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The integration of palaeogeography and tectonics in refining plate tectonic models: an example from SE Asia

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Our understanding of lithospheric evolution and global plate motions throughout the Earth's history is based largely upon detailed knowledge of plate boundary structures, inferences about tectonic regimes, ocean isochrons and palaeomagnetic data. Most currently available plate models are either regionally restricted or do not consider palaeogeographies in their construction. Here, we present an integrated methodology in which derived hypotheses have been further refined using global and regional palaeogeographic, palaeotopological and palaeobathymetric maps. Iteration between our self-consistent and structurally constrained global plate model and palaeogeographic interpretations which are built on these reconstructions, allows for greater testing and refinement of results.

Our initial structural and tectonic interpretations are based largely on analysis of our extensive global database of gravity and magnetic potential field data, and are further constrained by seismic, SRTM and Landsat data. This has been used as the basis for detailed interpretations that have allowed us to compile a new global map and database of structures, crustal types, plate boundaries and basin definitions. Our structural database is used in the identification of major tectonic terranes and their relative motions, from which we have developed our global plate model. It is subject to an ongoing process of regional evaluation and revisions in an effort to incorporate and reflect new tectonic and geologic interpretations. A major element of this programme is the extension of our existing plate model (GETECH Global Plate Model V1) back to the Neoproterozic.

Our plate model forms the critical framework upon which palaeogeographic and palaeotopographic reconstructions have been made for every time stage in the Cretaceous and Cenozoic. Generating palaeogeographies involves integration of a variety of data, such as regional geology, palaeoclimate analyses, lithology, sea-level estimates, thermo-mechanical events and regional tectonics. These data are interpreted to constrain depositional systems and tectonophysiographic terranes. Palaeotopography and palaeobathymetry are derived from these tectonophysiographic terranes and depositional systems, and are further constrained using geological relationships, thermochronometric data, palaeoaltimetry indicators and modern analogues. Throughout this process, our plate model is iteratively tested against our palaeogeographies and their environmental consequences. Both the plate model and the palaeogeographies are refined until we have obtained a consistent and scientifically robust result.

In this presentation we show an example from Southeast Asia, where the plate model complexity and wide variation in hypotheses has huge implications for the palaeogeographic interpretation, which can then be tested using geological observations from well and seismic data. For example, the Khorat Plateau Basin, Northeastern Thailand, comprises a succession of fluvial clastics during the Cretaceous, which include the evaporites of the Maha Sarakham Formation. These have been variously interpreted as indicative of saline lake or marine incursion depositional environments. We show how the feasibility of these different hypotheses is dependent on the regional palaeogeography (whether a marine link is possible), which in turn depends on the underlying plate model. We show two models with widely different environmental consequences. A more robust model that takes into account all these consequences, as well as data, can be defined by iterating through the consequences of the plate model and geological observations.