DATING THE STONE AGE AT ROSE COTTAGE CAVE SOUTH AFRICA

An exercise in optically dating cave sediments

BY

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ABSTRACT

Results and analysis of Optically Stimulated Luminescence (OSL) dating of the Middle Stone Age (MSA) and Later Stone Age (LSA) sediments at Rose Cottage Cave (RCC) are presented. Seventeen luminescence samples taken over the last decade were used in this study. Fourteen of these samples were dated (eight in Pretoria and six in Risø, Denmark by A. S. Murray). The samples were taken from the entire sequence and gave age ranges from the bottom of the sequence up until the Oakhurst LSA industry.

The protocol that was used is the conventional single-aliquot regenerative (SAR) protocol, due to its ability to correct for behavioural problems associated with OSL dating. This study is primarily concerned with testing the validity of the conventional SAR protocol applied to South African archaeological sites. RCC presents problematic sediments for OSL dating because of a high feldspar component in the sediments at the site (OSL dating is preferably done on quartz grains due to a better understanding of the mechanisms of OSL production). Assessing the radiation dose samples received during their burial period was problematic due to the large presence of potassium rich feldspars. Assessing the radiation dose was problematic because the measurement of potassium (K) returned different values using several independent techniques. The mode of sediment deposition via different depositional mechanisms such as, fluvial, and clast spalling present difficult challenges in assessing the zero age value of a sample.

OSL ages were compared to a well defined radiocarbon chronology from RCC, and any inconsistencies would motivate closer sorting of the different dating techniques. In this study it was found that not all feldspar grains were removed from the quartz extracts during pretreatment procedures. The ability of the SAR protocol to pick out feldspar contamination was therefore not conclusive, and single grain measurements had to be used to differentiate quartz and feldspar grains.

The likelihood of age contamination from problematic depositional events was not supported and the results suggest that aeolian deposition was the main mechanism at the site. The vertical separation of depositional events i.e. the varying archaeological events, is very dense at RCC and this introduces the possibility of sample mixing during collection. For a few samples it is shown that sample mixing has occurred as mixing is usually evident in the degree of scatter in the OSL results.

After all the inconsistencies in OSL/Radiocarbon age correlations were worked out, a coherent OSL chronology was obtained. Certain issues surrounding dosimetry however, are still not resolved. These issues are beyond the scope of this study and so caution is advised when using OSL dates done with little or no dose-rate analysis.

The resulting dates provide a useful dataset for archaeologists who now have added resources to asses the Middle Stone Age (MSA) and better compare synchronous evidence from different sites in order to contribute to the debate surrounding the origins of modern humans and modern human behaviour. These results combined with the well established radiocarbon chronology give age ranges as follows: The Pre-Howiesons Poort (Pre-HP) MSA IIb industry is between 94 and 68 thousand years ago (ka); the Howiesons Poort (HP) industry is between 68 and 55 ka; the Post –HP MSA III dates to between 55 and 48 ka; the ‘almost sterile sands’ (which include the MSA IV industry) are between 48 and >27 ka; the MSA/LSA transition is between 27 and 20 ka; the Robberg LSA industry is between 20 and 10.5 ka; the Oakhurst LSA industry ranges from 10.5 to 8.5 ka; and the Wilton LSA industries are <8.5 ka.

OPSOMMING

Uitslae en ontleding van Opties-gestimuleerde Ligtingsdatering of “Optically-stimulated Luminescence Dating” (OSL) van die middel steentydperk (MSA) en latere steentydperk (LSA) sedimente by Rose Cottage Cave (RCC) word voorgelê. Sewentien ligtingsmonsters wat oor die afgelope dekade geneem is was in hierdie studie gebruik. Veertien hiervan was gedateer (agt in Pretoria en ses in Risø, Denemarke deur A.S. Murray). Die monsters was geneem uit die hele volgreeks en het ouderdomsreekse opgelewer vanaf die bodem van die reeks tot en met die Oakhurst laatsteentydperk (LSA) bedryf.

Die protokol wat gebruik is, is die konvensionele enkel-alikwot herskeppende of “single-aliquot regenerative” (SAR) protokol vanweë dié se vermoë om gedragsprobleme met OSL datering te korrigeer. Die studie is hoofsaaklik gemoeid met toetsing van die geldigheid van die konvensionele SAR protokol soos toegepas op Suid-Afrikaanse argeologiese terreine. RCC bied problematiese sedimente vir OSL datering as gevolg van ‘n groter feldspar komponent in die sedimente van die terrein (OSL datering word verkieslik gedoen op kwartskorrels as gevolg van ‘n beter begrip van die meganismes van OSL produksie). Raming van die bestralingsdosisse wat monsters ontvang het in die tyd wat hulle begrawe was, is vergemoeilik deur die teenwoordigheid van groot hoeveelhede kaliumryke feldspar. Raming van die bestralingsdosis was problematies want die meting van kalium (K) het verskillende waardes gelewer wnneer verskeie onafhanklike tegnieke gebruik is. Die wyse van neerlegging van sedimente deur middel van verskillende neerleggingsmeganismes soos fluviale en klast afsplintering bied moeilike uitdagings vir raming van die nul ouderdomswaarde van ‘n monster.

OSL ouderdomme is vergelyk met ‘n goedgedefinieërde radiokoolstof kronogolie vanaf RCC en enige teenstrydighede sou dan motivering wees vir ‘n nadere sortering van die verskillende dateringstegnieke. In die studie is gevind dat nie alle feldsparkorrels uit die kwartsuittreksels verwyder is tydens

voorafbehandelingsprosedures nie. Die vermoë van die SAR protokol om felsparbesoedeling uit te lig is derhalwe nie onbetwisbaar bewys nie en enkelkorrel metings moes gedoen word om te onderskei tussen kwarts- en feldsparkorrels.

Die waarskynlikheid van besoedeling van ouderdomme in problematiese neerleggingsgebeurtenisse is nie ondersteun nie en die uitslae dui daarop dat eoliese neerlegging die hoof meganisme was by dié terrein. Die vertikale skeiding van neerleggingsgebeurtenisse dit wil sê die veranderende argeologiese gebeurtenisse is baie dig by RCC en dit bring die moontlikheid van monstervermenging tydens insameling te weeg. Vir ‘n paar monsters word daar getoon dat sodanige vermenging wel plaasgevind het want vermenging is gewoonlik duidelik uit die mate van spreiding in die OSL uitslae.

Nadat al die teenstrydighede in OSL/Radiokoolstof ouderdomskorrelasies uitgewerk was, was ‘n samehangende OSL kronologie verkry. Sekere kwessies rondom doserinsmeting (“dosimetry”) is egter nog nie opgelos nie. Daardie kwessies val buite die omvang van hierdie studie en omsigtigheid word aangeraai waar OSL daterings gedoen word met min of geen doseerverhoudingsontleding (“dose-rate analysis”).

Die resultate van die daterings lewer ‘n bruikbare datastel vir argeoloë wat nou bykomende hulpbronne het om die middelsteentydperk (MSA) te assesseer en beter vergelykings te tref tussen gelyktydige bewysmateriaal vanaf verskillende terreine en daardeur by te dra tot die debat rondom die oorsprong van die moderne mens en sy gedrag. Hierdie resultate gekombineer met die goedgevestigde Radiokoolstof kronologie lewer ouderdomsreekse soos volg: Die Pre-Howiesons Poort (Pre-HP) MSA IIb bedryf tussen 94 en 68 duisend jaar gelede (ka); die Howiesons Poort (HP) bedryf tussen 68 en 55 ka; die Post-HP MSA III tussen 55 en 48 ka; die ‘amper steriele sandlae’ (wat die MSA IV insluit) tussen 48 en >27 ka; die MSA/LSA oorgang tussen 27 en 20 ka; die Robberg LSA bedryf tussen 20 and 10.5 ka; die Oakhurst LSA bedryf wissel van 10.5 to 8.5 ka; en die Wilton LSA bedrywe is <8.5 ka.

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The direction of study that all students decide upon when confronted with the task of doing a Masters degree is a difficult one. This was a situation I found myself in, when the phone rang, and Dr. Stephan Woodborne asked if I was interested in being supervised in a field related to archaeological dating. All of a sudden a variety of study options presented themselves. Needless to say luminescence dating was the one that caught my attention.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Bq:	Becquerel, 1 Bq = 1 decay/sec
Ci:	Curie, 1 Ci = 37 x 10^9 Bq
CW-OSL:	Continuous-wave optically stimulated luminescence
D_e:	Equivalent laboratory dose
ELSA:	Early Later Stone Age
ESA:	Early Stone Age
FBP:	Fast bleaching TL peak
FGS:	Field gamma spectrometer
Gy:	Gray, 1 Gy = 1 joule/kg
HF Acid:	Hydrofluoric acid
HP:	Howiesons Poort
IR:	Infrared
IRSL:	Infrared Stimulated Luminescence
K:	Potassium
ka:	kilo year (1 year x 10^3)
LED:	Light Emitting Diode
LGM:	Last Glacial Maximum
LSA:	Later Stone Age
L_x:	Luminescence regenerative dose
MeV:	Mega Electron-volt
MSA:	Middle Stone Age
mW:	Mega-watt
OIS:	Oxygen Isotope Stage
OSL:	Optically Stimulated Luminescence
ppm:	Parts per million
Rb:	Rubidium
RCC:	Rose Cottage Cave
SAR:	Single aliquot regenerative (protocol)
SBP:	Slow bleaching TL peak
Th:	Thorium
TL:	Thermoluminescence
TSAC:	Thick Source Alpha Counting
T_x:	Luminescence test dose
U:	Uranium
WAV:	Weighted average
α:	Alpha (radiation)
β:	Beta (radiation)
γ:	Gamma (radiation)