Solid Earth Dynamics

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Lecture 18

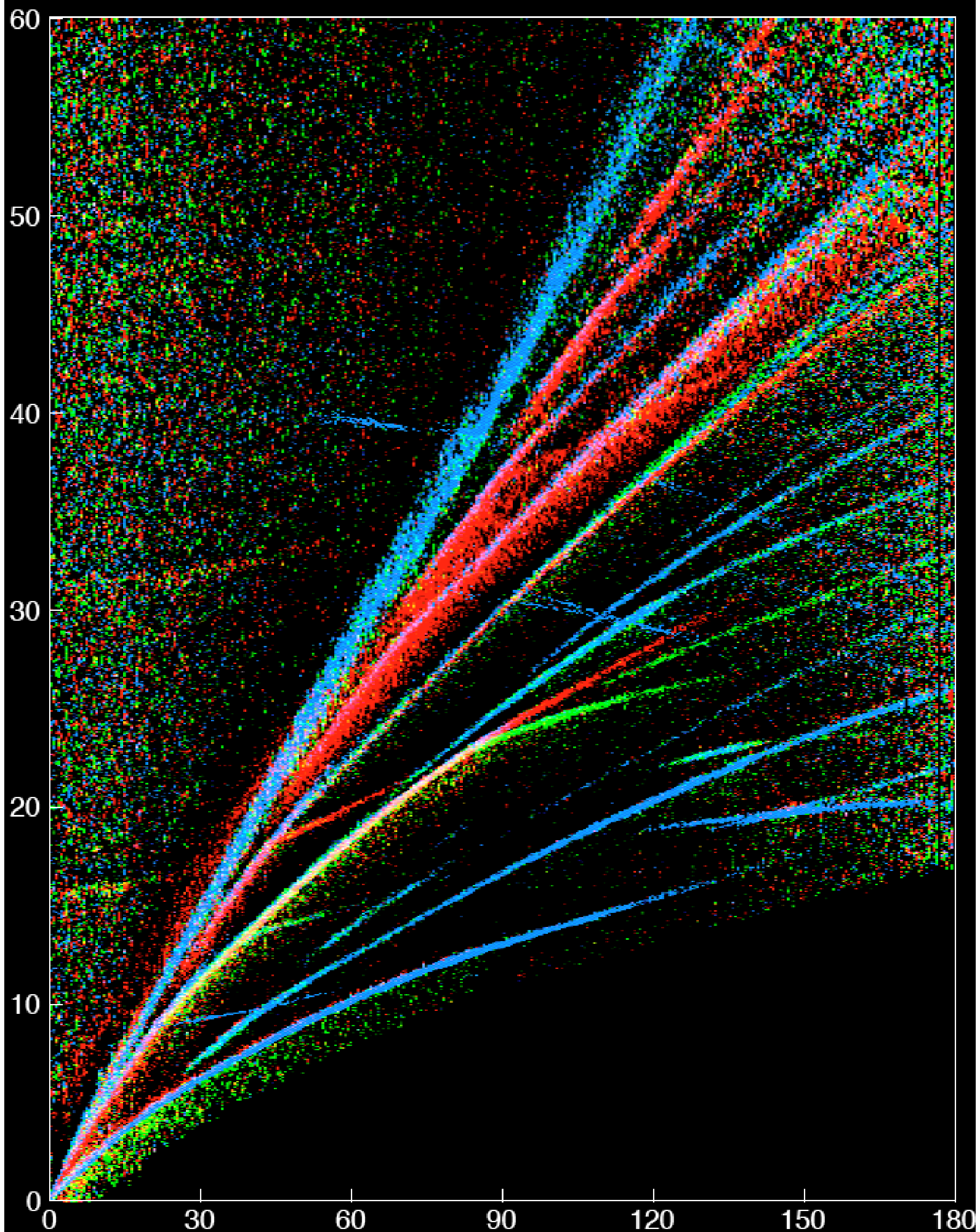
Solid Earth Dynamics

the core

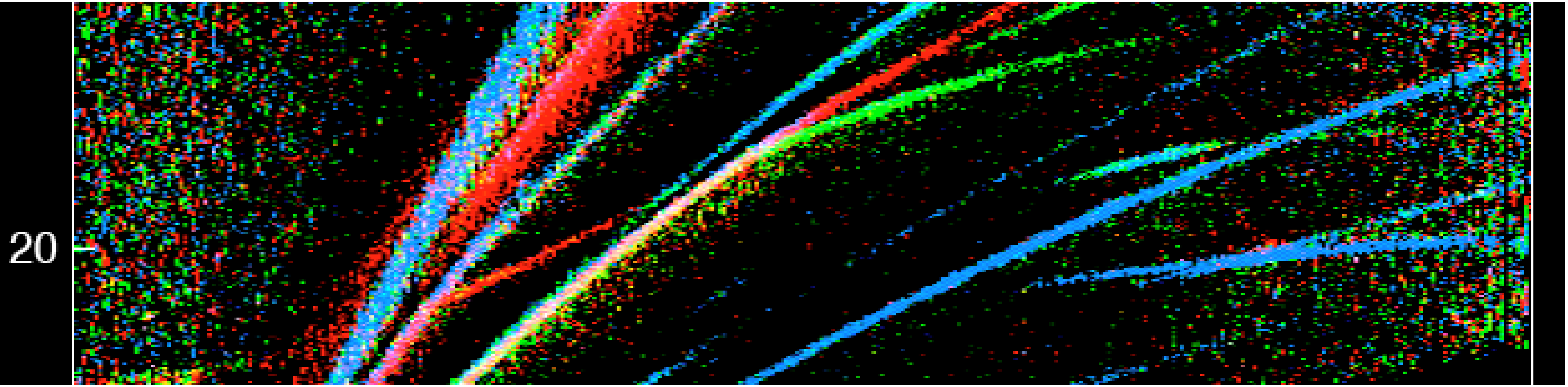
Faults and earthquakes

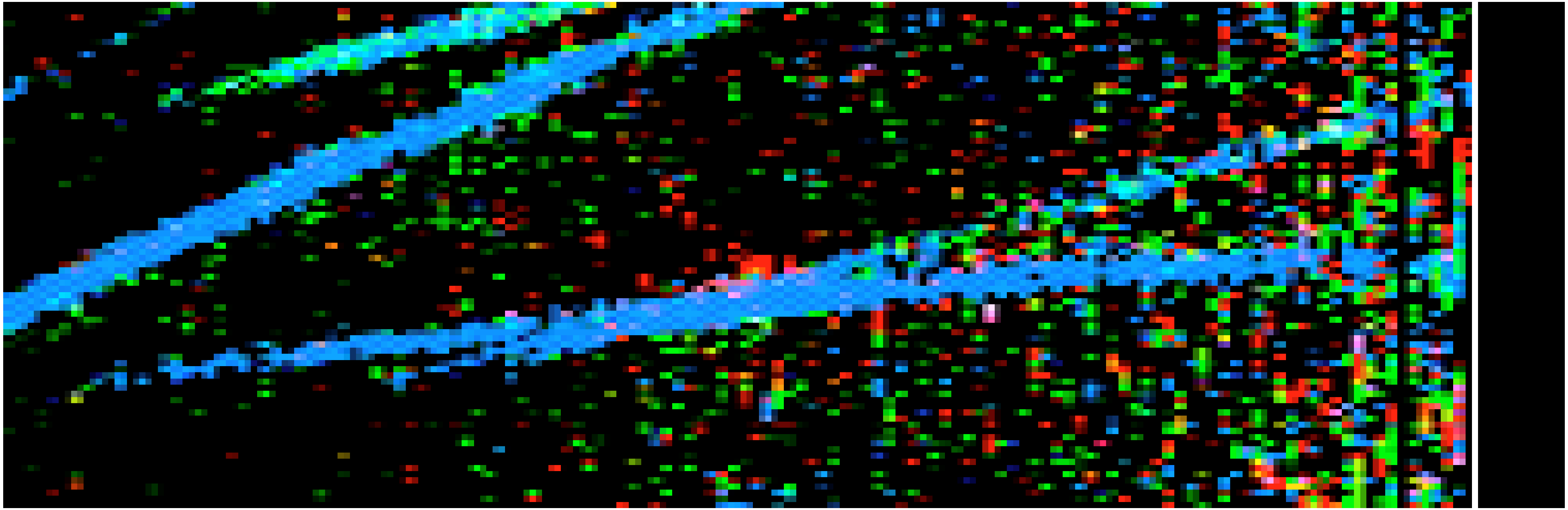
Part 1: The Core

Class exercise here



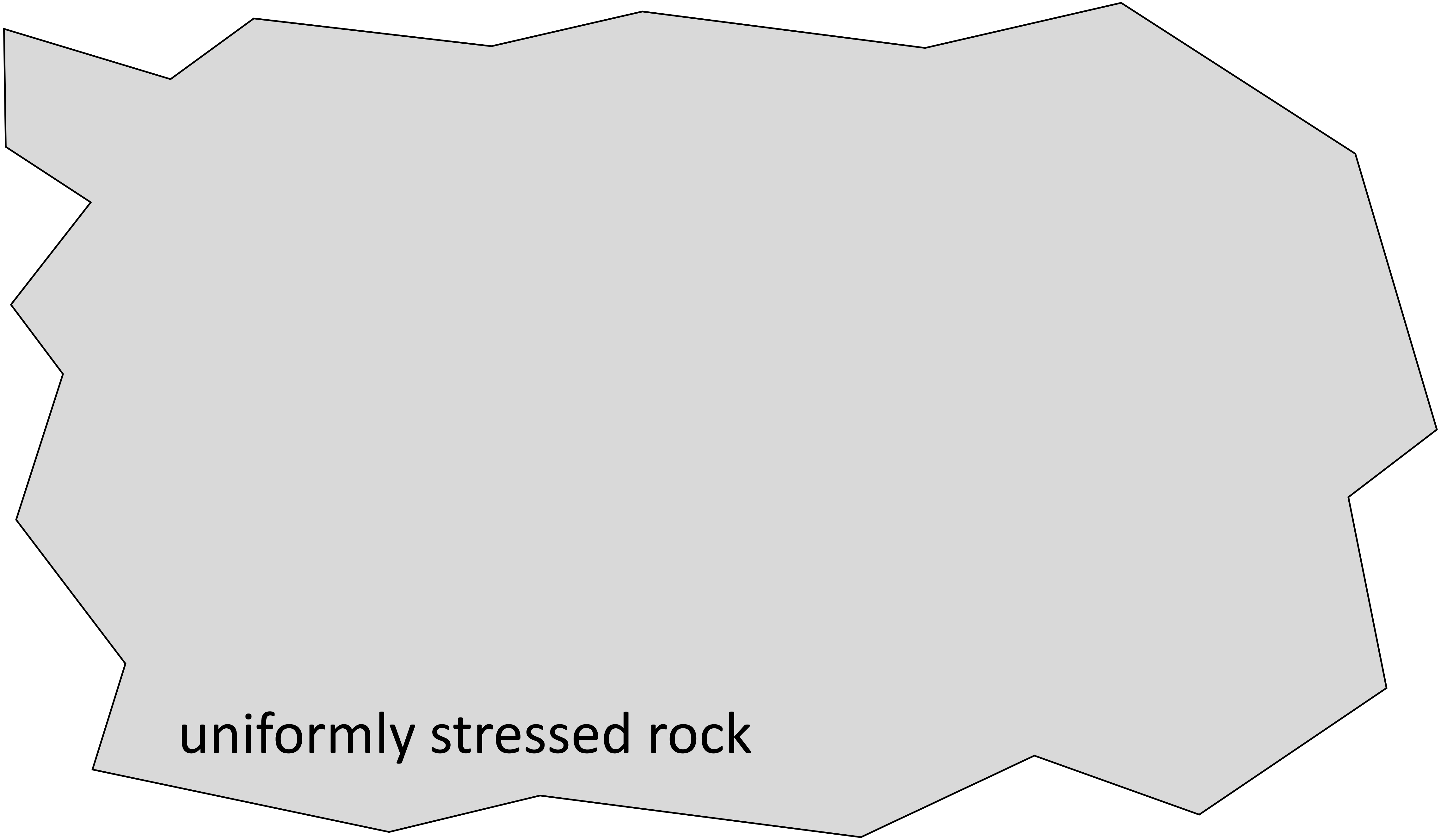
60
50
40
30
20
10
0
0
30
60
90
120
150
180

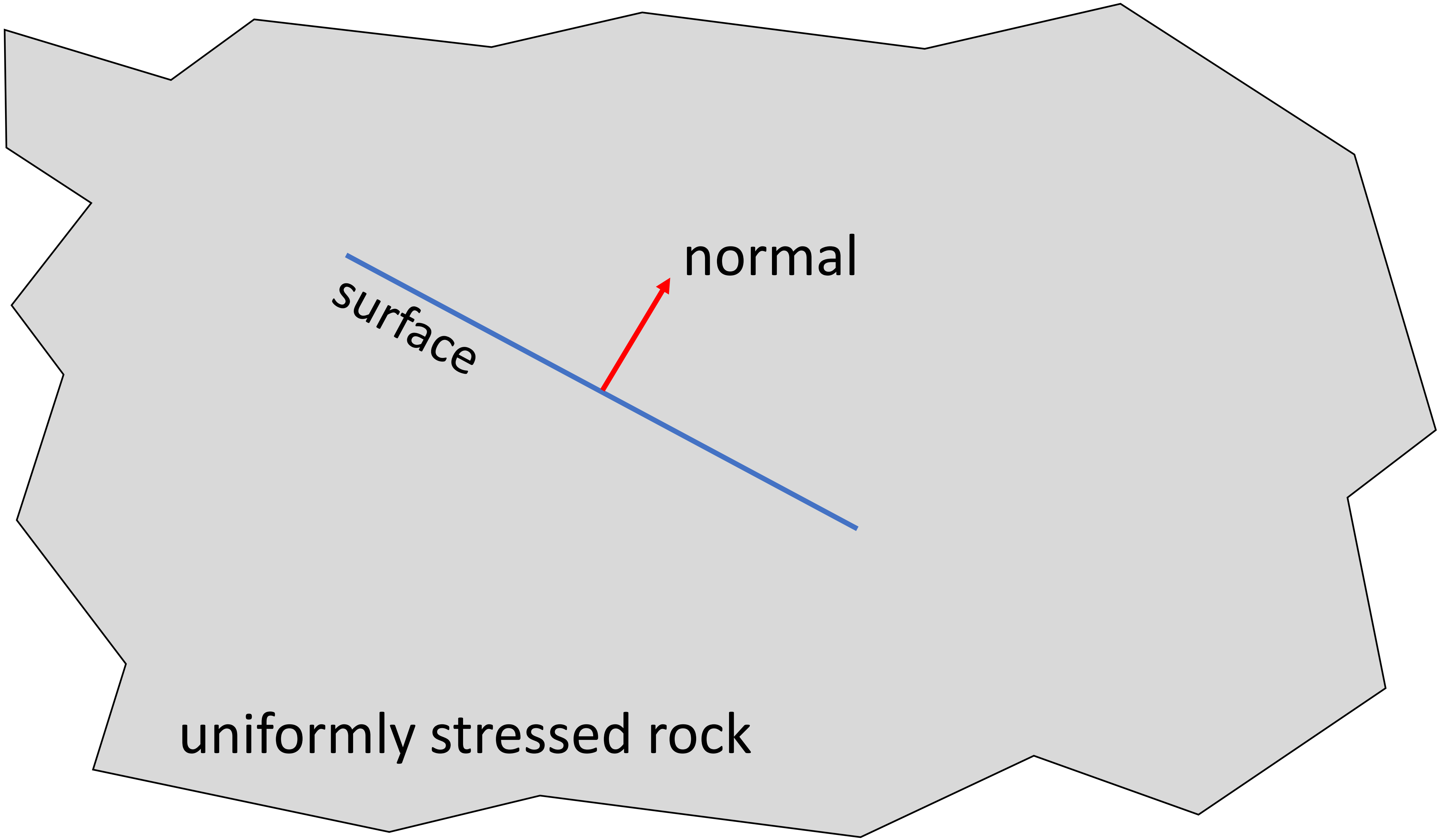

20

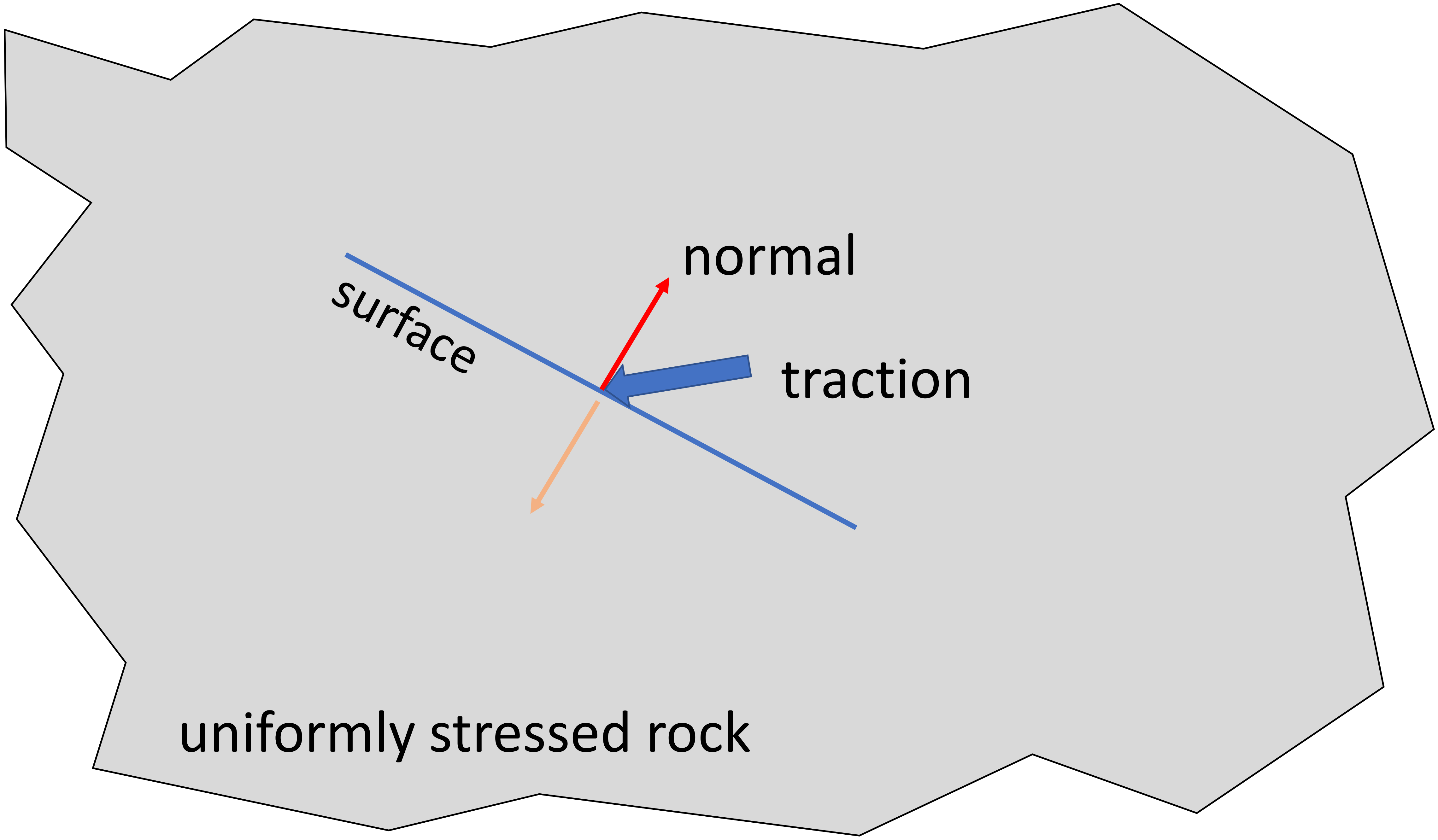


Part 2: Faults and earthquakes

Part 2A: Relationship between stress and faulting

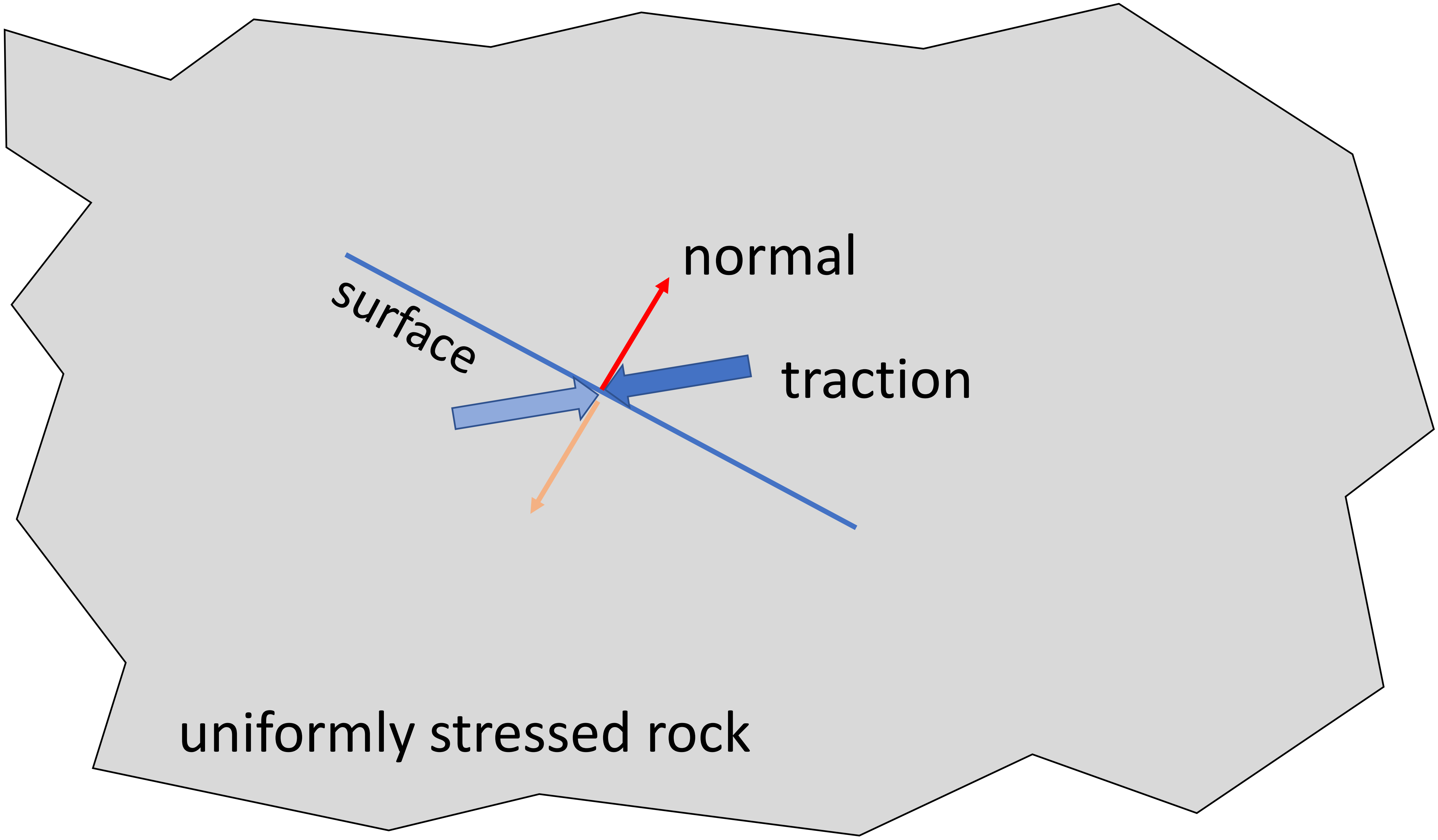

uniformly stressed rock

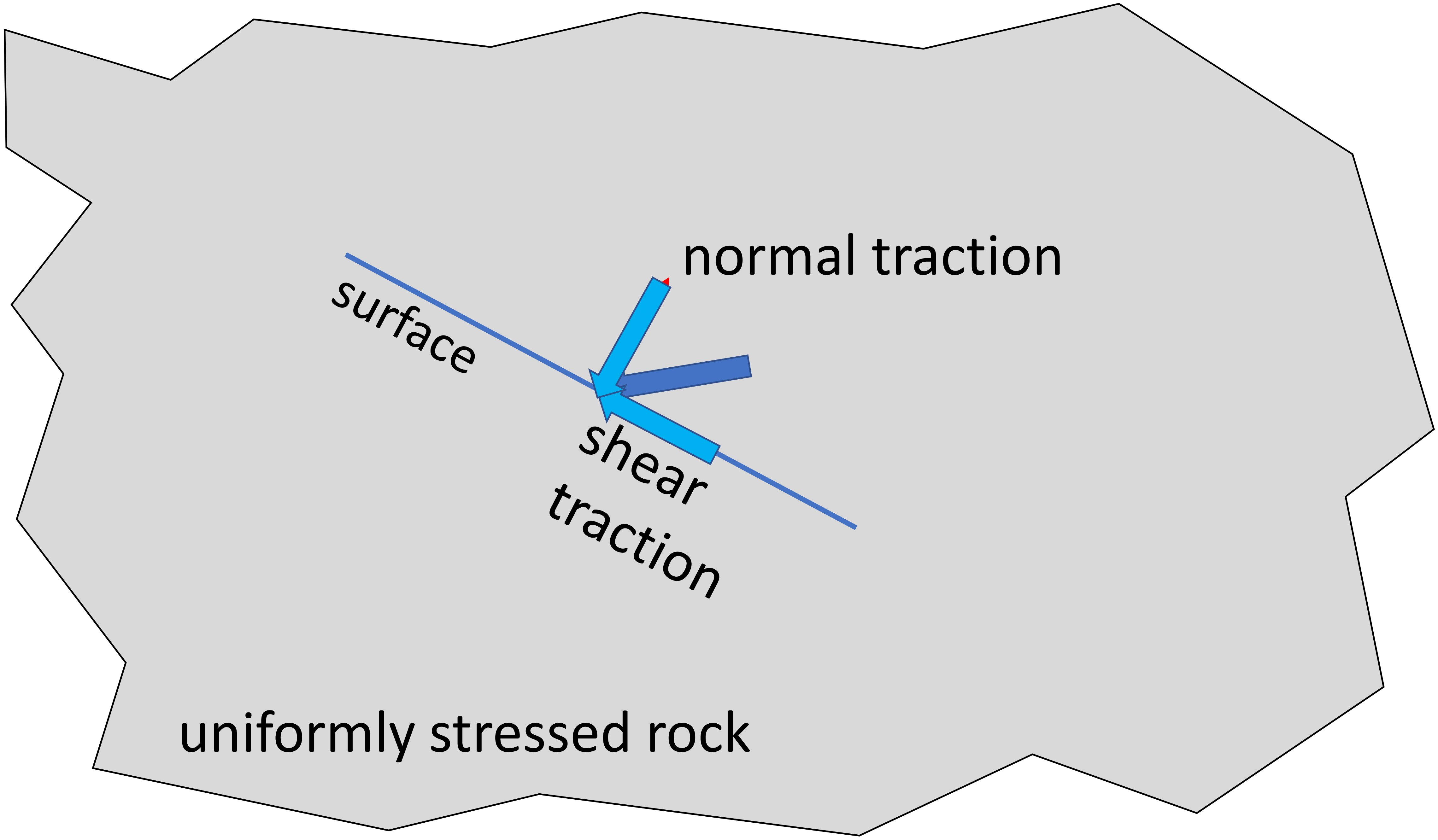

normal
surface
uniformly stressed rock


normal
surface
traction
uniformly stressed rock

Tractions on two sides of a surface

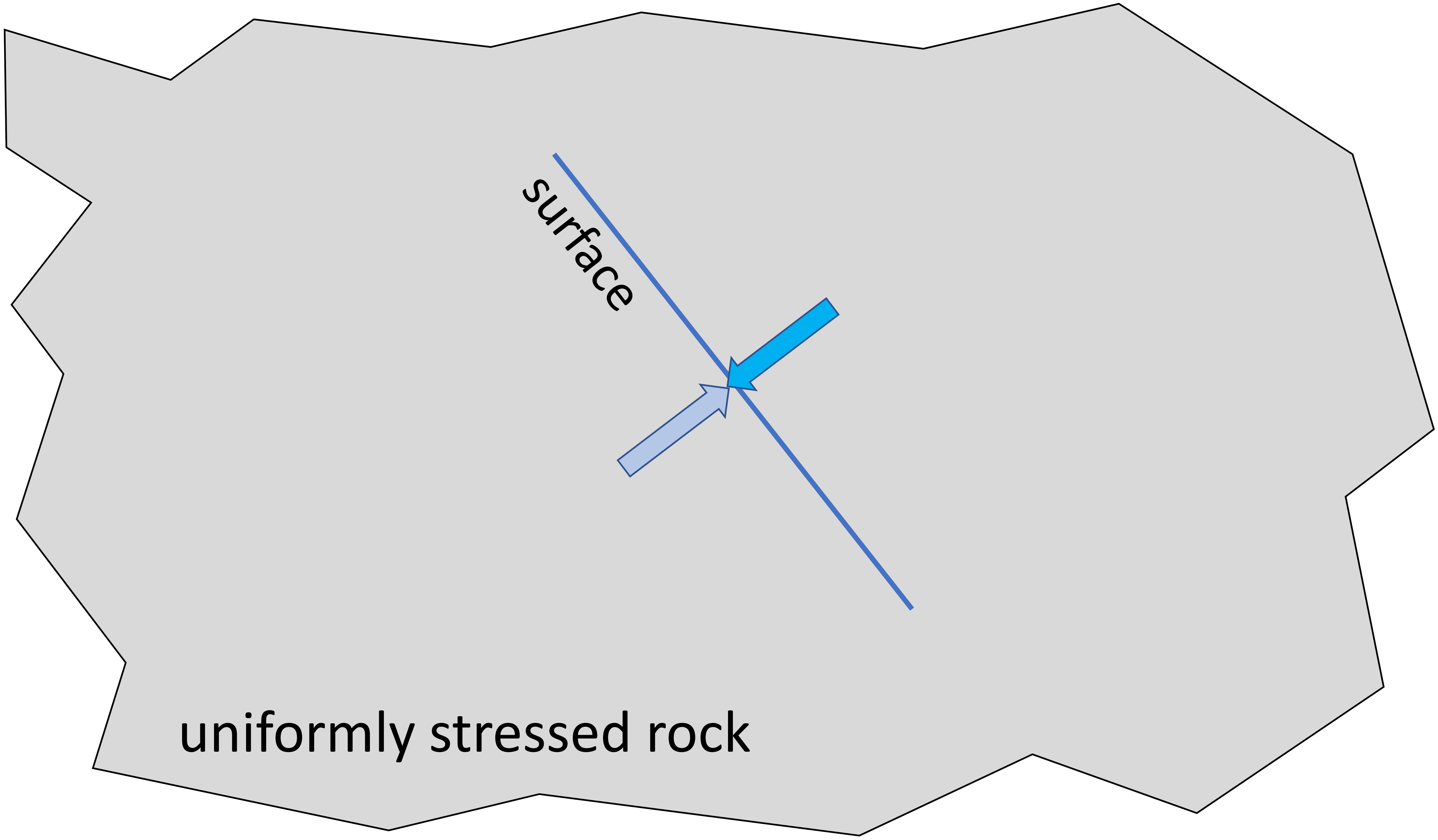
are equal and opposite

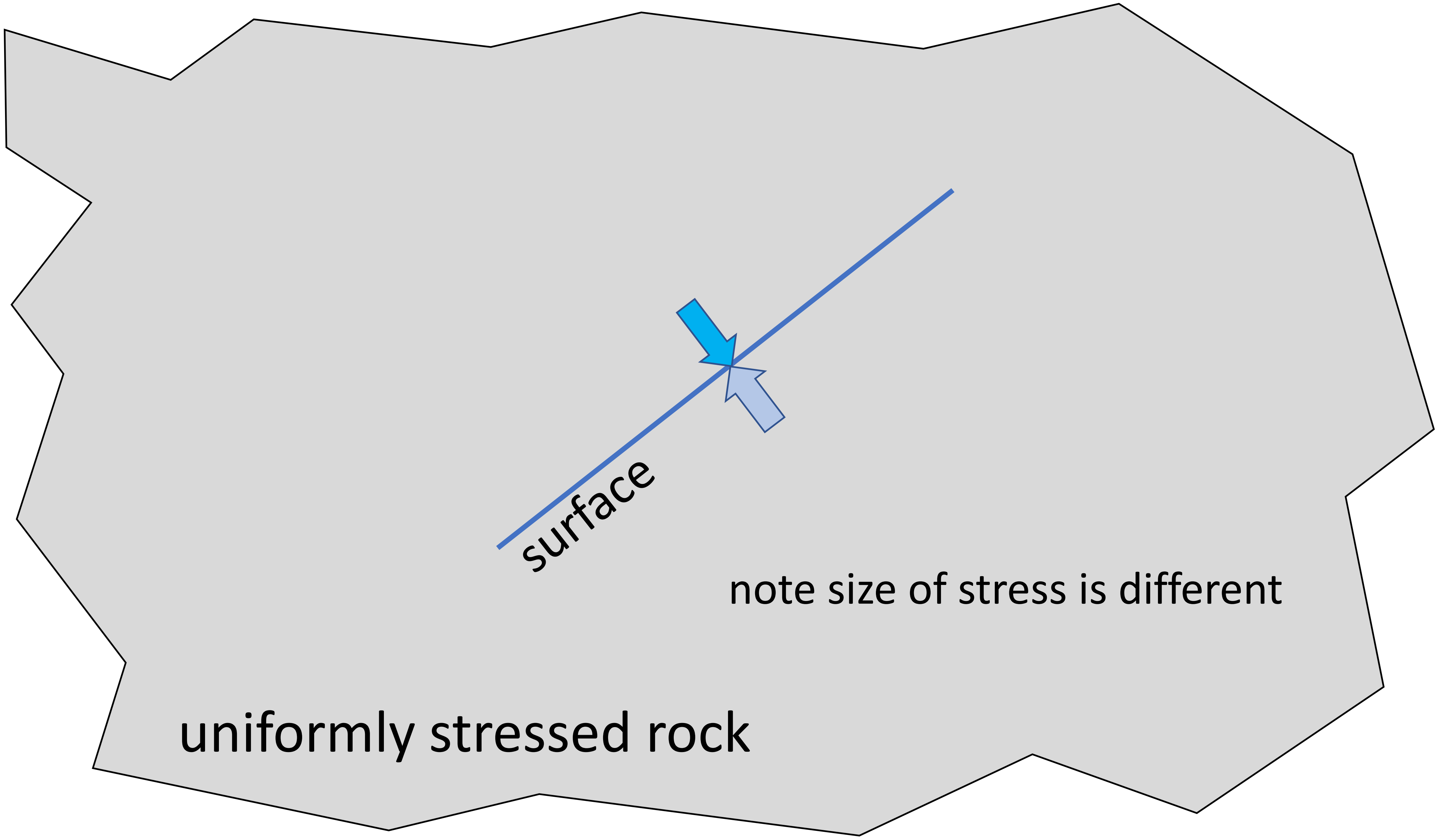

normal
surface
traction
uniformly stressed rock

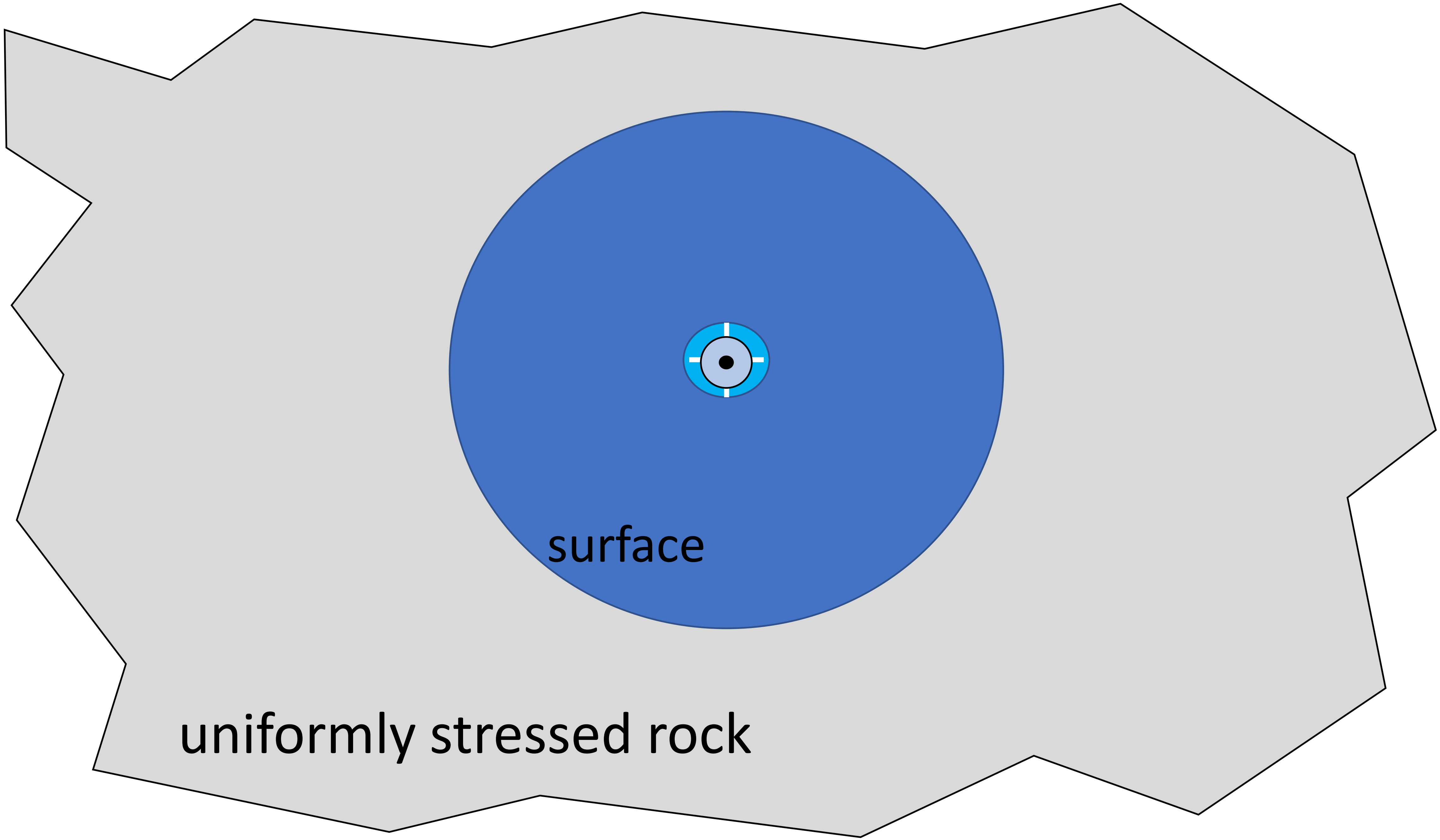

normal traction
surface
shear traction
uniformly stressed rock

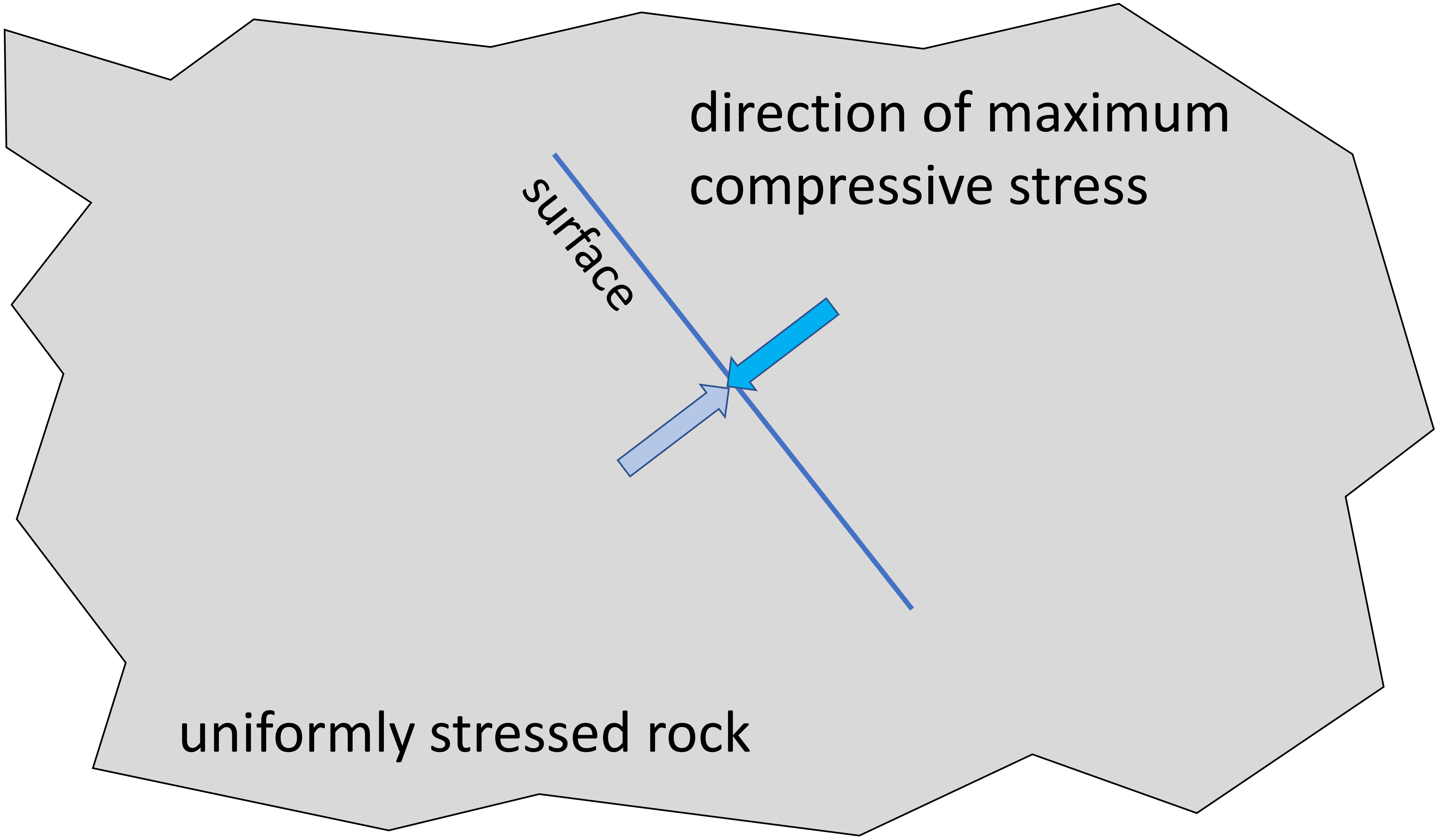
It is always possible to identify three surfaces with no shear tractions

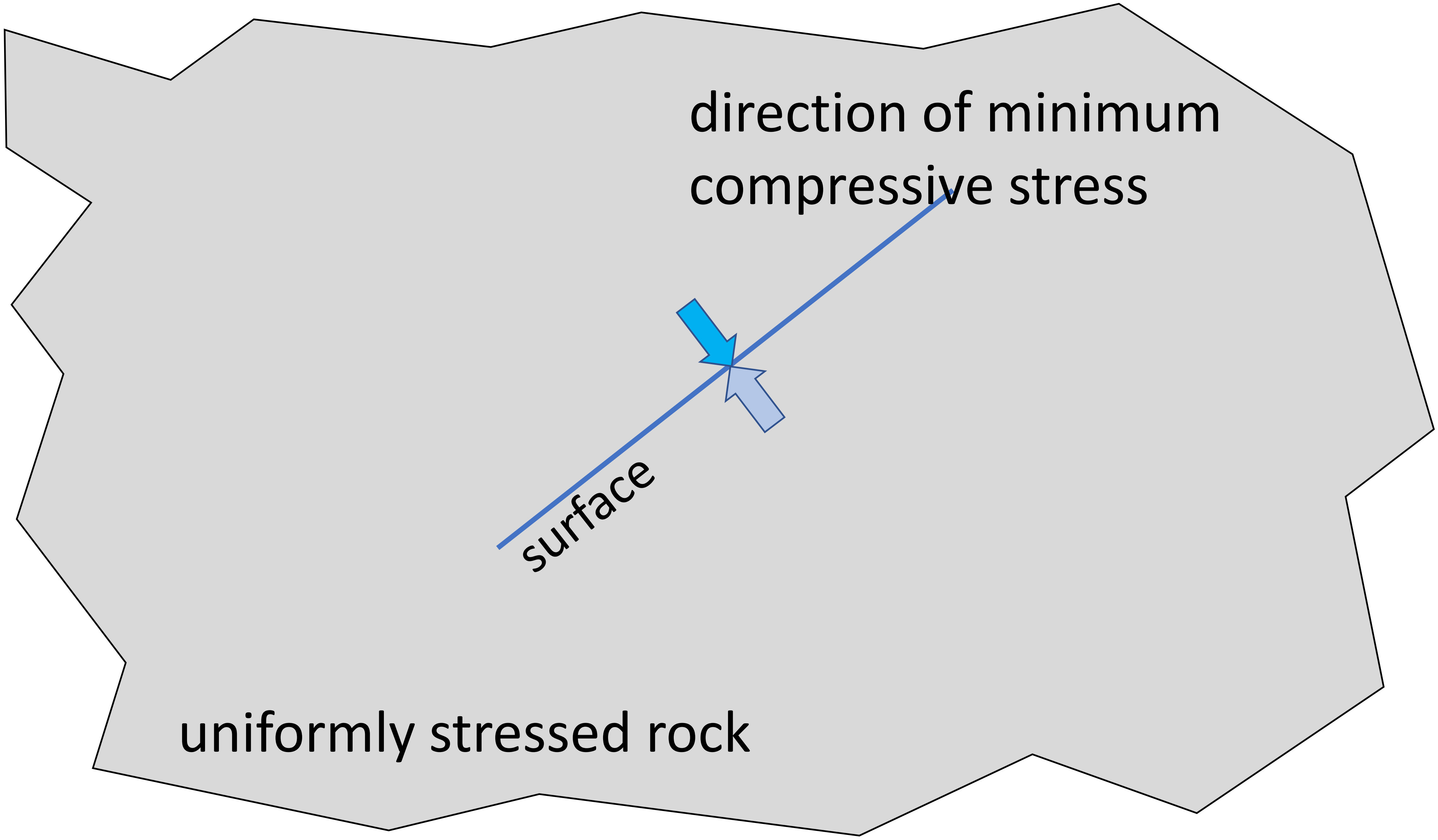
and those surfaces have mutually perpendicular normals

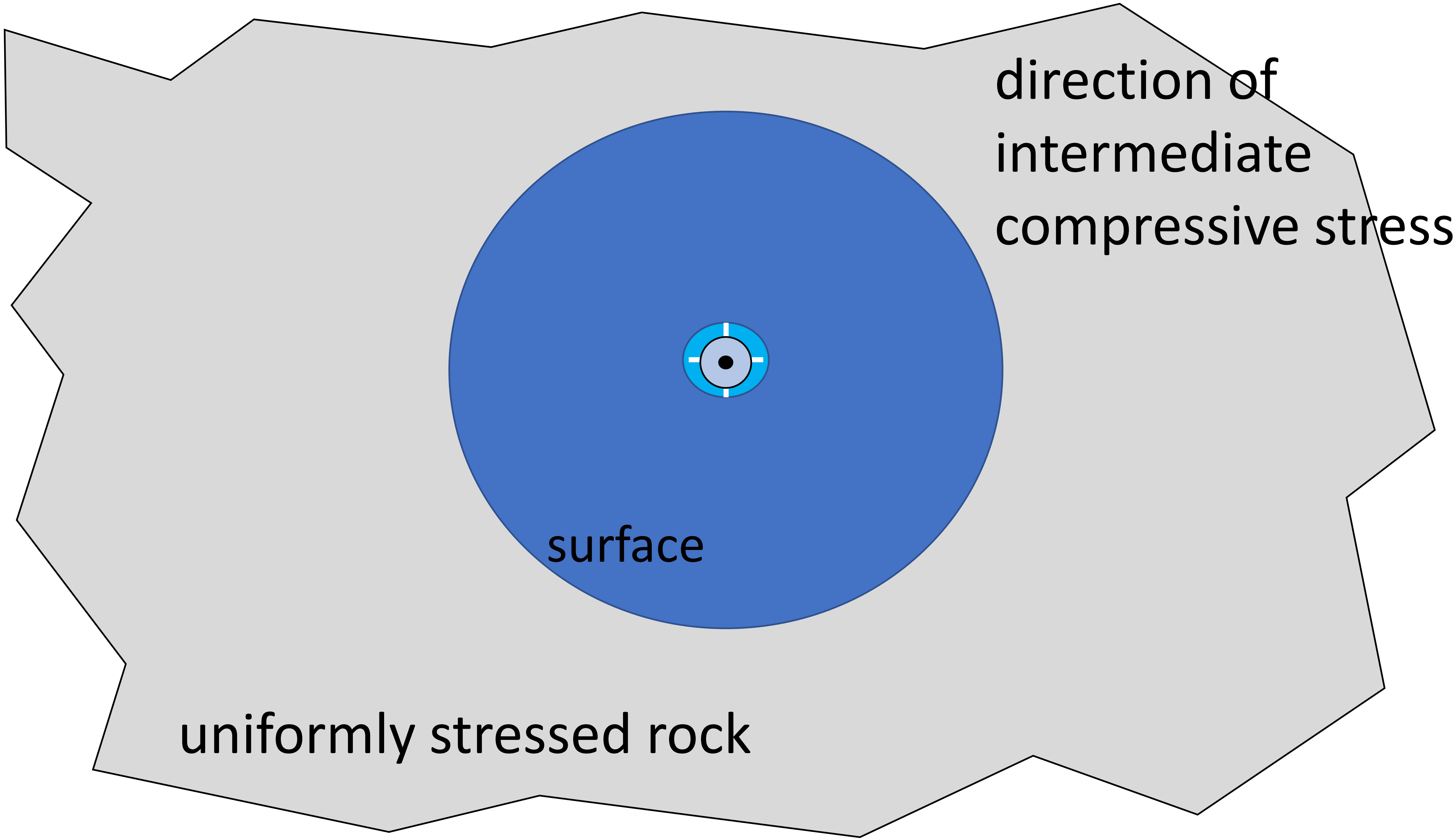

surface
uniformly stressed rock

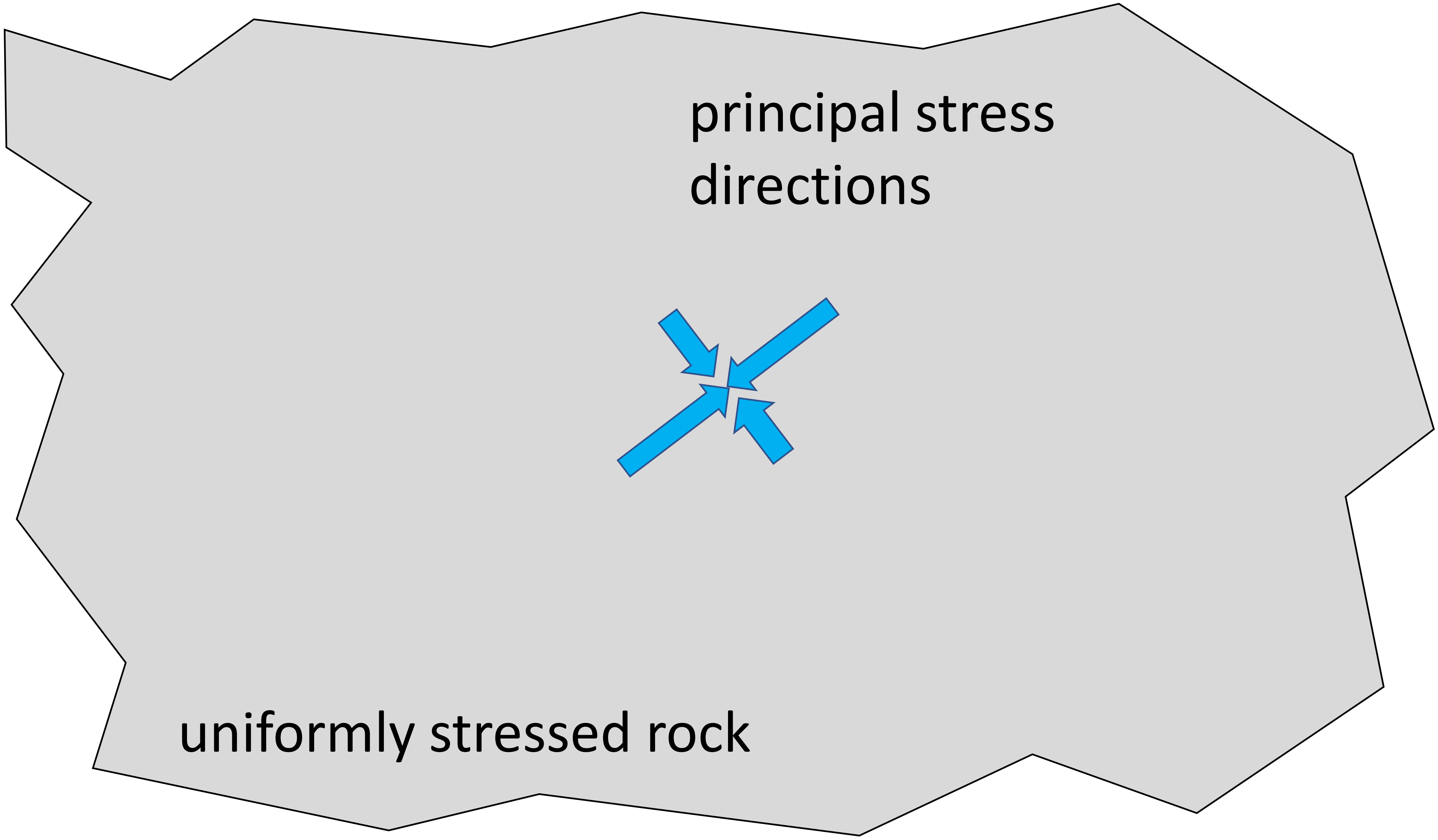

surface
note size of stress is different
uniformly stressed rock

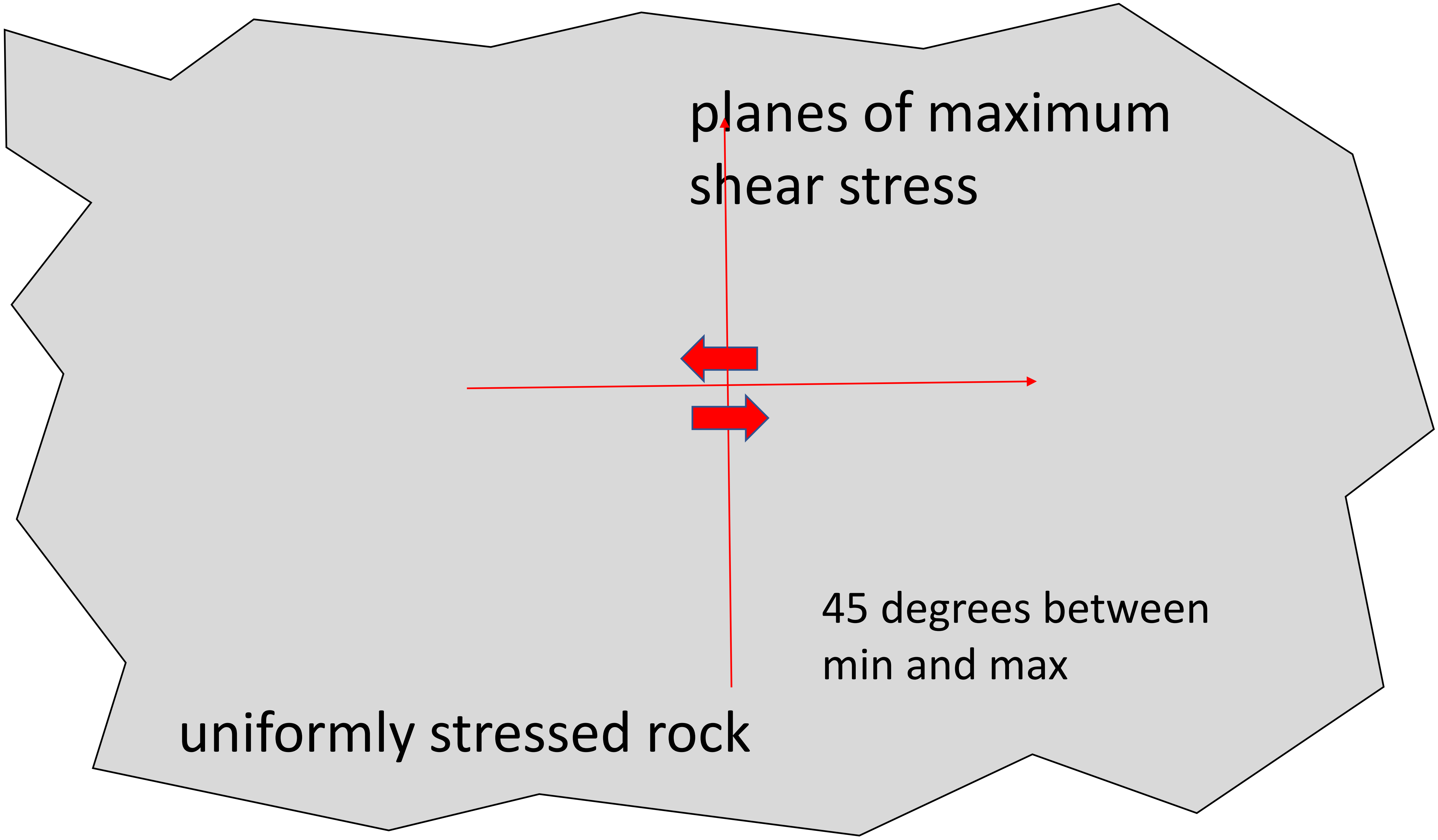

surface
uniformly stressed rock


direction of maximum
compressive stress
surface
uniformly stressed rock


direction of minimum
compressive stress
surface
uniformly stressed rock

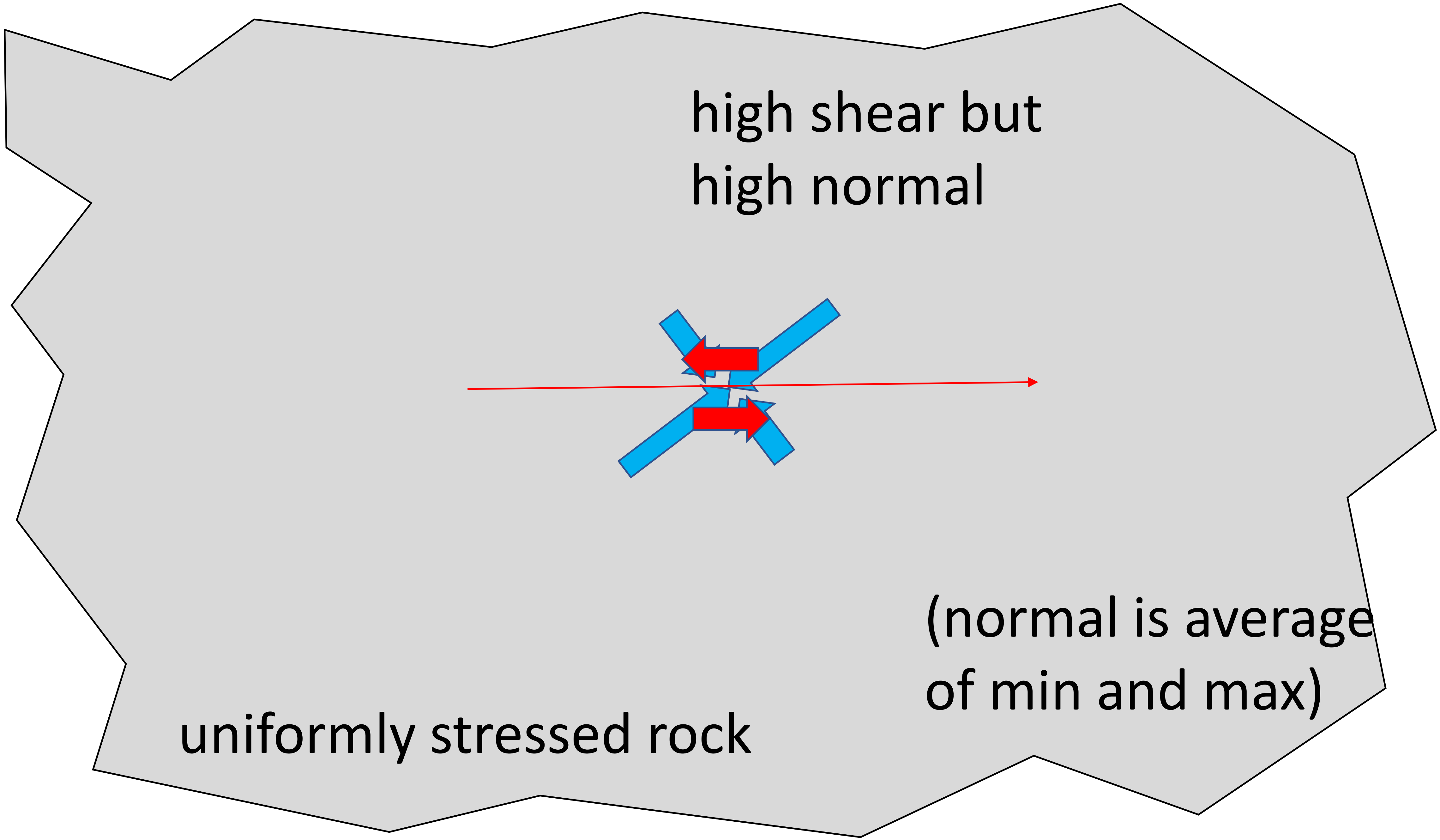

direction of
intermediate
compressive stress
surface
uniformly stressed rock

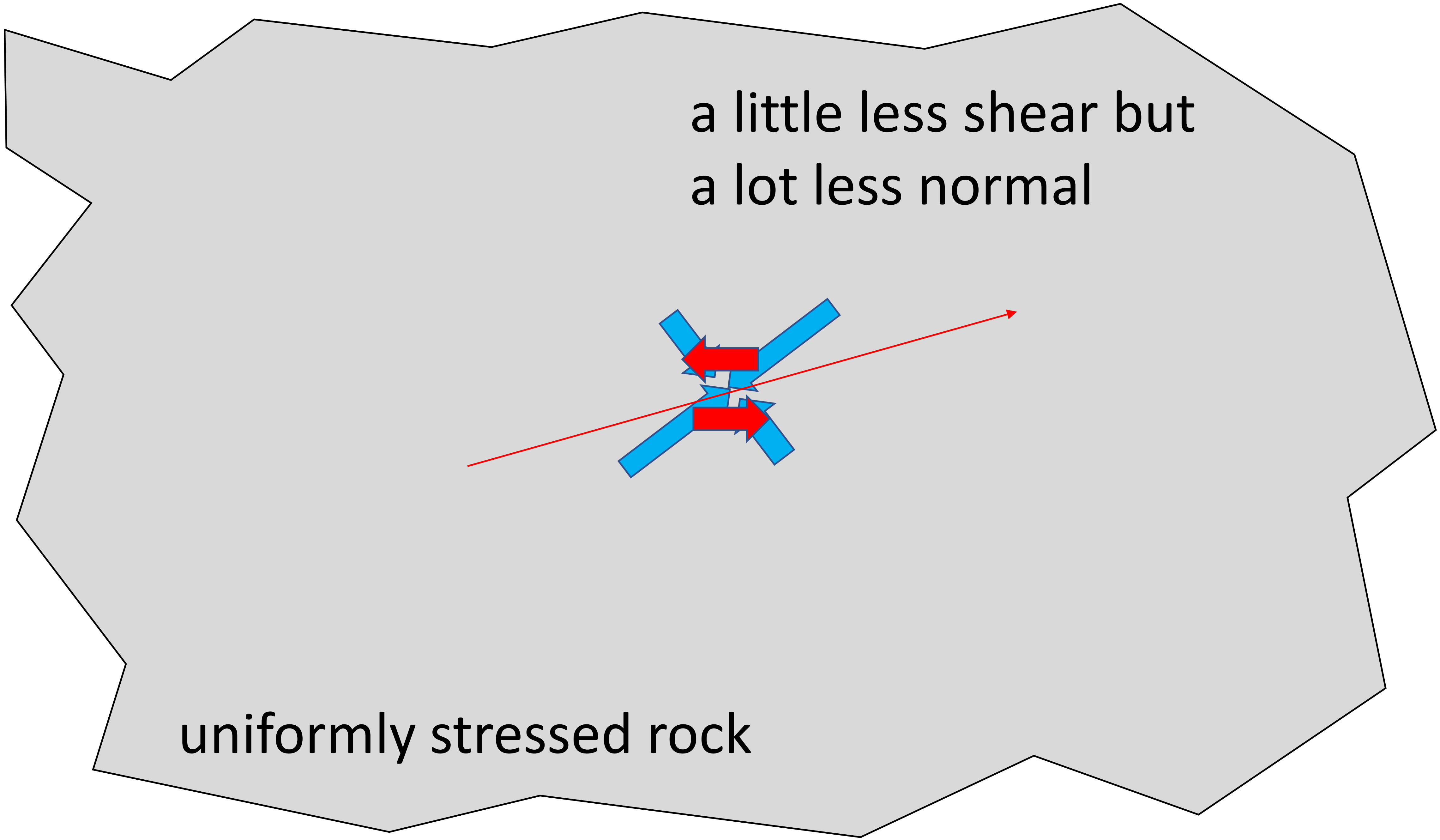

principal stress
directions
uniformly stressed rock


planes of maximum
shear stress
45 degrees between
min and max
uniformly stressed rock

a plane that favors faulting has high shear stress and low normal stress

normal stress relevant because it causes friction which resists sliding


high shear but
high normal
(normal is average
of min and max)
uniformly stressed rock


a little less shear but
a lot less normal
uniformly stressed rock

Faulting tends to occur on a plane that is

about 15 degrees away from the plane of maximum shear

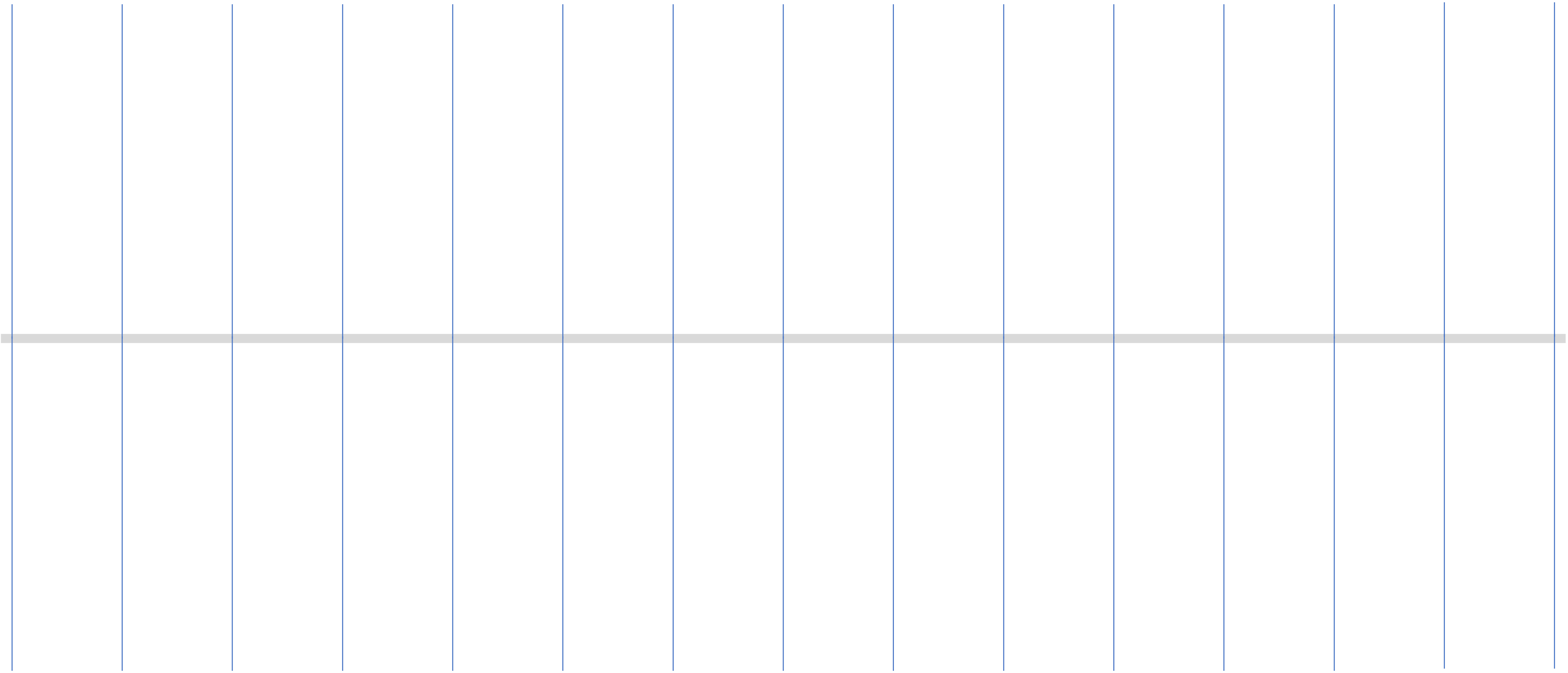
towards the direction of maximum compressive stress

Part 2B: What happens when it fault slips

This plane will fault

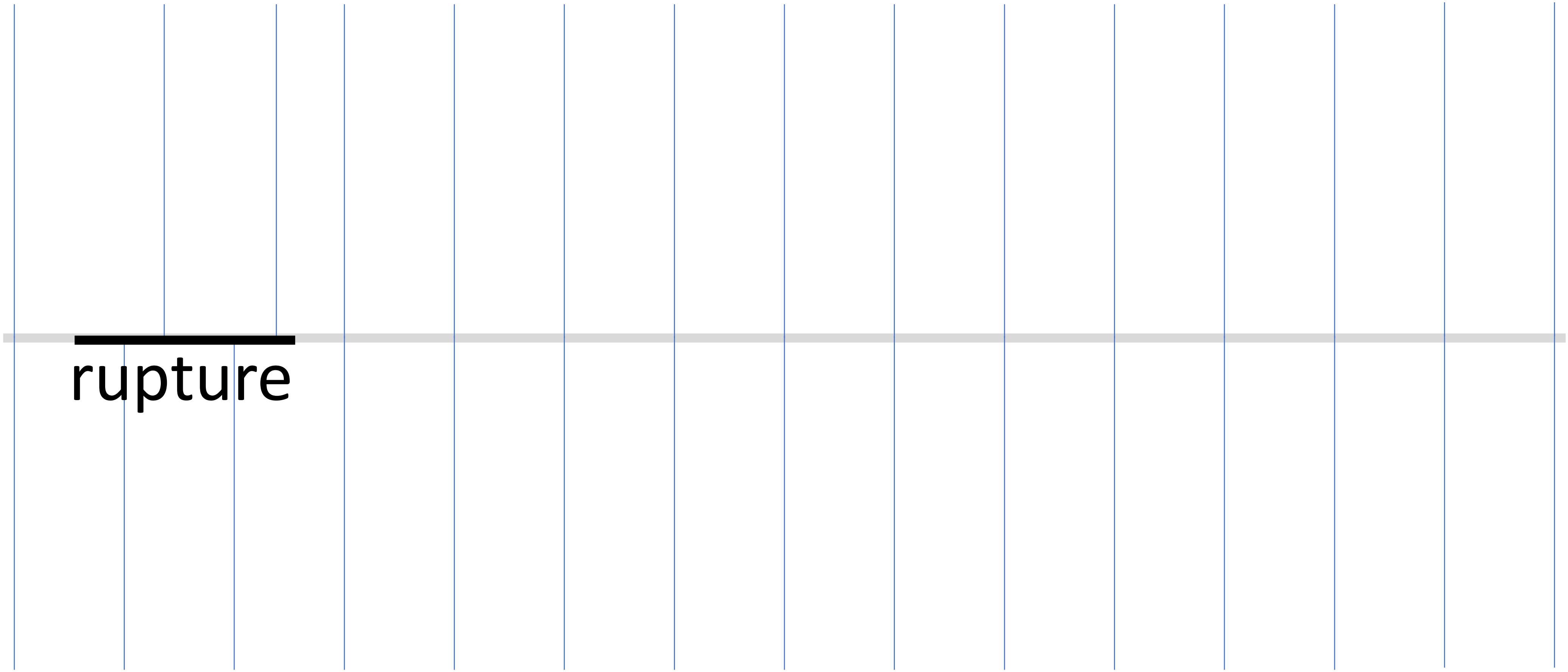
rock of rigidity μ

markers



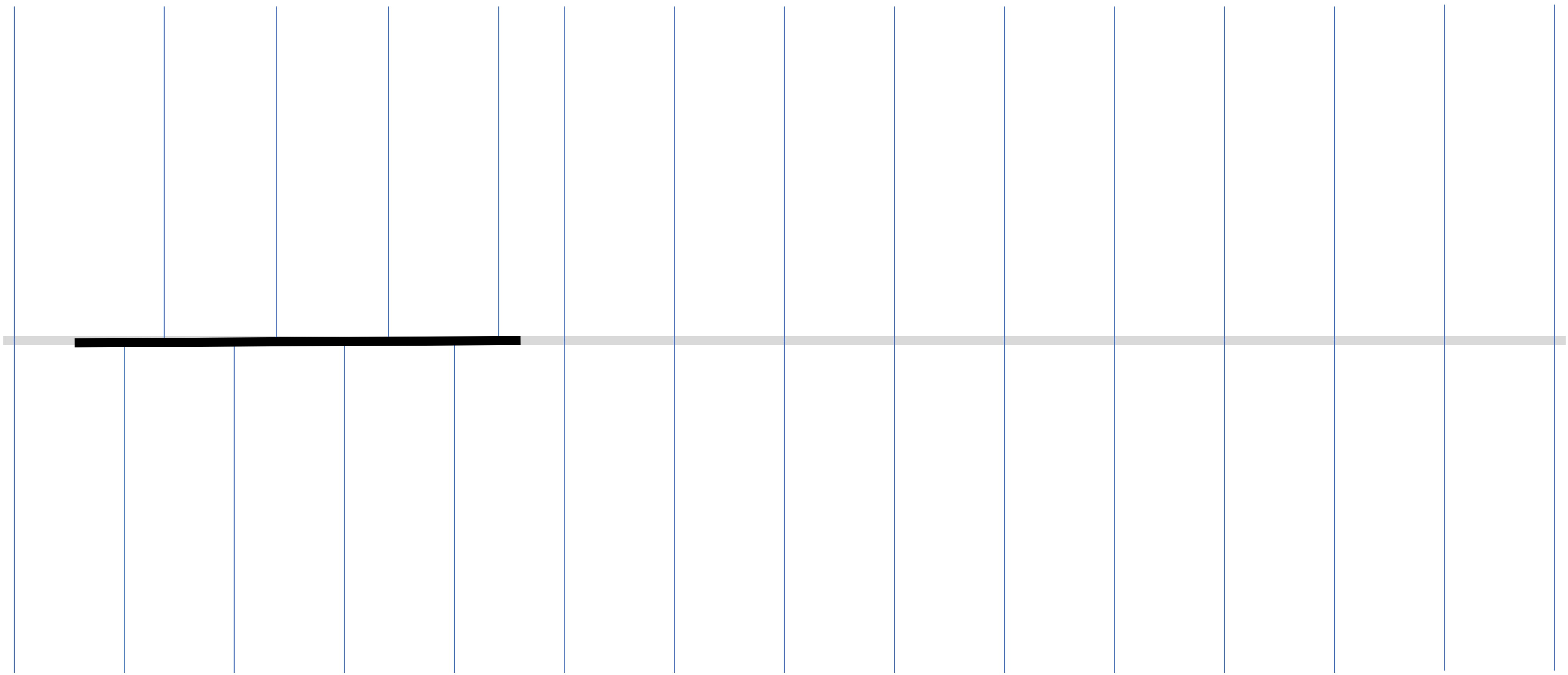
μ

faulting begins, time 1



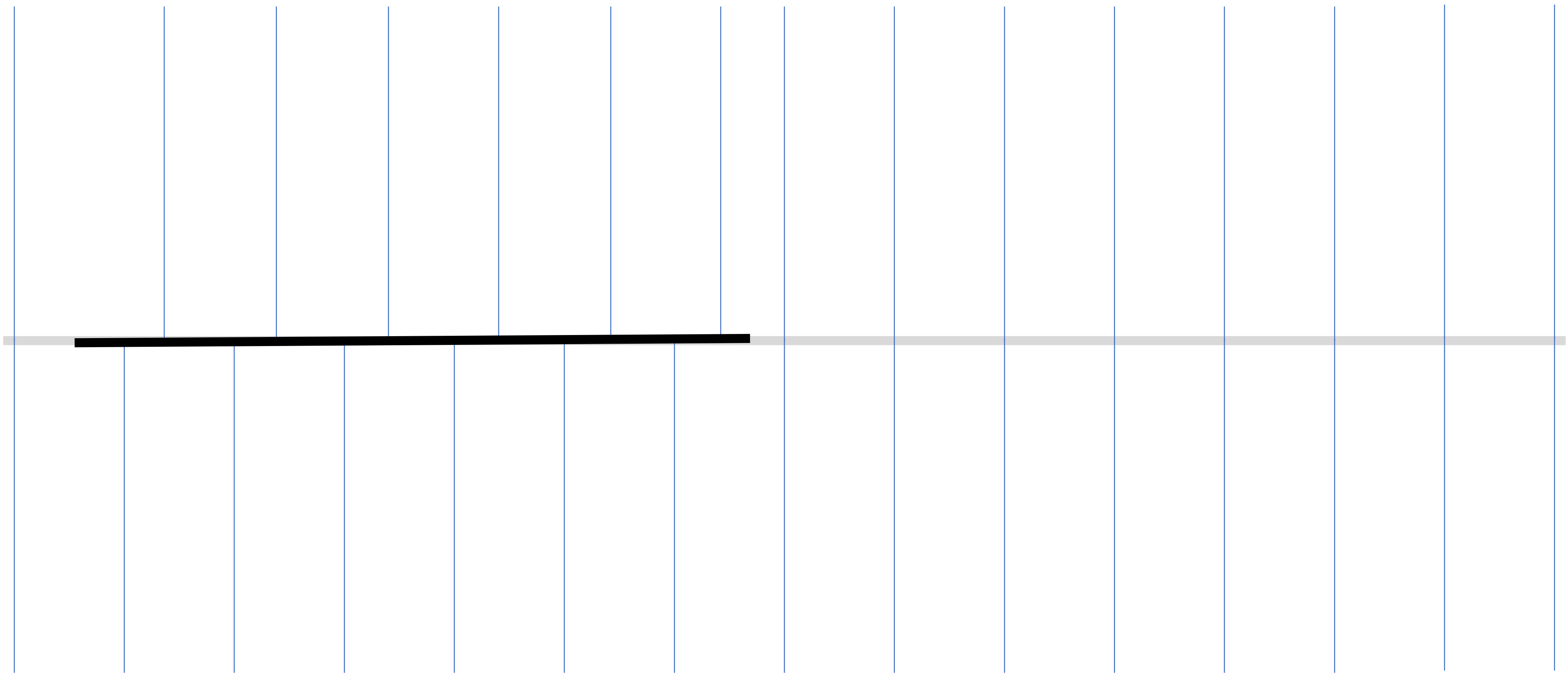
μ

time 2



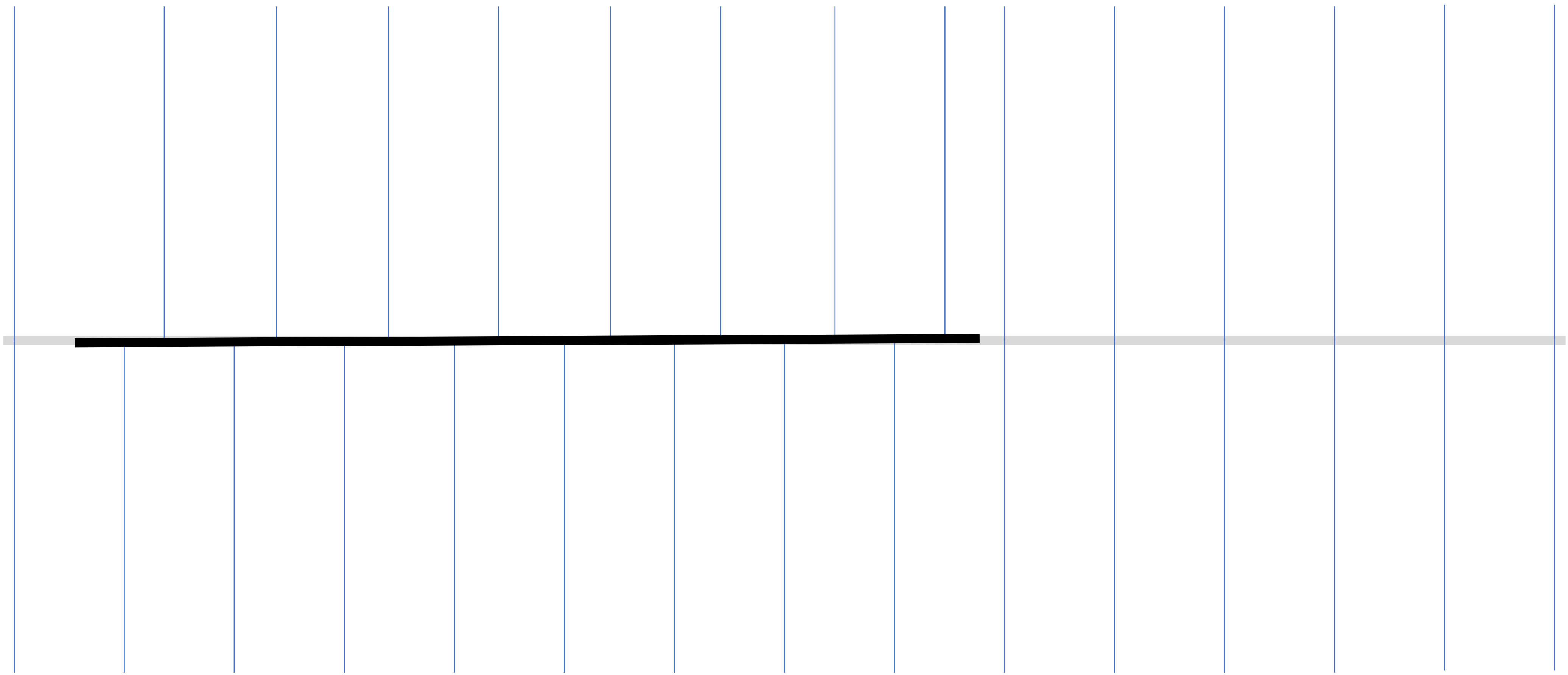
μ

time 3



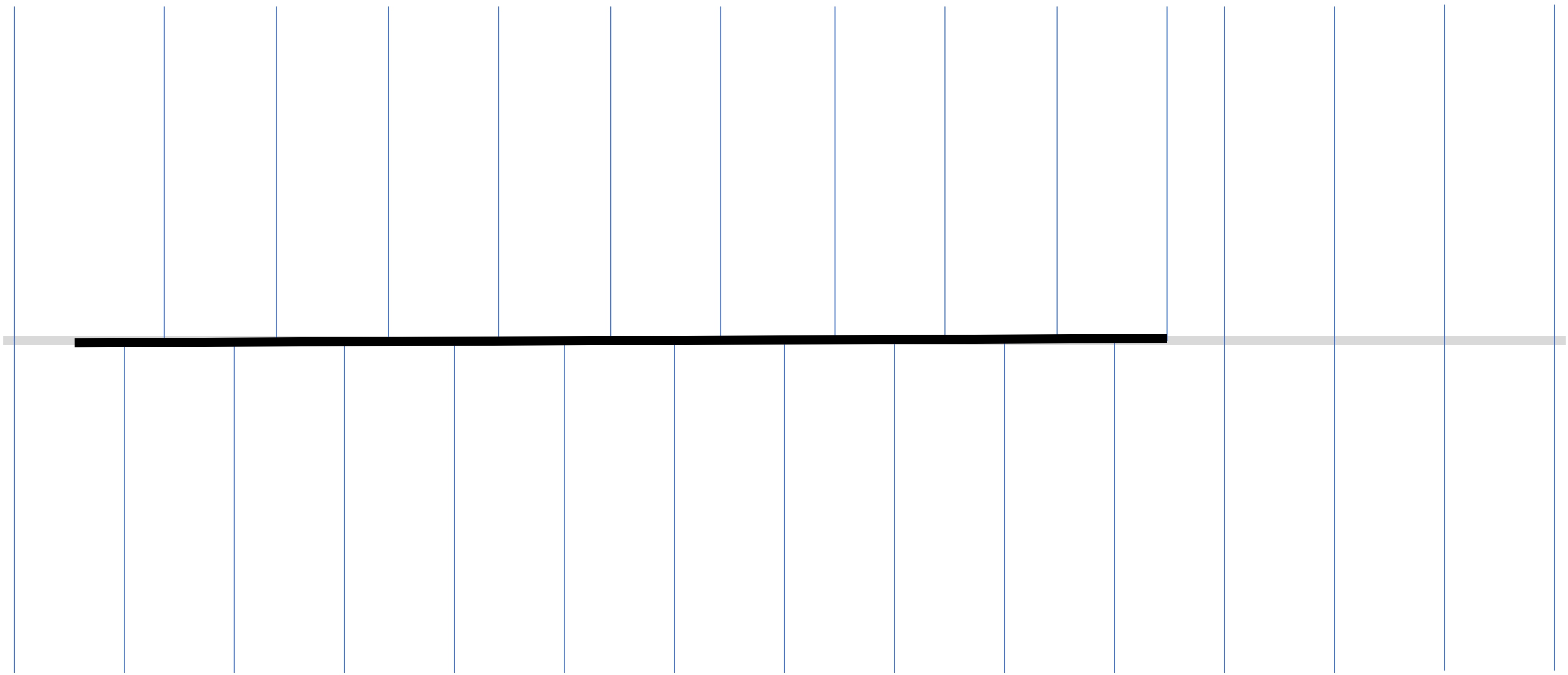
μ

time 4



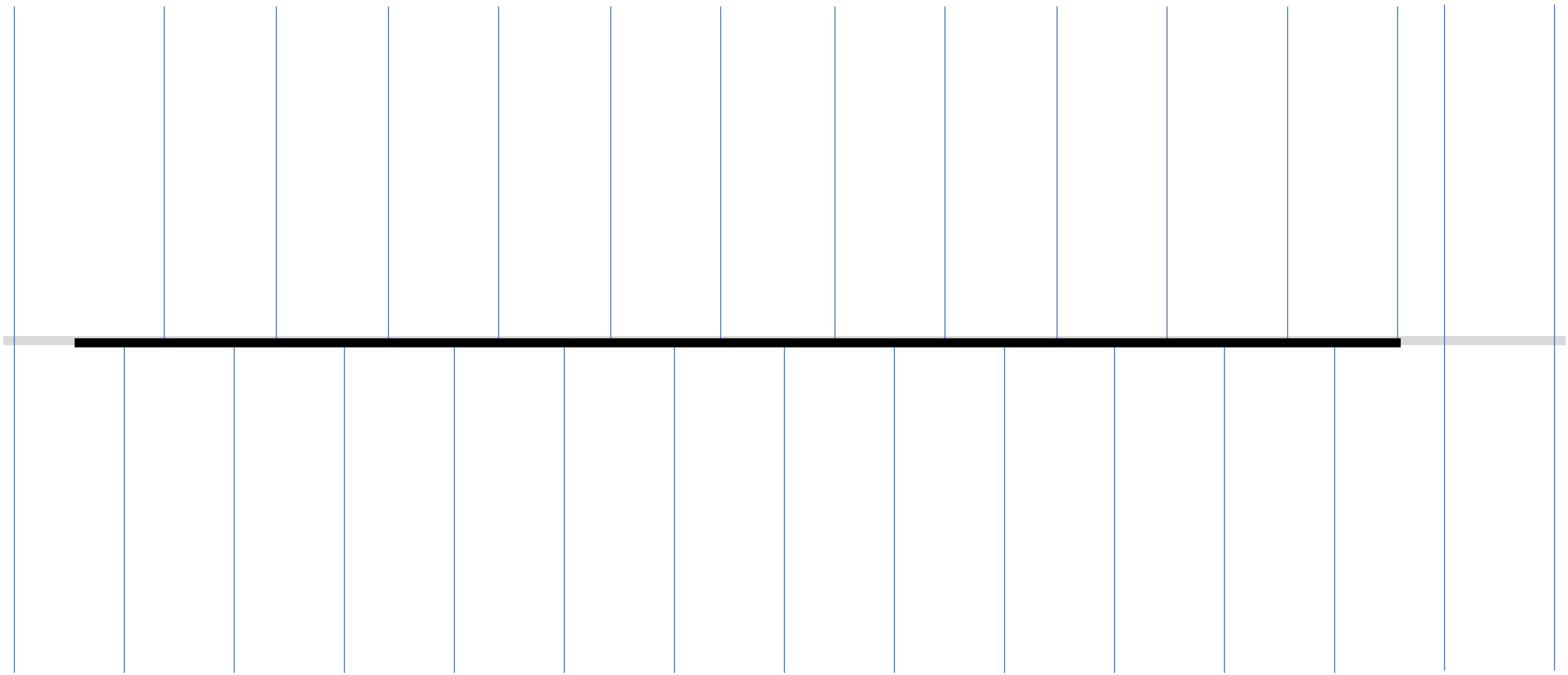
μ

time 5



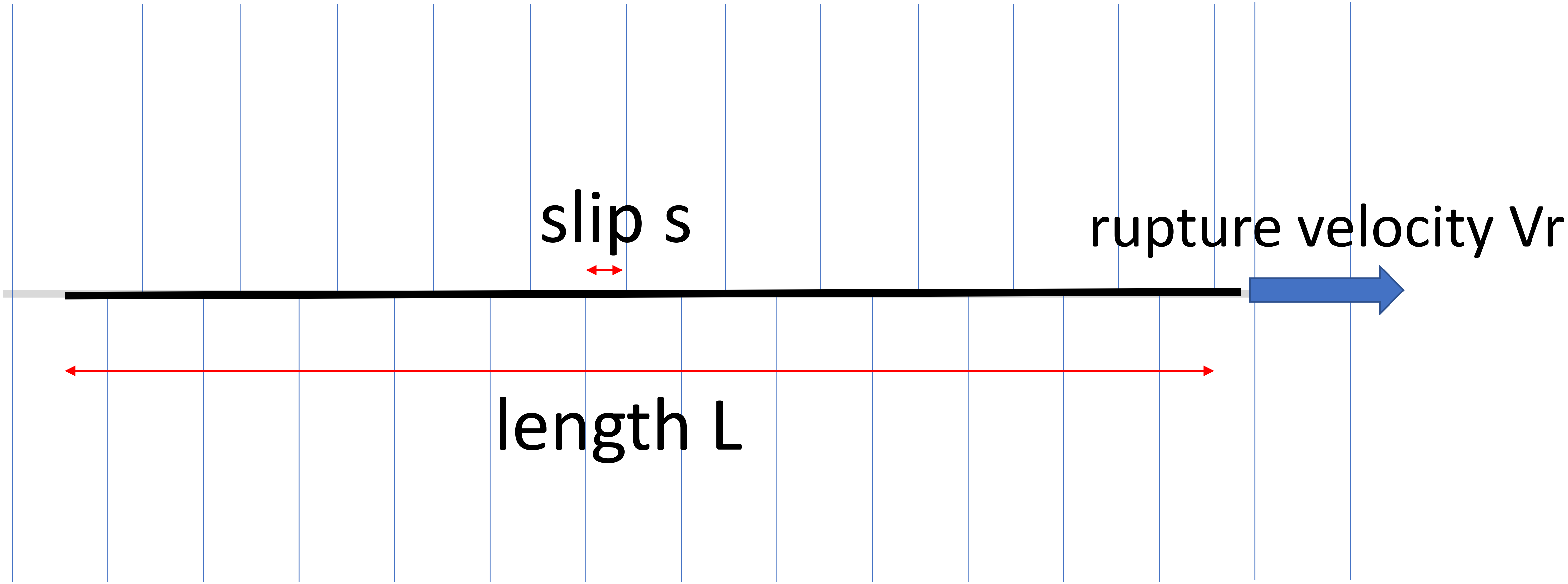
μ

faulting ends, time 6



μ

Duration of faulting T



μ

T=L/Vr

important fault parameters

slip s

length L(t)

width w

rigidity μ

Duration of faulting T

rupture velocity Vr=L/T

important fault parameters

slip s

length L(t)

width w

rigidity μ

$$M(t) = s\, w\, \mu\, L(t)$$

moment

Duration of faulting T

rupture velocity Vr=L/T

important fault parameters

slip s

length L(t)

width w

rigidity μ

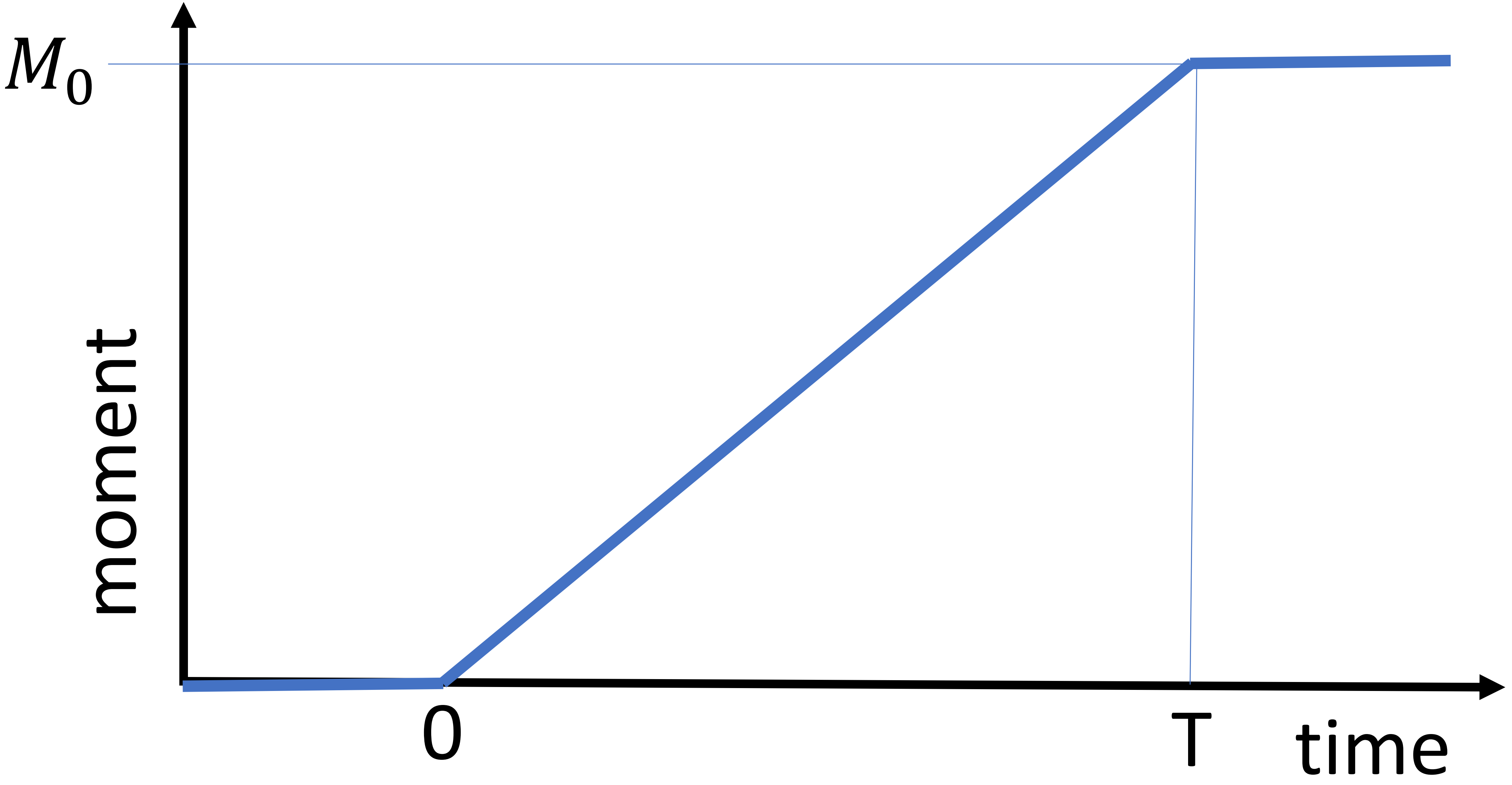
$$M(t) = s\,\mu\,A(t)$$

area

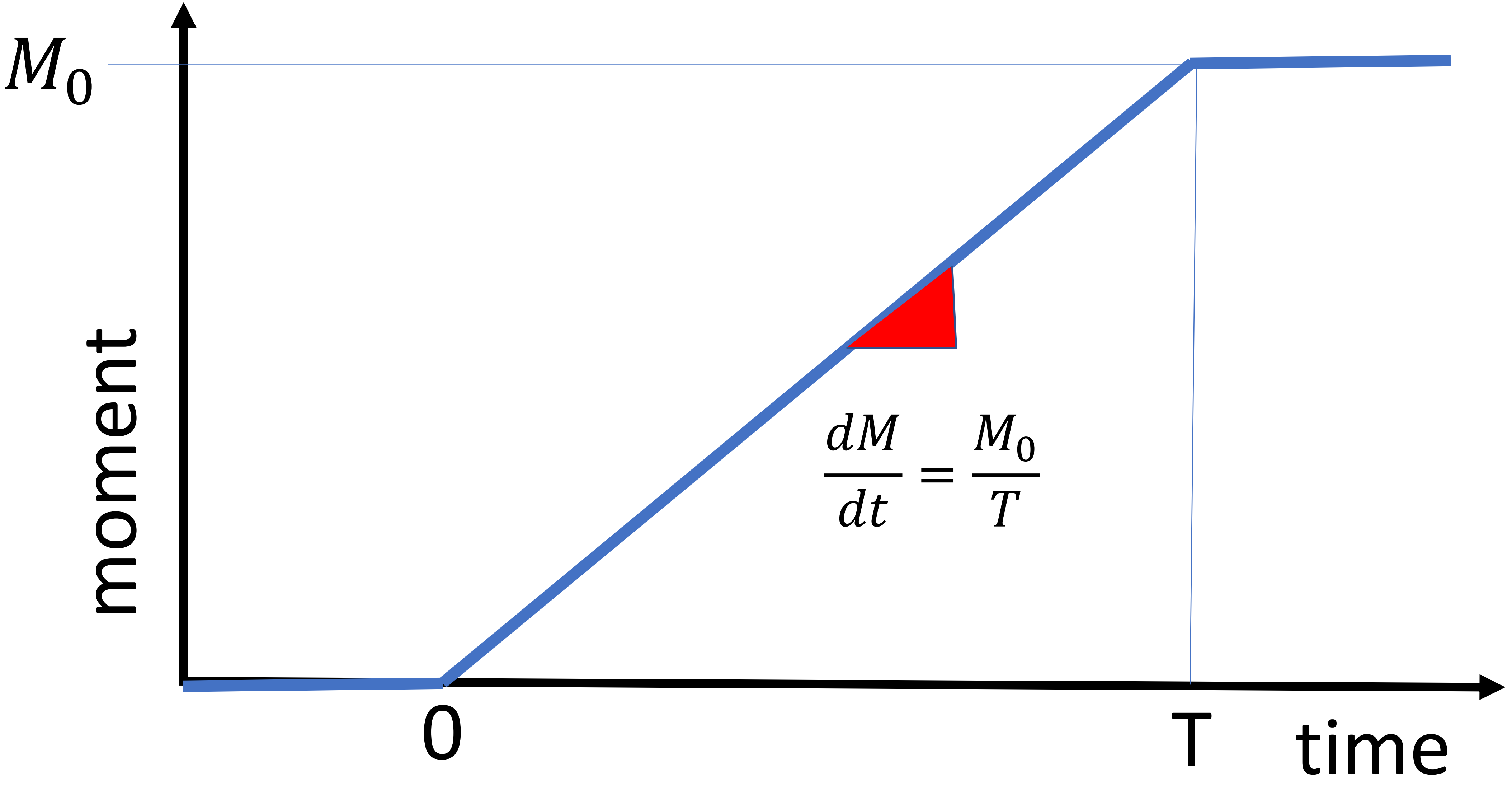
Duration of faulting T

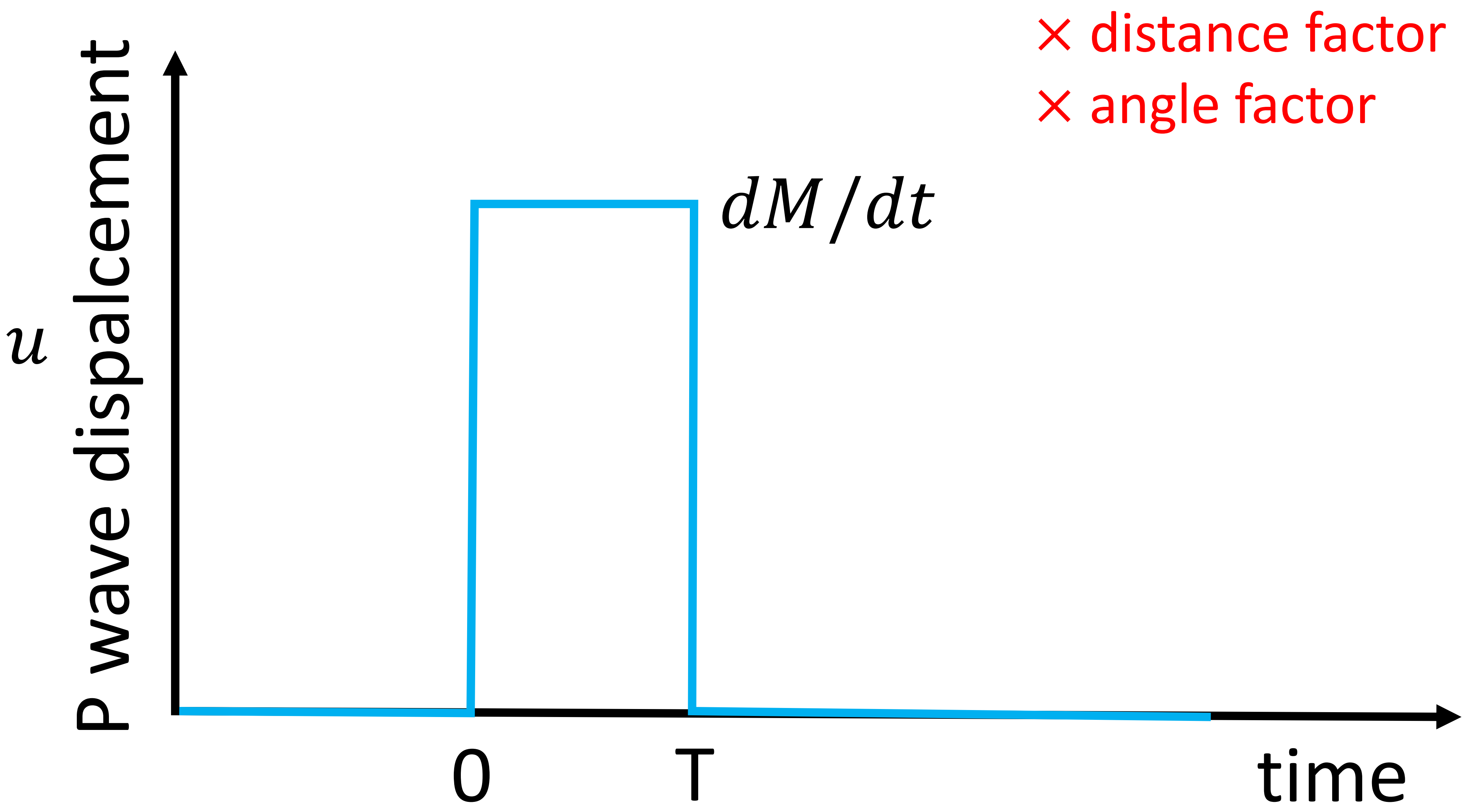
rupture velocity Vr=L/T

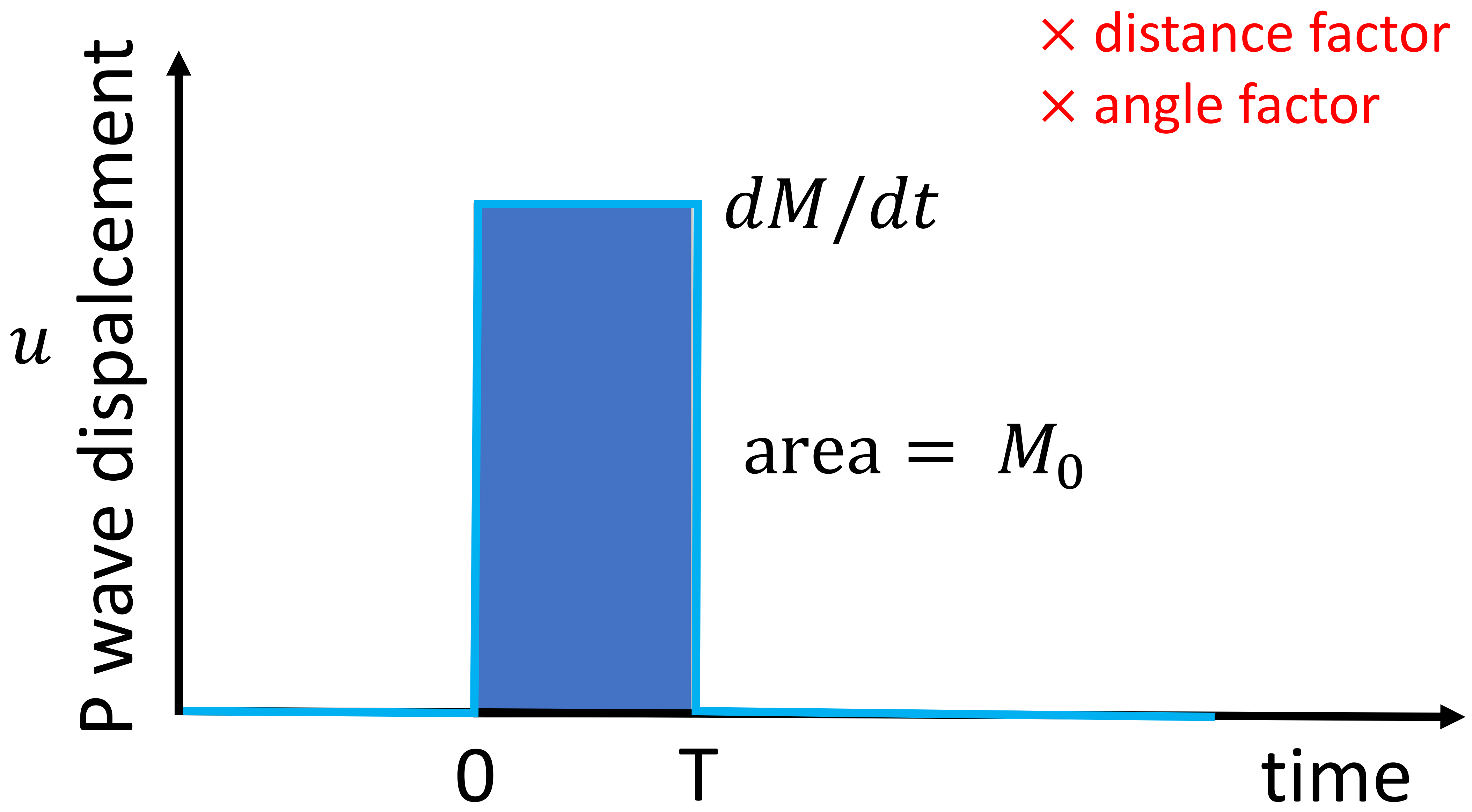
idealized growth of moment



idealized growth of moment




× distance factor
× angle factor
dM/dt
u
P wave dispalcement
0
T
time


× distance factor
× angle factor
u
P wave dispalcement
dM/dt
area = M_0
0
T
time