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Contribution to the mechanisms of compressing Prandtl Cell Model: The Karlıova Triple Junction as a case study from Eastern Turkey

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The Prandtl Cell (PC) model consists of an ideally plastic material, which is compressed between two parallel rigid plates (Prandtl, 1924). In the original PC model the material is allowed to flow only in one direction in response to compressive stresses. The original PC setting has been modified to accommodate different boundary conditions in later studies. For example, the plastic material is allowed to flow either towards or away from the apex of the wedge, where non-parallel plates move towards or away from each other. Cummings (1976) set up four different boundary conditions and classified four different PC models according to the geometry of the slip lines, the relative movement along the slip lines, and the movement of the plastic material. But none of the models explain the exact features of the slip lines and which factors controlled them. In this study, we consider one of the models of Cummings (1976) and we use field data, morphotectonic indices and analogue model results to interpret the fault pattern near the Karliova Triple Junction in Eastern Turkey, where the North Anatolian Fault Zone (NAFZ) and the East Anatolian Fault Zone EAFZ) meet. Quantified geomorphic features are used to understand local tectonic signals. We analyzed the drainage patterns, long profiles and hypsometric integral of bedrock rivers that drain across and around secondary faults between the NAFZ and the EAFZ. Morphotectonic analysis of different river system, which are bounded by strike-slip faults show that not only morphotectonic features but also deformation styles vary along the slip lines. Analyzing fourty branches of two main river systems between the NAFZ and EAFZ reveal that secondary faults can be classified into two fault sets. The first and most prominent fault,that formed close to NAFZ, consists of strike-slip faults that change along strike into oblique normal-slip faults when the strike of the fault changes from from NW to SE: The second fault set is less clearly recognizable and has a sinistral sense of slip. The constructed analogy of long profile and hypsometric integral demonstrates that those faults which formed near the EAFZ are tectonically quiescent whereas those that formed close to NAFZ are tectonically active. Our analysis shows that rivers controlled by these latter faults are undergoing permanent response to continuous tectonic uplift. Furthermore, the change of motion from dominant strike-slip to normal faulting creates the classic stratigraphic landform–cuesta-. Orientation of the NAFZ, the EAFZ and secondary faults between them are very similar to the PC model of Cummings (1976; Fig. 2B). Combining analogue models and morphotectonic analysis suggest that secondary faults propagated from west to east. The compressive stress distribution in analogue models varies along the boundary plates and the open ends of NAFZ and EAFZ triangle. From west to east formation of faults is both confirmed by morphotectonic analysis and analogue model experiment. In summary, for the region between the most eastern NAFZ, and the most northern EAFZ, we show that the compressive PC model slip lines start to develop from west to east. The sense of motion, the magnitude of displacement, and the evolving landcapes along these slip lines are fully controlled by the velocities of the boundary faults.