Convective patterns in viscous planetary interiors

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Abstract. The cooling and evolution of a planet strongly depends on the convective regime prevailing in its mantle (e.g. the 2900 km-thick enveloppe of solid rocks under our feet on Earth). Geophysical data show that the planets and rocky satellites of our solar system undergo very different evolutions and present-day dynamics. But the conditions necessary for convection to generate plate tectonics and quasi-continuous resurfacing on Earth, episodic resurfacing on Venus, heat pipes on Io, or no resurfacing on Mars, remain strongly debated. The difficulty comes from the complexity of rocks rheology : viscous at high temperature and on long time-scale, brittle at low temperature and short time-scale. This « soft matter » behaviour can be recovered in the laboratory using aqueous colloidal dispersions, whose rheology varies from viscous to elasto-visco-plastic to brittle when their temperature, and/or their water or ionic content, vary. We therefore have investigated the characteristics of thermal and solutal convection in those systems. They show a diversity of convective regimes, including the ones encountered in rocky mantles. Their physical understanding provides insights on the dynamics of planetary interiors.