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Origin and structure of major orogen-scale exhumed strike-slip

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The formation of major exhumed strike-slip faults represents one of the most important dynamic processes affecting the evolution of the Earth's lithosphere and surface. Detailed models of the potential initiation and properties and architecture of orogen-scale exhumed strike-slip faults and how these relate to exhumation are rare. In this study, we deal with key properties controlling the development of major exhumed strike-slip fault systems, which are equivalent to the deep crustal sections of active across fault zones. We also propose two dominant processes for the initiation of orogen-scale exhumed strike-slip faults: (1) pluton-controlled and (2) metamorphic core complex-controlled strike-slip faults. In these tectonic settings, the initiation of faults occurs by rheological weakening along hot-to-cool contacts and guides the overall displacement and ultimate exhumation. These processes result in a specific thermal and structural architecture of such faults. These types of strike-slip dominated fault zones are often subparallel to mountain ranges and expose a wide variety of mylonitic, cataclastic and non-cohesive fault rocks, which were formed at different structural levels of the crust during various stages of faulting. The high variety of distinctive fault rocks is a potential evidence for recognition of these types of strike-slip faults. Exhumation of mylonitic rocks is, therefore, a common feature of such reverse oblique-slip strike-slip faults, implying major transtensive and/or transpressive processes accompanying pure strike-slip motion during exhumation.

Some orogen-scale strike-slip faults nucleate and initiate along rheologically weak zones, e.g. at granite intrusions, zones of low-strength minerals, thermally weakened crust due to ascending fluids, and lateral borders of hot metamorphic core complexes. A further mechanism is the juxtaposition of mechanically strong mantle lithosphere to hot asthenosphere in continental transform faults (e.g., San Andreas Fault, Alpine Fault in New Zealand) and transtensional rift zones such as the East African rift. In many cases, subsequent shortening exhumes such faults from depth to the surface. A major aspect of many exhumed strike-slip faults is its lateral thermal gradient induced by the juxtaposition of hot and cool levels of the crust controlling relevant properties of such fault zones, e.g. the overall fault architecture (e.g., fault core, damage zone, shear lenses, fault rocks) and the thermal structure. These properties and the overall fault architecture include strength of fault rocks, permeability and porosity, the hydrological regime, as well as the nature and origin of circulating hydrothermal fluids.