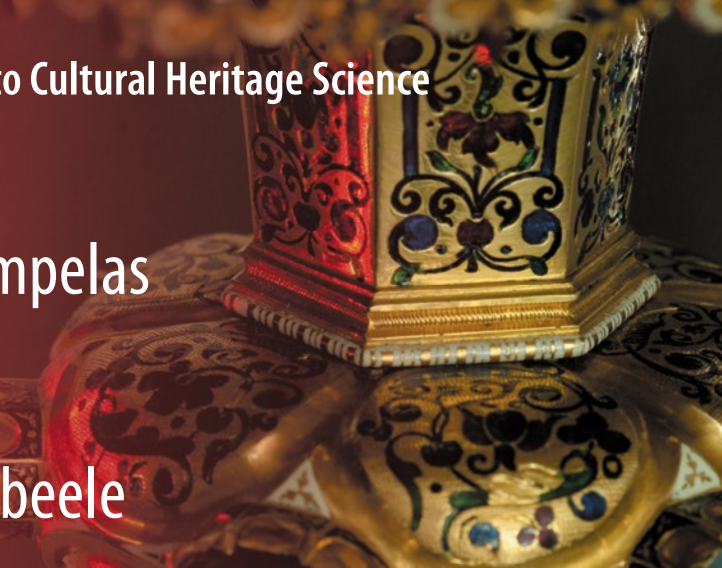
Short Introductions to Cultural Heritage Science



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Gems and Gemmology

An Introduction for Archaeologists, Art-Historians and Conservators

Springer

Short Introductions to Cultural Heritage Science

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Gems and Gemmology

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Stefanos Karampelas is Chief Gemmologist at the Laboratoire Français de Gemmologie (LFG), Paris, and he is also lecturing for the Advanced Gemmology Diploma at the University of Nantes, France. He started studying Geology and Mineralogy at Aristotle University of Thessaloniki (Greece), he has MSc in Geosciences and Advanced Gemmology Diploma, both from the University of Nantes (France), and he completed his PhD in Materials Physics at the University of Nantes (France) and Mineralogy at the Aristotle University of Thessaloniki (Greece) on the non-destructive study of the origin of pearls' color. He worked as a Research Scientist for about 7 years at Gubelin Gem Lab and a further year at GemResearch Swisslab, both in Switzerland, as well as for about 3 years as Research Director for the Bahrain Institute for Pearls and Gemstones (DANAT). His research interests include advanced non-destructive techniques applied to all kind of gem materials. He has published numerous peer-reviewed articles in scientific journals, contributed to books, and visited several gem mines as well as natural and cultured pearl producing areas around the globe. He is also frequently delivering lectures to international scientific conferences and gemmological meetings. He is a Member of the Commission of Gem Materials of International Mineralogical Association and of the Editorial Board of *Gems & Gemology*, Delegate for the International Gemmological Conference, and Associate Editor of *The Journal of Gemmology*.

Lore Kiefert is Chief Gemmologist at Gübelin Gem Lab, where she is, among other tasks, responsible for the training of gemmologists. She started studying mineralogy in Heidelberg, Germany, in 1981 and completed her master's thesis on the origin of sapphires in 1987. She then moved to Australia to study the mineralogical and chemical composition of desert dust, which earned her a PhD in 1996. Leaving Australia for Switzerland in 1994, she joined the SSEF Swiss Gemmological Institute as Deputy Director and went on to become its Director of the Coloured Stones Department as well. During her time at the SSEF, she completed her FGA Diploma in 1998. In 2005, she moved to New York to head the AGTA Gemmological Testing Center as Laboratory Director until she decided to return to Europe to join the Gubelin Gem Lab as Chief Gemmologist in October 2009.

She has authored and coauthored over 100 publications in gemmological and scientific journals, as well as chapters in textbooks such as the Handbook of Raman Spectroscopy. She regularly delivers gemmological lectures at conferences worldwide and has co-organised two gemmological conferences in Switzerland and the USA. She is also on the editorial review board of *Gems & Gemology* and *The Journal of Gemmology*, as well as Member of the LMHC. She was awarded Professorship at Tongji University in Shanghai, China, in 2017, where she regularly conducts workshops and lectures.

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The original version of this book was revised: The biography of Stefanos Karampelas has been updated, as well as his affiliation. Further, the Acknowledgements section now includes the names of those who took the photos for the replacement figures. The correction to this book is available at https://doi.org/10.1007/978-3-030-35449-7_6

Chapter 1
Introduction

In Archaeology and Art History, researchers are often confronted with gems of all types and ages. As gems are not man-made and most of them have formed thousands to millions of years ago, they have distinctly different properties, but also distinctly different problems, than monuments or artwork formed by humans. An archaeologist's concern about the latter besides verification of its authenticity is its preservation. In gemmology, preservation is not a major issue except for some organic gems such as pearls or amber. However, certain properties of gems, such as their geographic origin, cutting style and methods of treatment, can give valuable information about the authenticity and provenance of the jewellery piece.

People involved in the analysis of gems, starting from gem amateurs to professional gemmologists, including archaeologists, art historians, conservators, mineralogists, and gem dealers have a very complex task. They should not only understand the basics of many disciplines (mineralogy, crystallography, geology, chemistry, physics, and sometimes biology) but also take into consideration the economic aspects. The analysis of gems starts from the identification of their chemical composition, determining whether they are natural or "artificial" (*i.e.*, imitation or synthetic), checking for enhancement treatments, grading and sometimes determining their geographic origin. In addition, all the information should be obtained by applying non-destructive and non-invasive methods. Analysis of such gems becomes more complex when they are mounted or embedded in jewels or artworks. If the gems and jewels to be tested are preserved in collections and museums, it is often impossible to remove from their setting due to their high value and to avoid any damage, therefore such gems will require the use of *in situ* techniques for their identification.

Gemmology is the science dealing with gems. Therefore, it is extremely important for the gemmologist handling the gems to be professionally trained on the various methods of identification taking into account all the above-mentioned situations and tasks. In order to study gemmology, several gemmological laboratories offer

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private courses of various durations and qualities. Academic degrees in gemmology are scarce; and only few geological/mineralogical university departments around the globe offer gemmological courses in their degree program. Gemmology is, in general, considered a geoscience and a branch of mineralogy and its roots can be traced back to Theophrastus (315 BCE) who described how minerals and gems grow and to Pliny (79 CE) who mentioned identification issues of gems. At the beginning of the nineteenth century, R-J Haüy and his contemporaries started to develop gemmology as a modern science. When the first synthetic gems entered the market at the turn of the nineteenth to twentieth century, gemmology further developed as a separate science. During the same period, special gemmological microscopes were developed. Other instruments such as the polariscope, dichroscope and refractometer, which are still the standard instrumentations for gemmology, were already developed in the course of the nineteenth century (Ferguson and Brewster 1823; Abbe 1874). At the beginning of the twentieth century, the first gemmological laboratories appeared in the United Kingdom, France, the United States of America and Germany, soon followed by a private laboratory in Switzerland. Most of these laboratories also offered educational programmes. Parallel to the appearance of these laboratories, more gemstone mines were discovered worldwide, more synthetics were produced, and various types of treatments were applied on gems. By the 1970's, it was essential for important pieces of jewellery with gems to be accompanied with a report stating the nature of the gem as well as its treatment status. Prior to this development, gem reports stating the quality of diamonds were already issued in the 1950's. Nowadays, a multitude of gemmological laboratories exist, and nearly every gem needs to be tested. The major gemmological laboratories are now equipped with more and more advanced instruments to assist in identification and to meet the challenges of the modern gem market, where treatments are ubiquitous, and origin of a gem became more important than in the past.

In parallel, analytical techniques for archaeological and art-historical investigations have greatly improved over the past two decades, and often the same instruments can be used for several applications including gems. In addition, chapters in interdisciplinary handbooks describing some of these techniques, have become more popular. These handbooks, as well as international archaeological and art-historical conferences, contain chapters and sessions about gems (Kiefert et al. 2001, 2005, 2012, 2019; Karampelas and Kiefert 2012; Fritsch et al. 2012). However, none of these are solely dedicated to the challenges that archaeologists and art historians face when confronted with gems and their analysis. The current book is an attempt to consolidate knowledge about the history of gems, including synthetic gems and imitations, as well as of their treatments, together with analytical techniques in a form that makes it possible for archaeologists and art historians to draw on this gemmological knowledge.

People starting to work on the analysis of gems should be aware of the multitude of questions posed by the characterization of a gem. This book projects details of those aspects and instrumentation that can be used, at different levels, to obtain the desired answers. It starts with a chapter on the history of gems, reaching as far back as Palaeolithic and Neolithic and describing the appearance of all major gemstones, organic gems and other gem materials over time. It also covers their changing nomenclature as well as the cutting styles over the centuries. Knowledge about these factors assists in establishing a time frame to when the gem was probably used. This is followed by an extensive chapter describing not only the classical gemmological methods but also the advanced instrumentation. Details about microscopy, and the use of dichroscope, polariscope, hand spectroscope and refractometer are described in great detail. The principles of UV-Vis-NIR spectrometers, Raman spectrometers, FTIR spectrometers and XRF instruments as well as X-ray imaging, LIBS and Laser Ablation ICP-MS and other instruments such as the Diamond View are explained, followed by instruments that are usually only available at Universities such as PIXE or SIMS. Chapter 4 describes gem treatments and their developments over time, starting with the oldest methods like dyeing and foiling, and evolving in the more recent treatments which include heat treatment, glass filling and chemical element diffusion. This is followed by an insight in the development of imitations as well as synthetics. The chapter attempts also to list them chronologically, to enable archaeologists and art historians to date their observations. For example, a heat-treated sapphire is unlikely to be found in a piece of jewellery from Roman times.

The last chapter of the book shows some examples of gem testing and case studies of gems in the fifteenth century from the Basel treasure, ecclesiastical objects from the sixteenth century from the Monastery of Einsiedeln, two historic blue diamonds and a sapphire from the French Crown Jewels of Louis XV. These objects are mainly in museums and special care must be taken when analysing them, sometimes using hand-held instruments that can be applied in-situ. The chapter goes further to give examples of isotopic analyses on a series of ancient emeralds and natural pearls. Oxygen isotopic data provides useful information on origin determination of emeralds and carbon isotopes are used for age determination of natural pearls, and conclusions on the provenance can be drawn.

References

Abbe E (1874) Neue Apparate zur Bestimmung des Brechungs- und Zerstreuungsvermögens fester und flüssiger Körper. Jenaische Z Naturwiss, 8 NF I:96–174

Ferguson J, Brewster D (1823) Lectures on select subjects in mechanics, hydrostatics, hydraulics, pneumatics, optics, geography, astronomy and dialling, vol II, 3rd edn. Stirling & Slade, and Bell & Bradfute, Edinburgh

Fritsch E, Rondeau B, Hainschwang T, Karampelas S (2012) Raman spectroscopy applied to gemmology. In: Dubessy J, Caumon M-C, Rull F (eds) Applications of Raman spectroscopy to earth sciences and cultural heritage, vol 12. European Mineralogical Union and Mineralogical Society of Great Britain & Ireland, EMU Notes in Mineralogy, pp 453–488

Karampelas S, Kiefert L (2012) Gemstones and minerals. In: Edwards HGM, Vandenabeele P (eds) Analytical archaeometry: selected topics. Royal Society of Chemistry Publishing, Cambridge, pp 291–317

Kiefert L, Hänni HA, Ostertag T (2001) Raman spectroscopic applications to gemmology. In: Lewis IR, Edwards HGM (eds) Handbook of Raman spectroscopy. Marcel Dekker, Inc, New York, pp 469–489