A thousand pictures say a million words: digitisation and quantitative characterisation of structurally complex glaciogenic rocks

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Gathering statistically useful, quantitative structural data is always time intensive and laborious, and thus complete digital capture of an outcrop is ideal for the modern geologist. For instance, taking several hundreds of clast fabric measurements is tedious and time consuming, especially if material is lithified. For the “time poor geologist” under constant pressure, a solution is to digitize the entire outcrop and surfaces via ground based (hand held camera) or aerial surveying (Unmanned Aerial Vehicle) methods. The acquired imagery can then be processed to produce photogrammetric 3D models. This serves as the basis for both sedimentological and structural work, including bedding geometry, in appropriate 3D modelling software.

This paper presents both the workflow and the results of the digitization of multiple Late Carboniferous outcrops in Namibia. Each of these outcrops corresponds to Late Palaeozoic Ice Age (LPIA: 360-260) deposits that have only been subject to basic description, which exhibit varying degrees of structural complexity, and whose precise relationship to LPIA ice sheets across Gondwana remains unclear. A number of 3D models are presented, which provide vital new insights into the directions of ice movement. Some of this insight comes from diamicmites deposited beneath the ancient ice sheets. This is because: (i) clasts tend to align themselves in a stress-field in the active layer below the ice, (ii) striated pavements can be seen as analogous to fault surfaces and (iii) diamicrites may show evidence for complex internal shear planes. We measured the orientation of those clasts directly in the 3D models from several locations to acquire a precise understanding of ice flow over a wide (hundreds of km) area, which will serve as the basis for an ice sheet reconstruction. Integrating additional morphological data from numerous drone surveys, e.g. roches moutonnées, U-shaped valleys, striated pavements permits fresh insights into the ancient glacial environment. Thus, the digital outcrop approach underpins a truly interdisciplinary (structural, sedimentological, geomorphological) approach to unravelling the LPIA record.