# Supplementary Material

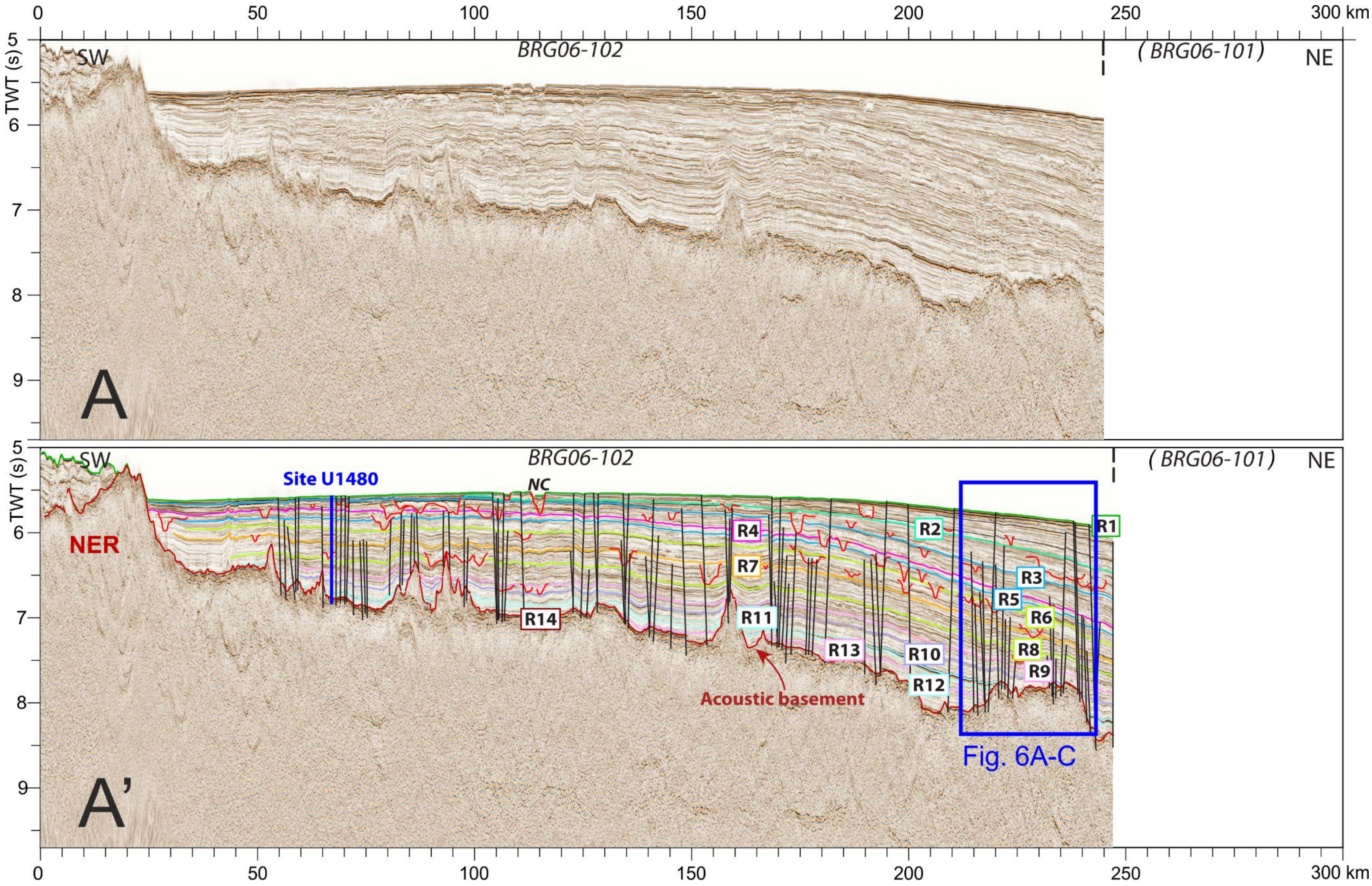
## Semi-automated fault throw measurements

We develop a tool coded in Matlab to return the (Common Depth Point (CDP), Two-Way-Time (TWT)) coordinates of the displaced horizon(s) on both sides of each fault from seismic picks, and calculate the TWT displacement. We index the displacement measurements against the visually interpreted faults in the MCS data, so that displacement measurements for each horizon can be assigned to individual faults. The resultant database contains each faults as a product of the displacement on the horizons that it displaces. We repeat the method where CDP discontinuities are separated based on fault polarity, therefore producing additional datasets with measurements for landward- and seaward-dipping faults separated.

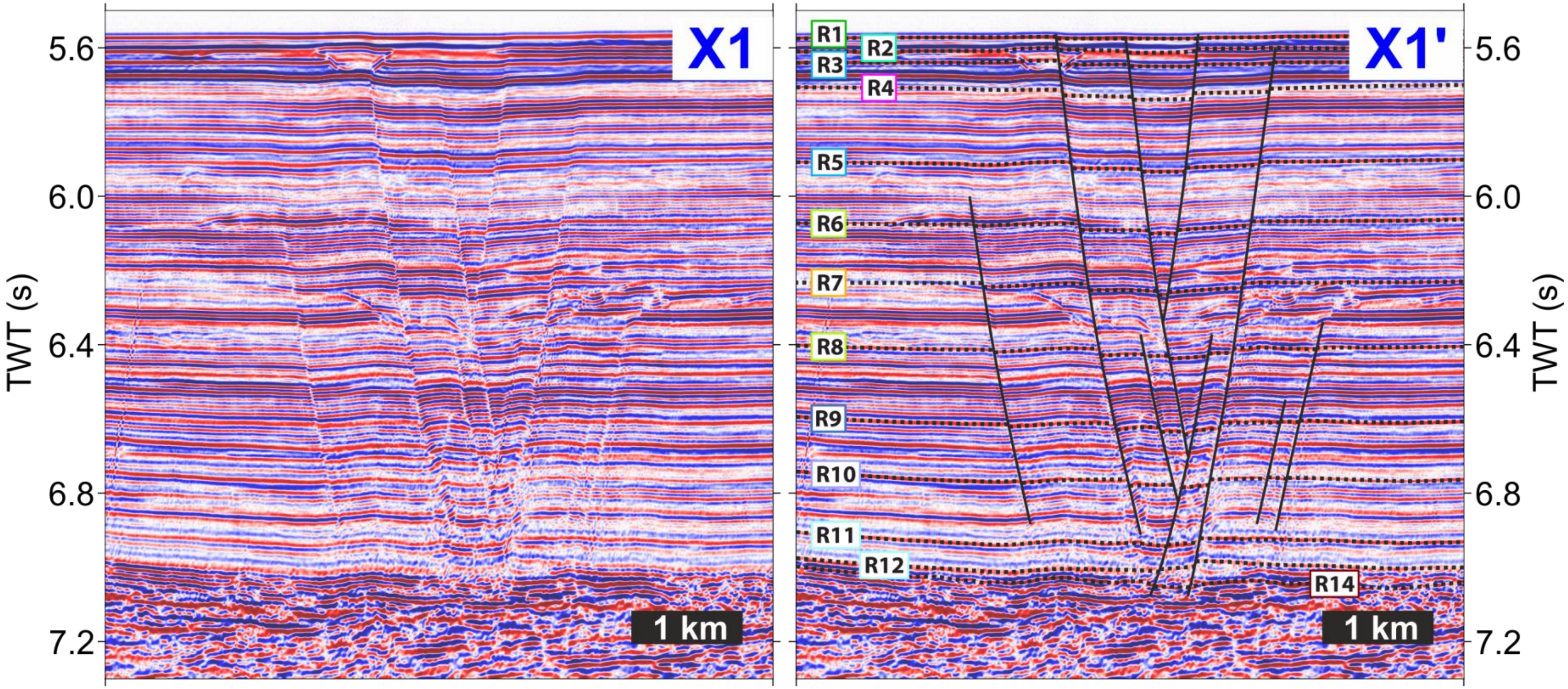
To depth convert our measurements we re-sampled the interval velocity profiles for each seismic line at every 100th CDP. Our Matlab tool uses the CDP location of each fault displacement measurement to return the closest interval velocity profile (≤ 50 CDPs away), finds the vertical position of the measurement within the velocity profile and calculates a vertical separation in metres.

## Figure S1 and expanded sections X1 and X2 from Fig. 2 (below)

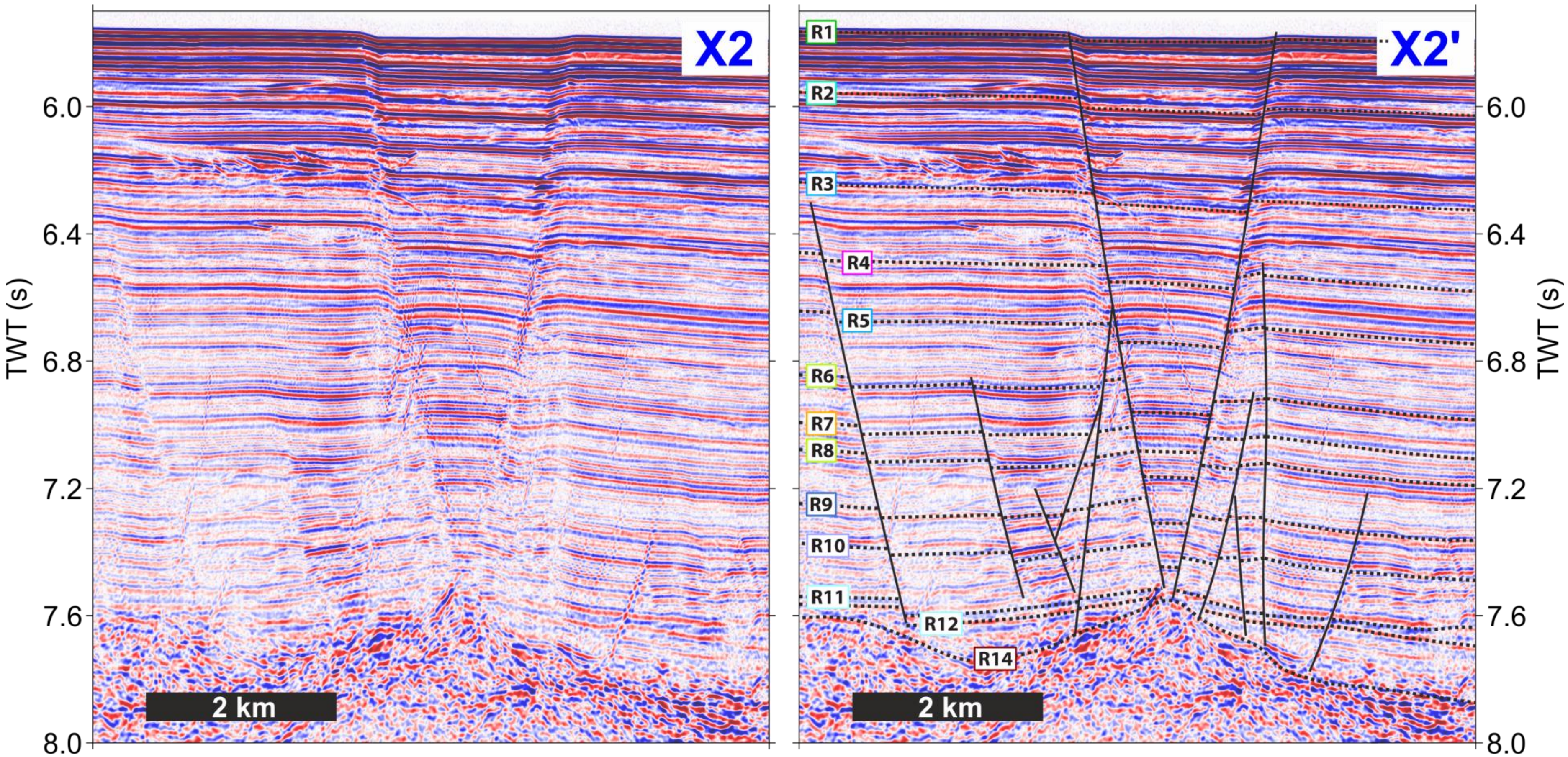
Seismic profile A from Fig. 1. A) Un-interpreted and A') interpreted (BGR06-101 i was not used in our study and is not shown). IODP drill site U1480 is shown by vertical thick blue line. Thin sub-vertical black lines are faults, and sub-horizontal coloured lines are major seismic reflectors labelled R1 to R14 from top to base, where R1 is the seabed and R14 is the top of basement, lens-shaped red lines are channels (NC = Nicobar Channel).  Positions of fracture zone structure F7 (extents of Fig. 6A-C) is highlighted by blue box. NER = Ninety East Ridge.


0
50
100
150
200
250
300 km
TWT (s)
5
6
7
8
9
SW
BRG06-102
( BRG06-101)
NE
A
SW
BRG06-102
( BRG06-101)
NE
Site U1480
NC
NER
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
Acoustic basement
Fig. 6A-C
A'

Expanded un-interpreted- (X1) and interpreted- (X1') seismic section indicated on Fig. 2 main text, showing typical example fault structure in MCS data. Solid, sub-vertical lines indicate faults, and dotted lines indicate interpreted seismic horizons (R1-R14).



Expanded un-interpreted- (X2) and interpreted- (X2') seismic section indicated on Fig. 2 main text, showing typical example fault structure in MCS data. Solid, sub-vertical lines indicate faults, and dotted lines indicate interpreted seismic horizons (R1-R14).



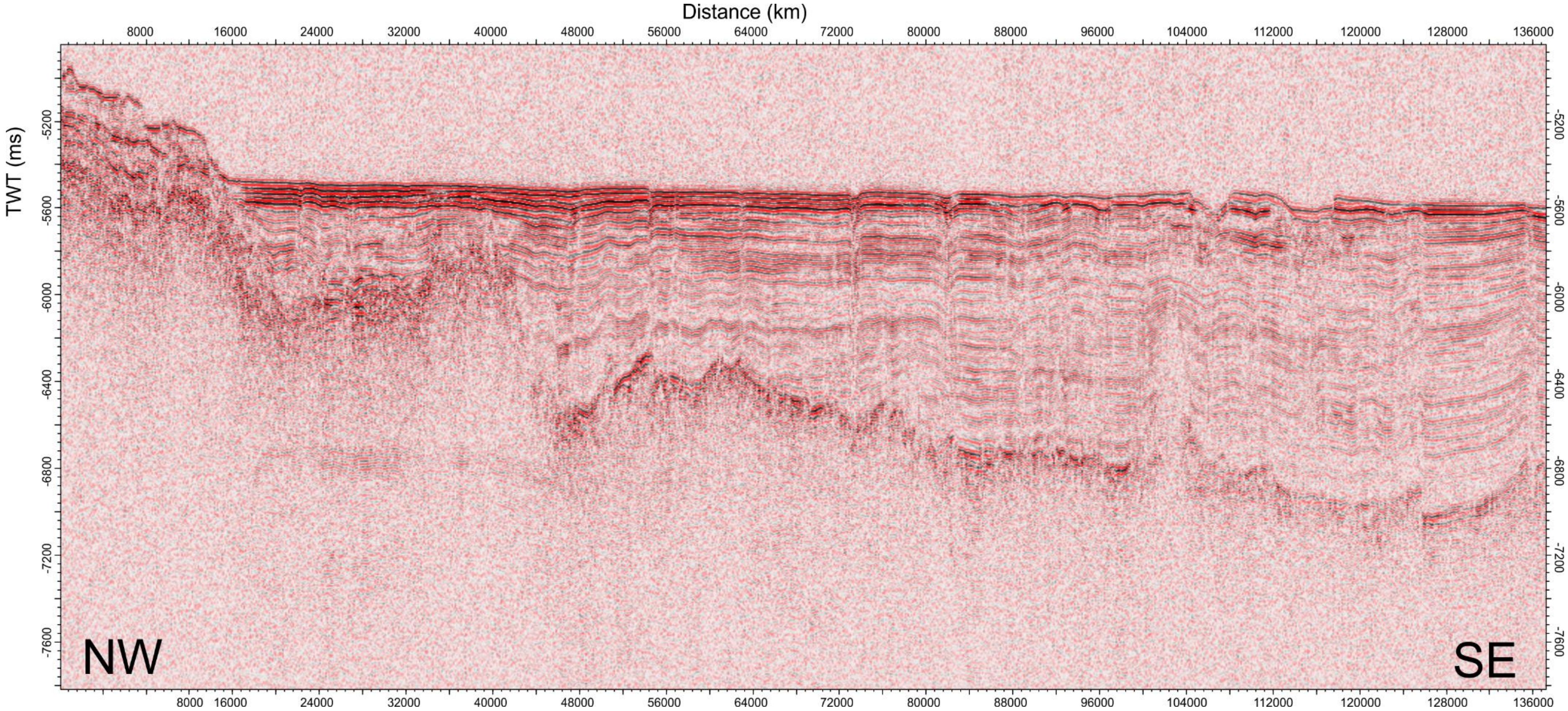



**Figure S2**

Seismic Profile C

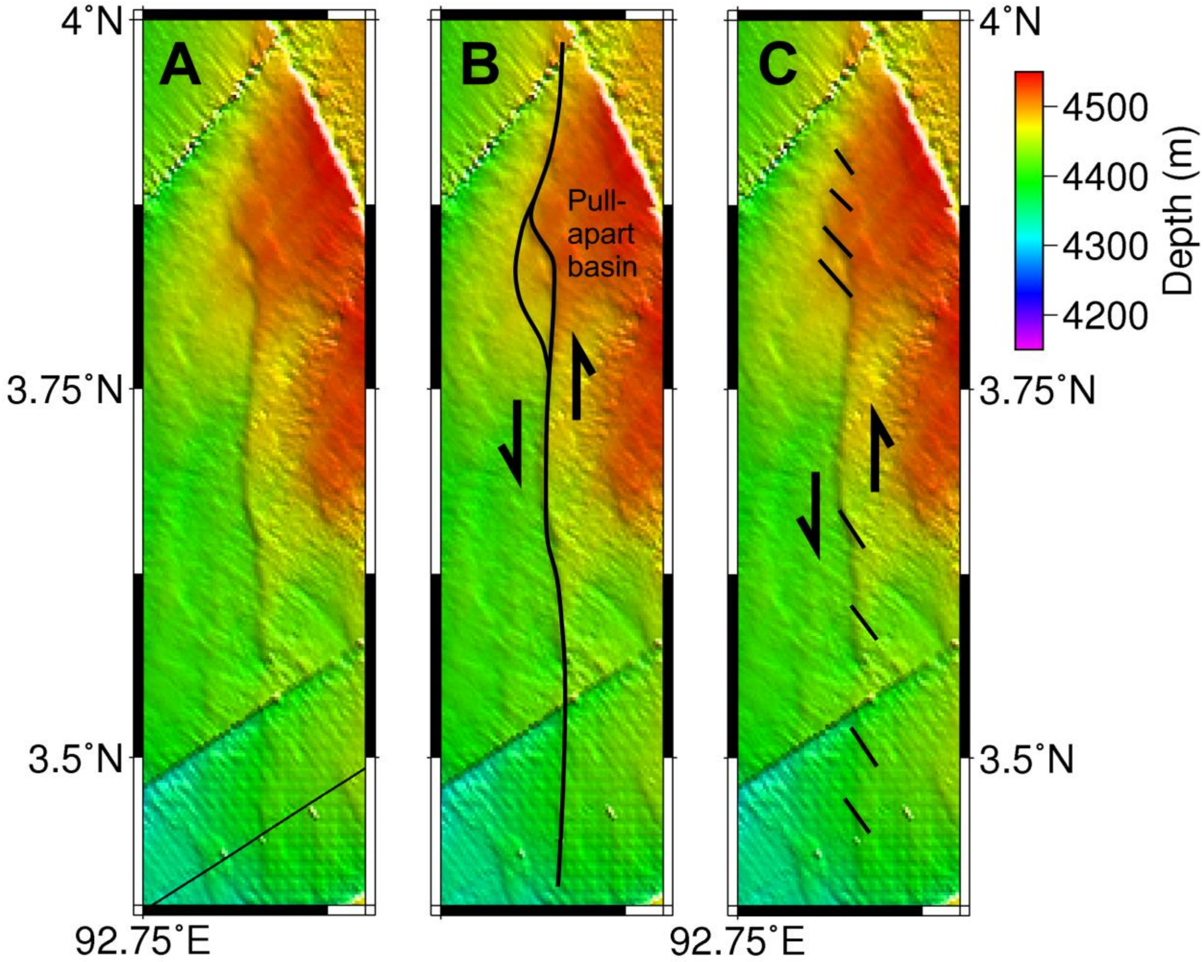



**Figure S3**

Expanded multibeam bathymetry map showing example surface trace associated with Class C faults. A) un-interpreted, black line indicates position of seismic profile B (Fig. 2). B) interpretation of main fault trend (black lines), that shows pull-apart basin geometry to the north (indicated). C) en-echelon normal faults indicated by short black lines. Black arrows indicate sense of motion along the structure.

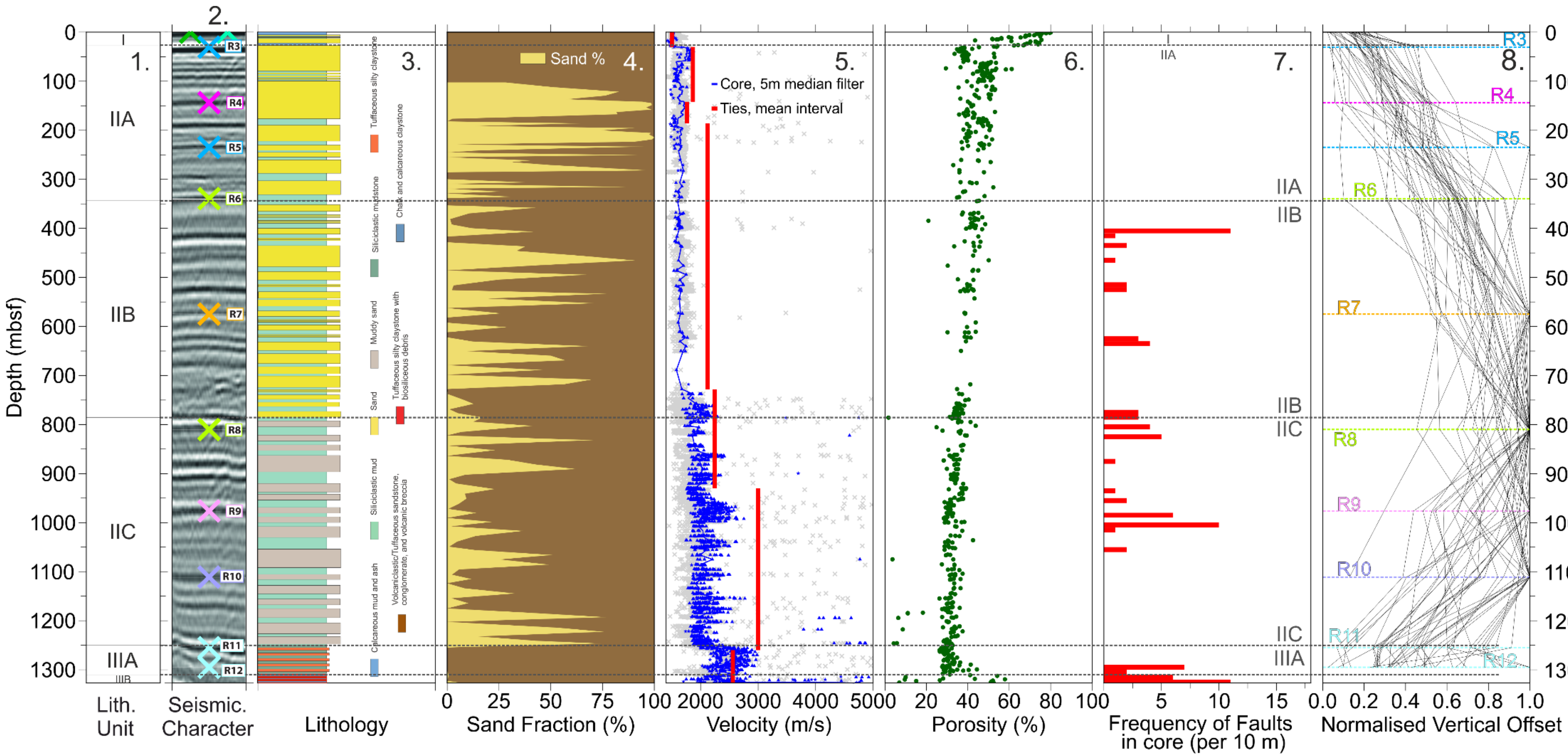



**Figure S4**

Comparison of fault throw/displacement with depth measurements with data from IODP expedition 362 borehole U1480 data (McNeill et al., 2017a). Panel 1) lithological units 2) seismic character observed at the borehole. Coloured crosses indicate the positions of interpreted seismic reflectors R1-12 (colour coded based to reflectors shown in figure 2). 3) lithological log. 4) sand fraction 5) seismic velocity information used for core-log seismic integration. 6) porosity measurements. 7) fracture intensity observed in core. 8) displacement pattern with depth for all 20 km fault groups (e.g. Fig 9B) normalised against the corresponding maximum displacement