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Coupling of thrust propagation and changes in sandstone provenance in the Miocene foredeep of the Apennines orogen (Italy)

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The turbidite sequences deposited in the Late Oligocene-Late Miocene foredeep basins of the Apennines orogen have been thoroughly investigated in terms of tectonics, stratigraphy, depositional facies and petrography (Mutti et al., 2009). These sequences belong to the formations known as Macigno, Mt. Modino sandstones, Mt. Falterona sandstones, Mt. Cervarola sandstones, Marnoso-arenacea and the Laga Flysch, with thicknesses ranging from 1000 to 6000 m.

Our petrographic study shows that the detrital QFL modes of these immature sandstones are similar to each other, their overall composition being in the range of Q35-65F15-55L5-45. The population of lithic grains, however, displays stratigraphically-coherent changes. In ascending stratigraphic order sandstone compositions dominated by foliated (metamorphic) and porphyric textured (volcanic) grains change to compositions rich in clastic textured (sedimentary) and carbonate grains (Valloni et al., 2002).

In the perisutural setting of these turbidite sequences it is possible to detect four distinct source areas: (1) the distant early-collision segment and (2) the neighbouring segment of the orogen flanking the foredeep, both paralleling the tectonic strike and feeding the foredeep mostly from its apex, (3) the nascent orogen and (4) the tectonically uplifted terrains in the foreland ramp, both representing minor sources lateral to the foredeep. The latter two are generally recognised as local sources (e.g. megaturbidites from the shelf margin) and their paleocurrent directions are commonly opposite to the main axial feed (Gandolfi et al., 1983).

In order to unravel the complexity of the provenances recorded in the foredeep basin fill we (1) considered only the turbidite deposits fed from the foredeep apex, (2) disregarded the deposits from local (lateral) sources, (3) used samples only from the base of turbidites if the grain size was bracketed between medium-fine to medium-coarse, and (4) conducted thin-section petrographic analyses concentrating on the fine-texture population of the lithic framework grains. Grain types were lumped in the following conventional categories: Lm, metamorphic, Lv, volcanic and aphanitic/microgranular, Ls, sedimentary-silicate and C, carbonate (Valloni et al., 2002)

The systematic change in the proportions of lithic-grain types can be traced axially in successive transversal sections of individual foredeep furrows. This indicates that two distinct provenance areas repeatedly fed the foredeep on a time span from one to a few Ma. For instance, in the 4000m-thick Marnoso-arenacea section of the Santerno valley (province of Bologna) the sandstone framework lithic-grain proportions change stratigraphically upwards from an average Lm56Lv22Ls+C22 to an average Lm46Lv14Ls+C40; in the 6000m-thick Laga Flysch section of the Vomano valley (province of Teramo) the lithic-grain proportions change stratigraphically upwards from an average Lm52Lv15Ls+C33 to an average Lm13Lv9Ls+C78.

The former provenance (Lm+Lv rich) denudated a relatively deep and the latter provenance (Ls+C rich) a relatively superficial crustal profile. We interpret the systematic changes of the lithic-grain proportions to correspond to tectonically-induced lateral shifts of the foredeep depocenter whose time of occurrence is comparable to the active duration of the two provenances described here. The thrusts propagating in the foreland region modified the source-to-basin pattern of sediment transport and caused the provenance shift from the distant early-collision segment to the neighbouring segment of the adjacent orogen.

References

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