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Effects of fault orientation on the fault rock assemblage of exhumed seismogenic sources (Adamello, Italy)

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Which factors do affect the production of frictional melts (pseudotachylytes once solidified) during seismic slip? In this study, we discuss how fault orientation may determine the presence or absence of pseudotachylytes in faults that were active under similar ambient conditions.

We compared two sub-vertical strike-slip fault zones crosscutting the northern Adamello batholith (Southern Alps): the Gole Larghe Fault Zone (GLFZ) and the Passo Cercen Fault Zone (PCFZ). Both faults cut tonalites, were active at 9-11 km depth (corresponding to an ambient temperature of 250-300˚C) and are formed by hundreds of subparallel cataclasite horizons exploiting precursor joints. The GLFZ is formed by dextral strike-slip faults striking mainly N105˚; the fault rock assemblage consists of cataclasites (cohesive fault rocks with no evidence of melting) associated with widespread, thick (up to few centimetres) pseudotachylyte veins. The PCFZ is formed by both dextral and sinistral faults striking in a range from N105˚ to N140˚; the fault rock assemblage consists of cataclasites associated with thick epidote + K-feldspar + quartz veins and thin ($<$ 5mm), rare pseudotachylyte veins. The switch in the sense of shear of faults of the PCFZ occurs at about N135˚ which is assumed to be the direction of the regional shortening direction σ_1. A similar orientation of σ_1 is also inferred for the GLFZ based on meso- and microstructural evidences. The presence of pseudotachylytes in both the GLFZ and PCFZ indicates that the fault zones were seismic. The different orientation of the two fault zones in the same stress field has been interpreted as the cause for the two types of fault rock assemblages. The GLFZ strikes at about 30˚ to the inferred σ_1 and is favourably oriented for activation in shear mode,

according to the Mohr-Coulomb criterion for failure; the PCFZ strikes at low angle to σ_1, in an orientation favourable for hybrid shear-extensional mode. For faults oriented at 30° to the σ_1, the stress normal to the fault plane is the maximum admissible for failure; for faults oriented at low angle to σ_1, the effective normal stress is low or negative (i.e., tensional cracks). Frictional melting along the PCFZ was thus inhibited by the low effective normal stress acting on fault planes.