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Formation of polygonal fault systems as a result of hydrodynamical instabilities in clay-rich deposits.

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Fine grained deposits as chalks and clays are characterised by the development of polygonal fault systems [1]. For the clay-rich deposits, two different environments are associated with their formation. First, on continents, dewatering leads to the development of polygonal desiccation cracks which have a centimetric to metric size [2]. Polygonal faults are also observed in sub-marine sedimentary deposits and here, can reach hectometric to kilometric size [3]. Since the giant polygons develop on basins with no clear evidences of tectonic stresses, the fracturing is attributed to stresses due to horizontal density variations generated during the basin subsidence. Several models have been proposed to explain the formation of the giant polygons and the two main hypotheses are the syneresis (spontaneous horizontal contraction) proposed by [4] and the low coefficient of friction of clay proposed by [5]. However, new understandings in the clay rheology and in the hydrodynamical instabilities, controlling the development of compaction in unconsolidated and consolidated clay deposits, permit us to propose an alternative hypothesis. We consider that the development of giant polygons results from the superposition of hydrodynamical instabilities leading to the formation of (i) mm-size agglomerates of clay particles while the deposit is unconsolidated [6], followed after by the consolidation of this layer, then (ii) hectometric to kilometric compaction spheres develop [7] and (iii) finally ends with the occurrence of hydrothermal and plastic convections. We show that the crucial conditions for the development of hectometric to kilometric size polygonal fault systems are: 1) the high permeability of the clay-rich deposit composed of mm-size agglomerates and 2) the dramatic increase of the strength of the clay as the deposit consolidates.

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