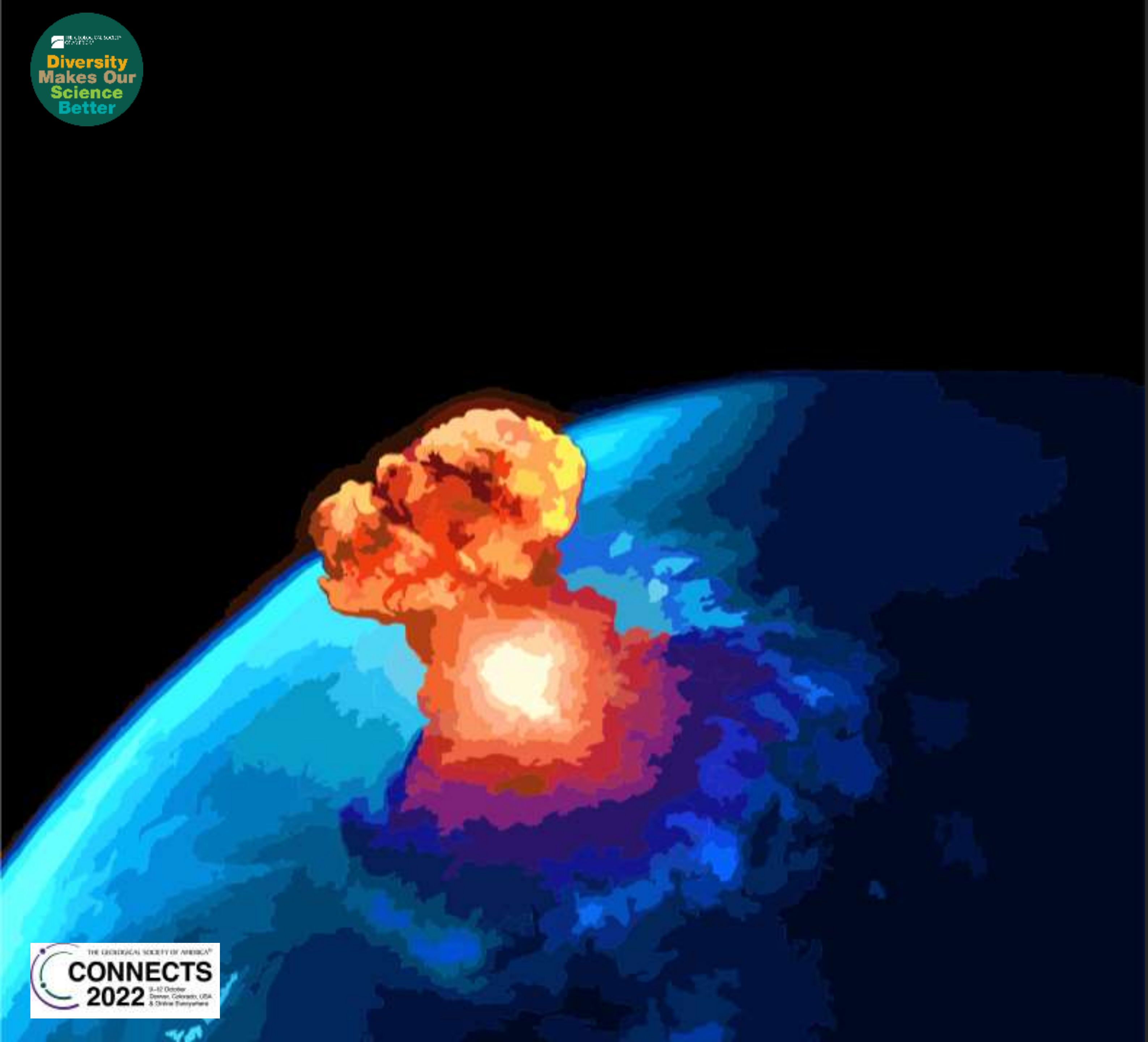

THE CHICXULUB MEGA-EARTHQUAKE

Evidence from Colombia, Mexico, and the United States

Hermann D. Bermúdez

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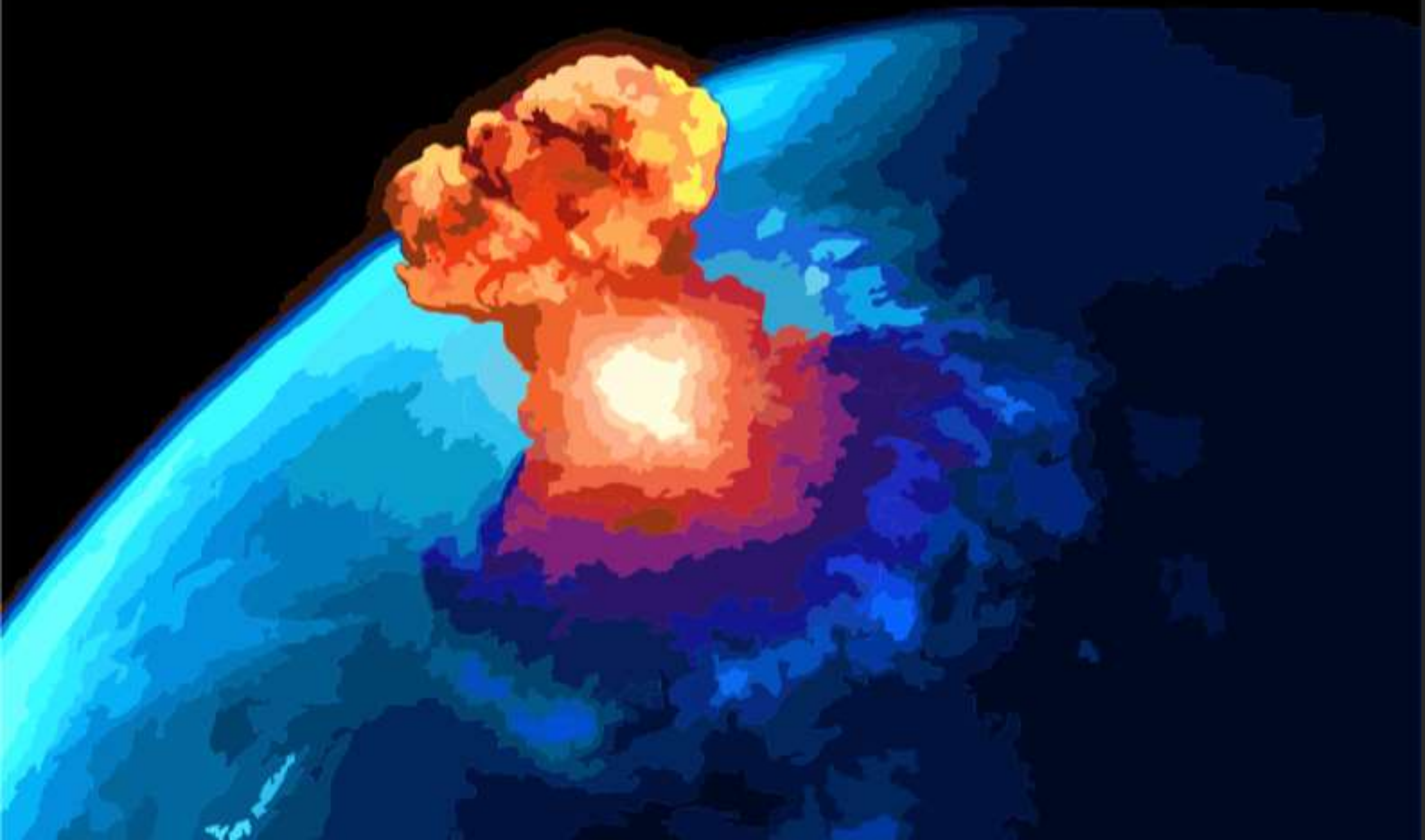
The Chicxulub Mega-Earthquake



The Chicxulub Asteroid Impact released significant energy to induce mega-earthquakes and tsunamis and create a 180-200 km diameter crater (Boslough et al., 1994; Collins et al., 2020; Pope et al., 1997).

The energy released was equivalent to the explosion of **ten billion Hiroshima bombs**

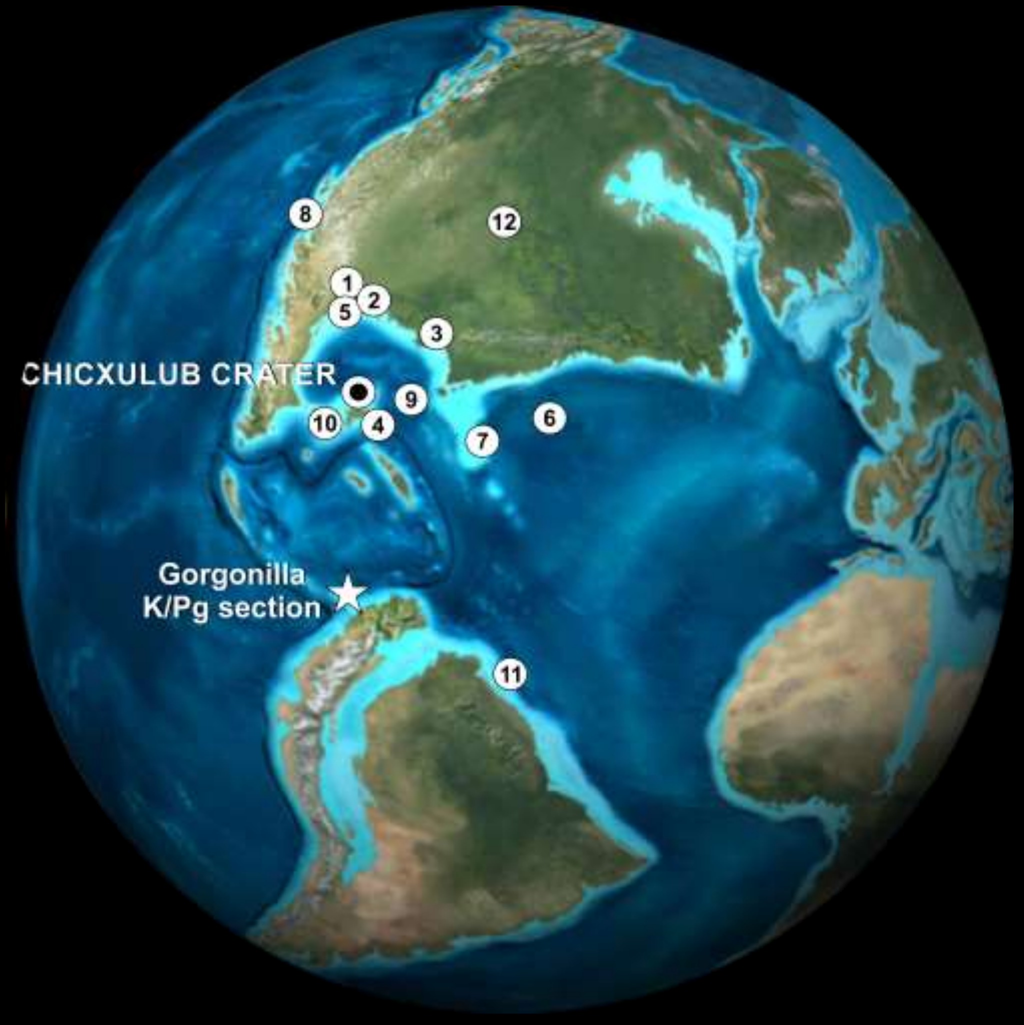
50,000 times more energy than the **Sumatra earthquake of 2004**

(10^{23} joules, Morgan et al., 2022)

This amount of energy was enough to trigger colossal earthquakes (with magnitude > 11) and generate tsunamis with waves over one kilometer high (DePalma et al, 2019; Range et al, 2022)

Several studies report deformation and catastrophic sedimentation induced by the Chicxulub Asteroid Impact, but to date, no study has investigated its seismic effects on the sedimentary record in detail.

Reports of catastrophic sedimentation triggered by Chicxulub asteroid impact



In most cases the description includes only one or two paragraphs, and no photos

N°	LOCALITIES		
1	La Popa basin, NE Mexico		Schulte et al., 2012
2	Brazos river Texas, EEUU; NE Mexico (La Sierrita, Mimbral, El Toro sections)	vertically inclined beds	2010; Smit, 1999, Arz
3	Alabama, United States	displaying a mixture of soft and semisoft sediment deformation;	
4	DSDP Sites 536 y 540, Gulf of Mexico	Large-scale slumping	al. 1984
5	El Tecolote, NE Mexico		
6	Bermuda Rise, NW Atlantic		
7	Black Nose, NW Atlantic		
8	Cañon de San Fernando, Baja California, Mexico		
9	Gulf of Mexico	depositional mixing	
10	SE Mexico		
11	Demerara rise, SE Caribbean		Schulte et al, 2009.
12	South Dakota, EEUU		

Soft-sediment deformation

Ball and pillow structures

Chaotic boulder - mudstone mixtures

Sedimentary dykes

Structureless or faint parallel lamination

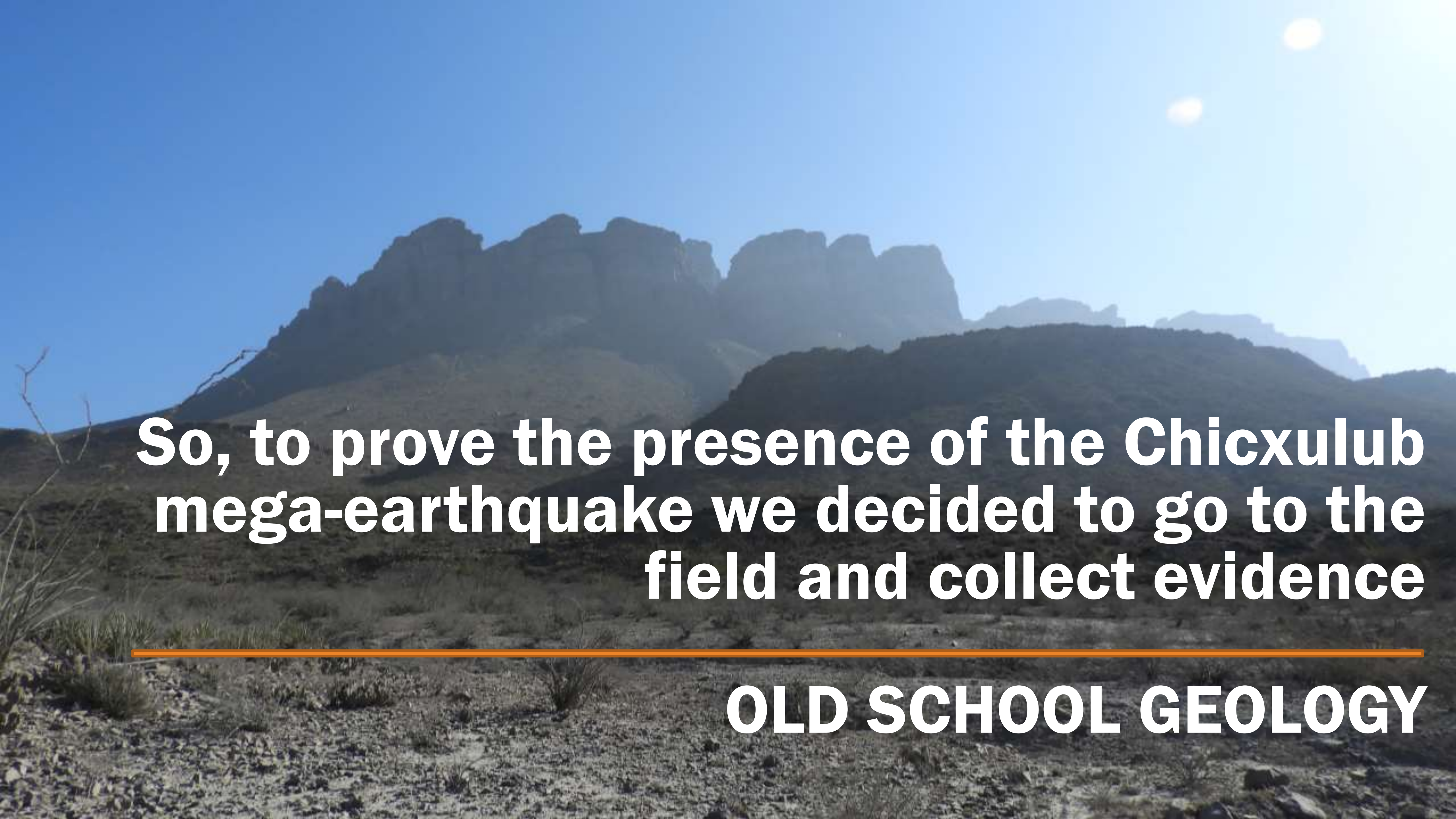
Slumps of slump folds

Disturbed beds

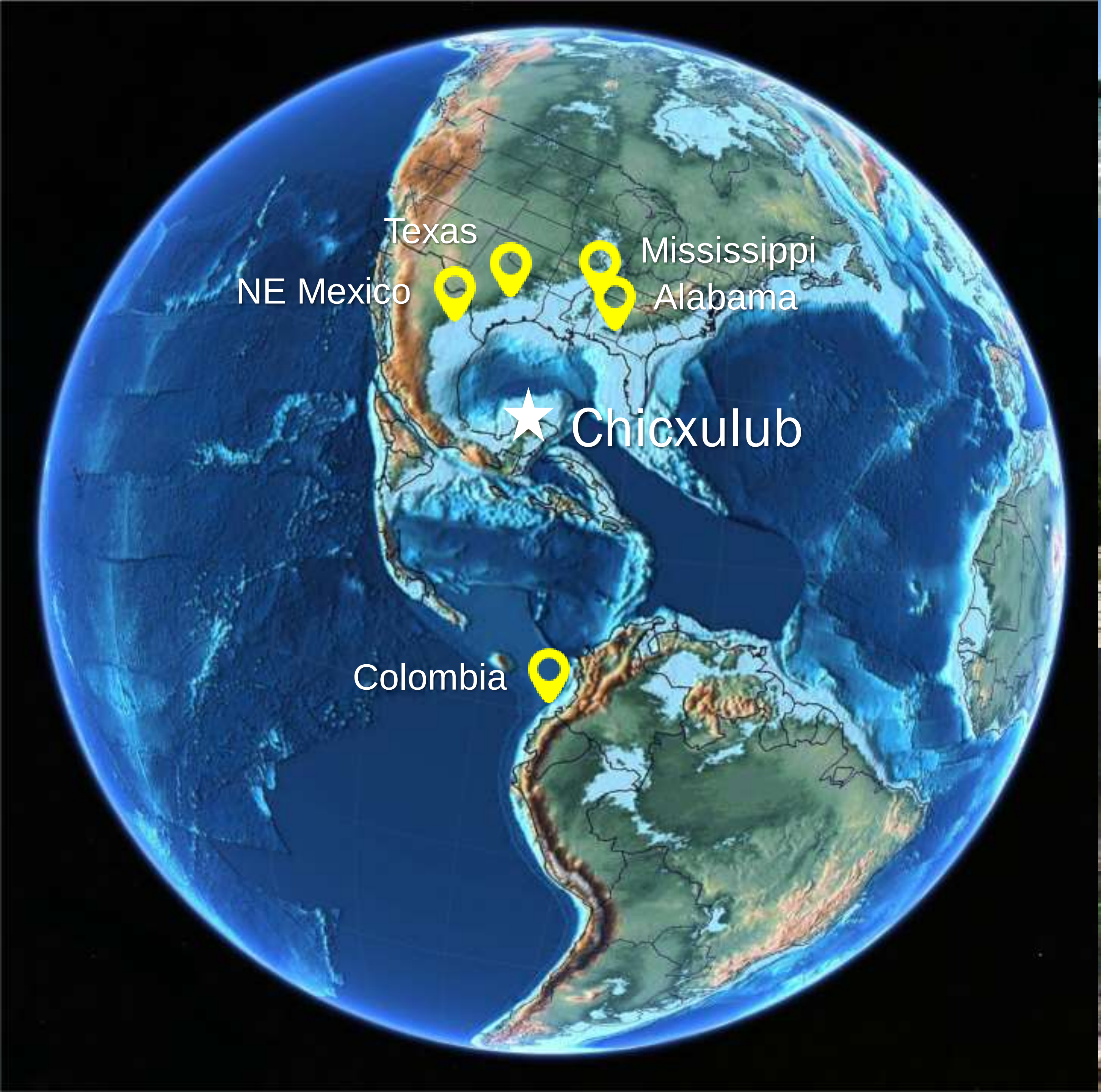
Tilted blocks bounded by the small normal faults

Chaotic bedding

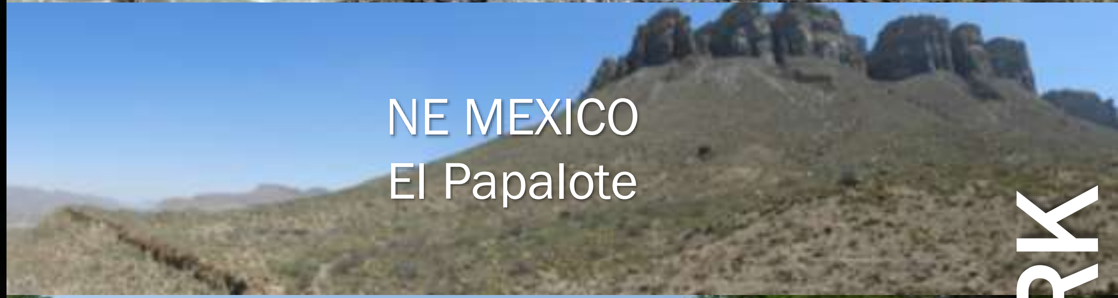
Folds, microfaults and faults


So, to prove the presence of the Chicxulub mega-earthquake we decided to go to the field and collect evidence
OLD SCHOOL GEOLOGY

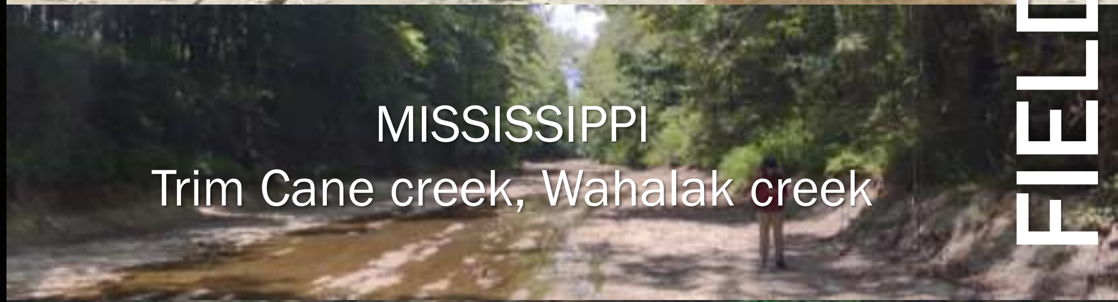
FIELD WORK


Texas
NE Mexico
Mississippi
Alabama
Chicxulub
Colombia


COLOMBIA
Gorgonilla Island

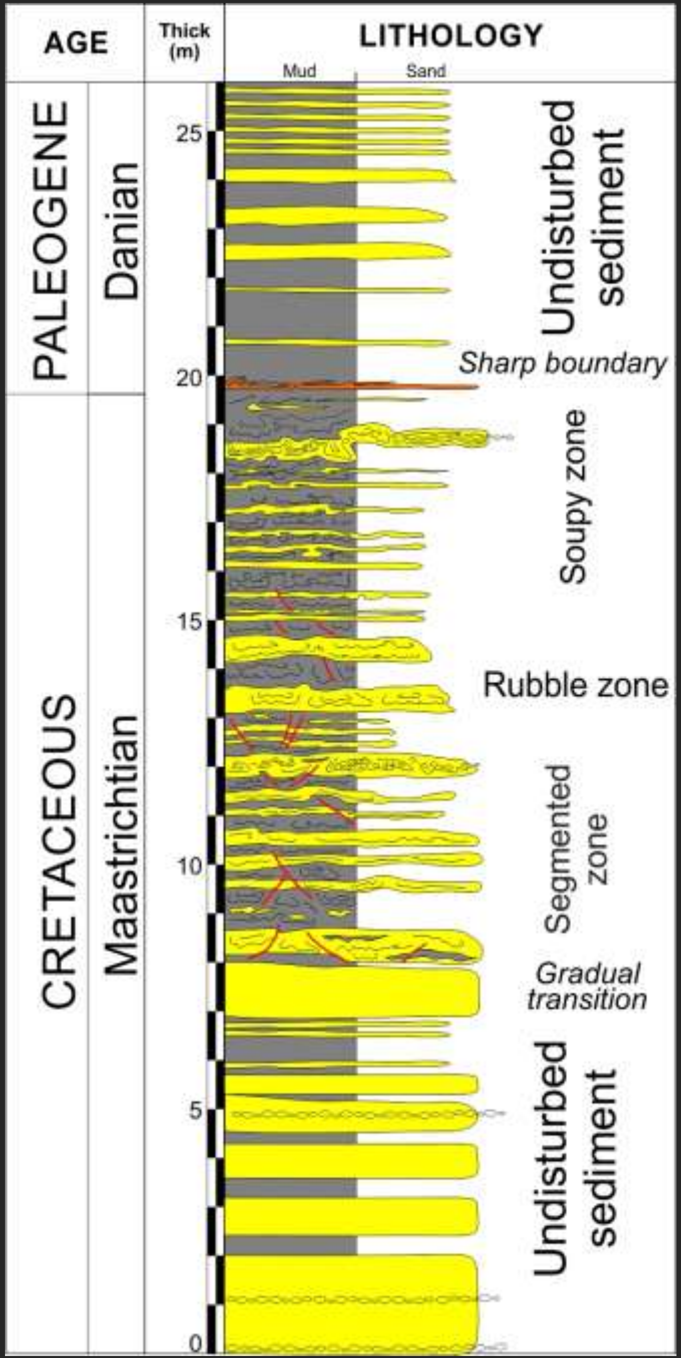

NE MEXICO
El Papalote


TEXAS
Brazos river


MISSISSIPPI
Trim Cane creek, Wahalak creek


ALABAMA
Moscow landing, Mussel creek

Gorgonilla Island, Colombia



No deformation

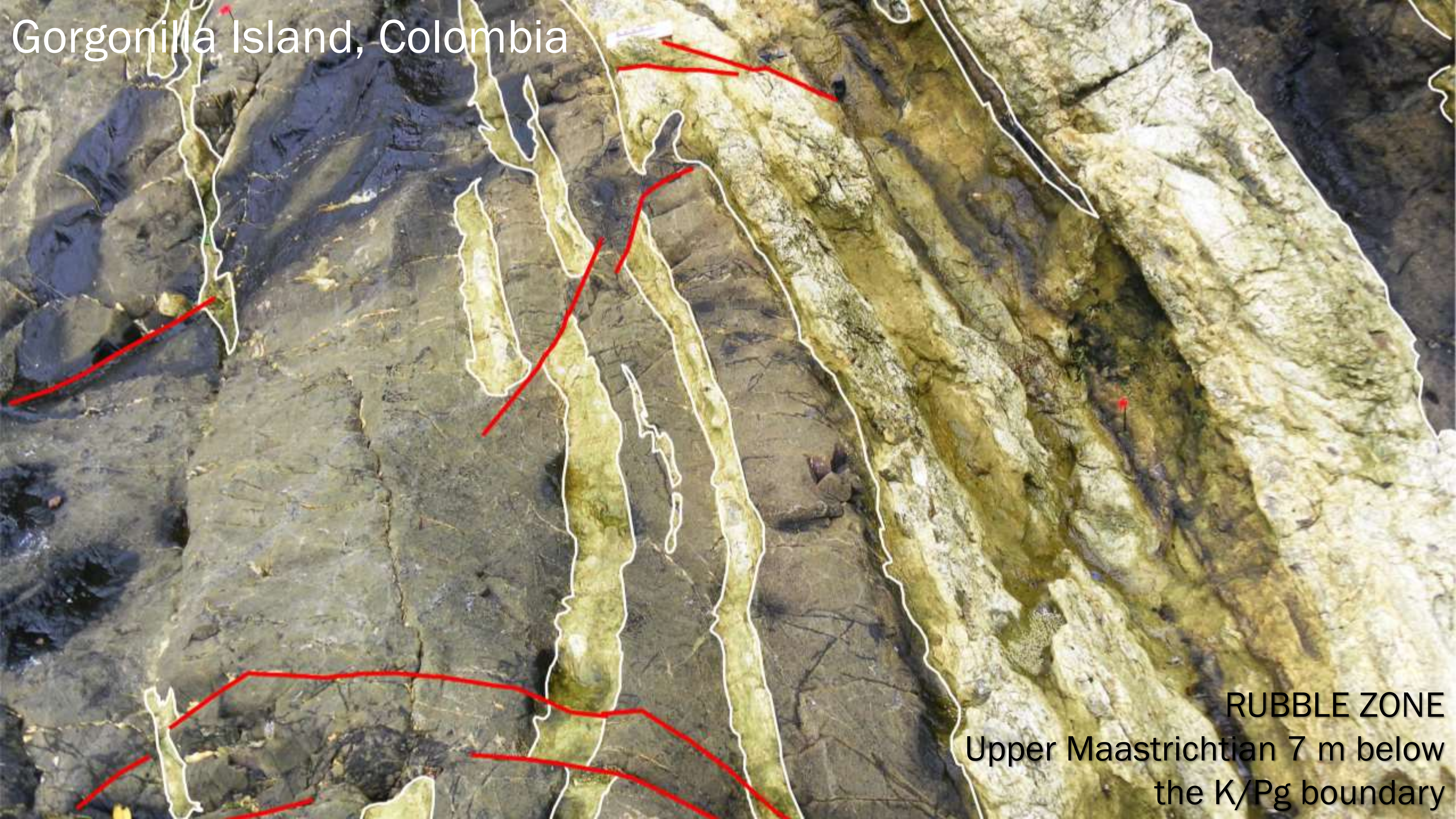
Very intense deformation:
In situ liquefaction - Soft–sediment deformation structures, Ductil deformation is predominant
At the top, complete destruction of sedimentary fabric

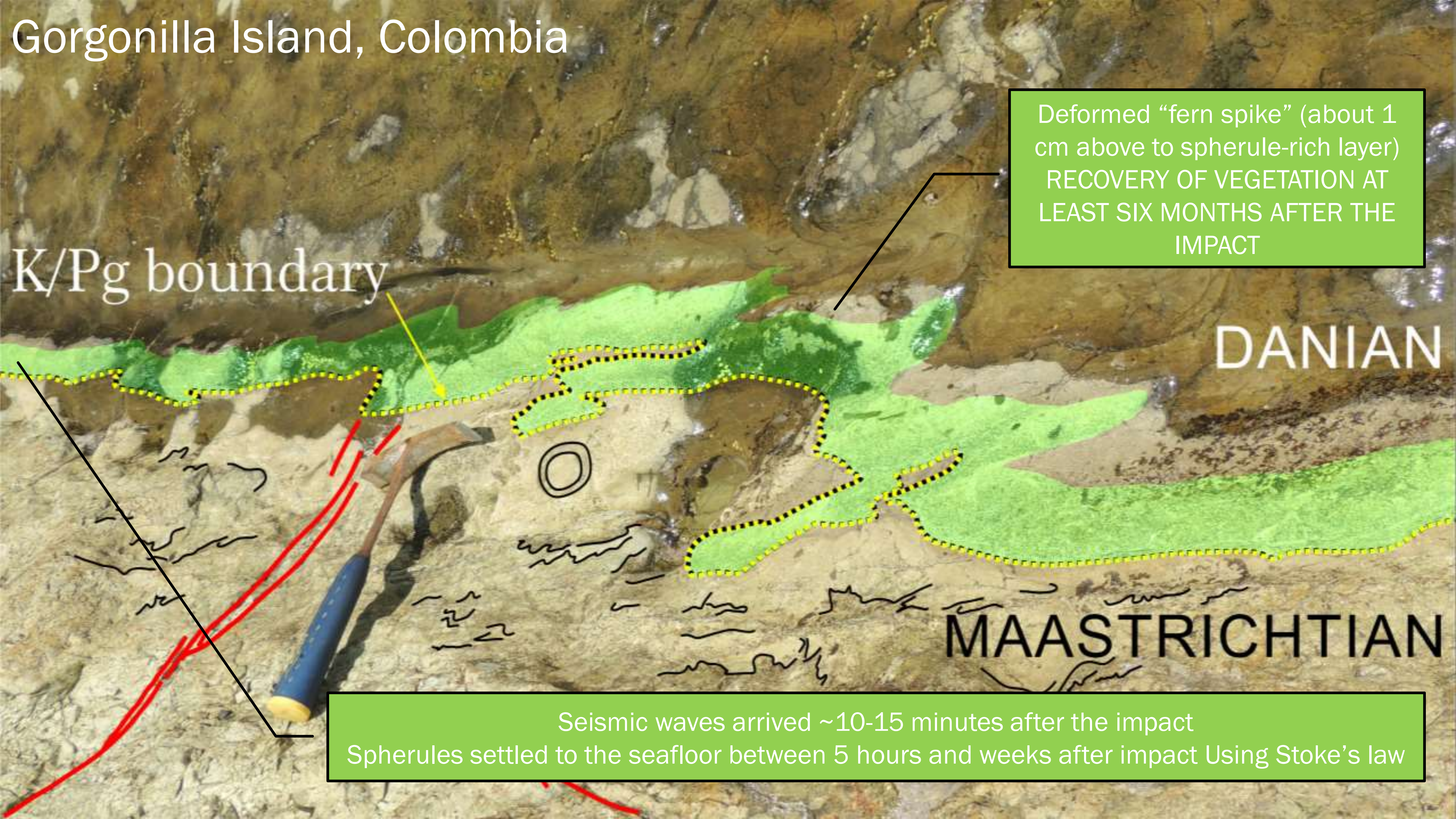
Fragile and ductile deformation

Moderate deformation:
Fragile deformation is predominant

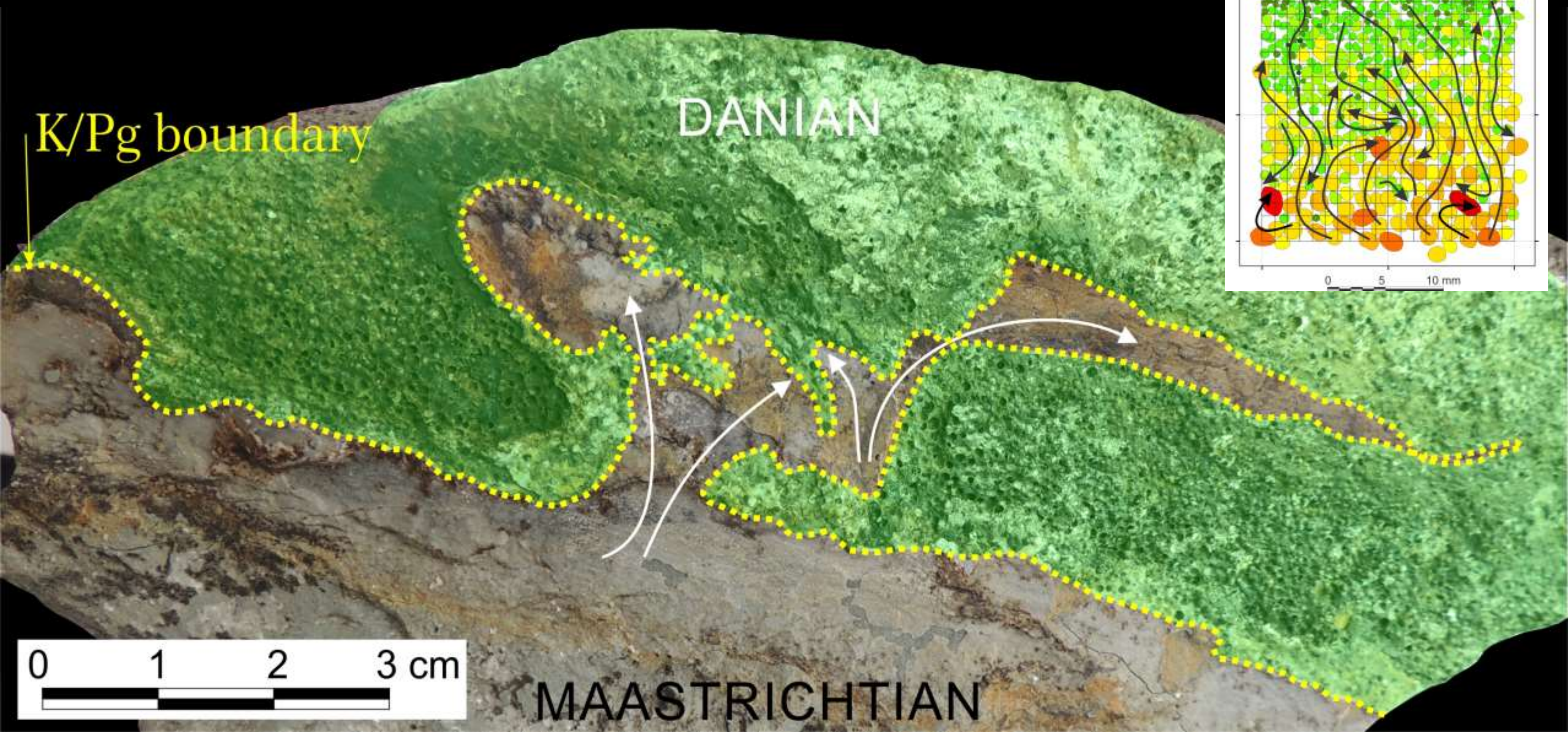
No deformation

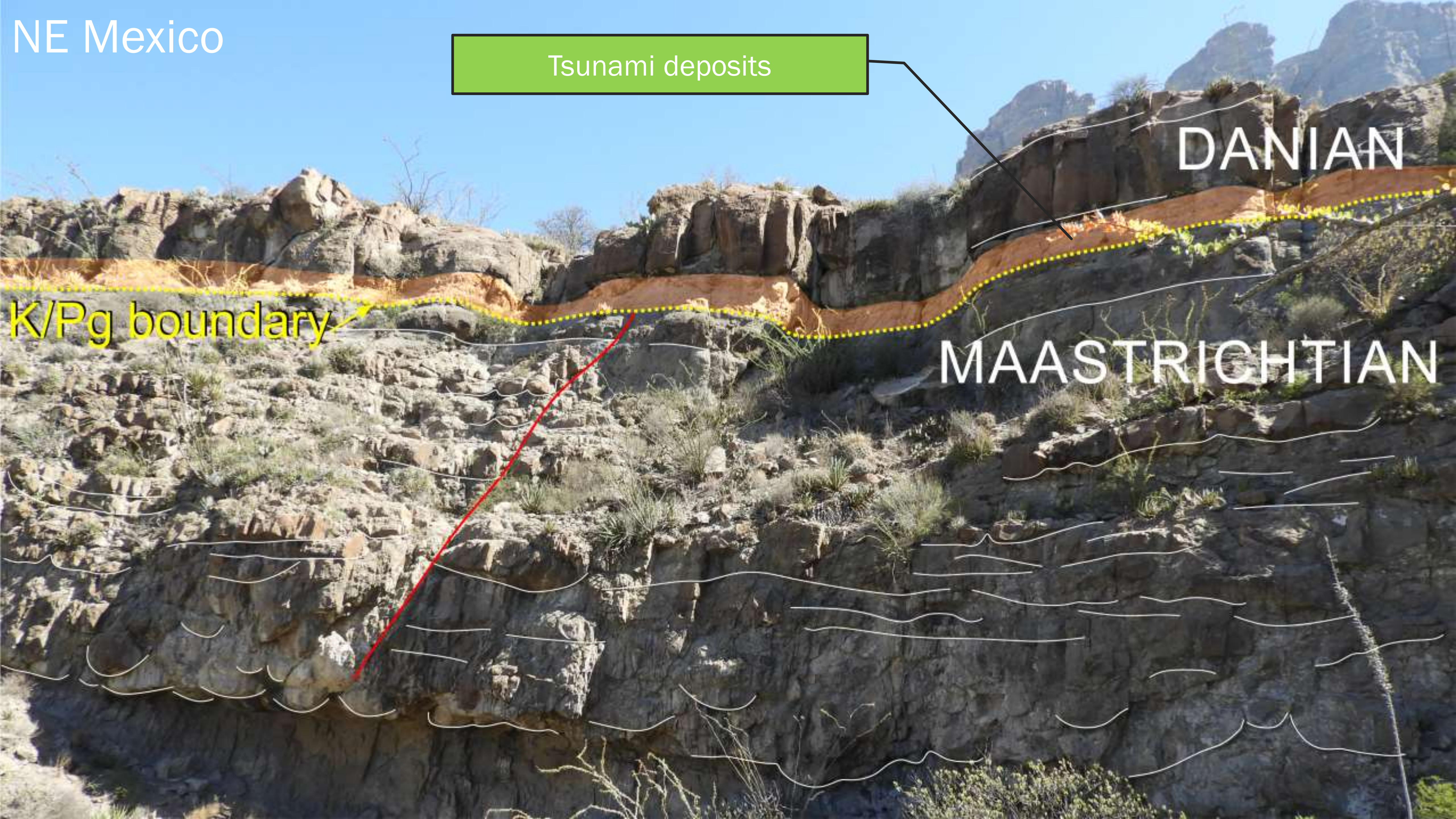
The evidence indicates that the bed–disruption processes began slightly before but continued during the emplacement of the ejecta deposit

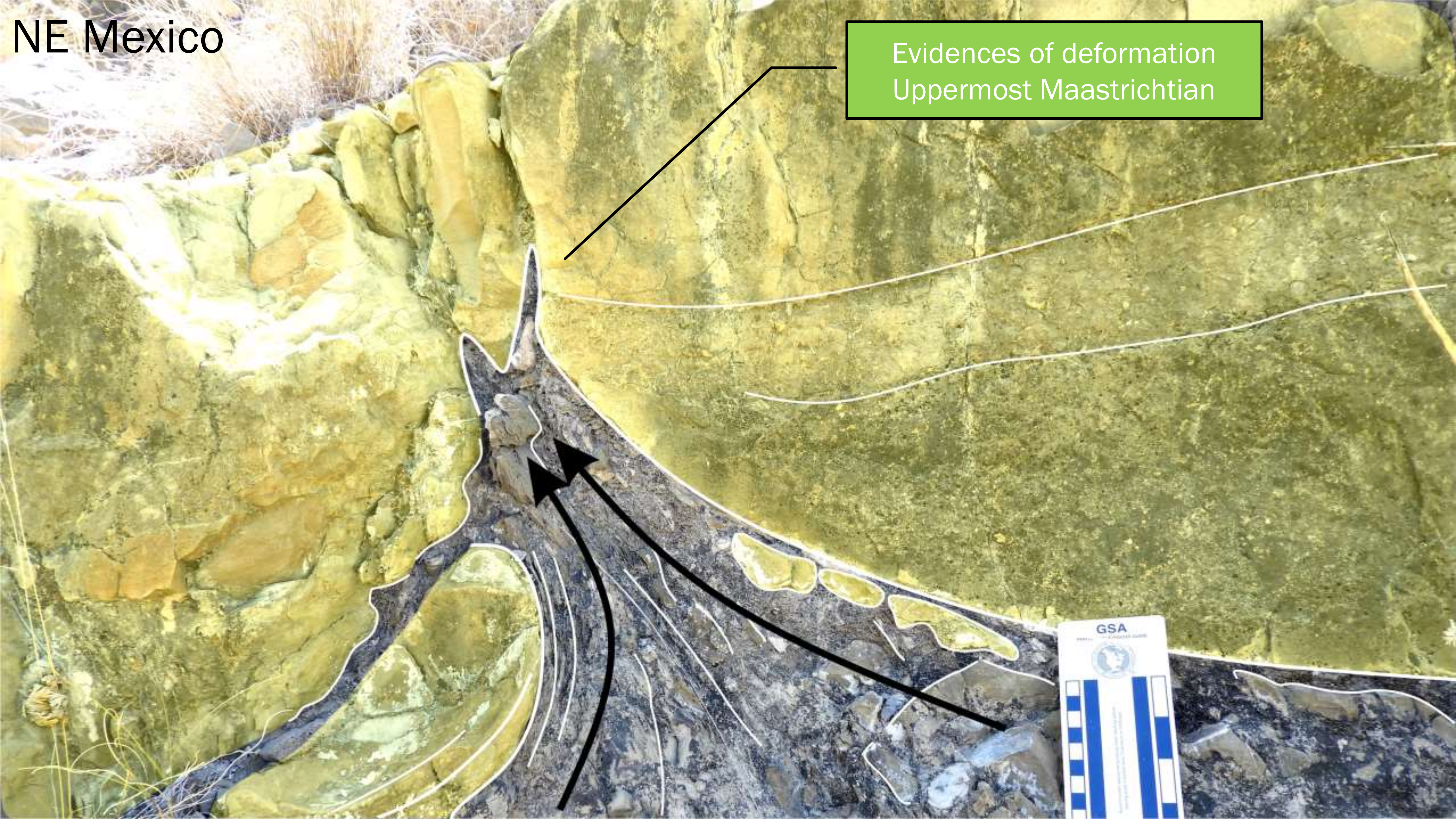

Gorgonilla Island, Colombia
RUBBLE ZONE
Upper Maastrichtian 7 m below
the K/Pg boundary

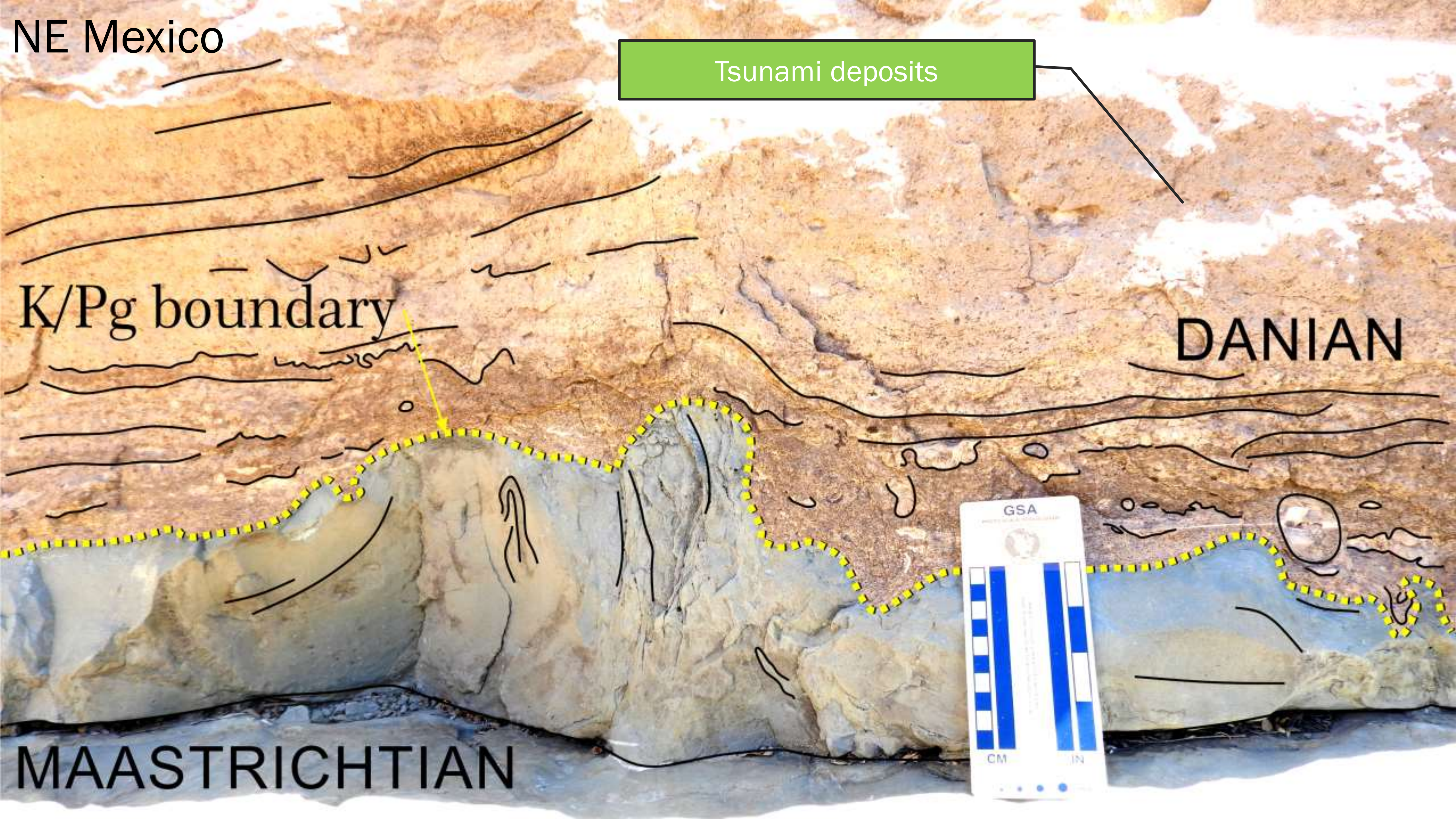

Gorgonilla Island, Colombia
Deformed "fern spike" (about 1 cm above to spherule-rich layer) RECOVERY OF VEGETATION AT LEAST SIX MONTHS AFTER THE IMPACT
K/Pg boundary
DANIAN
MAASTRICHTIAN
Seismic waves arrived ~10-15 minutes after the impact
Spherules settled to the seafloor between 5 hours and weeks after impact Using Stoke's law

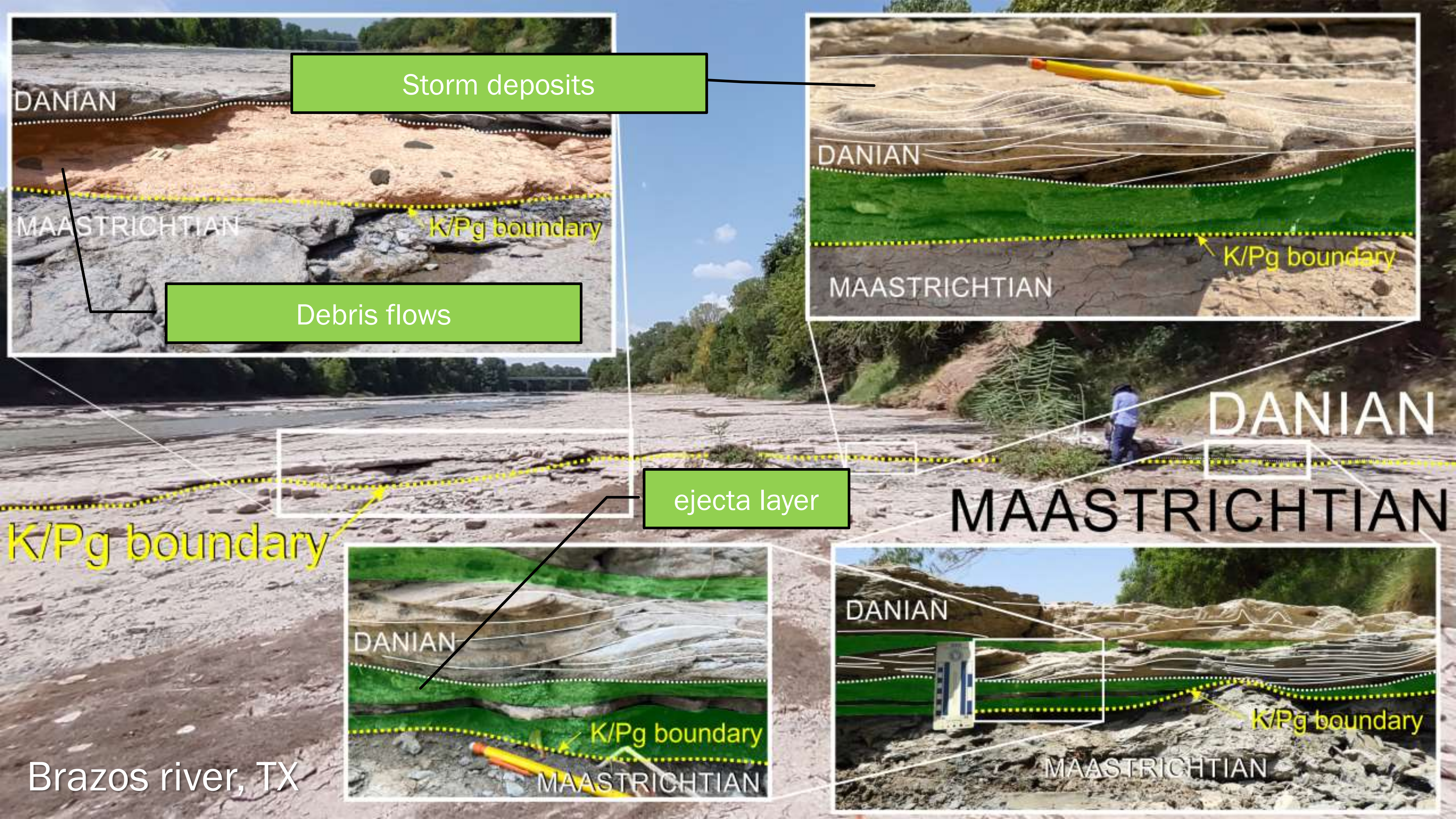
Gorgonilla Island, Colombia



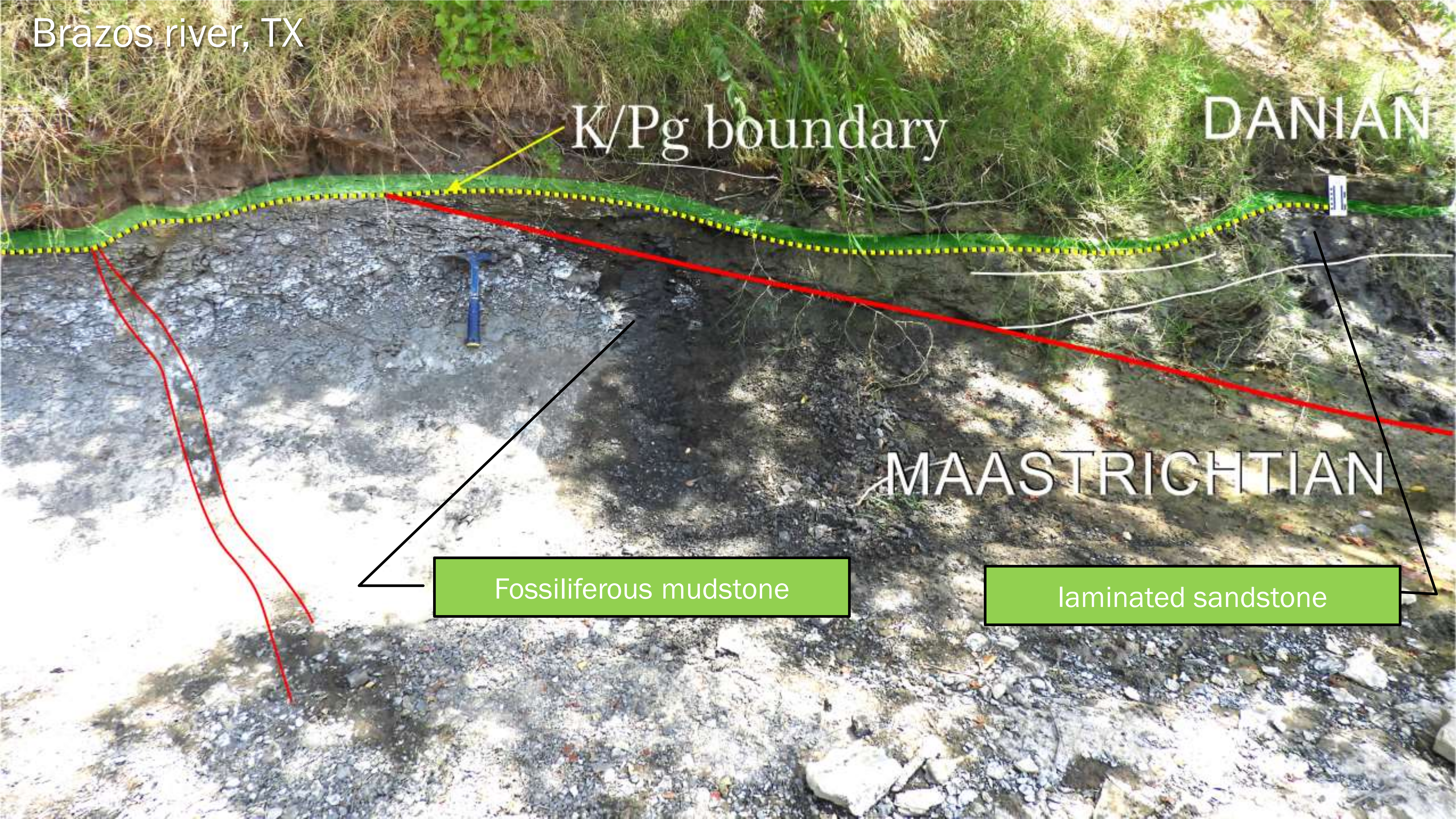

NE Mexico
Tsunami deposits
DANIAN
K/Pg boundary
MAASTRICHTIAN


NE Mexico
Evidences of deformation
Uppermost Maastrichtian
GSA


NE Mexico
Tsunami deposits
K/Pg boundary
DANIAN
MAASTRICHTIAN
GSA
CM
IN

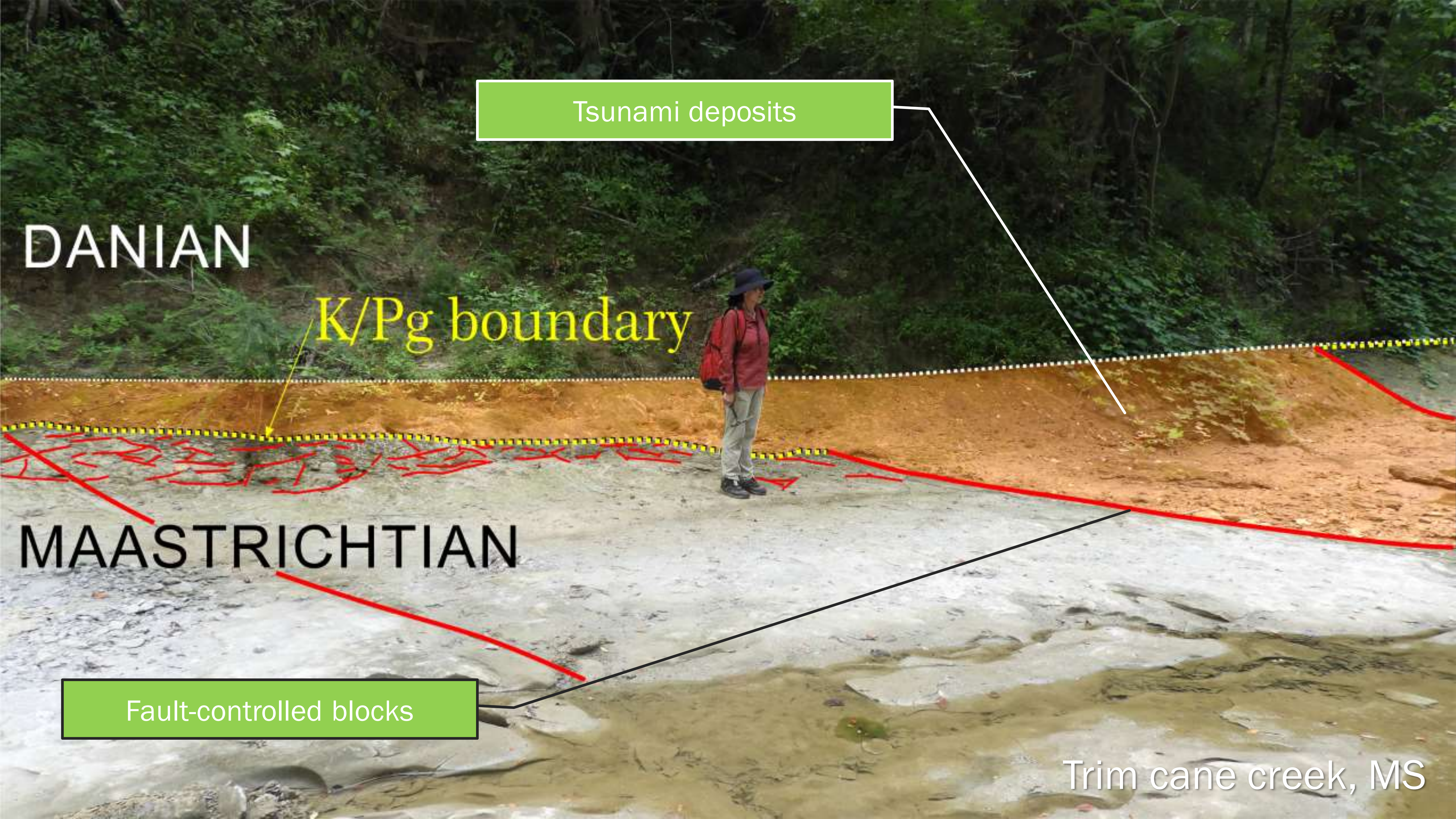


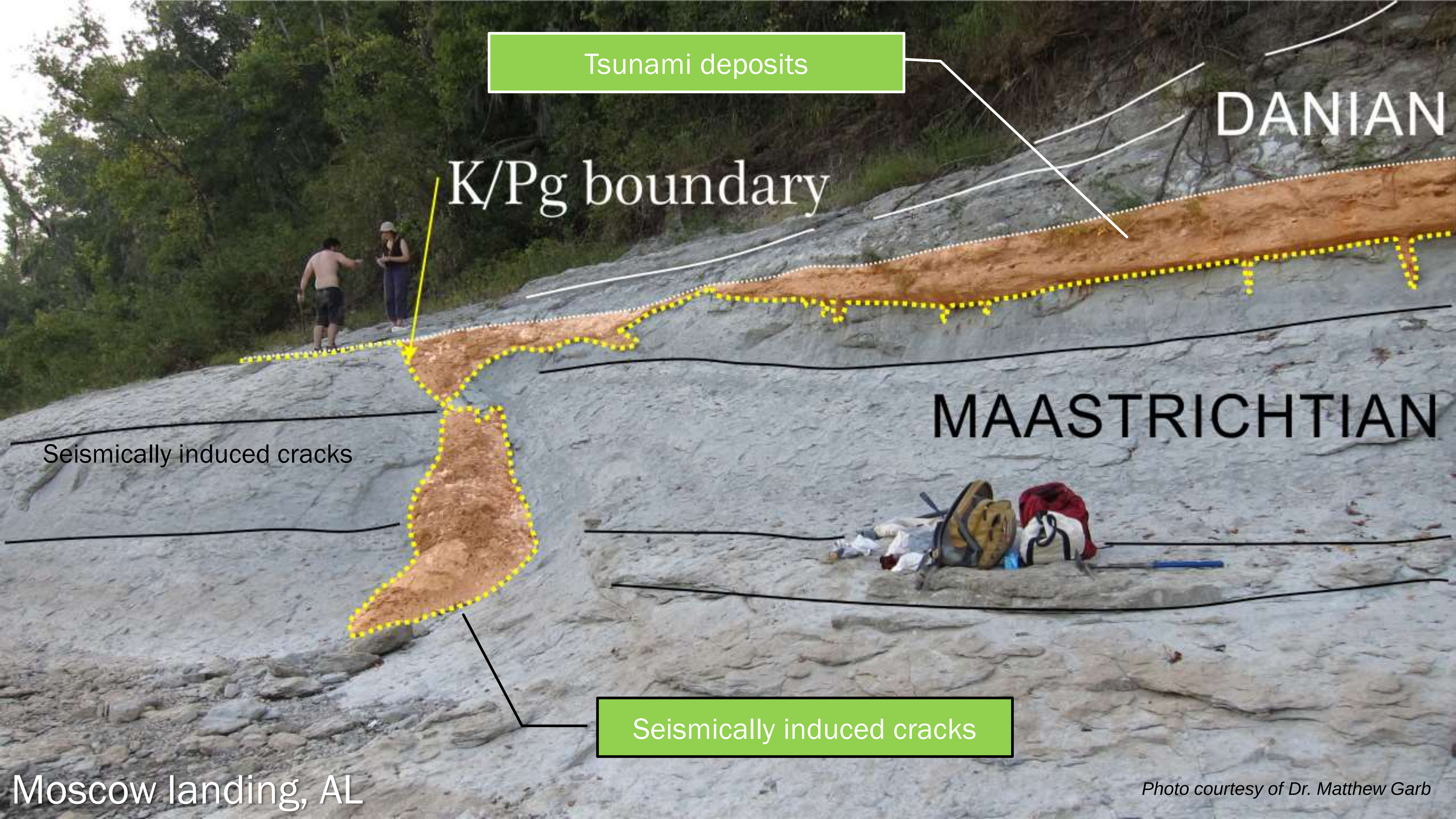
Storm deposits
DANIAN
MAASTRICHTIAN
K/Pg boundary
Debris flows
DANIAN
K/Pg boundary
MAASTRICHTIAN
DANIAN
MAASTRICHTIAN
K/Pg boundary
ejecta layer
DANIAN
K/Pg boundary
MAASTRICHTIAN
DANIAN
K/Pg boundary
MAASTRICHTIAN
Brazos river, TX

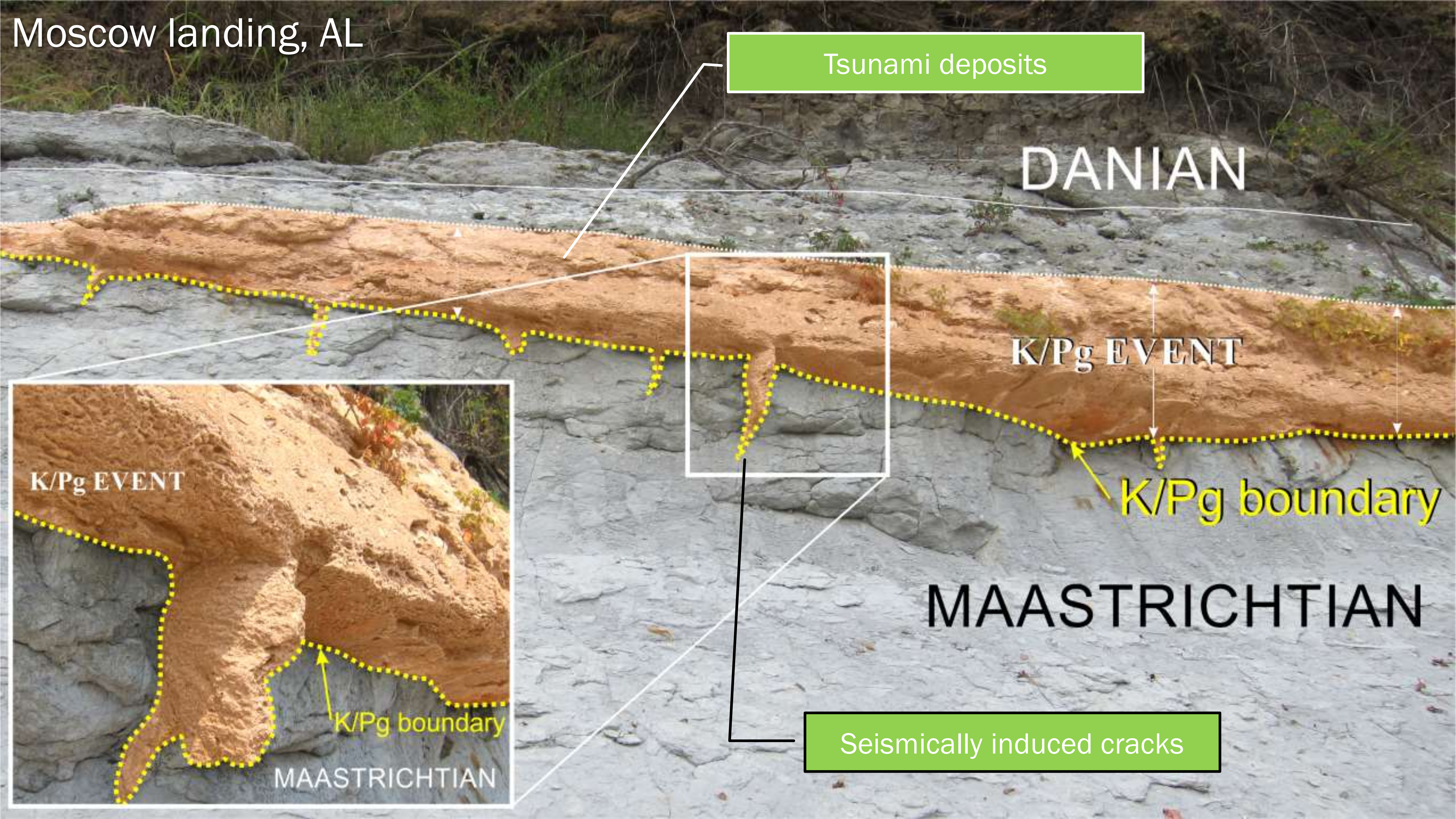


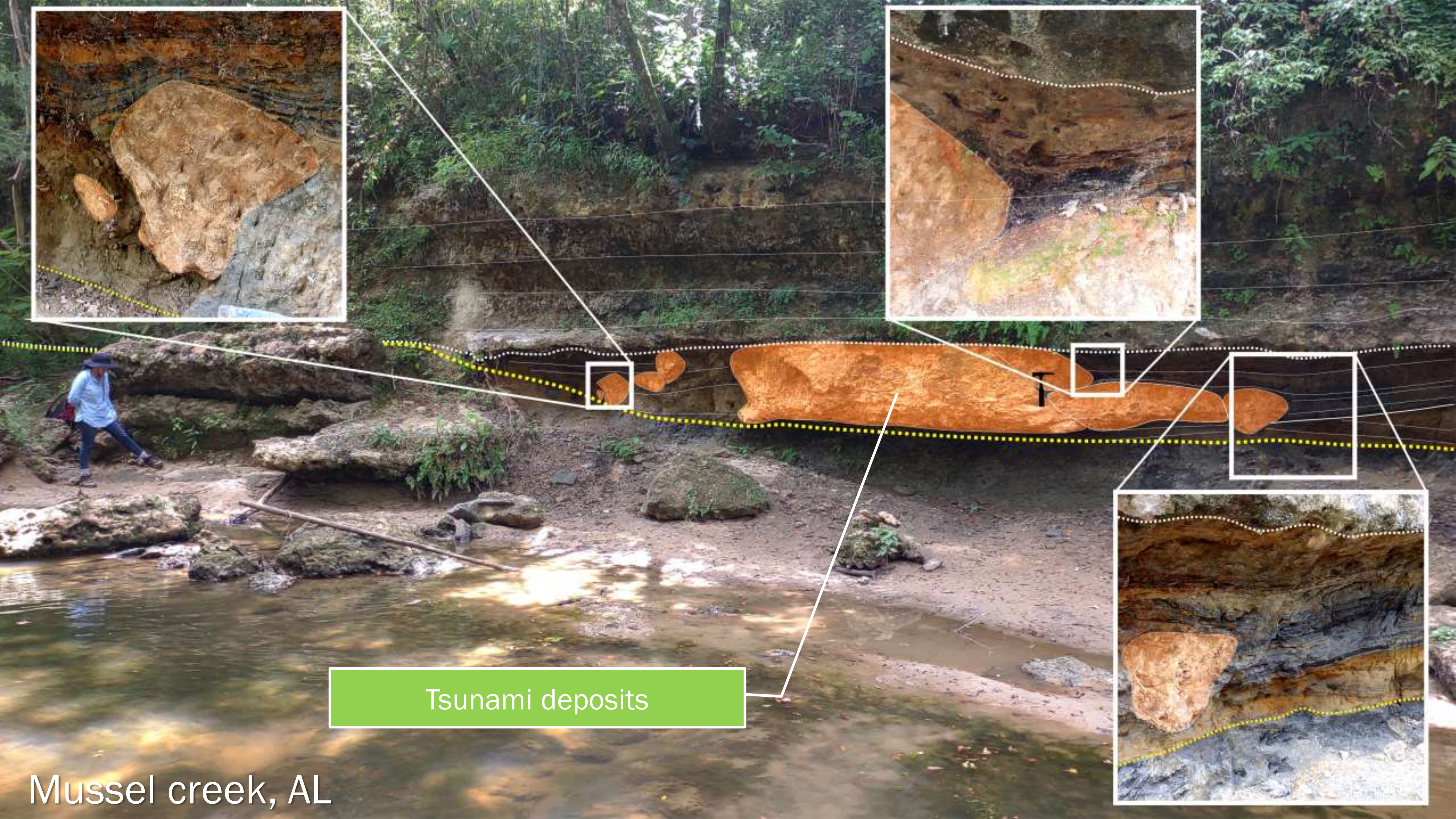
Brazos river, TX
K/Pg boundary
DANIAN
MAASTRICHTIAN
Fossiliferous mudstone
laminated sandstone


Brazos river, TX
Storm deposits
ejecta layer
DANIAN
K/Pg boundary
MAASTRICHTIAN

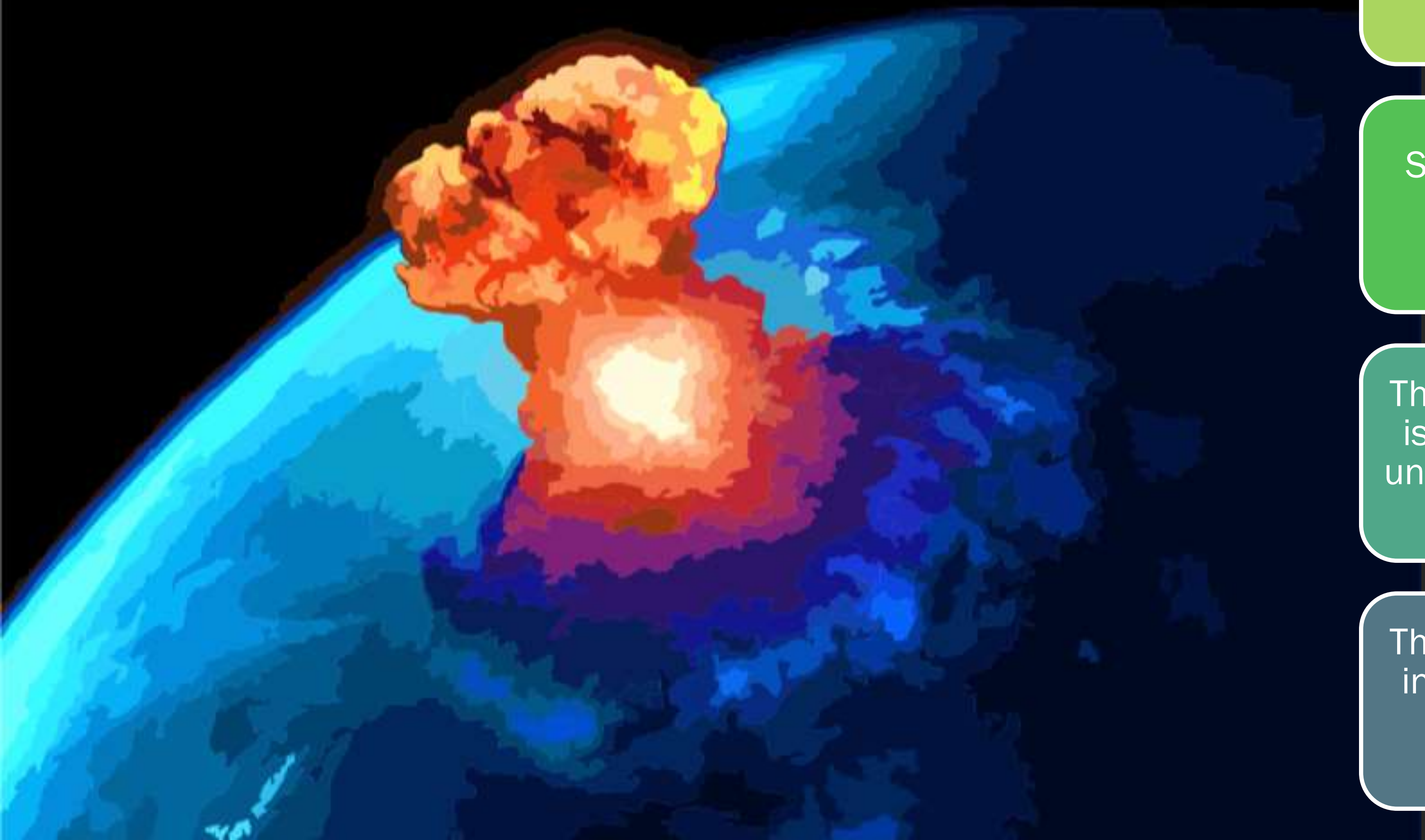

Tsunami deposits
DANIAN
K/Pg boundary
MAASTRICHTIAN
Fault-controlled blocks
Trim cane creek, MS


Tsunami deposits
DANIAN
K/Pg boundary
MAASTRICHTIAN
Seismically induced cracks
Seismically induced cracks
Moscow landing, AL
Photo courtesy of Dr. Matthew Garb


Moscow landing, AL
Tsunami deposits
DANIAN
K/Pg EVENT
K/Pg boundary
MAASTRICHTIAN
Seismically induced cracks
K/Pg EVENT
K/Pg boundary
MAASTRICHTIAN


Tsunami deposits
Mussel creek, AL

CONCLUSIONS



The information collected in the field proves the existence of intense seismic activity due to the Chicxulub asteroid impact.

The stratigraphic record of these events varies with paleodistance, paleogeography, and sedimentary paleoenvironment.

Sometimes the evidence is barely subtle or simply absent due to the rheological properties of the affected sequences or subsequent erosion.

The correct interpretation of the stratigraphic record is a basic but critical element for a comprehensive understanding of complex geological events, such as the Cretaceous-Paleogene boundary.

This is only possible by carefully observing the rocks in the field, which is a fundamental step to making reasonable and solid hypotheses following the scientific method.