Evidence for coseismic slip preserved in high-porosity sandstone at very shallow burial conditions (Crotone Basin, Italy).

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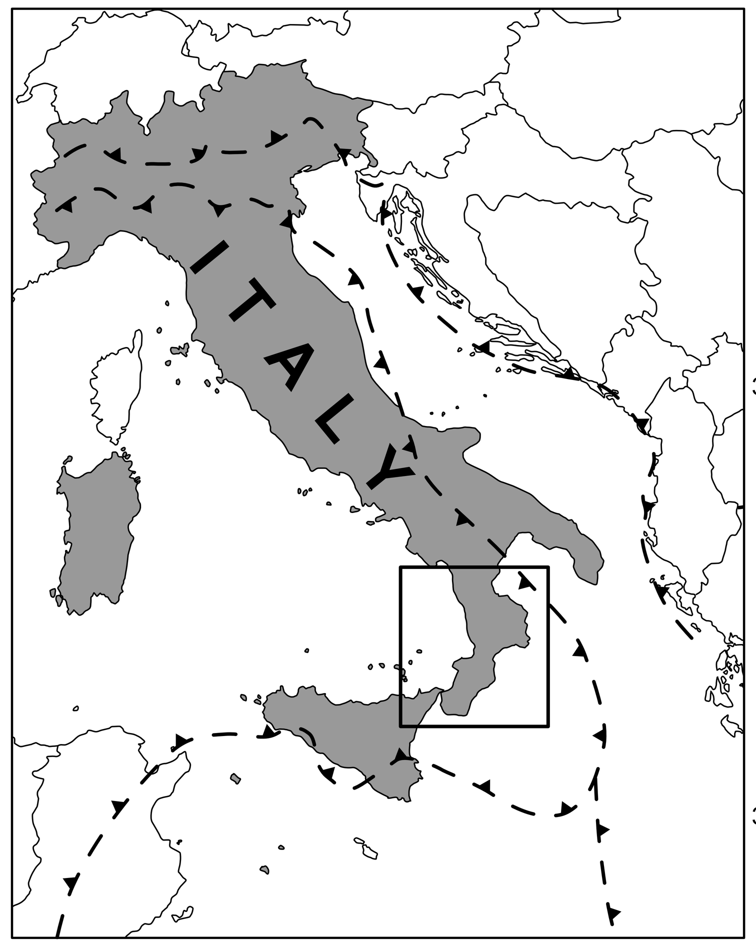
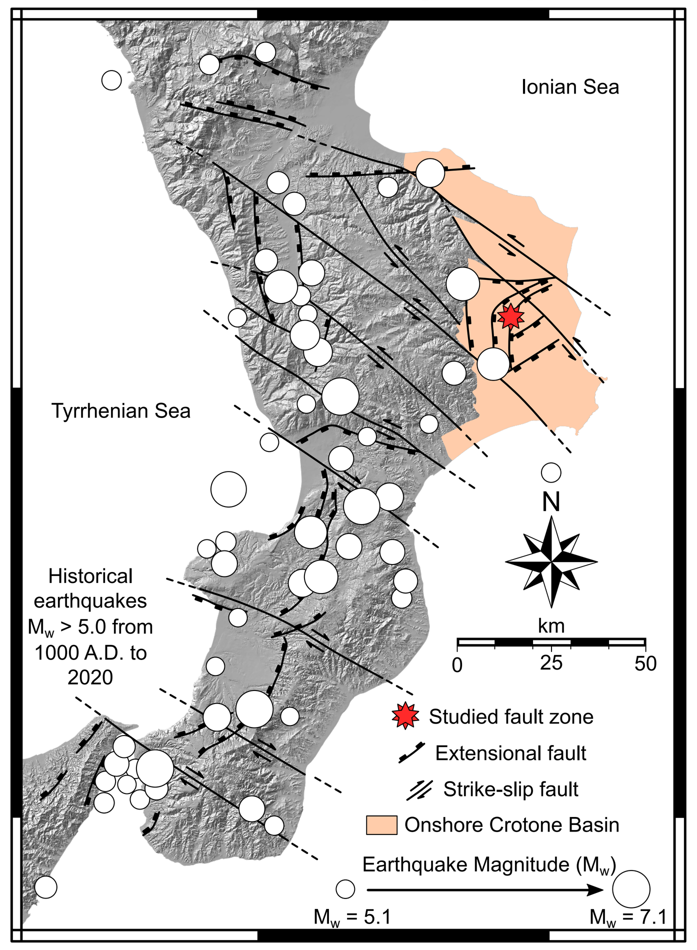
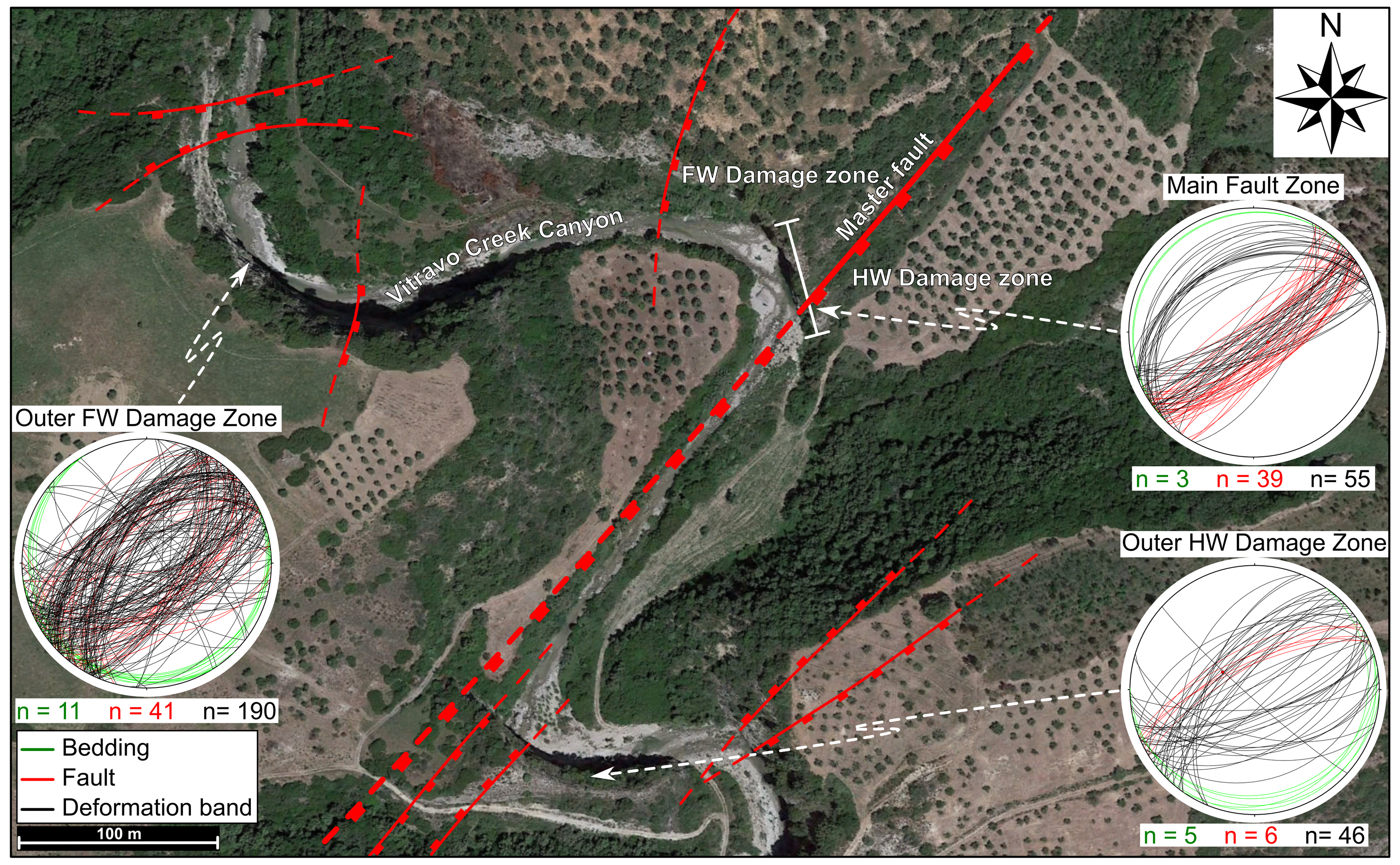




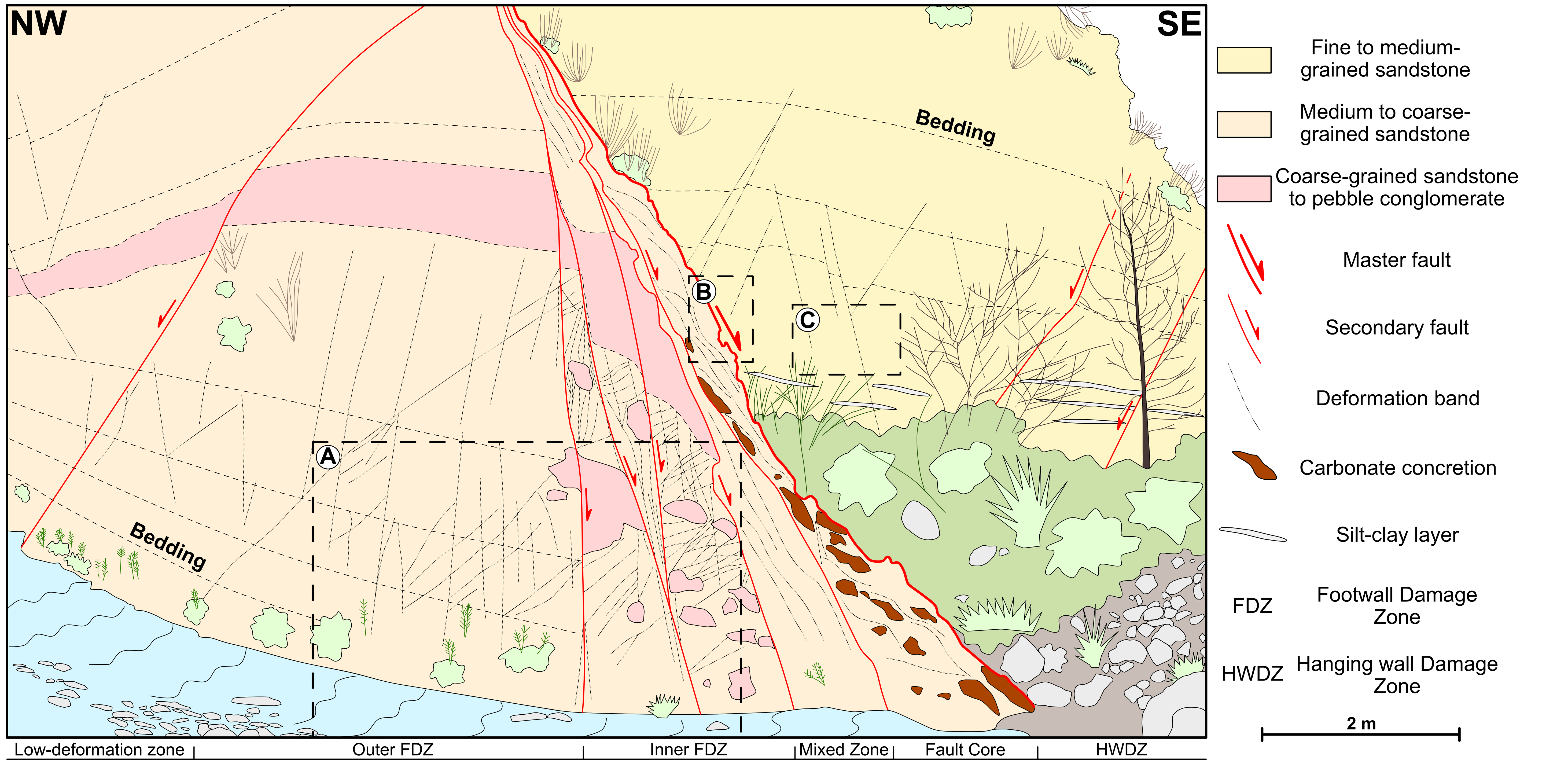


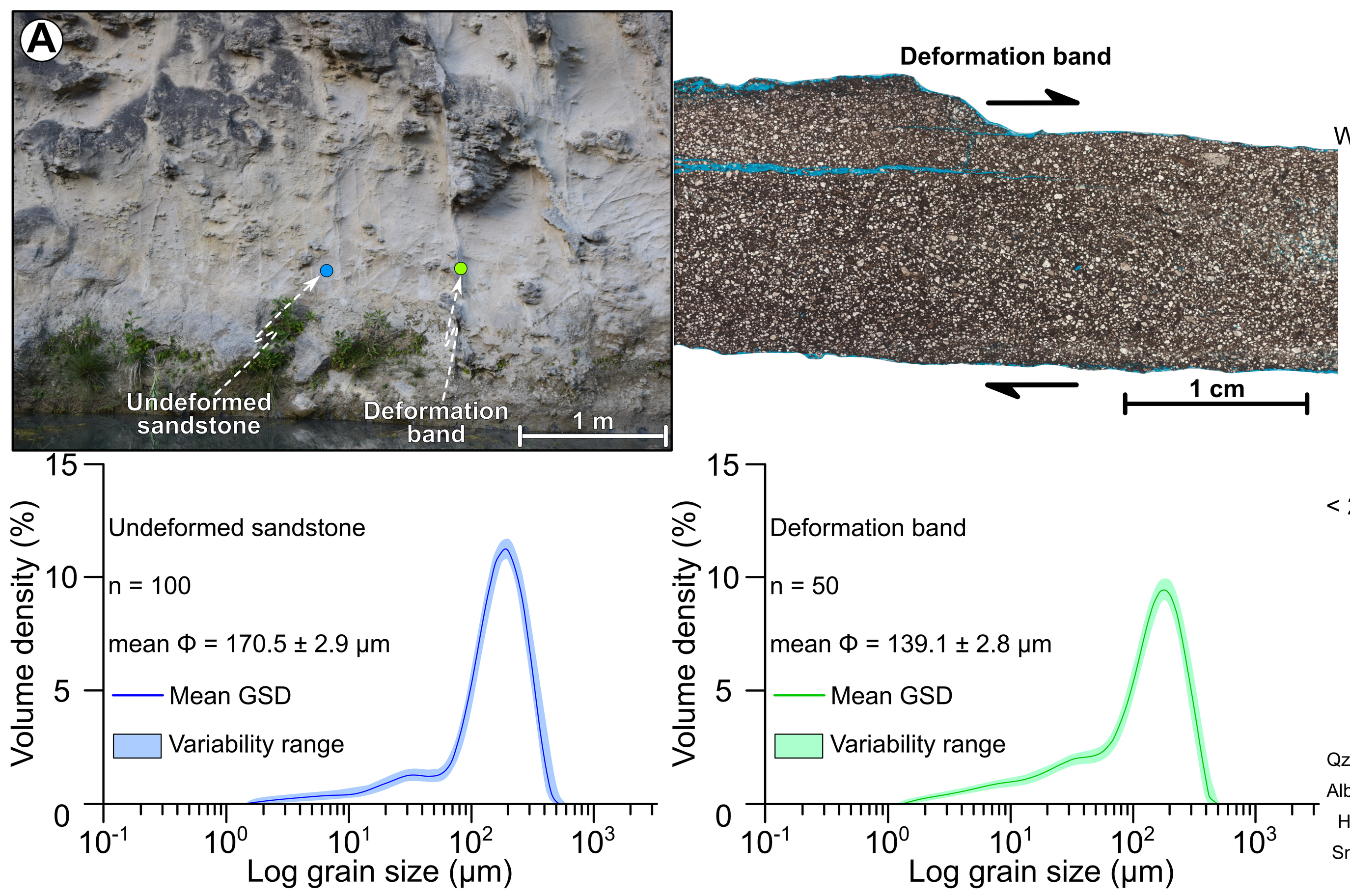
Introduction: Coseismic deformation in high-porosity granular media represents a topic to be investigated as the mechanical behavior of sediments is associated with strain-hardening and velocity-strenthening processes, which hamper the nucleation and propagation of seismic slip. We hereafter provide evidence for coseismic deformation under shallow burial conditions (< 1 km depth).

Geological and tectonic setting: The studied extensional fault zone is located along the Vitravo Creek, Crotone Forearc Basin, South Italy and deforms Plio-Pleistocene high-porosity, shallow marine sandstones. Grain size of sandstone bodies ranges from fine-grained to pebble conglomerate.

Fault zone structure: The fault accommodated ~50 m of extensional displacement and is composed of a fault core bounded by a 2-3 cm-thick dark gouge layer, a mixed zone and footwall and hanging wall damage zones, with a wealth of deformation bands and subsidiary faults.

Microstructural and mineralogical features: Severe grain size reduction characterizes the dark gouge layer, which displays high weight percentage of phyllosilicates (Illite and Smectite). Such peculiar minerals are absent in the host rocks both on the footwall and on the hanging wall side.



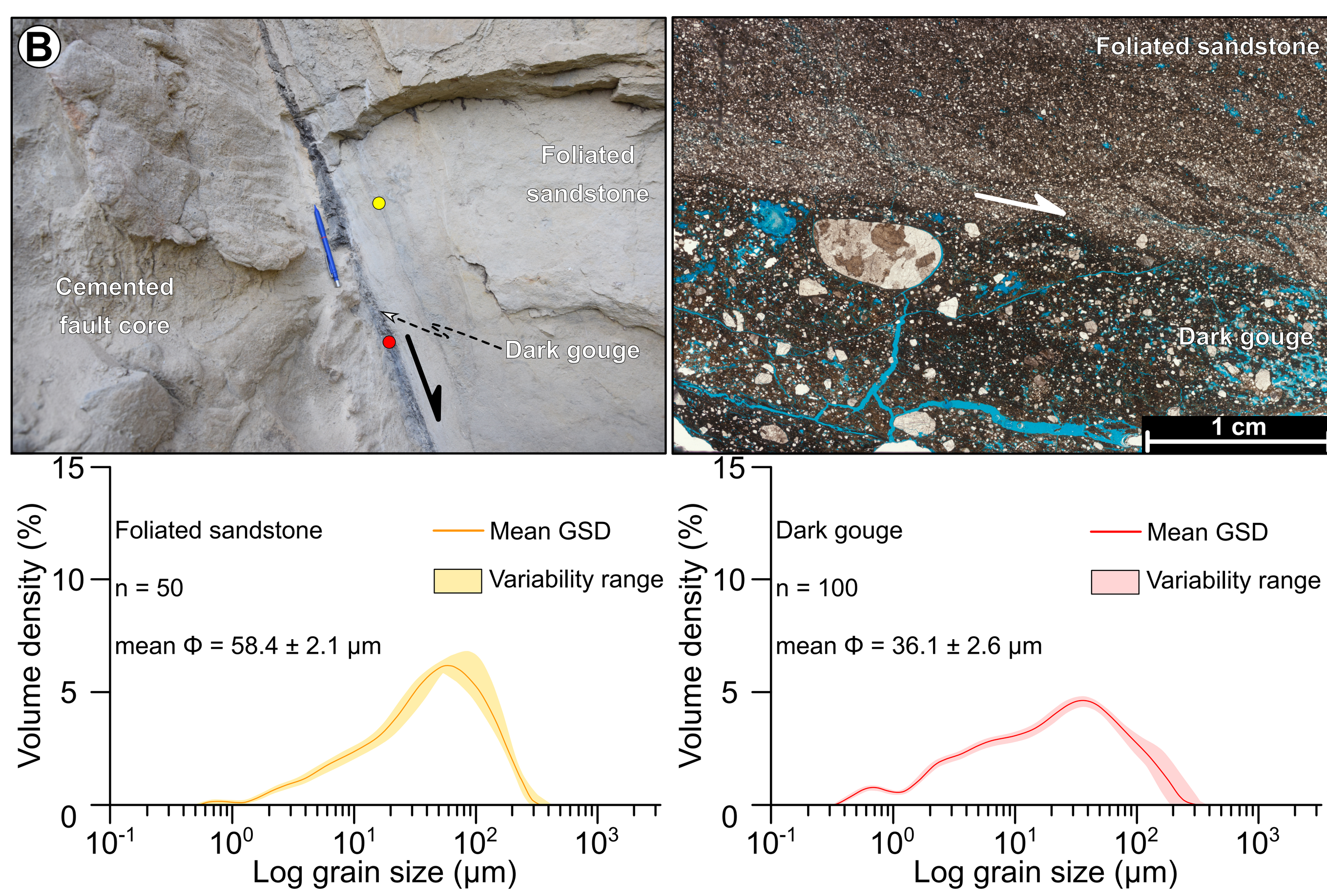


XRD analysis

Whole rock composition (wt.%)	Undeformed sandstone	Deformation band
Qz	53	42
Cal	26	39
Dol	tr	tr
Ab	8	7
Kfs	7	6
Ph	6	5
Hl	-	1
Gp	-	tr

< 2 μm grain size fraction (wt.%)	Undeformed sandstone	Deformation band
I	58	61
I-S	10	5
Kln	13	14
Chl	19	20
%I I-S	20	20

Qz, Quartz; Cal, Calcite; Dol, Dolomite; Ab, Albite; Kfs, K-feldspar; Ph, Phyllosiliocates; Hl, Halite; Gp, Gypsum; I, Illite; I-S, Illite-Smectite mixed layers; Kln, Kaolinite; Chl, Chlorite.

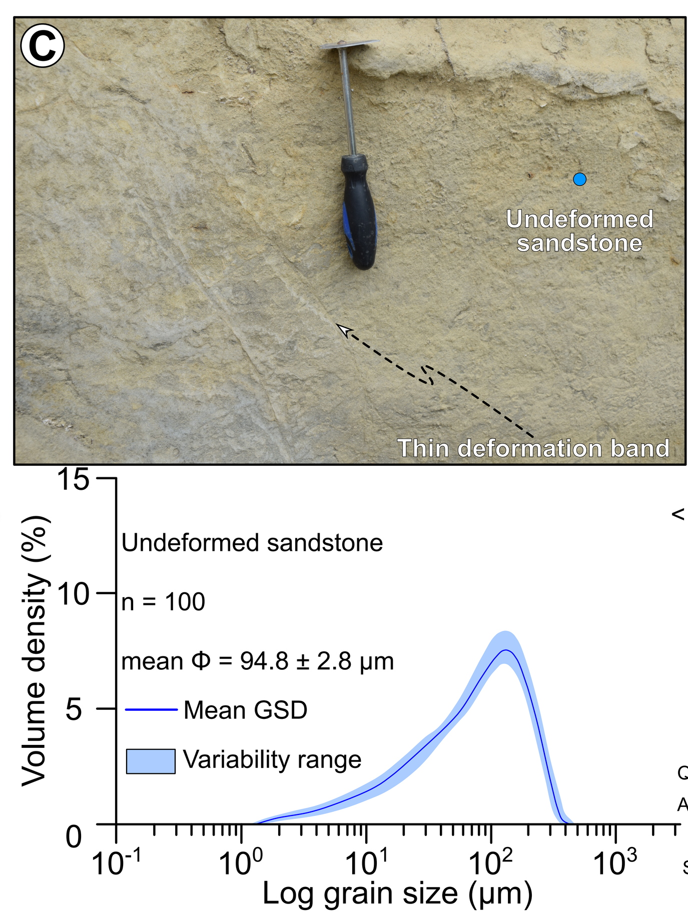


XRD analysis

Whole rock composition (wt.%)	Foliated sandstone	Dark gouge
Qz	44	44
Cal	35	-
Dol	1	-
Ab	6	4
Kfs	6	4
Ph	8	47
Hl	-	1
Gp	-	-

< 2 μm grain size fraction (wt.%)	Foliated sandstone	Dark gouge
I	58	62
I-S	4	5
Kln	10	12
Chl	28	21
%I I-S	20	60

Qz, Quartz; Cal, Calcite; Dol, Dolomite; Ab, Albite; Kfs, K-feldspar; Ph, Phyllosiliocates; Hl, Halite; Gp, Gypsum; I, Illite; I-S, Illite-Smectite mixed layers; Kln, Kaolinite; Chl, Chlorite.



XRD analysis

Whole rock composition (wt.%)	Undeformed sandstone
Qz	47
Cal	30
Dol	1
Ab	8
Kfs	5
Ph	9
Hl	-
Gp	-

< 2 μm grain size fraction (wt.%)	Undeformed sandstone
I	45
I-S	15
Kln	17
Chl	23
%I I-S	25

Qz, Quartz; Cal, Calcite; Dol, Dolomite; Ab, Albite; Kfs, K-feldspar; Ph, Phyllosiliocates; Hl, Halite; Gp, Gypsum; I, Illite; I-S, Illite-Smectite mixed layers; Kln, Kaolinite; Chl, Chlorite.

Discussion and conclusions: The occurrence of ordered Illite-Smectite layers suggests deformation temperatures above 100 °C, exceeding the expected burial-related temperature for 0.5-1.0 km sediment overburden. Strong cataclastic grain size reduction further supports the hypothesis of high slip rates deforming the host sandstone.

Further readings:

Balsamo, F., Aldega, L., De Paola, N., Faoro, I., and Storti, F., 2014, The signature and mechanics of earthquake ruptures along shallow creeping faults in poorly lithified sediments: Geology, v. 42, p. 435–438, doi:10.1130/G35272.1.

Pizzati, M., Balsamo, F., and Storti, F., 2023, Fingerprints and energy budget of the earthquake cycle in shallow sediments: Journal of Structural Geology, v. 170, p. 104858, doi:10.1016/j.jsg.2023.104858.