Geophysical Research Abstracts
Vol. 21, EGU2019-9256, 2019
EGU General Assembly 2019

Onset of plate tectonics on Earth and implications for habitability

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Understanding the geodynamic processes of the Early Earth is crucial because they have strong implications for the habitability of the Earth but also for other planets. The Earth is the only proven planet in the solar system displaying lithospheric plate tectonics. However, plate tectonics on Earth did not always function as today, and the Archean was likely characterized by a stagnant-lid regime. Characterizing the transition from ancient to modern-style geodynamic regimes, including subduction process, is therefore important to understand the evolution of our own planet but also to compare our model to other rocky planets in our solar system.
Here, we have characterized the oldest high pressure and low temperature eclogite worldwide (2089 $\pm$ 13 Ma) discovered in the Democratic Republic of the Congo (Kasai Block). Eclogites are generally only produced in subduction geodynamic setting. Moreover, we have identified the protolith of this eclogite, a gabbro, which formed 2216 $\pm$ 26 Ma ago in a narrow basin opening in a continental environment, and was then buried at $\sim$55 km in the mantle by subduction, before being exhumed to the surface during a complete Wilson cycle lasting about 130 Ma. This discovery evidences a modern-style plate tectonics operating since at least 2.2-2.1 Ga. This highlights the fundamental differences between the ancient Earth, without plate tectonics, and the modern Earth, as we know it today. The appearance of plate tectonics had important impacts on Life evolution on our planet, with an increasing supply of nutrients by erosion, increasing diversity of ecological niches and geographic isolation leading to increasing biodiversity, variable climatic conditions and oceanic circulation, as well as volcanic gases of different composition that may have influenced the composition of our atmosphere.