Ecole Doctorale des Sciences Fondamentales

Title of the thesis: The origins and significance of U-Pb isotopic discordance in monazite: A case study from the UHT Archean Napier Complex of East Antarctica and the contribution of nanoscale correlative microscopy.

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Project Summary:

The Archean Napier Complex (Enderby Land, East Antarctica) consists of multiply-deformed high-grade, ultrahigh temperature (UHT) granulite facies gneisses, and contains some of the oldest exposed rocks Earth as old as 3.8 Ga *[1, 2]*. While zircon crystals from this area have been widely studied to constrain the timing and durations of events, monazite crystals have been studied rather less. Nevertheless, *Black et al. [3]* in a seminal paper have documented very intriguing features in monazite grains from the Zircon point in the Casey Bay area. The grains, extracted from a UHT paragneiss, form different color (brown, yellow and grey) populations, each of which having a distinct U-Pb isotopic composition and position along a *discordia* line. Despite this, the grains present no significant variation in their chemical compositions between populations, and no difference in terms of nanostructure. The observed discordance was explained to result from different proportions of Pb loss, probably due to interactions with fluid; however no convincing mechanism was given to explain this phenomenon.

The objective of this study is to re-investigate the distinctive monazite grains from *Black et al. [3]* with state-of-the-art geochemical and mineralogical analytical tools down to atomic scale. In particular, the development of nanoscale correlative microscopy, a new technic combining structural (with latest generation Transmission Electron Microscope instruments-TEM) and isotopic (Atom probe tomography-APT) information down to atomic scale, will bring new data allowing to better understand the mechanisms that may disturb the radiometric ages, and to improve the dating of rocks that have undergone such a complex geological evolution *[4-6]*. We expect to obtain results that will enable the identification of a mechanism to explain the variable Pb loss from these monazites and hence more broadly the behaviour of monazite in the deep crust and approaches to its use in geochronology. These results will provide new information on the timing of geological events associated with the post-cratonisation history of the Napier Complex and hence evolution of East Antarctica. The monazite results will be compared and integrated with zircon data from the same area to provide an assessment of the different responses of the minerals to the geological processes that have affected them.

This thesis is highly international, in particular through the collaboration with the Curtin group for the atom probe analysis, which will require several stays in Australia.