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Global Paleogeography through the Proterozoic and Phanerozoic: Goals and Challenges

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Paleogeography is the merger of lithology, depositional environments, tectonic plate movements, topography, climate patterns and ecosystems (reefs, vegetation) through time (e.g., Scotese, 2014, 2016, 2017; Blakey, 2019). The construction of paleogeographic maps using tectonic plate reconstructions requires a multi-year community effort that shares databases, standards and computer projection methods.

The five main components are (1) compilation of depositional and volcanic histories of all regions on each plate using high-resolution age control (e.g., Scotese and Schettino, 2017), (2) models of the motion of tectonic plates based on integration of marine magnetic anomalies, paleomagnetic poles, hot-spot tracks, continental tectonic histories (collision zones, etc.) and plate tectonic rules (e.g., Torsvik and Cocks, 2017; Zahirovic et al., 2016), (3) the challenge of filling gaps in the preserved geologic and geophysical records, (4) visual output of the paleogeography as time-slice maps or digital animations, and (5) use of these paleo-maps to simulate paleoclimate and ecosystem characteristics. In turn, these visualizations often provide feedbacksfor the re-evaluation of databases and tectonic plate models.

There several existing major databases on regional depositional histories that could ideally collaborate on the global paleogeographycomponent of the proposed Deep-Time Digital Earth system. These include public ones, such as PaleoBiology Database (PBDB), Macrostrat, IODP, Geo Bio Diversity Database (GBDB), national geological surveys, One Geology, and commercial ones, such as the compilations by IHS, Neftex and international petroleum corporations. A challenge is how to balance the commercial and academic purposes for the benefit of all, yet to achieve the best public-accessible integration of relevant information at the appropriate scale.

The standardization of interpreted depositional facies and the patterns and types of volcanic activity provide initial estimates of paleo-topography, water depths and plate interactions through time to accompany the models of plate tectonic movements.The main public interface for displaying tectonic plate motion with superimposed geographic features onto a globe through time is community GPlates system (Earth Byte Group, 2019). The reference list (below) includes links to representative videos of global paleogeographic histories and to associated websites.

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We are preparing a trial regional-scale paleogeography of East Asia to test methodologies foreffective collaboration among research groups, synthesis and standardization of **d**istributed datasets, and integration into paleogeographic base maps that are projected on plate tectonic reconstructions that are produced using the GPlates visualization platform. Figure 1 illustrates avisualization of the China plates using the most recent (1985) set of published paleogeographic maps spanning the entire Phanerozoic (e.g., Wang et al., 1985). A movie version is included as a supplement to Hou et al. (2019).An updated suite for pre-Mesozoic of these China plates was published in 2010 (Zheng et al., 2010) and is also a supplement to Hou et al. (2019). However, there are no similar detailed compilationsthat

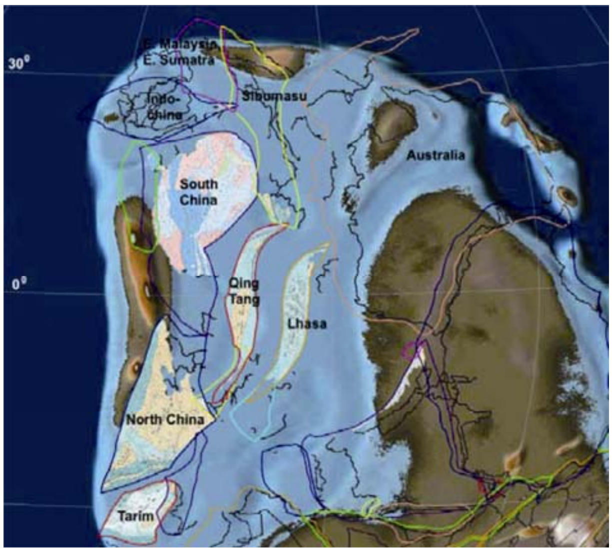

Fig. 1. Example of using GPlates to superimpose published lithofacies maps of China onto a reconstruction for the Middle Ordovician.
The scanned source maps (Wang, 1985, for all China, with an additional separate overlay of South China from Ma et al., 2009) were rectified, then assigned numerical ages based on an update of the China Stratigraphic Chart (National Commission on Stratigraphy, 2012), and uploaded into GPlates. GPlates enables an automatic assignment to the underlying plate boundaries in the modern world to dissect the raster image into plate components. The China lithofacies maps were rotated according to the selected plate-motion model and projected on an additional layer of interpreted paleotopography, which in this example was modified from Scotese (2016). Figure by Gabi Ogg is modified from Hou et al. (2016).

http://www.geojournals.cn/dzxbcn/ch/index.aspx
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include adjacent plates. Research challenges include the disputed placement of East Asian plates prior to the Triassic, the consumption of major portions of oceanic margins during the accretion process that formed modern Asia, and the correlation of terrestrial deposits. Therefore, a multi-institutional coordinated paleogeography program with shared user-friendly databases and visualization outputs from the basin- to inter-regional scale should be a major goal in the Asian component of the “Deep-Time Digital Earth” program.

Examples of paleogeographic reconstruction visualization videos using GPlates:
EarthByte YouTube Channel: *https://www.youtube.com/channel/UCa41IQEhmmuXmz9J6iMfsnA?spfreload=10*
Scotese Paleogeographic Map Project: *https://www.youtube.com/user/cscotese*, and *https://www.youtube.com/watch?v=g_iEWvtKcuQ*

Key words: Paleogeography, GPlates, Asia, China, databases

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