An Archaeo-metallurgical Investigation of
Sri Lankan Historical Bronzes

Arjuna Thantilage
Postgraduate Institute of Archaeology
University of Kelaniya

This thesis is submitted as a requirement for the Doctoral Degree
of the Postgraduate Institute of Archaeology, University of Kelaniya
2008
# TABLE OF CONTENTS

**ACKNOWLEDGEMENTS**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Figures</td>
<td>vi</td>
</tr>
<tr>
<td>List of Tables</td>
<td>viii</td>
</tr>
</tbody>
</table>

**AIMS AND OBJECTIVES**

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**OVERVIEW**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Introduction</td>
<td>2</td>
</tr>
<tr>
<td>1.2 Metal Sculpture and Archaeometallurgy</td>
<td>2</td>
</tr>
<tr>
<td>1.3 Inscriptions, Chronicles and Metal Working</td>
<td>4</td>
</tr>
<tr>
<td>1.4 Silpa Texts and Metal Images</td>
<td>6</td>
</tr>
</tbody>
</table>

**Chapter 2**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Introduction</td>
<td>10</td>
</tr>
<tr>
<td>2.2 The Beginnings of Metallurgy in the World</td>
<td>11</td>
</tr>
<tr>
<td>2.3 The Earliest Metals in Sri Lanka</td>
<td>13</td>
</tr>
<tr>
<td>2.4 Gedige Excavation</td>
<td>16</td>
</tr>
<tr>
<td>2.5 Metals and Megaliths: Sri Lanka and India</td>
<td>18</td>
</tr>
<tr>
<td>2.6 Copper Resources and Iron as a By-Product of Copper</td>
<td>18</td>
</tr>
<tr>
<td>2.7 Megalithic Culture and the ‘Iron Age’</td>
<td>21</td>
</tr>
<tr>
<td>2.8 Cultural Formation and the Spread of Technology</td>
<td>23</td>
</tr>
<tr>
<td>2.9 Pottery and Microliths</td>
<td>24</td>
</tr>
<tr>
<td>2.10 An Early Presence of Bronze</td>
<td>25</td>
</tr>
<tr>
<td>2.11 The Differences of Megalithic Metal Artefacts – India and Sri Lanka</td>
<td>26</td>
</tr>
<tr>
<td>2.12 An Early Sri Lankan Copper Metallurgy?</td>
<td>27</td>
</tr>
<tr>
<td>2.13 Cultural Formation of Sri Lanka on a Metallurgical Point of View</td>
<td>29</td>
</tr>
<tr>
<td>2.14 Conclusion</td>
<td>30</td>
</tr>
</tbody>
</table>
Chapter 3 32

METHODOLOGY

3.1 Introduction 32
3.2 Sample Selection 34
3.3 Scientific Analysis Methods 36
3.3.1 Elemental Compositional Analysis (with Trace Elements) 36
3.4 Sampling Methods and Metal Analysis 37
3.4.1 Sample Extraction 37
3.4.2 Sample Dissolution 38
3.4.3 Elemental Analysis 38
3.5 Stable Lead Isotope Analysis Method 39
3.6 Identification of Bronzes Made Using Copper Metal from the Seruwila Copper Magnetite Deposit 41

Chapter 4 45

RESULTS AND GROUPING OF IMAGES

4.1. Compositional Characteristics of the Sri Lankan Bronzes Belonging to the Different Historical Periods: 45
4.2. The Variation of Major Elements in Composition of Bronze Icons Belonging to the Different Historical Periods of Sri Lanka 47
4.2.1. Tin Metal 47
4.2.1.1. Average Value of Tin Metal Present in Anuradhapura Period Icons 48
4.2.1.1.1. Average Value of Tin Metal Present in Tiriyaya Icons 49
4.2.1.2. Average Value of Tin Metal Present in Polonnaruva Period Icons 49
4.2.1.2.1. Average Value of Tin Metal Present in Hindu Icons 49
4.2.1.3. Average Value of Tin Metal Present in Divided Period Icons 49
4.2.1.4. Average Value of Tin Metal Present in Kandy Period Icons 49
4.2.2. Lead Metal 50
4.2.2.1. Average Value of Lead Metal Present in Anuradhapura Period Icons 51
4.2.2.1.1. Average Value of Lead Metal Present in Tiriyaya Icons 51
4.2.2.2. Average Value of Lead Metal Present in Polonnaruva Period Icons 51
4.2.2.2.1. Average Value of Lead Metal Present in Hindu Icons 51
4.2.2.3. Average Value of Lead Metal Present in Divided Period Icons 51
4.2.2.4. Average Value of Lead Metal Present in Kandy Period Icons 51
4.2.3. Zinc Metal 52
Chapter 5

5.2 The Polonnaruva Period Hindu Images ........................................................................... 83
5.3 Comparison of the Sri Lankan lead isotopes values with some available values of the West ................................................................. 86

Chapter 6

DISCUSSION

6.1 Compositional Categories ......................................................................................... 92
6.2 Trace element and Lead Isotope Analysis ............................................................... 94
6.3 Anuradhapura Period Images and Artefacts .......................................................... 96
6.3.1 Compositional Characteristics and the Existence of two Schools of Image Productions ..................................................................................... 96
6.3.1.1 Kurunegala Buddha (A80) .......................................................................... 100
6.3.1.2 Tiriyaya Buddha Image (T74) .................................................................. 100
6.3.2 Lead Isotope group MLG1 and Anuradhapura Images ...................................... 101
6.3.2.1 Buddha Image from Abhayagiriya (A76) ...................................................... 101
6.3.2.2 Silver Tara Image from Kurunegala ............................................................ 101
6.3.3 Lead isotope Group MLG2 and Anuradhapura Images ....................................... 102
6.3.3.1 Recently Discovered Buddha Image from Pallama, Puttalam District ......... 105
6.3.3.2 Tara Image from Batticaloa ...................................................................... 106
6.3.4 Lead Isotope Group MLG5 and Bodisattva Image from Badulla (A34) ......... 108
6.3.5 Use of Zinc During Anuradhapura and Polonnaruva Periods ......................... 110
6.3.6 The Weheragala Images and the Different Technologies ................................. 113
6.3.7 The Tissamaharama Artefacts .......................................................................... 114
6.3.8 The Tiriyaya Bronze Images ............................................................................. 116
6.4 Ampara Buddha Image (79) .................................................................................. 120
6.5 The Polonnaruva Period Images ............................................................................ 121
6.5.1 The Polonnaruva Buddhist Images .................................................................. 121
6.5.2 The Polonnaruva Hindu Images .................................................................... 121
6.5.2.1 Polonnaruva Hindu Images Made with Seruwila Copper ...................... 122
6.5.2.2 Polonnaruva Hindu Images in MLG1 Isotope Group .............................. 122
6.5.2.3 Hindu Images in MLG3 Group .................................................................. 124
6.5.2.3.1 Siva and Parvati United by Lakdusinghe ............................................. 126
6.5.2.4 Hindu Images in MLG5 Group and Recycling of Tiriyaya Metals .......... 127
6.5.2.5 Recycling of Metals and Visual Styles ..................................................... 128
6.6 Divided Kingdoms Period Bronzes: ...................................................................... 129
6.7 The Kandy Period Images: ................................................................. 132
6.7.1 Composition of Kandy Images .................................................. 133
6.7.2 Technological Style, Visual Style .............................................. 134
6.8 Compositional Characteristics and Possible Dating of Sri Lankan Bronzes ...... ..................................................................................................................... 136
6.8.1 Use of Composition for Dating Sri Lankan Bronzes .................... 137
6.9 The Use of Tin metal in Sri Lanka ................................................ 139
6.10 Use of Antimonial Copper or Arsenical Copper ............................. 141
6.11 Use of Gold in Sri Lanka .............................................................. 142
6.12 South Indian Nagapattinam Images ............................................ 143
Bibliography ...................................................................................... 145
Appendix 1 - Results of the Compositional Analysis ............................. 155
Appendix 2 - Lead Isotope Ratio Values of the Sri Lankan Historical Bronze Images and Artefacts ............................................................................................................. 163
Appendix 3 - Images Represent Each Historical Time Period of Sri Lanka and the Analysis Methods Undertaken ................................................................. 165
Appendix 4 - Details of the Identified Lead Isotope Groups ..................... 166
Appendix 5 - Categorization of Bronzes According to Tin, Lead and Zinc Present in their Compositions ................................................................. 170
Appendix 6 - Alloy Types Present in Each Historical Time Period of Sri Lanka ...... 171
Anuradhapura Period icons ................................................................. 171
Appendix 7 - The Map Indicating Some Important Places Mentioned in this Thesis.. 173
Appendix 8 - Image Catalogue .............................................................. 174
Image Index ...................................................................................... 174