Introduction to *The book on how to make all the colour paints for illuminating books*

This book invites readers to step inside the workshop of a fifteenth century illuminator in Portugal. This illuminator, possibly an alchemist as well, was the carrier of a tradition on how to make colours 'which you can illuminate or paint or capitalize or write' that dates back, at least, to the thirteenth century. This unique knowledge and know-how was carefully preserved in Portuguese language in Hebrew characters, in a collection of texts, now known as Ms. Parma 1959. Its ultimate purpose was to possibly assist on the production of Hebrew Bibles, where the precision of the text would have been illuminated by the colours described in this 'book of all colour paints'.

This summary feeds from the research carried out, by a multidisciplinary team, in the project 'The Materials of the Image', and may be assessed in the homonymous book, edited by Luís Afonso as well as in the master thesis by Débora Marques supervised by L. Afonso and also in other publications from these authors (appendix 'Bibliography').

This new critical edition brings to the 21st century laboratory, the science and the technology used to produce the colour paints for medieval illuminations. The experimentation that has allowed us to recapture those 'lost colours' is carried out by students from the master's degree program in Conservation and Restoration as well as by researchers with a formal background in chemistry and conservation science. Our first contact with this book dates back to around 2000, through the edition of Moreira de Sá, but experimentation in the lab started in 2001 with the first of a series of unsuccessful experiments around vermilion production, HgS, as it is described in chapter 15. Which did not discouraged us, since each single failure allowed to understand what had gone wrong, leading us closer to the experience in which, for the first time, we saw the 'ash' transformed into 'fire'. Despite the making of vermilion has been investigated under Catarina Miguel's doctoral thesis, some aspects remain to be clarified, and the efficiency of the process continues to be as mysterious as when we began its experimentation; is it missing a catalyst, obvious at the time, that we may have not yet discovered? We do not know, but in vermilion as in other colours, even in those that seem easy to reproduce, the research we share today is a work in progress. A work that we wish to share so that it may be criticised and improved by others more knowledgeable, or with different know-how. Here we will focus on the pigments (organic and inorganic based) that are described in the table at the end of this introduction.

If the motivation to discover this precious book was the course in History of Art Technology and Materials (HTPA) from the Master's in Conservation and Restoration, the opportunity to systematise its study was achieved in the project 'A cor da iluminura medieval portuguesa no contexto Europeu: partilha e singularidade", and followed in "Colour in medieval illuminated manuscripts: between beauty and meaning". This investigation was also deepened with two master theses, by Tatiana Vitorino and Rita Araújo on brazilwood lake pigments (the pink colours), as well as with the doctoral thesis of Rita Castro, dedicated to the study of lac dye (the carmine colour). The main authors are anonymous, as was usual in medieval technical texts, and these are the students enrolled in the HTPA course. This does not mean that they are less important, and we foresee that, on the digital platform where the 'book of all colour paints' will be installed, it will be possible for them to more often sign works; as it is the case of the mosaic gold described in chapter 1, which was successfully achieved by Inês Coutinho in her first experiment that dates back to 2006.

Having presented the experimentalists, we may ask what have we learned from the 'book of all colour paints'? Enormously, I would like to write, as it has been a unique resource in our fundamental research. as it has been a unique resource in our fundamental research. Particularly on the reconstruction of the materials and techniques used in the past to create artistic and cultural objects. The paints obtained from this treatise have been systematically compared, at the molecular level, with the ones used in medieval manuscripts in Portuguese collections. In particular, the manuscripts produced in Portuguese monasteries in the 12th and 13th centuries and the French and Flemish Books of Hours from the 14th-15th centuries. This comparison has allowed us to validate the colours and paints obtained, and therefore, to propose them as reference materials to be used in

future research; for example, in the study of the degradation mechanisms taking place in these beautiful medieval paints, for their stabilisation and discovery of new treatments.

In these 15 years of experimentation we conclude that the descriptions of the making of colours and paints are brief and precise, and in many cases, they include additional information on the most critical steps, which can be crucial to the practitioner. Thus, in the making of vermilion, there are two valuable instructions in the time-consuming and essential step of grinding mercury with sulphur: i) we know that the grinding is finished (and that we have obtained the black form of α'-HgS) the moment we see 'the fire turns to ashes'; and, ii) it is advised to 'always stirring it with a dog's foot that has its hair and wool', which allows to capture the much fugacious mercury. Those who have not worked with the 'fugitive' – one of the many names for mercury – cannot imagine the advantage of this information. So, whenever we fail or feel that we are not quite there yet, we believe that it is because we have not yet correctly interpreted the science and technology of the process. Although it is possible to appreciate the clarity and precision of the instructions, many centuries separate us from the medieval practitioner; there were, and there will be obvious things that were invisibly integrated in their daily lives, which will elude us. We took many years to understand what was a 'piah' of gypsum or chalk, described in the preparation of the brazilwood lake pigments, however when we understood and reproduced it, it became obvious what was its benefit and purpose. It is also now clear for us that the word 'asado' in the preparation of lac dye means a vessel or pot with handles; however, we have come to experiment the 'fried meat' and its juices, by following Devon Strolovitch's transliteration.

Clear, concise and precise, a book for art practitioners, as valuable now as it was then. A beautiful book for a practitioner. A little key to the world of medieval technique as in the language of chemistry we communicate with our medieval ancestors (almost) without barriers, producing beautiful and lasting colours. A precious book to share, hoping you can enjoy it as much as we do.

Maria João Melo

Table of the paint colours reproduced; names adapted from the 10 colours listed in the book, orpiment and vermilion, red lead, green, blue, lac dye (carmine), brasil (rose colour), catasol, saffron and lead white

In the index, we present the colours according to the chapters of the 'book of all colour paints'. Here we choose to group them according to their chemical composition.

colour paint	final product	ingredients*	chapter§
	vermilion HgS	Mercury, sulphur	15
	red lead Pb_3O_4	Lead white	10
	gold (mosaic gold) SnS_2	tin, sulphur Amonium chloride, mercury	1
	verdigris $Cu(CH_3COO)_2.H_2O$	Copper foil, vinager Honey, animal manure	11
	fine blue $Cu(CH_3COO)_2.H_2O$		5
	fine carmine	Lac dye Urine, quicklime and ashes	13
	rose	Brazilwood, alum Urine, lead white, bowl (trough) in gypsum or calcium carbonate	8
	good rose colour	Brazilwood, alum Urine, calcium carbonate	44
	good rose colour	Brazilwood, alum Water ashes, calcium carbonate	27
	Another rose colour	Brazilwood, alum Water, calcium oxide	9
	catasol		24
	green lily		45

the main ingredients are in the first line.
§ in black, available recipes; in blue, completed experiments, writing stage; in pink, on-going experiments.