Gems in Hellenistic and Roman Jewellery of Northern Greece: An investigation from the Collections of the Archaeological Museum of Thessaloniki, Greece

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Keywords Hellenistic-Roman jewellery, Sapphire, Emeralds, Garnets, Chrome Chalcedony

This study presents the results of an interdisciplinary archaeogemological investigation focusing on gems embedded in Hellenistic and Roman jewellery from the collections of the Archaeological Museum of Thessaloniki (AMTh). Through a combination of non-destructive gemmological, spectroscopic and chemical analyses, a wide variety of gems – including a sapphire ring, emeralds, garnets and chalcedonies – were characterised and an attempt was made to determine their geographic – geological origin. This work is part of MN's PhD thesis conducted within the School of Geology at the Aristotle University of Thessaloniki, Greece. For security reasons, all experiments and analyses were carried out in the Archaeometry Laboratory of AMTh, using its equipment along with some portable instruments provided by the Laboratoire Français de Gemmologie (LFG).

Raman as well as photoluminescence (PL) spectroscopies were applied on all samples using a portable Raman spectrometer with a 532 nm laser excitation (GemmoRaman-532SG by MagiLABS). Vis-NIR spectra from 365 to 1000 nm were also acquired using a portable spectrometer (Gemmosphere by MagiLABS). Chemical analysis was contacted by EDXRF (micro-XRF, 1 mm, by Bruker, model: ARTAX 400) and for the observation of inclusions a Zeiss Stemmi, 500 was used.

In the collections of AMTh a rare Roman-period (3rd century CE) gold ring set (MΘ 16274) with a large (~12.4 ct) sapphire found in an unplundered marble sarcophagus in Thessaloniki was identified (Fig. 1a). Analytical results confirmed the natural origin of the sapphire without any indications of heat treatment, pointed to a metamorphic origin (Nikopoulou *et al*., 2023b), closely matching to Sri Lankan blue sapphires. The discovery of this elite jewel provides new insights into the rare use of sapphires in Roman-period luxury items and supports the existence of complex maritime and overland trade routes between South Asia and the Eastern Mediterranean during antiquity.

A group of 17 green-coloured gemstones which decorate 12 Roman-period jewellery (Fig. 1b) were identified as emeralds (ca. ~1.0 to 6.7 ct) and all of them presented similar spectroscopic and chemical characteristics. Under the microscope all emeralds presented growth tubes and/or prism-shaped multiphase inclusions without indications of treatments (Nikopoulou *et al*., 2024). Inclusion types along with the spectroscopic features and trace element concentrations strongly suggest an origin from the ancient emerald mines of Egypt (Nikopoulou *et al*., 2023a), highlighting their major role in the mining and trading of emeralds during the Roman era.

Figure 1. Representative macroscopic pictures of some of the studied gems from the Archaeological Museum of Thessaloniki. (a) ΜΘ 16274: Blue sapphire mounted in a gold ring (ca. 12.4 ct / 3rd century CE), (b) ΜΘ 15321: Emerald mounted in a gold bracelet (ca. 6.7 ct / 3rd – 4th century CE), (c) ΠΘ 76: Earrings with garnets (A: ca. 5.4 ct, B: ca. 3.7 ct / 3rd century BCE), (d) ΜΘ 11207: Pendant with chrome chalcedony (ca. 11.0 ct. / 1st century CE) © Archaeological Museum of Thessaloniki – Hellenic Ministry of Culture and Sports.

A large variety of 25 red garnet gems (ca. 0.6 to 16.7 ct) in 19 Hellenistic-Roman jewellery were also identified by Raman spectroscopy and micro-EDXRF analysis. These garnets (Fig. 1c) revealed three major compositional groups according to Thoresen & Schmetzer, 2013 and Gilg *et al*., 2024: (1) 17 garnets fall in the Cr-poor pyrope group (Cluster D), (2) 4 garnets fall in the Intermediate pyrope–almandine group (Cluster H), and (3) the rest 4 garnets belong in the Ca-rich almandine group (Cluster F) (Nikopoulou *et al*., 2025). These varieties are indicative of different geological sources, reflecting the diversity of garnet trade networks. The Cr-poor pyrope garnets (Cluster D) are associated with ultramafic and high-grade metamorphic rocks (e.g., Suimo in Portugal, Jos Plateau in Nigeria, Mount Carmel in Israel). The Intermediate pyrope–almandine garnets correspond to metamorphic rocks of granulite-amphibolite metamorphic phases which point to Sri Lankan sources, supporting the notion of gem importation from South Asia to the Mediterranean. Ca-rich almandine garnets, although their exact origin remains uncertain, suggest a source from metamorphic rocks with higher Ca content, such as amphibolites or biotite schists.

In the context of this study more than 40 gems composed of SiO_2 were identified, including varieties such as macrocrystalline quartz (e.g. rock crystal and amethyst), as well as microcrystalline forms like chalcedonies agates and jaspers. Among them there is a Roman gold pendant (ΜΘ 11207) decorated with a chrome chalcedony (ca. 11.0 ct, Fig. 1d) which further underlines the diversity of imported green materials during the Roman period, and it is possibly originating from deposits of Asia Minor (Hyrsl, 1999; Nikopoulou *et al*., 2024).

This study demonstrates the importance of interdisciplinary approaches combining archaeology, mineralogy, and gemmology, providing a clearer picture of the trading networks, socioeconomic dynamics and technological achieve-

ments of ancient civilizations. Similar studies have also been conducted focusing on the identification of gems from Hellenistic and Roman periods in collections from other museums, showing comparable results (Barone *et al*., 2016; Butini *et al*., 2018; Krzemnicki *et al*., 2019). The widespread presence of elite gems such as sapphires and emeralds, demonstrates both the technological adaptability of ancient artisans and the symbolic significance of gems in expressing wealth, status, and connections to global trade networks. Overall, the integration of advanced non-destructive analytical techniques has provided critical insights into the origin, selection, and distribution of gems in antiquity, underlining the pivotal role of ancient Macedonia in the broader context of economic, cultural, and technological exchanges across the Mediterranean and beyond in antiquity.

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