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# Sedimentological/Palaeogeographic Data as Fundamental Building Blocks of the DDE Project: Critical Underpinning of Reconstructing Deep-time Earth Systems

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## 1 Introduction

Sedimentary rocks archive important information for understanding how the earth system operates and how life and environments have evolved through earth history. Properly identifying characteristics of sedimentary rocks, along with the subsequent interpretation of depositional processes and sedimentary environments in a basin or locality, are fundamental to inter-basinal correlation of sedimentary successions as well as to understanding and deconvolving regional and global processes that govern the formation of the sedimentary successions (Peters and Husson, 2018). Analogous to the successful paleontological and stratigraphic databases such as the Geobiodiversity Database (GBDB; Fan et al., 2014) and Macrostrat (Peters et al., 2018), synthesizing global sedimentological and palaeogeographic data is critical to understanding large-scale, long-term earth surface processes and to the allied fields of paleoecology, paleogeography, paleoclimatology, and paleoceanography.

The Deep-time Digital Earth (DDE) project provides a timely platform for the geoscience community to be engaged fully in the Big-Data era. The DDE project aims to reconstruct a deep-time earth system, of which sedimentological and paleogeographic data are fundamental building blocks. This paper addresses the working plan and prospects of the Sedimentology and Palaeogeography Groups.

## 2 Working Plan

### 2.1 Sedimentological knowledge tree

Sedimentology is one of the traditional sub-disciplines of geology, dealing mostly with compositions, structures, and inferred sedimentary processes and environments of sedimentary rocks. Establishing a logical sedimentological knowledge tree is fundamental to creating a systematic database. Here we tentatively propose a broadly tripartite outline including the primary division: the stratigraphic unit as the basic carrier of data, the secondary division: lithological, physical, chemical, and biological characteristics of the stratigraphic unit, and the tertiary division: further constituents of variable characteristics (Fig. 1). The preliminary version of the sedimentological knowledge tree has been established by the DDE sedimentology group and

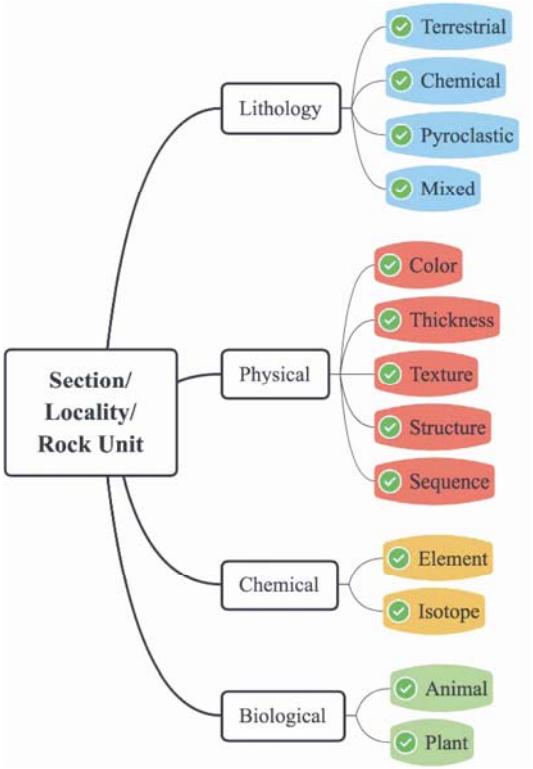


Fig. 1. Three-division outline of the sedimentological knowledge tree.

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discussed and evaluated among Chinese researchers, awaiting for further contribution from international scholars.

### 2.2 Palaeogeographic knowledge tree

Palaeogeography is the study of geographical features at periods in the geological past. The goal of the DDE Palaeogeography Group is to realize the reconstruction of palaeogeography in any area and any period based on systematic data, so that people can obtain multipurpose atlases of palaeogeographic maps at different scales. It will provide data and technical support for energy exploration prediction and global environmental evolution. Establishing a logical palaeogeography knowledge tree is fundamental to creation of a systematic database. Here we sum up the palaeogeographic elements that need to be displayed in atlases at the global and regional scales, then we subdivide each element into subfacies even microfacies that can represent the palaeogeographic environment, and list the geological evidence for facies classification, mainly: mineral, lithology, sedimentary structure and palaeoecology (Fig. 2). The preliminary version of the palaeogeographic knowledge tree has been established by the DDE Palaeogeography Group, and discussed among sedimentary researchers. This group's recommendations await for further finalization among international scholars.

### 2.3 Specific sedimentary database

Individual scientists (or collaborative groups) are encouraged to establish scientific question- or hypothesis-driven databases of specific focus in the broad field of sedimentary geology, including for instance, the distribution of global coal deposits, detrital zircon U-Pb ages, and carbonate strontium isotopes (Fig. 2). Such efforts can be funded and supported technically by the DDE project. Topic-specific databases will be interconnected and searchable within the sedimentological knowledge tree. Although the database will be open and free to use, anyone who intends to use it for his or her own studies if he/she wishescan assess interactively the reliability of the database as part of their efforts to contribute his or her own data. In this manner, the more the database is used, the more robust its data will become.

### 2.4 Palaeogeographic/palaeoclimate reconstruction

In the DDE palaeogeographic reconstruction includes six aspects: lithofacies palaeogeography, climatic palaeogeography, tectono-palaeogeography and biogeography. Reconstruction of tectono-palaeogeography requires information about plate locations and a basin's boundary attributes in geological time from related tectonic and paleomagnetic databases. Biogeographic reconstruction requires that the DDE Palaeogeography Group collaborate with the Palaeontology Group, the Stratigraphy Group, or the Sedimentology Group to establish scientific question- or hypothesis-driven databases for specific topics. At present, reconstruction of lithofacies and climatic palaeogeographies require defining time interfaces, then mapping atlas for different ages separately based on sedimentary lithofacies, climate-sensitive sediments, etc. In the future we hope to refer to and employ the principles of faces classification in our attempt to evaluate each piece of geological evidence quantitatively and finally, to establish a comprehensive mathematical geological model automate the mapping and prediction of the likely characteristics of different areas in

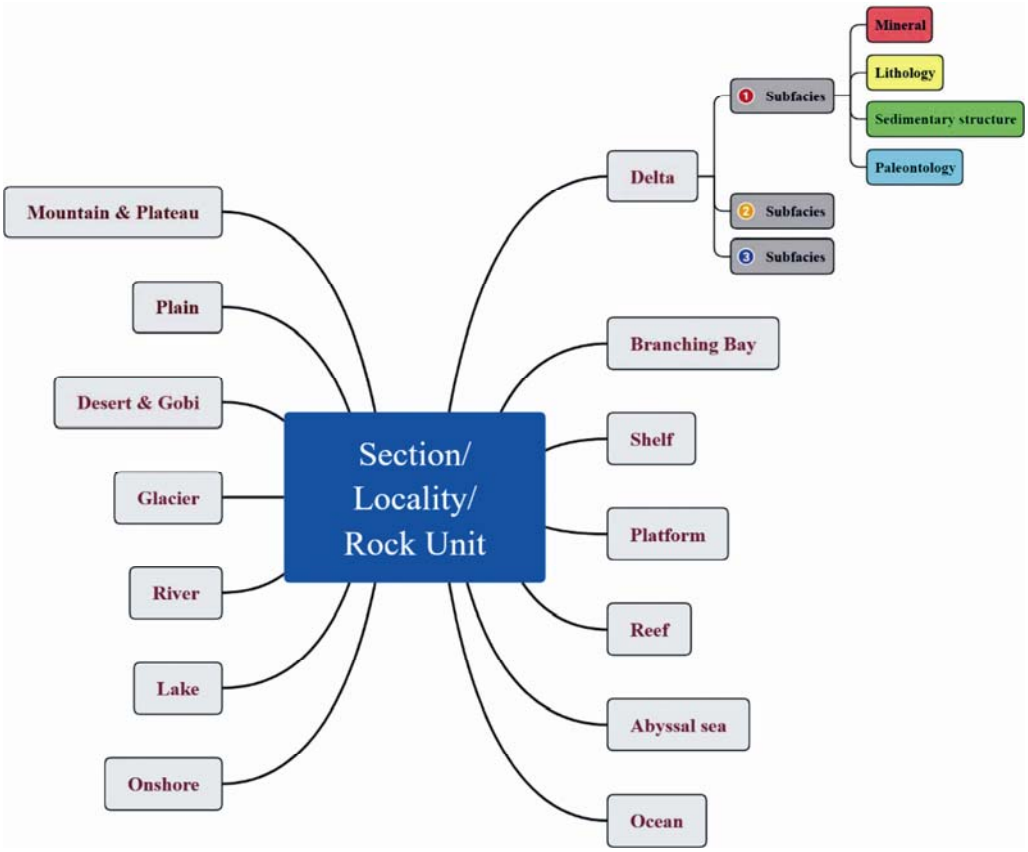


Fig. 2. Outline of the palaeogeographic knowledge tree in regional scale.


Fig. 3. Sedimentological database of specific topics.

different periods where data is lacking.

**Keywords:** sedimentology, palaeogeography, Earth system, Deep-time Digital Earth, data science

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