

The current state of the Earth is controlled by both the initial conditions set at birth and the Earth's specific evolutionary pathway. Yet, despite this critical dependence, and the plethora of data the Earth provides, we know very little about the specific initial conditions of the Earth (let alone any other planet). Additionally, the path the ancient Earth took to the present day is obscured in missing, biased, and often contradictory geologic and geochemical evidence. Therefore, even the simplest understanding of the Earth is very far from complete. This leads to the critical query of when plate tectonics started, and even why the Earth has plate tectonics in the first place. Natural questions arise, if the Earth was not always in a plate tectonic regime, what came before? What comes next? How does the planet lose heat, or cycle volatiles? To interrogate these questions we will use the Solar System and geodynamic models of planetary evolution and ask if we can 'backcast' to the true initial conditions or evolutionary history of the Earth? We will review the nature of plate tectonics, and explore the plethora of different tectonics found throughout the solar system, and those predicted by cutting edge physics based models.