Structures and deformations correlated to the activation of a major shear zone. Multi-scale study of the Eastern boundary of the Terre Adélie craton. (Mertz shear zone, East Antarctica)

The study of the behaviour and the structure of large shear zones, as well as their evolution in space and times is essential because shear zones accommodate the main deformation in intermediate and deep crust as well as in the mantle.

The Mertz shear zone (MSZ ; longitude 145_East, Antarctica) is a key target for the study of the deformation localization. The MSZ is located on the eastern boundary of the Neoarchean to Paleoproterozoic Terre Adélie craton (TAC) and it separates the TAC from a Paleozoic granitic domain to the east. Previous studies suggest that this strike slip structure was probably continuous with the Kalinjala shear zone (KSZ, South Australia) before the opening of the Southern Ocean. Outcrops indicate that the MSZ was formed in the intermediate crust during a transpressive event at 1.7Ga.

The structure of the MSZ was studied from terrain to micrometric scales. The field structural study shows that the Paleoproterozoic deformation is mainly accommodated by localized shear zones that are extremely anastomosed at the MSZ and become more scattered elsewhere in the TAC. Microstructures and crystallographic preferred orientation (CPO) of minerals (quartz, feldspaths, biotite, amphibole and orthopyroxene) of the MSZ indicate similar characteristics that can be interpreted in terms of conditions, cinematic and rate of deformation, which are distinct from those of the the tectonic boudins from the TAC. These tectonic boudins reveal microstructures and CPO including a large variety of mechanisms of deformation developed during their formation at 2.5 Ga.

The seismological study (receiver functions and SKS-waves anisotropy) permits the characterization of the deep structure on the MSZ area. Receiver functions results show that crustal thickness is about 40 to 44 km in the TAC, 36 km above the MSZ and 28km in the Paleozoic domain to the east. Analysis of SKS-waves anisotropy suggests that the mantle structures below the craton (ϕ=N90°E, δt=0,8-1,6 s) are different from the ones below the Paleozoic domain (ϕ=N60°E, δt=0,6 s). Thus, the MSZ constitutes the boundary between two lithospheres with distinct crustal thicknesses and mantle structures.

The geochronological study (U-Pb dating on zircon and monazite) reveals that the basement of the domain located to the east of the MSZ has a di_erent age and geodynamical story than the TAC. Inherited Archean and Paleoproterozoic ages are similar to those of the terrains located to the east of the KSZ in South Australia that con_rms the connection between the Mertz and Kalinjala shear zones. Moreover, the inherited and metamorphic Paleozoic zircon ages as well as the geographic location of the outcrops west of the Transantarctic mountains suggest that studied samples are derived from a pre-Gondwana passive margin formed in a back-arc basin opened in the continental crust just before the Ross orogeny at 514-505 Ma.

This multi-scale approach thus permits precise the geodynamic evolution of the region located east of the MSZ and provide new elements for Australia-Antarctica connection. Moreover, this thesis highlights the importance of tectonic inheritance in the development of shear zones (with the presence of archean inherited structures in the case of the MSZ), as well as localization processes in cratonic lithospheres from at least the Paleoproterozoic times.