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Sedimentological and geochimical features of chaotic deposits in the Ventimiglia Flysch (Roya-Argentina valley- NW Italy)

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The Ventimiglia Flysch is a Upper Eocene turbidite succession deposited in the SE part of the Eocene Alpine foreland basin, truncated at the top by the basal thrust of the Helminthoides Flysch, a Ligurian tectonic unit that presently covers part of the Dauphinois and Briançonnais successions of Western Ligurian Alps.
The Ventimiglia Flysch is made of alternations of sandstones and shales. The upper part is characterized by chaotic deposits. The chaotic deposits are constituted by:
- km to hm-sized intrabasinal blocks (Ventimiglia Flysch) and extrabasinal blocks (Cretaceous sediments of Dauphinois Domain, Nummulite Limestone of the Alpine foreland basin and Helminthoides Flysch);
- conglomerates with block-in-matrix fabric interpreted as debris flow deposits. They occur as m-thick beds interbedded with the normal turbidite succession or locally as matrix of the larger blocks.
Debris flow clasts show:
- different sizes, ranging from metre to centimetre;
- different shapes, from rounded to subangular;
- different lithologies, such as fine-grained quartz-arenites, marls, dark shales and fine-grained calcisiltites. They may be referred to both coeval, intrabasinal lithologies (Ventimiglia Flysch), and extrabasinal formations (Nummulite Limestone, Globigerina Marl and Helminthoides Flysch).
The clasts are disposed randomly into a chaotic matrix that consists of a dark mudstone in which submillimetre- to millimetre-sized lithic grains, with the same compositions of larger clasts, are present. Locally matrix consists of sandstones with quartz and feldspar grains and fragments of nummulitids that suggest reworking of unlithified Eocene sediments.
Cathodoluminescence observations allow the distinction of two kinds of clasts: dull clasts that underwent a cementation before the formation of conglomerates, and clasts with the same orange luminescence as the matrix that may be interpreted as soft mud clasts that were cemented together with the matrix.
Debris flow deposits are cross-cut by a network of crumpled and broken veins, 10's mm to cm-large, filled with orange luminescing calcite and locally with quartz. Their complex cross-cutting relationships with clasts and matrix show that several systems of veins are present, that may be referred to different fracturing events.
Some clasts are crossed or bordered by veins that end at the edge of the clasts. These veins show the same features as those that crosscut the whole rock. This indicates reworking of plastic sediments crossed by calcite-filled veins by mass gravity flows. Polyphase debris flow processes, proceeding along with fluid expulsion and veining, are thus documented.
Ellipsoidal, dm-large concretions of cemented pelites also occur. They represent a previous phase of concretionary growth within homogenous pelites subsequently involved in the mass gravity flow.
Stable O and C isotope analyses, performed on matrix, clasts, concretions and veins, show:
- 13C close to normal marine values (-3 to 0 13C %■ PDB)
- 18O markedly negative (-9 to –7 18O %■ PDB) that could be related to precipitation from relatively hot waters (60-70 ° C).
The block-in-matrix fabric and the variable composition and size of blocks show that these sediments are a sedimentary mélange related to mass wasting processes involving both extrabasinal and intrabasinal sediments. These gravitational movements took place along slopes of submarine tectonic ridges created by transpressional faults (Piana et al., 2009) that juxtaposed tectonic slices of different paleogeographic domains (Dauphinois, Briançonnais, Ligurian Units) in Late Eocene times, and involved both rock fall processes of huge blocks of

lithified, older formations, and debris flows of unlithified intrabasinal sediment. Faults also acted as conduits for an upward flow of hot fluids supersaturated in calcium carbonate. These fluids crossed unlithified sediments close to the sea floor resulting in localized concretionary cementation and formation of vein swarms within unlithified sediments prone to subsequent mass wasting.