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Phyllosilicate occurrence along extensional faults in carbonate rocks and implications for seismic slip propagation: case studies from the central Apennines, Italy

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The occurrence of phyllosilicate-rich layers and phyllosilicate-rich fault rocks has been documented and studied, for the first time, in five shallow (exhumed from depths < 3 km) carbonate-hosted extensional fault zones from the seismically-active central Apennines, Italy. The brittle portion of this domain is dominated by a sedimentary sequence consisting of ~5-6 km thick platform carbonates deposits upward followed by ~2 km thick phyllosilicate-rich deposits (marls and siliciclastic deposits). Along sharp fault surfaces within carbonate-hosted fault zones, the phyllosilicate-rich layers are usually thin (a few centimeters to decimeters thick), but can reach also a few meters in thickness. Structural, microstructural, and mineralogical analyses show that phyllosilicates derived from the overlying marls and sandstones and were involved during tectonic deformation. During fault zone evolution, phyllosilicate-rich material percolated downward into pull-aparts (i.e., dilational jogs) generated along staircase faults. With further displacement accumulation, this clayey material was smeared and

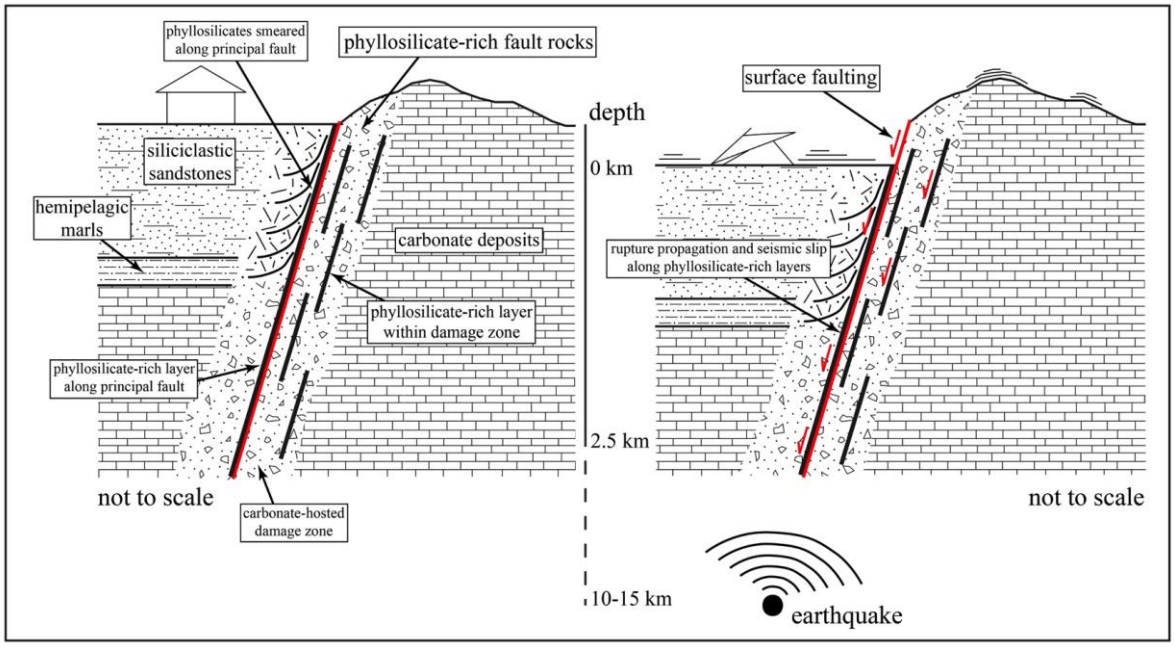

Figure 1: Cartoon showing the influence of phyllosilicate-rich layers during earthquake slip propagation up to the Earth's surface. The phyllosilicate rich layers along principal fault and within the damage zone of carbonate-hosted fault zones can behave as a very weak material promoting earthquake slip propagation up to the Earth's surface and generating the observed surface faulting associated with damages and casualties.

concentrated into narrow layers along the fault surfaces (Fig. 1). The occurrence of phyllosilicates promoted frictional sliding along weak phyllosilicate bands, which is energetically favored rather then cataclasis within strong carbonate rocks. These observations implies that, even in a tectonic setting dominated by high frictional strength rocks (e.g., carbonates), localized layers enriched in weak phyllosilicates can reduce the expected fault strength during earthquake, promoting seismic slip propagation up to the Earth's surface and surface faulting (Fig. 1). This concept can be valid in many other seismically active extensional settings where low friction and weak phyllosilicate-rich rocks overlain or are juxtaposed with high friction rocks.