Continental rifting results from extensional deformation of the continental lithosphere leading to its rupture and potentially subsequent formation of a new oceanic domain. Rifting plays consequently a major role in the evolution of the continental lithosphere and, in particular, in the so-called Wilson cycle describing the cyclical opening and closing of oceans during the Earth's history. However, the rifting does not always continue up to its end, and many rifts become inactive before the emplacement of oceanic crust, remaining "rifted basins" and not continental margins.

Two different processes have been proposed to explain rifting: either horizontal extensional forces acting at the lateral boundaries of the system or a heat source acting at the bottom of the lithosphere. In the first case, the required far-field stresses are essentially related to the "slab-pull" mechanism, while in the second, a connection with a mantle plume is envisaged. These two mechanisms, which can lead to the lithosphere breaking, correspond to the concepts of "passive" and "active" rifting, respectively. A passive style of rifting is mainly characterized by (1) the existence of a structural heritage, and (2) volcanism occurring during and after rifting. Secondary criteria are the development of wide and long-lived rift systems and the absence of pre-rift uplift. An active style is characterized by (1) the existence of a pre-rift uplift (hiatus between the pre- and syn-rift sediments), (2) volcanism before rifting, and (3) the absence of structural inheritance.

The Dniepr-Donets Basin (DDB) is the largest continental rift basin in Europe that is approximately 2000 km long, up to 170 km wide, and 22 km deep. It also represents one of a few examples of continental rifts worldwide that cut through an old Precambrian craton, seemingly running perpendicular to its structural grain. Rifting a thick and rigid cratonic lithosphere requires an effective rifting mechanism driving this process. An active versus passive mechanisms have been discussed in the case of the DDB, but no clear evidence has been presented for any of these hypotheses. Also, geometry and kinematics of the rift basin remains disputable with some features indicating asymmetric basin related to simple shear deformation, whereas others point out to a symmetric rift shaped by pure shear stretching. In this project, we are going to test a working hypothesis according to which the mechanism responsible for creating the largest rift in Europe, the DDB, is passive rifting that was initiated in the Late Devonian by back-arc extension in response to subduction of the Palaeo-Thetys Ocean.

We are going to use a combination of borehole and seismic data to verify a three-dimensional structural geometry of the rift zone investigating its possible asymmetry. The latter would be a manifestation of a simple-shear component in finite extensional strain that is characteristic of passive mode of rifting. We will also test the innovative idea that a major detachment fault through the entire crust, responsible for a crustal scale inversion of the Donbas fold belt, reactivated a system of syn-rift extensional shear zones. By means of potential field data, we will further explore the recent observations on the role of pre-existing Precambrian structures for the localisation of the DDB despite its apparent obliquity to Proterozoic structural grain. Finally, we will use thermochronological data to constrain timing of basin subsidence and subsequent uplift providing better time limits for tectonic processes.

Project is divided into 6 research work packages that are closely interrelated: (1) seismic imaging and interpretation od the rift structure, (2) basin subsidence 1-D and 2-D modelling constraining rift evolution, (3) gravity and magnetics processing, interpretation, 2-D and 3-D modelling to recognise a rift-related lithospheric architecture, (4) seismic analysis of salt tectonics to account for modifications to an internal rift structure caused by salt mobility, (5) apatite fission track (AFT) analysis and zircon U-Th/He (ZHe) thermochronology to know the time of basin frames uplift and basin inversion, and (6) construction of an integrated structural model of the DDB. These tasks will be mostly based on integration of geological and geophysical data, their processing and interpretation aided by numerical modelling.

Our project will contribute to better understanding of processes leading to continental break-up and resultant opening of oceanic basins. We will be able to assess whether mantle plume activity is a necessary pre-requisite for initiation of rifting. The control exerted by salt tectonics on evolution of rift basins as well as mechanisms and timing of basin inversion are additional goals of our project. We will be able to build a bridge between deep crustal processes driving continental rifting and their shallow level manifestation in the structural style of the rift's sedimentary fill.