

## DOCTORAL THESIS

# Late Quaternary diatom and palynomorph stratigraphies and palaeoenvironments of the Koora Graben and Lake Magadi Basin, Kenya Rift Valley

Muiruri, Veronica Mwihaki

*Date of Award:*  
2017

[Link to publication](#)

### General rights

Copyright and intellectual property rights for the publications made accessible in HKBU Scholars are retained by the authors and/or other copyright owners. In addition to the restrictions prescribed by the Copyright Ordinance of Hong Kong, all users and readers must also observe the following terms of use:

- Users may download and print one copy of any publication from HKBU Scholars for the purpose of private study or research
- Users cannot further distribute the material or use it for any profit-making activity or commercial gain
- To share publications in HKBU Scholars with others, users are welcome to freely distribute the permanent URL assigned to the publication

## ABSTRACT

Two sets of cores were recovered from the southern Kenya Rift (Koora and Magadi basins) through the Hominid Sites and Paleolakes Drilling Project and the Olorgesailie Drilling Project. These contain a detailed environmental Quaternary history with records of up to ~1 million years. This period correlates with much of the Olorgesailie Formation record of 1.2 Ma in the Olorgesailie Basin. The Magadi cores reached trachyte at ~ 194 and 133 m with this project focussed on the longer core, MAG14-2A, which includes limestone, zeolitic, laminated and massive clay and silt, massive mud, chert, trona, gravel and sand. The Koora Core (OLO12-1A) extended to depths of 166.14 m and contains laminated and massive diatomites, fine to coarse sands; lime and siliciclastic muds with pumice-rich gravels. The two cores are particularly important because they provide environmental records that help to fill erosional gaps in the history of the Olorgesailie Basin, which includes important evidence for changing hominin cultures and evolution.

The high-resolution lacustrine-terrestrial stratigraphies of the two basins have shown how landscapes were transformed because of complex interactions between tectonic and climatic processes. Volcanism also had a significant impact, partially damming lakes at Olorgesailie. Diatoms are present in much of the Koora Basin sequence and large parts of the Magadi sediments. These are dominated by a variety of planktonic *Aulacoseira*, *Cyclotella* and *Thalassiosira* taxa in both basins. Species comprising these genera and other planktonic, benthonic and epiphytic taxa preserve a detailed record of lakes that fluctuated in depth, extent and chemistry. The data document the presence of freshwater and saline lakes as well as wetlands. Diatom transfer functions from the Koora and Magadi basins indicate that these water bodies fluctuated widely in conductivity between ~200 to >20,000  $\mu\text{S cm}^{-1}$ , with pH changing between about 7.5 and 11.5. The palaeolakes also periodically exceeded diatom tolerance limits and intermittently dried out. Pollen are generally lacking in the Koora basin sediments, but deposits in the Magadi core contain common pollen that document a wide range of habitats, including forests, woodlands and grasslands that could have supported the presence of hominins and their activities in the region. Fungal spore data support pollen inferences and indicate periods when large mammals might have been common.

The microfossil record shows that there was a broad trend towards more arid conditions in the southern Kenya Rift after about 550 Ka, interrupted by periodic wetter conditions. A major episode of desiccation developed between about 500 to 450 Ka and 400 Ka that correlates with a period of mammal extinctions and a change from Acheulean to Middle Stone Age toolkits in the Olorgesailie Basin, suggesting that these changes might have been related to environmental conditions at that time.

# TABLE OF CONTENTS

DECLARATION .....	I
A B S T R A C T .....	II
ACKNOWLEDGEMENTS .....	III
TABLE OF CONTENTS.....	V
LIST OF TABLES .....	IX
LIST OF FIGURES.....	XI
ABBREVIATIONS.....	XIII
<b>CHAPTER ONE—INTRODUCTION .....</b>	<b>1</b>
1.1 Introduction.....	1
1.2 Background to the study .....	3
1.3 The Homini Sites and Palaeolake Drilling Project (HSPDP) and the Olorgesailie Drilling Project (ODP) .....	5
1.4. The Koorra Basin and Lake Magadi .....	6
1.5 Scope of study.....	9
1.6 Aims, Concepts and Context of the research.....	11
<b>CHAPTER TWO—THE CONTEMPORARY ENVIRONMENTS OF THE SOUTH KENYA RIFT .....</b>	<b>13</b>
2. Modern regional geological and environmental setting .....	13
2.1. Physiography and surface hydrology .....	13
2.2 Geology of the South Kenya Rift .....	15

<b>2.3 Soils</b> .....	<b>19</b>
<b>2.4 Vegetation</b> .....	<b>19</b>
2.4.1 Modern Vegetation patterns in East Africa.....	19
2.4.2 Present–day environmental conditions in the Magadi and Koora basins:.....	25
<b>2.5 Climate:</b> .....	<b>28</b>
 <b>CHAPTER THREE – LITERATURE REVIEWS:</b> .....	 <b>31</b>
<b>3.1 Literature review of microfossil studies in East Africa</b> .....	<b>31</b>
<b>3.2 Pollen in Palaeoecological studies:</b> .....	<b>32</b>
3.2.1 Pollen records from East Africa:.....	33
3.2.2 Summary of temporal vegetation changes in East Africa: .....	40
<b>3.3 Diatoms in environmental studies:</b> .....	<b>41</b>
3.3.1 Diatoms in palaeoecological study .....	42
3.3.2 Diatom ecology in East Africa .....	43
3.3.3 Diatoms and lake level records from East Africa .....	44
3.3.3.1. Palaeoenvironmental implications of lake-level and diatom records .....	44
3.3.3.2. Lake levels and diatom records during the Last Glacial Maximum.....	46
3.3.3.3. The Holocene period .....	47
<b>3.4 Fungal spore records from East Africa</b> .....	<b>48</b>
 <b>CHAPTER FOUR – MATERIAL AND METHODS</b> .....	 <b>51</b>
<b>4.1 Olorgesailie Drilling Project and Hominin Sites and Paleolakes Drilling Project</b> .....	<b>55</b>
4.1.1 Sedimentology data .....	51
4.1.2 Chronology .....	52
<b>4.2 Core collection and sampling: Site 1 (Koora Graben)</b> .....	<b>55</b>
<b>4.3 Core collection and sampling: Site 2 (Magadi basin)</b> .....	<b>58</b>
 <b>4.4 Diatom studies</b> .....	 <b>68</b>
4.4.1 Sample preparation.....	61
4.4.2 Light microscope observations.....	61
4.4.3 Diatom counts, statistical analyses and stratigraphic diagrams.....	63
4.4.4 Quantitative reconstructions.....	64

<b>4.5 Preparation and analysis of fossil pollen and spores .....</b>	<b>68</b>
4.5.1 Pollen identification and counting.....	69
4.5.2 Statistical analysis, construction and zonation of pollen and fungal .....	70
4.5.3 Analyses of drier/wetter conditions .....	70
<b>4.6 Identification and enumeration fungal spores.....</b>	<b>71</b>
<b>CHAPTER FIVE—GEOLOGICAL BACKGROUND AND CORE SEDIMENTS FROM THE KOORA AND MAGADI BASINS .....</b>	<b>72</b>
<b>5.1 Sediments in Core OLO12-1A, Koora Basin .....</b>	<b>72</b>
<b>5.2 Tectonic and geomorphological controls on sedimentation in the Koora Basin .....</b>	<b>77</b>
<b>5.3. Sediments in Core MAG14-2A, Magadi Basin .....</b>	<b>78</b>
<b>CHAPTER SIX—MICROFOSSIL STRATIGRAPHY OF THE KOORA BASIN.....</b>	<b>83</b>
<b>6.1 Diatoms and Pollen in Core OLO12-1A .....</b>	<b>83</b>
<b>6.2 Common diatoms and ecological preferences.....</b>	<b>84</b>
<b>6.3 The sediment and diatom stratigraphy: .....</b>	<b>88</b>
6.3.1 Unit I (161.80–145.48 m) .....	88
6.3.2 Unit II (145.48–107.07 m) .....	92
6.3.3 Unit III (107.07–66.05 m) .....	96
6.3.4 Units IV (66.05–27.00 m) and V (27.00–0 m) .....	99
<b>6.4 Environmental stratigraphy: .....</b>	<b>102</b>
6.4.1 Unit I (Zones 1–2) .....	105
6.4.2 Unit II (Zones 3–16) .....	107
6.4.3 Unit III (Zones 17–26) .....	109
6.4.4 Units IV (Zones 27–40) and V (Zone 41) .....	110
<b>CHAPTER SEVEN—MICROFOSSIL STRATIGRAPHY OF THE MAGADI BASIN .....</b>	<b>112</b>
<b>7.1 Diatom, Pollen and Fungal spore data from core MAG14-2A .....</b>	<b>112</b>
<b>7. 2 Diatom floras .....</b>	<b>113</b>
7.2.1 Common diatoms and ecological preferences .....	113

7.2.2 Diatom stratigraphy and interpretation .....	118
7.2.2.1 Zone 1 (194.40–132.11 m) .....	118
7.2.2.2 Zone 2 (132.11–101.01 m) .....	121
7.2.2.3 Zone 3 (101.01–86.61 m) .....	122
7.2.2.4 Zone 4 (86.61–66.96 m) .....	124
7.2.2.5 Zone 5 (66.96–43.11 m) .....	125
<b>7.3 Pollen stratigraphy .....</b>	<b>125</b>
7.3.1 Pollen Unit I: Zones I to IV (193.29–159.01 m): .....	127
7.3.2 Pollen Unit II: Zones V to XV (153.13–125.89 m): .....	130
7.3.3 Pollen Unit III: Zones XVI to XVIII (125.89–101.50 m) .....	132
7.3.4 Pollen Unit IV: Zones MP-XIX to XXVII (101.50–55.20 m) .....	133
7.3.5 Pollen Unit V: Zones MPXXVIII to XXXXII (55.20–3.19 m): .....	138
<b>7.4 Fungal spore stratigraphy: .....</b>	<b>142</b>
7.4.1 Fungal Unit I: Zones MFS-I and MFS-II (193.29–154.16 m) .....	143
7.4.2 Fungal Unit II: Zones MFS-III to MFS-VII (154.16–127.21 m) .....	144
7.4.3 Fungal Unit III: Zones MFS-VIII to MFS-X (124.43–106.50 m) .....	147
7.4.4 Fungal Unit IV: Zone MFS-XI to XVIII (106.50–46.14 m) .....	149
7.4.5 Fungal Unit V: Zone MFS-XVIII to XXV (43.93–3.19 m): .....	151
<b>7.5 Discussion - Palaeovegetation dynamics of the Magadi basin and environs post-1.08 Ma to present .....</b>	<b>154</b>
7.5.1 Introduction .....	154
7.5.2 Pollen Unit I (193.29–159.01 m) .....	155
7.5.3 Pollen Unit II (153.13–127.83 m) .....	159
7.5.4 Pollen Unit III (126.89–102.02 m) .....	163
7.5.5 Pollen Unit IV (102.02–55.20 m) .....	166
7.5.6 Pollen Unit V (55.20–3.19 m) .....	170

## **CHAPTER EIGHT—SYNTHESIS: PALAEOENVIRONMENTAL CORRELATIONS FOR THE, KOORA, MAGADI AND OLOGESAILIE BASINS FOR THE LAST ONE MILLION YEARS.....177**

<b>8.1 Introduction.....</b>	<b>177</b>
<b>8.2 Palaeoenvironments and lakes between ~1.00–0.46 Ma .....</b>	<b>178</b>
<b>8.3 Palaeoenvironmental conditions between 0.46–0.26 Ma.....</b>	<b>182</b>

