1. Introduction

1.1 Red Lustrous Wheelmade Ware

Red Lustrous Wheelmade Ware (RLWm ware) is one of the distinctive wares in the eastern Mediterranean Late Bronze Age (LBA) ceramic assemblage. Transport or storage vessels in this fabric were produced from the 16th century to the 12th century BC and are found in LBA contexts across a large area of the eastern Mediterranean, from Hittite sites in central Turkey, through Syria, Jordan, Israel, Egypt as far south as Semna (just below the second cataract of the Nile), and Cyprus (Merrillees, 1968; Eriksson, 1991; Eriksson, 1993, 30, 60, 100, 108, 130; Todd, 2001; Kozal, 2003; Knappett *et al*., 2005; Kozal, 2007; Mielke, 2007). A few samples have also been found in the Aegean and western Turkey (Eriksson, 1993, 136; Kozal 2003; Kozal 2007). At most sites it is not very abundant and many examples come from tomb or temple contexts (Eriksson, 1993, 5, 143). As a result archaeologists have concluded that this ware was an expensive, luxury item and, because of the plain nature of the pottery itself, that it was the contents which represented the valuable commodity (Eriksson, 1993, 5, 143; Knappett *et al*., 2005). Wherever it has been excavated it has been classed as exotic or imported (Eriksson, 1993, 5; Nordstrom & Bourriau, 1993, 184; Knappett *et al*., 2005). In addition the fabric is extremely consistent in both chemistry and mineralogy, leading to the conclusion that it must have been manufactured at least in the same area, possibly in the same place or even the same workshop (Eriksson, 1993, 149; Knappett, 2000; Knappett, 2002; Knappett *et al*., 2005).

The location of this one source of RLWm ware has remained a mystery since the first classification of the ware in the late 19th century (Eriksson, 1993, 5; Knappett, 2000; Knappett, 2002; Knappett *et al*., 2005), as has the exact nature of the commodities stored or transported in the vessels (Eriksson, 1993, 143-144). Locating the origins of RLWm ware would provide information about trade and political relationships across the LBA eastern Mediterranean and how these changed and developed during the period (Eriksson, 1993, 139-143; Kozal, 2003; Kozal 2007). Previous studies have suggested Cyprus as a source for the ware (Eriksson, 1993) although no kiln sites have ever been found (Knappett *et al*., 2005).

Previous analyses of the organic residues found in RLWm ware sherds identified three main materials: beeswax, bitumen and a fat or oil (Steele, 2004; Knappett *et al*., 2005; Steele *et al*., 2007). Beeswax may have been used as a sealant to make the unglazed pottery less porous (Steele, 2004; Knappett *et al*., 2005; Steele *et al*., 2007) and bitumen may possibly have been used in the same way, while the fat or oil may represent the contents of the vessels (Steele, 2004; Knappett *et al*., 2005; Steele *et al*., 2007). The possibility that the beeswax and bitumen were part of mixtures also containing an oil or fat could not be ruled out (Steele *et al*., 2007). However, questions still remain with respect to the contents of the vessels. Did they vary through time, with the shape of the vessel, with the context or place of use? Can variations in the contents give any indication of where the vessels might have originated? For example, if they originated on Cyprus, are all possible contents observed in samples from Cypriot contexts?

1.2 The aims of the study

The aims of this study were twofold. Firstly, to identify more accurately what commodities were being stored, used or traded in RLWm ware vessels. The second aim was to determine whether these commodities vary with the form or fabric of the vessels, with the context or place of use or with time. These two aims were inextricably linked as the second could not be attempted without achieving the first.

1.3 The objectives of the study

1.3.i Identification of contents of RLWm ware vessels

In order to identify the contents of RLWm ware vessels as accurately and precisely as possible, the first objective was to extract and analyse absorbed organic residues from as many sherds as possible. The identification and characterisation of a large number of residues would then enable some general conclusions about the nature of the contents of RLWm ware vessels to be reached.

Many RLWm ware vessels now in museums still contain at least traces of the original contents as visible residues. Another objective was therefore to locate and sample some of these visible residues. Visible residues have the advantage of being the actual contents of a vessel, and problems of contamination are greatly reduced, particularly if the vessel is complete or

nearly complete with the residue inside. They also generally provide a much larger sample of the contents than absorbed residues.

Initial analysis of both types of residue was carried out by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS). However, as these techniques do not normally distinguish between fats or oils from different sources, selected samples were sent for compound specific stable carbon isotope analysis by gas chromatography-combustion-isotope ratio mass spectrometry (GC-C-IRMS).

A further objective was to use other methods such as Fourier Transform Infra Red spectroscopy (FT-IR) and high performance liquid chromatography with tandem mass spectrometry (HPLC-MS-MS) to investigate some residues. The purpose of this was to ascertain whether more information about the residues could be retrieved using these methods (FT-IR in particular) and whether residues such as wine could be identified (HPLC-MS-MS).

In addition to the analysis of archaeological samples, a further objective was to analyse samples of modern plant oils by GC-C-IRMS to provide a database of modern samples with which to compare the archaeological material. Data on the isotopic signatures of ruminant and non-ruminant animal adipose fats (Dudd *et al.* 1999), and on dairy fats (Dudd *et al.* 1999) is routinely available and some data on fish oils has also been published (Craig *et al.* 2007). However, although there is an abundance of data on the stable isotopic signatures of compounds in modern plant oils, very little can be compared directly with

archaeological material (Spangenberg & Ogrinc, 2001). A database of the isotopic signatures of modern plant oils is essential to the identification of archaeological plant oils by this method and the creation of such a database allowed the more precise identification of the contents of RLWm ware.

1.3.ii Variation in the contents of vessels

Having established what commodities were traded, stored or used in RLWm ware vessels, the second main aim was to look for variations in these commodities. The objective was to analyse samples of RLWm ware from as many different sites as possible, representing as many areas of the eastern Mediterranean as possible. Samples from different areas gave information on any variation of commodities with geographical location. Samples from sites separated in time provided an insight into any variation through time, although this was always going to be a difficult objective to fulfil as many examples come from disturbed or poorly stratified contexts. In addition, as many as possible of these samples needed to be identified with a specific form of vessel and come from a well-identified context. This allowed an assessment of any variation in the contents of the vessels with all of these variables.

1.3.iii The structure of the thesis

In order to set out this work in context, the following two chapters of this thesis outline the previous work carried out on RLWm ware (Chapter 2) and the historical background in which it was traded and used (Chapter 3). Chapter 4 details the archaeological material which was analysed during this study and

Chapter 5 the methods which were used to examine that material. Chapter 6 describes the experiments which were conducted on modern materials, which fall into two parts. The first of these was the stable isotope analysis of modern oils and waxes, the results of which were used as a modern comparison for the archaeological material. The second was to reproduce some modern perfumed oils in an attempt to determine how difficult it might be to detect these in an archaeological context. The results are discussed in Chapter 7 and the final conclusions and suggestions for further work are outlined in Chapter 8.