

described and the location, orientation and width of the fractures measured. The fractures are mainly steeply dipping and oriented perpendicularly to the direction of progradation of the platform, mimicking local platform margin trends.

The integration of numerical models with field data gives the opportunity to quantify the extension triggered by differential compaction and predict the possible distribution of early fractures in carbonate platforms of known geometry and thickness, whereas the interpretation of early fractures as the effects of differential compaction can be supported or rejected by the comparison with the results of ad hoc numerical modelling. The obtained models on generic platforms further indicate that strain induced by differential compaction is strongly geometry- and lithology-dependent.

Subduction flip in the Mediterranean and the asymmetry of Alps and Apennines

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Geological (magmatological and tectonic) observations and numerical models are used to constrain and describe the last 50 Myr evolution of the Central-Western Mediterranean. Both oceanic and continental lithospheric plates were diachronously consumed along plate boundaries with different styles of evolution and polarity of subduction. The hinge of subducting slabs converged toward the upper plate in the double-vergent thick-skinned Alps-Betics and Dinarides. The hinge diverged from the upper plate in the single-vergent thin-skinned Apennines-Maghrebides and Carpathians orogens. The mass deficit caused by the lithosphere retreat was compensated by passive asthenosphere upwelling and by the opening of several back-arc basins. The magmatic evolution of the Mediterranean area cannot be easily reconciled with simple magmatological models proposed for the Pacific subductions. This is due to synchronous occurrence of several subduction zones that strongly perturbed the chemical composition of the upper mantle in the Mediterranean region and, above all, to the presence of ancient modifications related to past orogeneses.

In our reconstruction, the W-directed Apennines-Maghrebides nucleated along the retro-belt of the Alps, following a subduction flip. The origin this process is investigated with 2D thermo-mechanical models. In particular we focus on the influence of mantle flow relative to the overlying lithosphere on subduction dynamics. We obtain that, for mantle flow supporting the slab, as occurred in the Alps, an initial stage of slab steepening is followed by a stage of continuous decrease in slab dip. This slab shallowing eventually leads to mantle wedge closure, subduction cessation and slab break-off, possibly driving to subduction flips.

As a result of the described geodynamic evolution, Alps and Apennines developed highly asymmetric. The Alps have higher morphological and structural elevation, two shallow, slow subsiding foreland basins. The Apennines have rather low morphological and structural elevation, one deep and fast subsiding foreland basin. While the Alps sandwiched the whole crust of both upper and lower plates, the Apennines rather developed by the accretion of the upper crust of the lower plate alone. Alpine relics are boudinated in the hangingwall of the Apennines, stretched by the Tyrrhenian back-arc rifting. Relative to the upper plate, the subduction hinge moved toward it in the Alps from Cretaceous to present, whereas it migrated away in the Apennines from late Eocene to Present, apart in Sicily where since Pleistocene(?) it reversed.

We investigated the origin of part of these asymmetries using 2D and 3D viscoelastic models. In particular we analyzed the dependency of the stress field of slabs and overriding plates on geometry (dip of the slab) and kinematics (velocity of convergence between upper

and lower plates and their absolute velocity with respect to the underlying mantle) of subduction zones. We obtain that, although the state of stress in slabs and overriding plates is controlled also by other processes, down-dip compression in the subducting slab and extension in the overriding plate are enhanced by mantle flow opposing the direction of the dip of the slab, whereas down-dip extension in the slab and contraction in the overriding plate are favoured by mantle flow in the same direction of the slab dip (i.e., sustaining it). We conclude that the asymmetry of Alps and Apennines is primarily controlled by the slab polarity with respect to the westward drift of the lithosphere.

Structure and kinematics of the northern Adula nappe (Central Alps, Switzerland) and its emplacement in the Lower Penninic nappe stack

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The Adula nappe belongs to the Lower Penninic domain of the Central Alps. It consists mostly of pre-Triassic basement rocks containing also numerous eclogites. The Adula nappe has the peculiarity to comprise several cover occurrences within the basement. The nature of the deformation experienced by the nappe reveals a complex history with several deformation phases.

The purpose of our study is a better understanding of the Alpine kinematics of the northern Adula nappe with a special focus on the early deformation phases responsible for the nappe emplacement. This study is mainly based on a detailed geologic mapping of several representative key-areas in the Northern Adula nappe. It has been also extended to a multi-scale structural analysis of the nappe at a broader scale.

We recognized that the nappe emplacement is associated with two phases of deformation. The early Ursprung ductile deformation phase is characterized by folds that are compatible with a top-to-the-south shearing. The Zapport phase is partially contemporaneous with the Ursprung phase. It produces the main structural features of the nappe by ductile north directed shear and forms two generations of isoclinal nappe-scale folds. These folds are revealed by a detailed mapping in areas preserved by later deformation. The Zapport phase folds are complex synclines cored by the sedimentary cover at the front of the nappe.

In the Eastern transect of the Central Alps, the Adula nappe and the nappes derived from paleogeographic domains located south of the Adula domain (hyper-extended margin) are mostly emplaced by detachment and basal accretion in the Alpine accretionary prism. In contrast, the Adula nappe and the other nappes located northward in the paleogeography are derived from a coherent European slab and form fold-nappes. The specific paleogeographic position of the Adula domain at the leading edge of a coherent European slab explains why this unit was subducted to depth sufficient to form eclogites. This leads the Adula nappe to act as a major shear zone during the nappe emplacement.

Two later deformation phases postdate mainly the nappe emplacement. The Leis and the Carassino deformation phases are principally characterized by NW-vergent folds. These deformations affect the nappe front formed during the previous nappe emplacement phases.