## An Archaeo-metallurgical Investigation of Sri Lankan Historical Bronzes

Arjuna Thantilage Postgraduate Institute of Archaeology University of Kelaniya

TH 085



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

12297

## TABLE OF CONTENTS

ACK	NOWLEDGEMENTS	
TAB	LE OF CONTENTS	
List o	of Figures	v
List o	of Tables	vii
AIMS A	AND OBJECTIVES	1
Chapter	r 1	2
OVER	VIEW	2
1.1	Introduction	2
1.2	Metal Sculpture and Archaeometallurgy	2
1.3	Inscriptions, Chronicles and Metal Working	4
1.4	Silpa Texts and Metal Images	6
Chapter	r 2	10
COPPE	R METALLURGY IN SRI LANKA: A PREAMBLE	
2.1	Introduction	10
2.2	The Beginnings of Metallurgy in the World	11
2.3	The Earliest Metals in Sri Lanka	13
2.4	Gedige Excavation	16
2.5	Metals and Megaliths: Sri Lanka and India	18
2.6	Copper Resources and Iron as a By-Product of Copper	18
2.7	Megalithic Culture and the 'Iron Age'	21
2.8	Cultural Formation and the Spread of Technology	23
2.9	Pottery and Microliths	24
2.10	An Early Presence of Bronze	25
2.11	The Differences of Megalithic Metal Artefacts – India and Sri Lanka	26
2.12	An Early Sri Lankan Copper Metallurgy?	27
2.13	Cultural Formation of Sri Lanka on a Metallurgical Point of View	29
2.14	Conclusion	30

Chapter	· 3	.32
METHO	DDOLOGY	
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 Cop	per
	Magnetite Deposit	41
Chapter	4	45
RESUL	TS 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	g
	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
423	Zinc Metal	52

4.2.3.1.	Average Value of Zinc Metal Present in Anuradhapura Period Icons	53
4.2.3.1.1	Average Value of Zinc Metal Present in Tiriyaya Icons	53
4.2.3.2.	Average Value of Zinc Metal Present in Polonnaruva Period Icons	53
4.2.3.2.1	. Average Value of Zinc Metal Present in Hindu Icons	53
4.2.3.3.	Average Value of Zinc Metal Present in Divided Period Icons	53
4.2.3.4.	Average Value of Zinc Metal Present in Kandy Period Icons	53
4.2.4.	Iron Metal	54
4.3.	Grouping of Bronzes	55
4.4.	Grouping of Bronzes According to the Trace Element Results	56
4.5.	Distribution of Images Among the Trace Element Image Groups in the Scatt	er
	Plot of Co/Ni Vs Fe/Ni	59
4.5.1.	The Anuradhapura Period	59
4.5.1.1.	The Tiriyaya Images	59
4.5.1.2.	The Tissamaharama Artefacts	60
4.5.2.	The Polonnaruva Period Buddhist Images	60
4.5.2.1.	The Polonnaruva Period Hindu Images	61
4.5.3.	The Divided period Images	61
4.5.4.	The Kandy Period Images	62
4.6.	Grouping of Bronzes According to the Lead Isotope Results	62
4.7.	Main Lead Isotope Groups of the Studied Images	63
4.8.	Groupings of Bronze Images According to the Both Lead Isotope and Trace	
	Element Results	
4.9.	The Anuradhapura Period Images	66
4.9.1.	The Tiriyaya Images	67
4.9.2.	The Tissamaharama Artefacts	68
4.10.	The Polonnaruva Period	70
4.10.1.	Polonnaruva Period Buddhist Images	70
4.10.2.	Polonnaruva Hindu Images:	71
4.11.	The Lead Isotope Group MLG1, Trace Element Group S1 and the Use of	
	Seruwila Deposit	71
Chapter :	5	77
COMPA	RISON OF THE LEAD ISOTOPE RESULTS	
5.1	Comparison of the Lead Isotope Values of Sri Lankan Bronzes With the Sou	th
	Indian Bronzes	77

5.2	The Polonnaruva Period Hindu Images	83
5.3	Comparison of the Sri Lankan lead isotopes values with some available va	lues
	of the West	86
Chapter	6	92
DISCUS	SSION	
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, Puttlam 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	
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	
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
Bibliogr	aphy	.145
A ppend	lix 1 - Results of the Compositional Analysis	.155
Appendi	x 2 - Lead Isotope Ratio Values of the Sri Lankan Historical Bronze Images	3
	and Artefacts	163
Appendi	x 3 - Images Represent Each Historical Time Period of Sri Lanka and the	
	Analysis Methods Undertaken	165
Appendi	x 4 - Details of the Identified Lead Isotope Groups	166
Appendi	x 5 - Categorization of Bronzes According to Tin, Lead and Zinc Present in	
	their Compositions	170
Appendi	x 6 - Alloy Types Present in Each Historical Time Period of Sri Lanka	171
Anuradh	apura Period icons	171
Appendi	x 7 - The Map Indicating Some Important Places Mentioned in this Thesis	173
Appendi	x 8 - Image Catalogue	174
lmage In	idex	174