Fault Activity in Response to Rifting Episode in Ethiopian Afar using InSAR

Fringe 2011

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Geodynamical Setting

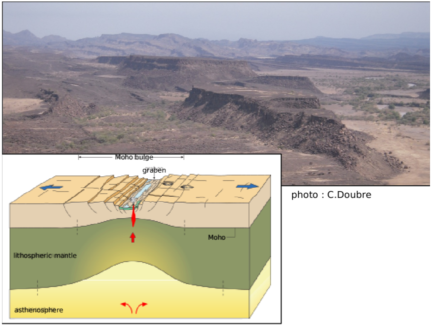
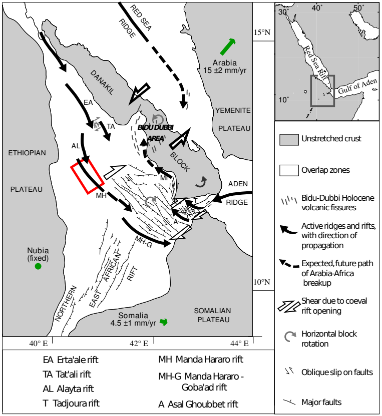


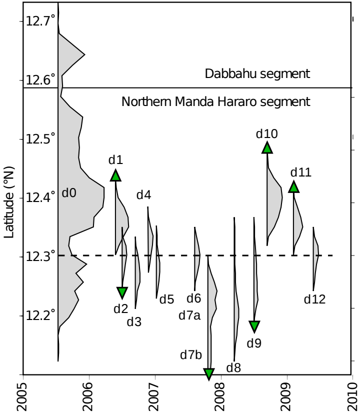
photo : C.Doubre

- Magma circulation from mantle to the ground surface
- Extension tectonic : normal faults and open fissures

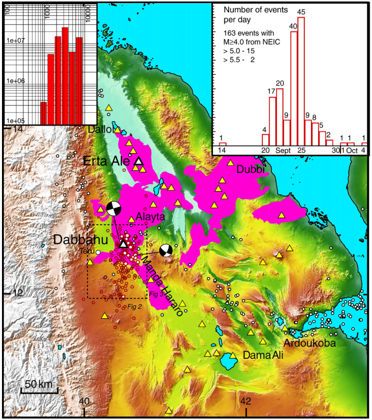


Modified from Manighetti et al.(2001)

Ethiopian Rifting Episode : 2005-2010



Modified from Grandin et al.(2010)

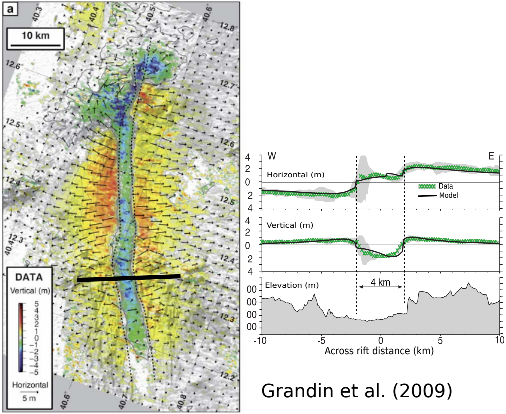


From Ayele et al.(2007)

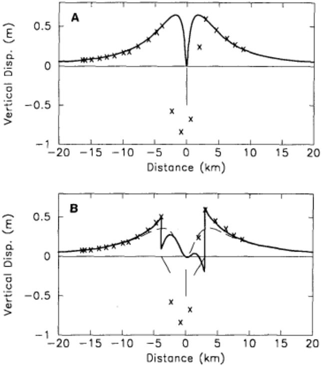
Dabbahu-Manda Harraro Rifting Episode : Observation/Modelisation

Displacement field from ENVISAT InSAR data :

2 ascending
2 descending tracks



Grandin et al. (2009)

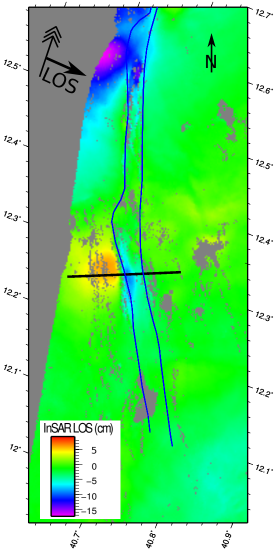


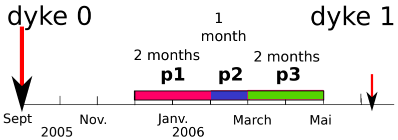
Rubin et al. (1988)

Role of Faults During the Rifting Episode ?

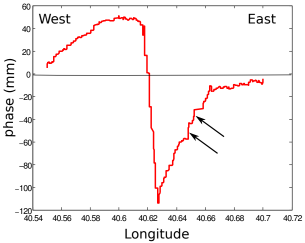
- Are the faults **activated only during diking** processes ?
- **Where are the active faults located** ?
  Is there a relation with the location of the last dyke intrusion(s) ?
  Is there a relation with the crustal magma chamber and its activity (inflation/deflation) ?
- How is the evolution of the dynamics of these faults with time ?

The Period of Interest : Dec - Mai 2006





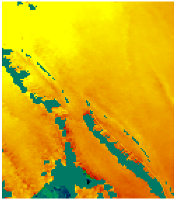
Interferograms (ascending tracks)



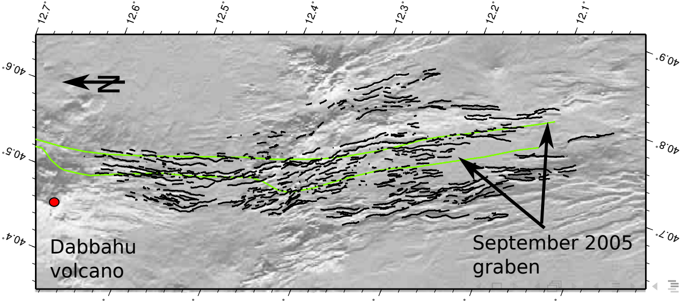
Fault Mapping

Quickbird images
(horiz. resol : 0.6 m)

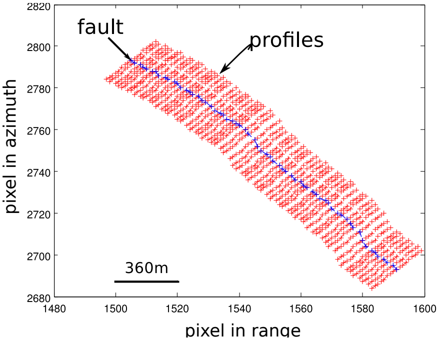
SPOT images
(horiz. resol : 2.5 m)

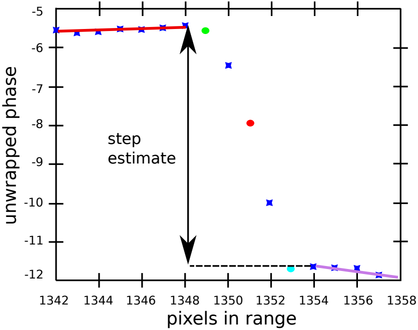


interferogram images
(horiz. resol : 20 m)



Measurement of LOS Offsets

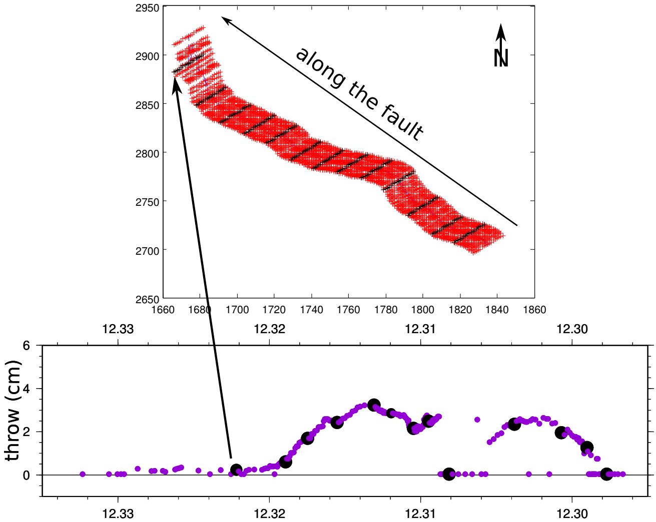




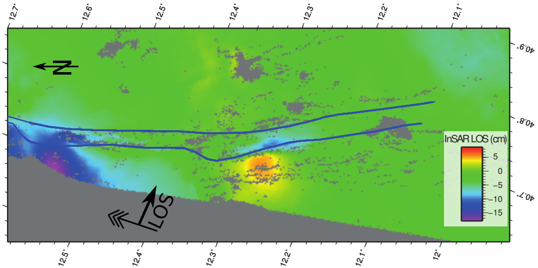
- end points of faults : reference for normal profiles
- 360 m long profiles

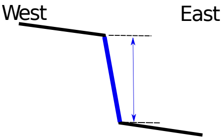
- bootstrap : robust estimate of fault location
- Step estimate using linear regressions

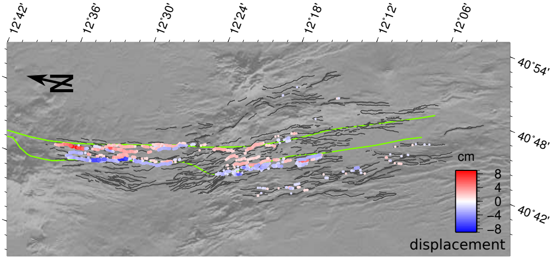
Slip profiles

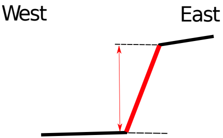


Location of Active Faults During the D0-D1 Period

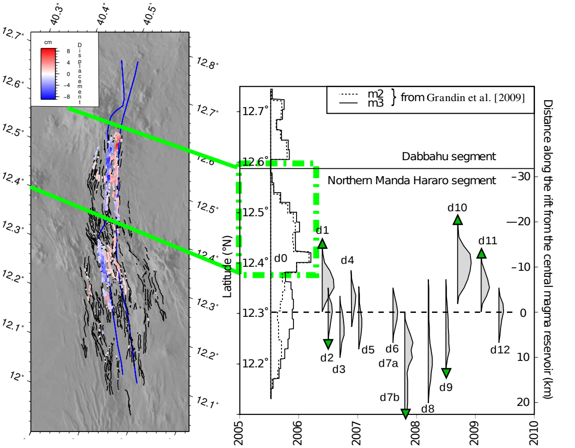








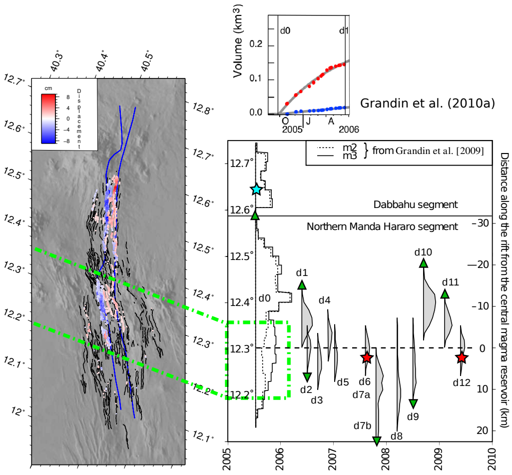
Faulting Related to the Opening of the Previous Dyke



From Grandin et al (2010b)

⇝ faulting in Northern area : **role** in the compensation of a lesser opening at depth

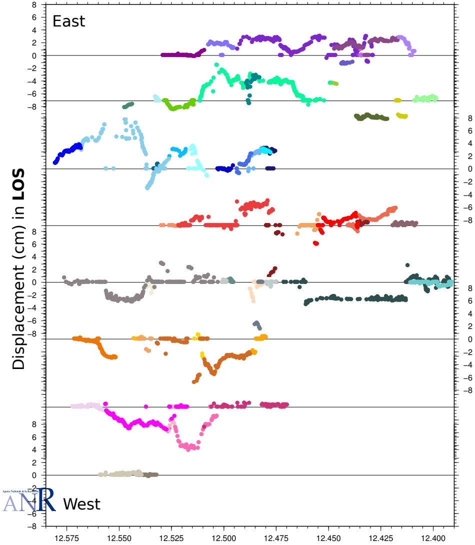
Faulting, Opening and Inflation of the deep magma chamber

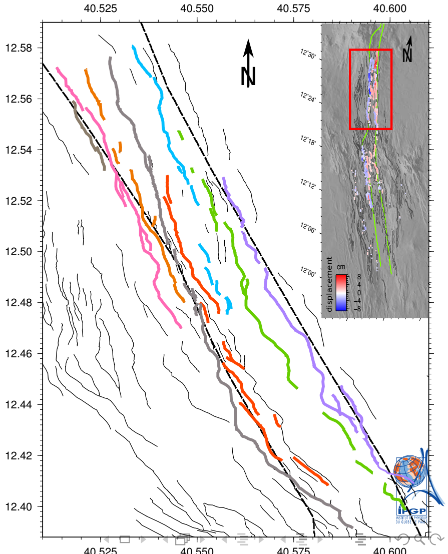


Grandin et al. (2010b)

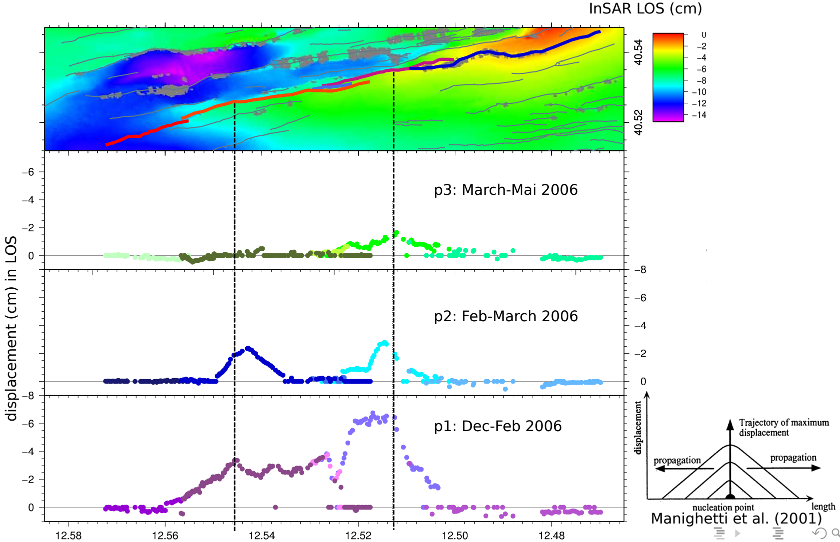
⇝ faulting in Southern area : **role** in the compensation of a lesser opening AND probably associated with **re-filling** of the crustal magma chamber

Fault Dynamics : Northern Region





Coherence of the Fault Deformation With Time



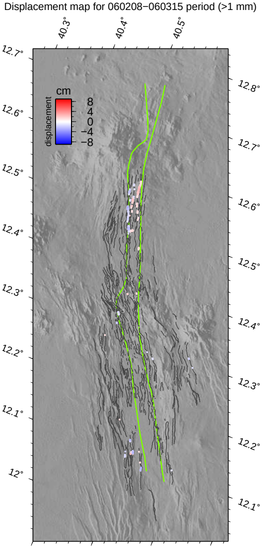
Summary

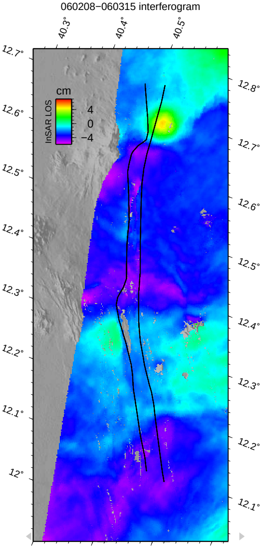
- **First interdiking period** : Activity in 2 distinct regions Northern and Southern areas
- **Northern et southern regions** : Faulting in regions of lesser opening due to mega-dike
- **Southern region** : Interaction with inflation of deep magma chamber
- Conservation of this fault segmentation during inter-diking period

Outlook

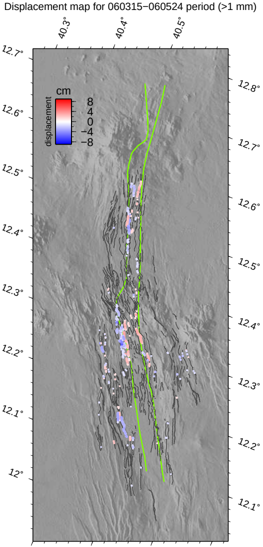
- Evolution of segmentation during rifting episode
- How do intrusions influence fault dynamics ?
- Distribution of opening ?

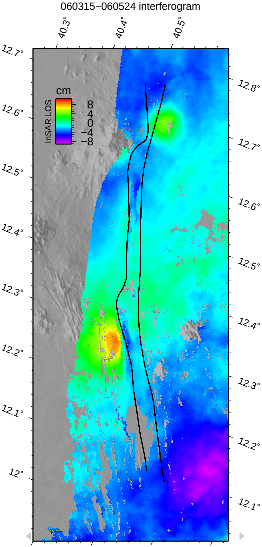
Appendix A : Feb-March 2008



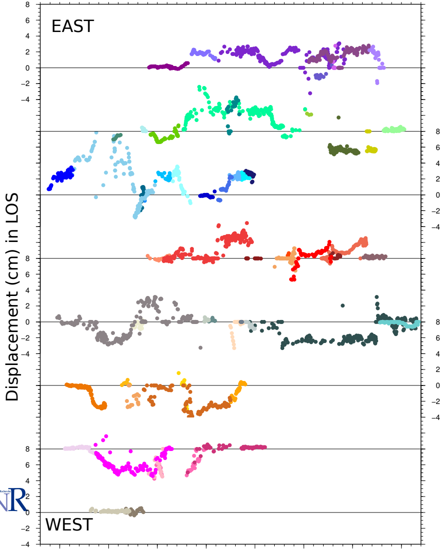


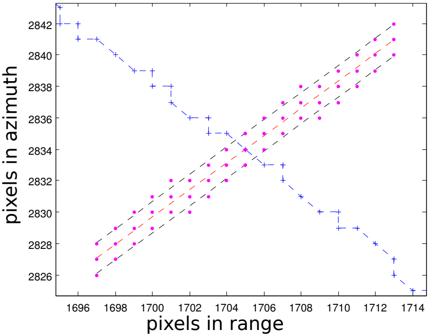
Appendix B : March-Mai 2008



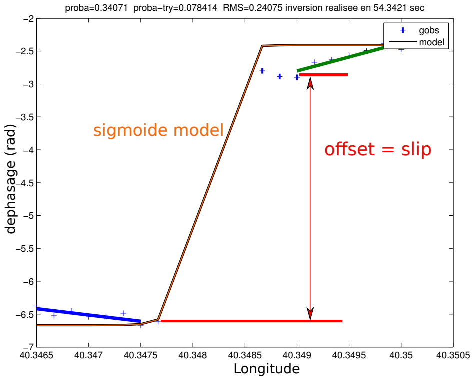


Appendix C : Box-profiles



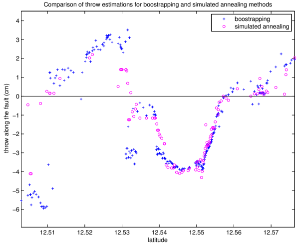


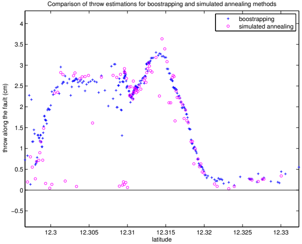
Appendix D : Simulated Annealing

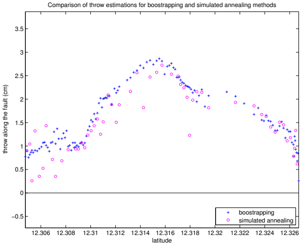


- offset located by a sigmoide (= forward model)
- non linear inversion by simulated annealing
- inflection points of sigmoide to constrain the linear fits

Appendix 5 : Comparison between the two methods







- same range in throw magnitudes
- similar distribution of throw along the fault

$\leadsto$ results validated by 2 independent methods