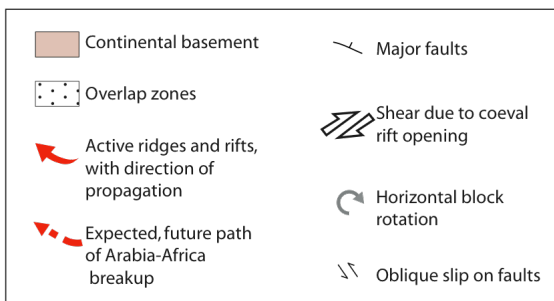
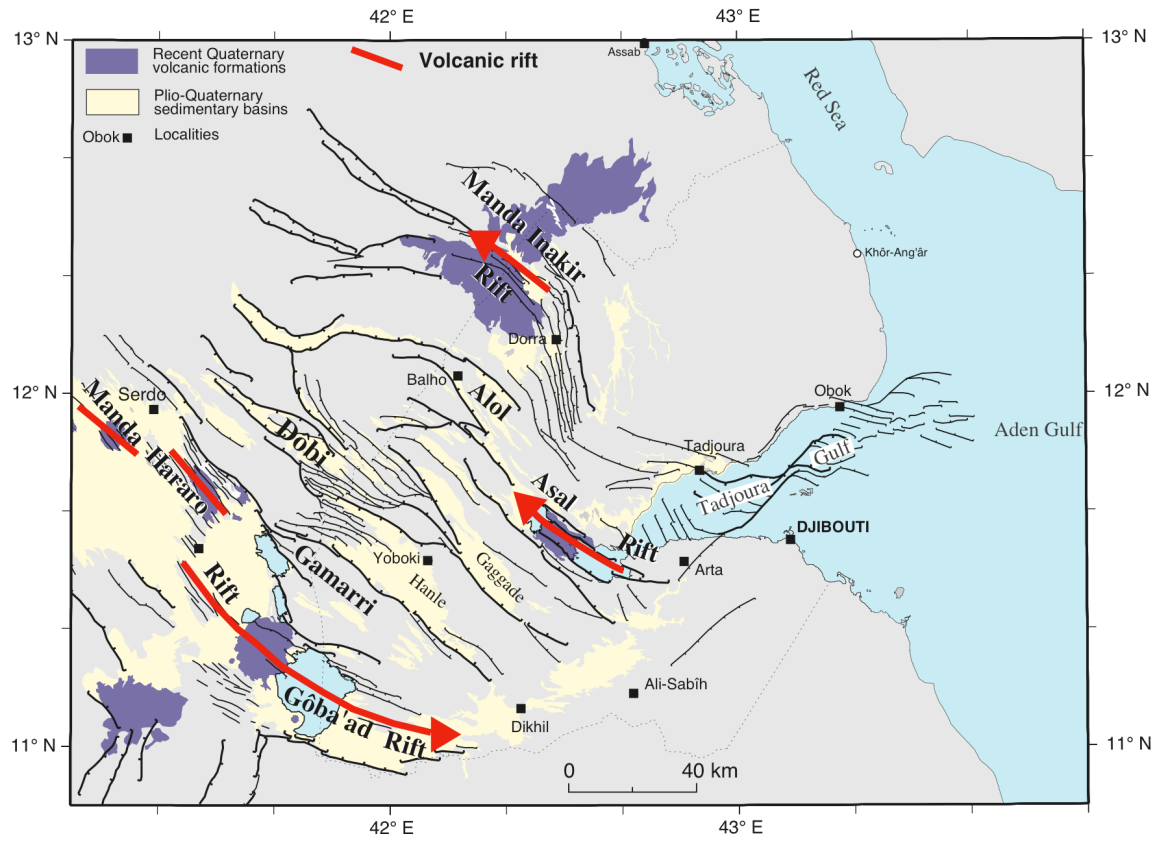
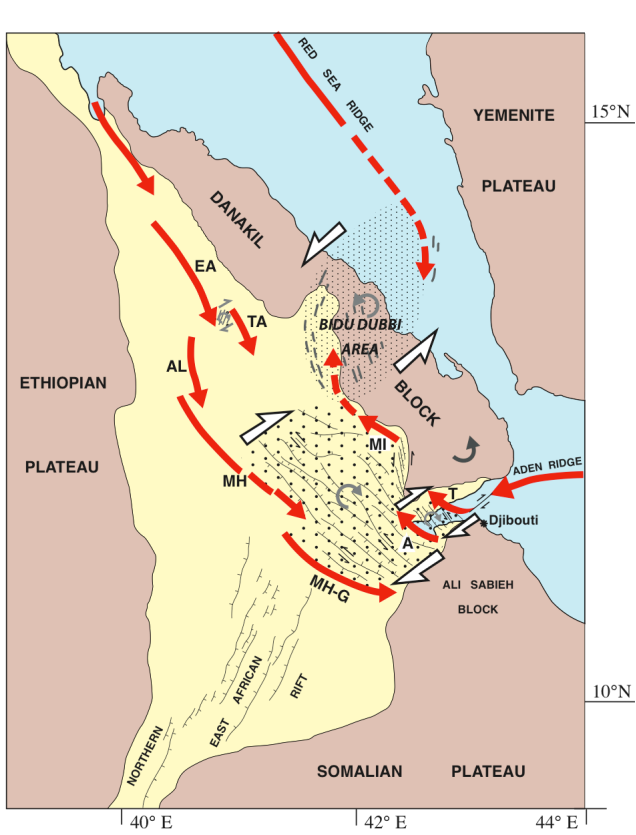




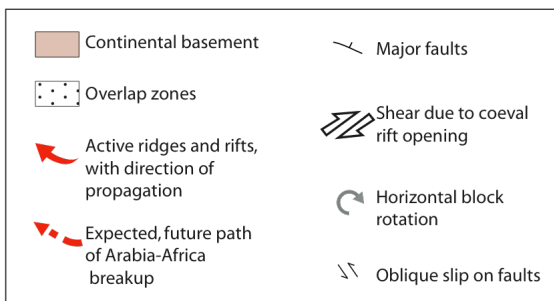
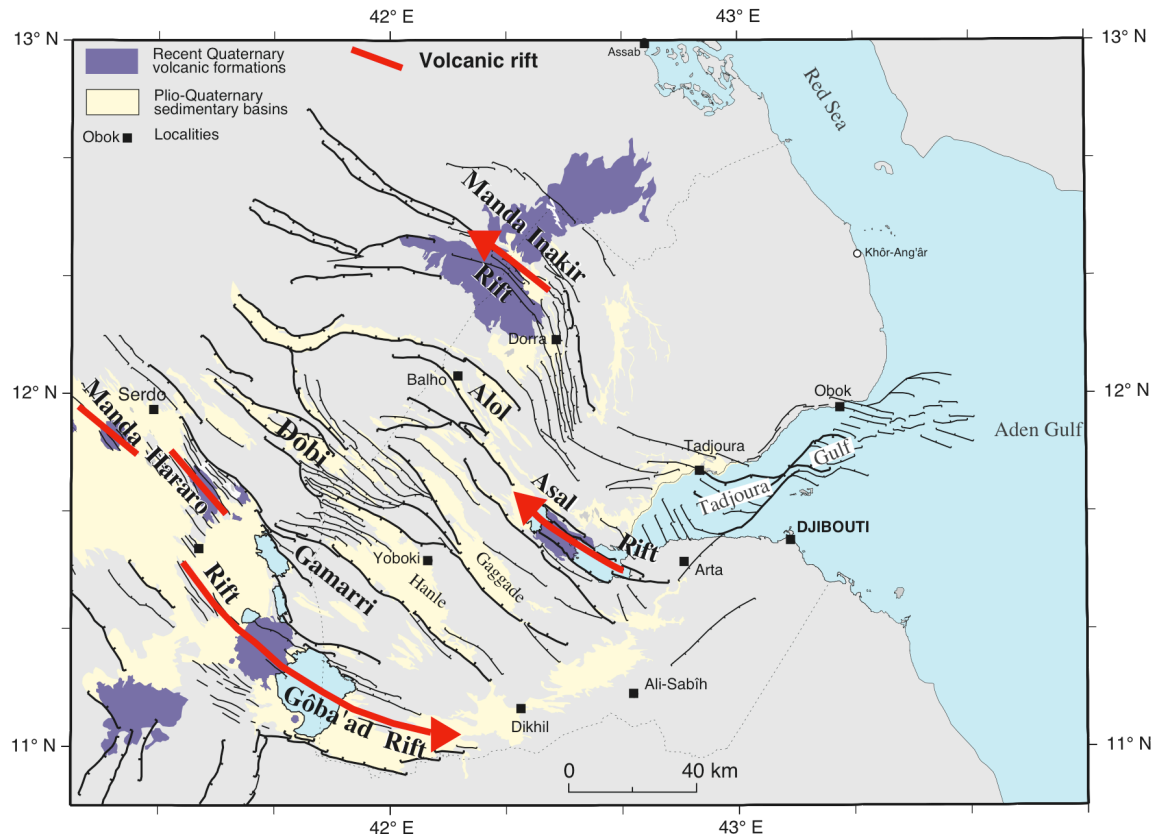
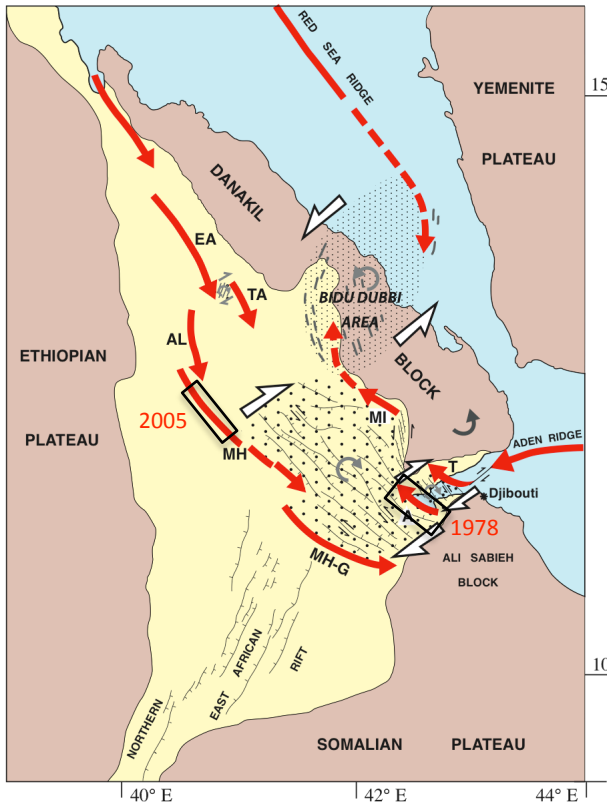
The 1989 Dôbi earthquake sequence: propagation of seismic normal faulting along the Dôbi Graben (Central Afar)

E. Jacques (1), T. Kidane (2), P. Tapponnier (3), I. Manighetti (4), L. Audin (5),
Y. Gaudemer (1), B. Meyer (6), J.C. Ruegg (7), and R. Armijo (1).

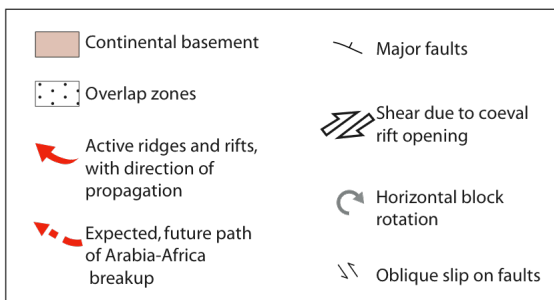
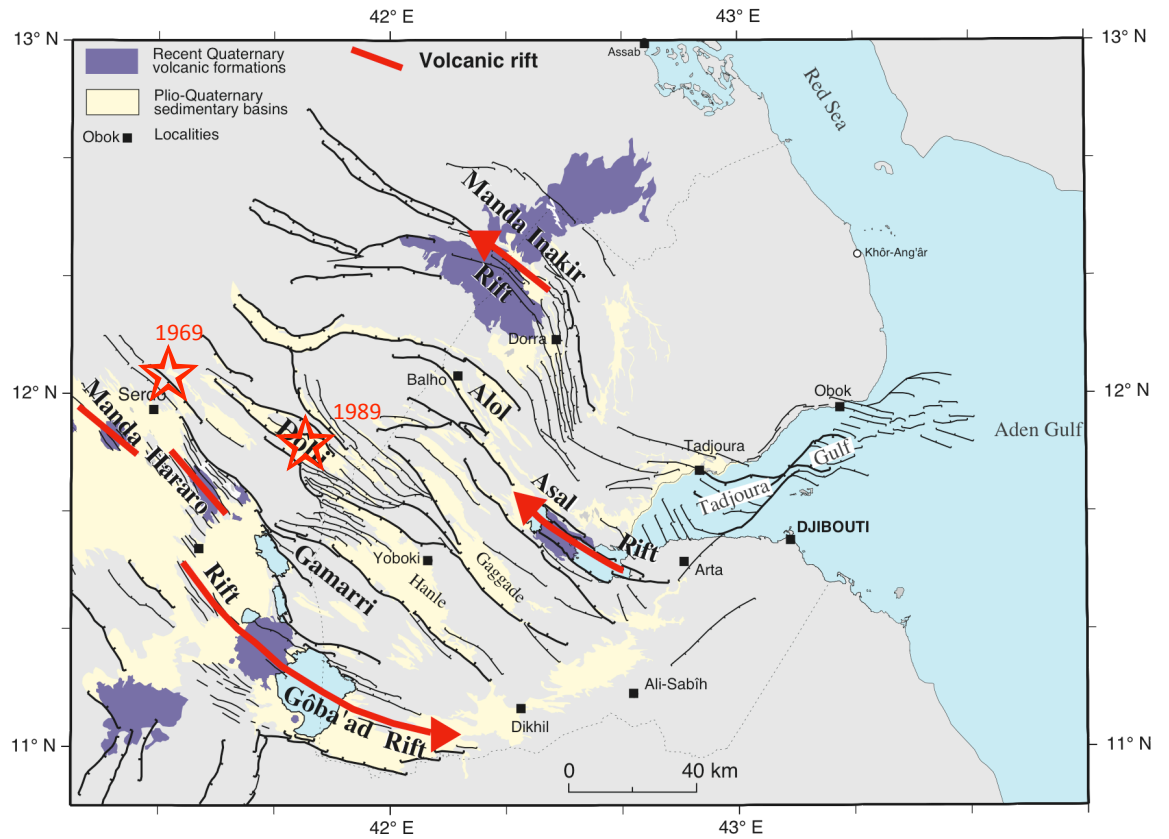
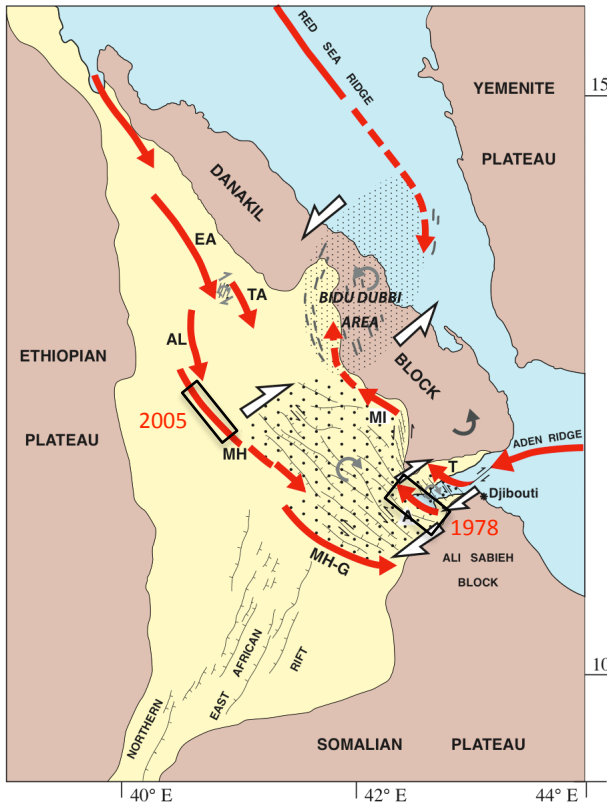
- (1) Équipe de Tectonique, Institut de Physique du Globe de Paris, Sorbonne Paris Cité, UMR 7154 CNRS, France.
- (2) Department of Earth Sciences, School of Earth and Planetary Sciences, Addis Ababa University, Ethiopia.
- (3) Tectonic Group, Earth Observatory of Singapore, Nanyang Technological University, Singapore.
- (4) Géoazur – UMR 6526 CNRS, Université Nice Sophia Antipolis, Nice, France.
- (5) UMR Isterre, OSUG, Maison des géosciences, Grenoble, France.
- (6) UPMC Université Paris 06, ISTEP, UMR 7193 CNRS, Paris, France.
- (7) Équipe de Sismologie, Institut de Physique du Globe de Paris, Sorbonne Paris Cité, UMR 7154 CNRS, France.



Manighetti et al. 2001

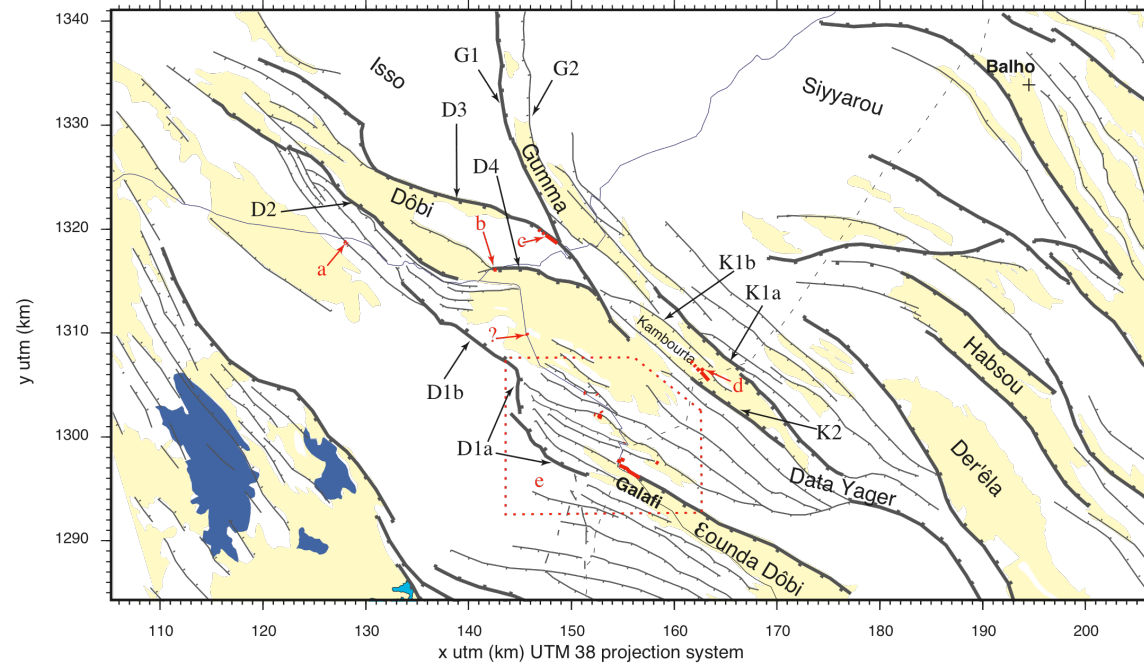
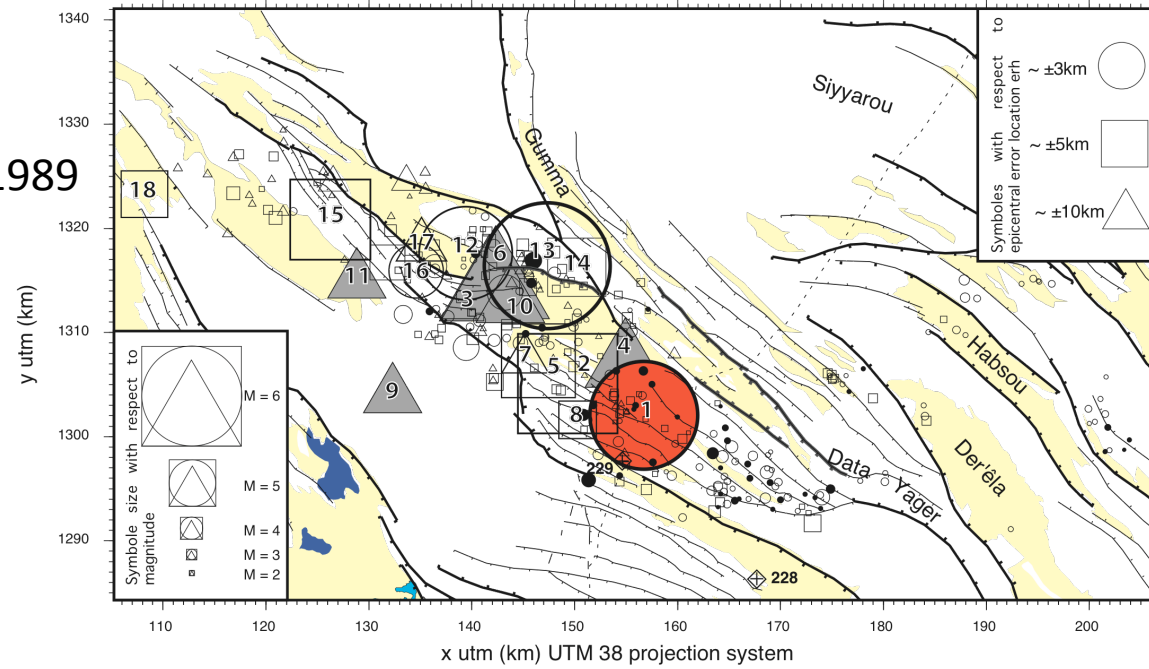


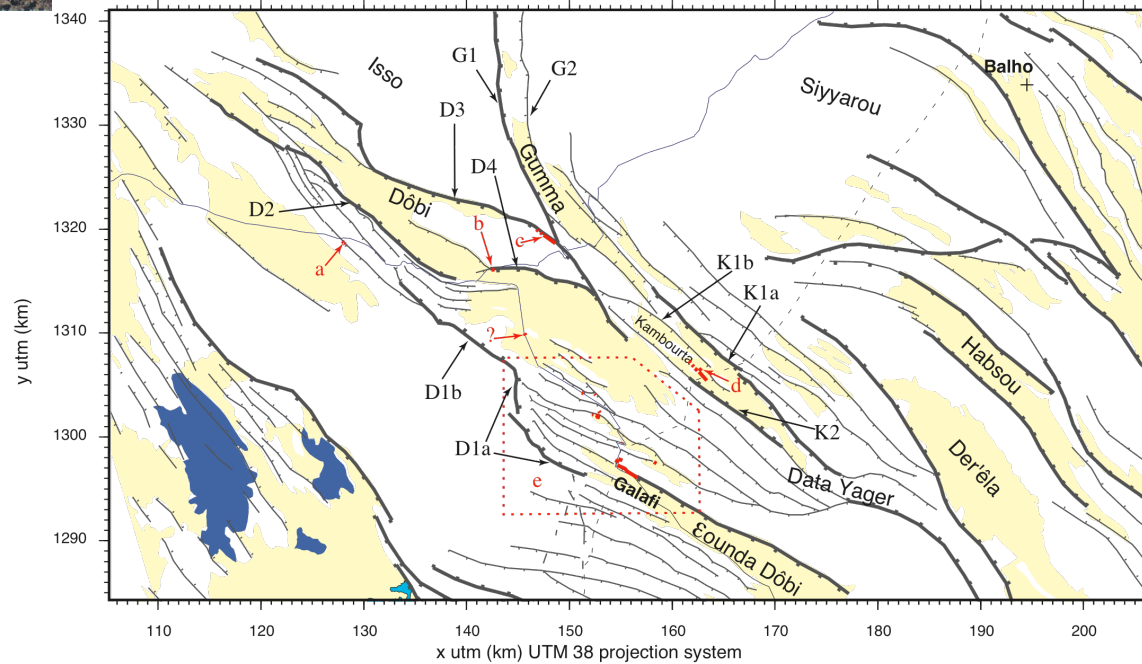
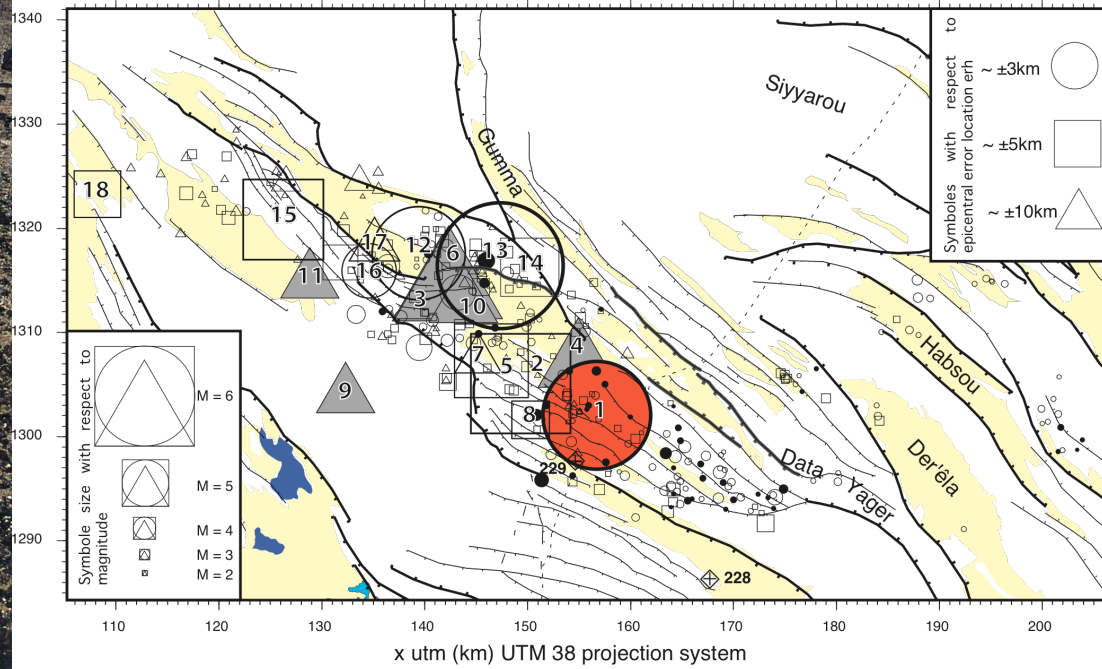
Manighetti et al. 2001



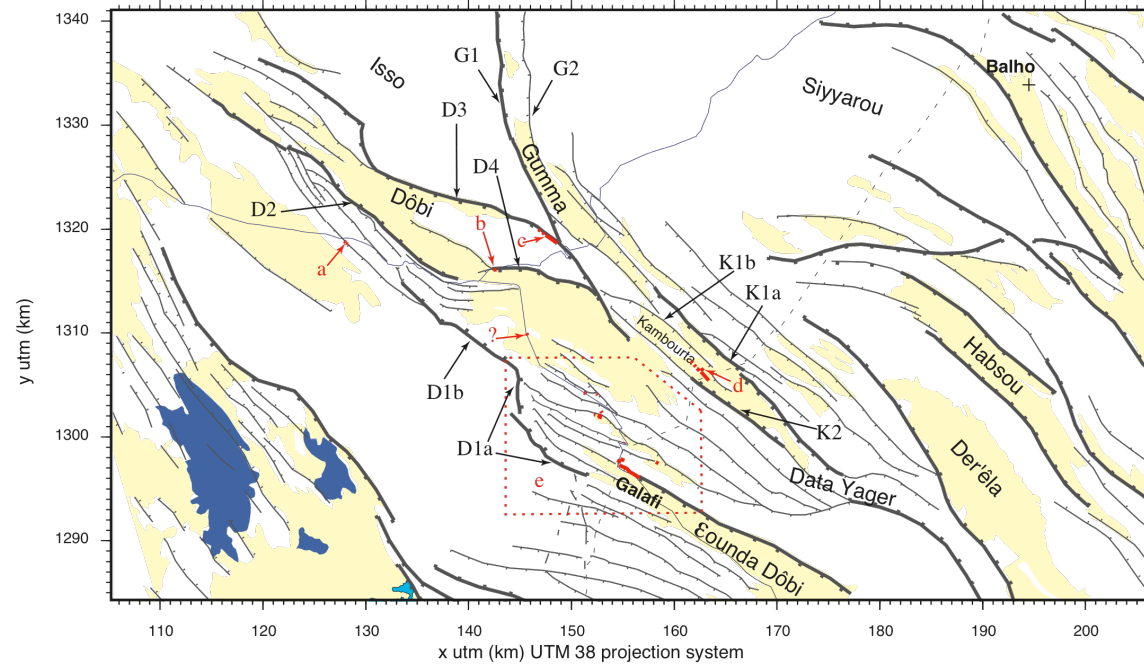
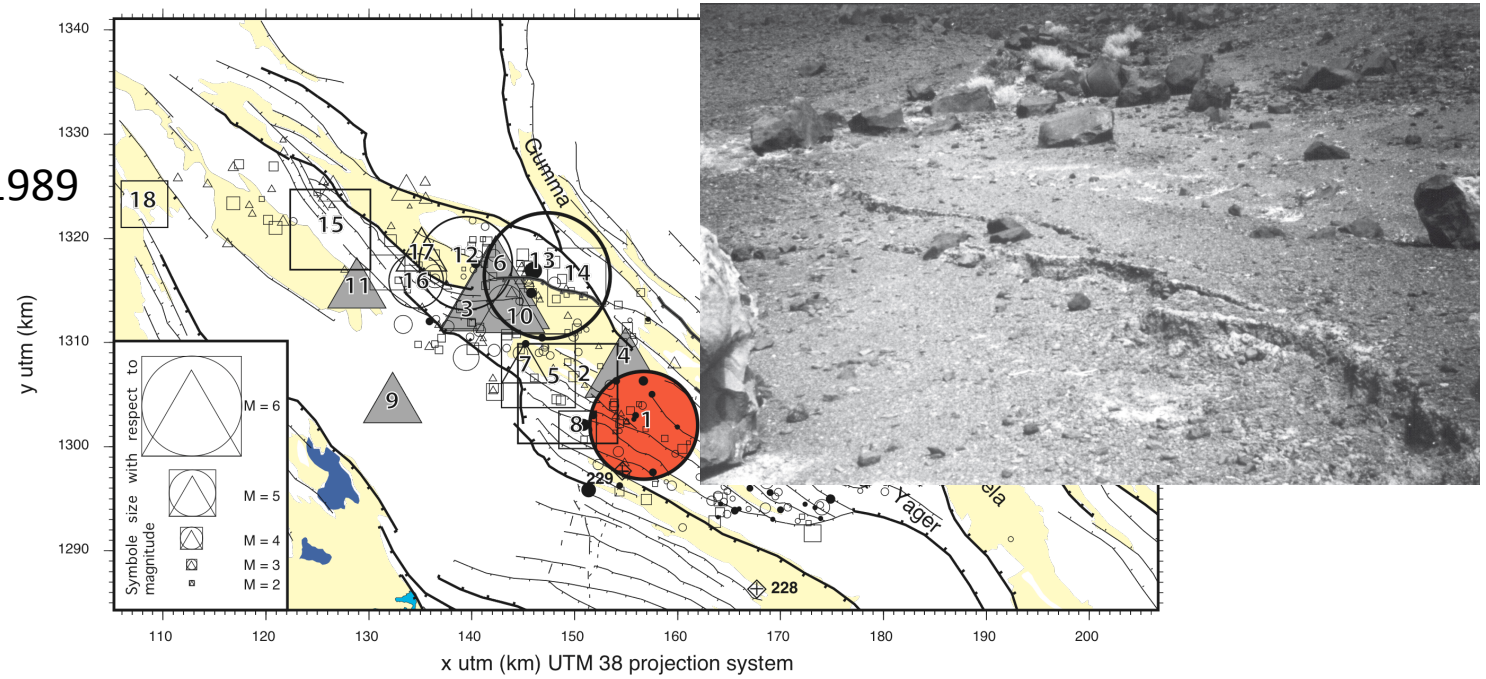
Manighetti et al. 2001

Dôbi earthquake Sequence, August 1989





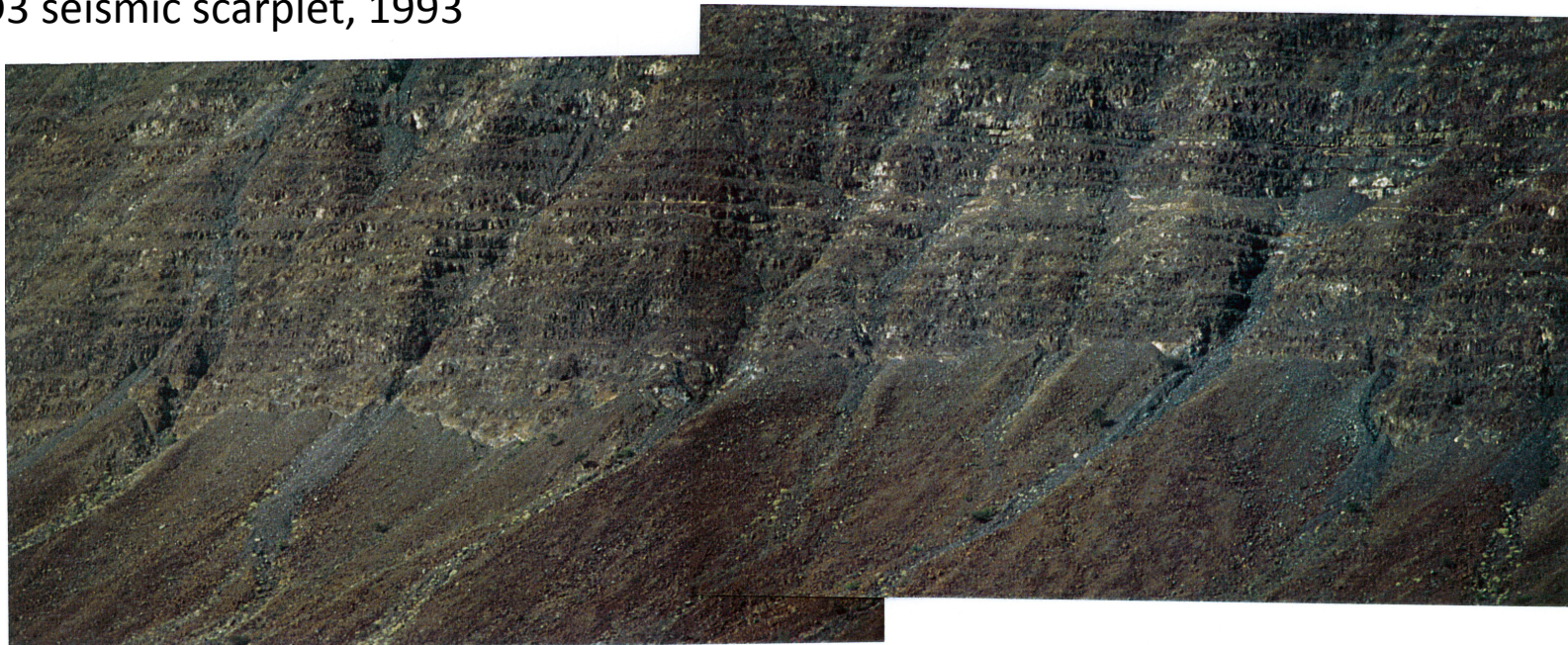
Dôbi earthquake Sequence, August 1989



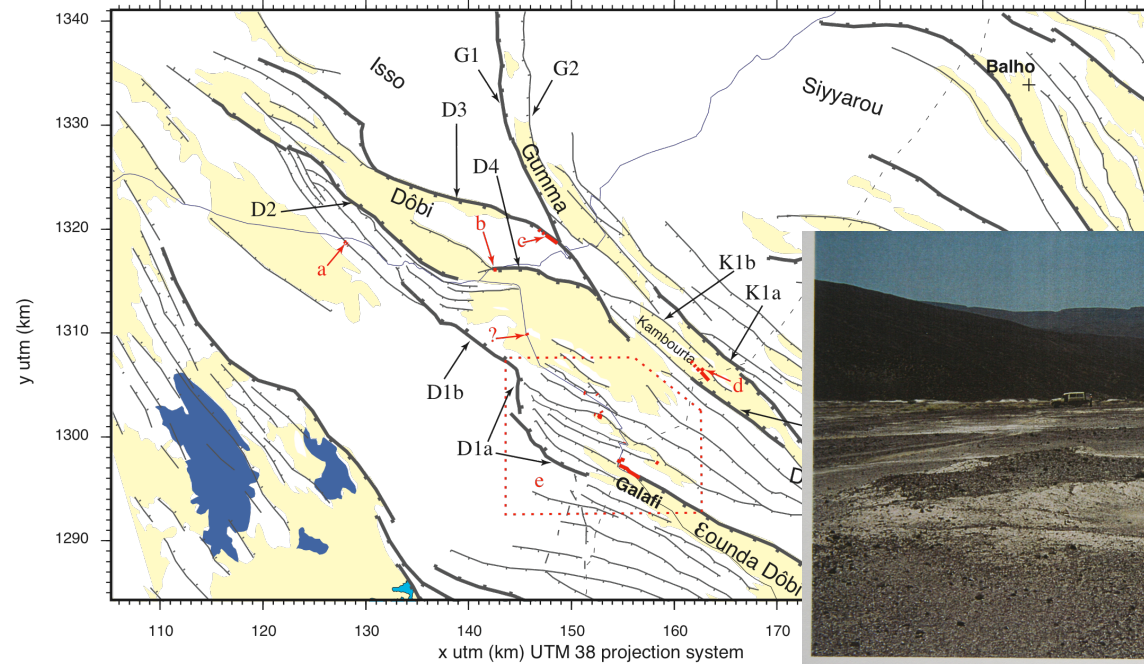
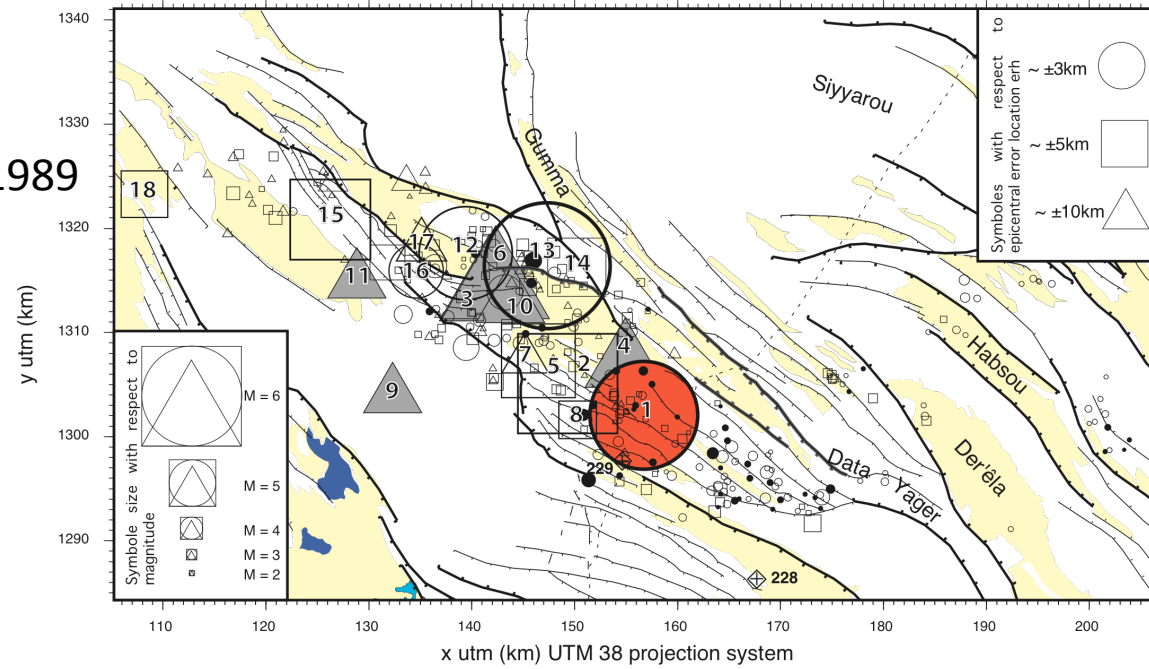
D3 fault scarp

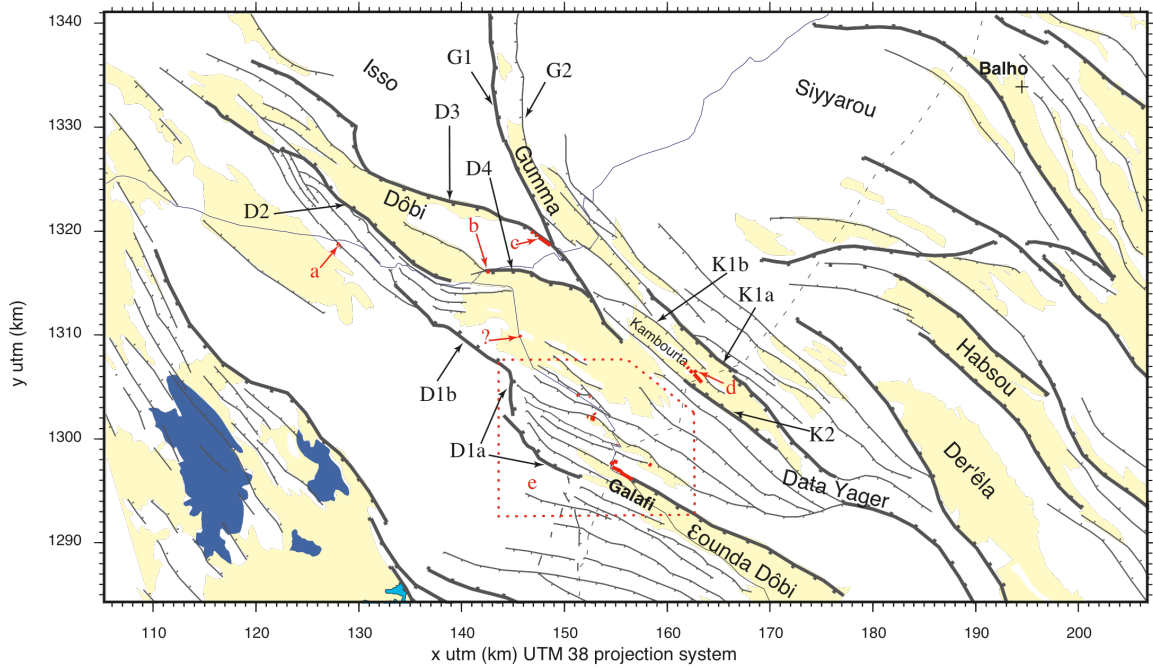
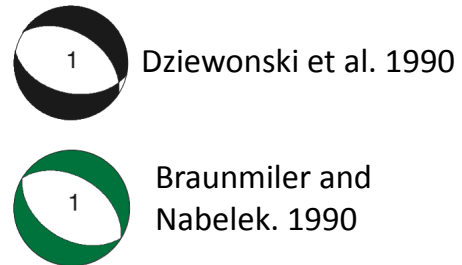
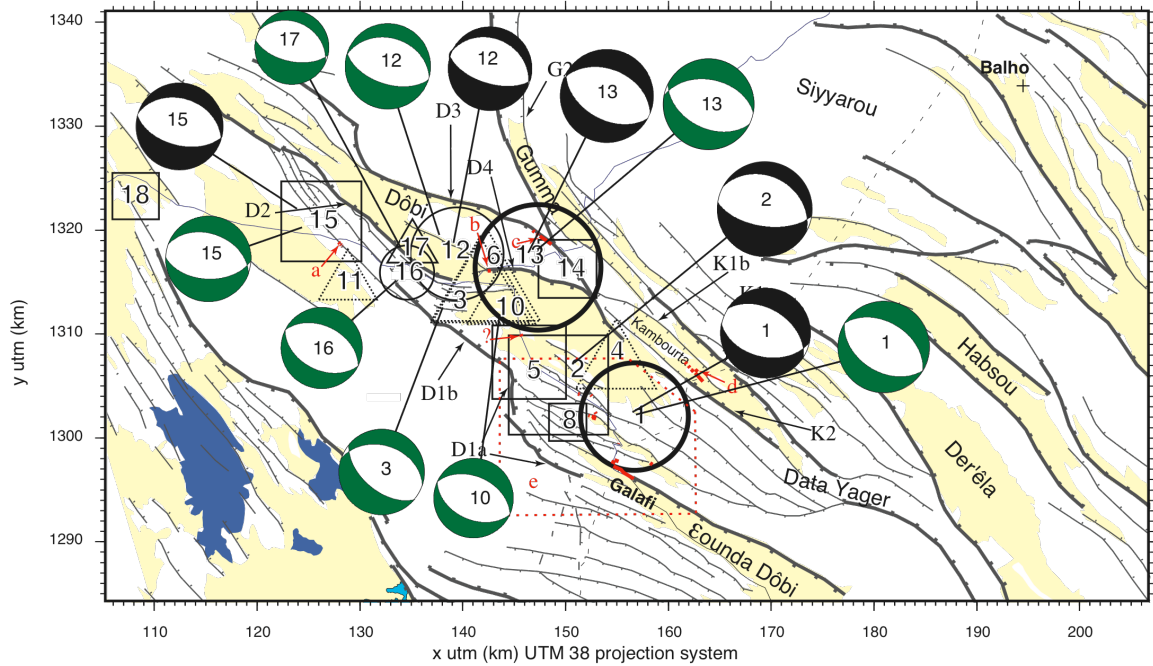


D3 seismic scarplet, 1993



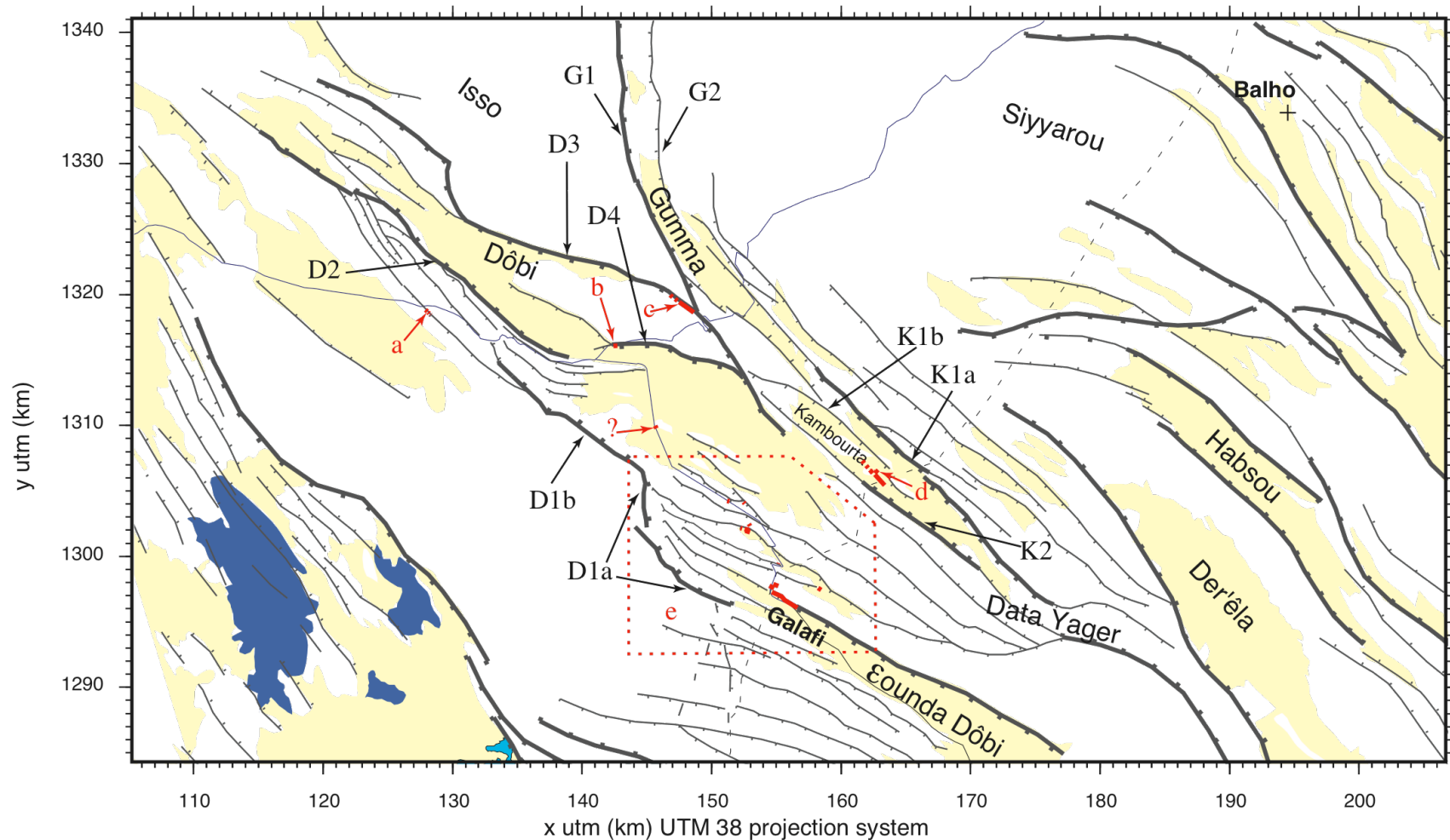
Dôbi earthquake Sequence, August 1989





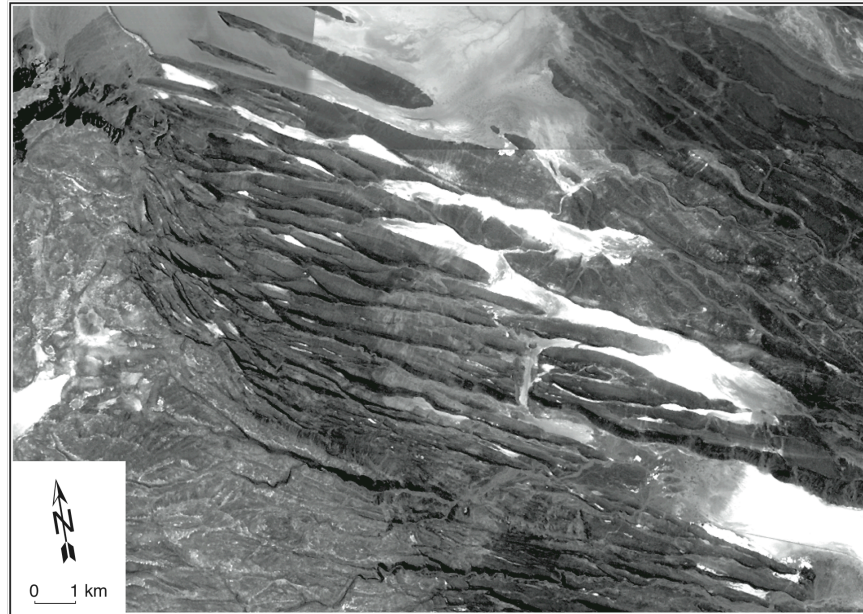
D3 free face, 1994



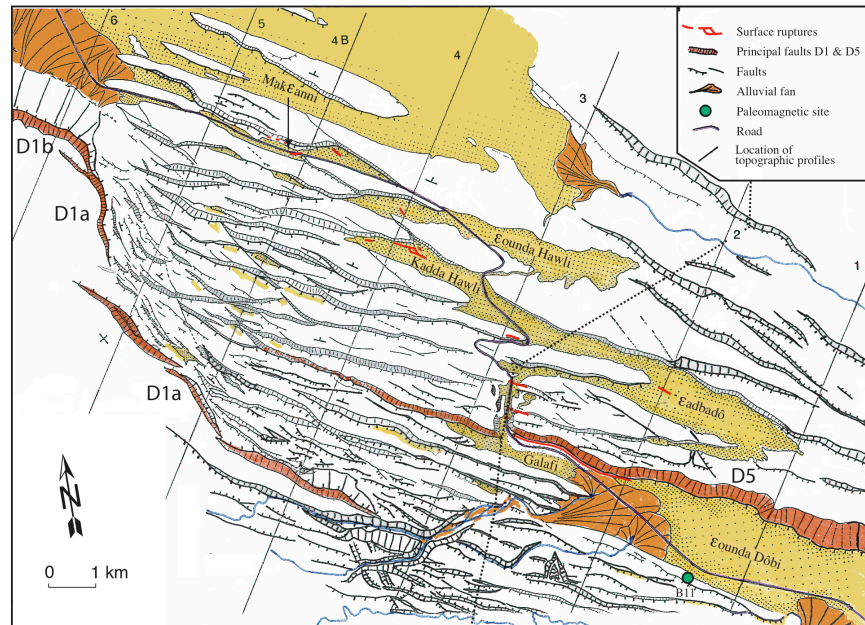


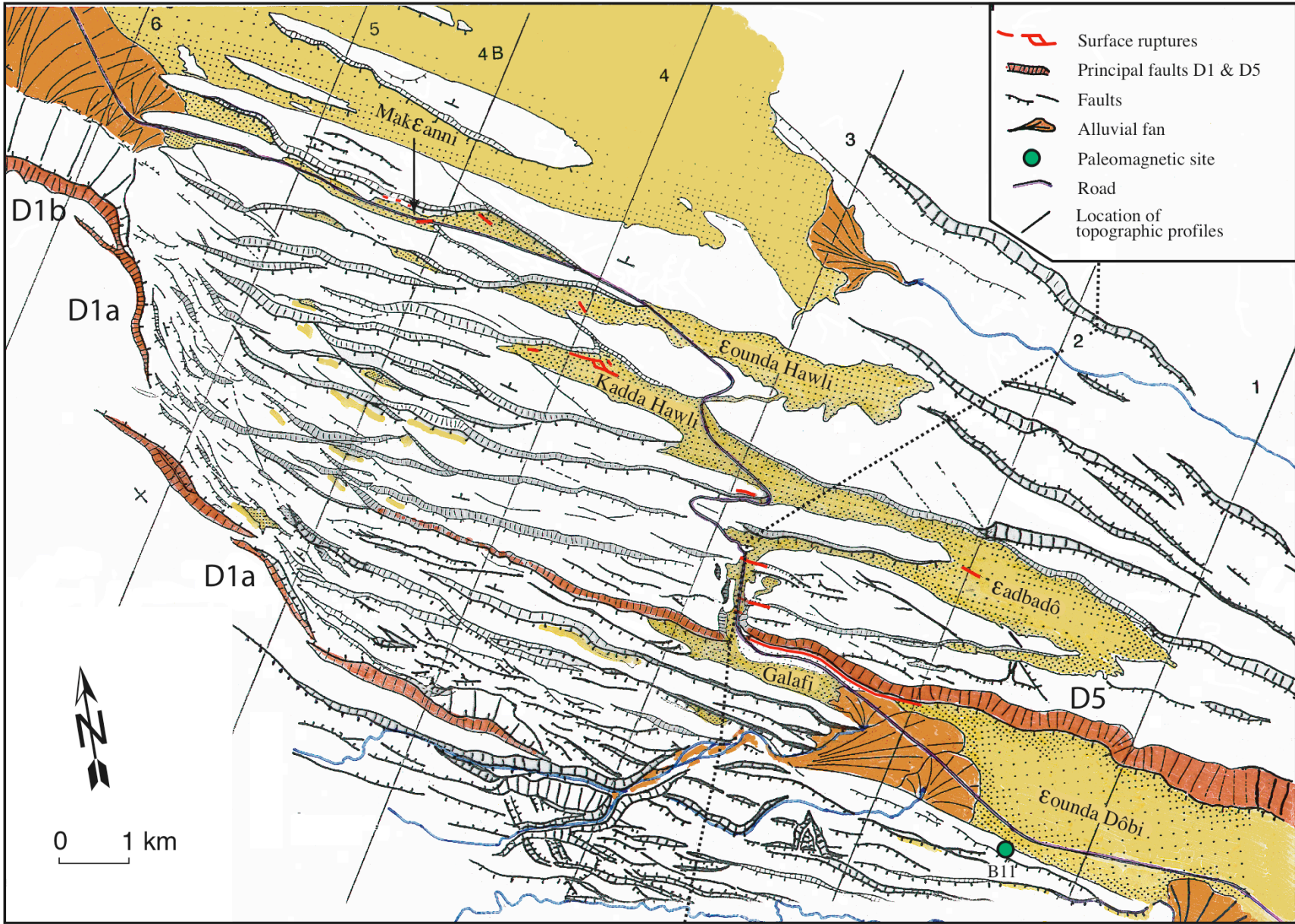
Galafi-Kada Hawli region

SPOT image

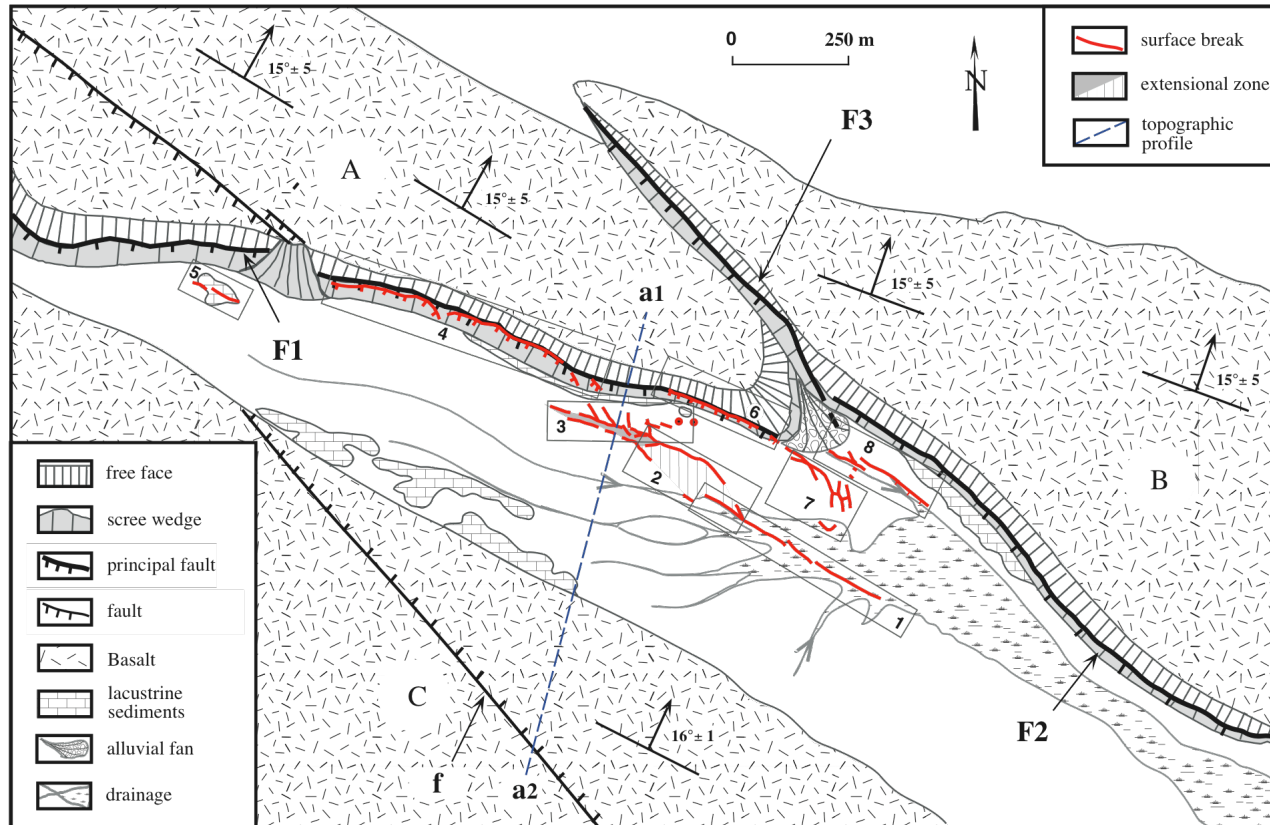


Tectonic interpretation



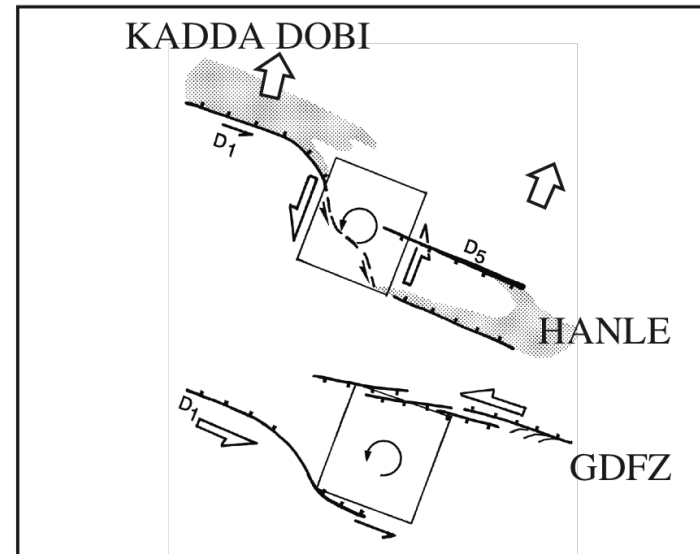
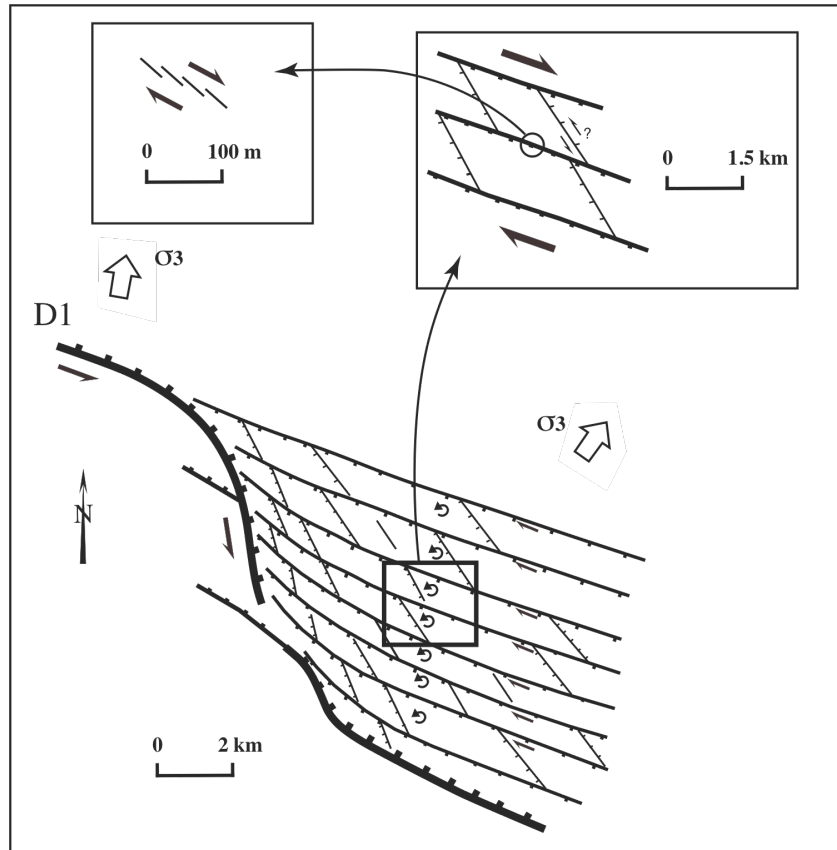


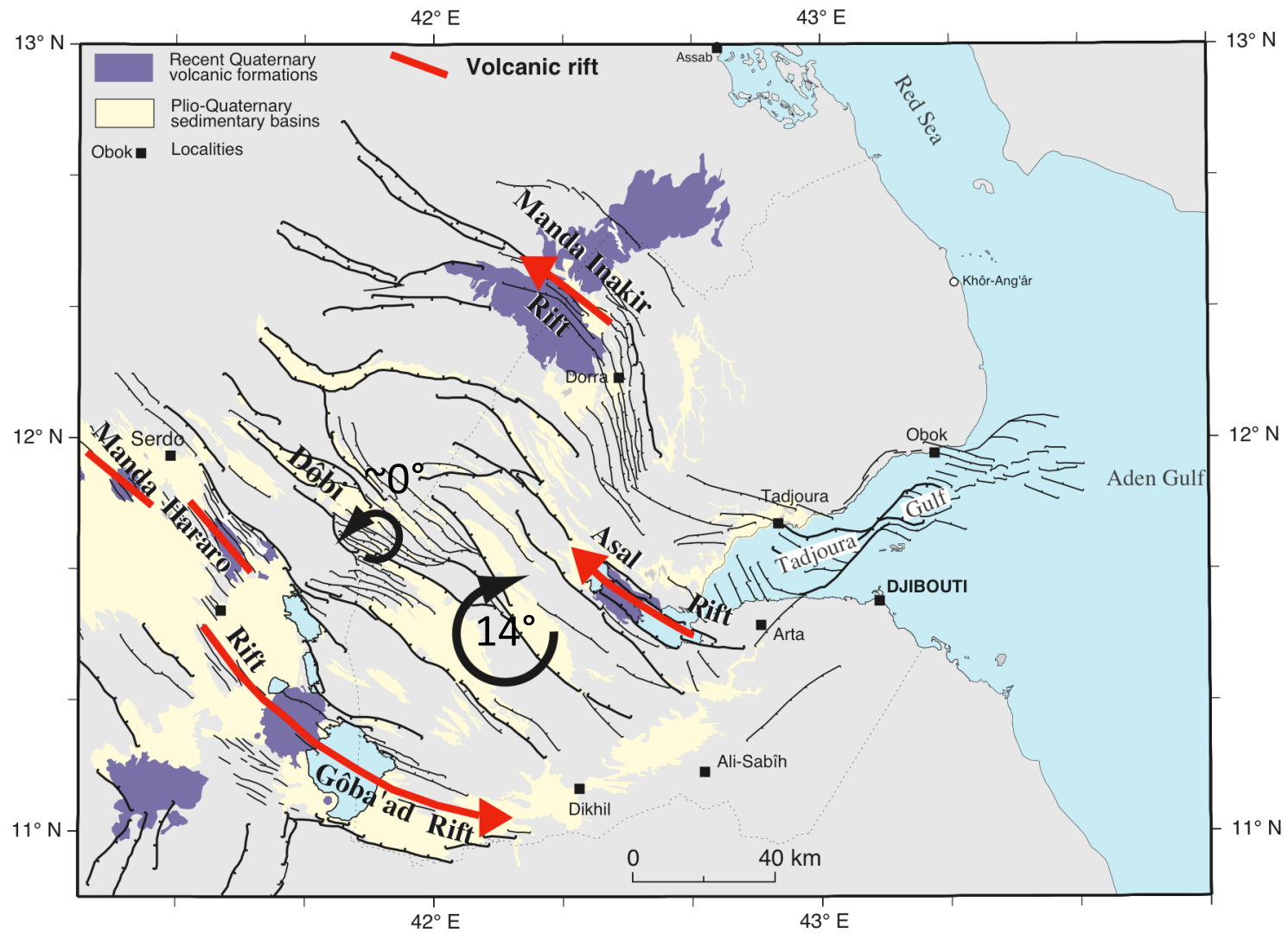
Tectonic map of Kadda Hawli half graben



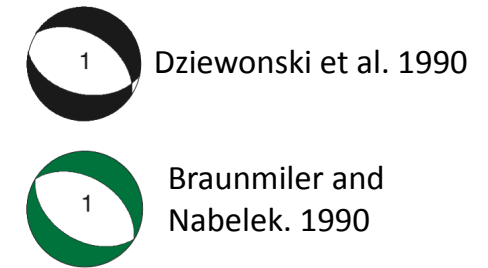
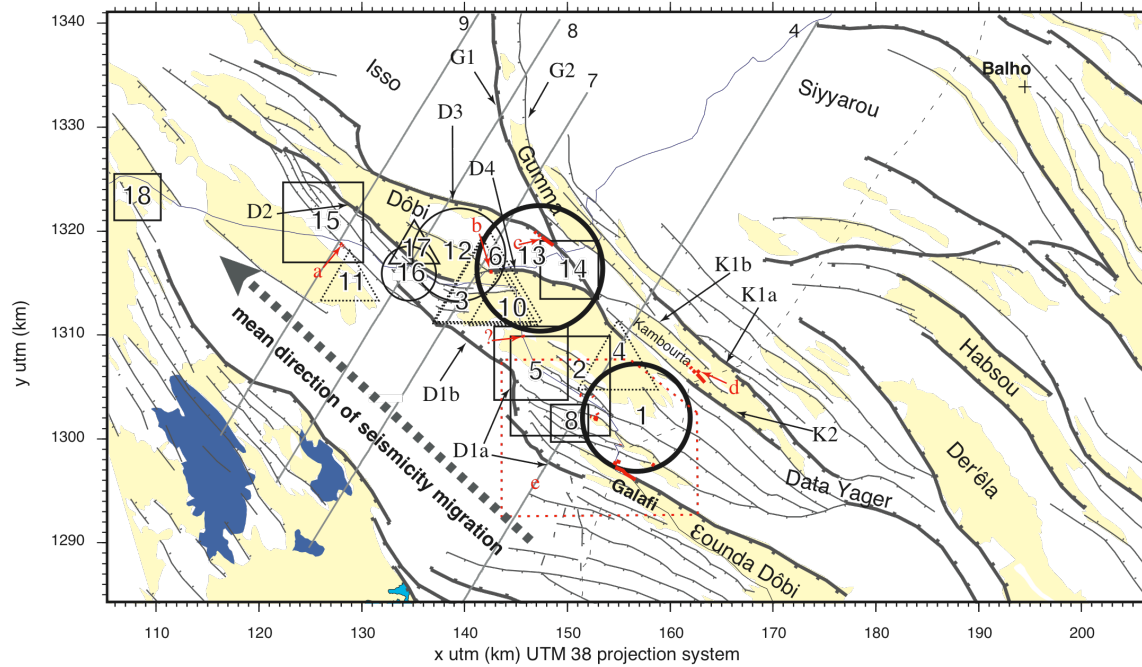
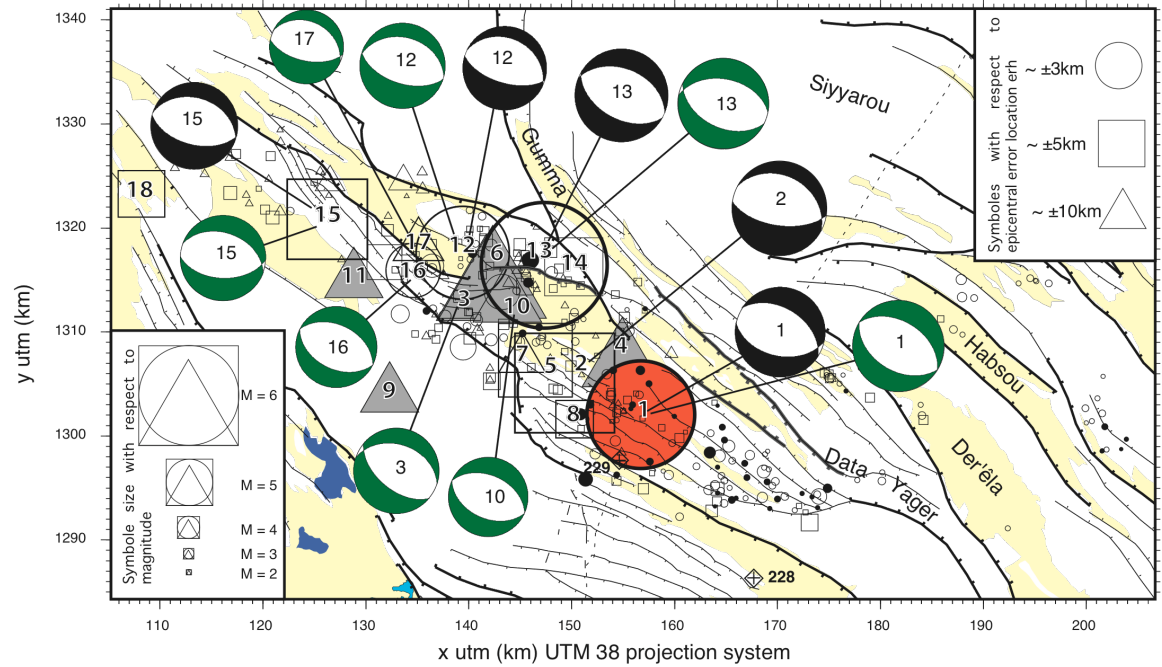
1989 Seismic surface breaks (measured in 1993)

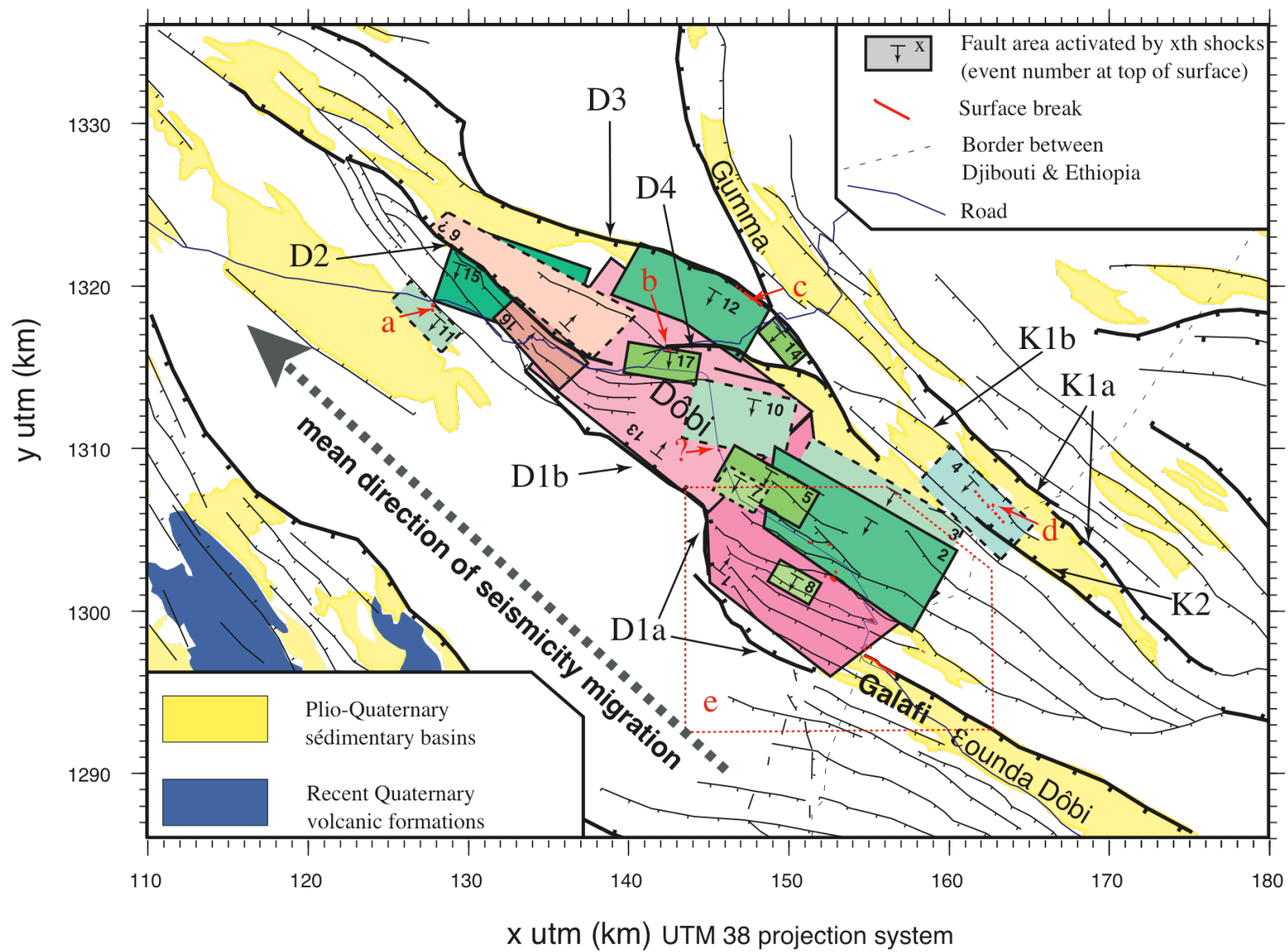
Deformation model of of Galafi Kadda Hawli region





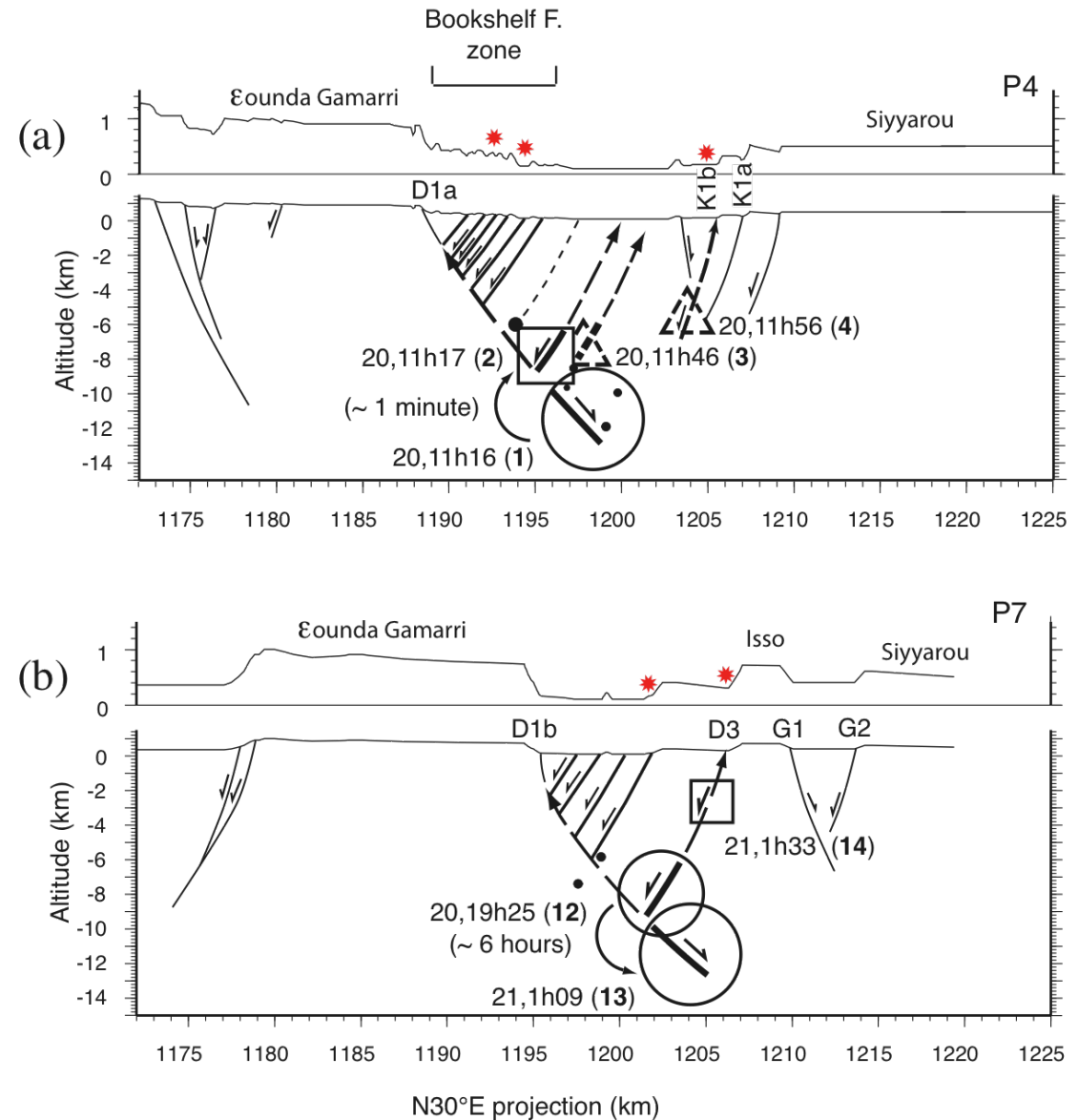
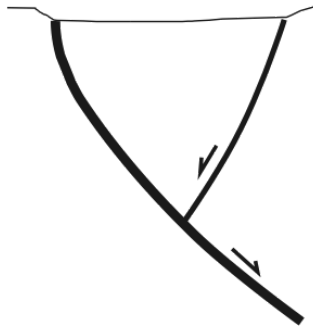
Seismotectonic analysis





Relationship, in section, between principal shocks and faults ruptured during Dôbi sequence

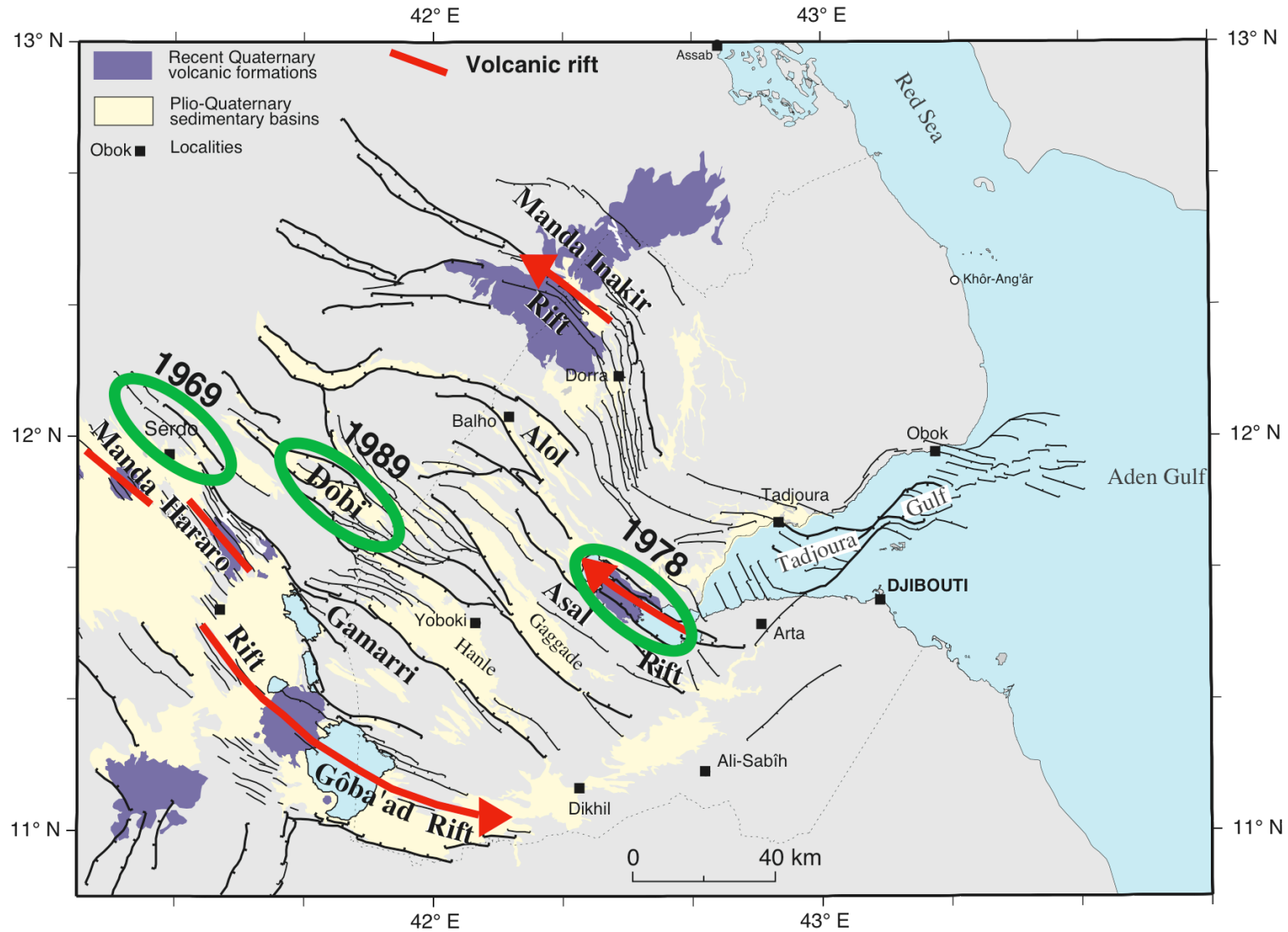
Most of the ruptures involved fault systems, which consist in a deeper main fault and a second order shallower fault abutting the former.




Conclusion

- In detail and in 3D, the faulting along the Dobi graben, which propagated about 35 km in 20 hours was probably governed by 3D Coulomb stress changes and mediated by water flow as proposed by noir et al. 1997 within a crustal volume of 65000km³.
- The coseismic kinematics inferred from the Dôbi earthquake sequence are in keeping with that inferred from regional deformation in the last 2 million years.
- Given the unusual density of active faults of different strikes, the complexity of the Dobi sequence typifies that of most multi-event sequences in Central Afar and other region of distributed normal faulting, elsewhere in the World.
- Such complex faulting coupling, explain the difficulty in interpreting previous Afar seismic sequences from sparser data (i.e. Serdo sequence, 1969).
- It is essential to study faulting at different time and spatial scales in order to understand how the hierarchy of imbricate structures of different sizes and the history of fault growth and propagation govern the finite kinematics of long term deformation.

The Dobi sequence partly bridges the gap between the largest sequences that occurred in Central and eastern Afar in the last 40 years



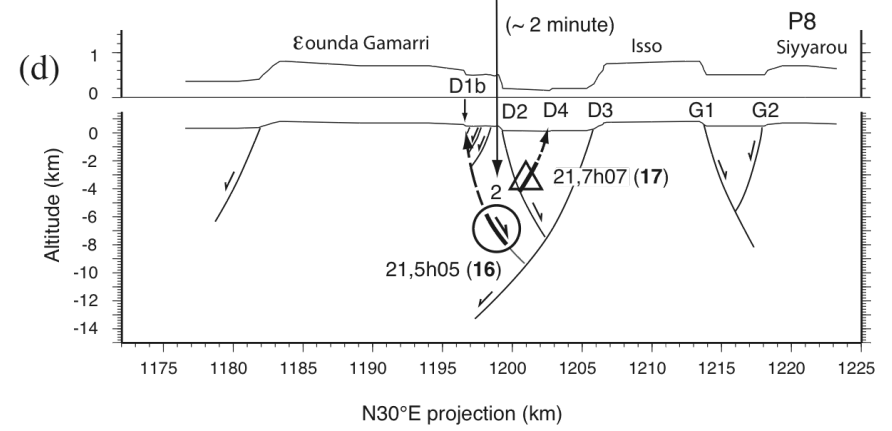
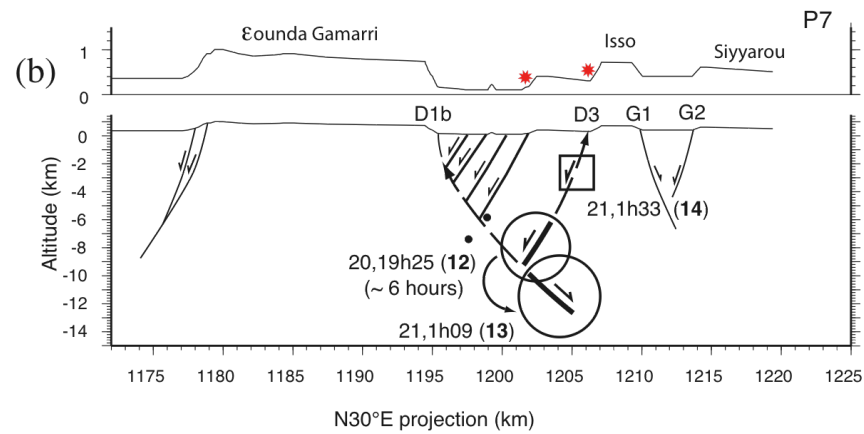
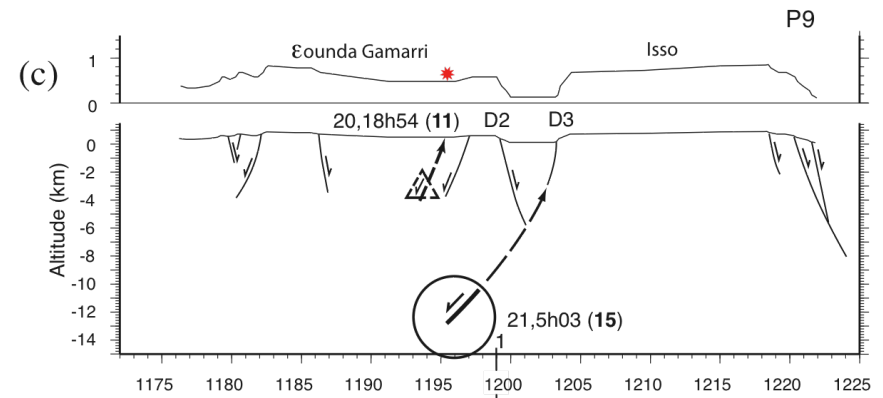
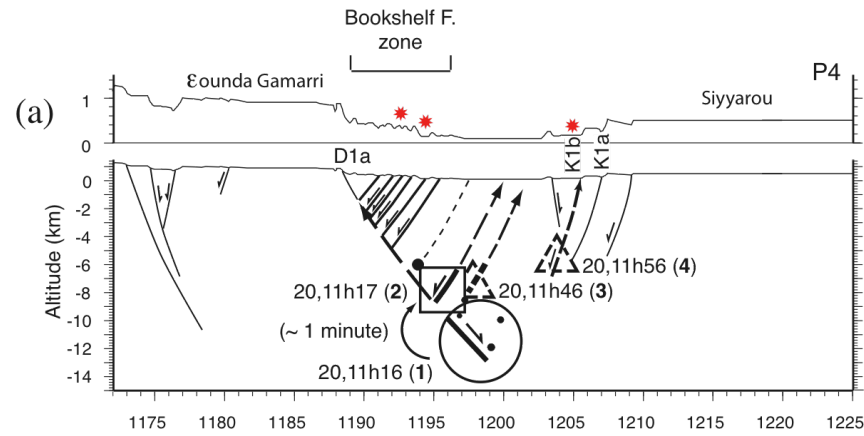
A scenic landscape photograph showing a volcanic region. In the foreground, there is a dark, rocky slope. In the middle ground, a large lake is visible, surrounded by low-lying volcanic hills. In the background, there are more mountains under a cloudy sky. The text "Thank you for your attention !" is centered over the image.

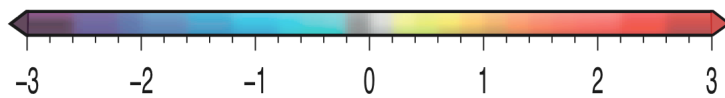
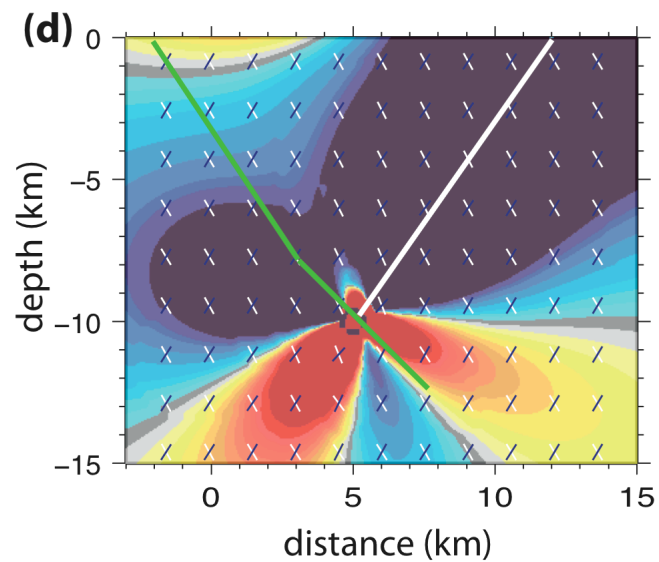
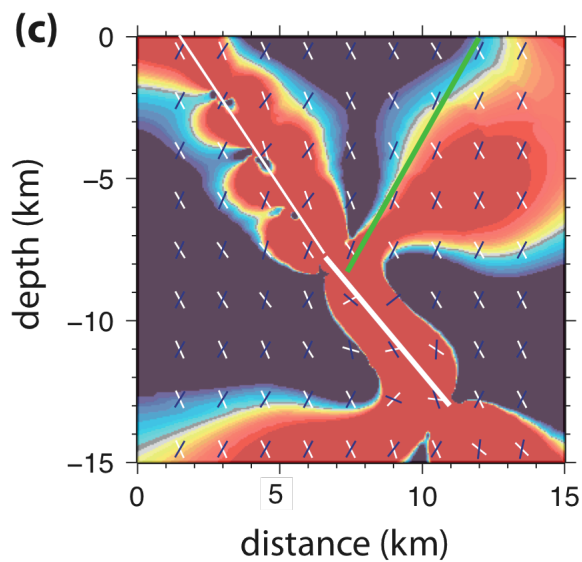
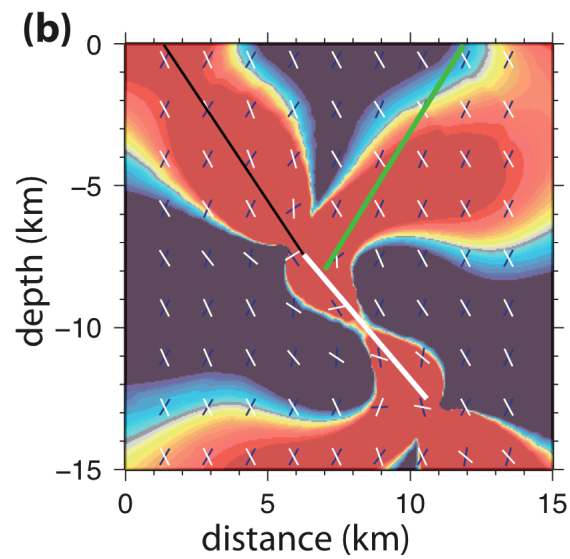
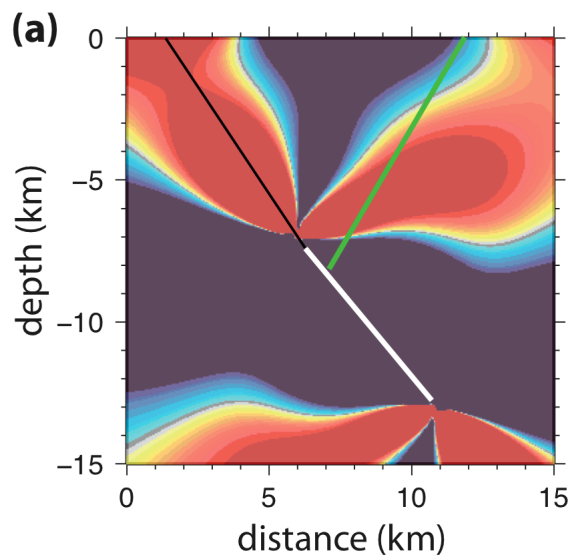
Thank you for your attention !

Thank you for your attention !



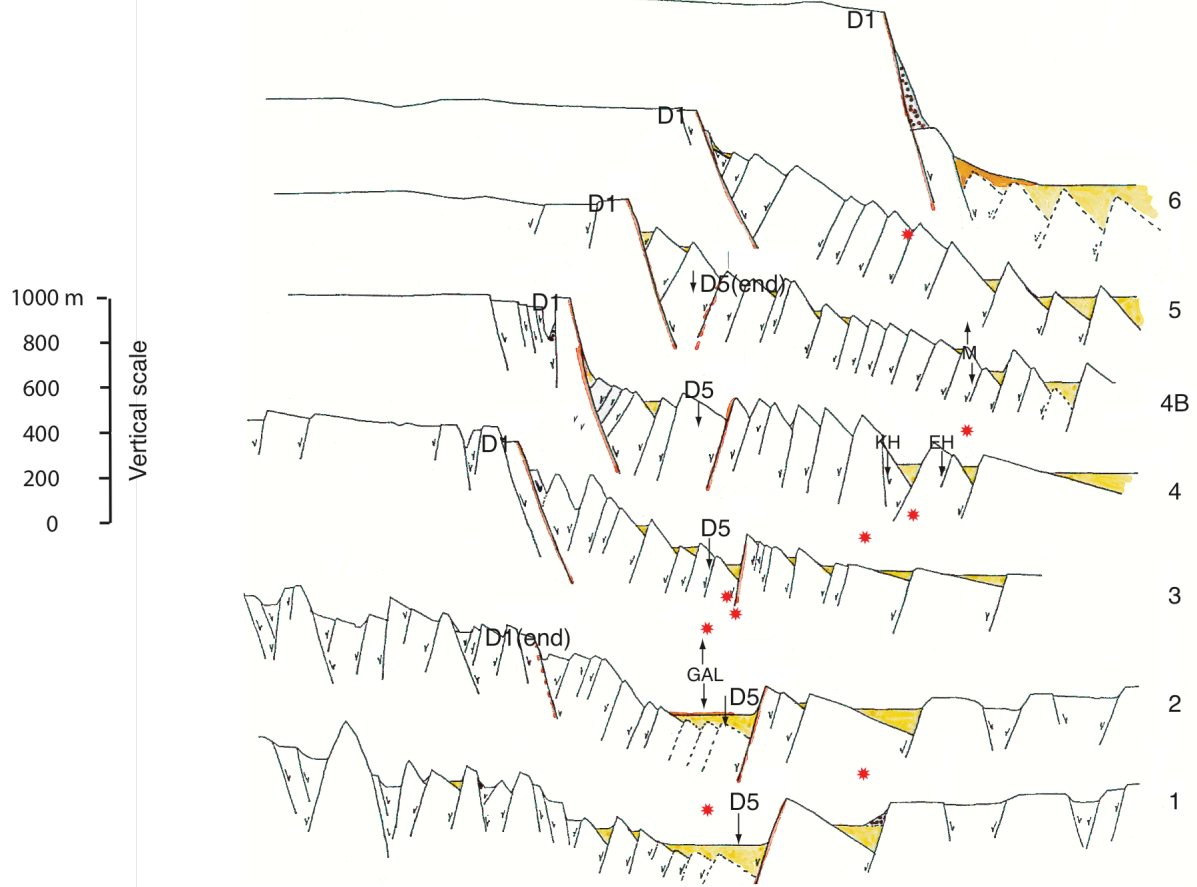
Relationship, in section, between principal shocks and faults ruptured during Dôbi sequence



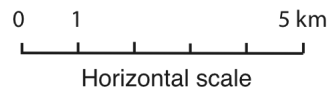


Coulomb Failure Stress Change (bars)

Εounda Gamarri plateau

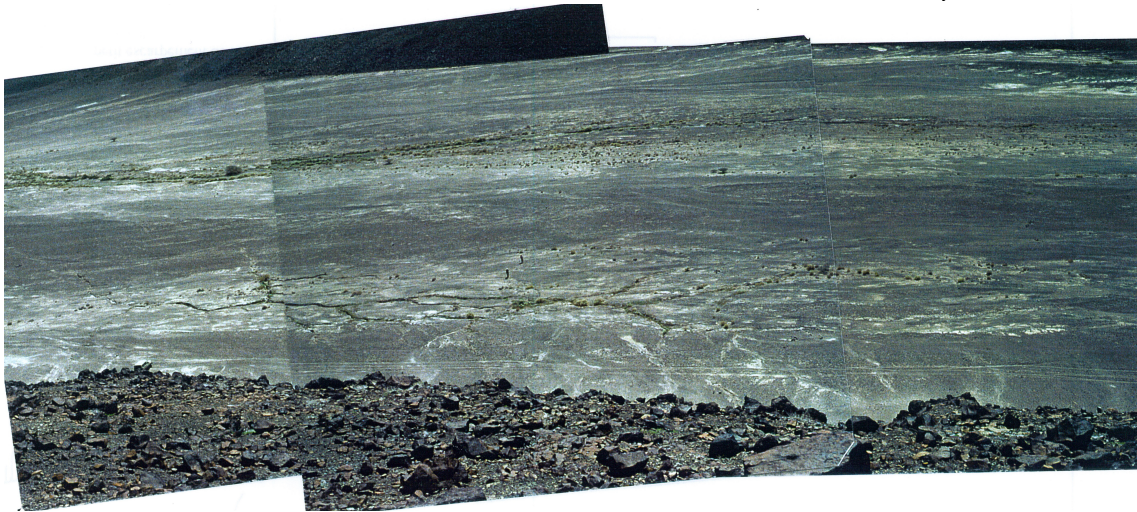


N30°E projection



Kadda Hawli region

Kadda Hawli, 1993



Kadda Hawli, 1993



Kadda Hawli, 1993



Kadda Hawli, 1993



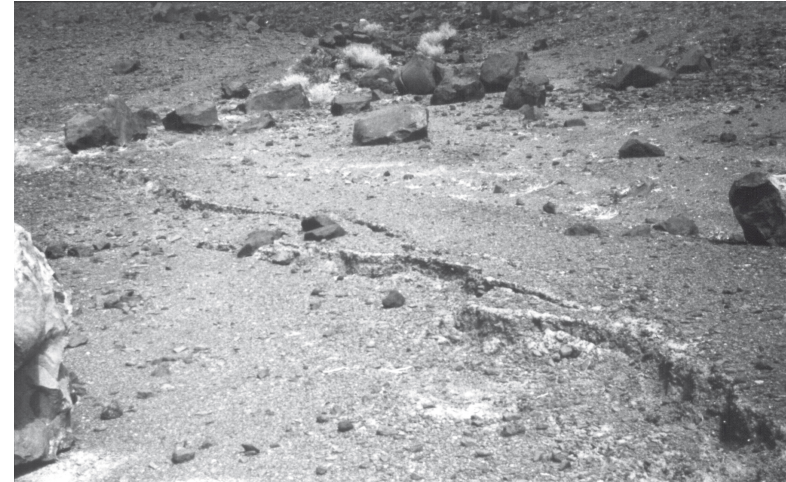
Makεanni, 1994

Surface effects of the earthquakes

Galafi 1989, Djibouti



Kambourta graben 1989, Ethiopia

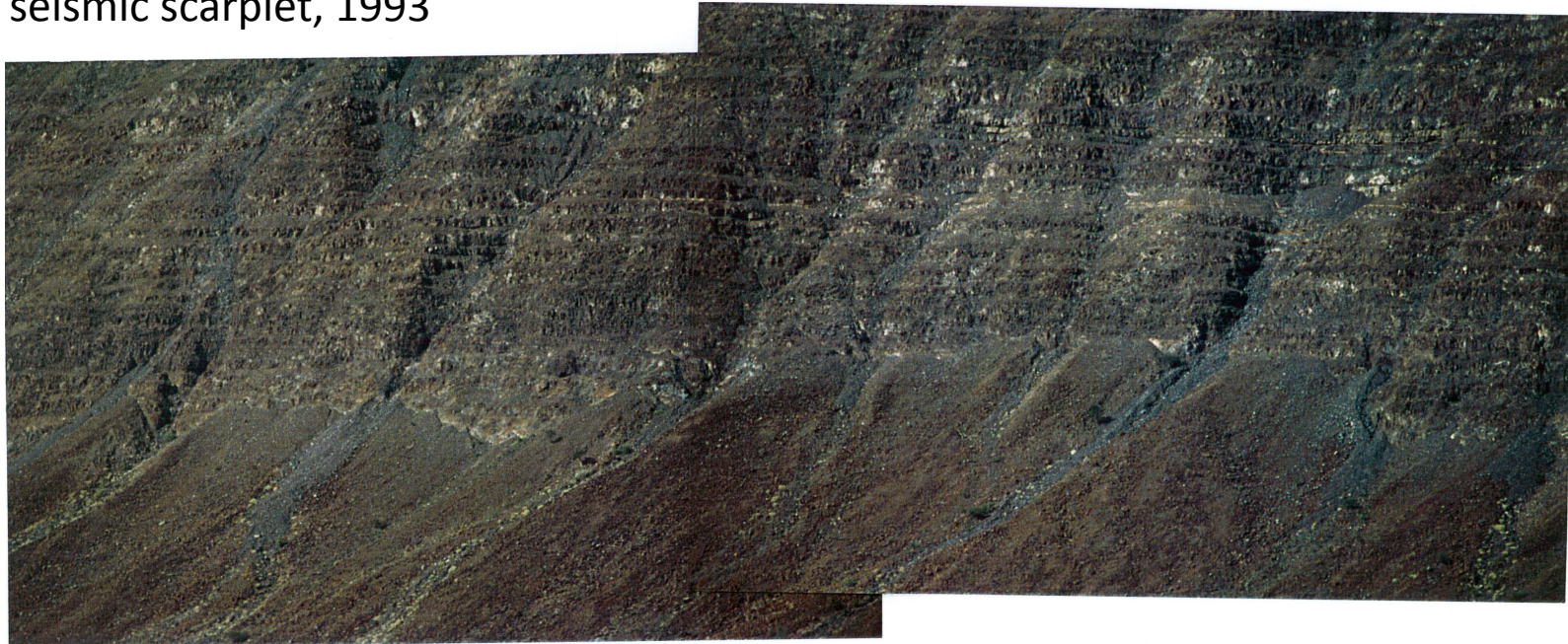


East of Dicitto 1993, Ethiopia

D3 fault scarp



D3 seismic scarplet, 1993





D5 seismic scarplet, 1993

