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Shark-fin structures: A new type of sedimentary structures produced by shear waves at the flow-bed interface. Examples from pyroclastic current deposits from the 2006 eruption of Tungurahua (Ecuador)

Quentin Chaffaut (1) and Guilhem Douillet (2)

(1) Ludwig Maximilians Universität, Earth and Environmental Sciences, Munich, Germany (chaffaut.quentin@gmail.com),
(2) Bern, Institut für Geologie, Switzerland (guilhem.douillet@geo.unibe.ch)

Pyroclastic currents consist of ground-hugging mixtures of gas and particles emitted in relation with explosive volcanic eruptions. They encompass a wide range of particle concentrations, transport processes and particle support mechanisms. The destructive nature of these flows makes in situ measurements difficult thus making our understanding rely mostly on the analysis of deposits combined with physical models. Considering that deposits of pyroclastic currents are shaped by the processes occurring at the flow-bed boundary zone, analyses at the finest scale are necessary to decipher the variability involved in such flows. Here, the deposits from the 2006 pyroclastic currents emitted at Tungurahua volcano (Ecuador) are examined at the lamina scale.

A new type of sedimentary structures is evidenced and consists of locally overturned laminae forming shark-fin, flame-like patterns aligned toward the flow direction. Several hundreds of those structures are documented regarding their shape dimensions and locations. We measured systematically the extent (distance involved in overturning : 1-10 cm), thickness (from non deformed root to top of overturned tail : 0,5-3 cm), and stretching/elongation (length of overturned tail : 0,2-3 cm).

The shark fin structures are generally found with two organisational schemes :
1. They can either form recurrent patterns on a single isochronous surface with a stable pseudo-wavelength. 2. A second type of clustering consists of a recurrence of structures migrating in a stack of beds.

The overturned patterns suggest that shark-fins are formed in relation to the shear occurring at the flow-bed interface. The confined extent and recurrent organisational patterns further point toward stable wave mechanisms.

We developed a physical model based on two fluid layers separated by a shear layer in order to relate the field observations to dynamics information on the parent flows. The framework provides an estimation for the deposition rate necessary to produce shark fin structures.

We suggest that such shark fin structures may be common in other types of environments yet not documented.