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Footstep-triggered grain flows on the lee side of a desert sand dune (Erg Chebbi, Morocco)

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(without abstract)

Grain flows — or grain avalanches — are important depositional processes on the lee side of aeolian sand dunes. Sediment deposition on the lee side of aeolian dune bedforms is mainly represented by saltating sand that is driven by the wind over the brink of the lee face and is deposited by grainfall as the flow separates at the brink (e.g., Allen 1970; Hunter 1977, 1985; Anderson 1988; McDonald and Anderson 1995). Grain flows occur when sediment deposition on the lee side causes it to reach the angle of repose of sand, so that further sediment deposition produces the failure of the slope and the initiation of a grain flow (e.g., Allen 1970; Hunter 1977, 1985; McDonald and Anderson 1995). The angle of repose for loose, non-cemented dry sand grains that are well sorted and rounded, as is typical of aeolian sands, is about 34° (e.g., Carrigy 1970; Fryberger and Schenk 1981; McDonald and Anderson 1995). In recent years, different studies have investigated the frequency and the magnitude of grain flows in relation to the morphology and dimensions of the bedforms on which they develop and to the speed and direction of the wind (e.g., Nickling et al. 2002; Breton et al. 2008; Sutton et al. 2013; Romain and Mountney 2014). A better understanding of the processes that control the development of grain flows and their resultant deposits has important implications in the modelling of aeolian sandstone reservoirs, as grain-flow deposits typically have significantly higher porosities and permeabilities than associated deposits (grainfall laminae and wind-ripple beds), due to the typically loose packing of well sorted, well rounded and highly spherical grains (e.g., Prosser and Maskall 1993; Howell and Mountney 2001). In addition to the above cited sedimentary processes, lee-side failures and consequent grain flows can be also triggered by animals (or persons) walking on the lee side or on the crest of a dune bedform (e.g., McKee 1947; Andreotti 2004; Vriend et al. 2007). An example of dinosaur-triggered grain flows has been described by Loope (2006) in the aeolian deposits of the Lower Jurassic Navajo Sandstone (Arizona–Utah, USA).

The photograph shows a series of tongue-shaped grain-flow lobes on the lee side of an aeolian sand dune at the northern edge of Erg Chebbi (Errachidia Province, eastern Morocco). The lobes are up to 1.5 m long and 0.4–0.5 m wide, and have a maximum thickness of 30–40 mm. Different generations of grain flows can be distinguished, with later, smaller grain flows locally developed from the partial reworking of earlier grain-flow lobes. The regular spacing of the grain-flow lobes, and their indentation directly on the dune crestline, indicate that the grain flows were probably triggered by a person walking along the dune crest, whose footsteps produced a series of localized slope failures at the top of the lee side. Wind ripples, striking almost perpendicular to the crest of the dune, are present on the dune apron. A winding beetle trail, about 40 mm wide, is visible in the left part of the image. The photograph was taken on November 12th, 2014 (coordinates: 31°12'38.7" N, 3°59'28.6" W).

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