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Syn-eruptive, soft-sediment deformation of dilute pyroclastic density current deposits: triggers from granular shear, dynamic pore pressure, ballistic impacts and shock waves

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Dilute pyroclastic density currents (PDCs) represent peculiar transport mechanisms sharing similarities with turbidity currents, wind-blown transport and granular flows. Outcrops of syn-eruptive, soft-sediment deformation are compiled from seven volcanic centers in order to provide a broad perspective on the variety of structures: Ubehebe craters (USA), Tungurahua (Ecuador), Soufrière Hills (Montserrat), Laacher See (Germany), Lago di Albano (Italy), Tower Hill and Purrumbete lake (both Australia). The interpretation of the variety of triggers enlightens the understanding of the sedimentary environment and basal boundary processes for PDCs:

1/ Isolated, cm-scale, overturned beds with vortex forms have been interpreted to be the signature of shear instabilities occurring at the boundary of two granular media. They may represent the frozen record of granular, pseudo Kelvin-Helmholtz instabilities.
2/ The occurrence of degassing pipes together with basal intrusive dikes suggest fluidization during flow stages. This, in turn, can facilitate the development of Kelvin-Helmholtz structures. The occurrence of injection dikes at the base of flow units in some outcrops compared with suction-driven local uplifts in others indicates the role of dynamic pore pressure and local changes between depletive and accumulative dynamics of flows.
3/ Isolated slumps as well as sinking pseudonodules are driven by their excess weight and occur after deposition but penecontemporaneous to the eruption.
4/ Impact of ballistic blocks can trigger local displacement or liquefaction. Based on the deformation depth, these can yield precise insights into depositional unit boundaries. Such impact structures may also be at the origin of some of the steep truncation planes visible at the base of the so-called "chute and pool" structures.
5/ Finally, the passage of shock waves emanating from the vent may be preserved in the form of trains of isolated, fine-grained overturned beds, which may disturb the surface bedding without occurrence of a sedimentation phase in the vicinity of a vent.

Dilute PDCs are frequently generated during seismogenic volcanic explosions. They can experience extremely high sedimentation rates and may flow at the border between traction, granular and fluid-escape boundary zones. They are often deposited on steep slopes. Additionally, they may incorporate significant amounts of water and gas in the sediment. These are just some of the many possible triggers acting in a single environment, and reveal the potential for insights into the transport and deposition mechanisms of dilute PDCs.