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Deformation-induced structural zonation during inhomogeneous non-coaxial strain: an alternative to extensional tectonics

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Ptolemais basin constitutes a Neogene fault-bounded basin developed onto Pelagonian Zone, lying in the area among Mesohellenic Trough to the west and Axios molassic basin to the east, in Northern Greece. An integrated structural analysis, using m- to km-scale geometrical and kinematic correlations, is documented in order to elucidate the bulk strain path and the produced structural end-members. Previous studies partly analysed the normal fault systems in the basin fill and in the basin marginal regions, accepting that extensional tectonics determined basin evolution in sequential stages. Surface geology combined with borehole analysis carried out in this study connotes that structures of different strain state and of variable orientation appear an inhomogeneous spatial arrangement. Qualitative and quantitative analysis of 720 boreholes and strain data in the basin marginal faults as well as in the basin fill sketch out that: 1) Intense syn-sedimentary deformation took place in the terrestrial deposits of the basin fill. Apparent differences in the rhythms of sedimentation are constrained comparing the period of the Pliocene lignite sedimentation with that of the younger sediments, 2) Kinematic coupling among basin fill successions and pre-Neogene basement-sequences is identified according to borehole and strain data, 3) Several lines of evidences suggest structural heterogeneity. Normal and reverse faults, rotations around E-W and N-S trending horizontal axes in all the scales as well as NE-SW trending anticline-like structures constitute the major structural features of the

basin fill. Basin marginal faults, tectonic horsts trending NE-SW with NE-SW directed rotational axes and anticline-like structures with NE-SW trending hinge lines enumerate the main structural configurations of the basement-sequences, produced during basin evolution, 4) Basin marginal faults, orientated in NW-SE, E-W, NE-SW and ENE-WSW direction appear contemporaneous activity, produced under a single faulting phase. Their spatial distribution reveals the predominance of NE-SW and ENE-WSW directed faults in the northern domains. Faulting patterns, affecting the basin fill and the basin marginal domains were activated concurrently, 5) Age determination of the entire structural pattern reveals its Plio-Quaternary formation, suggesting that the major paleo-geographic modifications have been taken place at that time-span, 6) The intricate three-dimensional geometry of the basin fill and the inhomogeneous distribution of the tectonic structures are concluded. Three distinct structural domains can be defined with individual tectonic styles from the northern parts towards the southern parts, reflecting the domainal distribution of the bulk strain. Qualitative strain evaluation of the distinct domains shows the higher strain gradients in the central parts of the basin than in the basin boundaries, 7) Non-coaxial inhomogeneous strain controls the bulk strain path, producing concurrently faults, rotations and fold-like structures. Progressive shear strain is responsible for deformation superpositions in the recognized structural patterns and reorientation of the major fault systems. Sinistral shearing with shortening perpendicular to extension has produced the entire basin geometry, 8) Taken these lines of evidences extensional and compressional stresses are contemporaneous constituents of the dynamic processes controlling the entire architecture. Their spatial distribution, following an inhomogeneous view, effectively determines the domainal structural patterns. Using our strain data, we come into conclusion that the recognized structural end-members, previously considered as a product of distinct events, produced by inhomogeneous non-coaxial strain in a distributed zonation.