A GLOBAL DIGITAL DATABASE AND ATLAS OF QUATERNARY DUNE FIELDS AND SAND SEAS

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INTRODUCTION

Sand seas and dune fields are globally significant sedimentary deposits, and occur on all continents at all latitudes. Many sand seas and dune fields have developed during the Quaternary Era, during which there have been significant changes in climate and sea level that have affected the supply, availability and mobility of sand.



The accumulation and present configuration of sand seas and dune fields therefore reflects the legacy of these changes, in addition to the effects of contemporary processes. Quaternary dune fields and sand seas therefore provide a valuable source of information on past climate conditions, including evidence for periods of aridity and unique data on past wind regimes.

The widespread application of luminescence dating to the study of dune fields and sand seas has enabled direct dating of periods of sand accumulation and stability.

These chronological data remain disconnected in time and space, however, making comparisons of dune systems at global and regional scales. This makes interpretation of the paleoclimatic significance of periods of aeolian accumulation challenging.

PROJECT GOALS AND OBJECTIVES

The primary goal of this project is to develop a global digital database of chronologic information for periods of inland sand dune accumulation and stabilization as well as pertinent stratigraphic and geomorphic information.

The database can then be used to:

1) Document the history of aeolian processes in arid regions with emphasis on dune systems in low and mid latitude deserts.

2) Correlate periods of sand accumulation and stability with other terrestrial and marine paleoclimatic proxies and records.

3) Develop an improved understanding of the response of dune systems to climate change.

The database is being compiled by a network of regional correspondents as part of INQUA Project 0704, a contribution to INQUA TERPRO (Commission on Terrestrial Processes, Deposits and History). More information on the database can found at http://inquaduneatlas.dri.edu.

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THE DATABASE

The database currently resides in Microsoft Access format, which allows searching and filtering of data. It consists of 4 linked tables containing:

- 1) Information on the site location, dune type, and stratigraphic context
- 2) Radiocarbon ages) Luminescence ages
- 4) Pertinent literature citations

The data are entered as-is from published sources supplemented by "grey literature" and theses and dissertations. There is no interpretation or "gate keeping" of data – thus all radiocarbon dates are reported as uncalibrated.

The database currently contains information for 1083 sites comprising some 3556 luminescence and radiocarbon ages. Numbers increase regularly as new data is added.

All entries in the database consist of point data and identify the site location from which they are derived. Data are linked to ArcGIS for display and searching on multiple criteria – e.g. dune type, time slice etc.



Current (October 2013) distribution of sites in Dunes Atlas Database.



Regional distribution of sites reflects research that has been carried out – not the real distribution of dunes.

Dune types represented are biased towards areas that have been studied. For example linear dunes represent about 60% of all dunes, yet are 26% of the dated sites.

GLOBAL PATTERNS

(19-26 ka)

The database can be used to examine global and regional patterns of dune activity.



FUTURE PLANS

Short term (2013)

A special issue of Quaternary International is being edited by Lancaster and Thomas. This will incorporate a series of reviews of data and interpretations for each major region incorporated in the database.

Medium term (2014)

A fully functional version of the database in Microsoft Access format will be finalized and made available via the web.

A web interface will be provided for data queries, submission of new datasets, and simple analyses and visualizations.

A Google Earth version of the database will be available to all.

Long term (2014 -)

The chronologic database will be expanded to include pertinent geologic, climatic and topographic data to provide a context for understanding how dune systems develop and interact with other physical and biological earth systems.



REGIONAL INSIGHTS

One strength of the database is that, for geographical areas that have ample data, the database can be used for more detailed investigations of the aeolian systems in these regions.

The North American Great Plains data set, for example, is comprised of over 800 ages from 50 discrete dune fields. Halfen and Johnson (2013) used this data to illustrate spatial and temporal patterns of dune activity before, during, and after the Medieval Climatic Anomaly (MCA).

The spatial patterns of dune activity after the MCA have helped delineate regional drought boundaries, particularly in the eastern Great Plains.

This spatial analysis has demonstrated that dune activity in the Great Plains within the last 1200 years was typical rather than the exception, despite fluctuations in climate.

Spatial analysis of dune activity in the Great Plains also makes possible more detailed analysis of the relationship between dune activity and regional shifts in climate.

Additional regional analyses, such as that investigating the wind vectors responsible for dune deposition may also lead to refined interpretations of regional paleoclimate.

Analysis of other database attributes will also provide new and important information for researchers in the future.



Great Plains dune activity from 1000–800 years ago in 50-year time-slices superimposed upon gridded Palmer Drought Severity Index data (Cook and Krusic, 2004).



Dune trend vectors of dune deposits in the North American Great Plains

REFERENCES





Great Plains dune activity from 1200–600 years ago in 100-year time-slices. Squares indicate activity supported by luminescence ages and circles by radiocarbon ages. (Halfen and Johnson, 2013).

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