Looking into the gouge layer within a fault under stresses by transmission waves

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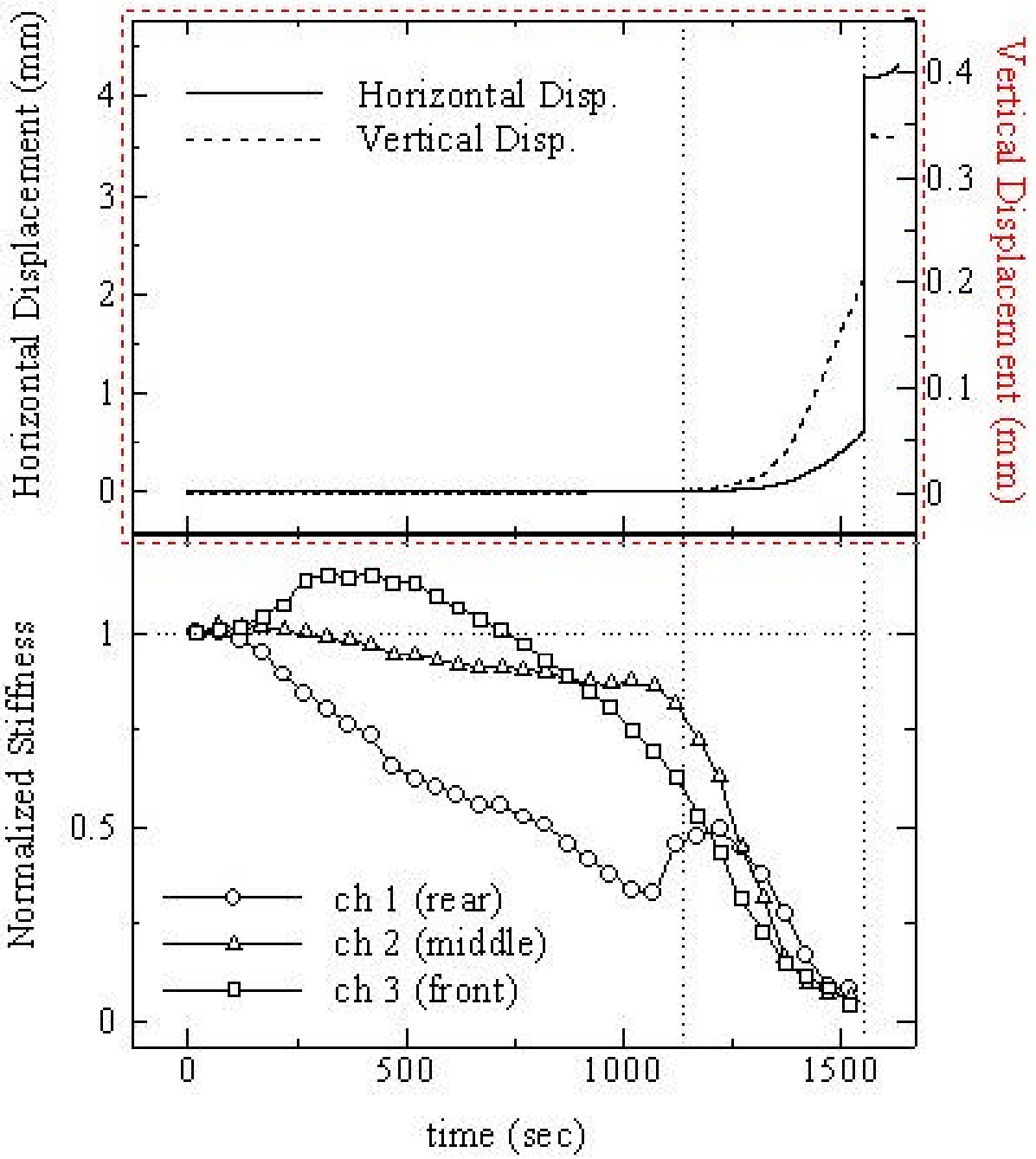
We are now performing a laboratory experiment in which elastic waves are transmitted across a fault with a gouge layer under normal and shear stresses until a final stick slip occurs. The fault consists of a upper block and a lower block, and a gouge layer between them. The waves are transmitted and observed independently at 3 locations along the fault: front, middle and rear. An example of the results is shown in the figure which was taken with a quartz sand gouge layer (0.15 - 0.2 mm) in diameter) and under a dry condition. The upper part of the figure shows the horizontal displacement of the upper block (solid line). There is a very slow precursory slip prior to the stick slip event. The vertical displacement of the upper block is also shown in the figure (broken line). This clearly shows that the upper block climbs up the gouge layer as the horizontal precursory slip begins. The vertical movement amounts to about a diameter of the gouge particles. The lower part of the figure shows the change in stiffness of the gouge layer calculated from the change in waveform of the transmitted waves. While the stiffness once increases and then decreases at the front, it gradually decreases from the beginning of shear stress application at the rear. The middle part of the fault exhibits an intermediate behavior. It seems, however, that it results from a poor configuration of the experiment system because there must be no distinction of 'rear' or 'front' of a fault. On the other hand, all parts of the fault show significant decreases in stiffness as the precursory slip once commences. This suggests that a re-arrangement of the gouge particles occurs and the stress chain significantly changes although the detailed mechanism is not clearly understood at the present stage.


Horizontal Displacement (mm)
Vertical Displacement (mm)
Horizontal Disp.
Vertical Disp.
0
1
2
3
4
0
0.1
0.2
0.3
0.4
Normalized Stiffness
0
0.5
1
ch 1 (rear)
ch 2 (middle)
ch 3 (front)
0
500
1000
1500
time (sec)