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Km-scale polygonal seafloor depressions in the Hatton Basin: New clues on the origin of polygonal fault systems

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Polygonal faulting is widespread in sedimentary basins worldwide. It is of importance for basin-scale fluid flow patterns and it changes the physical properties of the sediments. It is generally accepted that polygonal fault patterns derive from dewatering and compaction of the host sediments, but there is heated debate regarding the processes that control polygonal faulting. New multibeam-bathymetry data from the Hatton Basin, NE Atlantic, show up to 10 m deep and 20-30 m wide troughs at the seabed. They connect to each other forming polygons that are several hundred meters across, i.e. of similar size as buried polygonal fault systems observed in 3D seismic data. The troughs are symmetrical and resemble elongate pockmarks. Previously unpublished high-resolution seismic data from the same area show seismic disturbance zones similar to pipes observed under pockmarks elsewhere. Both data strongly indicate that the polygonal pattern forms through focused fluid migration. This has several important consequences: (1) the fluid migration pathways are weakness zones that develop prior to the polygonal faulting proper. This is a pre-requisite of the hypothesis that residual shear strength controls polygonal faulting, and the absence of such weakness zones has been the main point of criticism of this hypothesis. (2) Development of the polygonal patterns at the surface shows that surface processes are important for their origin. Analogy with polygonal surface patterns in salt lakes, permafrost regions in drying starch suggests that the processes are slow, because in all these cases the size of the polygons is reciprocal to the duration of the formation, which is controlled by stress focusing.