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Magma-assisted strain migration during the progression from rifting to break-up

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It is important to understand a mechanism of the strain redistribution in order to progress our understanding of sedimentary basin migration and/or continental-ribbon/micro-continent insulation. The change in the lithospheric strength due to thermal relaxation and/or replacement of weaker crust with stronger mantle has usually been considered as a possible mechanism that cases successive deformation to migrate to adjacent regions. This is, however, hardly applicable for an extensional process that can lead to continental break-up. In our previous studies (Yamasaki and Gernigon, Tectonophysics, 468, 169-184, 2009; J. Geol. Soc. Lond., 167, 961-971, 2010), the effect of underplated mafic bodies (UPMB) on the redistribution of extensional strain was examined quantitatively, in which UPMB is emplaced beneath a different region some time after the first rifting process has initiated. It was showed that there possibly exist three different modes of strain redistribution, 1) a shift-completed mode: the strain is completely shifted into a newly weakened region, 2) a transition mode: the strain is redistributed, but lithospheric extension is accommodated by thinning in two regions and 3) a shift-failed mode where the strain is not redistributed. The modes are dependent on the configuration of UPMB and on the initial rheological heterogeneity in the initially deformed region, but it becomes difficult for any UPMB to initiate the redistribution of the deformation once the stretching factor in the first deformed region exceeds a critical value. The general model behaviour can characterise the dynamic process of the strain migration, in terms of which the geological process observed during rifting and break-up is discussed in this study, providing an important implication for a typical rift/margin configuration that the shift-completed or transition mode can be applied for the regions where UPMB has been clearly observed (e.g., the Indian Ocean, the Norwegian-Greenland Sea, the Red Sea/Afar region, the Western Barents Sea and the Brazilian margin).