Understanding basin evolution using global data sets

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Abstract

The formation and evolution of broad intraplate sedimentary basins is usually attributed to failed, unsuccessful rifting followed by thermal cooling and subsidence of the lithosphere. However, the tectonic subsidence history of basins such as the West Siberian Basin, Central European basin or the Australian Canning and Eromanga Basins deviates from that expected from a simple failed rift basin. Intraplate basins often form on a very heterogeneous basement, sometimes referred to as "accretionary crust". In this context we define accretionary crust as crust having formed in Phanerozoic times by a series of continent-continent, arc-continent or terrane-continent collisions, incorporating major geological boundaries or sutures. This means, the basins form on relatively new, young continental lithosphere which is, due to its incorporated inhomogeneities, rheologically weaker than relatively old and stable continental lithosphere (e.g. shields and cratons).

It appears, that the simple post-rift thermal subsidence model is not applicable to those basins on accretionary crust, and that we have to consider a broader variety of parameters when modelling the basin history. Not only the architecture of the basin-underlying substrate has to be accounted for but also a range of geodynamic processes, like the position of these basins relative to mantle upwellings/downwellings or active plate boundaries, the response to changes in relative plate motions and igneous processes. Much of this information is already available, but the community is lacking tools and workflow implementations to explore the large parameter space, extract the necessary data for a given scenario and process the large amount of geological and geophysical information and meta-data in such a way that a input for numerical models can easily be generated.

We investigate the formation and evolution of basin regions as described above by analysing their crustal structure, geology and plate tectonic history using a combination of an open-source geospatial database (PostgreSQL with PostGIS), freely available data and plate tectonic reconstruction tools glued together by Python scripts and XML. The purpose of this analysis is to generate and store a large amount of observational data using an automated workflow and derive a set of generalised parameters (e.g. thickness and 2D/3D geometry of various crustal layers, Moho temperature, crustal extension factors, tectonic subsidence) that will be used as input for geodynamic basin modelling. Using this workflow we create a library of classes of basin formation scenarios and corresponding numerical model outputs. This method facilitates a better understanding of the complex geological evolution of intraplate basins.

Keywords: intraplate sedimentary basins; plate tectonics; global data analysis; geospatial databases; workflow