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Onset of an Ordovician ice stream in the Djado Basin.

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Ice streams are corridors of fast-flowing ice within an ice sheet. The recognition of ice streams in the ancient record is crucial in reconstructing palaeo-ice sheet extent and dynamics, over the whole duration of the glaciation thanks to stratigraphy. It is an opportunity to access physical processes acting at the base of ice streams and to identify factors controlling their onset. This is still a matter of debate for present-day ice streams.

The Late Ordovician ice sheet developed on Gondwana and underwent two polyphased, major advances and recessions. In the southwestern Djado Basin, these stages were recorded by two main glacial pavements, separated by a 20 to 80 m-thick glaciomarine to marine succession made up of muddy diamicton. Strong evidence of palaeo-ice stream activity has been found in this area, located 700 km south of the maximal ice front (highly attenuated subglacial lineations, pervasive soft-bed deformation, glacial palaeovalleys). Unlike recent, generally coarse subglacial sediments, those of the Djado Basin are fine, with very visible deformation structures, allowing the chronology of subglacial processes to be reconstructed.

The structural approach applied to glacial pavements and subglacial bedforms, observed at outcrop and thin-section scale, reveals that glacier bed lithology controls the deformation sequence. The basal glacial pavement lies on permeable sandstones, and is characterised by brittle deformation and cataclasis. This indicates that fluid pressure was low and that the glacier was highly coupled to its bed, so ice velocity was slow. Upper glacial pavements, which developed on clay-rich substrates (deposited during the major glacial recession), show high-rate ductile deformation, shear fabrics, sheath folds, intense dewatering structures and fluidised beds. The clay-rich nature of glacier bed allowed the build-up of very high water pressure, leading to glacier decoupling

and ice-stream onset.

This approach emphasises that the primary control on ice stream onset is the presence of subglacial clay-rich sediments favouring high pore-water pressure at glacier base, as stipulated for present-day ice streams in Antarctica.