80 INCIPIENCE OF TECTONIC FAULTING: CONTINUUM MECHANICS VERSUS FRACTURE MECHANICS

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Tectonic faulting in the brittle crust of the Earth proceeds in very narrow zones. Geoscientists have been motivated by this phenomenon to apply the concepts of linear elastic fracture mechanics (LEFM) in analysing shear rupture and slippage along pre-existing planes of weakness. More recently, efforts have increased to model also the incipient growth of tectonic faults as a quasistatic or dynamic growth of a single shear crack in a pre-dominately elastic environment.

Contrary to this approach, the modelling of fault formation as a continuum mechanical process of shear concentration in an elastic/frictional plastic material accounts for the fact that - apart from very special situations - tectonic faulting is preceded by irreversible damage of the rock in a wider 'proto-fault' zone.

The paper presents an attempt of a comparative evaluation of the two approaches.

81 FLUID CIRCULATION, GEOCHEMICAL MASS TRANSFER AND PROGRESSIVE DEFORMATION IN THE UPPER CRUST: EXAMPLE OF BASEMENT-COVER RELATIONSHIPS IN THE EXTERNAL CRISTALLINE MASSIFS, CENTRAL ALPS SWITZERLAND

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This external zone of the Swiss Alps is composed of sedimentary cover (Permian to Tertiary sediments) and prealpine cristalline basement (External cristalline massifs), mainly consisting of old cristalline rocks and variscan granites. These rocks are affected by tertiary ductile deformations under greenschist facies conditions (450-300°C; 4,5-3Kb). In this part of the upper crust (10-15 km), the evolution of fluid circulation and chemical mass transfer are outlined in the two contrasted tectonic units. The fluid interactions between basement and cover are analysed using stable isotope systematics. With these data sets, the variation profiles of chemical elements across major structures (shear zones or veins) show two types of behaviour:

(i) Closed system: no modifications of $\delta^{18}O$ composition could be associated with vein formation in the helvetic cover. Variations of $\delta^{18}O$ reflect the chemical heterogeneity of each sedimentary layer. In granite shear zones, some oxydes show increase then decrease for the same oxyde in the same profile (eg. Na_2O or K_2O). This fact argues for an equal volume gain and loss along variation profiles for each oxyde.

(ii) Open system: variation profiles in cover mylonites show continuous increase of $^{87}Sr/^{86}Sr$ and decrease of $\delta^{18}O$ approaching values close to those of the basement. In granites, the same continuous evolution can be described for decrease of CaO and increases of MgO and LOI.

For the basement-cover relationships in the upper crust, a two step tectonic and geochemical model is proposed: (i) a progressive evolution of chemical instabilities controled by the propagation of mechanical instabilities in a closed system and (ii) with increasing deformation, an interconnected network of shear zones becomes available and permits a channelized fluid circulation and mass transfer in an open system. Fluid sources and transport mechanisms of chemical elements are discussed.

82 CYCLIC DEFORMATION AND FLOW INSTABILITIES IN THE NUCLEATION OF THE VILARIÇA STRIKE-SLIP FAULT, NE PORTUGAL

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The Vilariça fault zone (VFZ) is a 250 km long, NNE-SSW, zone of left-lateral faulting generated in late Variscan times. It has nucleated in the D_3 Moncorvo-Vila Real granitic batholith of Intra-Westphalian age, during the late stages of its emplacement (when highly quartziferous pegmatites were still molten). The multiple deformation events responsible for the VFZ nucleation produced a cyclic and heterogeneous redistribution of strain accommodation in granitic rocks and pegmatite veins, as suggested by the syntectonic hydrothermal alteration, temporal cyclicity and spatial coexistence of plastic-brittle microstructures. Strain heterogeneity is favoured by the development of mechanical instabilities at the microscale, mainly from: (1) distinct recovery mechanisms (dynamic recovery and dynamic recrystallisation-accommodated dislocation creep) act upon various minerals, for each set of P T conditions; (2) initiation and quasi-static propagation of intragranular cracks, specially those controlling the late continued fracturing and subsequent chemical softening of the feldspars; (3) strain features related with grain-boundary mechanisms, such as the sub-critical propagation of dilational inter- and transgranular cracks. The participation of fluid-assisted processes in the quasi-static growth of microfracture systems suggests that stress corrosion dominates over other time-dependent cracking processes during the stress cycling associated with the nucleation cycle of the VFZ; furthermore, the cyclic sealing of these structural discontinuities might have enabled transient increases in fluid pressure and, therefore, contributed decisively to the critical damage level of the granitic rocks. Thus the deformation might have involved long periods of time at low strain rate, separated by intermittent short-wavelength, high-amplitude tectonic increments coupled with significant fluid inflow.

83 ON THE FORMATION OF THE TIBETAN PLATEAU

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The Tibet 5000 m high plateau spreads from the Himalaya to the South to the Altyn Tagh fault to the North. The age and the elevation of this plateau has been interpreted in terms of either (i) homogeneous thickening of the lithosphere, or (ii) superposition of two normal crusts, India underneath Asia, permitting a 70 km crustal thickening. None of these models are consistent with the refraction seismic profile across the southern half of the plateau that gives evidence for marked offsets of the Moho boundary. The several kilometers offsets have a periodic occurence of about 100 km.

The 100 km periodicity suggests that the Tibetan plateau results from the growth of a mechanical instability with a regular wavelength. We associate the growth and amplification of this instability to the N-S convergence