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Aspects of the geomorphology of the Late Palaeozoic glaciated landscape of Namibia as revealed by photogrammetry

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The geometry of unconformities carved by deep time ice sheets is often obscured and restricted by discontinuous exposure, or outcrop conditions that do not readily permit the examination of glacial unconformities (for example, steeply dipping strata). Here, we present new uncrewed aerial vehicle (UAV) data from selected outcrops across northern, central and southern Namibia to shed new light on the nature of the basal Dwyka unconformity. This includes the onlap relationship of basal diamictites onto the Gomatum palaeo-fjord system in northern Namibia, highly complex mapped ice flow orientations elsewhere in the northern Kaokoveld, previously undiscovered grooves along the Fish River area, and a spectacular set of subglacial grooves along the border with South Africa along the Orange River. In the latter two cases, photogrammetric methods integrating orthophotos and digital elevation models reveal the presence of subglacial grooves for the first time, since the features are too subtle to observed using conventional approaches at outcrop. Furthermore, subglacial grooves often show different orientations to striations and fabrics measured in overlying diamictites, raising fresh questions about the nature of small-scale flow variations beneath Late Palaeozoic ice sheets.