



MORPHOLOGY AND GENESIS OF CALCRETE IN SOUTH AUSTRALIA
WITH SPECIAL REFERENCE TO
THE SOUTHERN MURRAY BASIN AND YORKE PENINSULA

John Charles Dixon, B.A.Hons. (N.S.W.)

Submitted in fulfilment of the requirements
for the degree of Master of Arts
The University of Adelaide

1978

Approved, September 1978

STATEMENT OF ORIGINALITY

This thesis is based on original research carried out in the Department of Geography, University of Adelaide. It contains no material previously published or written by another author, except where due reference is made in the text of the thesis.

John C. Dixon

ACKNOWLEDGEMENTS

The completion of this thesis would not have been possible without the assistance of a number of people to whom I am most grateful.

In particular I would like to thank:

- Dr. C. R. Twidale, my supervisor, for his interest, advice and invaluable criticism.
- Mr. J. Hutton from C.S.I.R.O. Division of Soils for his assistance and advice with X-ray fluorescence analyses.
- Mr. J. Pickering from C.S.I.R.O. Division of Soils for his assistance and advice on the preparation of samples for X-ray diffraction and for interpreting X-ray powder photographs.
- Miss C. Barrington, cartographic assistant in the Department of Geography, for printing photographs so speedily and efficiently.
- Mr. F. Hilton, education section, South Australian Museum, for identifying the molluscs.

CONTENTS

	PAGE
STATEMENT OF ORIGINALITY	i
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	v
LIST OF FIGURES	vi
SUMMARY	viii
CHAPTER I INTRODUCTION	1
Aim of Thesis	1
Definition of Calcrete	4
CHAPTER II GEOLOGICAL SETTING	7
The Murray Basin	7
Yorke Peninsula	13
CHAPTER III MORPHOLOGY OF CALCRETE IN THE MURRAY BASIN AND ON YORKE PENINSULA	20
Terminology of Calcrete Varieties	20
Calcrete Varieties in the Murray Basin and on Yorke Peninsula	22
Murray Basin and Yorke Peninsula Calcrete Profiles	29
CHAPTER IV THE CHEMISTRY AND MINERALOGY OF CALCRETE IN THE MURRAY BASIN AND ON YORKE PENINSULA	46
Calcrete Chemistry - Introduction	46
Gross Chemistry	46
Discussion	52
Chemistry of Principal Calcrete Types	54
Spatial Variation of Calcrete Chemistry	57
Mineralogy of Calcretes	60
Clay Mineralogy	65

	PAGE
CHAPTER V GENESIS OF CALCRETE	68
Previous Investigations	68
Origin of the Murray Basin Calcretes	69
Source of Calcium and Magnesium Ions in the Murray Basin	77
Genetic Implications of Calcrete Morphology in the Murray Basin	79
Origin of Yorke Peninsula Calcretes	81
Source of Calcium and Magnesium Ions on Yorke Peninsula	83
Genetic Implications of Calcrete Morphology on Yorke Peninsula	84
CHAPTER VI SUMMARY AND CONCLUSIONS	89
REFERENCES CITED	92

LIST OF TABLES

	PAGE
2.1 Stratigraphy of the Murray Basin	8
2.2 Stratigraphy of Yorke Peninsula	15
4.1 Chemical analyses of calcrete samples from the Murray Basin	47
4.2 Chemical analyses of calcrete samples from Yorke Peninsula	49
4.3 Mean oxide percentages for calcrete types in the Murray Basin	55
4.4 Mean oxide percentages for calcrete types on Yorke Peninsula	56
4.5 Elemental ratios in different rock environments	58
4.6 Ratios of major elements in Yorke Peninsula calcretes	61
4.7 Calcite and dolomite percentages in calcretes of the Murray Basin	63
4.8 Calcite and dolomite percentages in Yorke Peninsula calcretes	64

LIST OF FIGURES

		PAGE
1.1	Location map of towns and sample sites in the Murray Basin	2
1.2	Location map of towns and sample sites on Yorke Peninsula	3
3.1	Netterbergs stages of calcrete development	21
3.2	Massive hardpan calcrete with laminar surface	25
3.3	Strongly indurated hardpan calcrete with nodules floating in the matrix	26
3.4	Continuous hardpan calcrete horizon, Virginia, Adelaide Plains	27
3.5	Strongly indurated hardpan calcrete showing stromatolitic appearance of laminar calcrete	28
3.6	Calcrete profile Monteith Quarry I, Murray Bridge	30
3.7	Calcrete profile, Monteith Quarry II, Murray Bridge	31
3.8	Calcrete profile, Dukes Highway, Taillem Bend	32
3.9	Calcrete horizon developed on limestone of the Mannum Formation, Murray Bridge	33
3.10	Calcrete horizons, Old Martins Quarry, Black Hill	34
3.11	Laminar calcrete lenses, Martins Quarry, Black Hill	35
3.12	Calcrete horizon, Council Quarry, Black Hill	36
3.13	Calcrete horizon on granite weathering profile, Long Ridge	37
3.14	Horizon of calcrete nodules and cobbles, Ardrossan, Yorke Peninsula	38
3.15	Calcrete profile in coastal cliffs, Port Julia	39

	PAGE
3.16 Calcrete profile at Wool Bay	40
3.17 Calcrete profile, Port Vincent	41
3.18 Calcrete profile west of Yorketown	43
3.19 Calcreted Pleistocene shell bed, south west of Warooka	44
3.20 Calcrete profile, Moonta Bay	45

SUMMARY

The aim of this thesis is to describe and account for the calcrete which occurs extensively throughout the Murray Basin and Yorke Peninsula in southern South Australia and to see what light, if any, their investigation throws on similar features developed elsewhere. Calcrete is widely distributed in South Australia. It is of considerable geomorphological significance and is in some quarters used as a stratigraphic marker. Yet there has been little work done on the morphology and genesis of these deposits. Unless we understand the ways in which calcrete forms it is obviously fruitless to draw conclusions from it about the age of the land-surfaces on which it is developed.

In order to come to some understanding of the processes responsible for the formation of calcrete the chemistry and mineralogy of calcrete from various sites in the two selected study areas were examined using X-ray fluorescence spectrometry and X-ray diffraction techniques. The gross morphology and geomorphological setting of the calcretes also provided information on the processes of formation.

Field observations and laboratory analyses show that the calcretes of the Murray Basin and Yorke Peninsula form in various ways. In the Murray Basin the occurrence of considerable quantities of palygorskite, sepiolite and dolomite strongly suggest that many of the calcretes developed there are of lacustrine origin. The dominant

clay minerals in the calcrete from the western margin of the Murray Basin are illite and kaolinite which suggests that the carbonates are of a pedogenic origin. On Yorke Peninsula also, where the dominant clay minerals in the calcrete are illite and kaolinite and where dolomite contents are very low, pedogenic processes are responsible for the formation of the extensive calcrete hardpans.

Calcretés of the southern Murray Basin appear to have been formed in shallow saltwater lakes related to Pleistocene marine regressions. The calcretes of Yorke Peninsula have been derived from the solution and subsequent redeposition of carbonates in the Pleistocene aeolian dunes and sand sheets which cover large areas of the landscape and from the Tertiary and Cambrian limestones on which the younger sediments are developed.