Geophysical Research Abstracts
Vol. 18, EGU2016-14821, 2016
EGU General Assembly 2016

The rift architecture and extensional tectonics of the South China Sea

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Non-volcanic rifted continental margins are classically described as the product of lithospheric stretching and breakup leading to mantle exhumation, and subsequent seafloor spreading. However, recent studies question this model and indicate a wider range of structural evolutions, that challenge the existing model (e.g. Australia-Antarctic Rift System (Direen et al. 2007, 2011); the Tyrrhenian basin (Prada et al., 2014) or the South China Sea (Cameselle et al. 2015)).

Rifting in the South China Sea developed from a series of extensional events, from early Eocene to Late Oligocene, resulting in a V-shape oceanic basin affected by the occurrence of several spreading centers, ridges, transform faults and post-spreading volcanism. In recent years, this marginal basin – the largest in East Asia – has increasingly become one of the key sites for the study of rifting and continental break-up. Its relative small size – compared to many classic, Atlantic-type continental margin settings – allows to easily match conjugated rifted margins and its relative youth promotes the preservation of its original nature.

To examine the rifting evolution of the South China Sea, we have reprocessed with modern algorithms multichannel seismic profiles acquired during Sonne49 and BGR84 cruises across the three major subbasins: NW, SW and East subbasins. State-of-the-art of processing techniques have been used to increase the signal to noise ratio, including Tau-P and Wiener predictive deconvolution, multiple attenuation by both radon filtering and wave-equation-based surface-related multiple elimination (SRME) and time migration. To complement seismic interpretation, available vintage multichannel seismic data have been reprocessed with a post-stack flow, including Wiener deconvolution, FK-filtering, space and time variant band-pass filter and time migration.

The improving quality of the seismic images shows a range of features including post-rift and syn-rift sediments, the structure of fault-bounded basement blocks, fault reflections, and crust-mantle boundary reflections, which defines the tectonic structure formed during rifting. The images clearly show the progressive thinning of the continental crust related to different styles of faulting. The continental and oceanic domains can be distinguished based on their different tectonic styles and supported by published magnetic anomalies. Between both crustal domains, the continent-ocean transition is interpreted as an abrupt change in tectonic style and some characteristics features. It can be defined in most seismic profiles at both conjugated margins of the South China Sea subbasins, providing key information to understand the mechanisms for crustal extension and to discuss the classical pure- and simple-shear extensional model.

Seismic profiles are distributed spatially and with a direction perpendicular to the continental margin, which have allowed studying the structure and variability of the continent-ocean transition along-strike. The resulting information helps to understand the processes involved in the last stages of continental rifting, directly before the final breakup of continental crust, the final emplacement of the spreading centre, and the earliest stages of seafloor spreading.