The Development of a Spatial Database for Research into Cryogenic Processes and Landforms in Southern Africa

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ABSTRACT

Title of dissertation : The development of a spatial database for research into cryogenic processes and landforms in southern Africa

by

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The first publication on southern African geocryology in 1944 resulted in a recognition of the potential of cryogenic phenomena in establishing long-term climatic records in the region, leading to a substantial increase in publications and research. Cryogenic studies are concerned with the way frost-induced processes have modified, and continue to modify, the mountain regions of the subcontinent. However, problems exist in interpreting relict forms, while supportive evidence for glacial and periglacial hypotheses are lacking. Insufficient data regarding Quaternary cryogenic activity have resulted in contradicting qualitative interpretations of the palaeoclimate and poor spatial and temporal resolution.

It is apparent that there is a need for a more rigorous approach in southern African cryogenic studies as well as a better understanding of relict phenomena and the palaeoenvironment. For this purpose a database that acts as a supplementary source and a tool for GIS-based analysis, was compiled. In addition, several glossaries and indices were constructed. The main glossary is a first effort at explaining past terminology usage and providing a terminology basis specifically for current research in southern Africa.

Through database manipulation, the spatial distribution of past and present cryogenic phenomena as found in southern Africa, was mapped and it was found that cryogenic features and processes cluster along the Main Escarpment and the Western Cape Mountains. It is not clear if this is the actual situation or whether it represents a bias in the areas investigated.

Further, likely regions for glacial ice development and survival and regions for periglacial activity were determined. The extent of relict and contemporary cryogenic activity was also verified. Evaluation of available data indicates that the extent of the cryogenic palaeoenvironment did not differ considerably from the current one.

An improved understanding of the spatial distribution of both relict and current cryogenic phenomena was achieved. The database represents a contribution towards the reconstruction of the southern African Quaternary environment and supplements current knowledge on the subject. While not necessarily providing solutions to current research problems, the database, combined with the glossaries and indices, will be invaluable in future research and modelling of the Quaternary in southern Africa.

UITTREKSEL

Titel van die verhandeling : Die ontwikkeling van 'n ruimtelike databasis vir navorsing oor Suider Afrikaanse kriogeniese prosesse en landvorms

deur

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Die belangrikheid van kriogeniese verskynsels in die vasstelling van langtermyn klimaatsrekords vir Suider Afrika is reeds met die eerste publikasie daaroor in 1944 gevestig. Die gevolg was 'n aansienlike toename in die aantal publikasies en navorsing oor die onderwerp. Die prosesse verantwoordelik vir die vorming van die bergagtige gebiede van die suidelike kontinent word vervat in kriogeniese studies oor die gebied. Die interpretasie van relieke verskynsels is egter problematies weens die tekort aan voldoende bewys vir glasiale en periglasiale hipoteses. Ontoereikende inligting oor Kwarternêre kriogeniese aktiwiteit en die paleo-omgewing lei tot verskeie teenstrydige kwalitatiewe interpretasies en groot leemtes in die tyd-ruimtelike resolusie van verskynsels.

Dit is duidelik dat daar 'n behoefte bestaan vir 'n meer noukeurige benadering tot die bestudering van Suider Afrikaanse kriogeniese aktiwiteit, asook 'n beter begrip van die paleo-omgewing en relieke verskynsels. Vir hierdie doel is 'n databasis ontwikkel wat ook dien as 'n aanvullende inligtingsbron en 'n instrument in GIS-gebaseerde analise. Verskeie woordelyste en indekse is opgestel as bykomende hulpmiddels. Die hoofwoordelys vorm die basis vir die gebruik van terminologie in huidige en toekomstige navorsing en help mee tot die ontwikkeling van 'n eiesoortige terminologie vir Suider-Afrikaanse kriogeniese navorsing.

Die ruimtelike verspreiding van kriogeniese verskynsels in Suider Afrika is deur middel van databasis manipulasie gekarteer, en dit is bevind dat kriogeniese vorms en prosesse langs die Groot Eskarp en die Wes-Kaap berge voorkom. Dit is nie duidelik of beskrywings die werklike situasie reflekteer nie en tot watter mate dit deur bestaande hipoteses en menslike faktore beïnvloed is nie. Moontlike gebiede vir glasiale ysvorming en gebiede vir periglasiale aktiwiteit is in die studie vasgestel en die strekking van relieke en kontemporêre kriogeniese aktiwiteit is ondersoek. Evaluasie van beskikbare data dui daarop dat die strekking van die kriogeniese paleo-omgewing nie drasties verskil van dié van die huidige nie.

In die studie is 'n beter begrip van die ruimtelike verspreiding van relieke en huidige kriogeniese verskynsels verkry. Die databasis vorm 'n bydrae tot die herkonstrukterering van die Suider Afrikaanse Kwarternêre omgewing en is aanvullend tot die bestaande kennis van die onderwerp. Die databasis, in kombinasie met sy woordelyste en indekse, verskaf kan gebruik word as verwysingsbron vir toekomstige Kwarternêre navorsing en modelering in Suider Afrika.

"In the beginning was the Word, and the Word was with God, and the Word was God. All things were made by him; and without him was not anything made that was made. In him was life; and the life was the light of men. And the light shineth in darkness; and the darkness comprehended it not" (John 1: 1-5),

"... the invisible things of him from the creation of the world are clearly seen, being understood by the things that are made, even his eternal power and Godhead ..." (Rom. 1: 20),

"... the heavens and the earth, which are now, by the same word are kept in store, reserved unto fire against the day of judgement and perdition of ungodly men. But, beloved, be not ignorant of this one thing, that one day is with the Lord as a thousand years, and a thousand years as one day" (2 Pet. 3: 7-8)

PREFACE

On the use of the term "cryogenic"

Cryogenic processes are thermophysical, physico-chemical and physico-mechanical processes occurring in freezing, frozen and thawing earth materials. Specific processes of cryogenic action include water migration during freezing and thawing of the ground, frost heave, heat and mass (moisture) exchange, regelation and gelifluction (Poppe & Brown, 1976, cited by Van Everdingen, 1998). This is a very specific definition of what constitute cryogenic processes. For the purposes of this study the term "cryogenic" is used as a generic term to include both periglacial and glacial features and processes. It must be kept in mind, however, that the term may fall short in including or describing certain features and processes, e.g. terracettes and solifluction.

On other terminology usage

The reader may refer to The Terminology Glossary (Appendix C) for terminology usage throughout the study.