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Relation between grain size and modal composition in deep-sea gravity-flow deposits. Example from the Voirons Flysch (Gurnigel nappe, Chablais Prealps, France)

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A coupled analysis of modal composition, grain size and sedimentary features of gravity-flow deposits in the Gurnigel nappe shows that the transition from coarse proximal to fine distal deposits is accompanied by a change in composition from siliciclastic to calcareous. Such compositional variation should be taken into account when interpretating deep-sea deposits if sampling is restricted to a single part of the fan.

The Chablais Prealps (Haute-Savoie, France) represent a well-preserved accretionary wedge in the Western Alps. They comprise a stack of northward-thrusted sedimentary cover nappes originating from the Ultrahelvetic realm (distal part of the European margin) to the southern part of the Piemont Ocean. The present study focuses on the Voirons Flysch, belonging to the Gurnigel nappe, which includes four formations consisting of gravity-flow deposits (from bottom to top): (1) the Voirons Sandstone Fm., composed of channel to lobe deposits; (2) the Vouan Conglomerate Fm., represented by the proximal part of a channel system; (3) the Boëge Marls Fm., constituted by distal lobe deposits; finally, (4) the Bruant Sandstone Fm., which consists in channel to lobe deposits. Recent biostratigraphic results using planktonic foraminifers attributed a Middle to Late Eocene age to the Voirons Flysch, which was formerly believed to range from the Paleocene to the Middle Eocene (based on calcareous nannofossils).

A total of 270 thin sections with stained feldspars were prepared, representing the four formations of the Voirons Flysch. Circa 300 extrabasinal grains were counted per thin section using the classic Indiana method. In addition, the quantity of intrabasinal grains (i.e. bioclasts, glauconite), cement and porosity was analysed. Cement was stained with alizarine and potassium ferrocyanide. 200 grain-size measurements on ca. 100 samples were performed using 3D conversion and statistical moment analysis. Sedimentary observations for each sampled bed were categorized following Mutti's turbiditic facies scheme.

Cluster analysis on the composition of major grains discriminated 10 clusters which are merged into seven petrofacies (P1 – P7) following optical observations under the microscope: **P1**: poorly cemented porous arenite; **P2**: all porosity are filled by calcitic cement; **P3**: well-cemented volcano-clastic arenite; **P4**: red algae-rich highly cemented arenite to calcarenite; **P5**: highly cemented arenite; **P6**: globigerina-rich laminated calcarenite and **P7**: glauconitic quartzarenite.

Grain-size distribution is grouped following the petrofacies. They provide a homogeneous distribution within each petrofacies with a gradual fining and progressively increasing sorting from P1 to P7. Moreover, Mutti's facies distribution indicates a progressive change towards more distal environments: from channel facies (F2 to F5) in P1-P3 to lobe facies (F8 to F9) in P4-P6. The washed composition of the P7 petrofacies is interpreted as distal turbidites that were reworked by bottom currents.

The results presented here reveal a link between sand composition, grain size and gravity-flow facies. They highlight that composition of gravity flows is modified during their basinward transport. Consequently, coarse proximal deposits are more siliciclastic with limited filling of voids due to low carbonate contents. On the contrary, carbonate content increases significantly in the fine-grained calcarenites of the distal petrofacies. In distal settings, the segregation of light and porous foraminifera from the heavier siliciclastic fraction occurs under the increasing importance of traction currents.