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First direct observation of the link between supercritical flow processes, crescent-shape bedforms and massive sand deposits

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Massive sandstones have been studied in many outcrops worldwide as they form a building stone of good subsurface petroleum reservoirs. Massive sands are often associated with turbidites sequences in ancient sedimentary successions. Turbidites are widely known to result from the deceleration of turbidity currents, these underwater flows driven by the excess density of sediments they carry in suspension. Depositional processes that are associated with the formation of massive sands are still under debate in the literature and many theoretical mechanisms have been suggested based on outcrops interpretations, lab experiments and numerical models. Here we present the first field observations that show how massive sands are generated from flow instabilities associated with supercritical flow processes occurring in turbidity currents. We combine turbidity current measurements with seafloor topography observations on the active Squamish Delta, British Columbia (Canada). We show that supercritical flow processes shape crescent-shape bedforms on the seafloor, and how these crescent-shape bedforms are built by massive sands. This modern process-product link is then used to interpret massive sandstone successions found in ancient outcrops. We demonstrate that supercritical-flow processes can be recognised in outcrops and that these processes produce highly diachronous stratigraphic surfaces in the rock record. This has profound implications on how to interpret ancient geological successions and the Earth history they archive.