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3D discrete element modeling of the Arabia-Eurasia collision zone and related extrusion of the Anatolian Block

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The Arabia-Eurasia collision zone is an example of large-scale continental deformation. The collision started recently (25-15 Ma) and is characterized by a low shortening rate. The shortening caused by the collision is partly accommodated by vertical uplift, leading to large fold-and-thrust belts that give rise to the Zagros, Caucasus, and Alborz mountain ranges. The other part of the shortening is presently taken up by the lateral extrusion toward the west of the Anatolian block, a relatively rigid continental lithospheric block. This extrusion is accommodated by the conjugate North and East Anatolian Faults.

In this work we aim at understanding the dynamic of the crustal deformation processes resulting from the continental collision, including generation of positive topography and localization of major shear zones that evolve into lithospheric-scale strike-slip faults. Previous modeling attempt were mostly limited to the kinematic description of the strike-slip fault system and did not consider any topographic changes. In this earlier attempt fault geometry was usually assigned a-priori, and most often slab-pull along the Aegean subduction zone was partly needed to drive the extrusion.

Here, using a Discrete Element Modeling approach, we built a 3D model of the Arabia-Eurasia collision zone, including gravity forces, to study the temporal evolutions of the different tectonic structures, thrust and strike-slip faults, involved in accommodating the continental collision deformation processes.

On one hand, our modeling approach does not require to pre-set any fault geometry at the beginning of the collision. On the other hand, this approach allows us testing the impact of specific boundary conditions, such as the existence of two oceanic-crust relics forming respectively the Black Sea and the Caspian Sea, and which are considered 100% rigid.

Our preliminary models reproduce at first order the successive deformation steps of the Arabia-Eurasia collision that lead to the current configuration. The first phase of deformation is characterized by the formation of a wide fold-and-thrust belt in front of the Arabian plate indenter. Only in a second phase, the extrusion of an Anatolian block westward is taking place. This extrusion, however, happens only when rigid bodies (the Black Sea and the Caspian Sea) are present in the model. Conversely, extrusion in our models does not require the existence of slab-

pull to occur. Eventually, the strike-slip faults generated in our models are showing good qualitative agreement with the current geometry of the North and East Anatolian faults. Faults generated in our models accommodate the rotation of the extruded block in a consistent way with the present-day pattern of the Anatolia block. Further work will allow quantifying the length of the different time steps in the collision process, and to explore the impact of the geometry of the indenter.