APPENDIX

Crustal Faults

Anders and Schlische, 1994 – NE Idaho, Beaverhead Fault

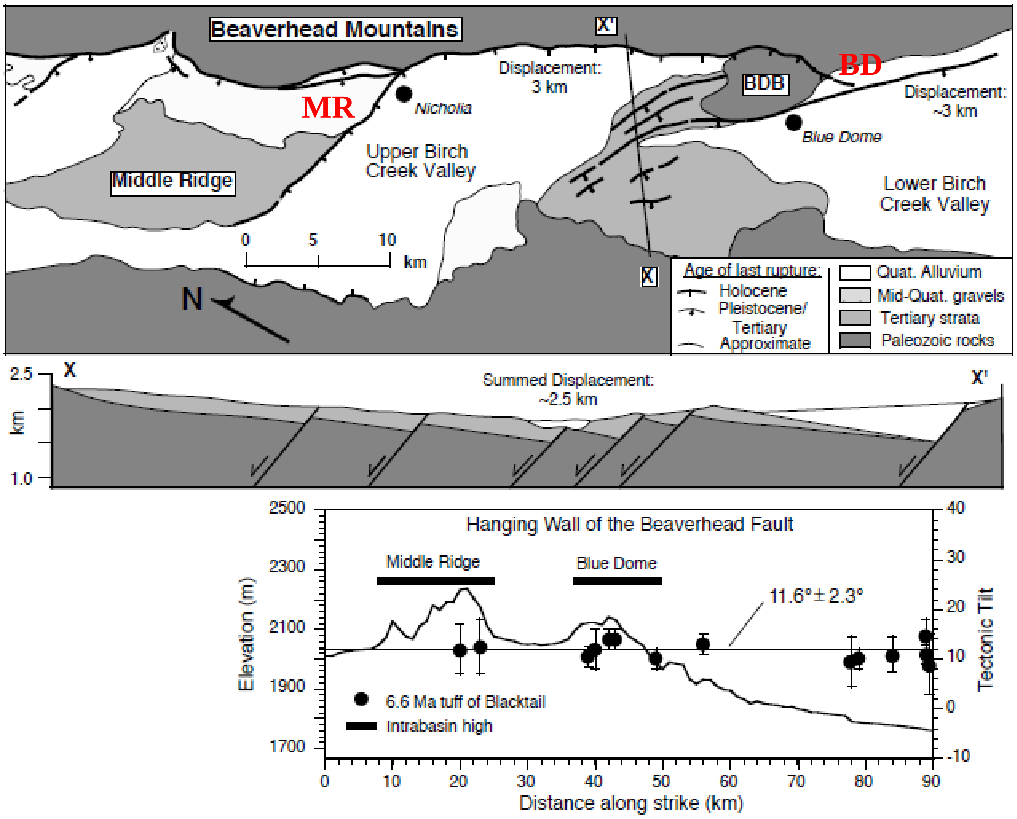


Figure 4. Generalized geological map of two intrabasin highs found along the southern portion of the Beaverhead fault in northeast Idaho. Modified from Crone and Haller (1989) and Rodgers and Anders (1990). Also shown is cross-section X-X' through the Blue Dome intrabasin high.

Middle Ridge
OL=11667m
L=11667m
Wmax=9722m
S=9722m
Lt=47222m
L1=16944m
L2=45833m
Wmin=0m
DmaxF1=?
DmaxF2=3000m
Tilt = 3°
Upper Ramp Breach

Blue Dome
OL=19722m
L=19722m
Wmax=9444m
S=9444m
Lt=57222m
L1=45833m
L2=30833m
Wmin=0m
DmaxF1=3000m
DmaxF2=3000m
Tilt = 3°
Upper Ramp Breach

Thickness = 16000m

Anders and Schlische, 1994, Newark Basin

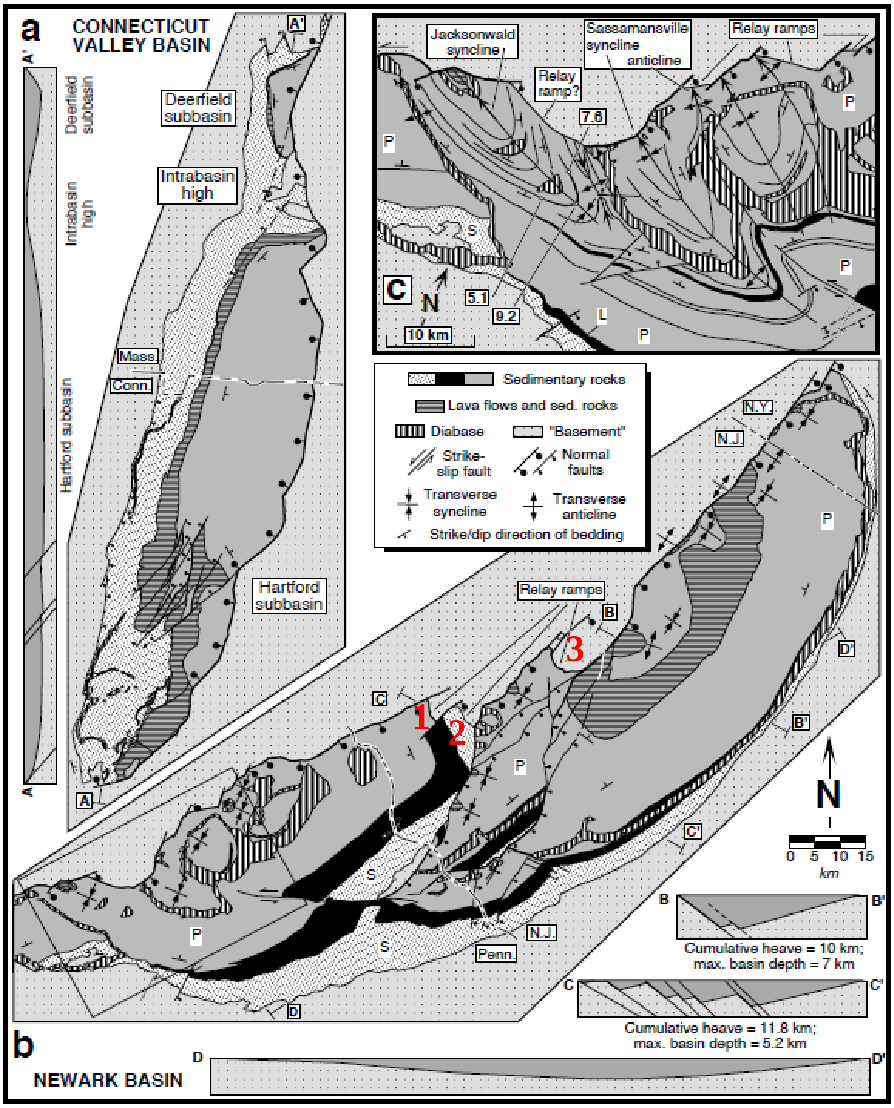


Figure 3. *a*. Geologic map and longitudinal cross section of the Connecticut Valley basin. Modified from Schlische (1993) and based on Wise (1992). *b*. Geologic map and cross sections of the Newark basin, showing the segmented border fault system, intrabasinal splay faults, and relay ramps. Modified from Schlische (1992). *c*. Geologic map of southwestern Newark basin (box in *b*. gives location), showing the relationships among overlapping border fault segments, relay ramps, and transverse folds. Numbers indicate thickness in meters of stratigraphic marker unit across the hinge of the Jacksonwald syncline. Modified from Schlische (1992).

1	2	3
OL=9167m	OL=2500m	OL=10000m
L=9167m	L=3333m	L=15833m
Wmax=5833m	Wmax=5000m	Wmax=6666m
S=5833m	S=2500m	S=5833m
Lt=40000m	Lt=37500m	Lt=89167m
L1=38333m	L1=10000m	L1=29167m
L2=10000m	L2=29167m	L2=73333m
Wmin=3333m	Wmin=5000m	Wmin=6666m

Thickness = 20000m

Cartwright, 1991 – North Sea Central Graben

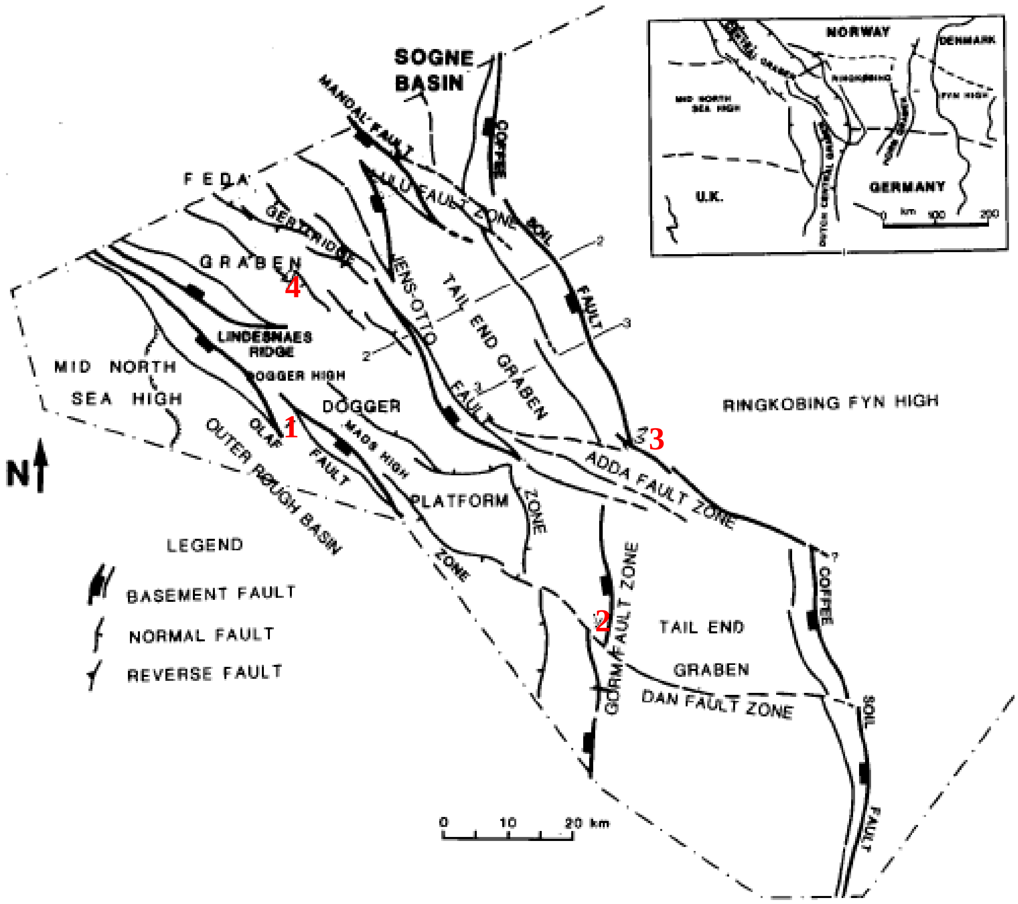


Fig. 1. Principal tectonic elements of the Danish Sector of the Central Graben. The inset figure gives the regional location and shows the curvilinear form of the Coffee Soil Fault as depicted on early maps of the area.

1
OL=5000m
L=13750m
Wmax=5000m
S=3125m
Lt=60000m
L1=38750m
L2=25000m
Wmin=2500m

2
OL=2500m
L=11250m
Wmax=2500m
S=1250m
Lt=41250m
L1=23750m
L2=21250m
Wmin=2500m

3
OL=2500m
L=2500m
Wmax=1250m
S=1250m
Lt=47500m
L1=10000m
L2=40000m
Wmin=0m
Upper Ramp Breach

4
OL=625m
L=625m
Wmax=1250m
S=1250m
Lt=26250m
L1=17500m
L2=7500m
Wmin=1250m

Thickness = 13000m

Childs et al., 2003 – North Sea

C. Childs et al. / Journal of Structural Geology 25 (2003) 633–648 635

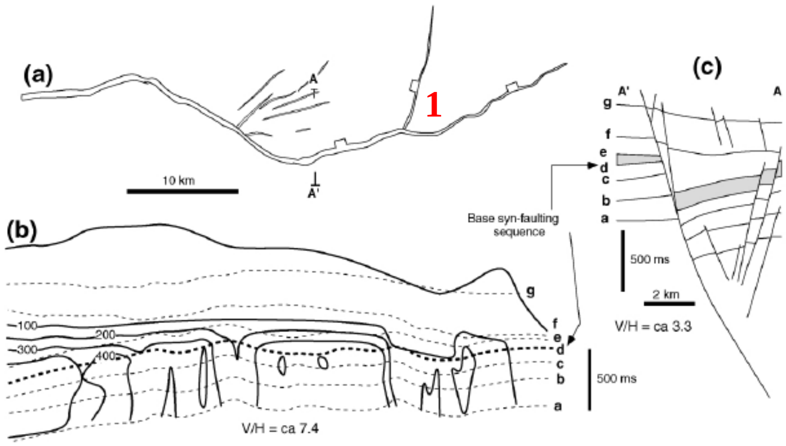


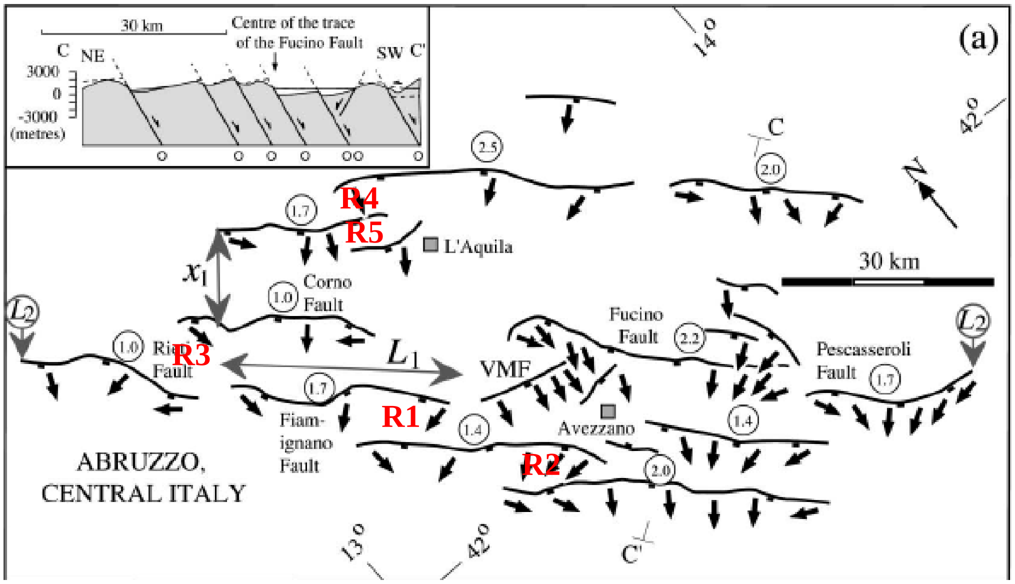
Fig. 2. (a) A large synsedimentary fault from the North Sea as seen on a map of pre-faulting Horizon d. (b) Throw contoured strike-projection of fault, viewed from the footwall side, with contours (solid lines) in ms TWT (1 ms = ca. 1.5 m) and the uppermost contour representing the zero throw upper tip-line. Horizon traces on the fault surface (taken as midway between footwall and hanging wall cutoffs) are shown by broken lines with the base syn-faulting Horizon d shown by the heavy broken line. The strike-projection is aligned with and on the same scale as map (a). (c) Cross-section along line A–A′ on map (a). Note the difference in thickness of the syn-faulting sequence (Horizons d–g) in footwall and hanging wall.

1

OL=15500m
L=15500m
Wmax = 10000m
S=10000m
Lt=48500m
L1=52000m
L2=11500m
Wmin=0
Thickness = 13000m
Upper Ramp Breach

Cowie and Roberts, 2001 – Central Italy, Abruzzo

P.A. Cowie, G.P. Roberts / Journal of Structural Geology 23 (2001) 1901–1915



R1
OL=13125m
L=16875m
Wmax=8125m
S=8125m
Lt=52500m
L1=35625m
L2=31875m
Wmin=6250m
DmaxF1=1.4km
DmaxF2=1.7km

R2
OL=14375m
L=14375m
Wmax=6875m
S=6875m
Lt=66250m
L1=35625m
L2=46250m
Wmin=2500m
DmaxF1=1.4km
DmaxF2=2.0km

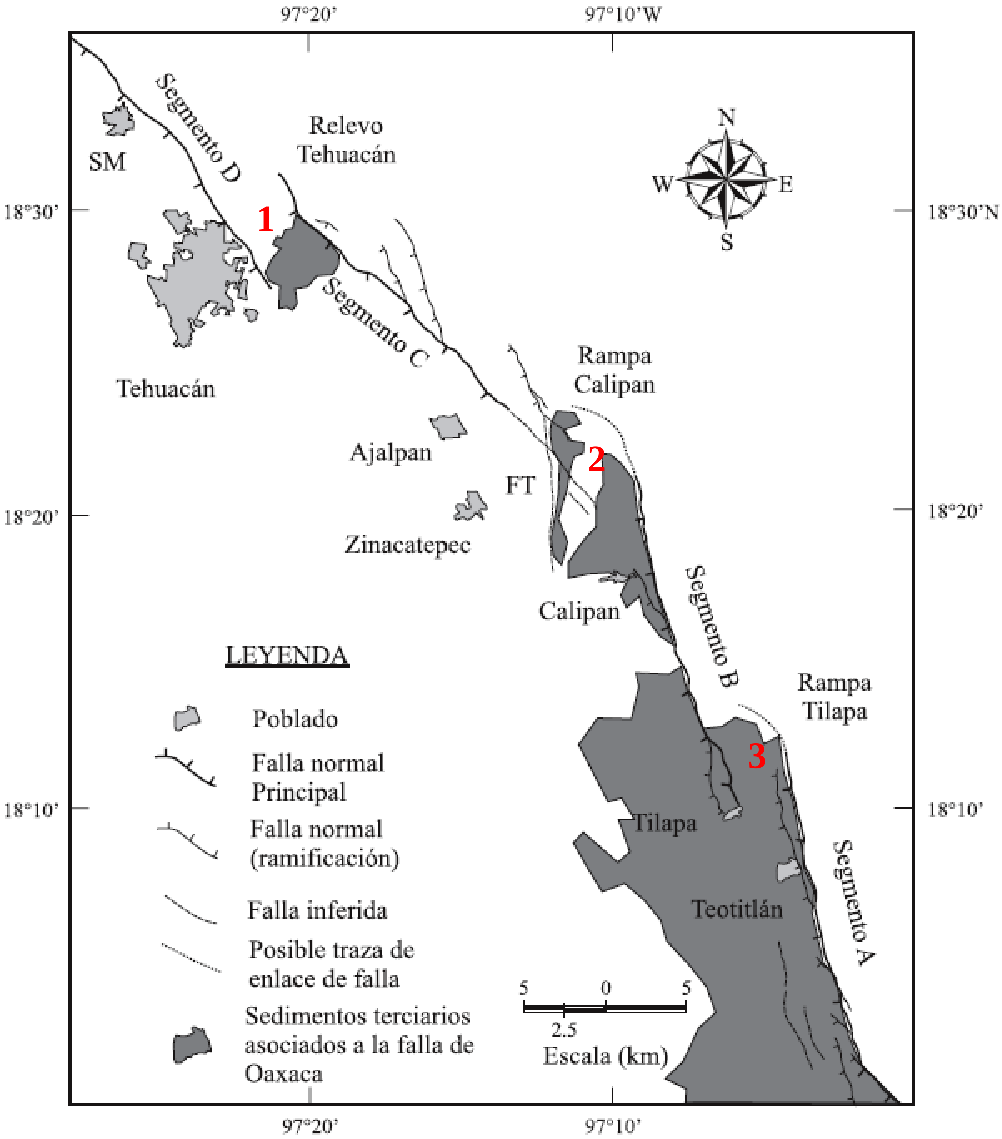
R3
OL=3125m
L=8750m
Wmax=11250m
S=8750m
Lt=49375m
L1=28750m
L2=26250m
Wmin=10625m
DmaxF1=1.0km
DmaxF2=1.0km

R4
OL=7500m
L=7500m
Wmax=5625m
S=5625m
Lt=58750m
L1=43125m
L2=24375m
Wmin=5000m
DmaxF1=2.5km
DmaxF2=1.7km

R5
OL=5000m
L=5000m
Wmax=4375m
S=4375m
Lt=28750m
L1=24375m
L2=11250m
Wmin=3750m
DmaxF1=1.7km
DmaxF2=?

Thickness = 8800m

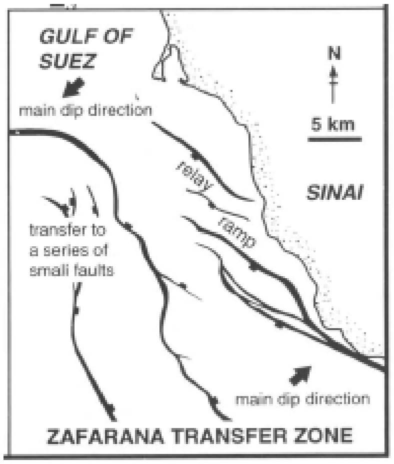
Davalos Alvarez et al., 2007 - Mexico



1	2	3
OL=5714m	OL=5714m	OL=5714m
L=5714m	L=5714m	L=5714m
Wmax=4286m	Wmax=3929m	Wmax=3571m
S=4286m	S=3929m	S=3571m
Lt=42857m	Lt=47857m	Lt=47857m
L1=19643m	L1=28214m	L1=27500m
L2=28214m	L2=27500m	L2=27143m
Wmin=3571m	Wmin=2857m	Wmin=2857m

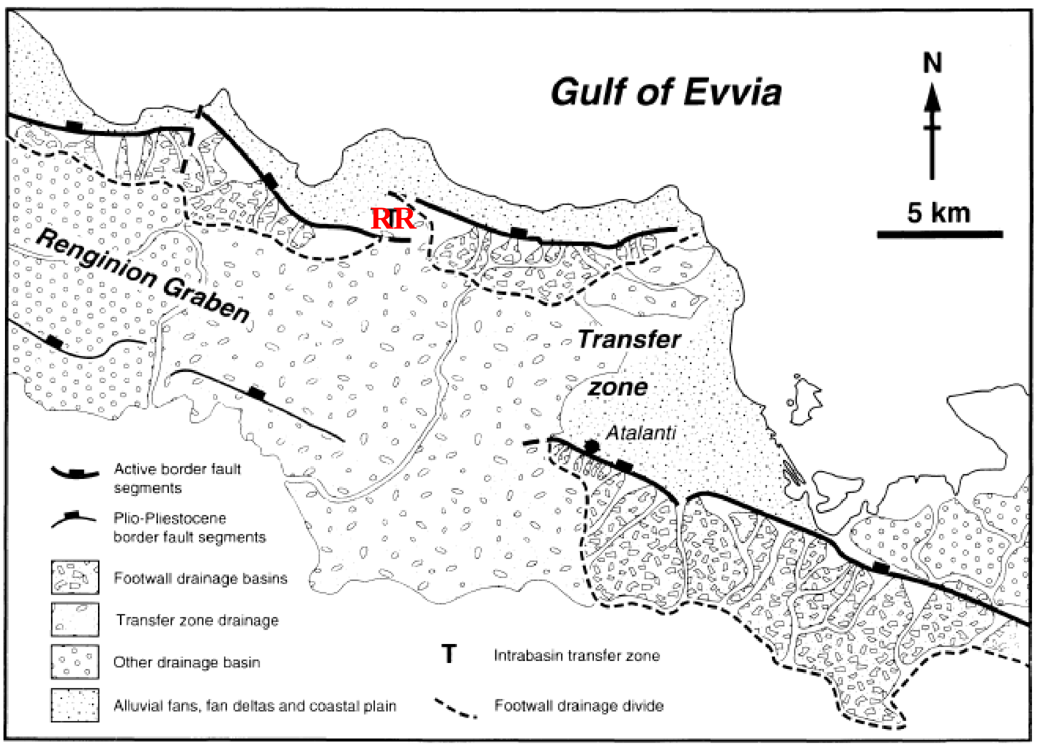
Gawthorpe and Hurst, 1993 – Zararana Transfer Zone

Thickness = 9000m



RR
OL=4283m
L=4283m
Wmax=4283m
S=4283m
Lt=32143m
L1=12143m
L2=24286m
Wmin=4283m

Gawthorpe and Hurst, 1993 –Central Greece, Gulf of Evvia, Atalanti



RR
OL=1364m
L=1364m
Wmax=1818m
S=1818m
Lt=19545m
L1=10227m
L2=12045m
Wmin=1818m
Tilt = 35°

Thickness = 10000m

Gawthorpe and Hurst, 1993 – Gulf of Suez, Esh el Mallaha

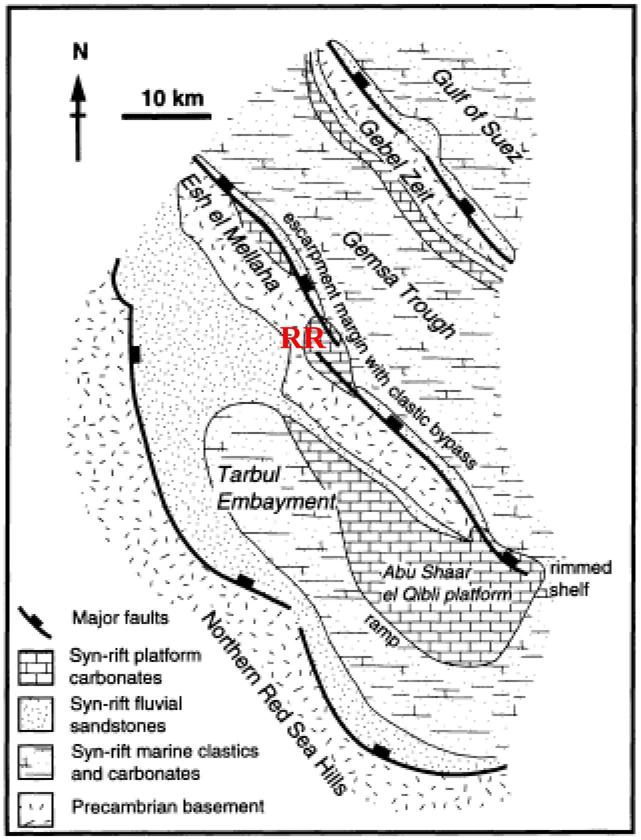


Fig. 10. Miocene palaeogeography for the area around Esh el Mellaha, southern dip province, Gulf of Suez (after Burchette 1987) (see Fig. 6 for location). The Tarbul embayment is located at the synthetic relay ramp, developed at the southern end of the Esh el Mellaha border fault. The Abu Shaar el Qibli carbonate platform is localized within the transfer zone and has carbonate ramp and rimmed shelf margins that are controlled by the topography of the transfer zone. These platform margins contrast markedly with the escarpment bypass margins developed along the Esh el Mellaha border fault.

RR

OL=833m
L=833m
Wmax=2500m
S=2500m
Lt=59167m
L1=34167m
L2=26667m
Wmin=2500m
Thickness = 9000m

Gawthorpe and Hurst, 1993 – Nevada, Tobin Range

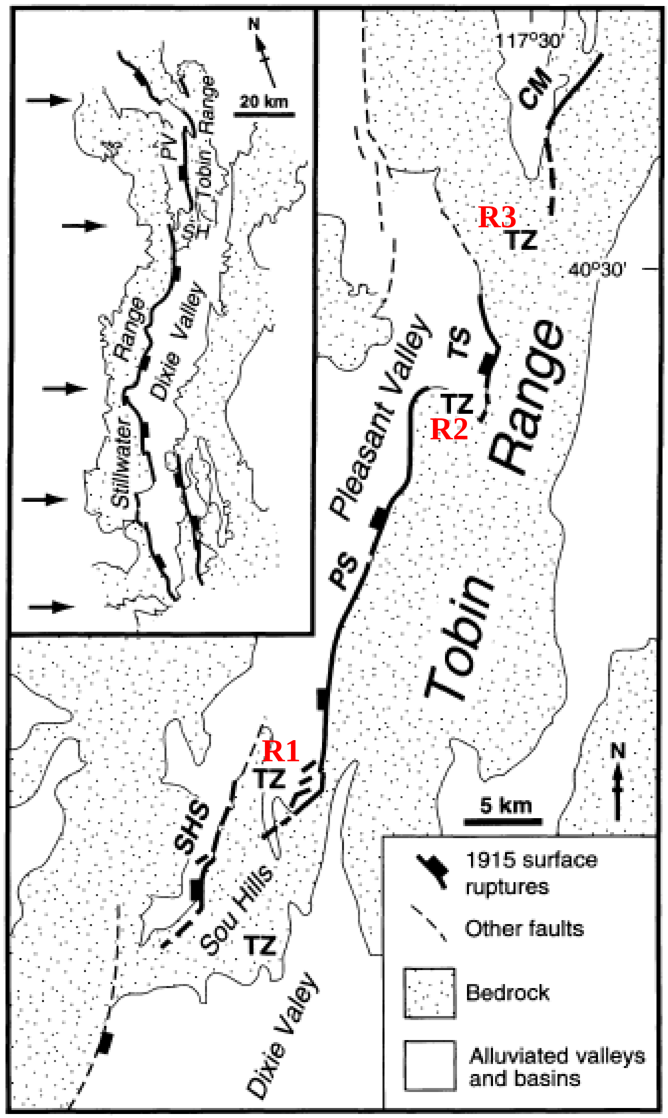


Fig. 13. Surface ruptures associated with the 1915 Pleasant Valley earthquake (after Wallace 1984; dePolo *et al*. 1991; Zhang *et al*. 1991). Note the intrabasin relay ramps (TZ) separating the main fault segments defined by the 1915 ruptures. The Sou Hills represents an interbasin antithetic transfer zone separating the Pleasant Valley and Dixie Valley segments and is a persistent barrier to rupture propagation (Fonseca 1988). Arrows in the inset mark the location of major segment boundaries (interbasin transfer zones), from Zhang *et al*. (1991). PV, Pleasant Valley; SH, Sou Hills; PS, Pleasant Valley segment; TS, Tobin segment; CM, China Mountain segment.

R1
OL=6500m
L=6500m
Wmax=5000m
S=5000m
Lt=41000m
L1=16000m
L2=32500m
Wmin=2500m

R2
OL=1500m
L=10000m
Wmax=4500m
S=2500m
Lt=45000m
L1=32500m
L2=17500m
Wmin=3000m

R3
OL=1500m
L=1500m
Wmax=7500m
S=7500m
Lt=25500m
L1=17500m
L2=11000m
Wmin=7000m

Thickness = 20000m

Larsen, 1988 – East Greenland, Karstryggen

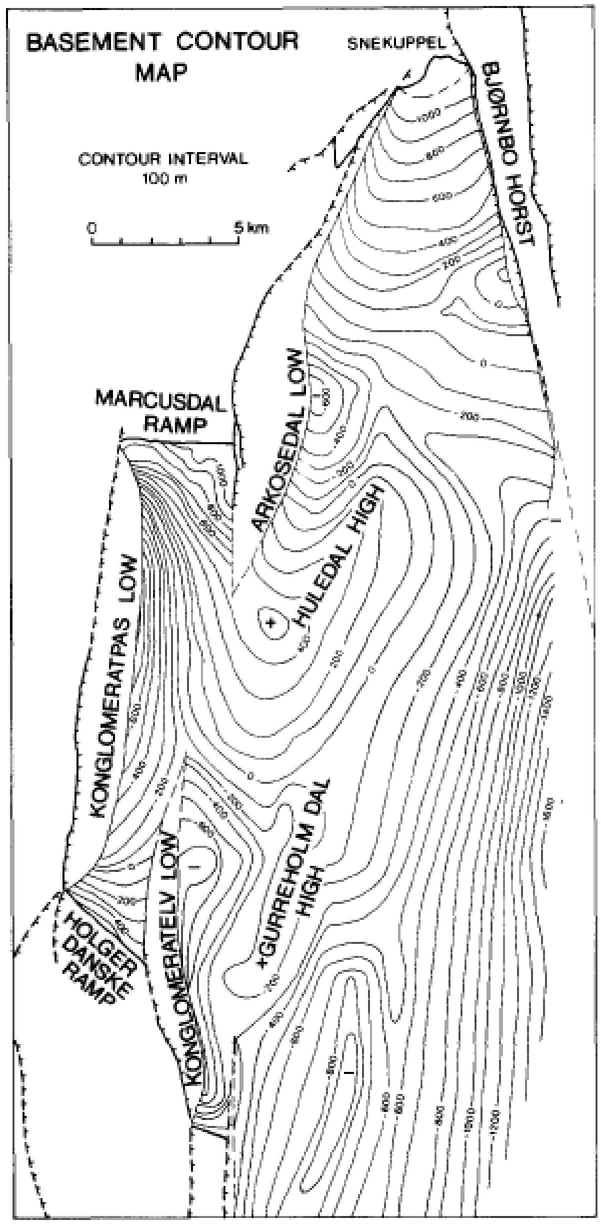


Fig. 6. Basement contour map of the Karstryggen area, East Gree land. The contours show the Caledonian crystalline basement surfa in the downfaulted areas in relation to present day sea-level. The fa surfaces in lows are without ornamentation.

Holger Danske Ramp
OL=2333m
L=2333m
Wmax=3000m
S=3000m
Lt=26000m
L1=18167m
L2=12667m
Wmin=0m
Upper Ramp Breach

Marcusdal Ramp
OL=2167m
L=3833m
Wmax=4167m
S=3333m
Lt=31667m
L1=16167m
L2=18167m
Wmin=3833m
Tilt=16°

Morley et al., 1990 – North Sea Central Graben Argyll and Auk Fields

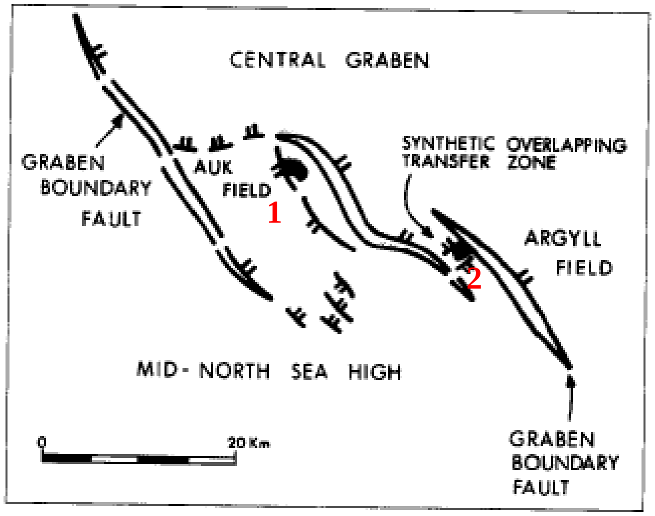


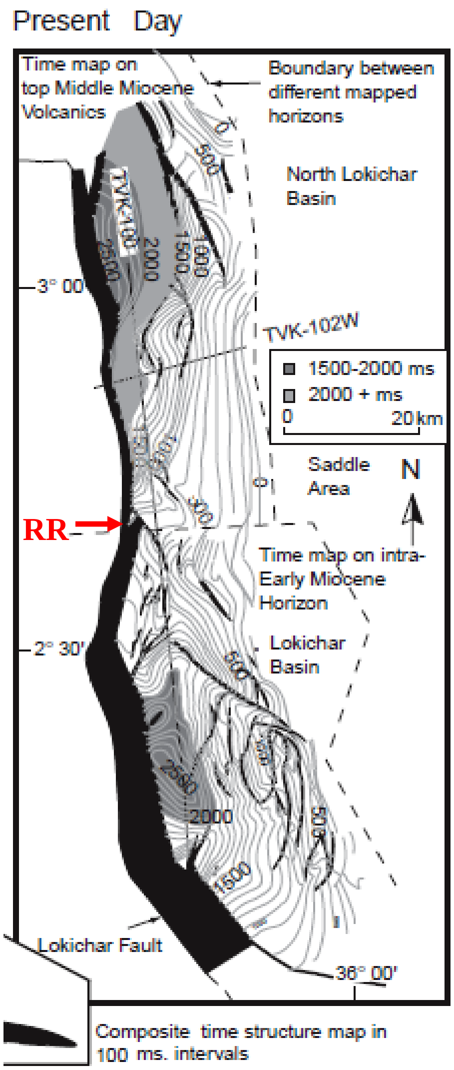
Figure 14—Argyll field, Central Graben, North Sea (from Brennand and Van Veen, 1975). See Figure 11 for location. The field is located in one of a series of left-stepping synthetic overlapping transfer zones.

Thickness = 13000m

1
OL=13461m
L=13461m
Wmax=17308m
S=17308m
Lt=49231m
L1=35385m
L2=30385m
Wmin=10769m

2
OL=10000m
L=10000m
Wmax=4615m
S=4615m
Lt=37308m
L1=30385m
L2=21538m
Wmin=3846m

Morley, 2002 – NW Kenya, Lokichar Fault



RR
OL=3529m
L=3529m
Wmax=2353m
S=2353m
Lt=124706m
L1=77059m
L2=61176m
Wmin=0m
Thickness = 8000m
Upper Ramp Breach

Roberts and Jackson, 1991 – Central Greece, North Gulf of Evvia

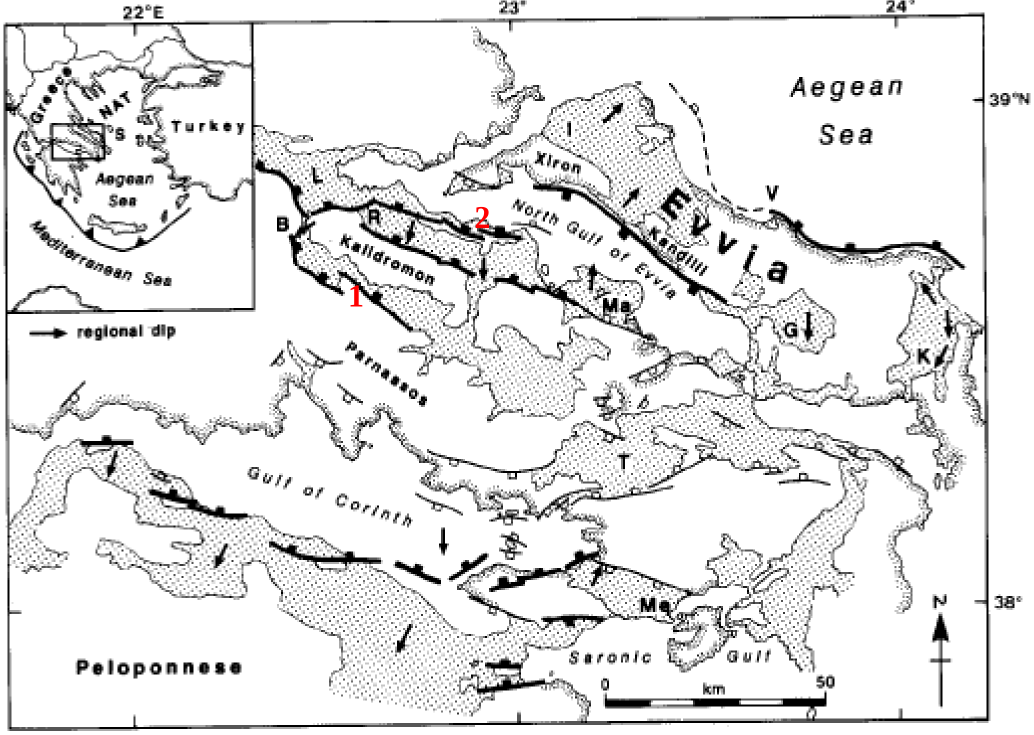
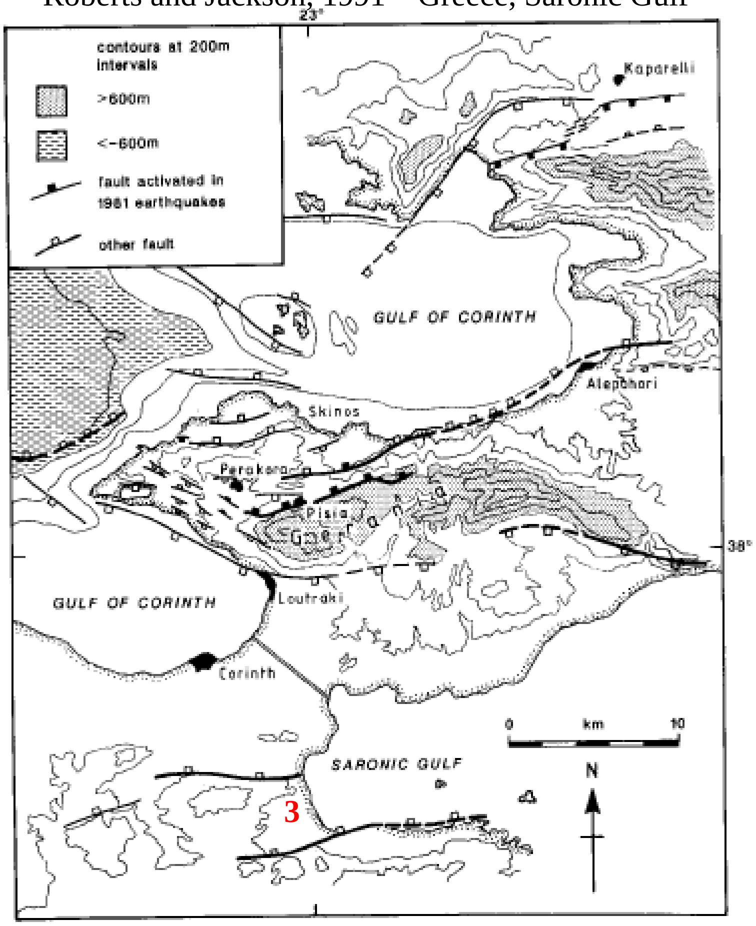


Fig. 1.(a) General fault map of central Greece, showing the principal areas (stippled) where Miocene–Recent sediments are preserved. The region is identified in the inset map, where NAT is the North Aegean Trough and S is the island of Skyros. Major range-bounding faults are shown in heavy lines with filled blocks on their downthrown side. Other 'large' faults, capable of generating earthquakes of magnitude 6.0 or greater, but with apparently less displacement or topographic expression, are shown in thinner lines with open blocks. The distinction between these two fault types is, to some extent, subjective. Some faults, such as those on the NE

1	2	
OL=3846m	OL=1923m	Thickness = 10000m
L=3846m	L=1923m	
Wmax=3846m	Wmax=962m	
S=3846m	S=962m	
Lt=28846m	Lt=19231m	
L1=11538m	L1=9615m	
L2=21154m	L2=9615m	
Wmin=3846m	Wmin=1923m	

Roberts and Jackson, 1991 – Greece, Saronic Gulf



3
OL=4000m
L=4000m
Wmax=4500m
S=4500m
Lt=19500m
L1=15000m
L2=8500m
Wmin=4000m
Tilt=3°
Thickness = 10000m

Roberts et al., 2004 – Central Italy, Lazio-Abruzzo Apennines

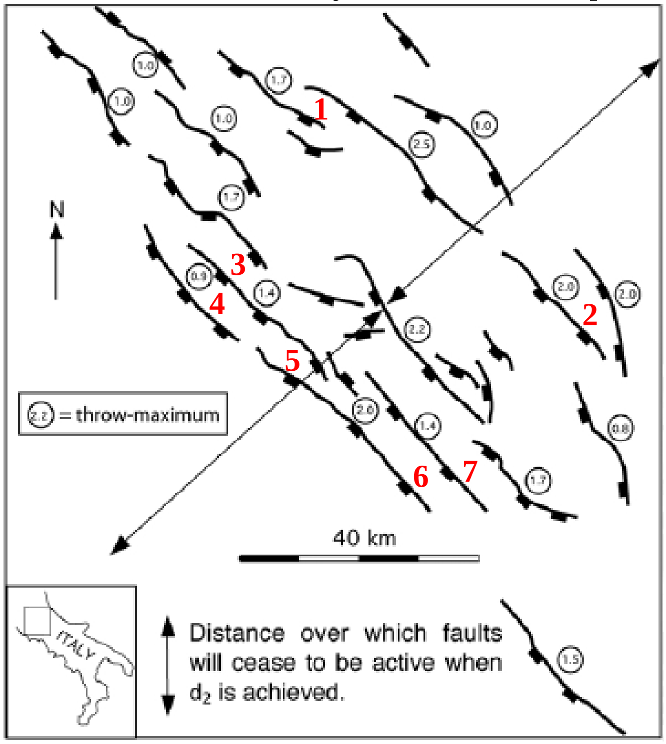


Fig. 2. Map of active faults in the Lazio–Abruzzo Apennines, central Italy from Roberts and Michetti (2003, this issue). The map also shows the across-strike distance within which faults will cease to be active (x_2) if the central Fucino Fault achieves d_2 (see Fig. 1 for reasoning). The Fucino fault has not achieved d_2 so the across-strike fault spacing remains close to x_1.

1	2	3	4
OL=5714m	OL=17143m	OL=11429m	OL=15714m
L=5714m	L=17143m	L=11429m	L=15714m
Wmax=4286m	Wmax=8571m	Wmax=7143m	Wmax=5714m
S=4286m	S=8571m	S=7143m	S=5714m
Lt=51429m	Lt=28571m	Lt=47143m	Lt=38571m
L1=21429m	L1=24286m	L1=28571m	L1=31429m
L2=38571m	L2=22857m	L2=31429m	L2=24286m
Wmin=4286m	Wmin=2857m	Wmin=5714m	Wmin=5000m
DmaxF1=1.7km	DmaxF1=2.0km	DmaxF1=1.7km	DmaxF1=1.4km
DmaxF2=2.5km	DmaxF2=2.0km	DmaxF2=1.4km	DmaxF2=0.9km

5	6	7
OL=11429m	OL=22857m	OL=10000m
L=11429m	L=22857m	L=10000m
Wmax=5714m	Wmax=7143m	Wmax=7143m
S=5714m	S=7143m	S=7143m
Lt=58571m	Lt=45714m	Lt=41429m
L1=31429m	L1=38571m	L1=30000m
L2=38571m	L2=30000m	L2=24286m
Wmin=2857m	Wmin=7143m	Wmin=5714m
DmaxF1=1.4km	DmaxF1=2.0km	DmaxF1=1.4km
DmaxF2=2.0km	DmaxF2=1.4km	DmaxF2=1.7km

Thickness = 8800m

Soliva and Benedicto, 2004 – Spain, Granada province, Andalucia, Padul-Niguelas

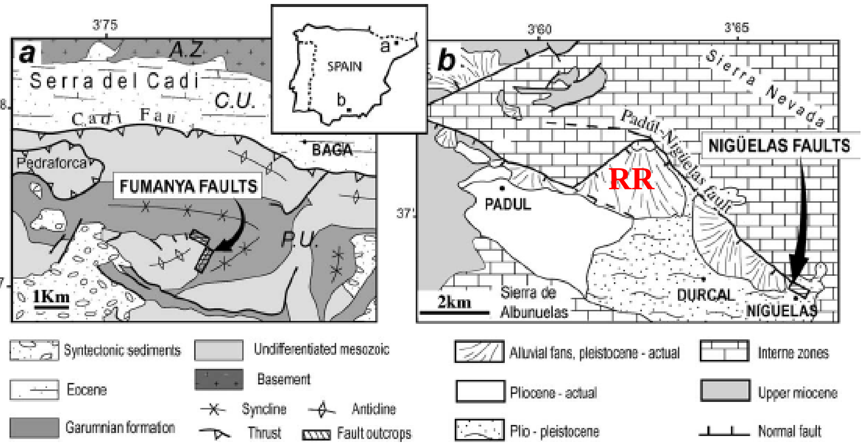


Fig. 2. Location of the study areas. (a) The Fumanyá faults (Figols Quarry, Berguedá, Catalonia), located in the Serra d'Ensije anticline, are exposed on a Maestrichtian bedding plane of the early Garumnian Formation. A.Z. = axial zone, C.U. = Cadi unit, P.U. = Pedraforca unit. (b) The Nigüelas faults (Granada province, Andalucía), located in the southwestern Betics, are exposed on a large slip surface of the Padúl–Nigüelas fault zone.

RR

OL=3500m
L=3500m
Wmax=2167m
S=2167m
Lt=11000m
L1=6333m
L2=8500m
Wmin=1333m
Connecting Fault Breach

Upper-Crustal Confined Faults

Bozkurt Ciftci and Bozkurt, 2007 – Western Turkey

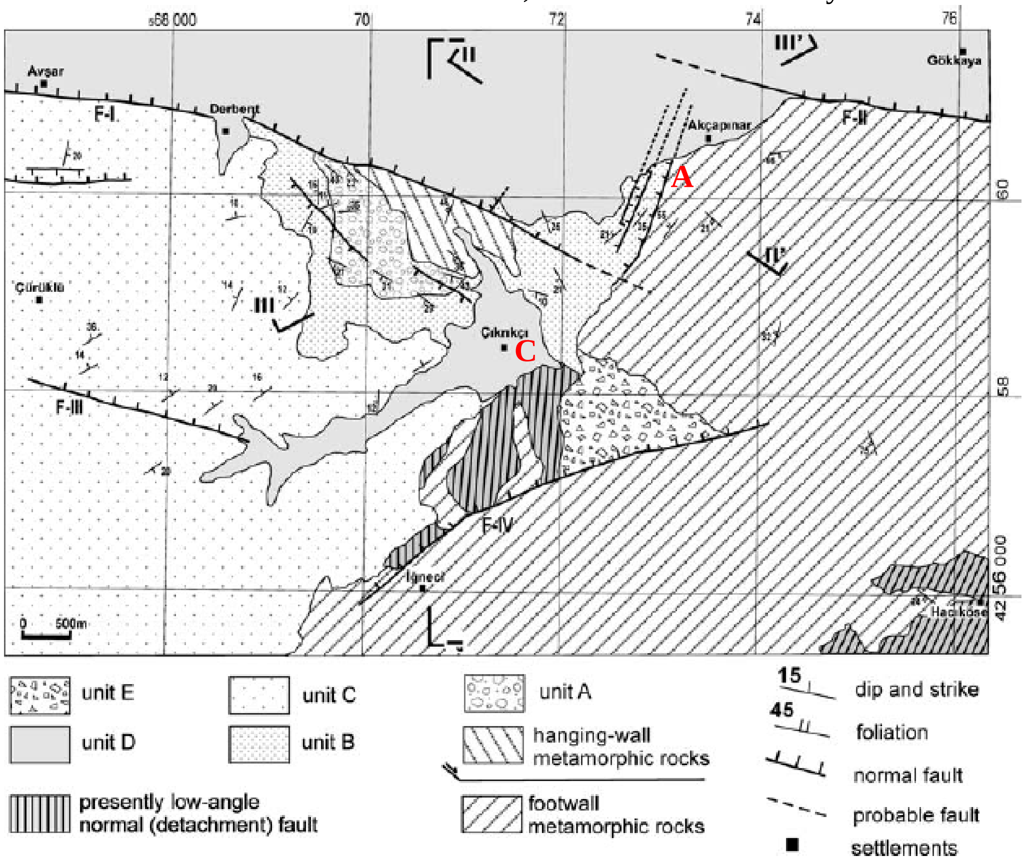


Figure 5. Geological map of the study area (Map grid is UTM, Zone 35). The low-angle normal fault is illustrated as an area representing the exposed slickensided surface of the fault (lines are parallel to slickenlines). Major high-angle normal faults are labelled on the map as F-I, F-II, F-III and F-IV. Five different lithostratigraphic units comprising continental clastics overlie the metamorphic rocks of the Menderes Massif. The Akçapınar relay ramp is located between the overlapping segments of F-I and F-II.

Akcapinar RR

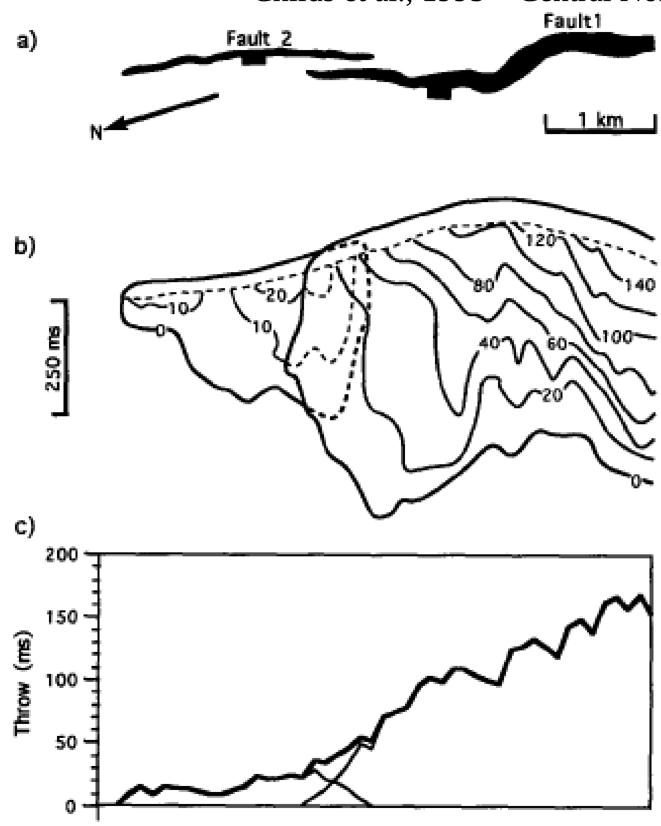
OL=938m
L=938m
Wmax=2375m
S=2375m
Lt=10375m
L1=6938m
L2=3563m
Wmin=2313m
Tilt=25°

Cikrikci RR

OL=2938m
L=2938m
Wmax=4500m
S=4500m
Lt=8000m
L1=6938m
L2=4625m
Wmin=1688m

Thickness = 17000m

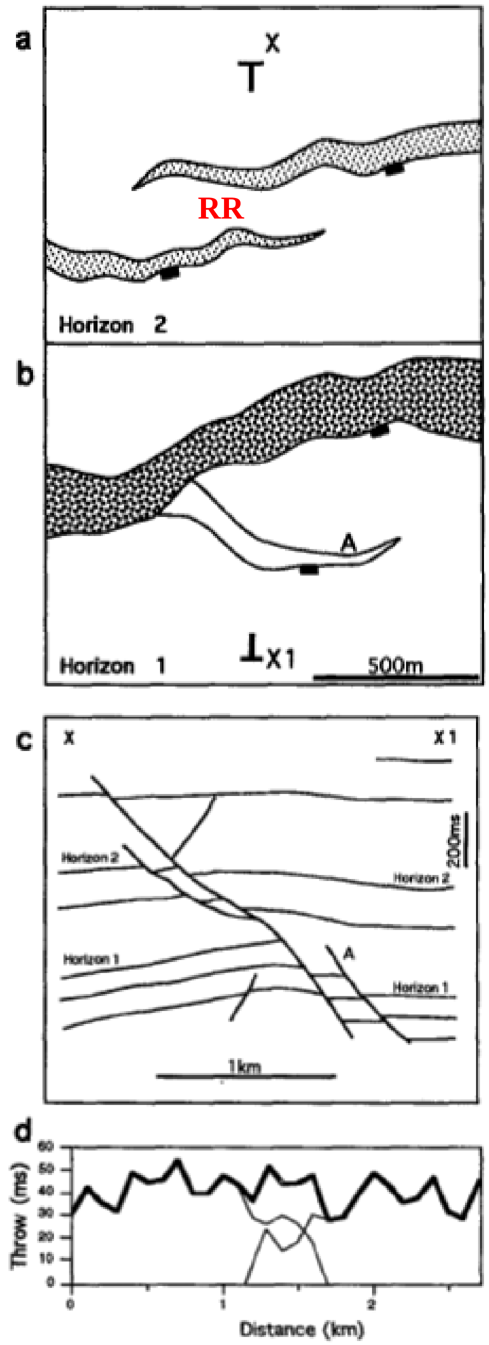
Childs et al., 1995 – Central North Sea



RR
OL=636m
L=1758m
Wmax=242m
S=333m
Lt=5030m
L1=3455m
L2=2394m
Wmin=182m
Thickness = 13000m

Fig. 3. (**a**) Map showing the traces of two synthetic overlapping faults from the Central North Sea; the faults are unconnected in 3D. The map is derived from a seismic survey with shotlines oriented perpendicular to the fault traces and spaced every 100 m.
(**b**) Vertically exaggerated (×5) throw strike-projection of the two faults mapped in (a). The throw contours (ms), are derived from *c.* 200 datapoints: note that the contour interval is different for the two faults and that contours on the smaller fault are shown by broken lines where this fault lies behind the larger fault. The sub-horizontal light broken line shows the trace on the fault surfaces of the horizon mapped in (a). Heavy lines indicate the fault tip-lines; the tip-line of the smaller fault is shown as a broken line where it lies behind the larger fault. (**c**) Throw versus distance profiles for the two faults shown in (a). Throws are measured on the horizon which is mapped in (a) and indicated by the broken line in (b). The bold line shows the aggregate throw for the two faults.

Childs et al., 1995 –
Northern North Sea



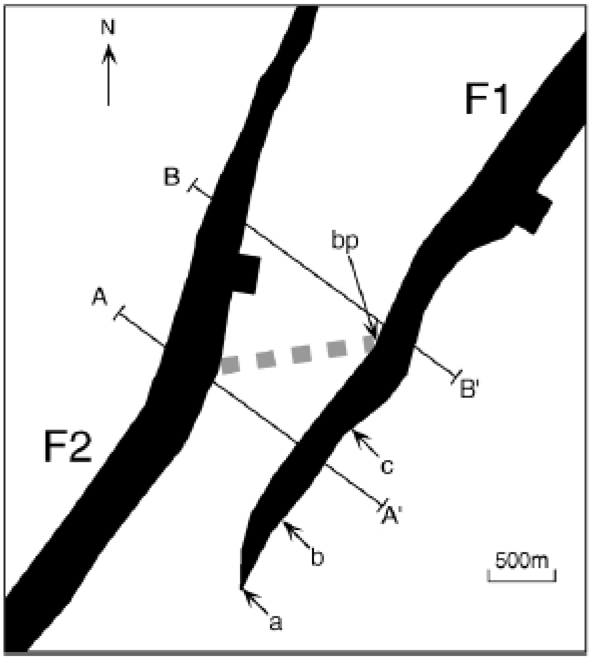
RR
OL=591m
L=845m
Wmax=273m
S=318m
Lt=1318m
L1=882m
L2=1100m
Wmin=236m

Upper Ramp
Breach at depth

Thickness =
13000m

Fig. 5. (**a**) and (**b**) Two map views of the same fault array from the Northern North Sea. Horizon 2 is within the syn-rift sequence and Horizon 1 is at the top of the pre-rift sequence. Overlapping normal faults on Horizon 2 link at depth along a horizontal branch-line and connect to the large fault on Horizon 1 (stippled). Fault A on Horizon 1 does not intersect Horizon 2. The maps are constructed from seismic shotlines spaced every 100 m and oriented parallel to the line of section X–X1. (**c**) On a cross-section (X–X1) through the fault array shown in (a) and (b), the branch-line between the two overlapping faults on Horizon 2 is seen as a branch-point, near to the centre of the cross-section. (**d**) Throw profiles of the two overlapping faults on Horizon 2 shown in (a). The bold line is the aggregate throw for the two faults.

Childs et al., 2003 – Inner Moray Firth



RR
OL=4125m
L=4125m
Wmax=1688m
S=1688m
Lt=6250m
L1=4375m
L2=5250m
Wmin=1000m
Thickness=13000m
Connecting Fault Breach at depth

Fig. 12. Map (on Horizon a; Figs. 13 and 14) of overlapping faults bounding a relay zone. The successive locations of the tip-line of F1 at the time of deposition of Horizons a–c are indicated. The approximate location of a relay breaching fault, which offsets only Horizons b and c, is indicated by the heavy broken line. The branchpoint between F1 and the breaching fault is shown (bp). Locations of cross-sections A–A′ and B–B′ (Fig. 13) are indicated.

Dawers and Anders, 1995 – Eastern California, Volcanic Tablelands

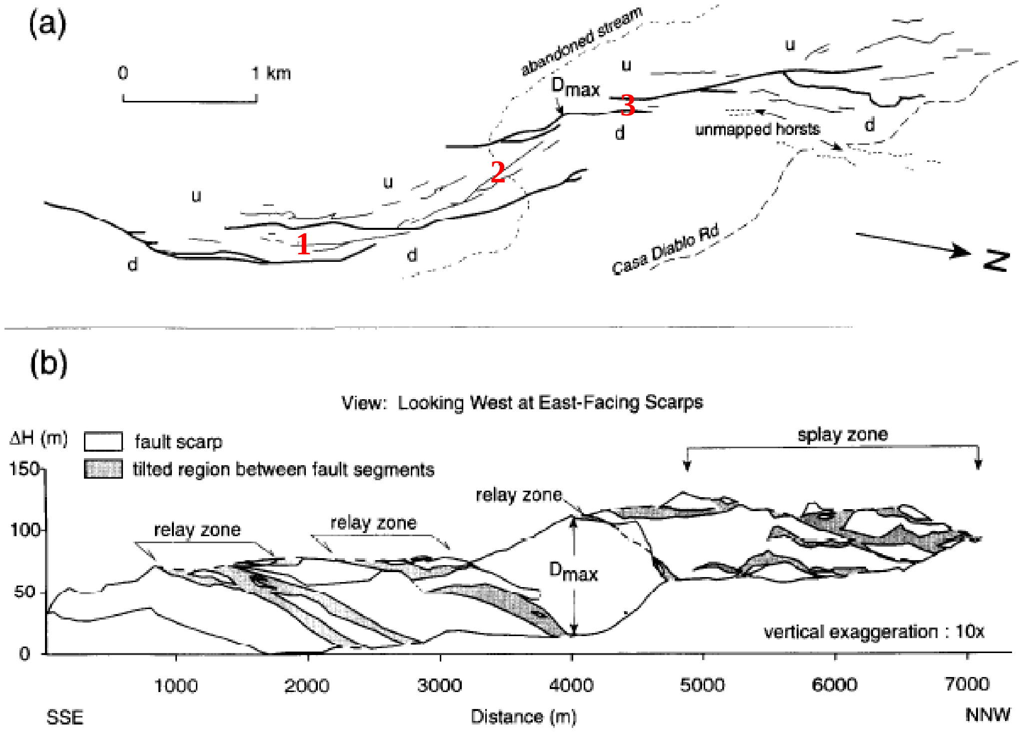


Fig. 4. (a) Map view of the mapped fault segments. (b) Elevation change along the strike of the fault zone; the view is looking toward the scarps from the hangingwall. The shaded regions represent tilting of the upper surface of the tuff toward the hangingwall. Note that smaller faults are concentrated at the overlapping regions of the four large throw segments and in the splay zone at the northern fault tip.

1	2	3
OL=1136m	OL=1000m	OL=318m
L=1136m	L=1000m	L=318m
Wmax=273m	Wmax=500m	Wmax=91m
S=273m	S=500m	S=91m
Lt=4045m	Lt=3318m	Lt=3318m
L1=2682m	L1=2773m	L1=1591m
L2=2773m	L2=1591m	L2=2045m
Wmin=91m	Wmin=409m	Wmin=91m
DmaxF1=41m	DmaxF1=58m	DmaxF1=90m
DmaxF2=58m	DmaxF2=90m	DmaxF2=60m

Thickness = 150m

Fossen et al., 2005 – Northern North Sea, Gulfaks Sor Field

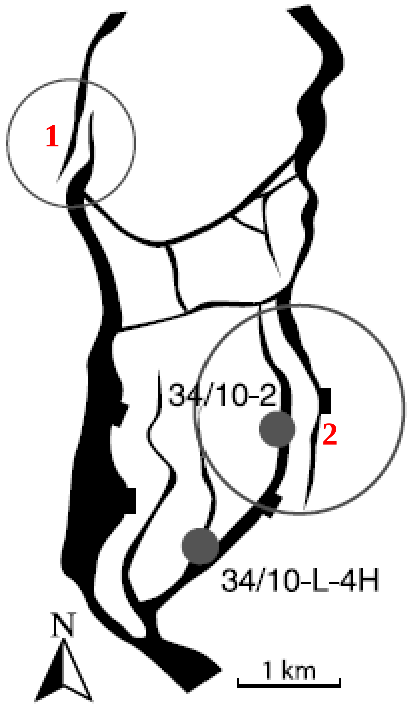


Figure 16. Map of an internal part of the Gullfaks Sør field in the northern North Sea. Two areas mapped as fault overlap structures (areas of double-tip interaction) are circled. One is penetrated by a well (34/10-2), which indicates multiple subseismic faults and numerous deformation bands. The map is based on Barstad (2003).

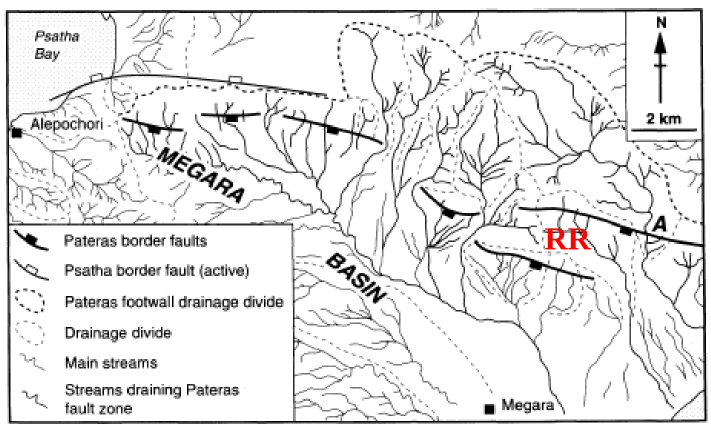
1
OL=750m
L=875m
Wmax=250m
S=188m
Lt=6625m
L1=6313m
L2=1813m
Wmin=188m

2
OL=1938m
L=1938m
Wmax=313m
S=250m
Lt=6750m
L1=5000m
L2=3375m
Wmin=250m

Thickness = 13000m

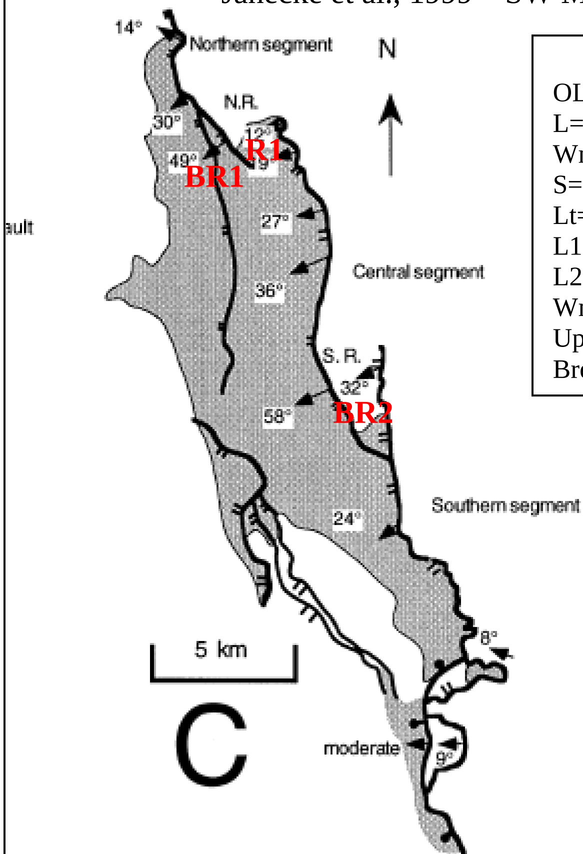
Gawthorpe and Hurst, 1993 – Central Greece, Gulf of Corinth, Pateras Fault Zone

Fig. 16. Drainage and structure map of the Pateras fault zone, east end of the Gulf of Corinth, central Greece. Note that all the major streams draining the footwall upland enter the Megara Basin through intrabasin transfer zones separating the fault segments. In contrast, the large drainage system (A) at the eastern end of the fault zone has cut a large gorge through the footwall and its location is not controlled by transfer zones.



RR
OL=2909m
L=2909
Wmax=1818m
S=1818m
Lt=7091m
L1=6000m
L2=3818m
Wmin=1636m
Thickness = 10000m

Janecke et al., 1999 – SW Montana, Muddy Creek



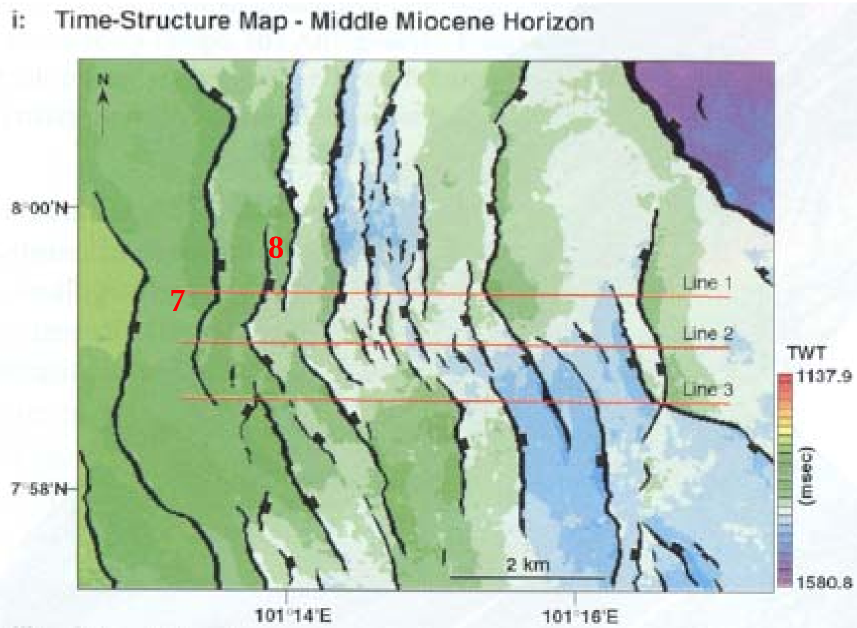
BR1
OL=2333m
L=2333m
Wmax=1333m
S=1333m
Lt=13667m
L1=7000m
L2=12667m
Wmin=0m
Upper Ramp Breach

BR2
OL=4000m
L=4000m
Wmax=2333m
S=2333m
Lt=21333m
L1=14333m
L2=14667m
Wmin=0m
Upper Ramp Breach

R1
OL=1000m
L=1000m
Wmax=2000m
S=2000m
Lt=18000m
L1=14333m
L2=7000m
Wmin=1666m

Thickness = 2000m

McClay et al., 2004 – Gulf of Thailand, Patanni Basin



7	8	Thickness = 12000m
OL=2857m	OL=1071m	
L=3143m	L=1071m	
Wmax=1429m	Wmax=286m	
S=1000m	S=286m	
Lt=6857m	Lt=4286m	
L1=5714m	L1=2571m	
L2=5000m	L2=3429m	
Wmin=857m	Wmin=286m	

McClay et al., 2004 – Southern North Sea, Jupiter Fields

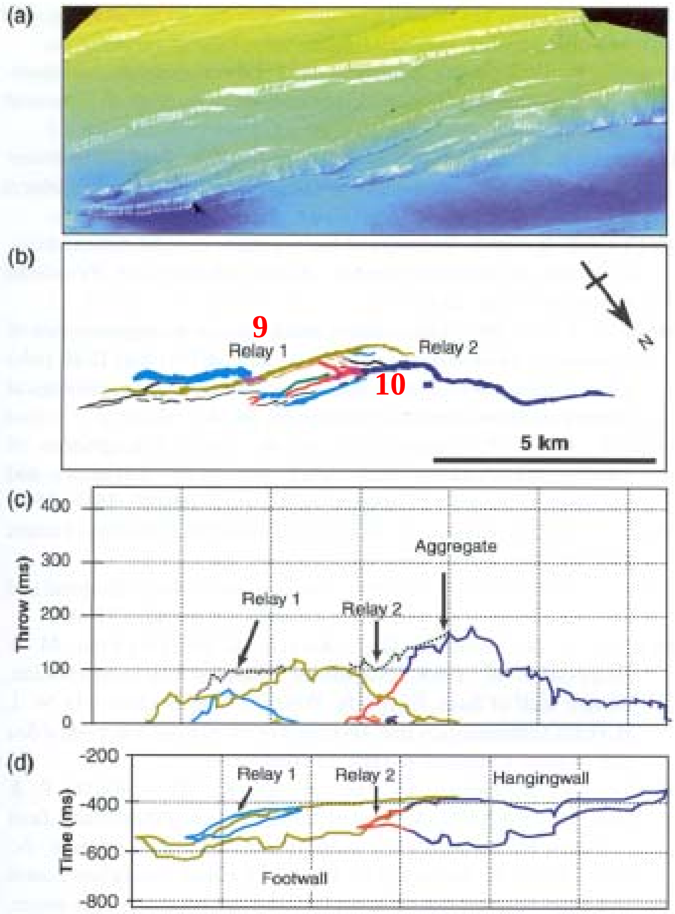


Fig. 14. Example of segmented extensional fault system at the Base Tertiary horizon, Jupiter Fields, Southern North Sea. (**a**) 3D oblique visualisation of offset extensional fault system. (**b**) Map pattern of north-dipping extensional faults shown in (**a**) above. Two prominent relay systems 1 and 2 are developed between overlapping fault segments. (**c**) Fault length–displacement diagram for the fault map shown in (**b**) above. Faults are colour coded as in the map. Note the displacement minima at the relay ramps. (**d**) Along-strike hangingwall–footwall map (in the fault plane) showing the elliptical fault displacement patterns (Base Tertiary horizon) for individual fault segments.

9
OL=2500m
L=2500m
Wmax=385m
S=385m
Lt=7115m
L1=7115m
L2=2500m
Wmin=0m
Upper Ramp Breach

10
OL=1154m
L=1154m
Wmax=577m
S=577m
Lt=11538m
L1=7115m
L2=5962m
Wmin=192m
Connecting Fault Breach

Thickness = 13000m

McLeod et al., 2000 – Northern North Sea, Strathspey-Brent-Statfjord

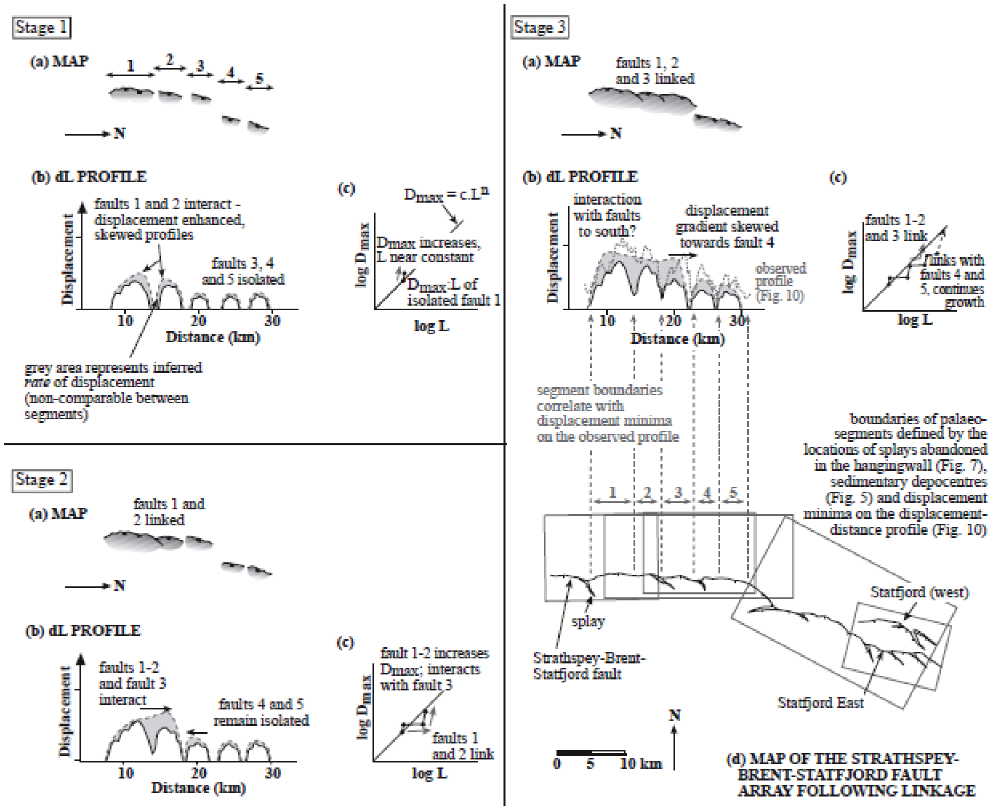


Fig. 15. Schematic model of the growth of the SBS fault system. Based on the observations from the displacement–distance profile between 10 and 30 km along-strike (Fig. 10a). In each stage (a) is a plan view of the fault system with depocentres shaded in grey, (b) is a schematic displacement–distance profile and (c) is a plot of D_{max} against L for the evolving fault 1. See text for further explanation.

1&2	**2&3**	**3&4**
OL=1429m	OL=2857m	OL=1429m
L=1429m	L=2857m	L=1429m
Wmax=714m	Wmax=1429m	Wmax=1429m
S=714m	S=1429m	S=1429m
Lt=10714m	Lt=9286m	Lt=7857m
L1=5714m	L1=3571m	L1=5000m
L2=3571m	L2=5000m	L2=3571m
Wmin=0m	Wmin=0m	Wmin=0m
Upper Ramp Breach	Upper Ramp Breach	Upper Ramp Breach

Thickness =
13000m

Resor, 2008 – Grand Canyon, Parashant Canyon

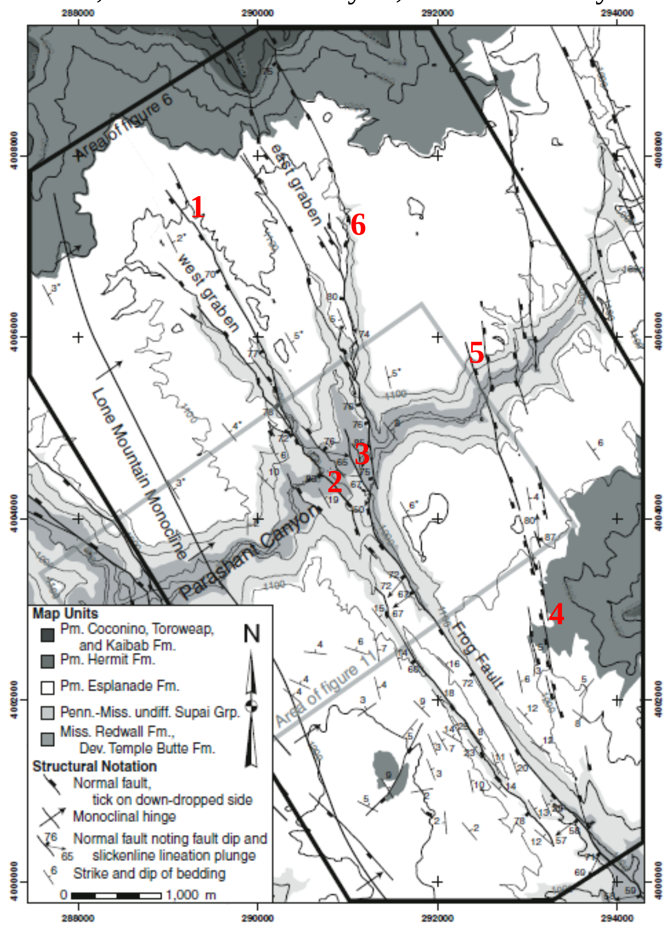


Figure 2. Geologic and structural map of study area. Formation contacts modified from Huntoon and Billingsley (1981). Faults from this study. Bedding attitudes with asterisks (*) are from Huntoon and Billingsley (1981); all others are new data. Bold black outline is boundary of area of surface model presented in Figure 6. Bold gray box shows area of Figure 11. Coordinate system: Universal Transverse Mercator (UTM) zone 12 N, World Geodetic System (WGS) 1984 datum. Grid unit: meters. Pm—Permian; Penn—Pennsylvanian; Miss—Mississippian; Dev—Devonian.

1
OL=238m
L=238m
Wmax=143m
S=143m
Lt=4476m
L1=4333m
L2=476m
Wmin=95m

2
OL=1095m
L=1095m
Wmax=476m
S=476m
Lt=8286m
L1=4333m
L2=5000m
Wmin=190m

3
OL=667m
L=762m
Wmax=238m
S=143m
Lt=6952m
L1=5000m
L2=1857m
Wmin=95m

4
OL=119m
L=119m
Wmax=48m
S=48m
Lt=1190m
L1=667m
L2=619m
Wmin=48m

5
OL=524m
L=524m
Wmax=190m
S=190m
Lt=2048m
L1=1905m
L2=762m
Wmin=95m

6
OL=95m
L=595m
Wmax=95m
S=95m
Lt=3905m
L1=1762m
L2=2286m
Wmin=71m

Thickness = 15000m

Walsh et al., 1999 – Timor Sea

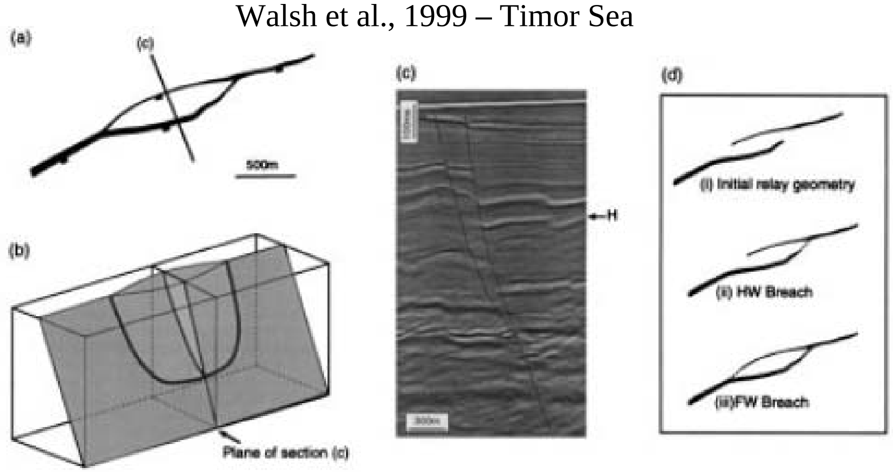
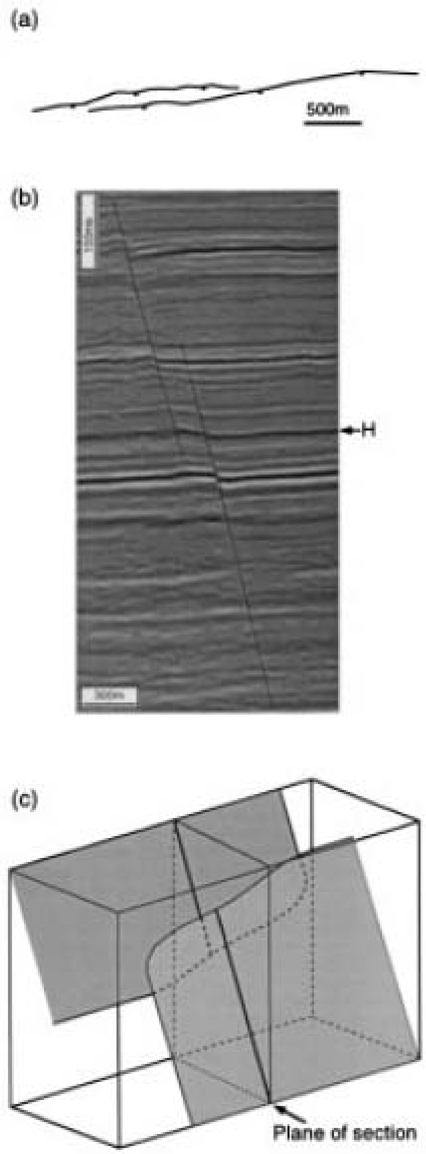


Fig. 3. (a) Fault polygons on horizon H [arrowed in (c)], with ticks on downthrown sides, enclosing a hostrock lens. Axes of the neutral fault bends are parallel to the normal fault slip direction. (b) U-shaped branch-line (heavy line) bounding the lens in (a), or incomplete horse, which terminates upwards at the sea floor (c). The location of the seismic section (c) is indicated. The branch-line is defined by data points (branch-points) on 42 seismic sections spaced at 25 m. (c) Seismic section [as located in (a) and (b)] showing interpreted fault traces and branch-point. Note the bed rotation within the relay, locally accommodating a small proportion of the aggregate throw across the structure. Vertical to horizontal scale is approximately 2.1:1 (1 ms = ca 1.25 m). (d) Interpreted growth sequence on horizon H for the breached relay, based on throw back-stripping of comparable structures (Childs et al., 1993, 1995). (i) Initial relay structure; (ii) breaching by both footwall and hanging wall faults; (iii) further growth by slip mainly or exclusively on the hanging wall fault with the re-joining splay inactive. Seismic from the Timor Sea.

3
OL=1432m
L=1432m
Wmax=318m
S=318m
Lt=3114m
L1=2341m
L2=2250m
Wmin=0m
Double Breach

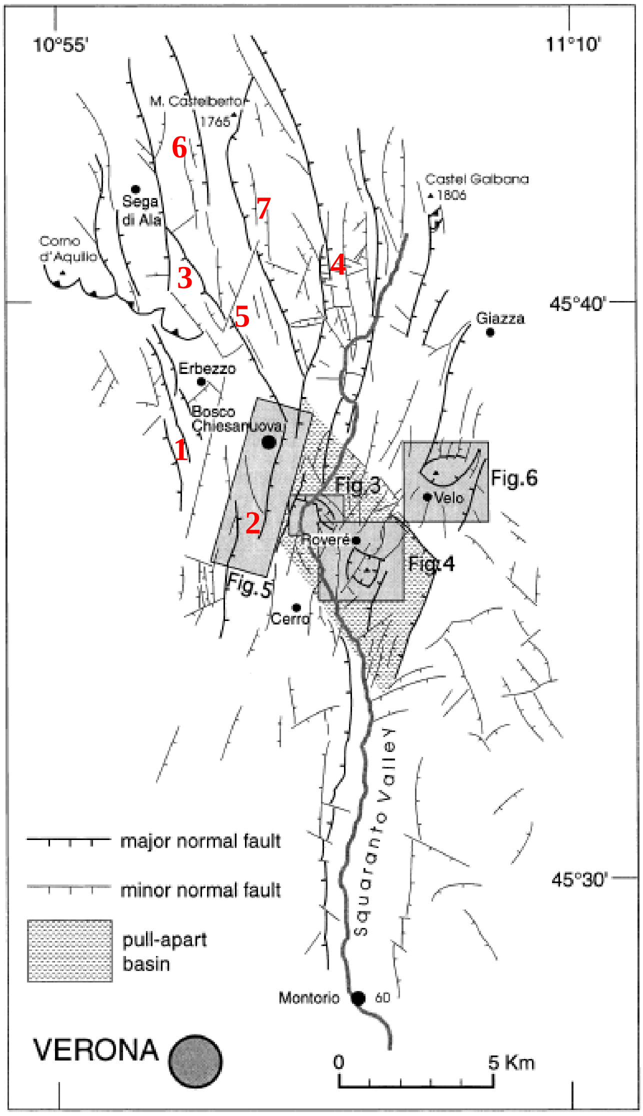
Walsh et al., 1999 – Timor Sea



5
OL=1309m
L=1333m
Wmax=143m
S=71m
Lt=3381m
L1=1833m
L2=2881m
Wmin=48

Fig. 5. (a) Fault polygons on a map of horizon H [arrowed in (b)] showing the long length of overlap relative to the separation distance, which would not be expected on a neutral relay. (b) Seismic section showing interpreted traces of overlapping normal faults forming an unbreached contractional relay. Note the increased bed dips within the relay which accommodate a simple shear and accounts for a high proportion of the total fault offset. The apparent offset of the strong reflection immediately below the lower tip-point of the footwall fault, is believed to be an artefact due to distortion of the seismic signal. (c) Block diagram of the relay shown in (a) and (b) with tip-lines bounding the fault surfaces (shaded); the plane of section in (b) is indicated. The tip-lines are mapped on 58 lines spaced at 25 m. Seismic from the Timor Sea.

Zampieri, 2000 – Verona Italy



1
OL=1481m
L=1481m
Wmax=463m
S=463m
Lt=5741m
L1=2963m
L2=4259m
Wmin=370m

2
OL=1111m
L=1111m
Wmax=926m
S=926m
Lt=7222m
L1=4444m
L2=3889m
Wmin=741m

3
OL=2037m
L=2037m
Wmax=1111m
S=1111m
Lt=9074m
L1=3519m
L2=7593m
Wmin=0m
Upper Ramp Breach

Fig. 2. Structural map of the study area showing the complex array of Paleogene normal faults. Some faults were reactivated as strike-slip faults during the Neogene, when the Corno d'Aquilio inversion structure (NW corner of map) developed.

Thickness = 8800m

4
OL=1111m
L=1111m
Wmax=370m
S=370m
Lt=13333m
L1=6667m
L2=8333m
Wmin=0m
Upper Ramp Breach

5
OL=93m
L=93m
Wmax=185m
S=185m
Lt=7407m
L1=3889m
L2=3519m
Wmin=185m

6
OL=556m
L=556m
Wmax=370m
S=370m
Lt=2963m
L1=1019m
L2=2407m
Wmin=370m

7
OL=556m
L=556m
Wmax=370m
S=370m
Lt=3148m
L1=2037m
L2=1667m
Wmin=370m

Detached/Mobile Substrate Faults

Fossen et al., 2005 – SE Utah, Moab Fault

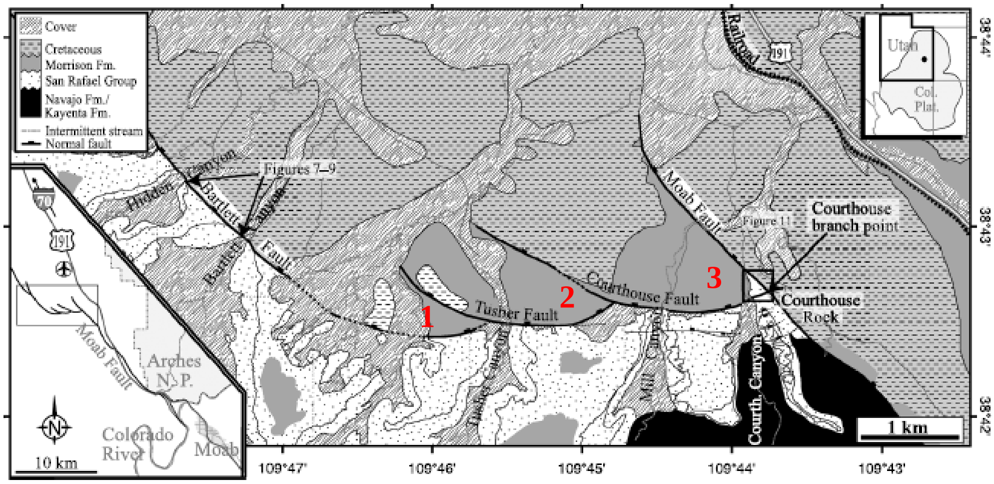
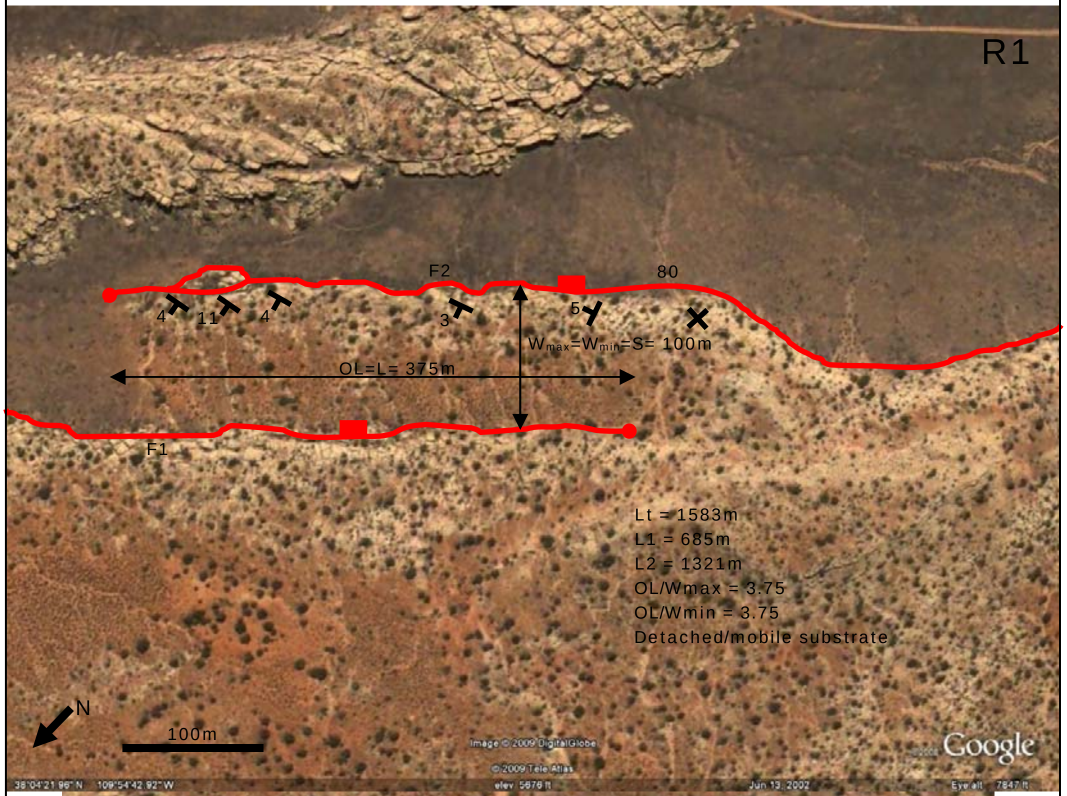
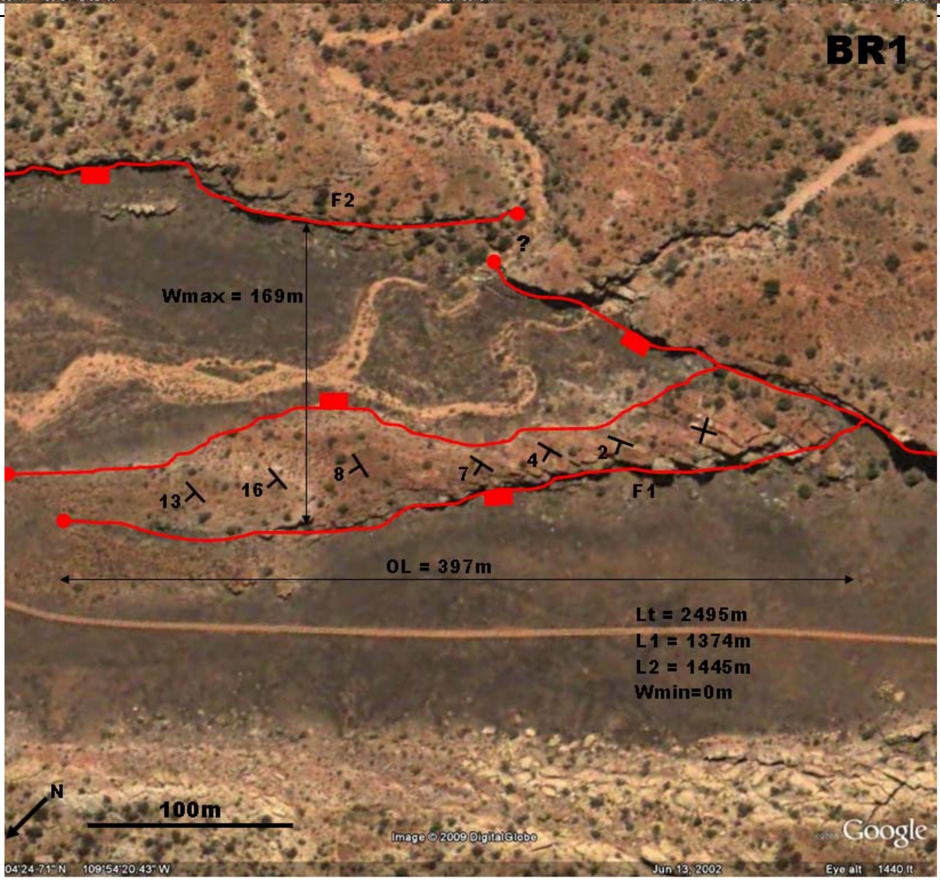


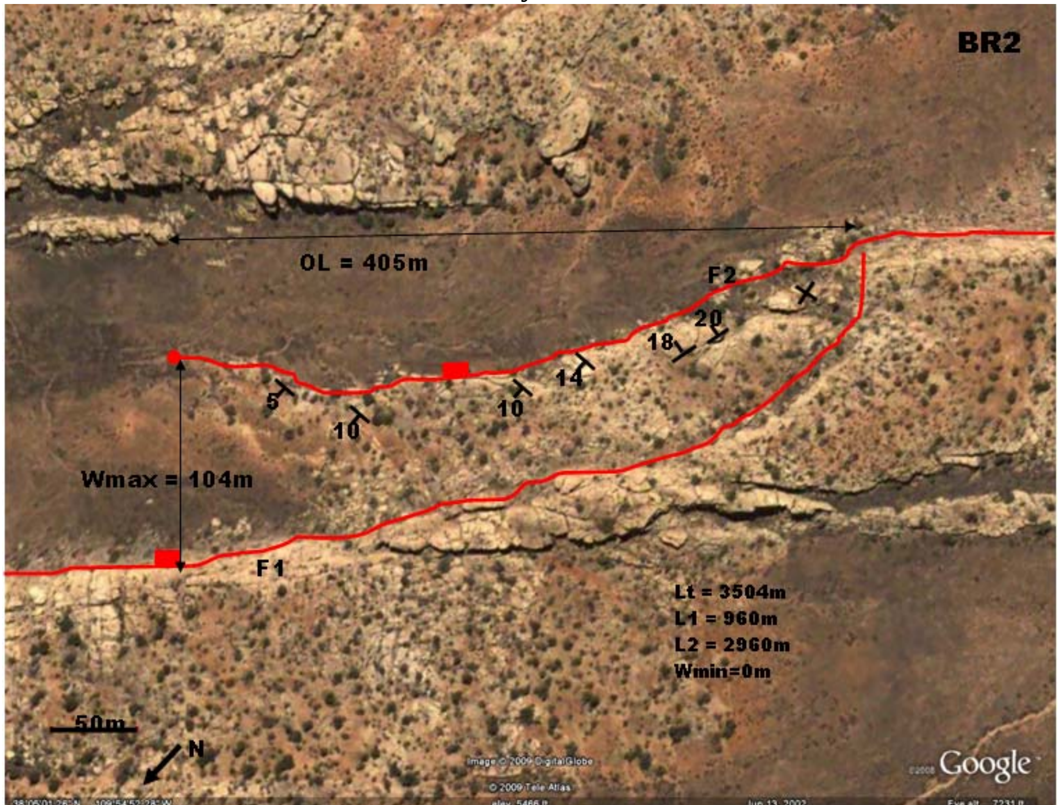
Figure 6. Geologic map of the northern part of the Moab fault. Several fault branch points that we interpret as areas of single-tip interaction are seen. Based on Doelling (2001) and own mapping.

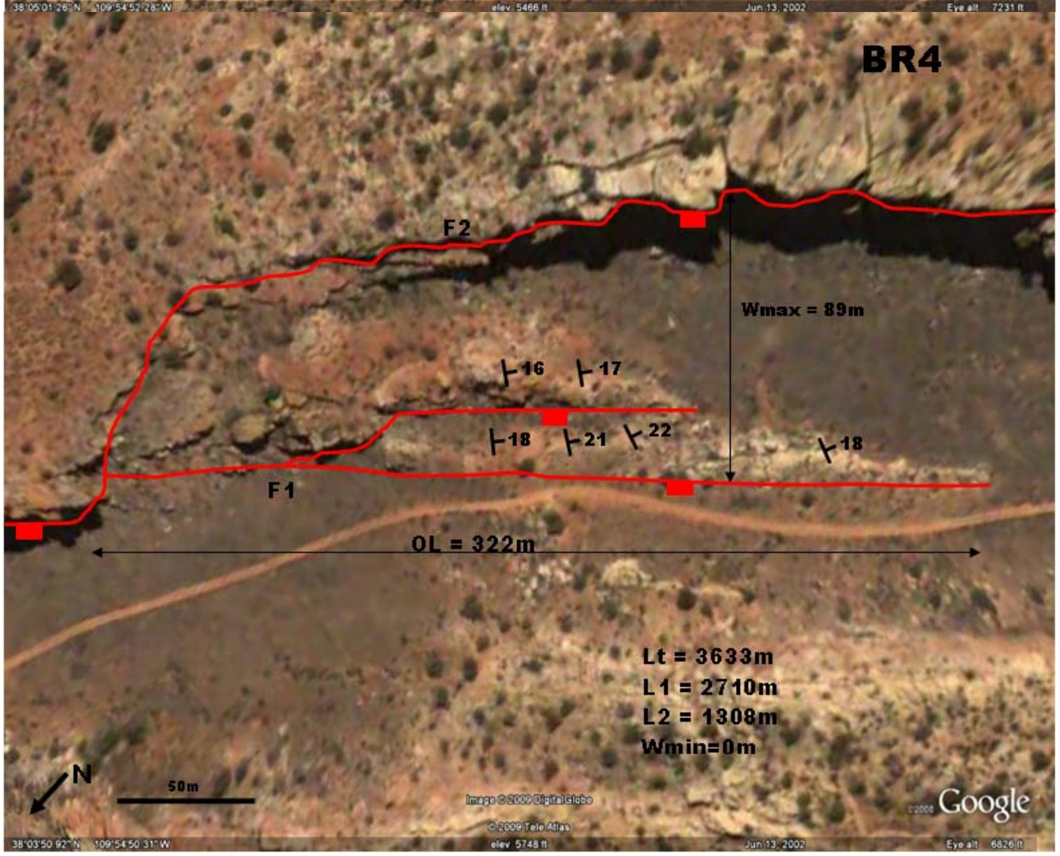
1	2	3	Thickness = 2000m
OL=1000m	OL=1588m	OL=1882m	
L=1000m	L=1588m	L=1882m	
Wmax=647m	Wmax=824m	Wmax=1765m	
S=647m	S=824m	S=1765m	
Lt=5412m	Lt=3765m	Lt=4588m	
L1=4470m	L1=2529m	L1=3235m	
L2=2529m	L2=3235m	L2=4176m	
Wmin=0m	Wmin=0m	Wmin=0m	
Upper Ramp Breach	Upper Ramp Breach	Upper Ramp Breach	

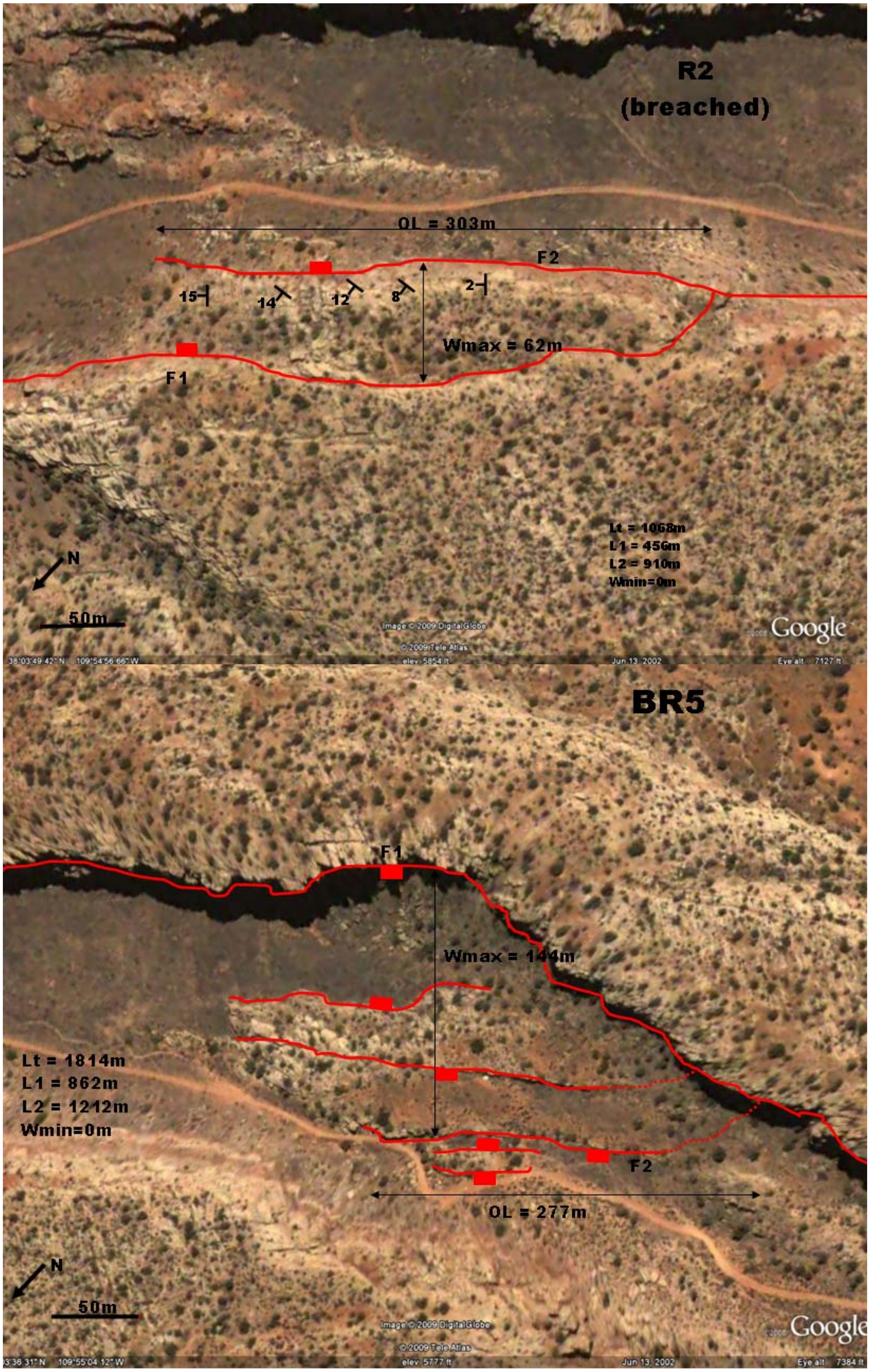
Huenink – Canyonlands, Utah



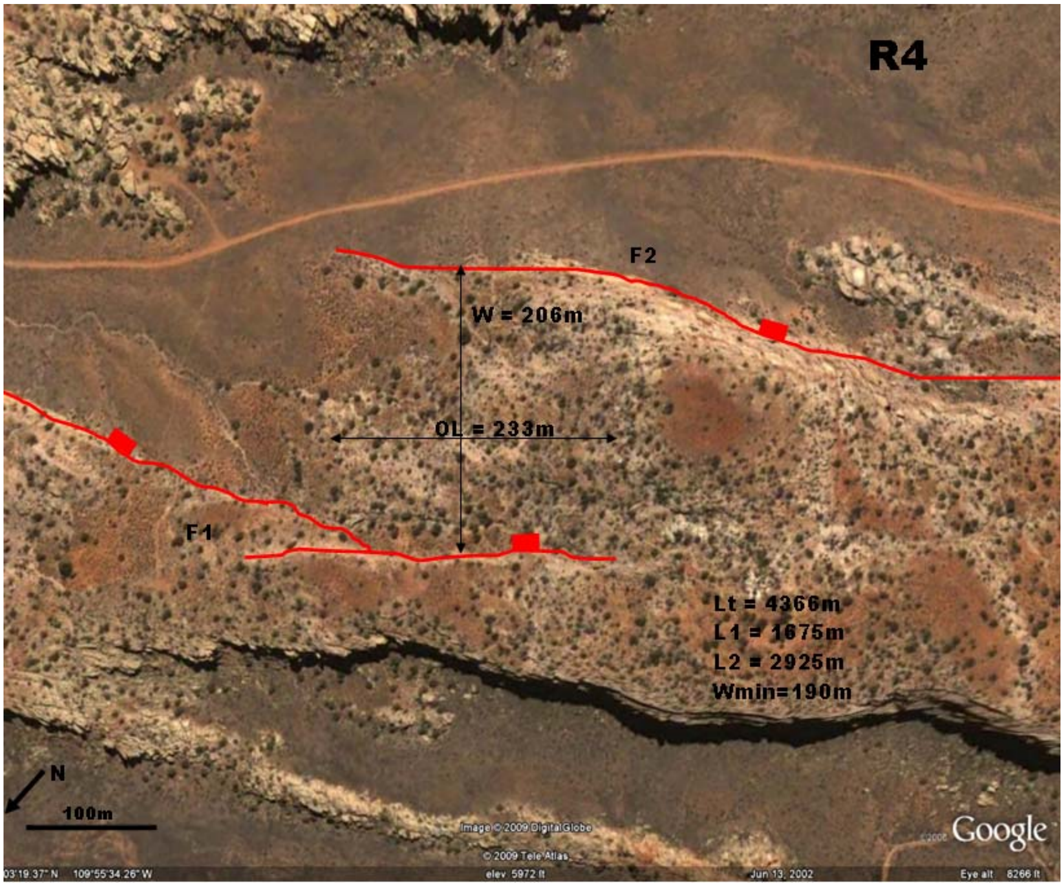



BR2
OL = 405m
F2
20
18
14
10
5
10
Wmax = 104m
F1
Lt = 3504m
L1 = 960m
L2 = 2960m
Wmin=0m
50m
N
Google


BR4
F2
Wmax = 89m
16
17
18
21
22
18
F1
OL = 322m
Lt = 3633m
L1 = 2710m
L2 = 1308m
Wmin=0m
N
50m
Google


R2
(breached)
OL = 303m
F2
15
14
12
8
2
Wmax = 62m
F1
Lt = 1068m
L1 = 456m
L2 = 910m
Wmin=0m
N
50m
BR5
F1
Wmax = 144m
Lt = 1814m
L1 = 862m
L2 = 1212m
Wmin=0m
F2
OL = 277m
N
50m

Huenink – Canyonlands, Utah



Peacock and Parfitt, 2002 – Big Island, Hawaii, Kilauea Volcano

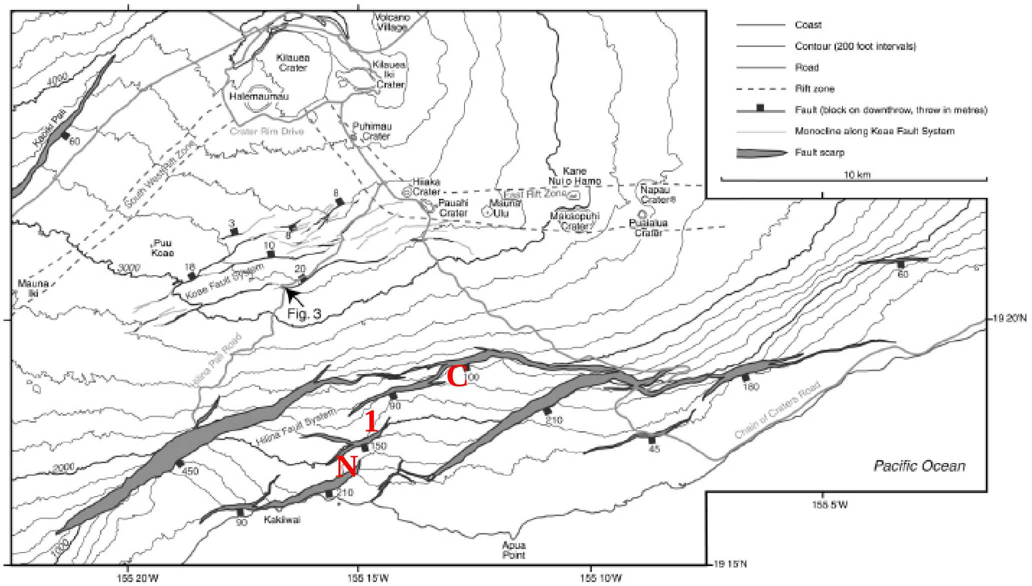


Fig. 2. Map of the southeast part of the Big Island, Hawaii, showing the location of Kilauea Volcano, its rift zones, and its fault systems. This map is based on the USGS 1:24,000 scale maps and photo-quadrangles.

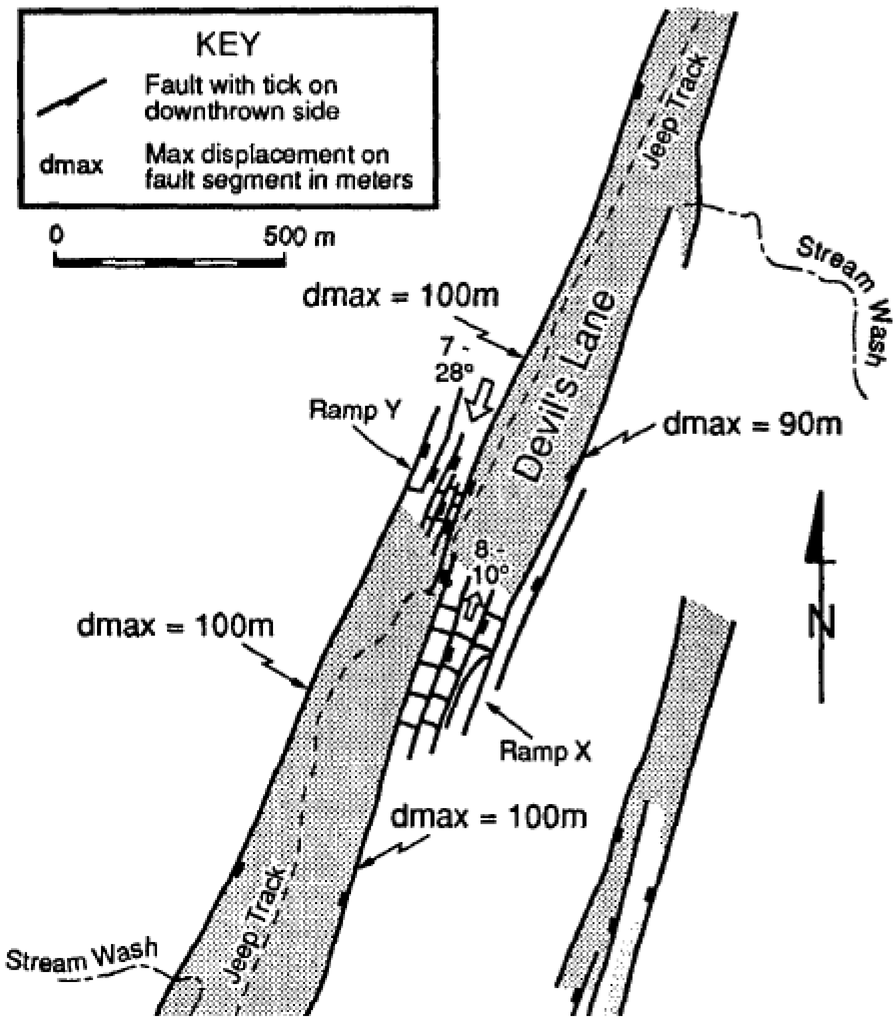
N
OL=1231m
L=1231m
Wmax=769m
S=769m
Lt=8308m
L1=6615m
L2=3077m
Wmin=615m
DmaxF1=210m
DmaxF2=150m

C
OL=1692m
L=1692m
Wmax=615m
S=615m
Lt=10461m
L1=4000m
L2=8308m
Wmin=615m
DmaxF1=90m
DmaxF2=100m
Connecting Fault Breach

1
OL=1385m
L=1385m
Wmax=1230m
S=1230m
Lt=5231m
L1=3538m
L2=3385m
Wmin=769m
DmaxF1=150m
DmaxF2=90m

Thickness = 9000m

Trudgill and Cartwright, 1994 – Canyonlands, UT, SOB Hill



X	Y	Thickness = 500m
OL=350m	OL=363m	
L=350m	L=363m	
Wmax=150m	Wmax=138m	
S=150m	S=138m	
Lt=1825m	Lt=2350m	
L1=1013m	L1=1388m	
L2=1175m	L2=1313m	
Wmin=138m	Wmin=113m	
DmaxF1=100m	DmaxF1=100m	
DmaxF2=90m	DmaxF2=100m	
Tilt=10°	Tilt=28°	

Trudgill and Cartwright, 1994 – Canyonlands, UT, Twin Valleys

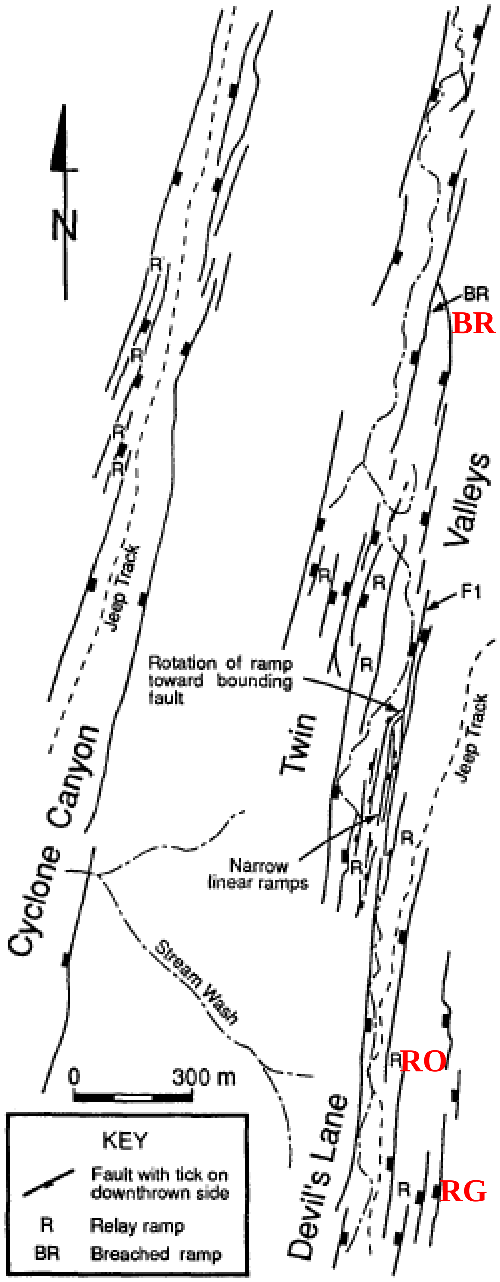


Figure 5. A simplified structural map of the Twin Valleys region (northern Devil's Lane). Three major overlapping graben segments are present, linked by a series of normal faults and associated relay ramps.

BR
OL=338m
L=338m
Wmax=75m
S=75m
Lt=700m
L1=700m
L2=375m
Wmin=0m
Upper Ramp Breach

RO
OL=75m
L=75m
Wmax=50m
S=50m
Lt=963m
L1=575m
L2=450m
Wmin=38m

RG
OL=88m
L=88m
Wmax=50m
S=50m
Lt=538m
L1=450m
L2=175m
Wmin=50m

Thickness = 500m

Bedding/Layer Confined Faults

Barnett et al., 1987 – Cumbria, England

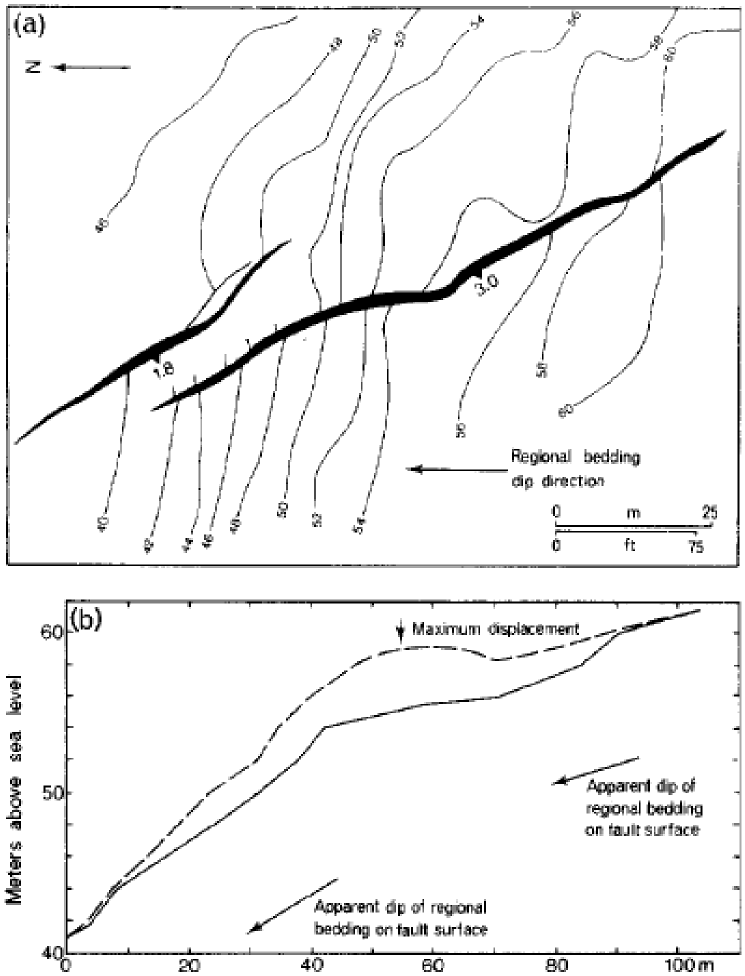


Figure 12—(a) Structural contours on worked coal seam, Outgang opencast site, Cumbria, England. Contours in meters above sea level. Asymmetric contour patterns on either side of fault [maximum vertical displacement, 9.8 ft (3 m)] result from reverse drag of bedding that had a pre-faulting strike oblique to that of fault. (b) Stratigraphic separation diagram for same fault. Dashed curve = footwall, solid curve = hanging wall.

RR

OL=34m
L=34m
Wmax=13m
S=13m
Lt=122m
L1=55m
L2=103m
Wmin=8m
DmaxF1=1.8m
DmaxF2=3m

Fossen et al., 2005 – Goblin Valley State Park, Utah, Buckskin Sping

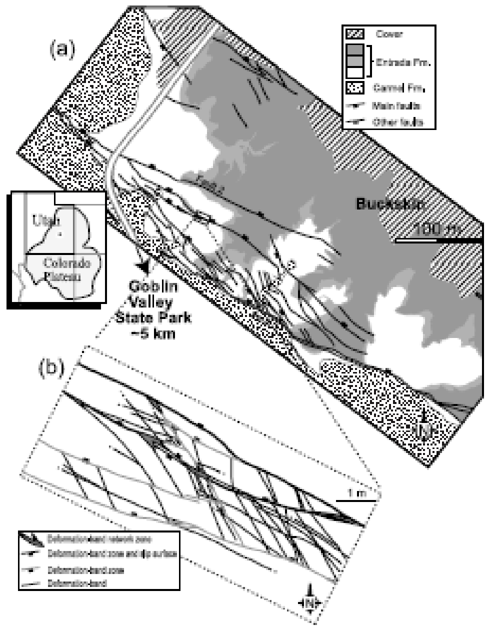


Figure 14. Relay structure at Buckskin Spring near Goblin Valley. Oblique deformation bands in the wide overlap damage zone are present.

RR

OL=157m
L=157m
Wmax=107m
S=107m
Lt=579m
L1=393m
L2=350m
Wmin=79

Huggins et al., 1995

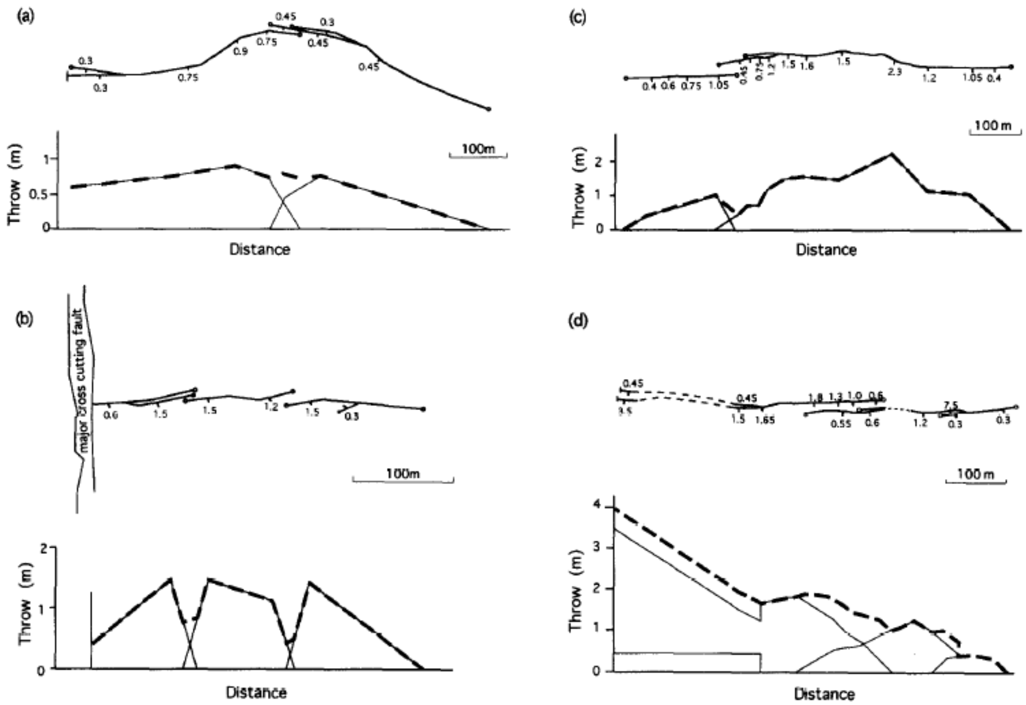


Fig. 2. Fault trace geometries and corresponding throw profiles for four segmented faults. Recorded throw values (m), fault throw directions (tick on downthrown side), fault trace tip-points (open circles), and ends of data (vertical bars) are shown. Throw profiles show individual trace profiles (thin solid lines) and aggregate throw profiles (thick broken lines). (a) Silkstone seam, Rockingham Colliery, South Yorkshire; (b) Parkgate seam, Denaby Main Colliery, South Yorkshire; (c) 1st Waterloo seam, Glapwell Colliery, Derbyshire—note that throw readings on the footwall splay were not recorded; (d) 2nd Waterloo seam, Silverwood Colliery, South Yorkshire.

Rockingham Colliery
OL=55m
L=120m
Wmax=15m
S=25m
Lt=715m
L1=405m
L2=415m
Wmin=5m
DmaxF1=0.95m
DmaxF2=0.75m

Glapwell Colliery
OL=40m
L=65m
Wmax=25m
S=35m
Lt=735m
L1=220m
L2=575m
Wmin=20m
DmaxF1=1m
DmaxF2=2.4m

Denaby Main 2-3B
OL=11m
L=11m
Wmax=5m
S=5m
Lt=200m
L1=111m
L2=103m
Wmin=5m
DmaxF1=1.5m
DmaxF2=1.5m

Denaby Main 2-3A
OL=13m
L=13m
Wmax=13m
S=13m
Lt=200m
L1=111m
L2=108m
Wmin=11m
DmaxF1=1.5m
DmaxF2=1.5m

Denaby Main 1-2
OL=11m
L=61m
Wmax=13m
S=3m
Lt=239m
L1=139m
L2=111m
Wmin=11m
DmaxF1=1.5m
DmaxF2=1.5m

Silverwood Colliery
OL=129m
L=129m
Wmax=17m
S=17m
Lt=650m
L1=433m
L2=350m
Wmin=12.5m
DmaxF1=1.5m
DmaxF2=1.5m

Huggins et al., 1995 Northumberland, Daisyhill Coal Site

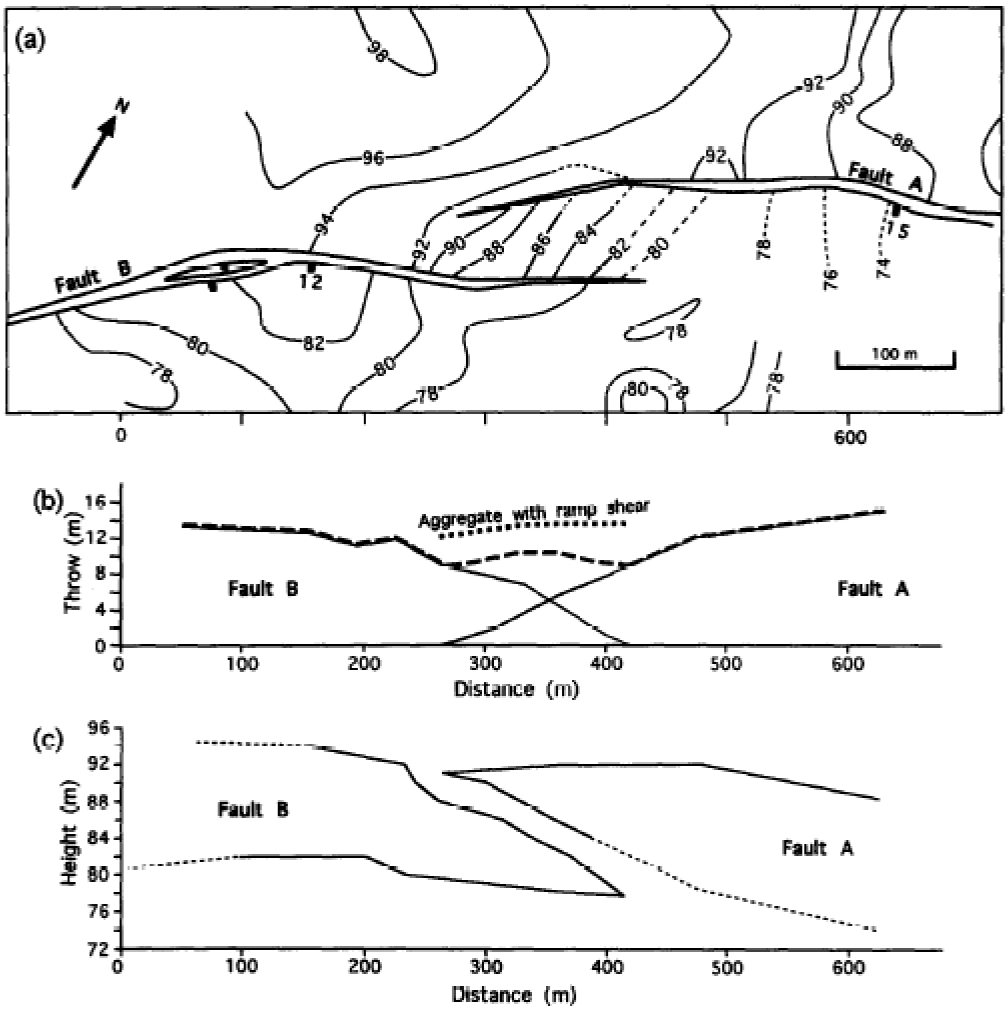


Fig. 6. Relay ramp at Daisyhill open-cast coal site, Northumberland. (a) Map of fault segments A and B on the Main Seam, from the British Coal Exploration Geological Plan, showing recorded fault throw values (m), throw directions (ticks on downthrown sides) and seam elevation contours in m, broken contours are poorly constrained; (b) throw profiles of fault segments A and B (solid line) in the region of the relay zone, aggregate fault throw (broken line) and aggregate throw, including the ductile shear strain component (broken line, labelled); (c) composite horizon separation diagram for fault segments A and B.

Daisyhill Coal Site

OL=162m
L=510m
Wmax=86m
S=83m
Lt=852m
L1=476m
L2=552m
Wmin=59m
Tilt=3°
DmaxF1=15m
DmaxF2=14m

Huggins et al., 1995 – North Derbyshire, Markham Colliery

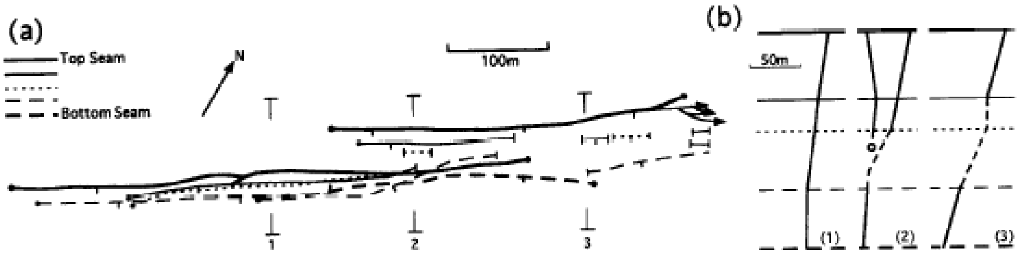


Fig. 15. (a) Fault trace geometries, on five seams, of part of a relay zone at Markham No. 2 Colliery, North Derbyshire, projected vertically onto a common horizontal surface. The fault has a continuous trace on the bottom two seams. Fault trace tip-points (open circles), ends of data (bars), truncated data (arrow heads) and throw directions (ticks) are shown. Seam dip is 4.5° to the northeast. Locations of the cross-sections shown in (b) are indicated; (b) cross-sections through the fault, viewed from the right (east).

RR
OL=197m
L=234m
Wmax=44m
S=44m
Lt=666m
L1=513m
L2=356m
Wmin=31m
DmaxF1=0.6m
DmaxF2=0.7m

Peacock and Parfitt, 2002 – Big Island, Hawaii, Kilauea Volcano, Hilina-Pali Road

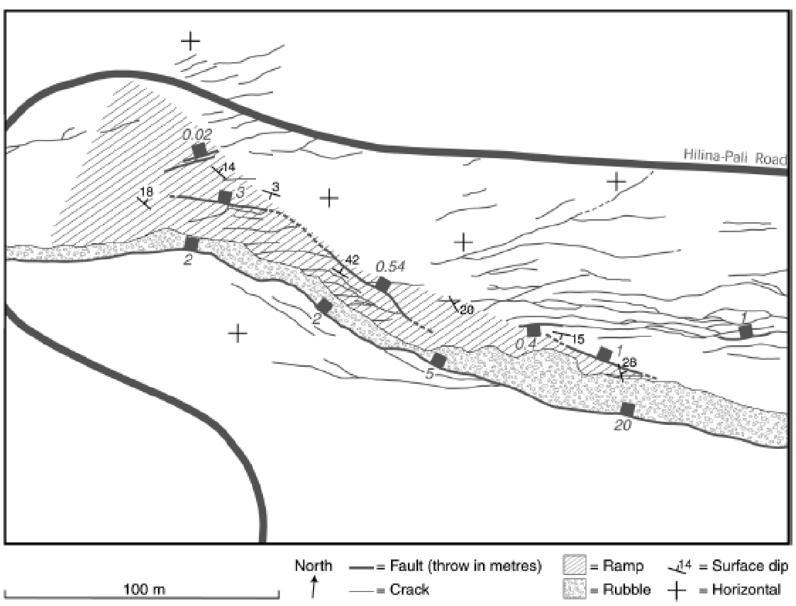
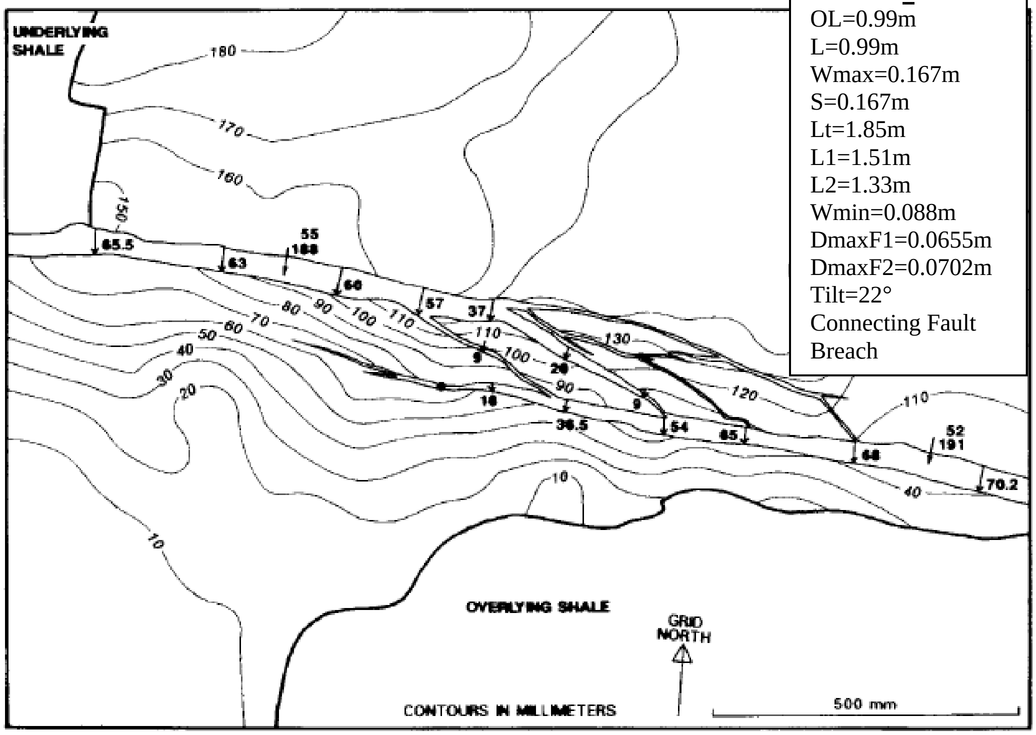


Fig. 8. Map of the breached relay ramp at bend of Hilina–Pali road. The air photograph of this area is shown in Fig. 3(a).

1
OL=107m
L=107m
Wmax=25m
S=25m
Lt=293m
L1=293m
L2=110m
Wmin=110m
DmaxF1=20m
DmaxF2=3m

2
OL=43m
L=43m
Wmax=22m
S=22m
Lt=293m
L1=293m
L2=43m
Wmin=15m
DmaxF1=20m
DmaxF2=1m

Peacock and Sanderson, 1994 – Somerset, Kilve



2
OL=0.99m
L=0.99m
Wmax=0.167m
S=0.167m
Lt=1.85m
L1=1.51m
L2=1.33m
Wmin=0.088m
DmaxF1=0.0655m
DmaxF2=0.0702m
Tilt=22°
Connecting Fault
Breach

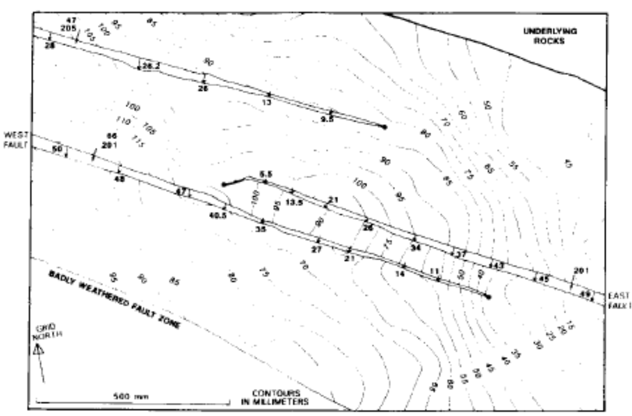


Figure 5—(a) Map of a stage 2 relay ramp at Kilve, Somerset. See Figure 2 for key. (b) Hanging wall and footwall cutoffs for map in part (a). (c) Throw–distance (*t-x*) graph for same map. The relay ramp does not cause a notable minimum in throw. (d) Displacement–distance (*d-x*) graph for same map.

5
OL=0.74m
L=0.74m
Wmax=0.098m
S=0.098m
Lt=1.54m
L1=1.25m
L2=1.04m
Wmin=0.054m
DmaxF1=0.050m
DmaxF2=0.049m
Tilt=9°

Peacock and Sanderson, 1994 – Somerset, Kilve

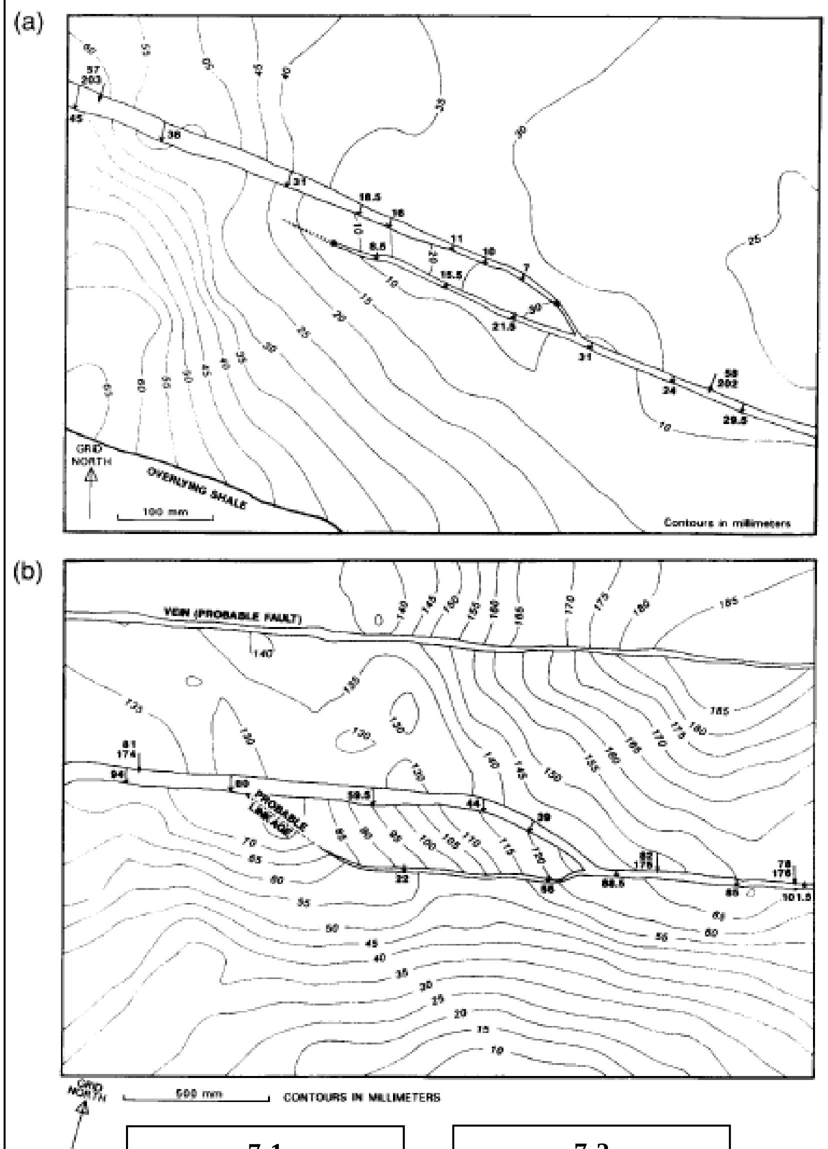


Figure 7—Maps of relay ramps illustrating different locations of breakage by fractures that connect the overstepping segments. See Figure 2 for key. (a) A connecting fault has developed at one end of the relay ramp. (b) Both ends of the relay ramp have been broken, forming a rhomb-shaped horse within the composite fault. (c) Possible example of fracturing at the center of the relay ramp. Relay ramps can be fractured at several locations to produce a complex fracture zone (Figure 2a), often with the relay becoming almost brecciated. A ramp can become locked, so further displacement has been accommodated by renewed propagation of one or both of the fault segments, thereby preserving the ramp. These examples are comparable with the positions of breakage of the bridges between overstepping veins (Figure 6 of Peacock, 1991a).

7-1

OL=0.33m
L=0.33m
Wmax=0.04m
S=0.04m
Lt=0.87m
L1=0.60m
L2=0.59m
Wmin=0m
DmaxF1=0.045m
DmaxF2=0.0295m
Tilt=6°
Upper Ramp Breach

7-2

OL=1.203m
L=1.203m
Wmax=0.243m
S=0.243m
Lt=2.581m
L1=1.851m
L2=2.041m
Wmin=0m
DmaxF1=0.094m
DmaxF2=0.01015m
Tilt=5°
Upper Ramp Breach

Soliva and Benedicto, 2004 – Andalucia Spain, Granada province

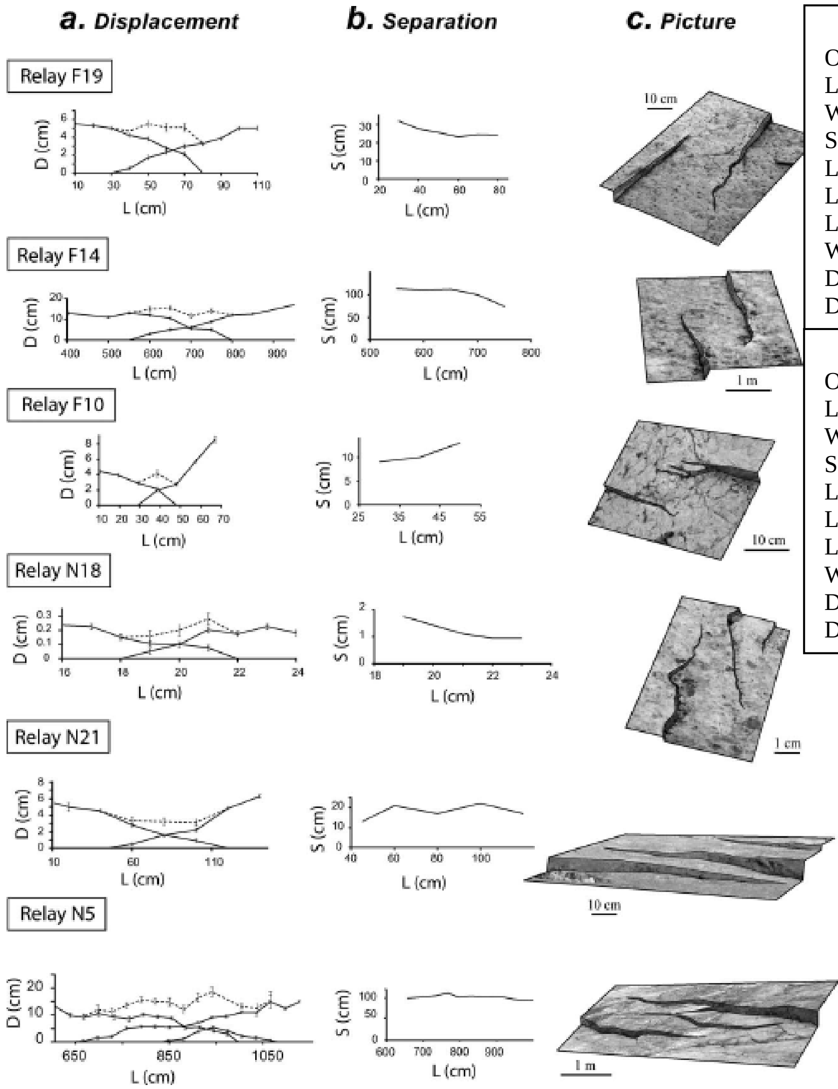


Fig. 5. Examples of open relays. (a) Displacement profiles at relay ramps, (b) associated separation profiles (distance between faults normal to their trace along overlap), and (c) rendered photograph of each relay. Relays referenced by the letters F and N are from Fumanyá and Nigüelas fault sets, respectively. In displacement profiles, broken lines represent aggregate profiles at the overlap zone. Displacement profiles of each segment are projected following an axis perpendicular to fault segments. Error bars are labelled on profiles. Separation is taken following an axis perpendicular to fault segments, and error is about 1 mm.

F19
OL=0.22m
L=0.22m
Wmax=0.22m
S=0.22m
Lt=0.54m
L1=0.38m
L2=0.42m
Wmin=0.20m
DmaxF1=0.055m
DmaxF2=0.050m

F14
OL=1m
L=1m
Wmax=1.2m
S=1.2m
Lt=2.1m
L1=1.4m
L2=1.3m
Wmin=1.11m
DmaxF1=0.14m
DmaxF2=0.17m

F10
OL=0.085m
L=0.085m
Wmax=0.125m
S=0.125m
Lt=0.325m
L1=0.238m
L2=0.188m
Wmin=0.075m
DmaxF1=0.085m
DmaxF2=0.045m

N18
OL=0.034m
L=0.034m
Wmax=0.024m
S=0.024m
Lt=0.054m
L1=0.05m
L2=0.04m
Wmin=0.01m
DmaxF1=0.0025m
DmaxF2=0.0024m

N21
OL=0.7m
L=0.7m
Wmax=0.08m
S=0.08m
Lt=0.96m
L1=0.9m
L2=0.76m
Wmin=0.04m
DmaxF1=0.055m
DmaxF2=0.064m

N5
OL=1.78m
L=1.78m
Wmax=0.78m
S=0.78m
Lt=5m
L1=4.1m
L2=2.67m
Wmin=0.56m
DmaxF1=0.15m
DmaxF2=0.13m

Soliva and Benedicto, 2004 – Andalucia Spain, Granada province

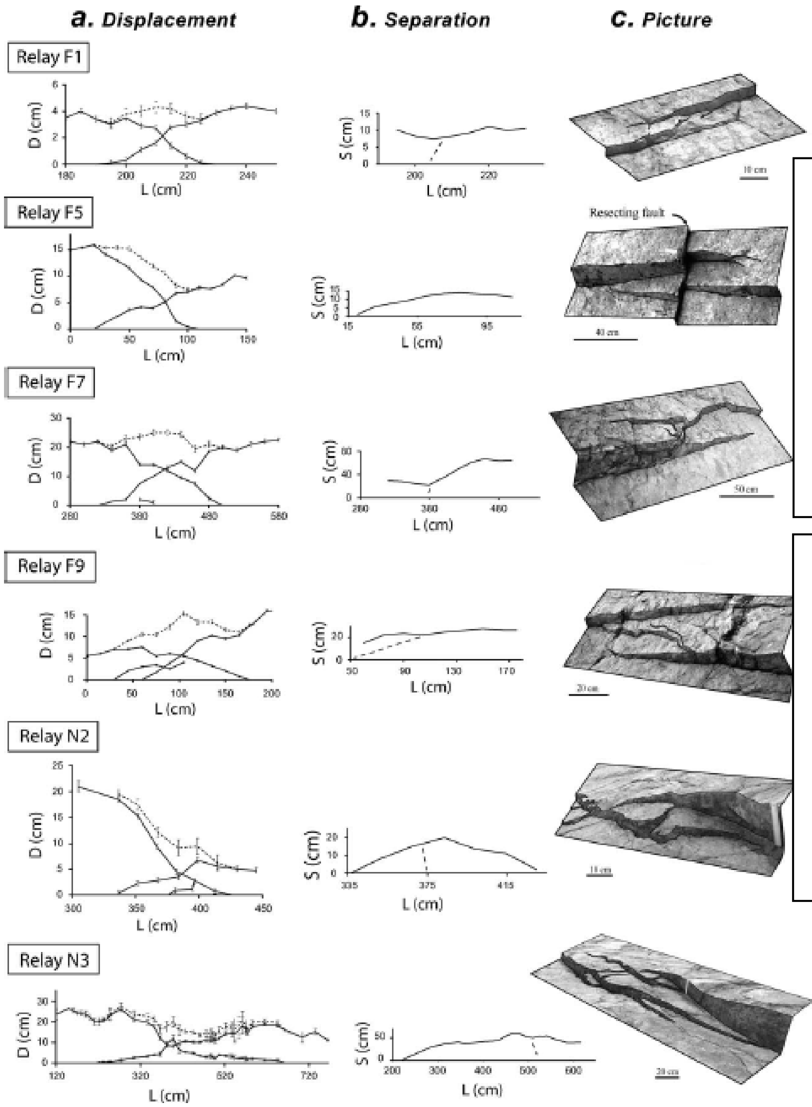


Fig. 6. Examples of linked relays; see text of Fig. 5 for more details. In separation profiles (b) broken lines represent linking through-going faults.

<u>F1</u>
OL=0.42m
L=0.42m
Wmax=0.08m
S=0.08m
Lt=0.6m
L1=0.52m
L2=0.5m
Wmin=0.02m
DmaxF1=0.04m
DmaxF2=0.045m
Stage 3 - Fracturing

<u>F5</u>
OL=0.93m
L=0.93m
Wmax=0.2m
S=0.2m
Lt=1.267m
L1=1.03m
L2=1.167m
Wmin=0.03m
DmaxF1=0.10m
DmaxF2=0.16m
Stage 3-Fracturing

<u>F7</u>
OL=1.25m
L=1.25m
Wmax=0.35m
S=0.35m
Lt=1.8m
L1=1.7m
L2=1.4m
Wmin=0.2m
DmaxF1=0.22m
DmaxF2=0.22m
Connecting Fault
Breach

<u>F9</u>
OL=1m
L=1m
Wmax=0.29m
S=0.29m
Lt=1.14m
L1=1m
L2=1.11m
Wmin=0.17m
DmaxF1=0.17m
DmaxF2=0.08m
Connecting Fault
Breach

<u>N2</u>
OL=0.58m
L=0.58m
Wmax=0.14m
S=0.14m
Lt=0.8m
L1=0.76m
L2=0.64m
Wmin=0.02m
DmaxF1=0.07m
DmaxF2=0.21m
Connecting Fault
Breach

<u>N3</u>
OL=1.9m
L=1.9m
Wmax=0.25m
S=0.25m
Lt=2.25m
L1=2.1m
L2=2m
Wmin=0m
DmaxF1=0.19m
DmaxF2=0.26m
Lower Ramp
Breach

Soliva and Benedicto, 2004 – Andalucia Spain, Granada province

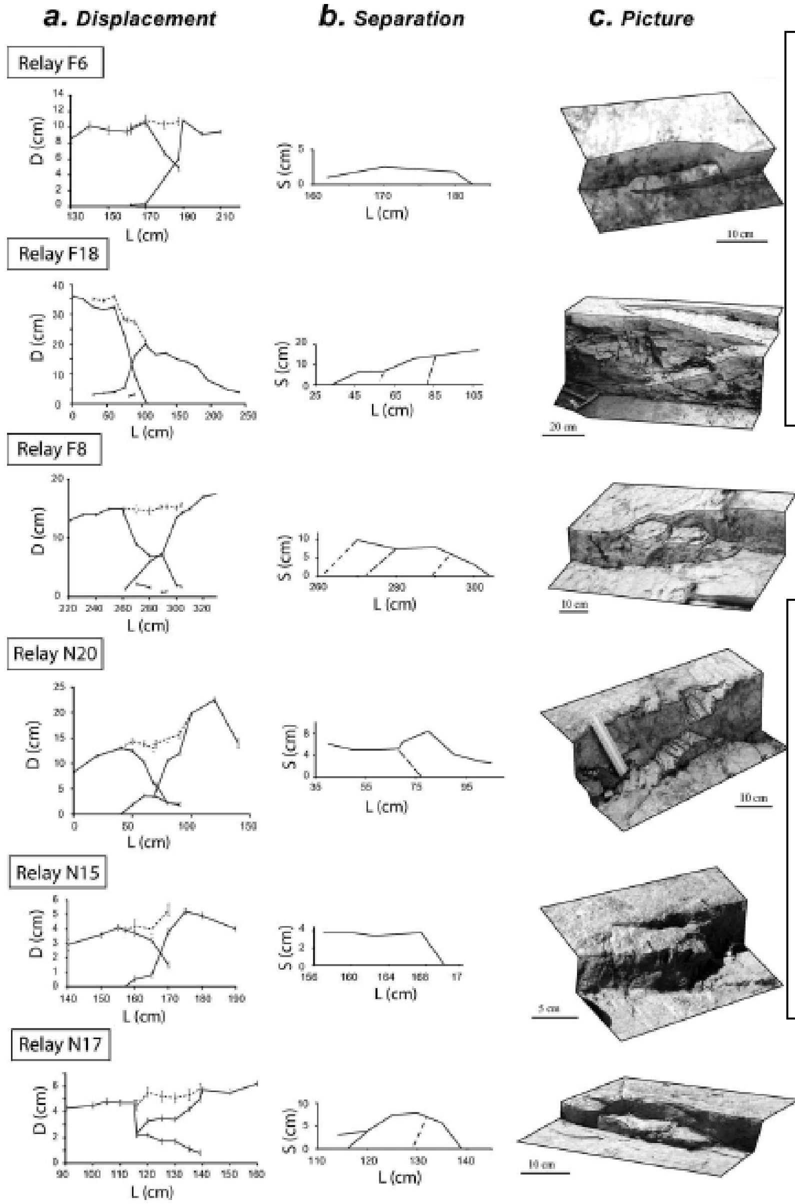


Fig. 7. Examples of fully breached relays; see text of Figs. 5 and 6 for more details.

F6
OL=0.189m
L=0.189m
Wmax=0.056m
S=0.056m
Lt=0.367m
L1=0.256m
L2=0.278m
Wmin=0m
DmaxF1=0.105m
DmaxF2=0.11m
Upper Ramp Breach

F18
OL=0.77m
L=0.77m
Wmax=0.086m
S=0.086m
Lt=1m
L1=0.77m
L2=0.97m
Wmin=0m
DmaxF1=0.20m
DmaxF2=0.36m
Lower Ramp Breach

F8
OL=0.42m
L=0.42m
Wmax=0.08m
S=0.08m
Lt=0.72m
L1=0.58m
L2=0.56m
Wmin=0m
DmaxF1=0.15m
DmaxF2=0.18m
Double Breach

N20
OL=0.25m
L=0.25m
Wmax=0.083m
S=0.083m
Lt=0.583m
L1=0.33m
L2=0.467m
Wmin=0m
DmaxF1=0.13m
DmaxF2=0.23m
Connecting Fault Breach

N15
OL=0.113m
L=0.113m
Wmax=0.031m
S=0.031m
Lt=0.181m
L1=0.15m
L2=0.144m
Wmin=0m
DmaxF1=0.041m
DmaxF2=0.053m
Lower Ramp Breach

N17
OL=0.25m
L=0.25m
Wmax=0.038m
S=0.038m
Lt=0.425m
L1=0.35m
L2=0.35m
Wmin=0m
DmaxF1=0.048m
DmaxF2=0.062m
Double Breach

Stewart and Hancock, 1991 – Aegean Region

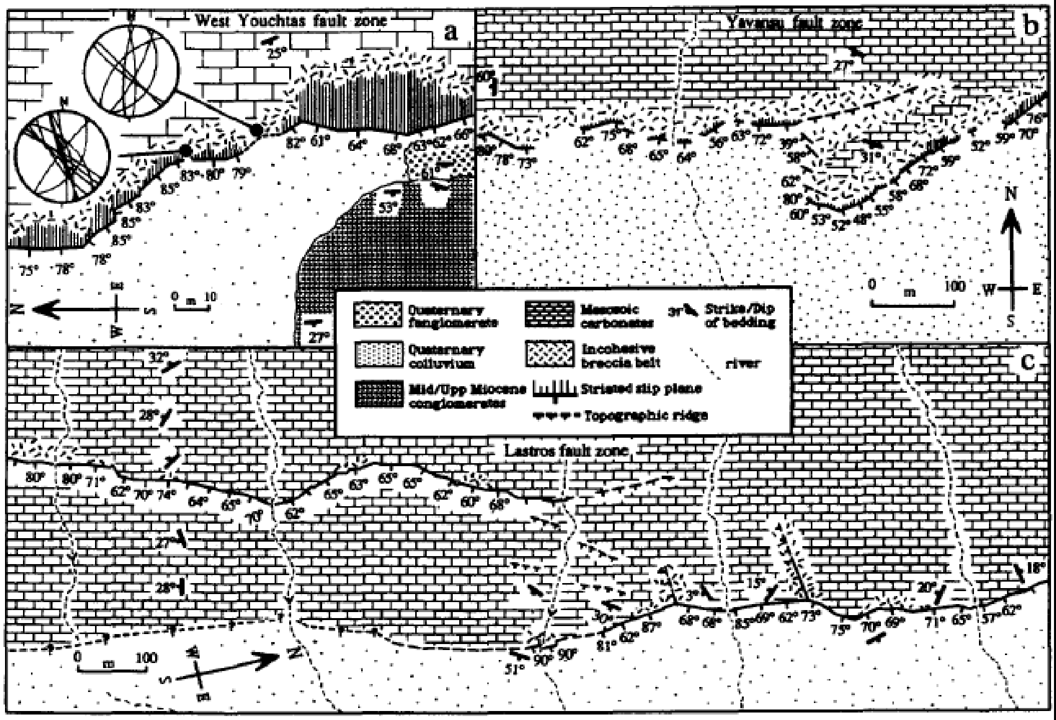


Fig. 5. Step-over zones within (a) the West Youchtas fault zone, (b) the Yavansu fault zone, and (c) the Lastros fault zon Diagrams show how slip-plane inclination and height (lengths of vertical lines in ornament indicate heights directl proportional to horizontal scale) vary in relation to the location of step-over zones. 'Stereoplots' are lower-hemisphe equal-area diagrams.

Lastros

OL=265m
L=429m
Wmax=265m
S=200m
Lt=1494m
L1=835m
L2=976m
Wmin=206m
Tilt=30°

Yavansu

OL=175m
L=175m
Wmax=118m
S=118m
Lt=682m
L1=554m
L2=332m
Wmin=82m
Tilt=31°

Walsh et al., 1999 – South East Asia

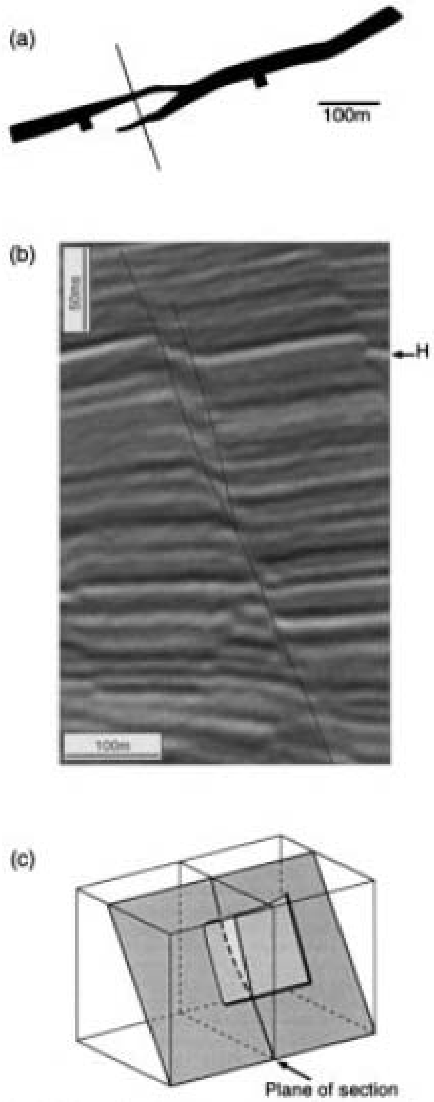


Fig. 2. (a) Fault polygons on a map of horizon H [arrowed in (b)] with location of cross-section in (b) indicated. (b) Seismic section with interpretation of traces of a master fault and a splay intersecting at a branch-point. Vertical to horizontal scale is approximately 1.5:1 (1 ms = ca. 1.25 m). (c) Block diagram of fault interpretation with surface of master fault shaded, and boundaries of the splay fault defined by an L-shaped branch-line (heavy line) and curved tip-line. The plane of cross-section in (b) is indicated together with traces of master fault and splay on this section. The branch-line and tip-line of the splay fault are each defined by 10 data points on 10 seismic sections spaced at 12.5 m. Note the significant proportion of the fault displacement accommodated by a continuous strain, with bed rotation, between the overlapping faults. The structure is interpreted as breaching of a normal fault neutral relay by the footwall fault, with the relay originally terminating downwards at a branch-point at the approximate position of the cross-section (see Fig. 1a). The initial breaching probably occurred at some point on the down-dip segment of the branch-line. Seismic from the South-East Asia.

OL=133m
L=133m
Wmax=48m
S=48m
Lt=690m
L1=300m
L2=519m
Wmin=0m
Upper Ramp Breach

Willemse, 1997 – Volcanic Tableland, CA

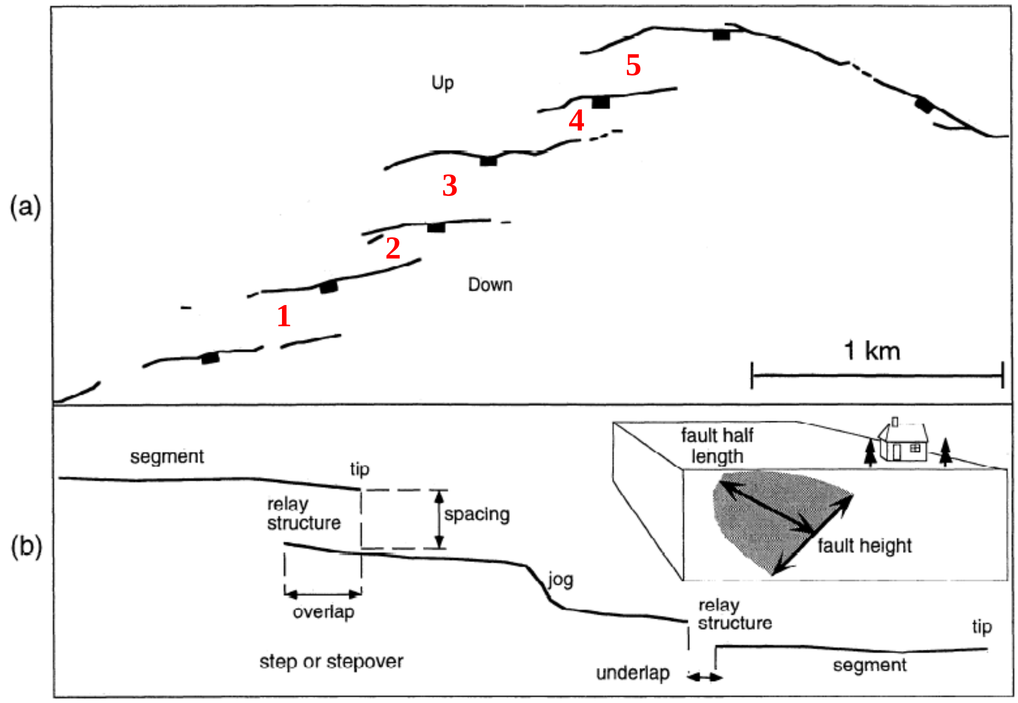


Figure 1. Map traces of segmented normal faults. (a) A normal fault zone in the Bishop Tuff, Volcanic Tableland, California. The faults are widely spaced, overlap, and are left-stepping. (b) Terminology for the trace geometry of discontinuous fault zones. A relay structure is the zone connecting the footwall and hanging wall of a fault zone, where slip is transferred between segments [*Goguel*, 1950; *Larsen*, 1988]. Reorientation of bedding at the fault step may create a relay ramp [Peacock and Sanderson, 1991]. Where segments link, the term jog has been used [*Sibson*, 1986]. Inset illustrates definitions of length and height of a fault surface (shaded).

1
OL=359m
L=359m
Wmax=205m
S=205m
Lt=1179m
L1=795m
L2=718m
Wmin=205m

2
OL=231m
L=231m
Wmax=154m
S=154m
Lt=1051m
L1=718m
L2=590m
Wmin=128m

3
OL=513m
L=513m
Wmax=282m
S=282m
Lt=1051m
L1=590m
L2=974m
Wmin=256m

4
OL=333m
L=333m
Wmax=154m
S=154m
Lt=1179m
L1=974m
L2=564m
Wmin=128m

5
OL=385m
L=385m
Wmax=231m
S=231m
Lt=846m
L1=564m
L2=667m
Wmin=179m

Willemse, 1997 – Volcanic Tableland, CA

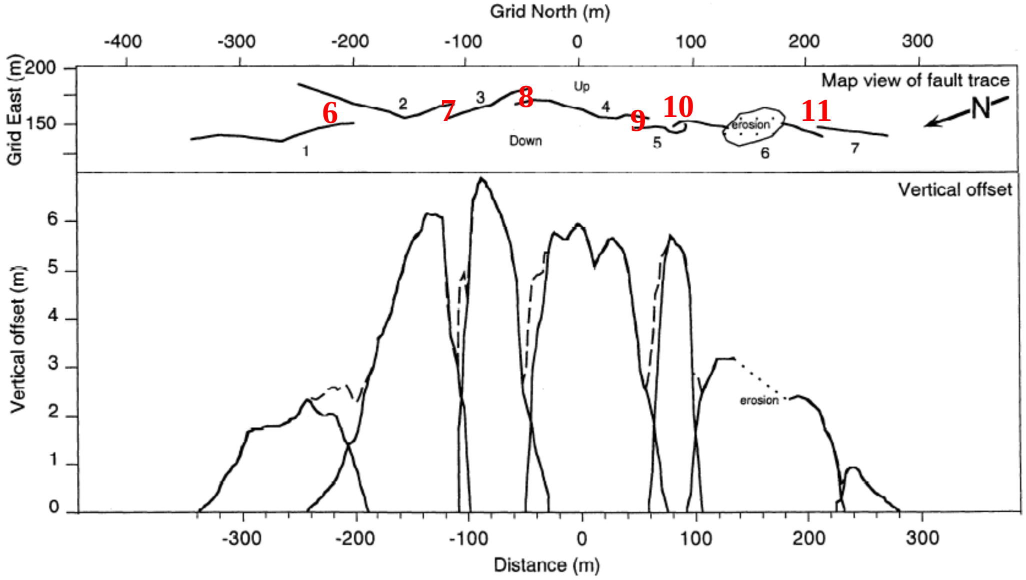


Figure 3. The 2-D slip distributions along segmented normal fault in the Bishop Tuff, California. Numbers on the fault trace map identify the seven segments. The distribution of vertical offset along the various segments is asymmetric on the distal segments and more symmetric on the central segments. The slip-to-length ratio is greatest on the central segments. Dashed line indicates aggregate of all segments but does not include the extra offset accommodated by rotation of bedding in the relay zones

6
OL=49m
L=109m
Wmax=44m
Wmin=16m
S=22m
Lt=235m
L1=153m
L2=153m
DmaxF1=2.4m
DmaxF2=6.2m

7
OL=11m
L=76m
Wmax=11m
Wmin=11m
S=11m
Lt=207m
L1=153m
L2=82m
DmaxF1=6.2m
DmaxF2=7m

8
OL=16m
L=22m
Wmax=11m
Wmin=11m
S=11m
Lt=180m
L1=82m
L2=120m
DmaxF1=7m
DmaxF2=5.9m

9
OL=11m
L=27m
Wmax=11m
Wmin=8m
S=11m
Lt=125m
L1=120m
L2=54m
DmaxF1=5.9m
DmaxF2=5.7m

10
OL=8m
L=30m
Wmax=5m
Wmin=0m
S=5m
Lt=136m
L1=54m
L2=115m
DmaxF1=5.7m
DmaxF2=3.1m
Lower Ramp Breach

11
OL=5m
L=5m
Wmax=8m
Wmin=5m
S=8m
Lt=191m
L1=115m
L2=65m
DmaxF1=3.1m
DmaxF2=1.0m

Model Generated Faults

Childs et al., 1993

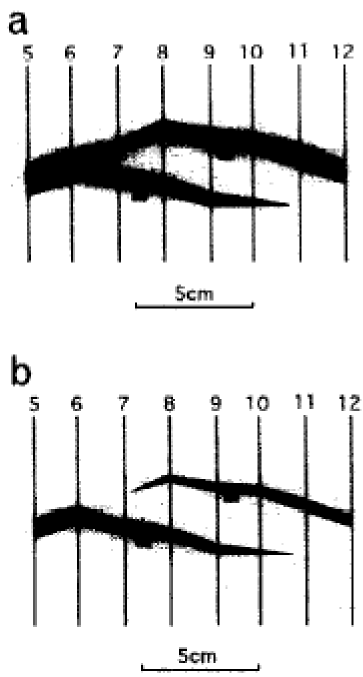


Fig. 9. (a) Portion of the fault map of Horizon 8 for the final model, showing fault F2 and its synthetic splay. (b) As (a) but with fault heaves restored to their approximate values at the time of deposition of Horizon 10.

A
OL=0.077m
L=0.077m
Wmax=0.023m
S=0.023m
Lt=0.131m
L1=0.108m
L2=0.104m
Wmin=0m
Upper Ramp Breach

B
OL=0.069m
L=0.069m
Wmax=0.023m
S=0.023m
Lt=0.131m
L1=0.112m
L2=0.092m
Wmin=0.092

McClay et al., 2004 – Model 1

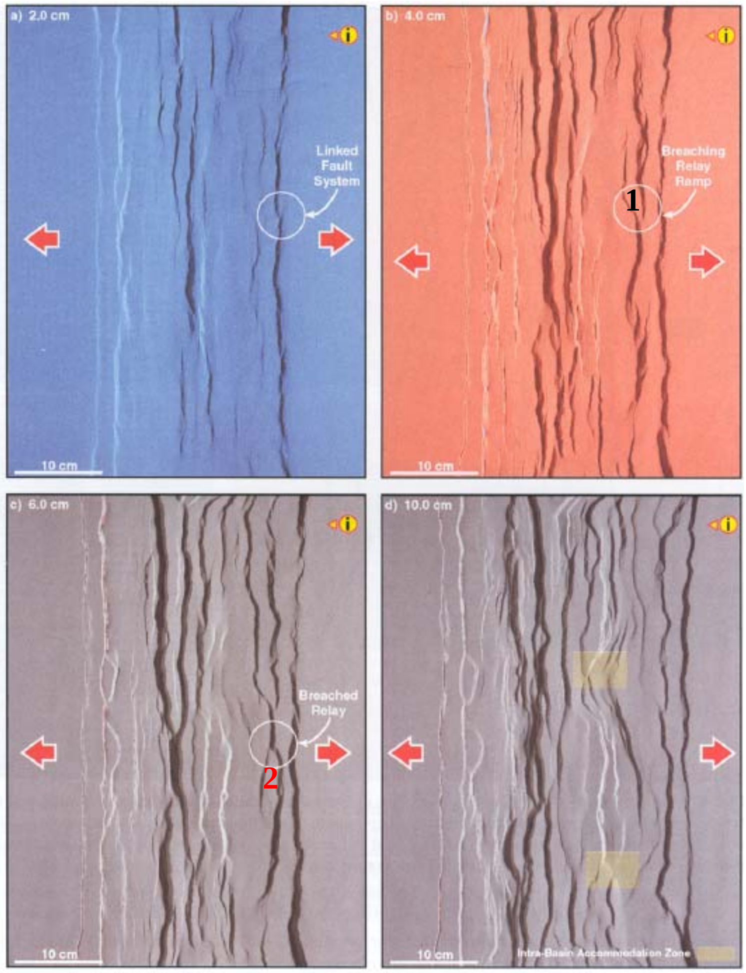
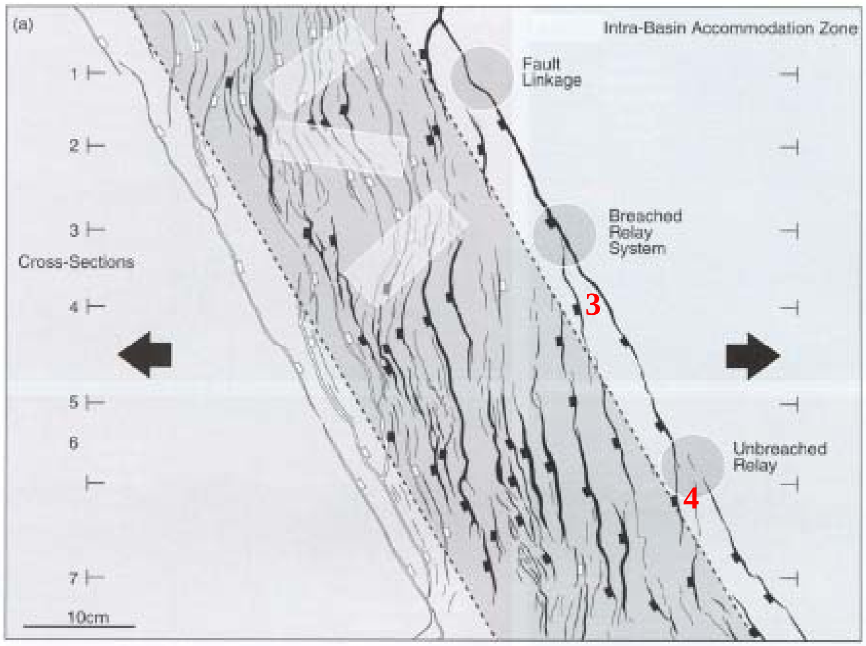


Fig. 3. Analogue model 1—orthogonal rift. (**a**) Overhead view of the analogue model after 2 cm extension. Illumination is from the left. Dark bands are faults dipping to the left and light bands are faults dipping to the right. The linkage of the right-hand border fault system is highlighted. (**b**) Overhead view of the analogue model after 4 cm extension. Note the increased displacement on the fault systems with fault overlaps producing relay ramps and breaching of relay ramps (highlighted). (**c**) Overhead view of the analogue model after 6.0 cm extension. Relay ramps have become breached by along-strike propagation of overlapping faults. (**d**) Overhead view of the analogue model after 10 cm extension. Local accommodation zones are highlighted.

Model 1-1
OL=0.093m
L=0.093m
Wmax=0.021m
S=0.021m
Lt=0.314m
L1=0.164m
L2=0.229m
Wmin=0.007m

Model 1-2
OL=0.071m
L=0.071m
Wmax=0.021m
S=0.021m
Lt=0.229m
L1=0.129m
L2=0.171m
Wmin=0m
Upper Ramp Breach

McClay et al., 2004 – Model 2



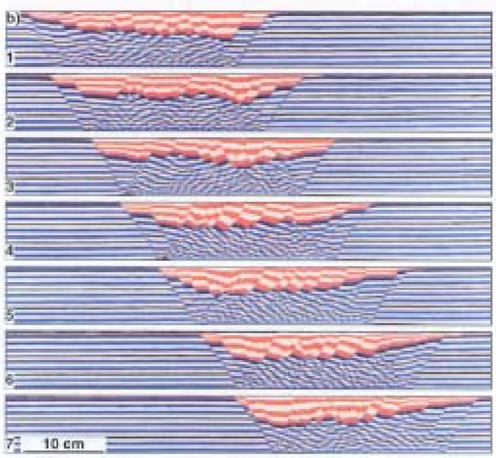


Fig. 6. Analogue model 2—60° oblique rift. (**a**) Line diagram interpretation of the surface fault pattern at the end of extension. Dark bands are faults dipping to the left and light bands are faults dipping to the right. Segmentation and linkages along the right hand border fault system are highlighted together with the intra-basin accommodation zones. (**b**) Serial sections through the oblique rift model. Syn-kinematic strata are the red and white layers that infill the graben system whereas pre-kinematic strata are the blue, black and white layers. Intra-basin accommodation zones are characterized by conjugate fault arrays—Sections 2, 3, 5 and 7.

Model 2-3
OL=0.133m
L=0.133m
Wmax=0.044m
S=0.044m
Lt=0.361m
L1=0.361m
L2=0.133m
Wmin=0m
Upper Ramp Breach

Model 2-4
OL=0.050m
L=0.050m
Wmax=0.039m
S=0.039m
Lt=0.194m
L1=0.133m
L2=0.111m
Wmin=0.028m

McClay et al., 2004 – Model 3

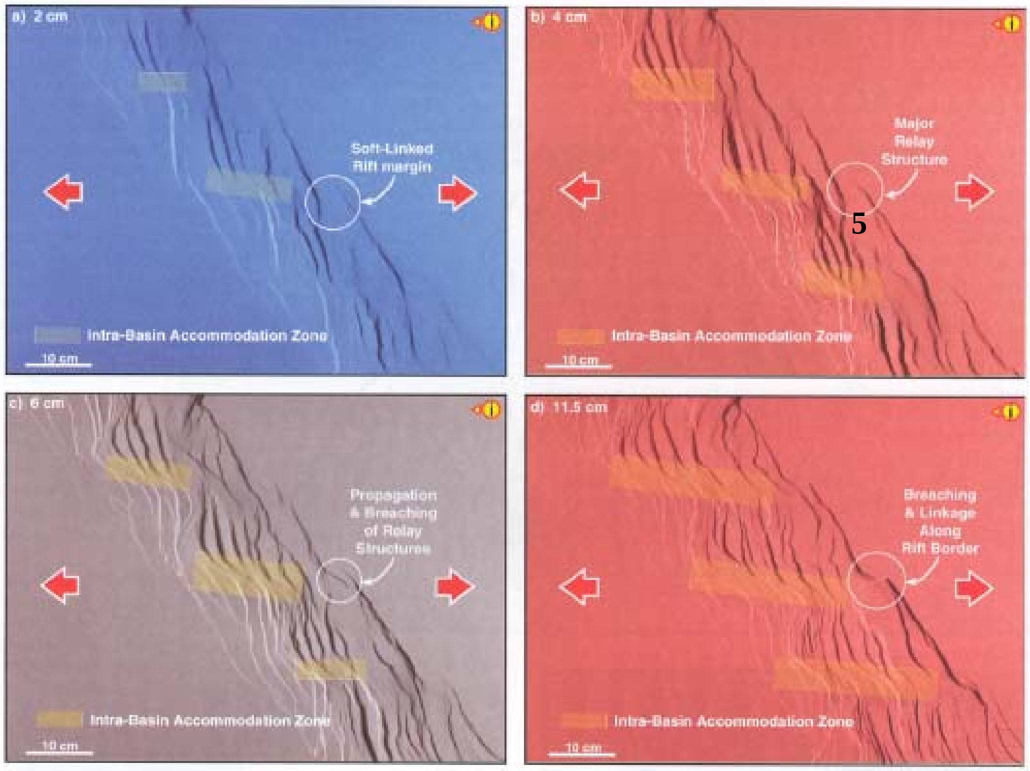
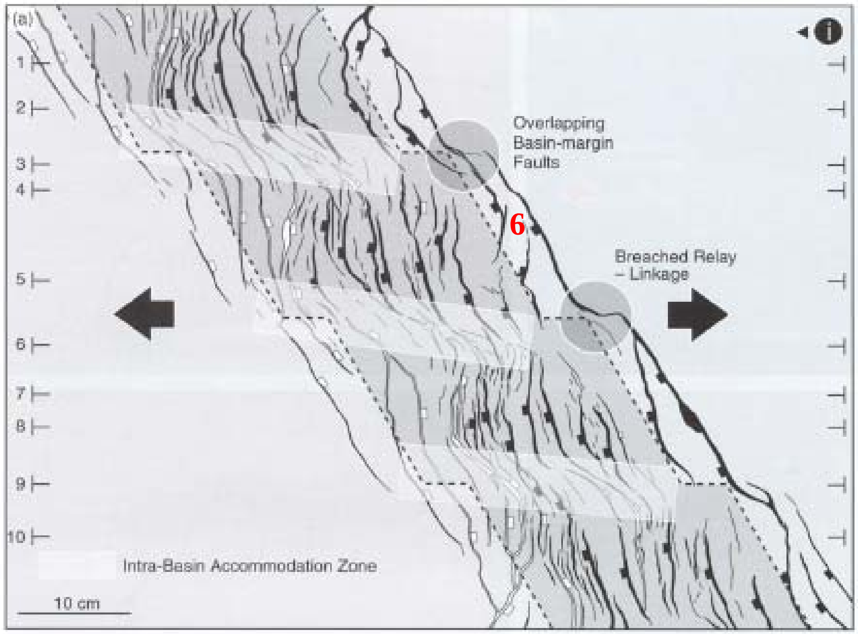


Fig. 7. Analogue model 3—60° offset oblique rift. (**a**) Overhead view of the analogue model after 2 cm extension. Illumination is from the left. Dark bands are faults dipping to the left and light bands are faults dipping to the right. Intra-basin accommodation zones (highlighted) develop above the basement offsets. (**b**) Overhead view of the analogue model after 4 cm of extension. Intra-basin accommodation zones (highlighted) are well developed and consist of overlapping and interlocking fault arrays. Overlapping faults at the rift borders produce well-developed relay ramps. (**c**) Overhead view of the analogue model after 6.0 cm extension. The intra-basin accommodation zones are highlighted. At the borders of the rift relay ramps are breached by propagation of overlapping faults. (**d**) Overhead view of the analogue model after 11.5 cm extension. Three well-developed accommodation zones (highlighted separate different domains of like-dipping faults.

Model 3-5

OL=0.109m
L=0.109m
Wmax=0.091m
S=0.091m
Lt=0.391m
L1=0.264m
L2=0.200m
Wmin=0.036m

McClay et al., 2004 – Model 3



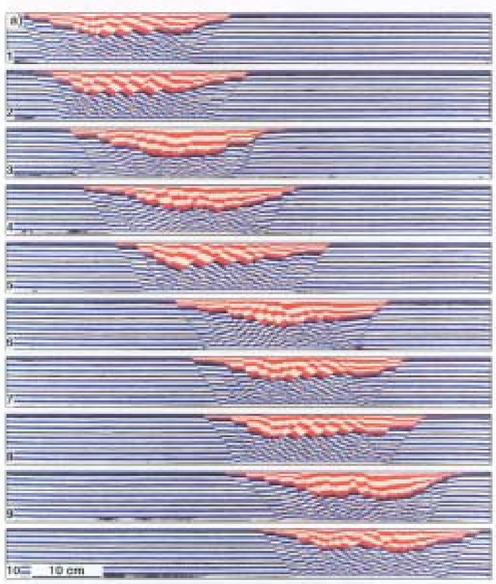


Fig. 8. Analogue model 3—60° offset oblique rift. (**a**) Line diagram interpretation of the surface fault pattern at the end of extension. Dark bands are faults dipping to the left and light bands are faults dipping to the right. The intra-basin accommodation zones above the offset basement are highlighted. Linkages of the right-hand border fault system are also shown. (**b**) Serial sections through the offset oblique rift model. Syn-kinematic strata are the red and white layers that infill the graben system whereas pre-kinematic strata are the blue, black and white layers. The well developed intra-basin accommodation zones are marked by conjugate fault arrays in Sections 4, 6, 7 and 10.

Model 3-6
OL=0.089m
L=0.089m
Wmax=0.050m
S=0.050m
Lt=0.328m
L1=0.256m
L2=0.167m
Wmin=0.017m

McClay et al., 2004

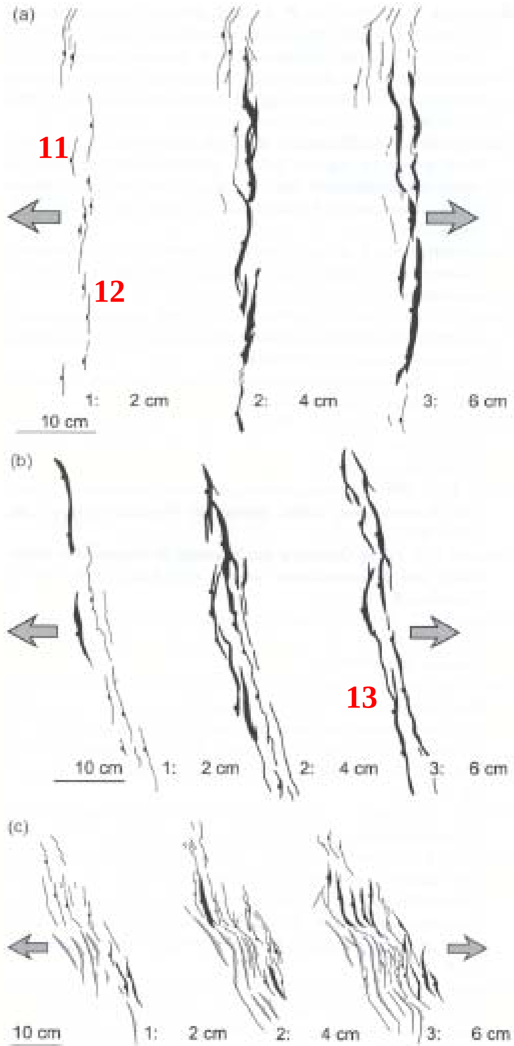


Fig. 15. Conceptual patterns of fault evolution derived from analogue model results. **(a)** Sequential development of a fault system in an orthogonal rift experiment from 2–6 cm of extension. Note initial segmentation and development of relay ramps and breached relay ramps with increased extension. **(b)** Sequential development of a fault system in a 60° oblique rift experiment from 2–6 cm extension. Note the strong en-echelon offset of fault segments and linkage with increased extension. **(c)** Sequential development of an accommodation zone in an offset 60° oblique rift model. Note the complex overlapping fault tips.

11
OL=0.033m
L=0.033m
Wmax=0.021m
S=0.021m
Lt=0.108m
L1=0.092m
L2=0.050m
Wmin=0.021m

12
OL=0.008m
L=0.008m
Wmax=0.008m
S=0.008m
Lt=0.075m
L1=0.033m
L2=0.050m
Wmin=0.008m

13
OL=0.045m
L=0.045m
Wmax=0.009m
S=0.009m
Lt=0.327m
L1=0.200m
L2=0.182m
Wmin=0m
Upper Ramp Breach