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Editorial

Lid tectonics – Preface

The idea that plate tectonics may not have operated deep in Earth's Precambrian past has a long legacy. What predated plate tectonics is unknown, and advances in data – from geochemical, geological and tectonic, to paleomagnetic, as well as modelling approaches, and planetary science, have the potential to contribute significantly to the debate. To contrast with the activity of plate tectonics, in this issue we use the term 'lid tectonics' to encapsulate a variety of envisaged regimes – from stagnant, sluggish, plutonic-squishy, or heat pipe – which are characterized by comparatively subdued tectonic signatures.

This special issue of *Geoscience Frontiers* aims to present a snapshot of current research in the field of lid-tectonics – from detailed field interpretations, to global conceptual models, data compilations, and insights from simulations, and provide unique insights into both the Precambrian Earth, and the dynamics of lid-tectonics.

In the first paper, Wyman (2018) addresses the question of whether cratons possess evidence of a stagnant-lid tectonic regime. He synthesizes a wide range of geological, geochemical, and tectonic constraints, as well as observations from geodynamic modelling, to argue that the Superior craton possesses evidence of a stagnant episode between 2.9 and 2.8 Ga, which may have implications for the style of plume dynamics seen at ~2.7 Ga, their scale, and their source region.

Following this, Bedard (2018) argues for a primarily stagnant early Earth with volcanism largely driven by fertile overturning upwelling zones (OUZOS). In this model, convergence is accommodated by imbrication and subcretion, with modern-day style i.e. steep subduction, only beginning with the development of stronger, negatively buoyant plates in the Neoarchean.

Condie (2018) explores variations in mantle incompatible elements to show that the evolution of depleted and enriched mantle domains is fairly unique to Earth. He then assesses the geological record for transitions in tectonic regime, arguing that rocks formed between zircon peaks in the interval of 4–2 Ga are similar to other periods, but that major geochemical and geological changes between 3 and 2 Ga, including the 'thermal divergence' of the mantle, may be related to the propagation of tectonics.

Piper (2018) argues that, unlike plate tectonics, the presence of lid tectonics is testable on the Precambrian Earth, and presents an updated paleomagnetic database PALEOMAGIA to assess Precambrian apparent polar wander paths. He identifies three intervals where APW paths slow-down significantly ~2650–2200 Ma, 1550–1250 Ma, and ~800–600 Ma. Concentration of the poles near the centre of continental lids are argued to suggest a polar configuration of stable continents over long periods of geological time, except for episodes of rapid APW motions at 2.7 Ga and 2.2 Ga. The paleomagnetic signature at 0.6 Ga of breakup of the supercontinent Rodinia marks the end of quasi-static Precambrian lid-tectonic style.

Weller and Lenardic (2018) show that the tectonic states of terrestrial planets are non-unique, and that two identical planets, with the same physical properties, may exhibit different tectonic regimes due to small variations in initial conditions, or surface temperatures – a feature they dub 'bi-stability'. They show that perturbations in surface temperature, perhaps due to Venus's atmospheric evolution, have the potential to cause a bifurcation in tectonic evolution.

Stern et al. (2018) assesses the geological activity of twenty-six solar systems planetoids (planets and moons) over 500 km in diameter, including eight rocky and eighteen icy bodies. They develop a tectonic activity index (TAI) based on the recent incidence of faults/folding, volcanism/geyserism, and resurfacing based on impact cratering. They argue that nine bodies exhibit tectono-volcanic activity, with six being within a stagnant lid, two in a non-plate tectonic fragmented lid, and one – Earth – exhibiting plate tectonics.

We hope this special issue provides a fascinating insight into the recent evolution of the thought on the nature of lid-tectonics, and its application to the Precambrian Earth. The Guest Editors would like to thank the *Geoscience Frontiers* editorial staff, and especially Prof. M Santosh for the chance to develop this volume, and Dr. Lily Wang for her assistance. We would also like to thank the authors for their incredibly insightful contributions, and all the reviewers for their time and feedback on the submitted manuscripts.

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