vated by strike-slip motions, longitudinal (right-lateral) and transverse (left-lateral) to the belt. Paleostress inversion of associated microtectonic data shows that both normal and strike-slip faulting correspond to a single late--Alpine tectonic event with permutation of the stress axes. This multi-scale brittle deformation is particularly well developed close to the Frontal Penninic Thrust, the crustal boundary between Internal and External Zones (Sue and Tricart 1999). Normal faults branch this Oligocene Thrust at depth, suggesting its extensional reactivation.

The present day activity of this area, which belongs to the Briançonnais seismic arc, has been inferred from seismotectonic analysis, using the Sismalp (Grenoble) and IGG (Genova) database. It is also extensive, and implies the same fault network. Several active faults have been recognised, especially along the High Durance fault zone. The roughly E–W extension deduced from fault plane solutions analysis has been confirmed by a geodetic study showing rapid tectonic motions in the alpine context (Sue et al. 2000). Seismotectonic cross-sections show that the seismic activity is located above the Frontal Penninic Thrust, and that active normal faults are linked to the former Thrust: it is currently inverted as a crustal-scale detachment.

The seismotectonic analysis of the Western Alpine arc as a whole, from the Argentera massif up to the Aar massif, 300 km along the belt, establishes that extensional tectonics affects the most part of the internal zones. Active extension spreads out to the North up to the Aar massif, and to the East in the Piemont Zone, along the Piémont seismic arc, which corresponds to the western side of the Ivrea Body. Thus, the recent and still active extensional tectonic regime reactivates the main crustal structures at the scale of the Western Alpine belt: the Frontal Penninic Thrust and the western side of Ivrea body. The current stress field, inferred from inversion of focal mechanisms, presents extensive stress axes perpendicular to the belt's arcuate geometry in the whole internal zones (Sue et al. 1999). The analysis of the GeoFrance3D database (using a temporary dense seismic network) confirms the extensional stress field to the south of the belt. Nevertheless, transpressive and compressive tectonic regimes are found to the front of the belt and in the Pô plain respectively. The core of the western Alps is thus undergoing extensional tectonics, while the alpine collision seems to be still active.

This major tectonic contrast asks for an accurate dynamic model. A competition between boundary forces at the limits of the belt (Europe–Apulia collision and Apulia counterclockwise rotation) and buoyancy forces in the alpine lithospheric root could control the present-day tectonic contrast in the Western Alps. We propose two dynamic models in which extension may be explained by the detachment or the roll-back of a continental slab in the alpine lithospheric root.

Intracontinental tectonics in the Atlas ranges of Morocco

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The Atlas ranges of northern Africa are belts of localized deformation in the foreland of the Rif–Tell plate-boundary orogen. Characteristics that are often cited for the Atlas mountains are high topography (summits above 4000 m) but moderate orogenic shortening, and lack of crustal roots in seismic refraction studies. In addition to these features, the absence of flexural basins in the periphery of the ranges is also striking .

A new balanced cross-section has been constructed through the central High Atlas of Morocco, between the localities of Midelt and Errachidia, parallel to the existing seismic refraction traverse. The section describes well the upper crustal structure and basement/cover interactions. As documented by previous works, the range derives from the inversion of a Triassic–Jurassic E–W trough, in whose former evolution extensional and strike-slip faults played a debated role. However, the process of fault reactivation during alpine shortening is perhaps less widespread than hitherto assumed. The margins of the Atlas range are formed by outward verging basement-involved thrusts, some of them deriving from inversion of Jurassic faults but others not. Towards the center of the range, large-scale buckle folding of basement and cover alike is recognized. Basement is downwarped in wide sinclinal areas to ca. 3000 m below sea level, but it is exposed at the surface outside of the range in the undeformed High Plateau to the north (Zaida area) and the Saharan platform to the south (S of Errachidia), thus lying at a higher regional elevation than in much of the interior of the range. Although mountain peaks near the section reach 3700 m, the mean altitude of the range is slightly above 1500 m. Refraction seismics showed crustal thicknesses between 35 and 38 km.

When considering a potential isostatic undercompensation, the following facts should be taken into account: 1) the relatively low mean altitude, 2) the regional elevation difference of the top of basement in the range and adjacent plateaux and its crustal density implications, and 3) the fact that the actual uplifted region exceeds the extent of the deformed belt (the plateaux are well above 1000 m – with crustal thickness of 33–35 km – and in other traverses the Atlas is flanked by prominent 100 km scale uplifts with very mild alpine reworking – Moroccan Meseta and Antiatlas).

A crustal origin for the relief difference between High Atlas and marginal plateaux can be accepted, but larger-scale dynamic topography is invoked for the entire region. Teleseismic P-wave investigations suggested a thinned lithosphere under the High Atlas mountains, consistently with abundant quaternary vulcanism. However, neotectonic features and fault-plane solutions of shallow earthquakes indicate a compressional (thrust and wrench) setting. In the light of these evidence we propose that lithosphere folding was a significant contributor to uplift in the North African foreland, sustaining high topography and balancing peripheral flexural subsidence during building of the High Atlas topographic loads.

Plio-Pleistocene oblique plate convergence and modes of transtensional deformation in the south–southeastern Hellenic Forearc (Greece)

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Southward migration of the Hellenic subduction zone (HSZ) and north–south (N–S) extension within the overthickened Hellenic orogenic wedge began as early as Late Oligocene and increased the curvature of the subduction zone from a nearly straight E–W plate margin to its present arcuate map pattern. The subduction front continued to migrate southward with N–S extension reaching Crete at ~19 Ma, and high-pressure/low-temperature assemblages (HP/LT) were rapidly exhumed along a top-to-the-north extensional detachment until they reached the surface to serve as Middle Miocene sediment sources. The first extensional basins formed in the earliest Late Miocene, when continued N-S extension formed rapidly deepening elongated half-graben basins, striking parallel to the arc. The increasing curvature of the HSZ imparts changing kinematics of fore-arc deformation due to arc-parallel gradients in obliquity of plate convergence. On Crete this is evidenced by a change towards radial extension that dominated during the remainder of the Late Miocene, forming a series of N–S and E–W trending half-graben basins.

Numerical modeling (Ten Veen & Meijer, 1998) have shown that from 11 Ma till 5 Ma arc-normal pull, acting on a curved arc geometry, seems to be the dominant force distribution responsible for radial extension in the overriding plate. This corroborates the observations on the style of extension/deformation for that period on Crete. Model results for the last 5 Ma predict an increased transform resistance along the eastern segment of the arc (Pliny and Strabo trenches) due to increased obliquity. This Pliocene change in fore-arc kinematics established the neotectonic strain regime of the southern Hellenic Arc, which is suggested to be than dominated by wrench tectonics.

Recent structural mapping/kinematic analyses, tectonostratigraphy, and chronostratigraphy on Crete and Rhodos addressed the changing kinematics along the strike of the Hellenic arc with increasing obliquity of convergence for the past 5 Myears. The Plio-Pleistocene Agia Galani Basin (Southern Crete) formed in response to faulting along a series of ENE trending strike-slip faults. An important part of the basin is made up of longitudinal syn-sedimentary dragfolds ("forced folds"), whereas older Miocene faults were reactivated as prominent normal faults. The NE trending Apolakkia Basin on Rhodos has an internal (syn-sedimentary) deformation that is characterized by forced folds, oblique normal faults and antithetic strike-slip faults. For both basins studied, the orientation of the main structures and kinematic analyses suggest that the