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Dynamic processes in the lithosphere leading to extension, rifting and basin formation

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The similarity of ages of extensional core complexes, co-genetic basin formation, and kinematically compatible movements along large strike-slip faults in western North America to ages of comparable events within the Himalayas-Alps orogenic belt leads to the speculation that strain related to changes in Pacific (PAC)-North America(NA) plate motions may be recorded on a global scale affecting the coupled plates and extending eastward across Eurasia. The contemporaneous global deformation reflects abrupt changes in PAC-NA plate motions in response to coupling following convergence of buoyant oceanic lithosphere, commonly part of a spreading center, which impedes subduction and leads to collision followed by coupling when the buoyant lithosphere binds against the base of the overriding continental plate. Critical coupling of a sufficiently long ridge segment leads to "capture", after which the former movements of the newly coupled plates are integrated abruptly and changed from previous directions. In western North America, episodes of capture of the NA plate by the (PAC) plate are recorded by break-up unconformities (ca. 55, 35, and 17 Ma) and basins commonly within extensional domains distinguished by age and direction of tectonic transport (Eocene [∼55-42 Ma], ca. 285o, Oligocene [∼35-20 Ma], 240o, Miocene [17-0 Ma], ca. 280o). The transport directions record the integration of the southwesterly motion of NA , related to mantle convection, and the northwesterly motion of PAC, driven by slab pull. Following each coupling event, PAC moves westward dragging: 1) the formerly subducting Farallon slab, 2) the coupled, formerly overriding, NA plate, and 3) Eurasia (EA), with it. In response to the strong extension that is imposed upon rocks within domains encompassed by the PAC-NA coupled region, and along the southern margin of Eurasia, brittle deformation, accommodated by normal and strike-slip faults, and formation of contemporaneous basins, takes place. Core-complexes may form in regions of coupled lithosphere within domains of ductile crust, as well as along the Alpine-Himalayan suture where contemporaneous ductile shearing and detachment are known. During westward movement, mantle displaced at the front of western NA, may form a swell that progresses eastward causing cratonal uplift and exhumation of cover strata. Co-genetic intra-continental unconformities record the passage of the mantle swell. Where mantle flows toward the wake of the moving plates, fluid pincers may push Africa and Eurasia closer thereby inducing subduction and adding to constriction recorded by uplift and cooling. De-coupling generally takes place after ca. 10 Ma of cooling of the oceanic lithosphere followed by resumption of subduction. The diverse movements of the Pacific and NA plates suggest that the motions of oceanic and continental plates are independent and that movements take place in response to different forces. Oceanic plates that passively move in response to gravitational forces acting upon the coolest parts of the slabs differ from large continental plates such as NA and Australia that may move in response to the effects of convecting mantle acting upon their lithospheric keels. Hiatuses between extensional episodes record decoupling of oceanic lithosphere from the overlying plate, a process that takes at least 10 m.y.