upper hangingwall unit, which remains brittle during deformation. One of the most important meanings to occur in these low grade metamorphism rocks is the new recrystallized assemblage formed the lower the strength of the rock, active representing a matrix-controlled interconnected weak layer rheology. Strain partitioning results in preservation of high-temperature microfabrics, minerals and textures with low-grade mylonitic shear zones. As a result, grain size reduction associated by fluids circulating within shear zones leads to rock softening, which results in strain localization, weak rock rheology and the overall thermal structure of the crust.

Acknowledgements: This work is financially supported by the Austrian Science Fund (FWF)-Lise Meitner program, grant no. M1343 to SC.

Differential compaction and early rock fracturing in the Triassic Esino Limestone high-relief carbonate platform (Central Southern Alps): field evidence and numerical modeling

Carminati, E.[1] & Berra, F.[2]

[1] Dip. di Scienze della Terra, Università di Roma “La Sapienza”, P.le A. Moro 5, Roma, Italy (eugenio.carminati@uniroma1.it)
[2] Dip. di Scienze della Terra ‘‘A. Desio’’, Università degli Studi di Milano, Milano, Italy

Syndepositional fractures are important features in high-relief, steep-slope carbonate systems as they control the occurrence of platform-margin collapse events, drive the generation of early diagenetic fluid flow systems and development of karst networks and may enhance permeability. Studies on modern and fossil carbonate systems recognized the importance of early (syndepositional) fractures, which can be generated by different processes (gravitationally controlled fractures, antecedent-topography controlled fractures, and tectonically controlled fractures).

In this study we focus on the generation of margin-parallel, gravitationally-induced early fractures driven by compaction of basinal sediments prograded by early-cemented high-relief carbonate platforms with steep slopes. Compaction is most effective when brittle early-lithified sediments prograde over unconsolidated basinal deposits.

Numerical models were used to investigate the effects of differential compaction on strain development and early fracturing in early-cemented high-relief carbonate platform, prograding onto basinal sediments, whose thickness increases basinward. Results show that basinal sediment compaction induces stretching of internal platform and slope strata in prograding platforms. When sediments are early cemented, such extensional strain is accommodated by the generation of syndepositional fractures. The amount of stretching is predicted to increase from the oldest to the youngest layers, due to the thickening of the compactable basinal sequences towards the external parts of the platform. Stretching is also controlled by the characteristics of the basin: the thicker and the more compactable the basinal sediments, the larger will be the stretching.

To test this model on a real case, ad hoc computations were dedicated to the Ladinian-Early Carnian carbonate platform of the Esino Limestone (Central Southern Alps, Italy), up to 800 m thick and with a top to basin relief of more than 500 m. This platform, after a prevailing initial aggradational stage, rapidly progrades on thinly-bedded fine-grained resedimented limestones. This case study is favorable for numerical modelling, as it is well exposed and both its internal geometry (inner platform, reef and prograding steep clinostratified slope deposits, consisting of reef-derived breccias) and the relationship with the adjacent basin can be fully reconstructed, as the Alpine tectonic overprint is weak in the study area. Furthermore, rapid early cementation processes affect the carbonate platform facies, so that conditions for creation and preservation of early fractures occurred. Evidence for early fracturing (fractures filled by fibrous cements coeval with the platform development) is 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

Carminati, E.[1], Doglioni, C.[1], Lustrino, M.[1], Negredo, A.M.[2], Petricca, P.[1] & Rodríguez-González, J.[2]

[1] Dip. di Scienze della Terra, Università di Roma “La Sapienza”, P.le A. Moro 5, Roma, Italy (eugenio.carminati@uniroma1.it)
[2] Dpto. de Geofísica y Meteorología, Universidad Complutense de Madrid, Av. Complutense, s/n. 28040, Madrid, Spain.

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