed to evaluate the variations induced by treatment, while colorimetric measurements have been aimed to assess aesthetical issues. Results have shown that treatments lead to a moderate superficial cohesion. Furthermore, nanolime does not induce large colour variations, hence it can be considered aesthetically acceptable.