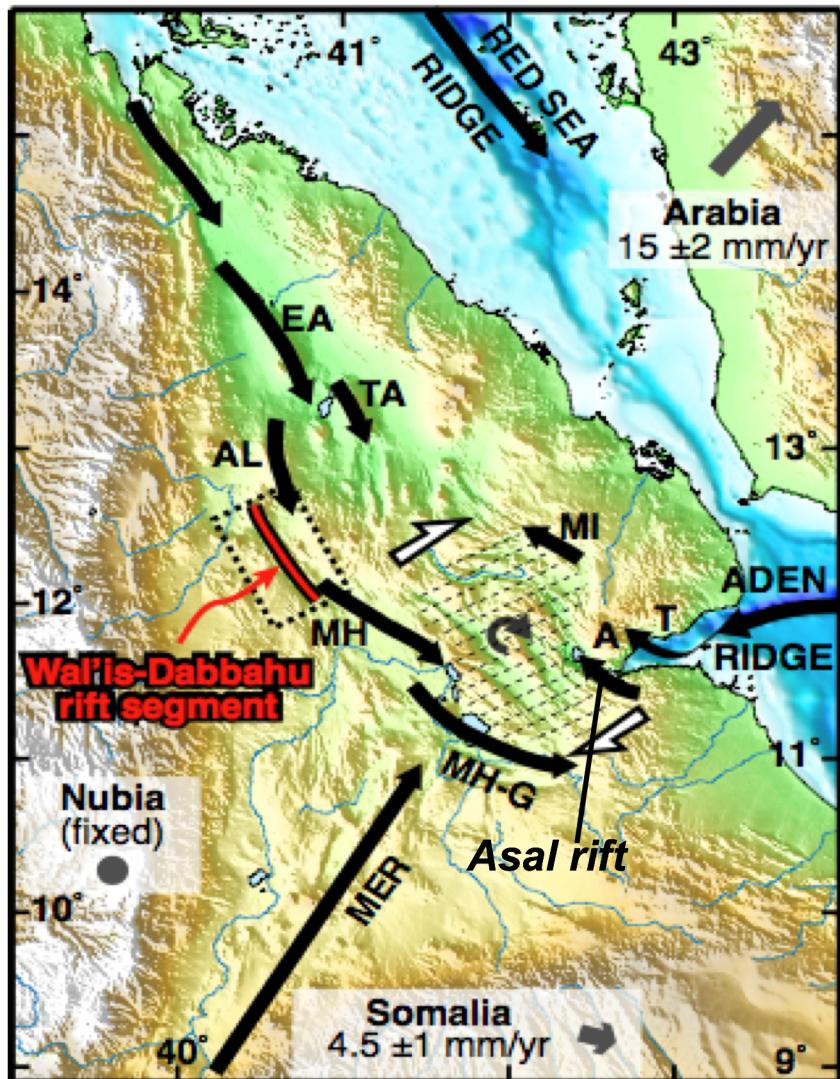


Co- to Post-diking deformation in the Manda-Hararo rift (Afar, Ethiopia) insights from high-resolution InSAR time-series

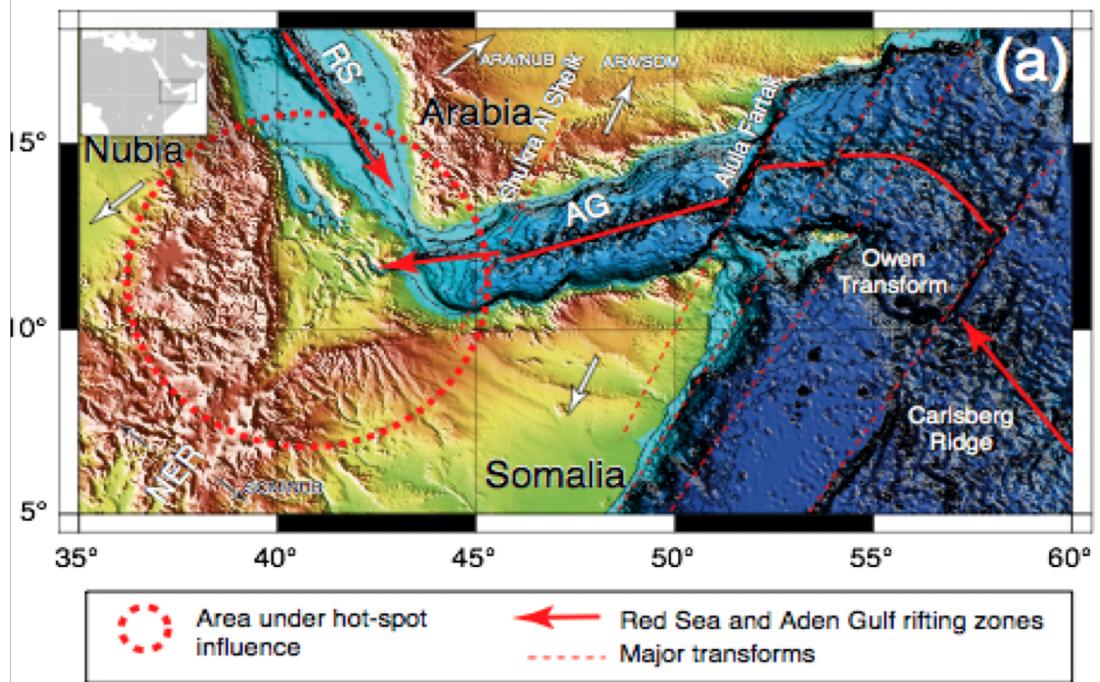
Anne Socquet; Raphaël Grandin; Stéphanie Dumont; Cécile Doubre; Eric Jacques; Yann Klinger

Institut des Sciences de la Terre, Université de Grenoble 1, France
Laboratoire de géologie, Ecole Normale Supérieure de Paris, France
Institut de Physique du Globe de Paris, France
Institut de Physique du Globe de Strasbourg, France

The Afar depression: an hot-spot influenced triple junction



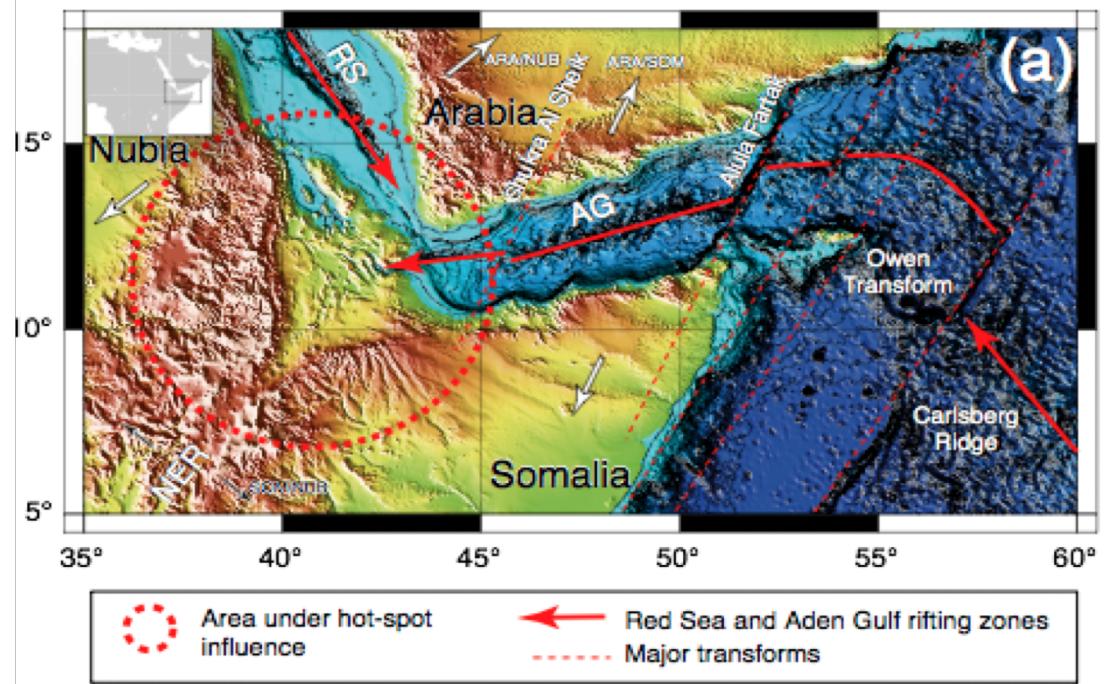
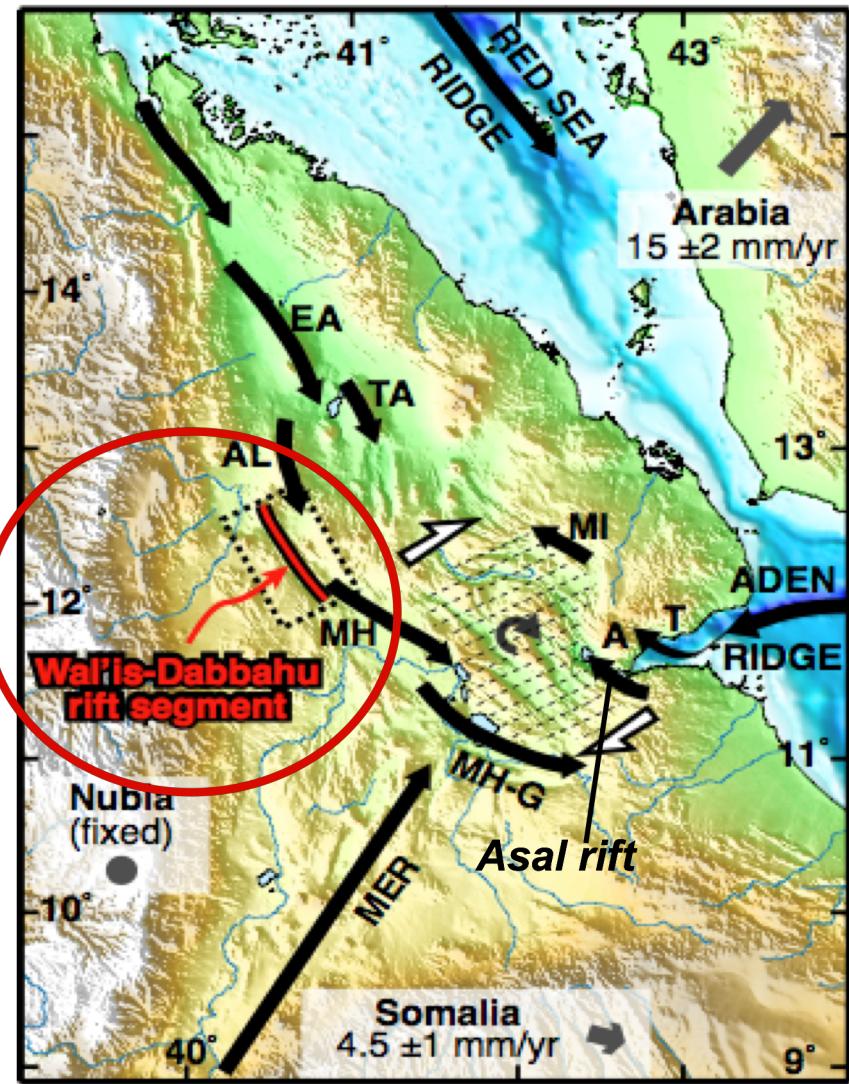
[Tapponnier et al., 1990; Manighetti et al., 2001; Pinzuti, 2006]



Rupture of the lithosphere due to:

- far-field extensional tectonic forces
- hot-spot influence since ~ 30 Myrs
=> a sub-aerial analogue of slow-spreading Mid-Oceanic Ridges

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September 2005: onset of a rifting episode at Dabbahu - Manda-Hararo rift segment

Recent Seismovolcanic Crisis in Northern Afar, Ethiopia

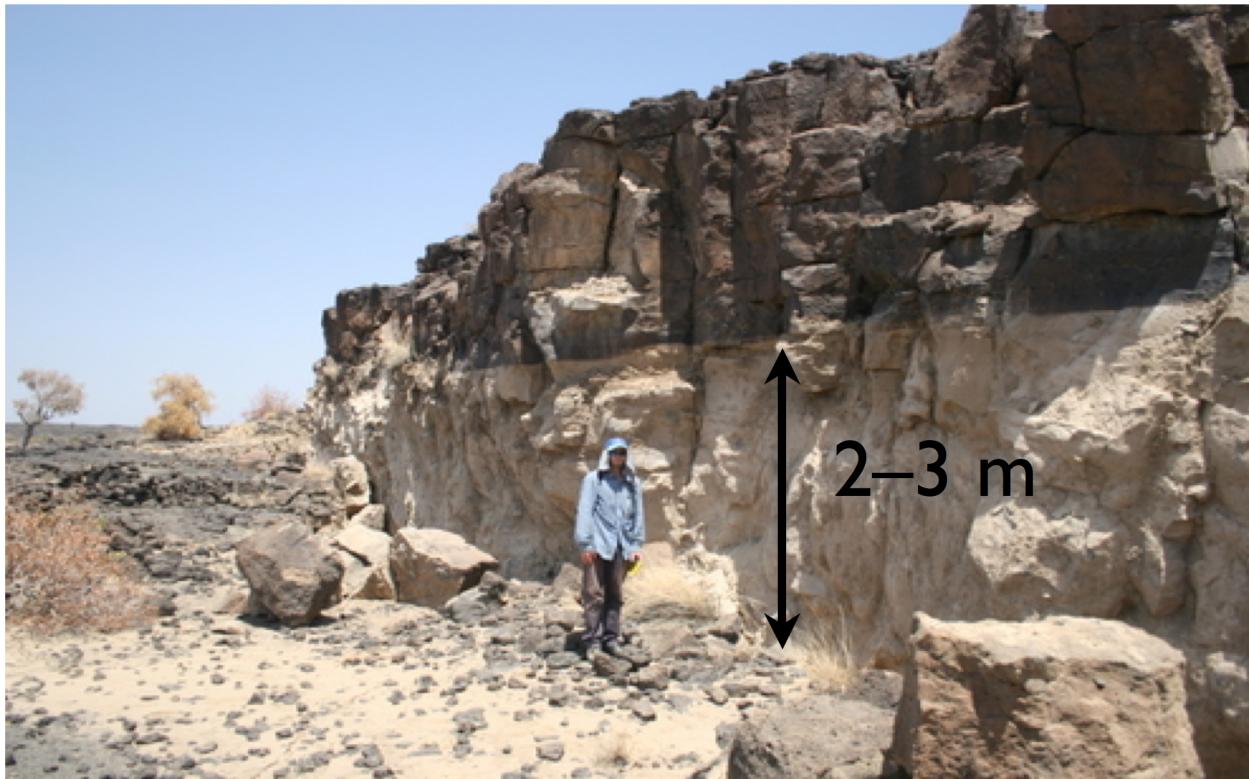
BY G. YIRGU, A. AYELE, AND D. AYALEW



[Yirgu et al 2006, EOS]

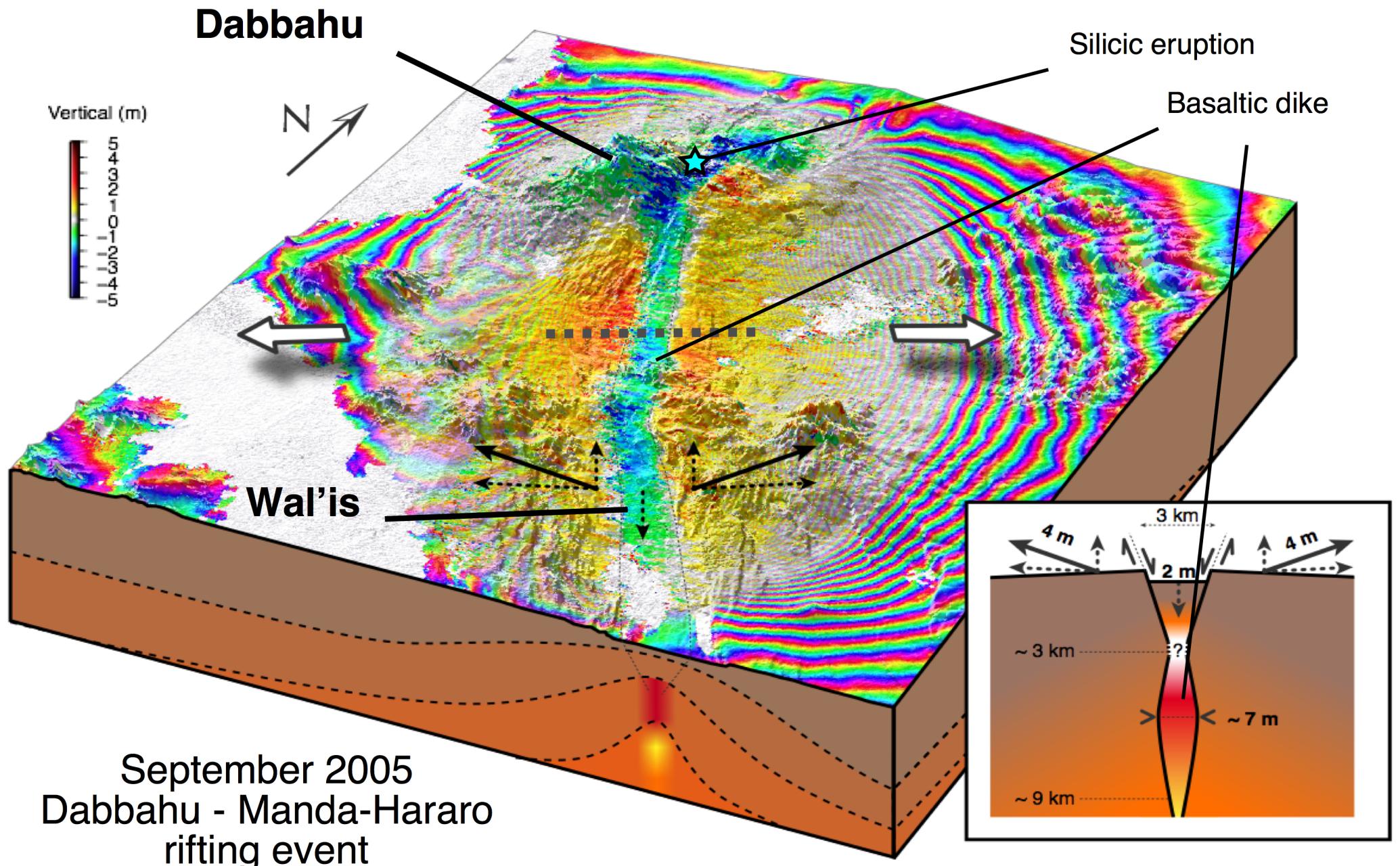
September 26, 2005

“Da’Ure” silicic eruption
pumice projections
+ obsidian dome growth



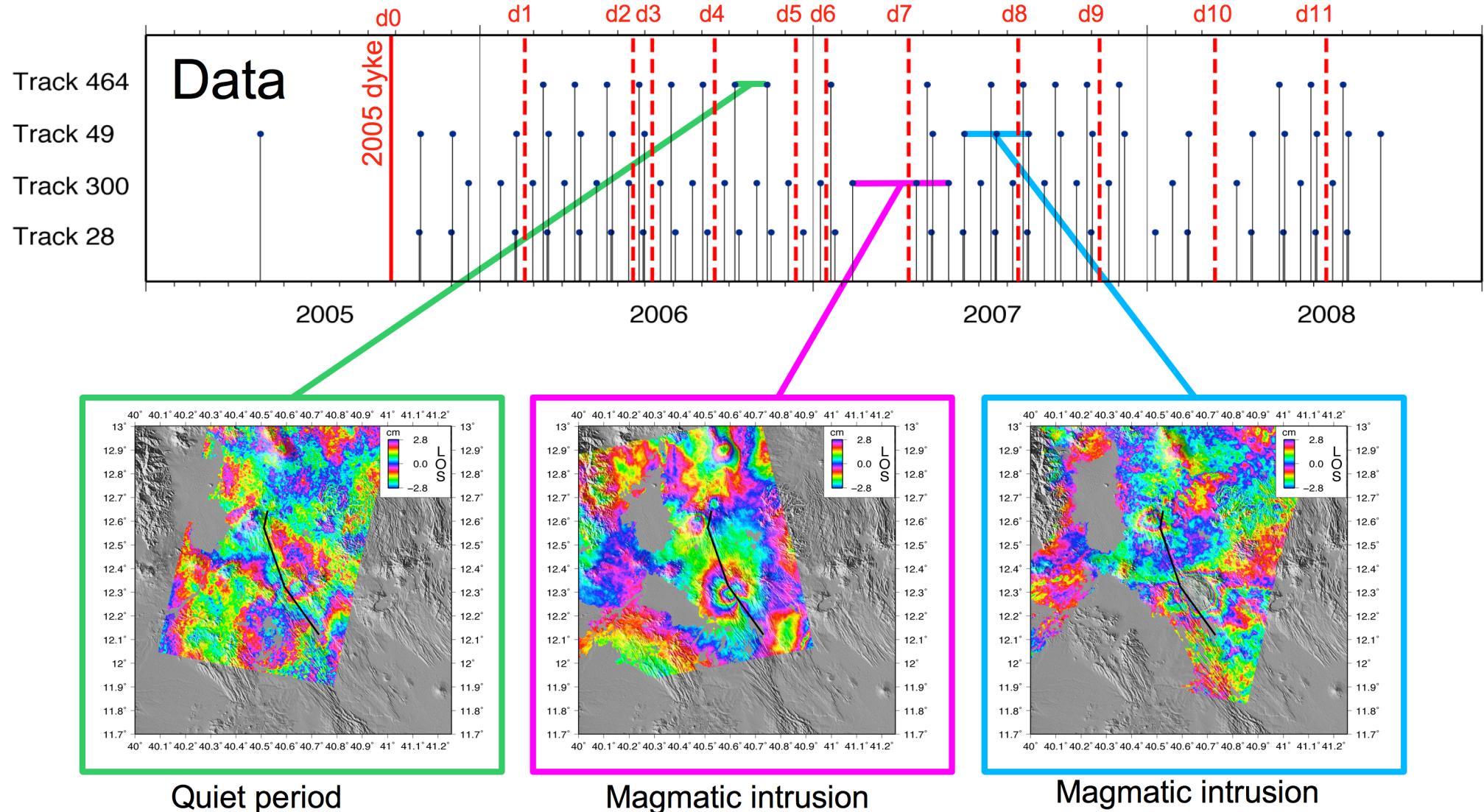
[Yirgu et al 2006, EOS]



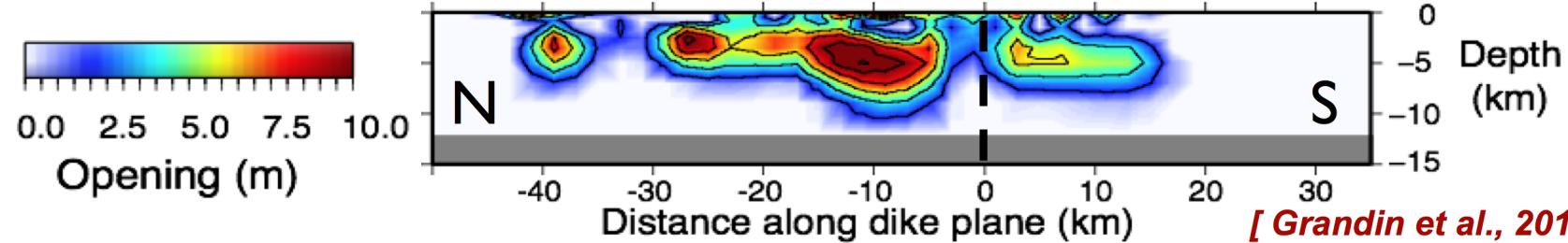
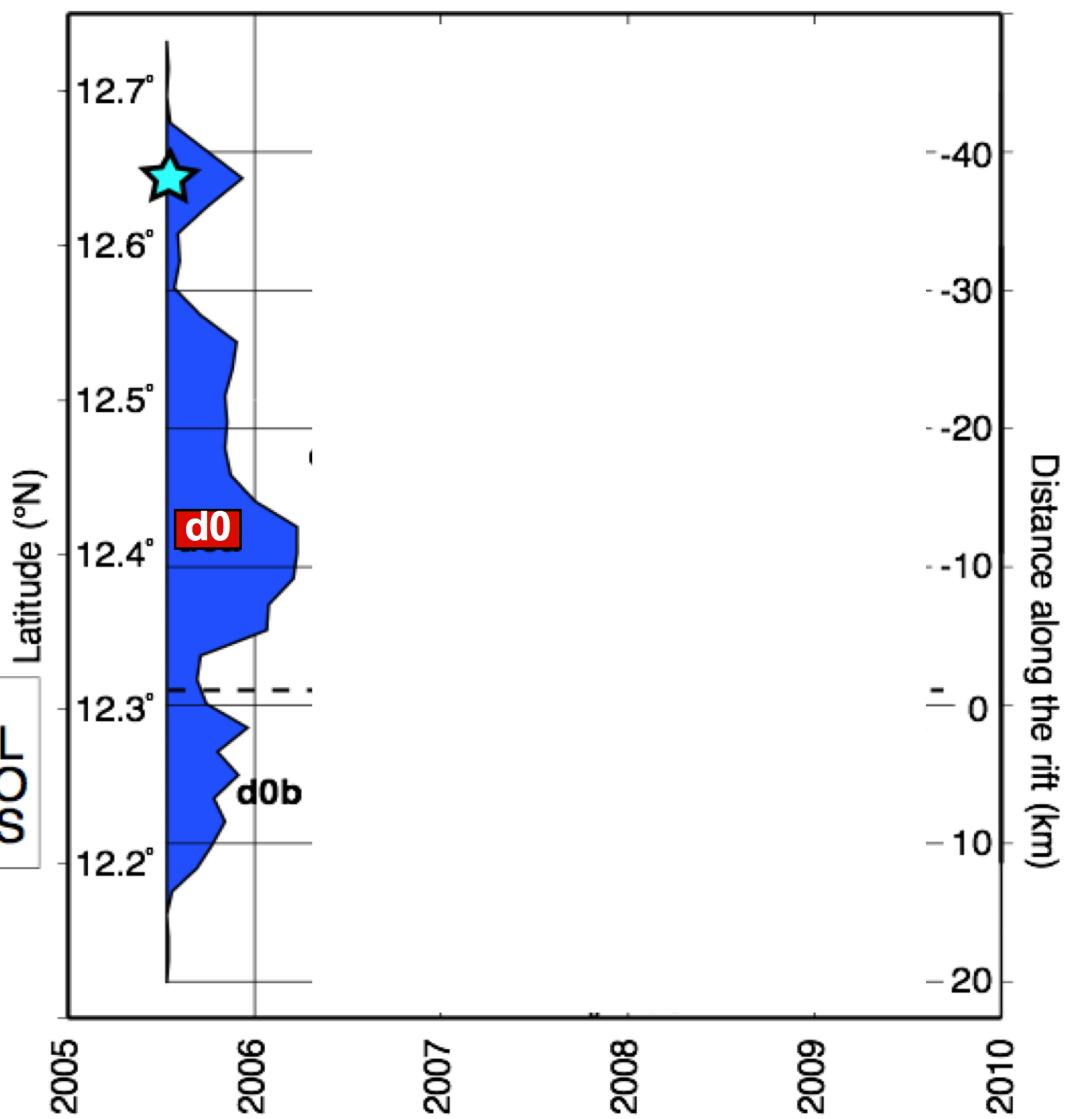
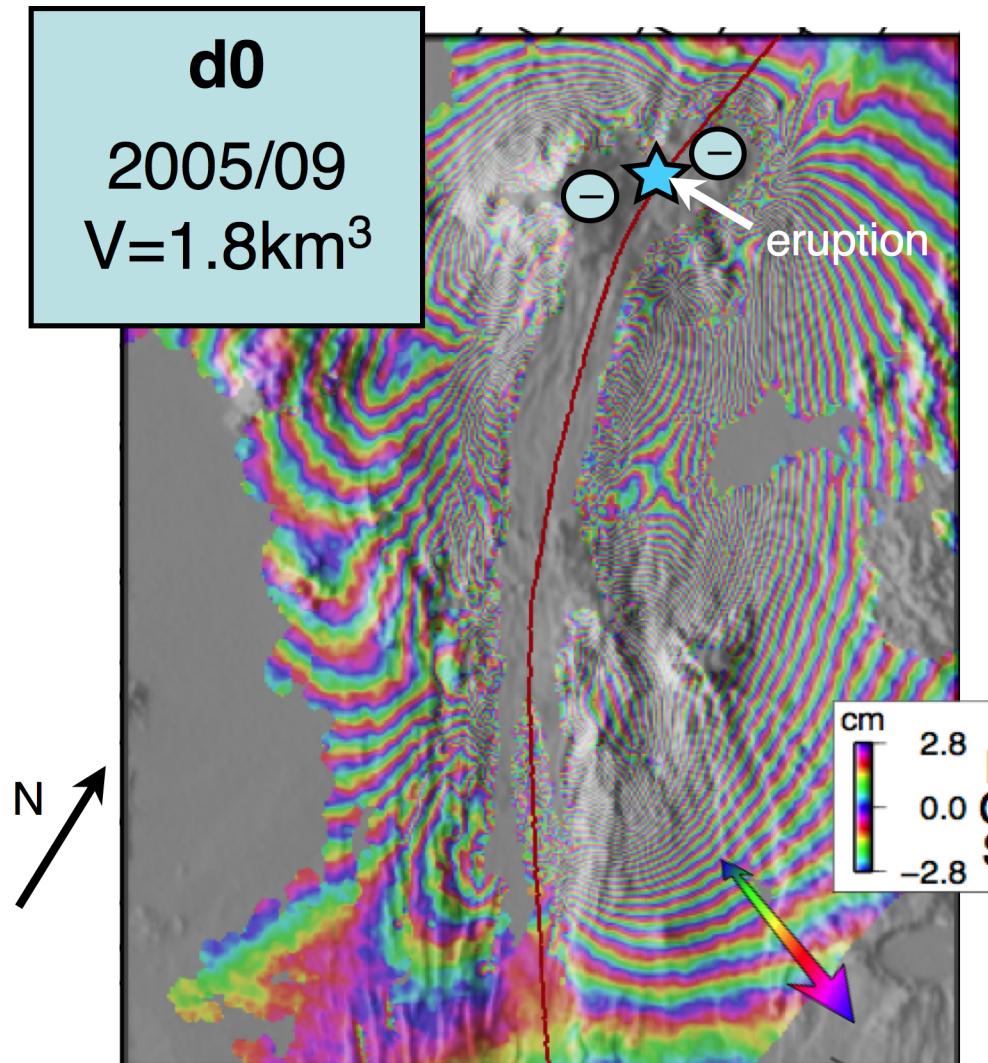


[Grandin et al., 2009, JGR]

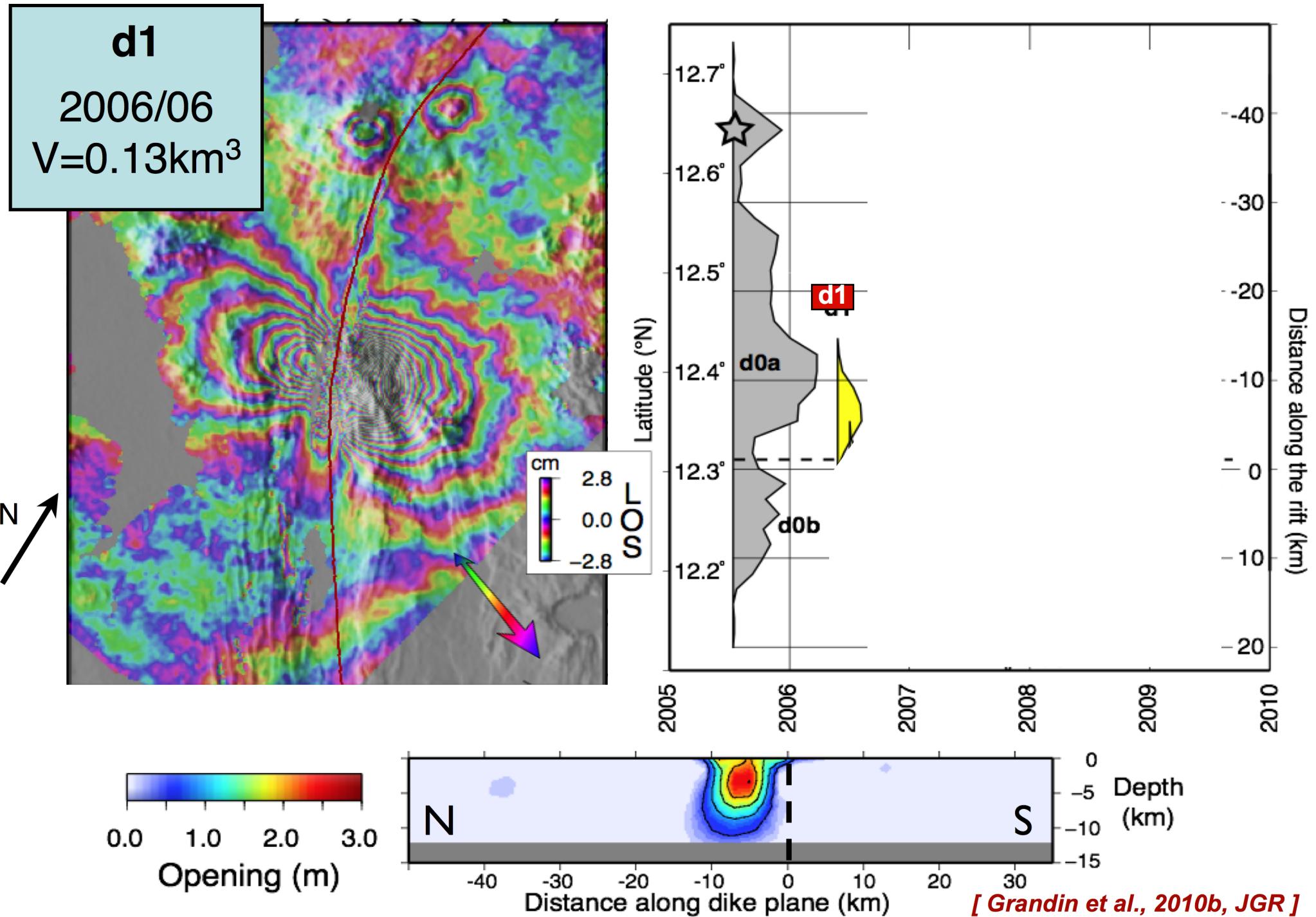
SAR interferometry time series allow mapping of deformation with time



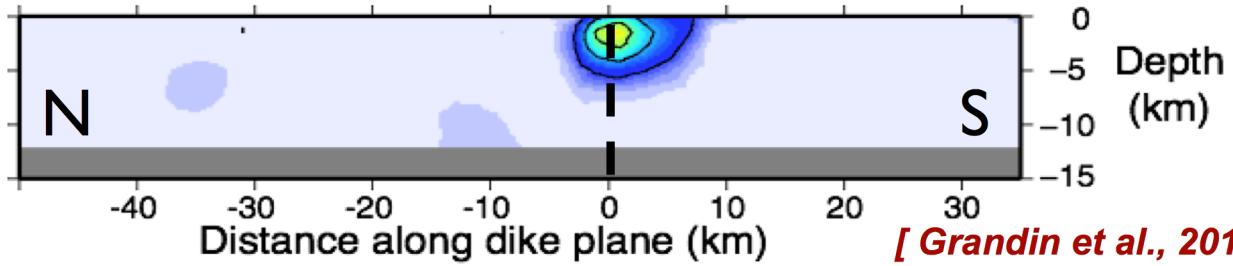
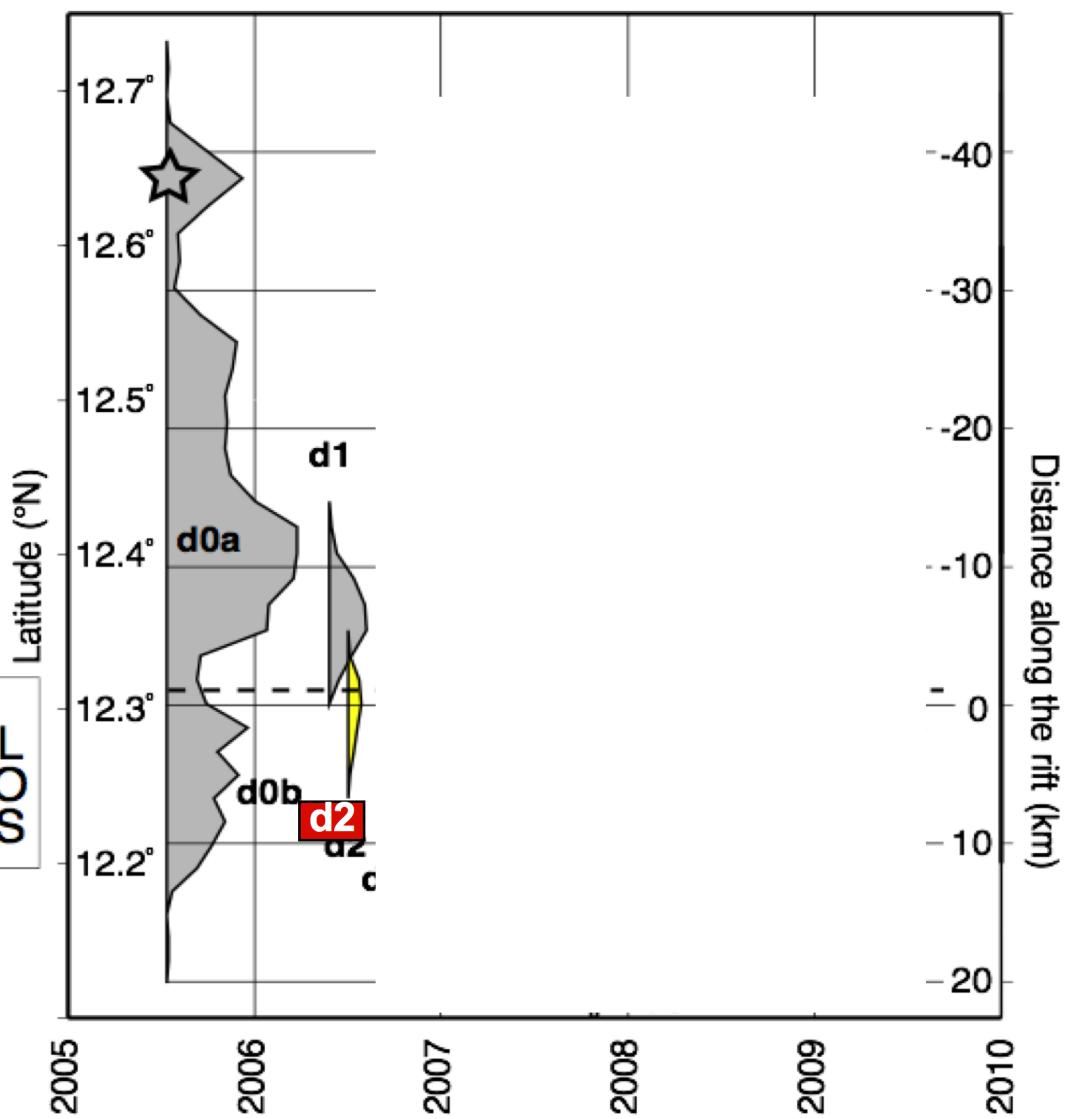
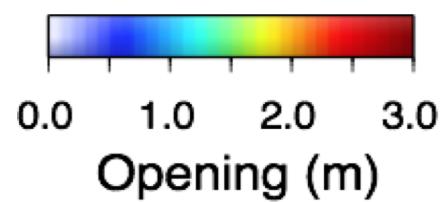
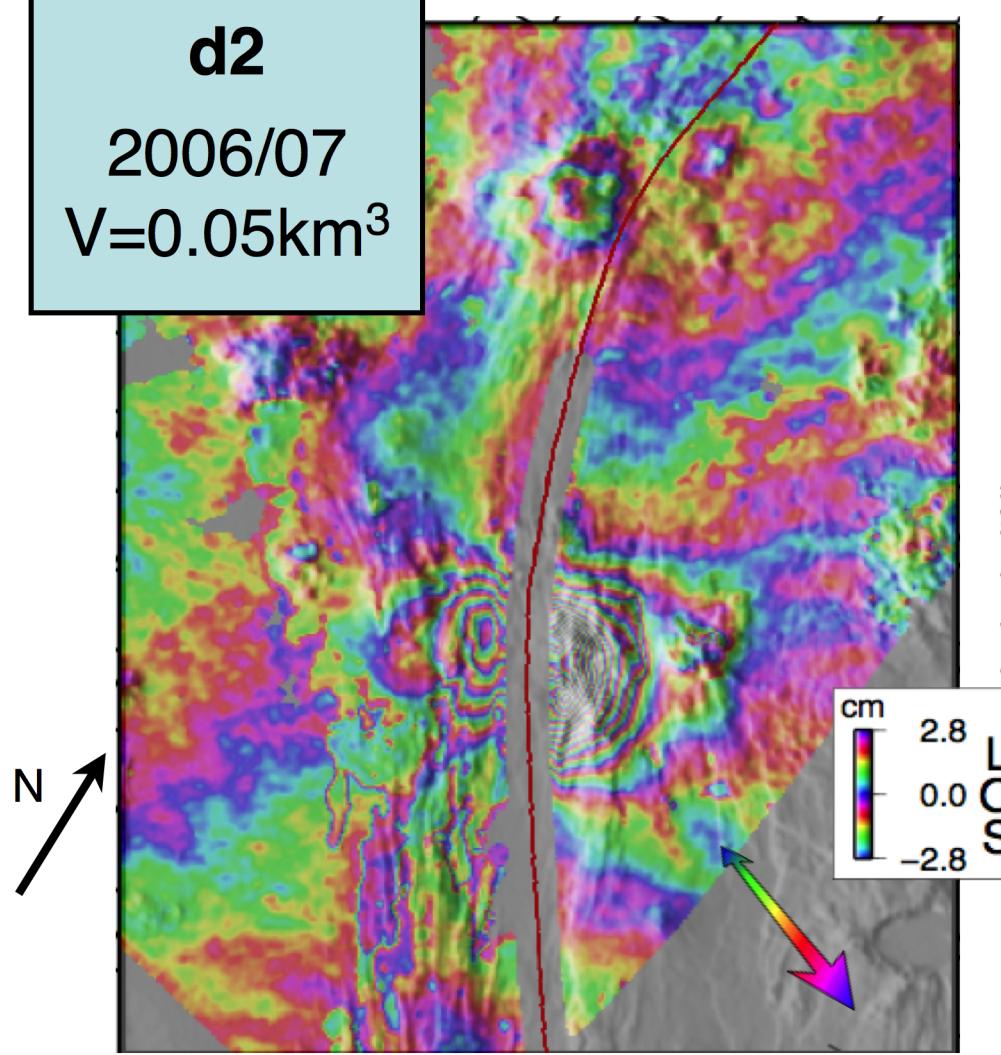
d0
2005/09
 $V=1.8\text{ km}^3$



[Grandin et al., 2010b, JGR]

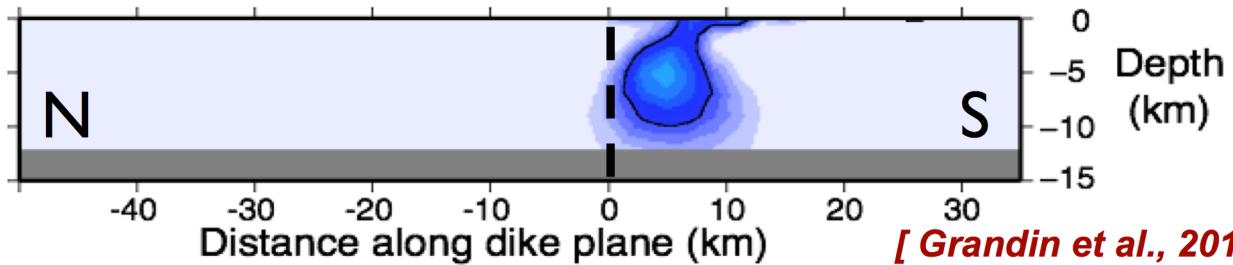
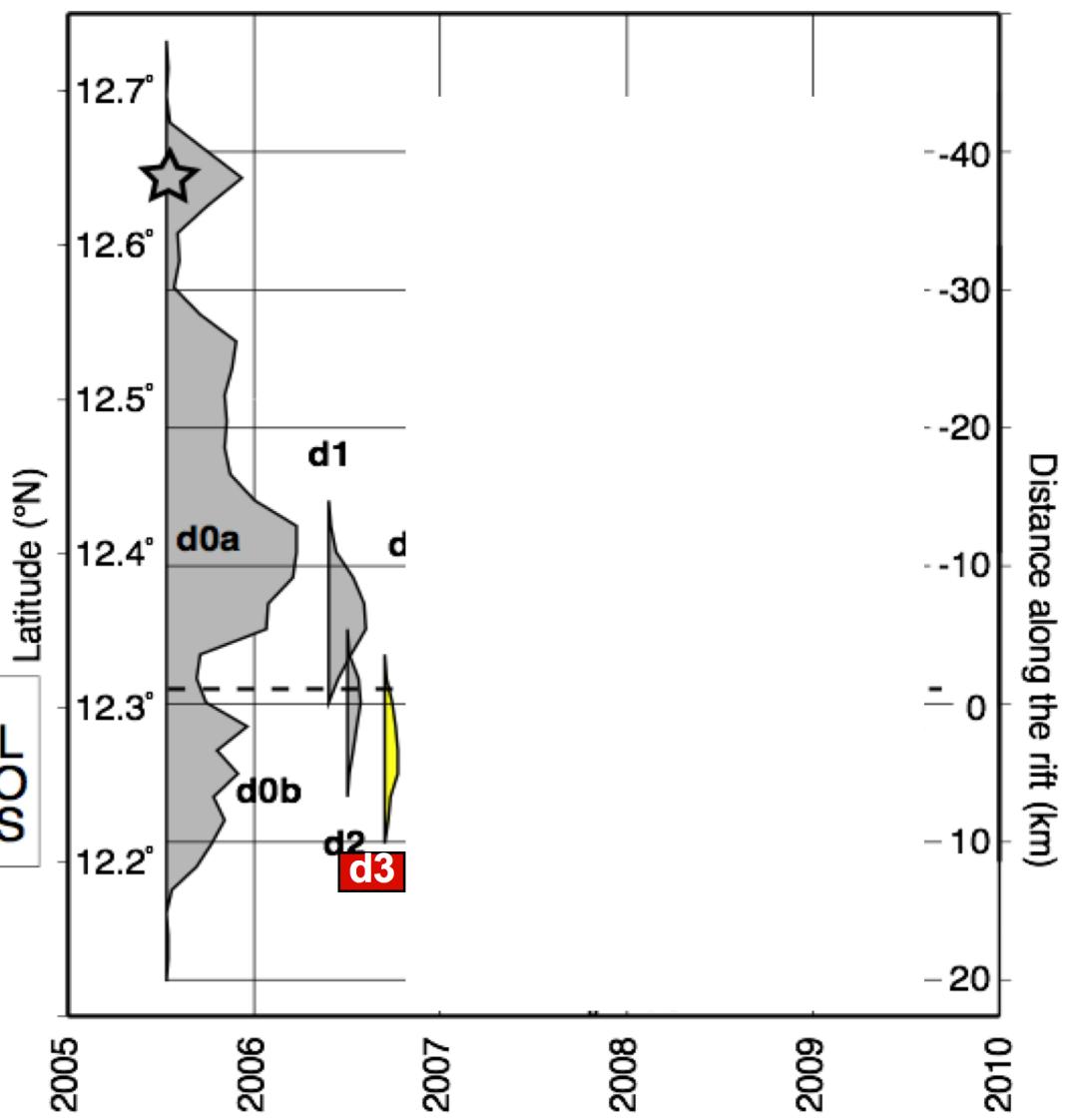
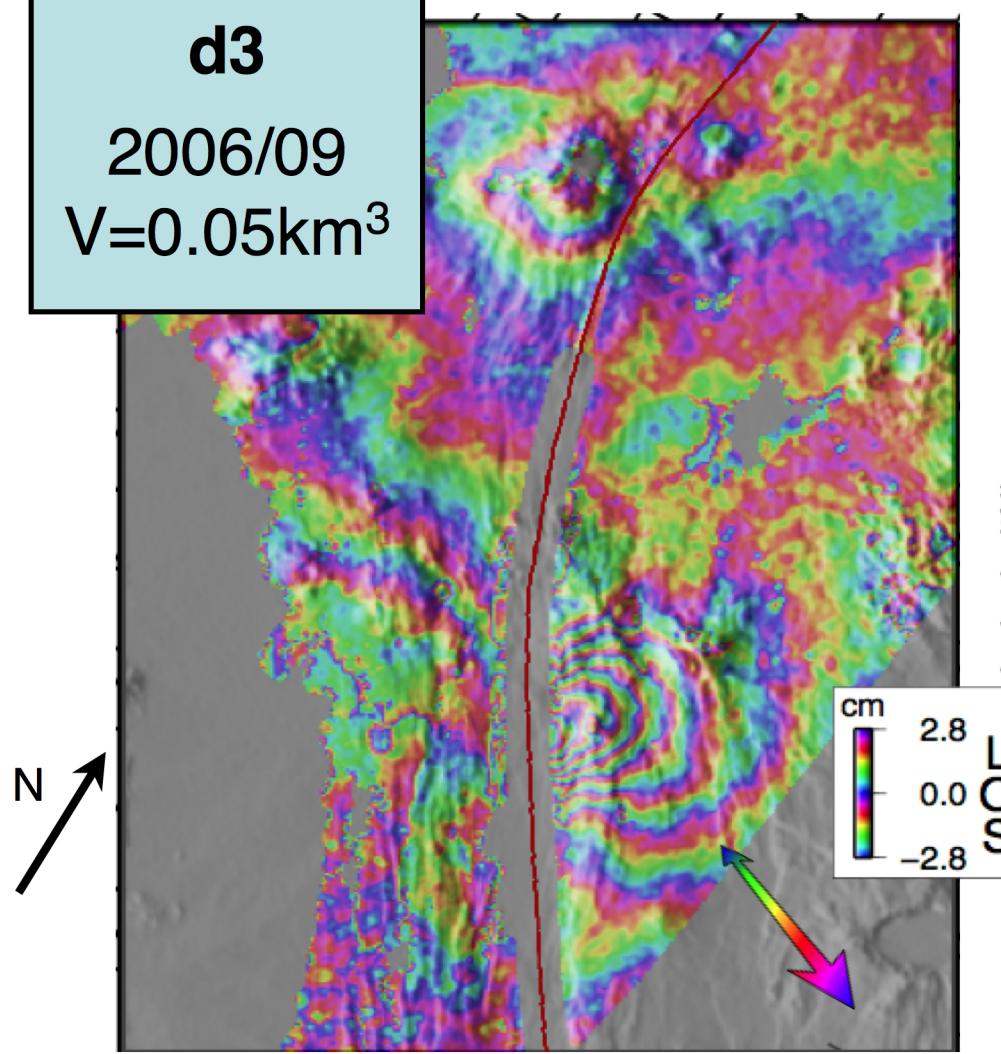


d2
2006/07
 $V=0.05\text{km}^3$



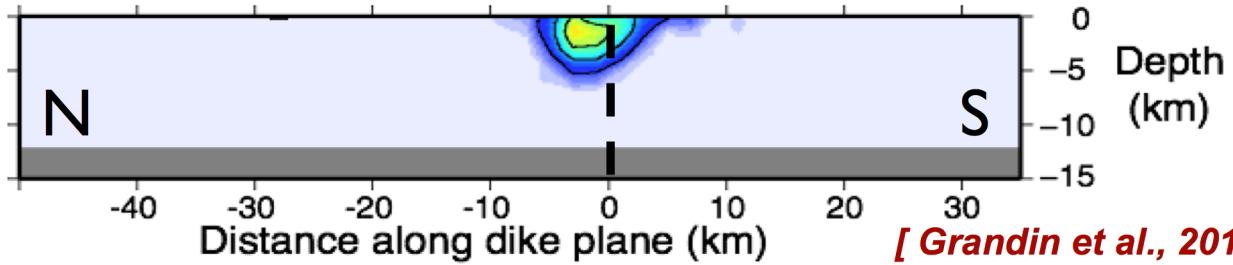
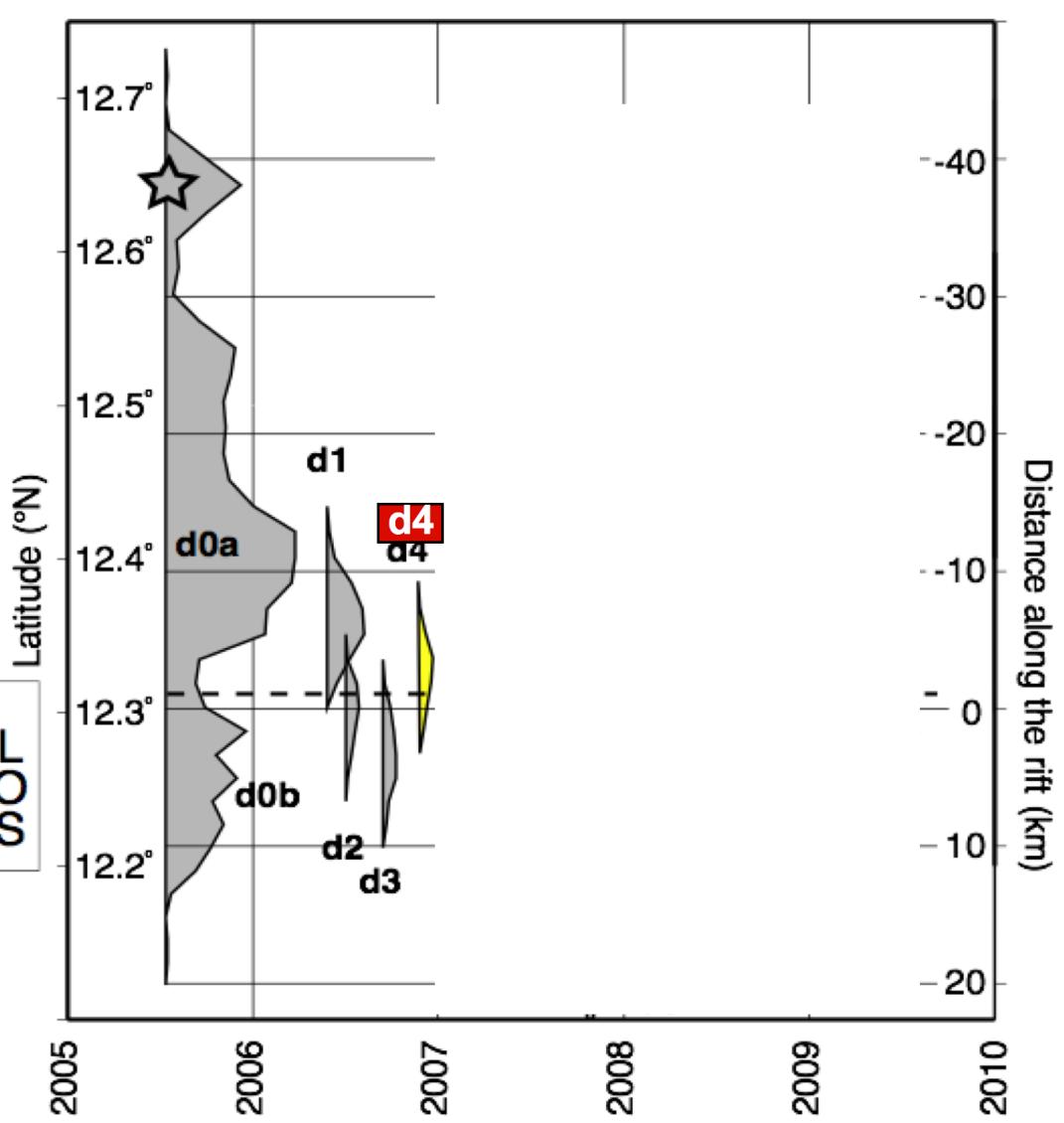
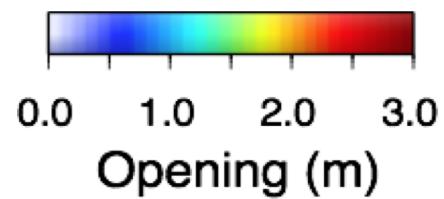
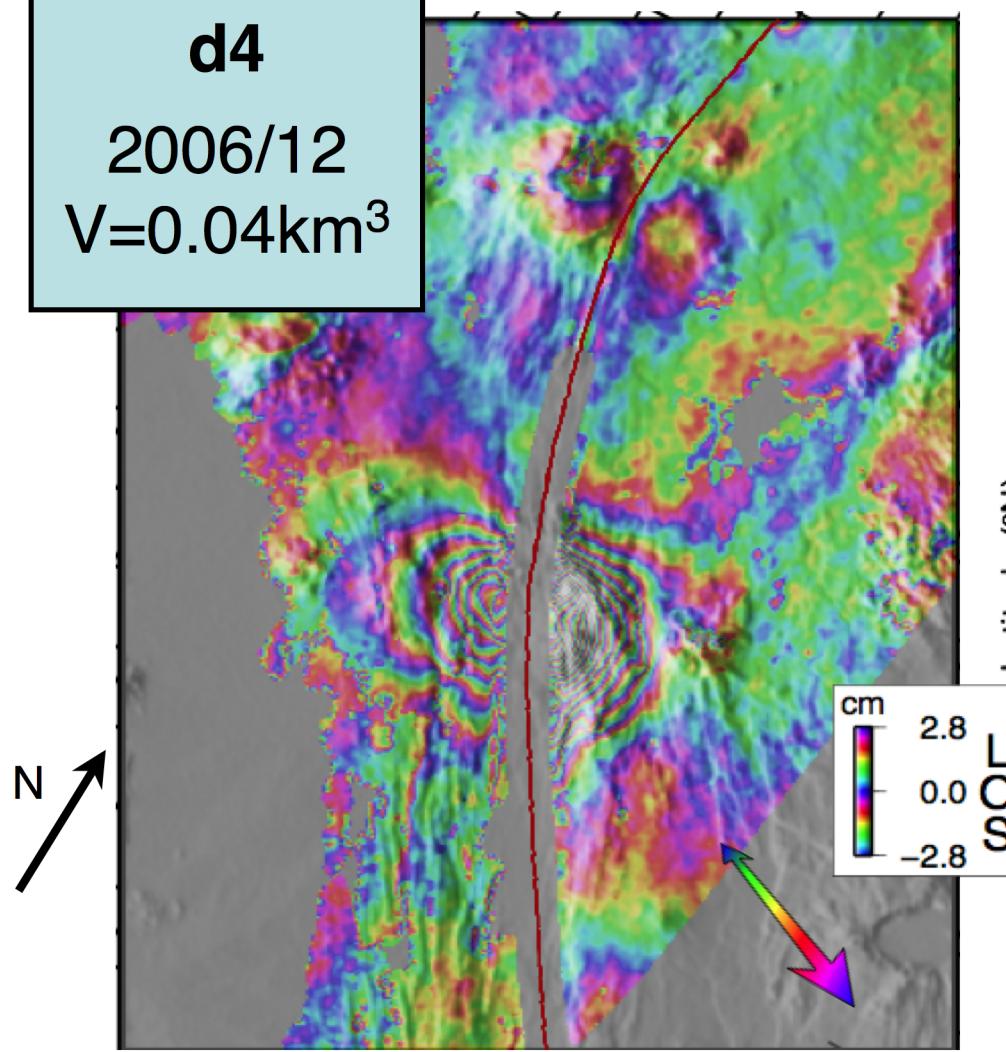
[Grandin et al., 2010b, JGR]

d3
2006/09
 $V=0.05\text{km}^3$



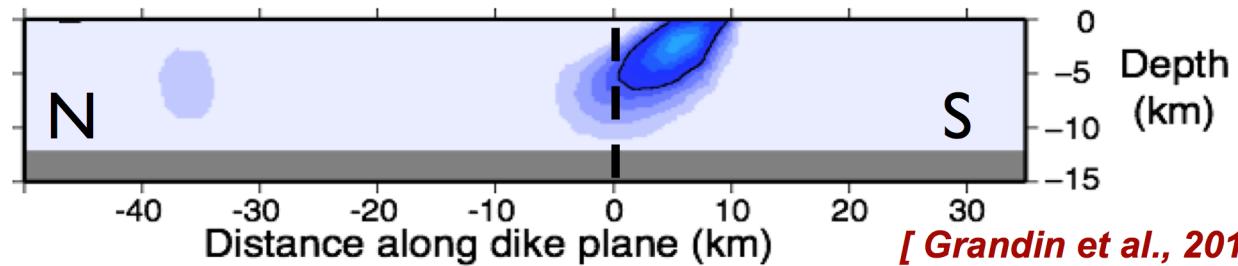
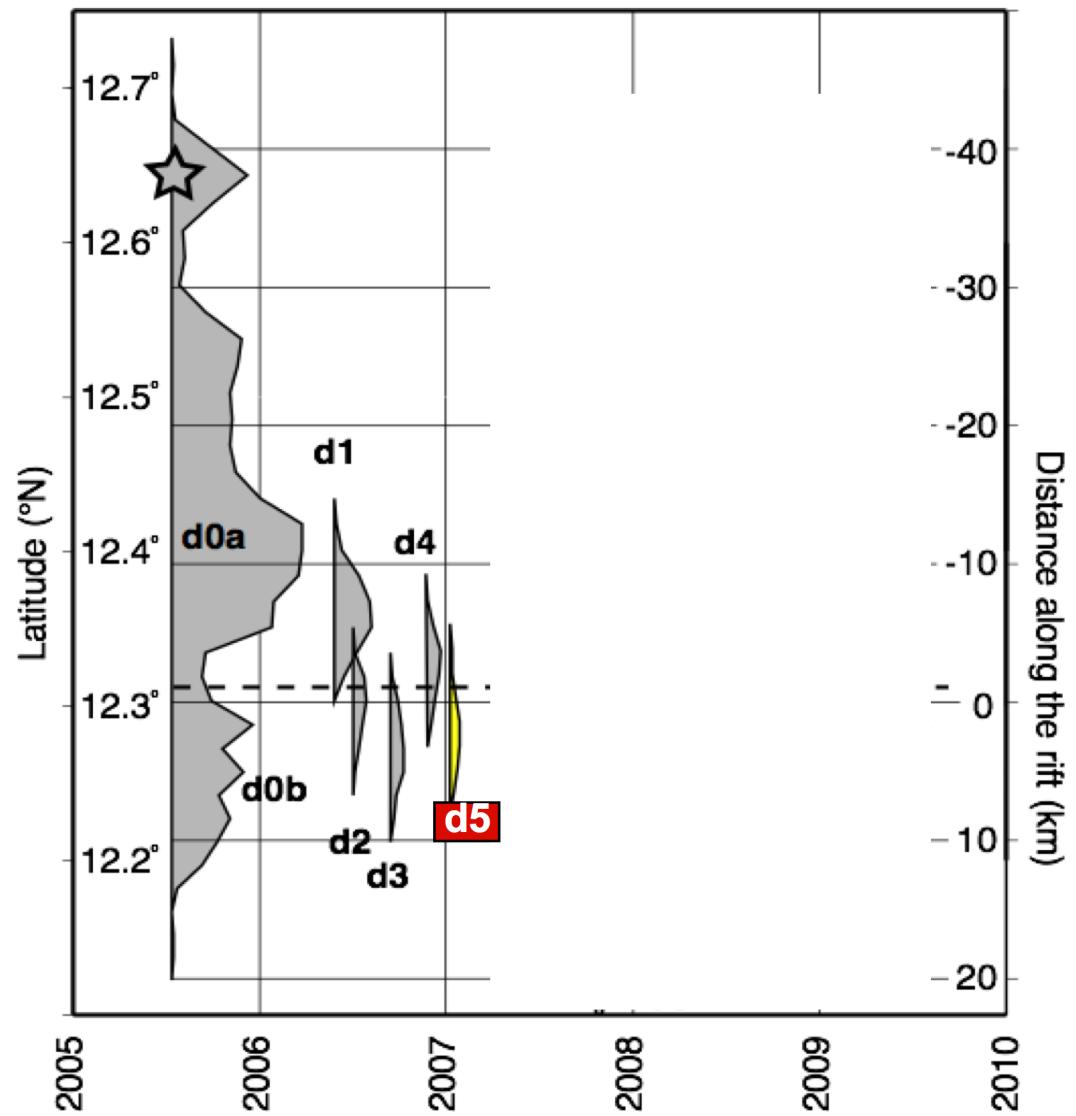
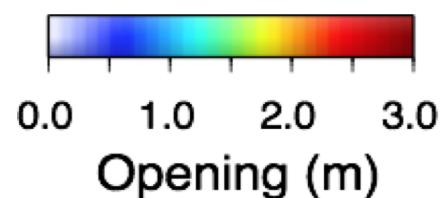
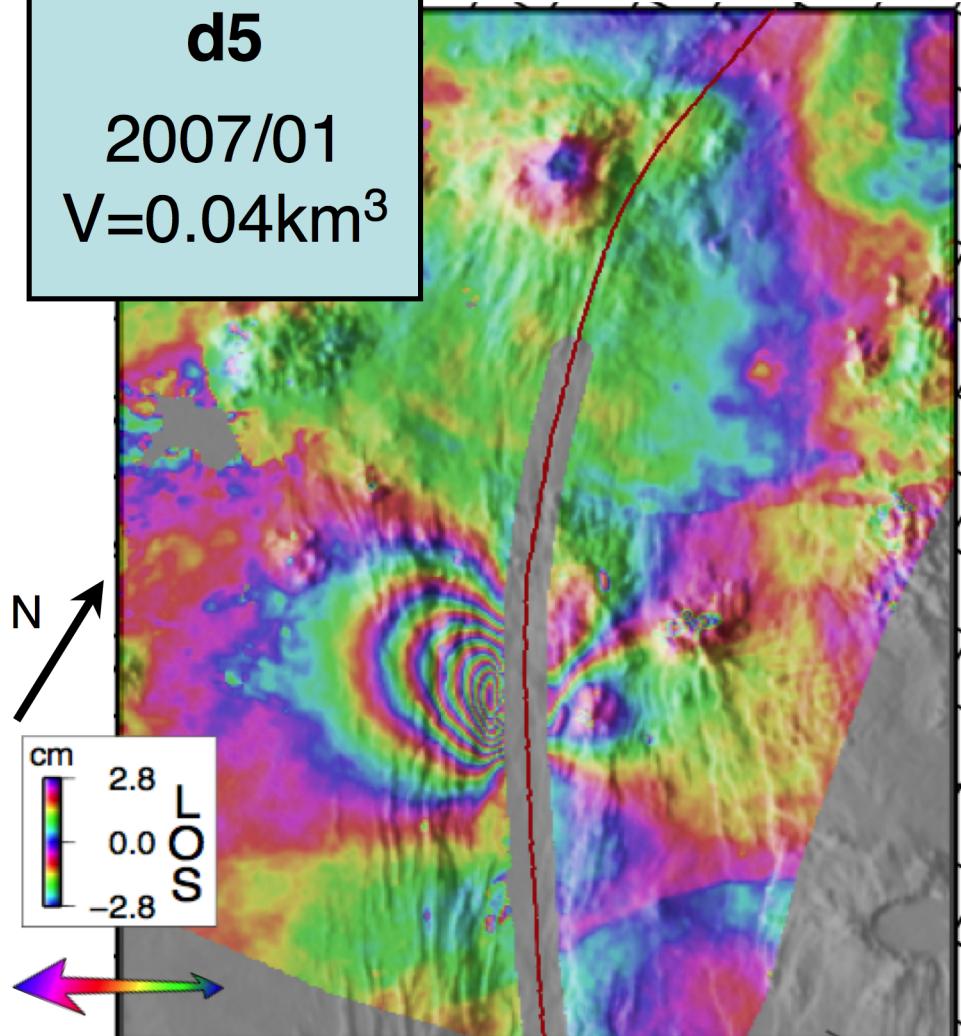
[Grandin et al., 2010b, JGR]

d4
2006/12
 $V=0.04\text{ km}^3$



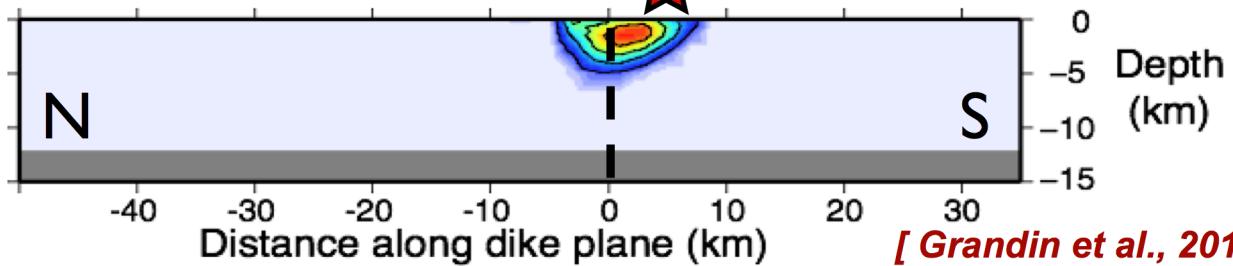
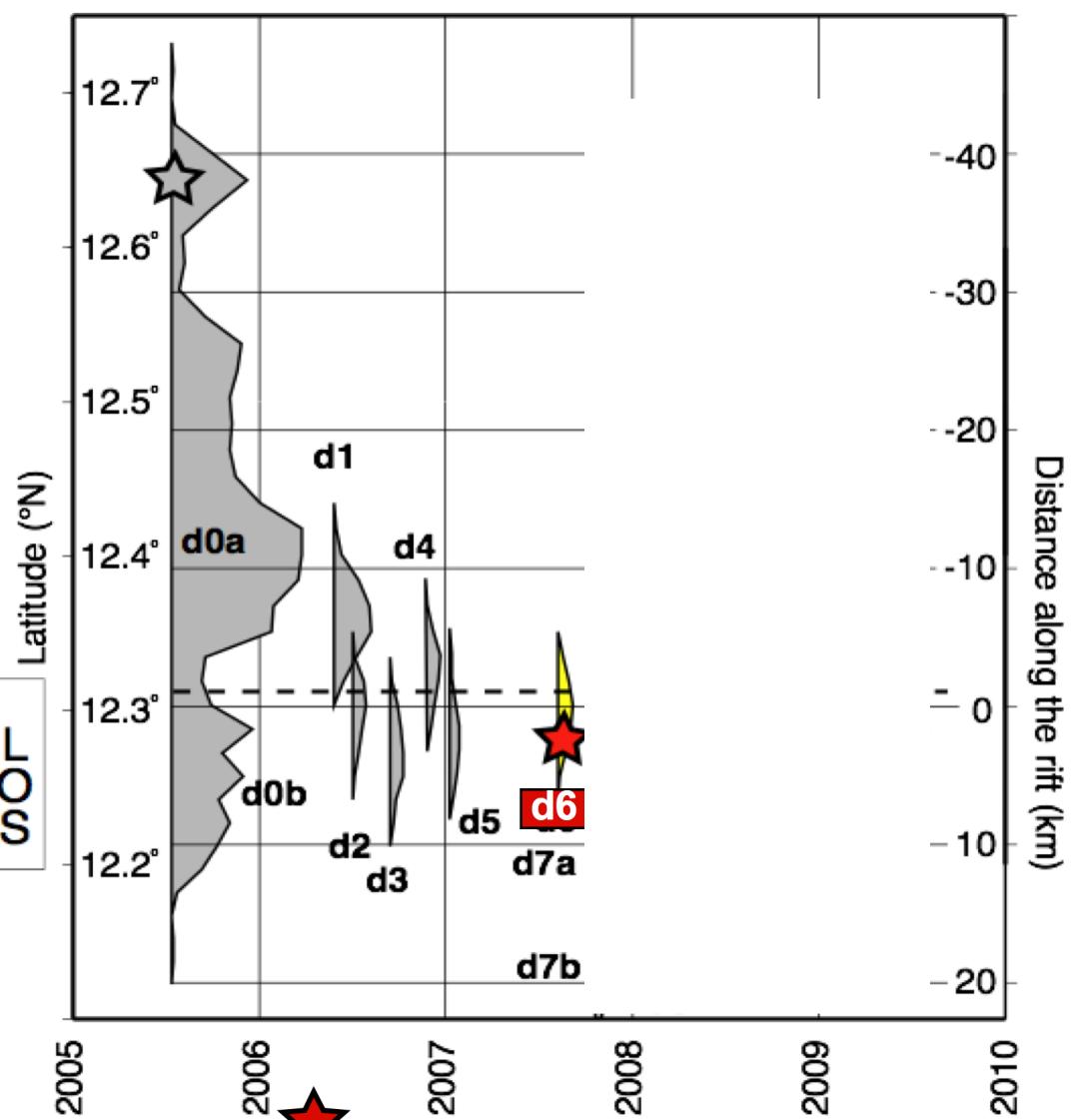
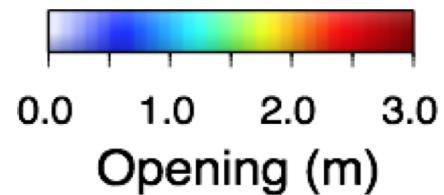
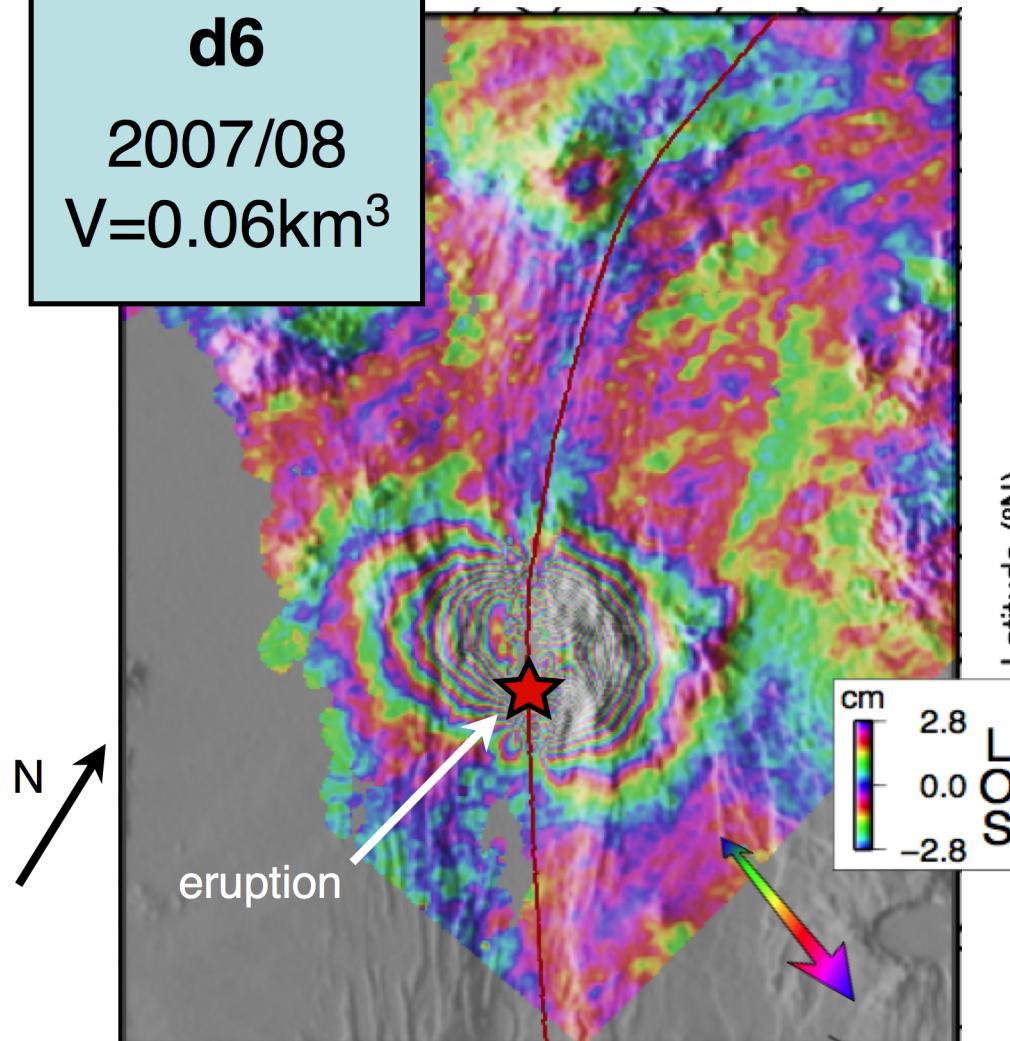
[Grandin et al., 2010b, JGR]

d5
2007/01
 $V=0.04\text{ km}^3$

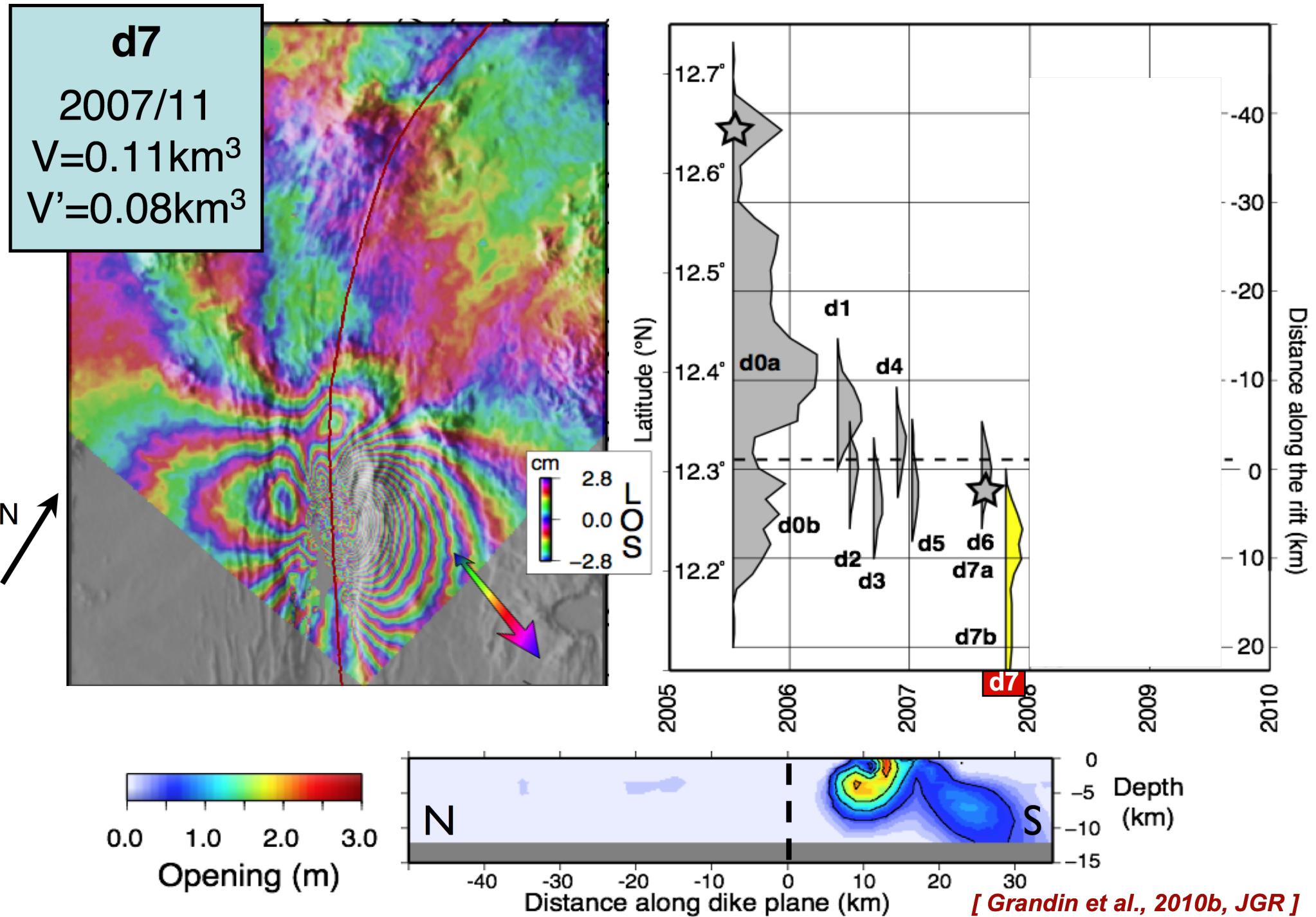


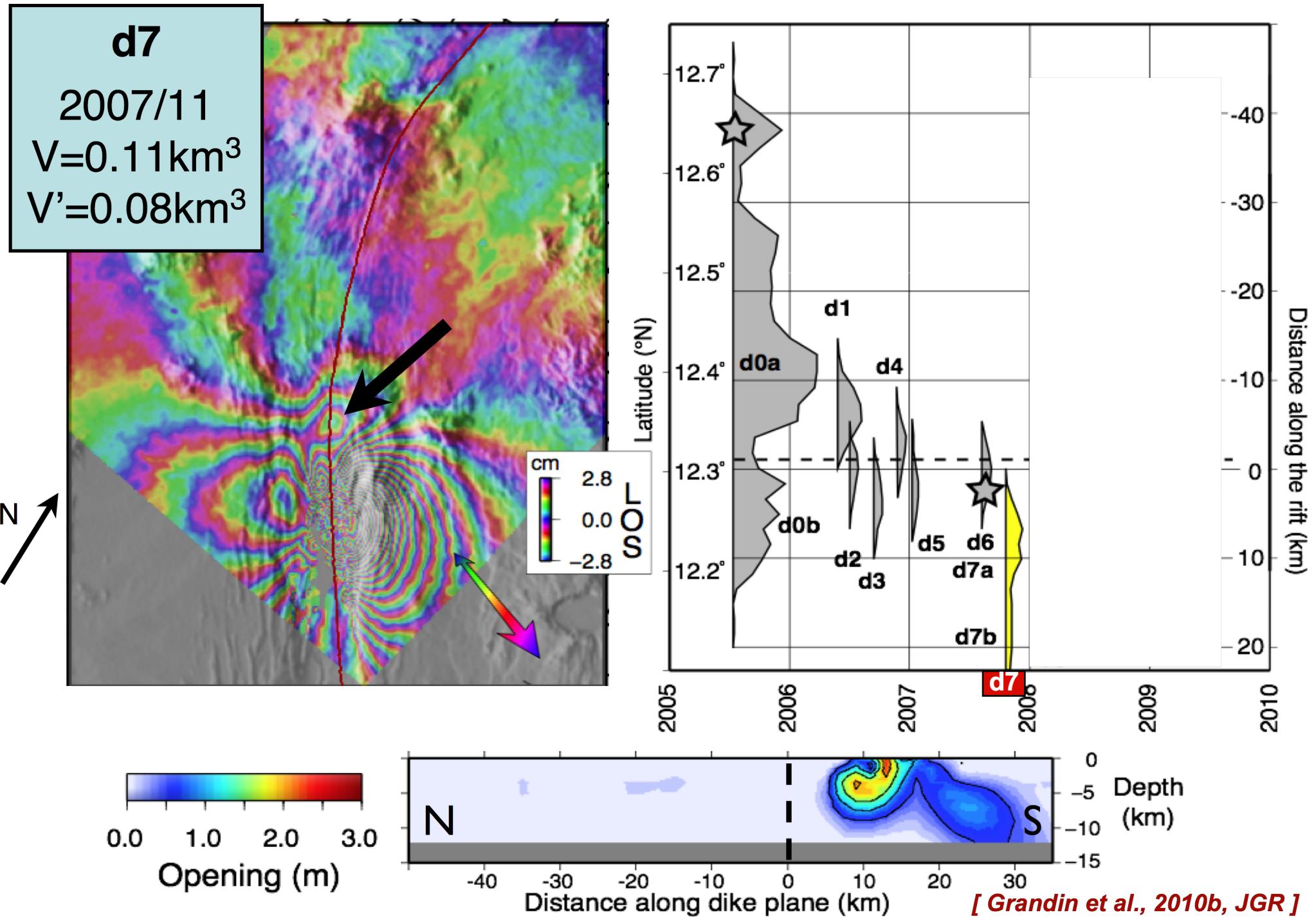
[Grandin et al., 2010b, JGR]

d6
2007/08
 $V=0.06\text{ km}^3$

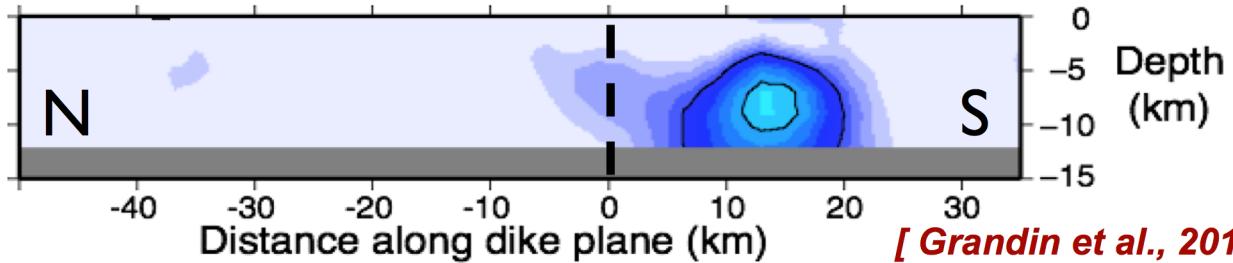
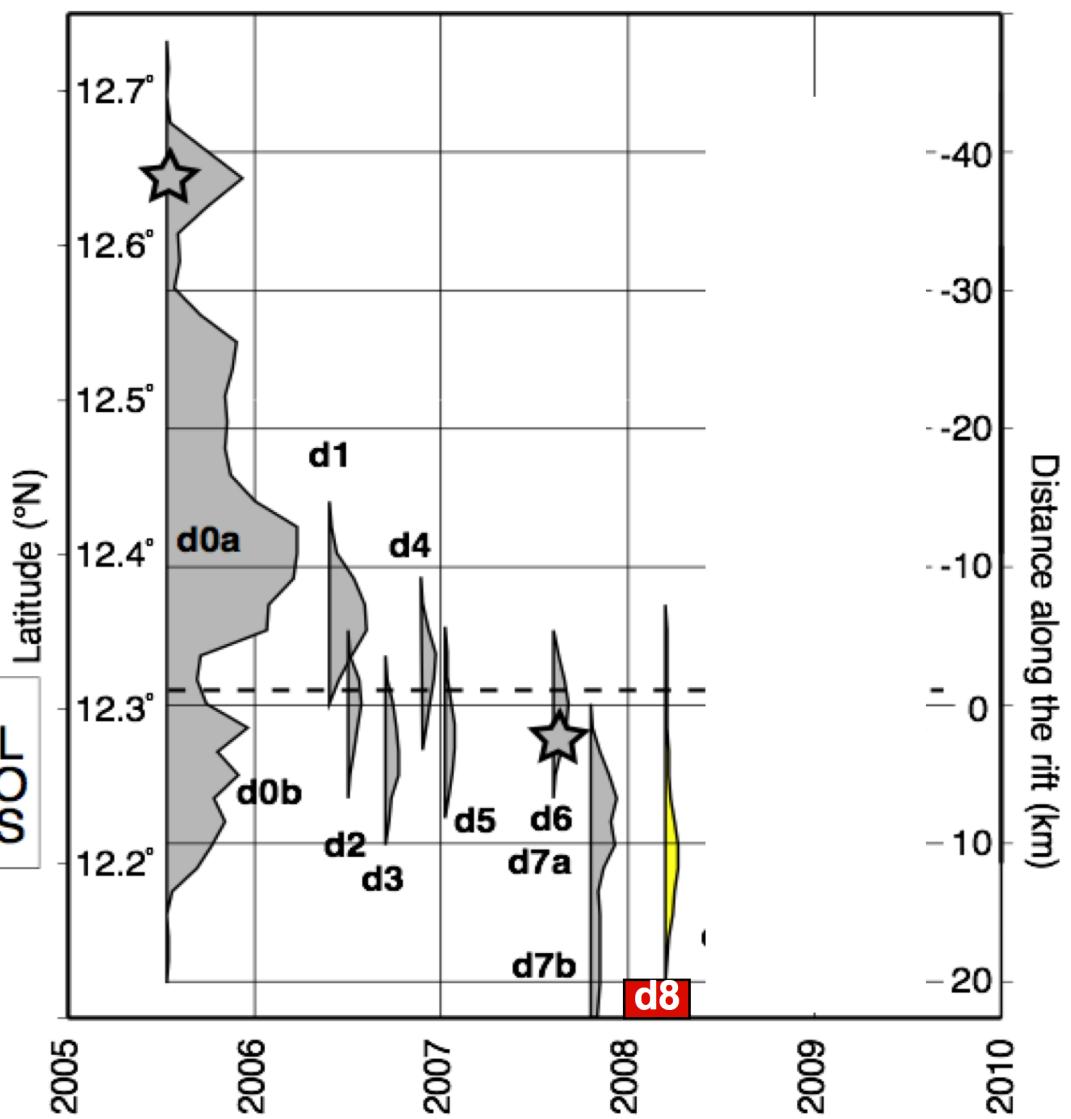
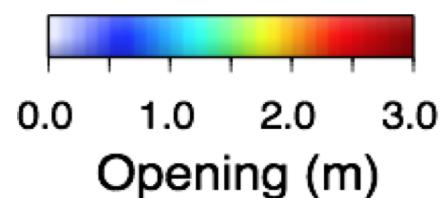
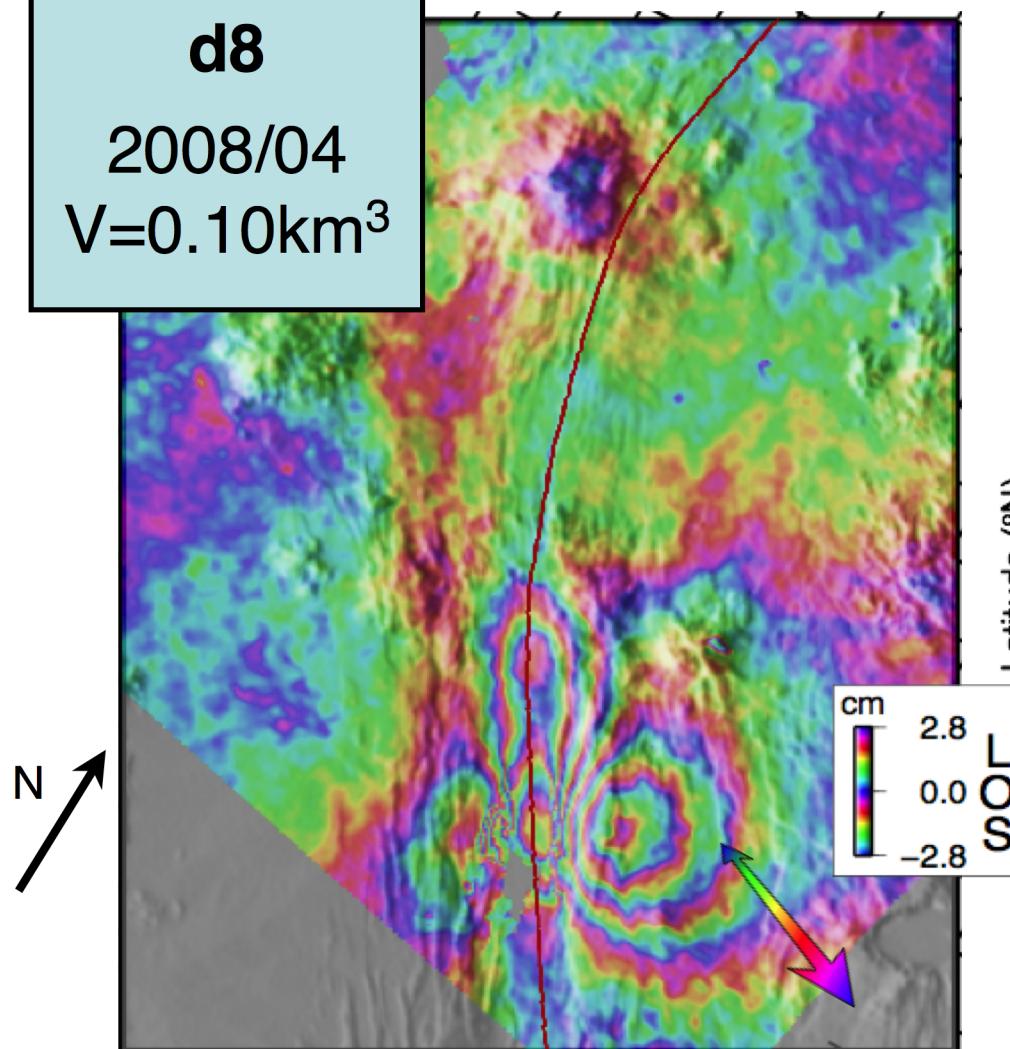


[Grandin et al., 2010b, JGR]

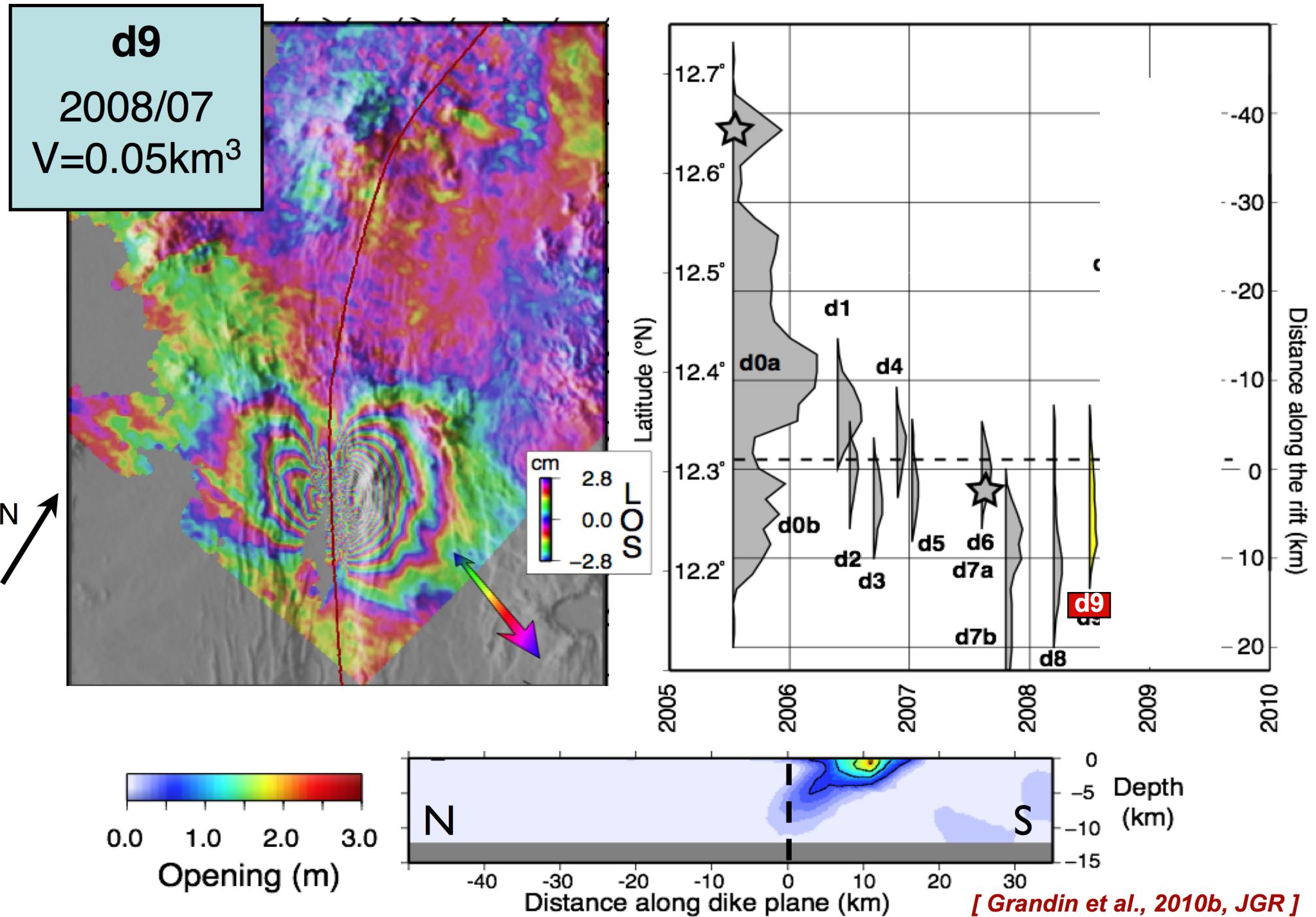




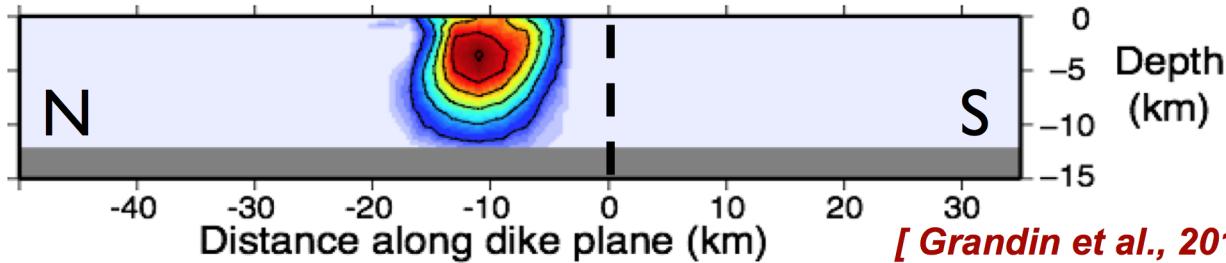
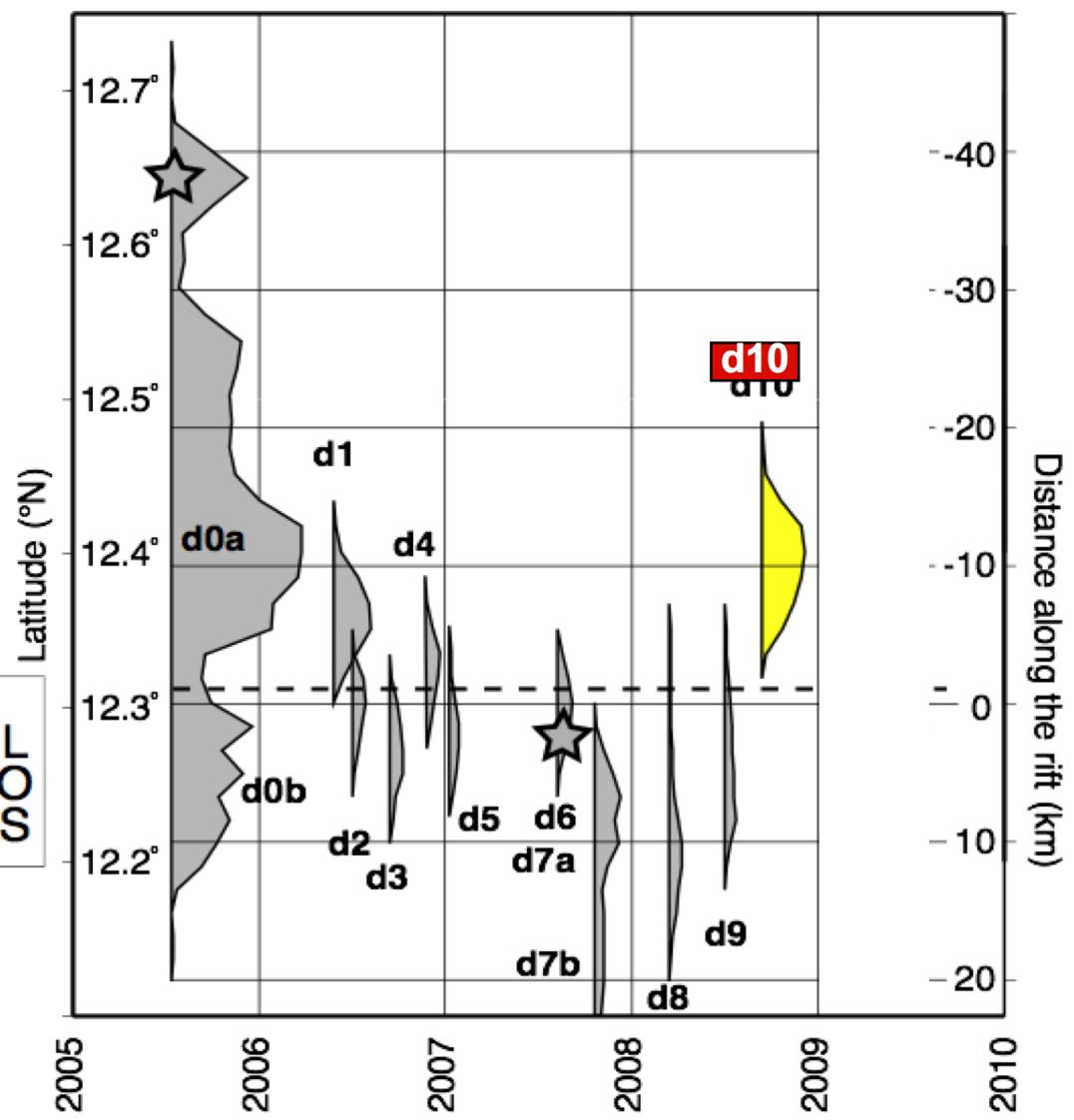
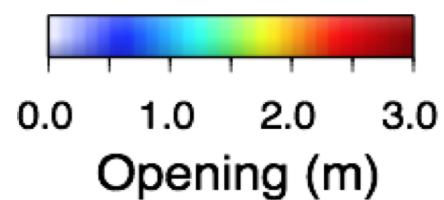
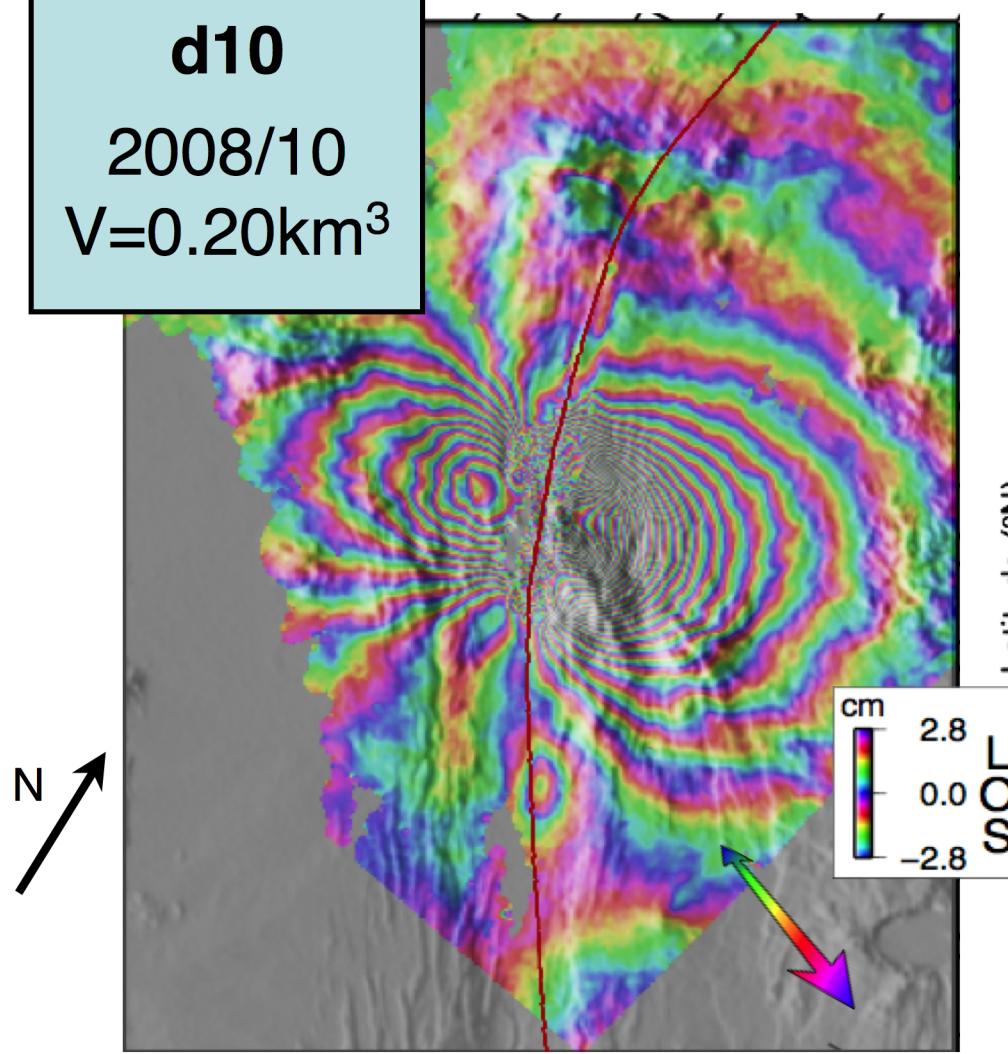
d8
2008/04
 $V=0.10\text{ km}^3$



[Grandin et al., 2010b, JGR]

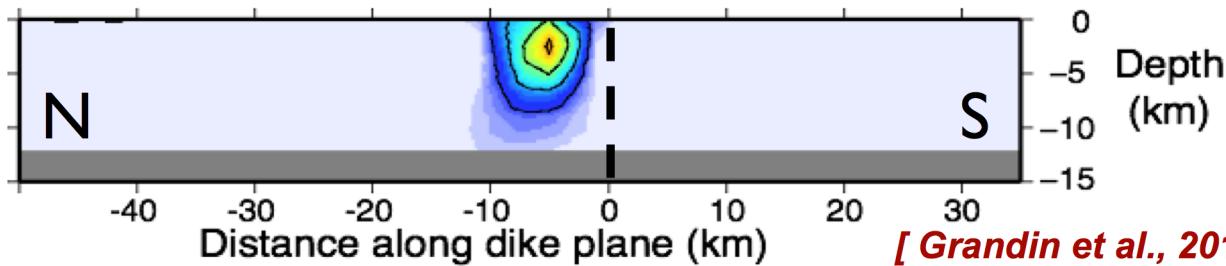
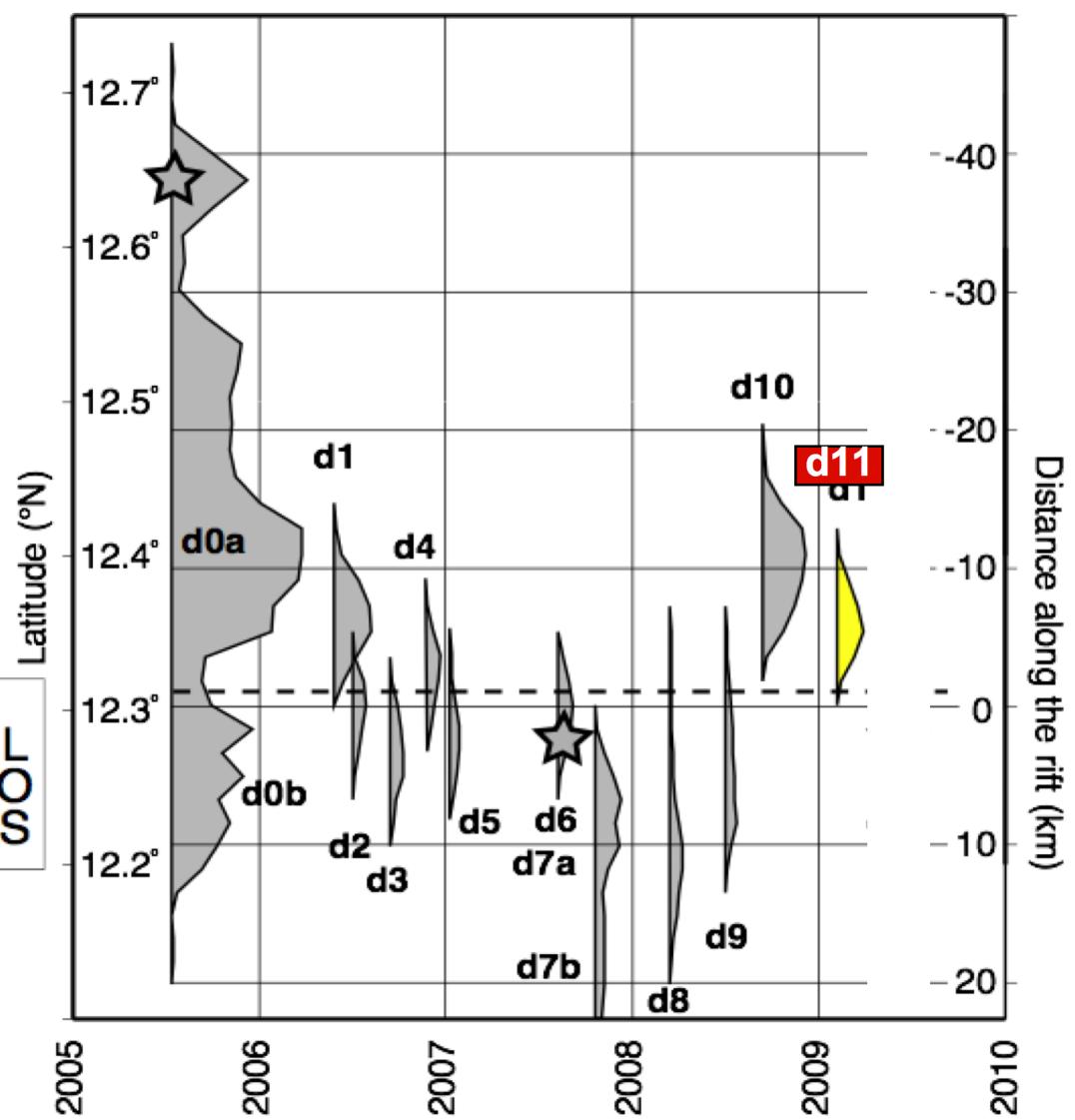
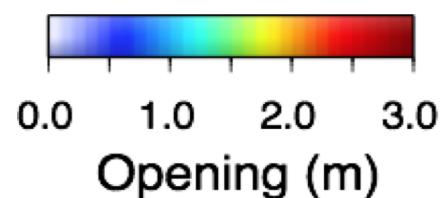
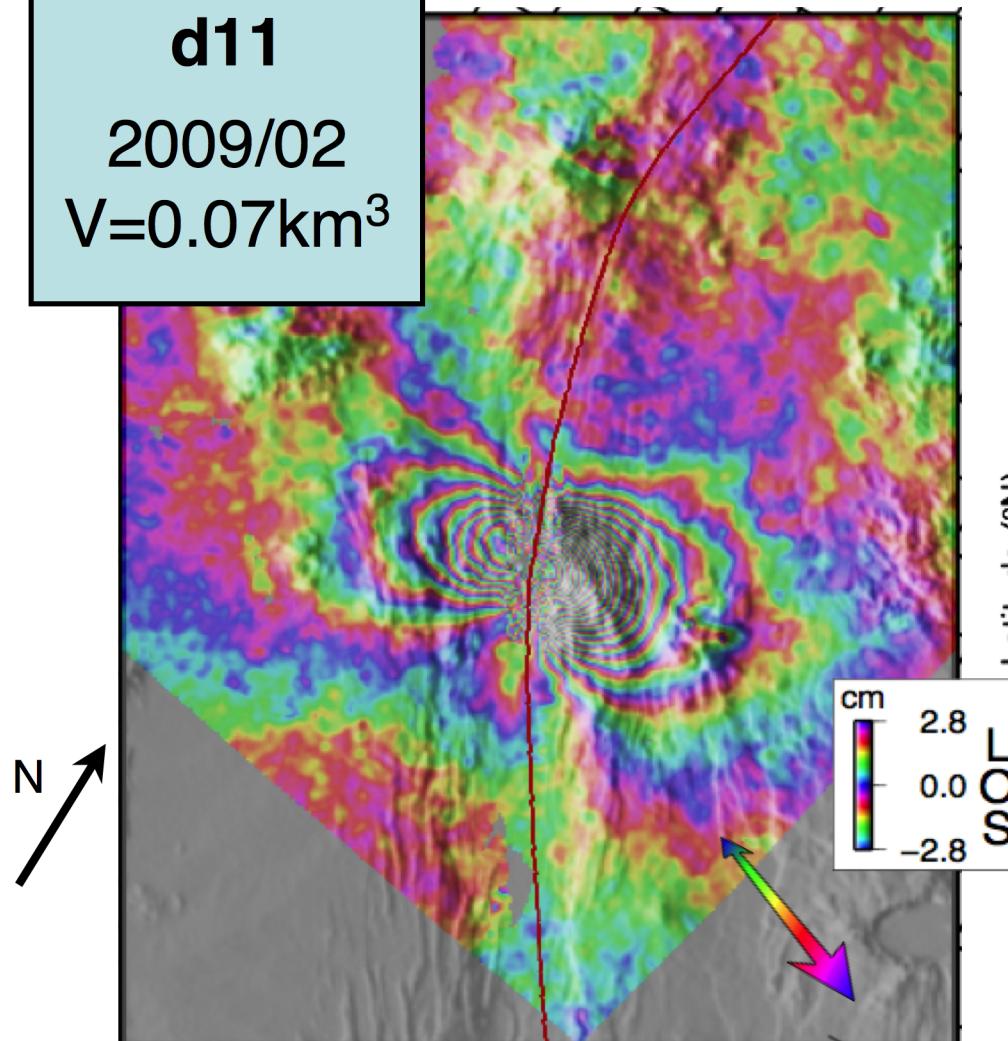


d10
2008/10
 $V=0.20\text{ km}^3$



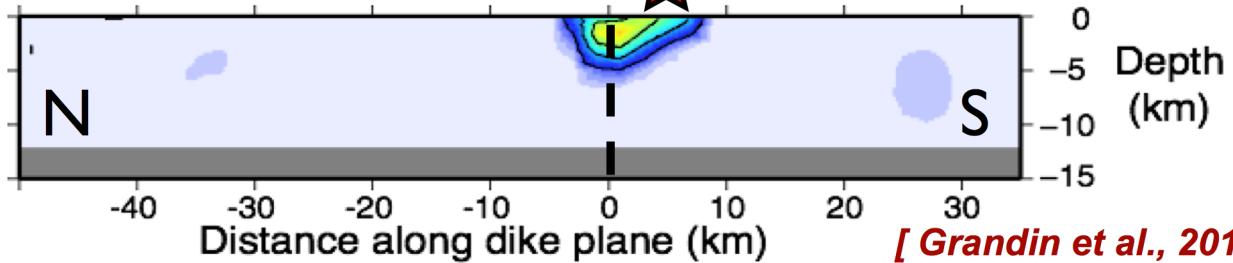
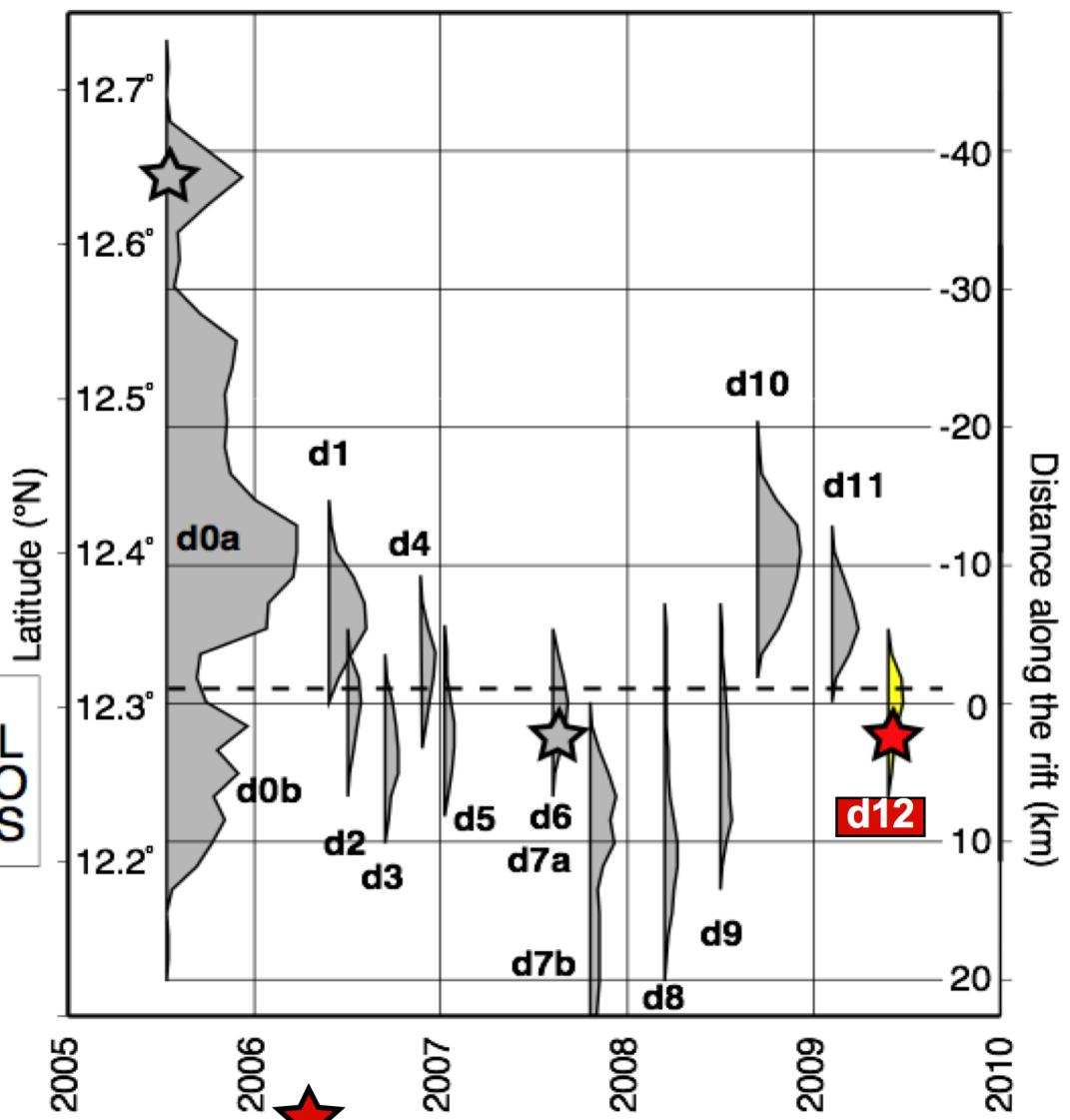
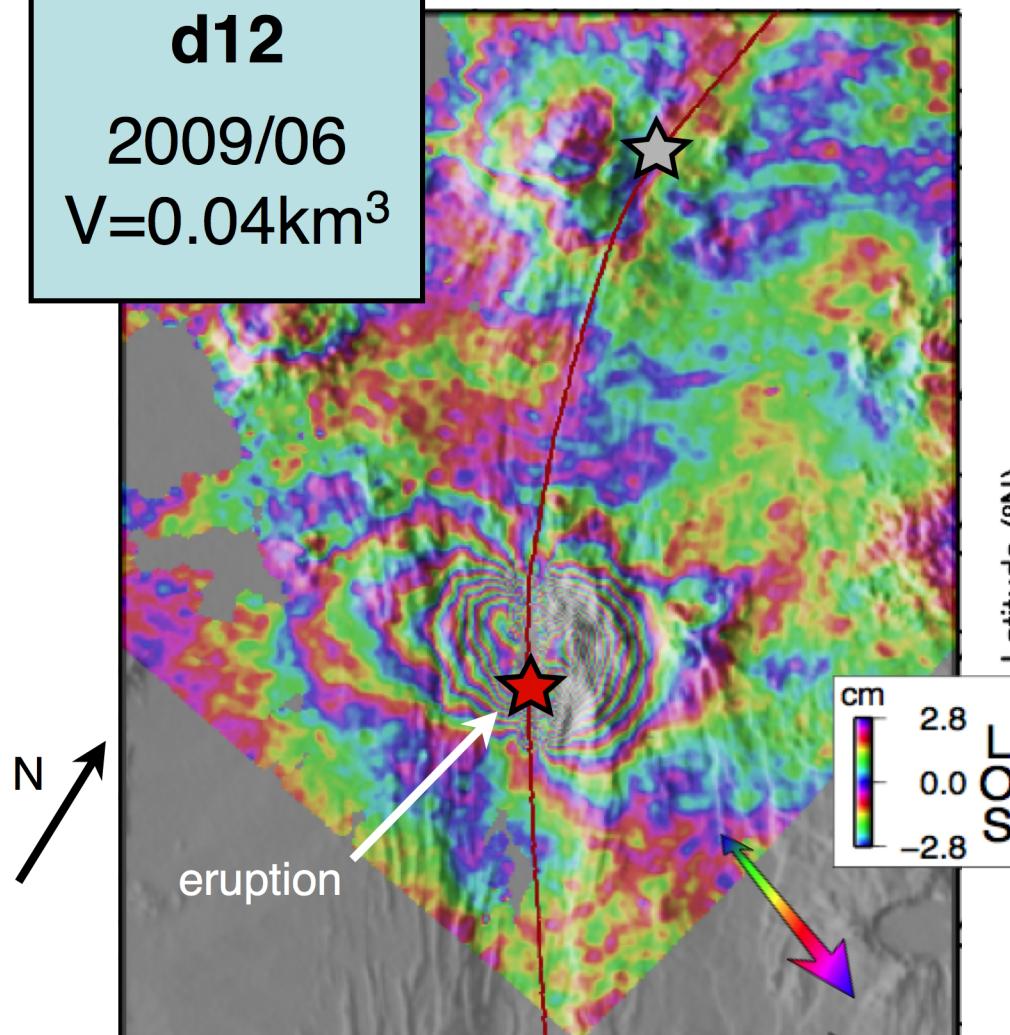
[Grandin et al., 2010b, JGR]

d11
2009/02
 $V=0.07\text{ km}^3$

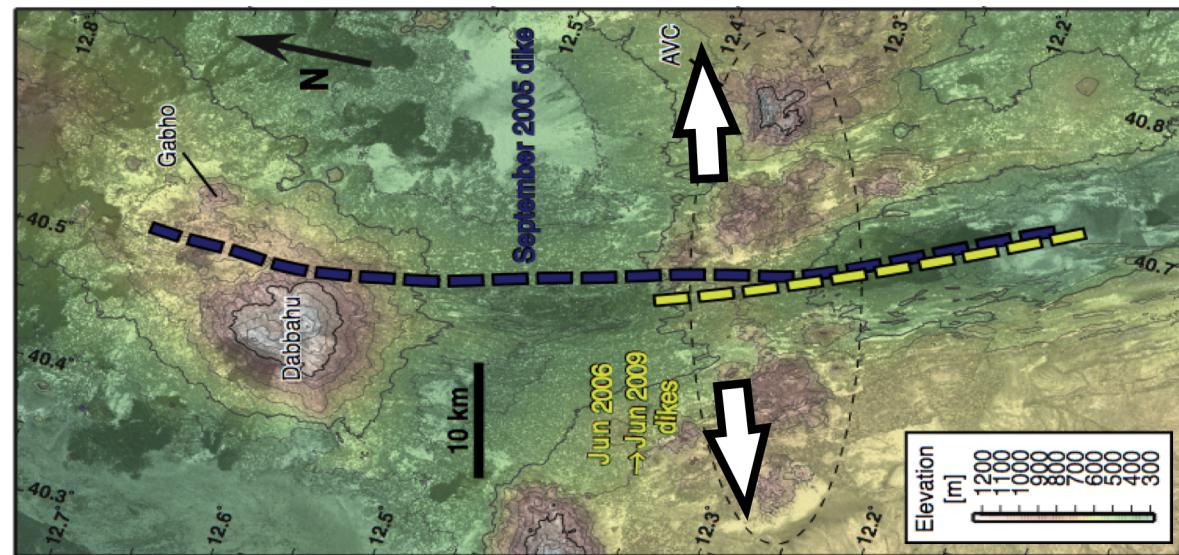
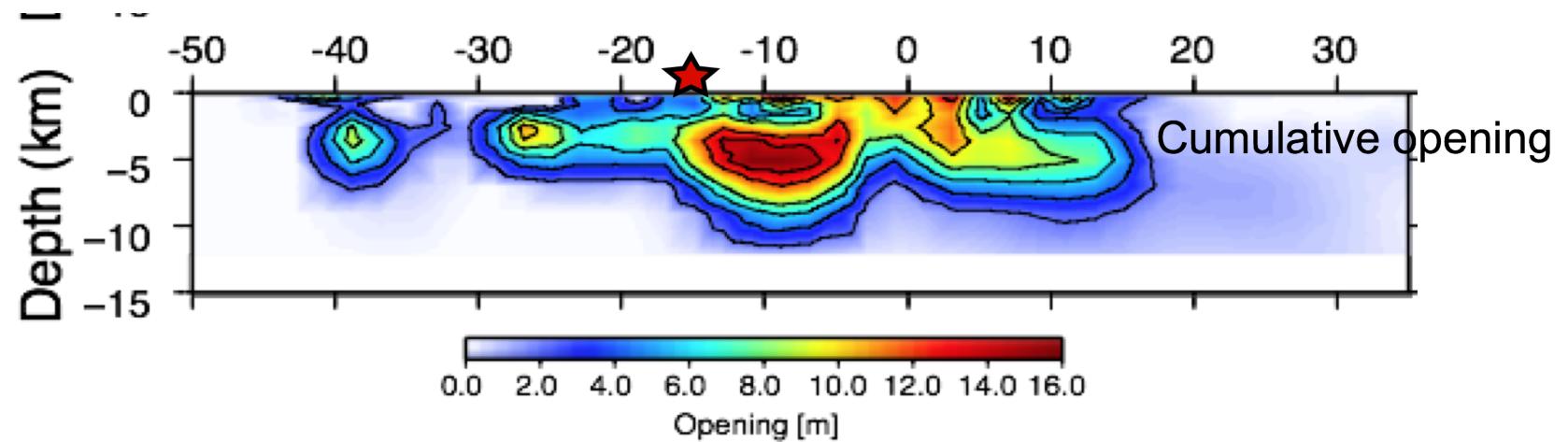


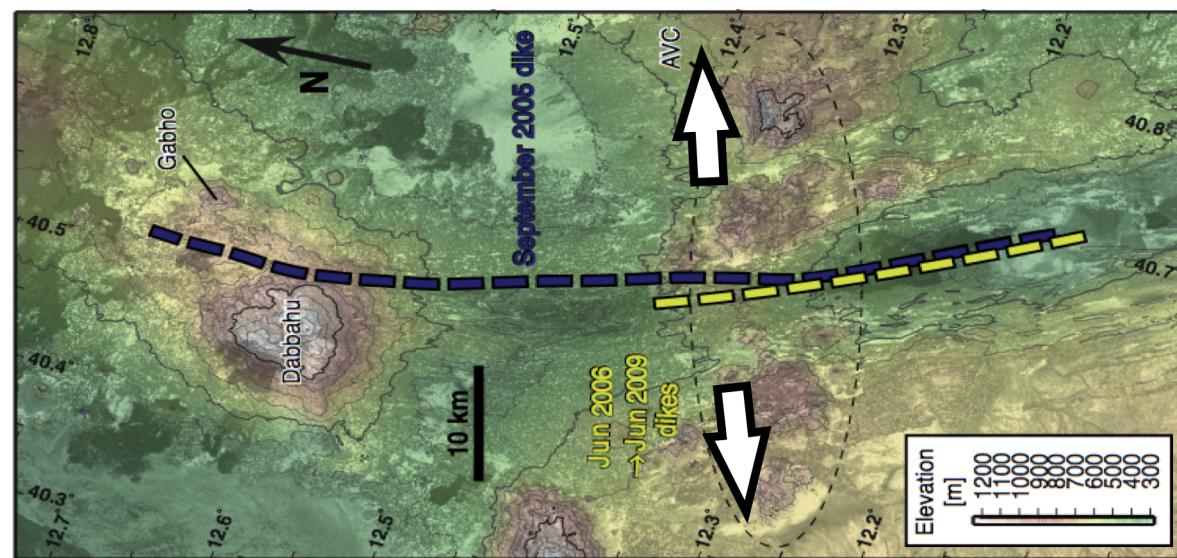
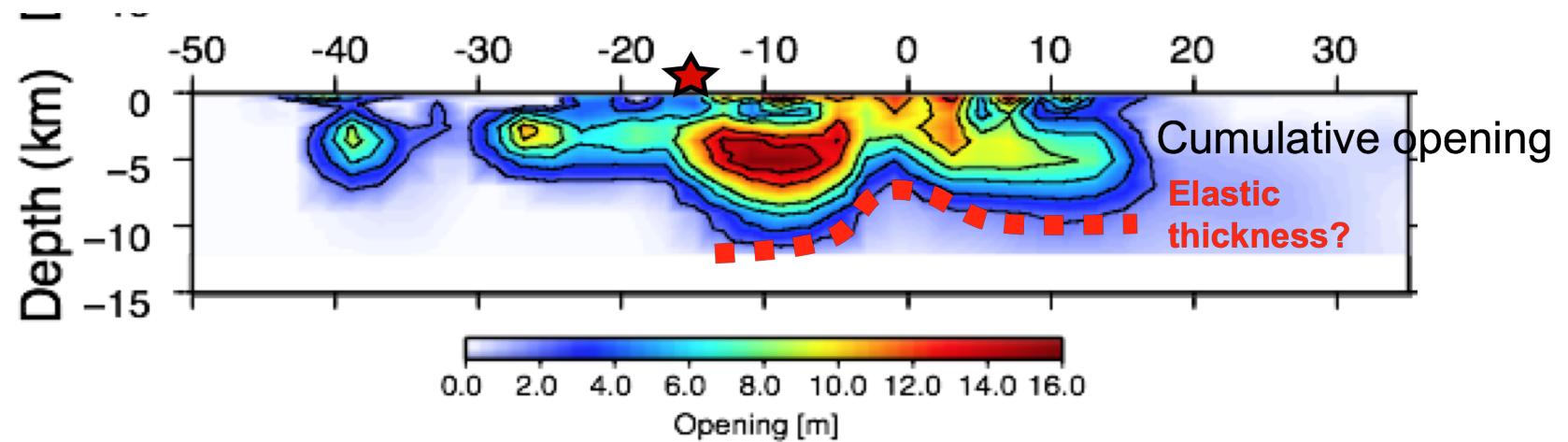
[Grandin et al., 2010b, JGR]

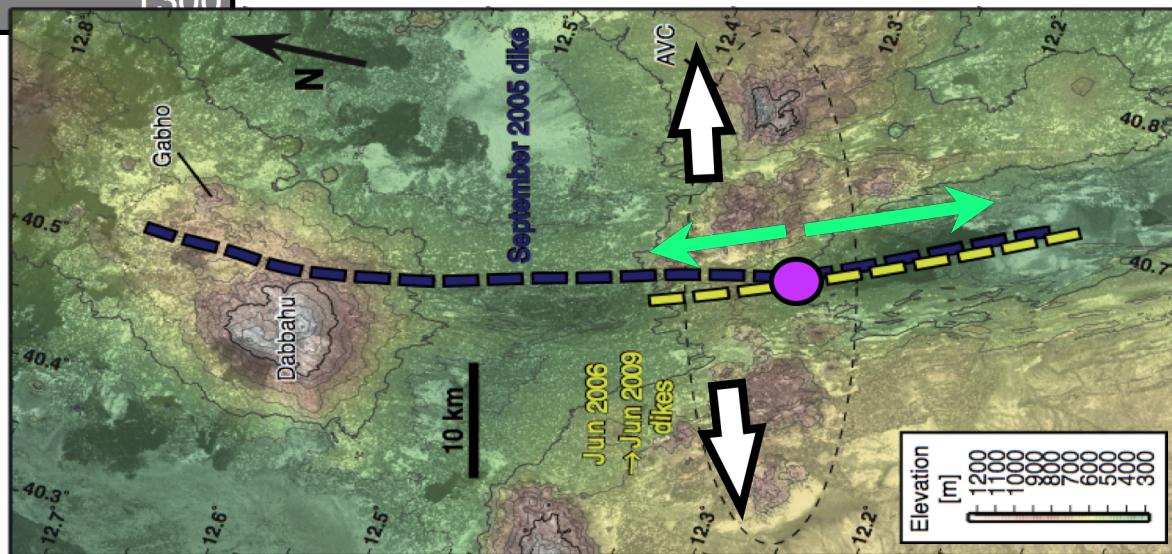
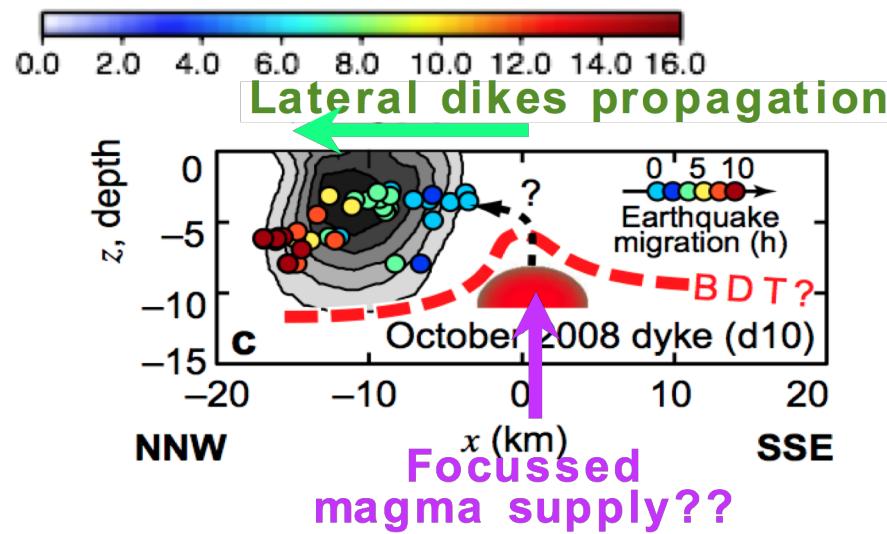
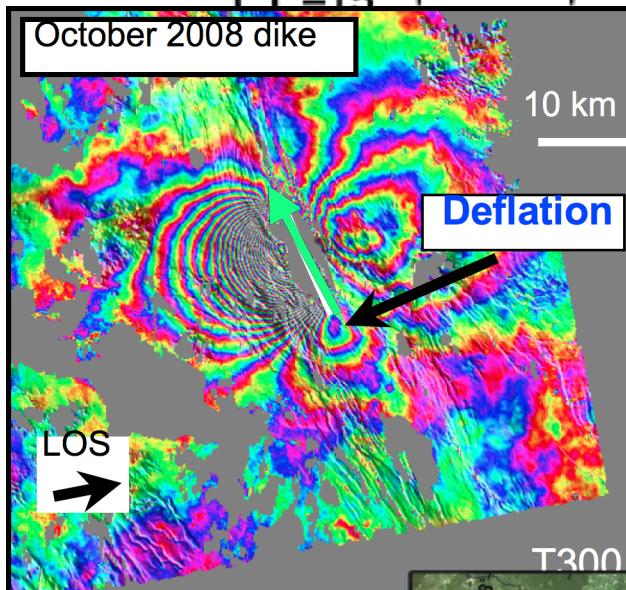
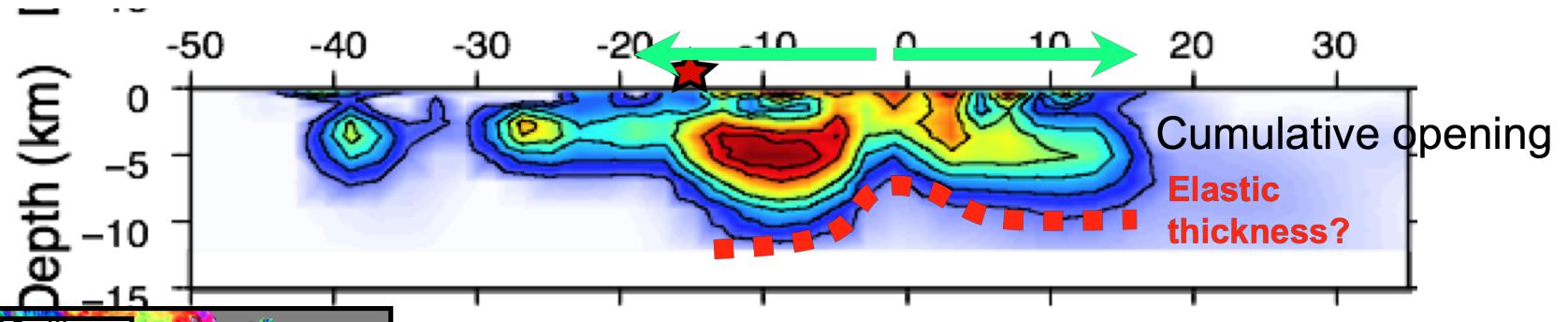
d12
2009/06
 $V=0.04\text{ km}^3$



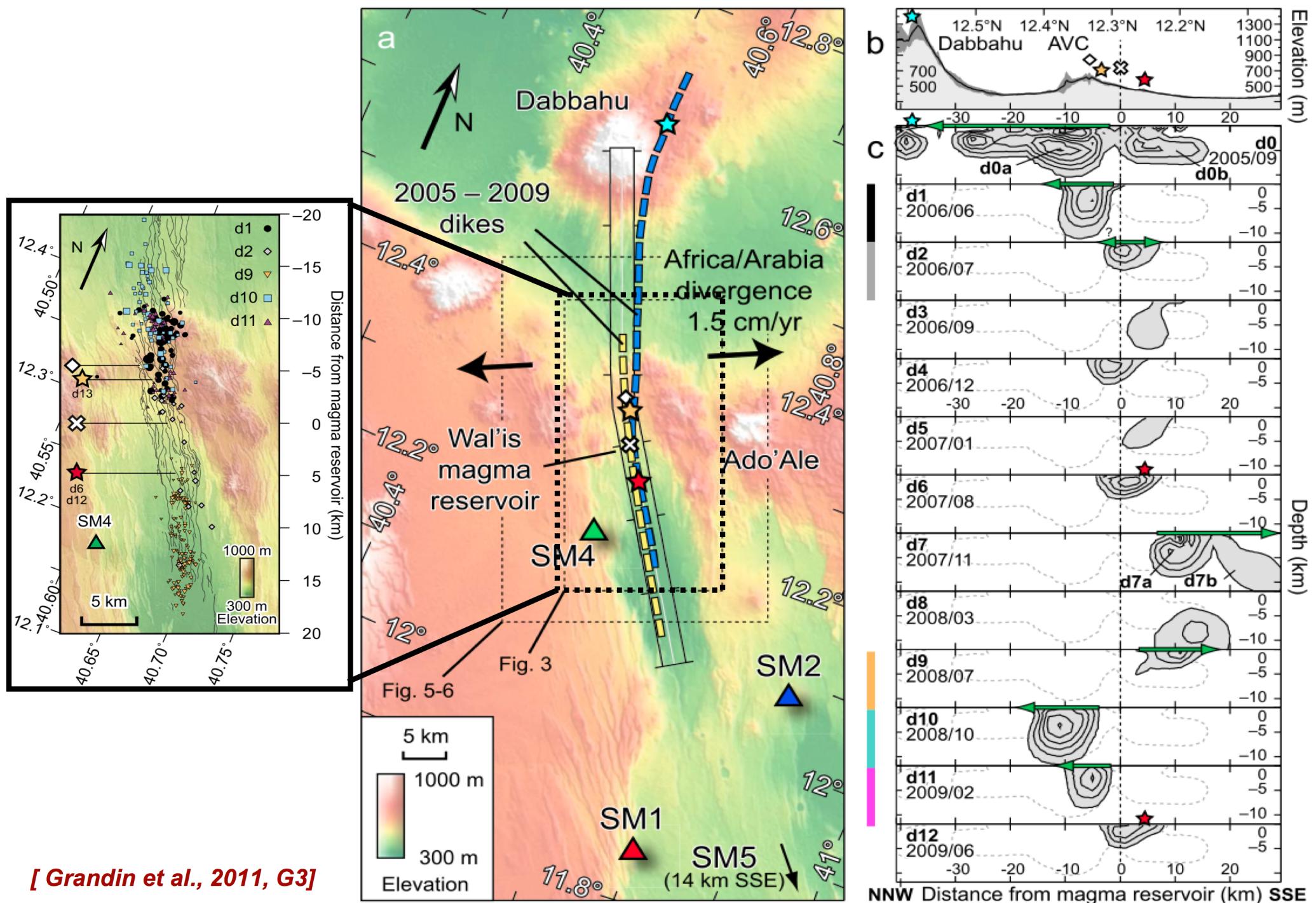
[Grandin et al., 2010b, JGR]

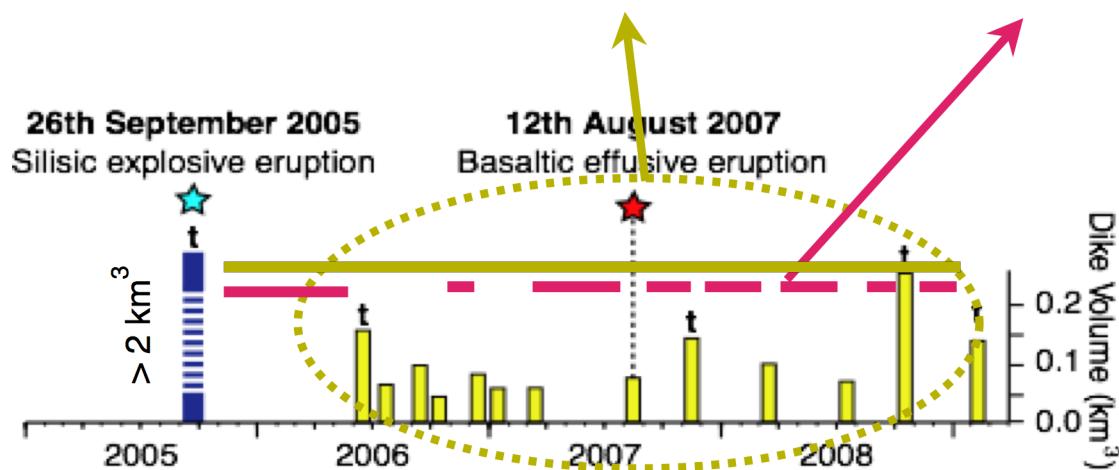
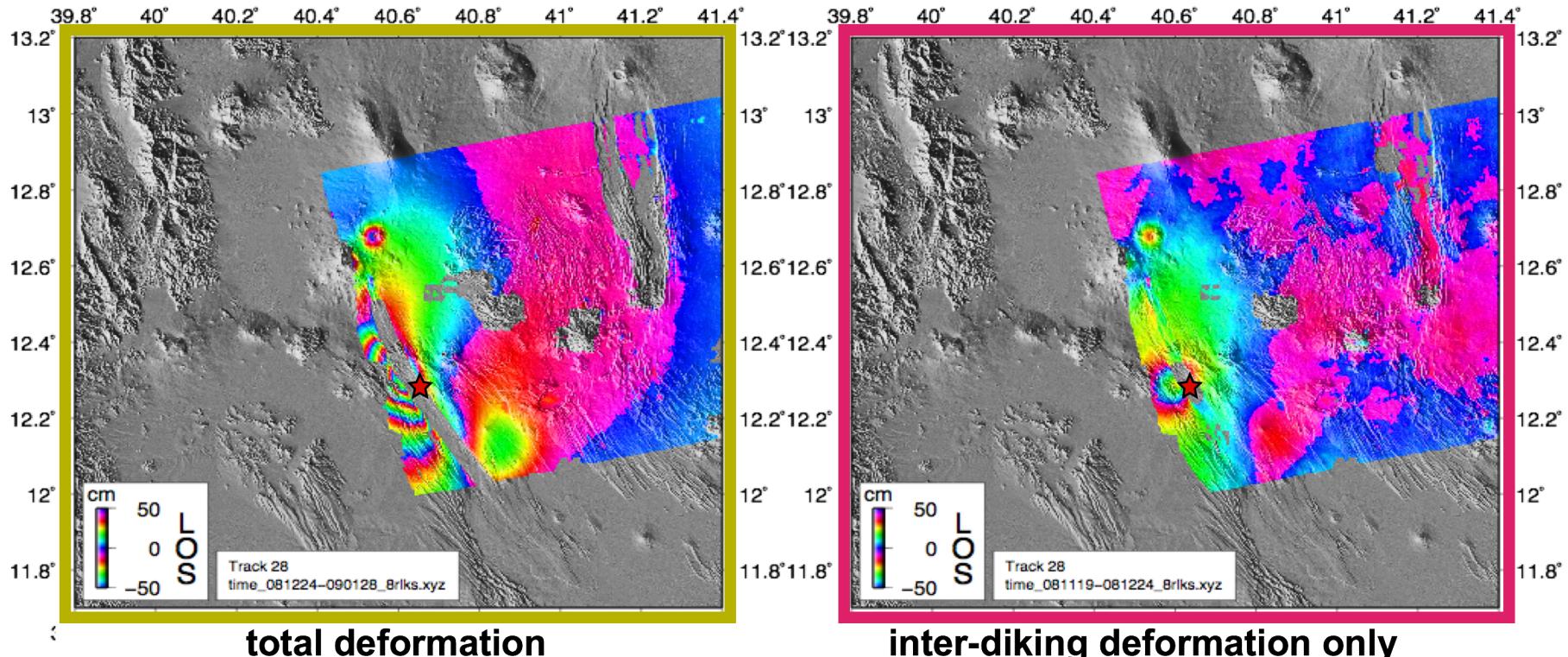




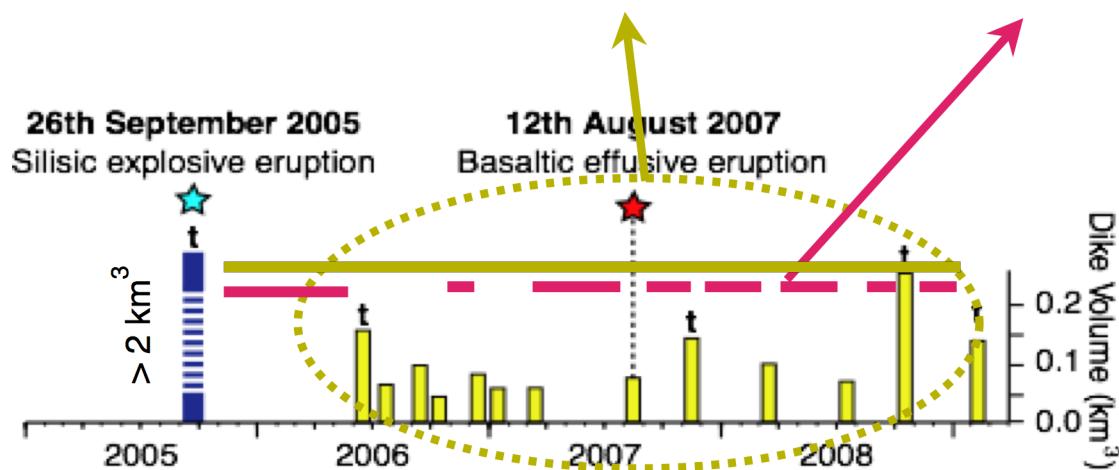
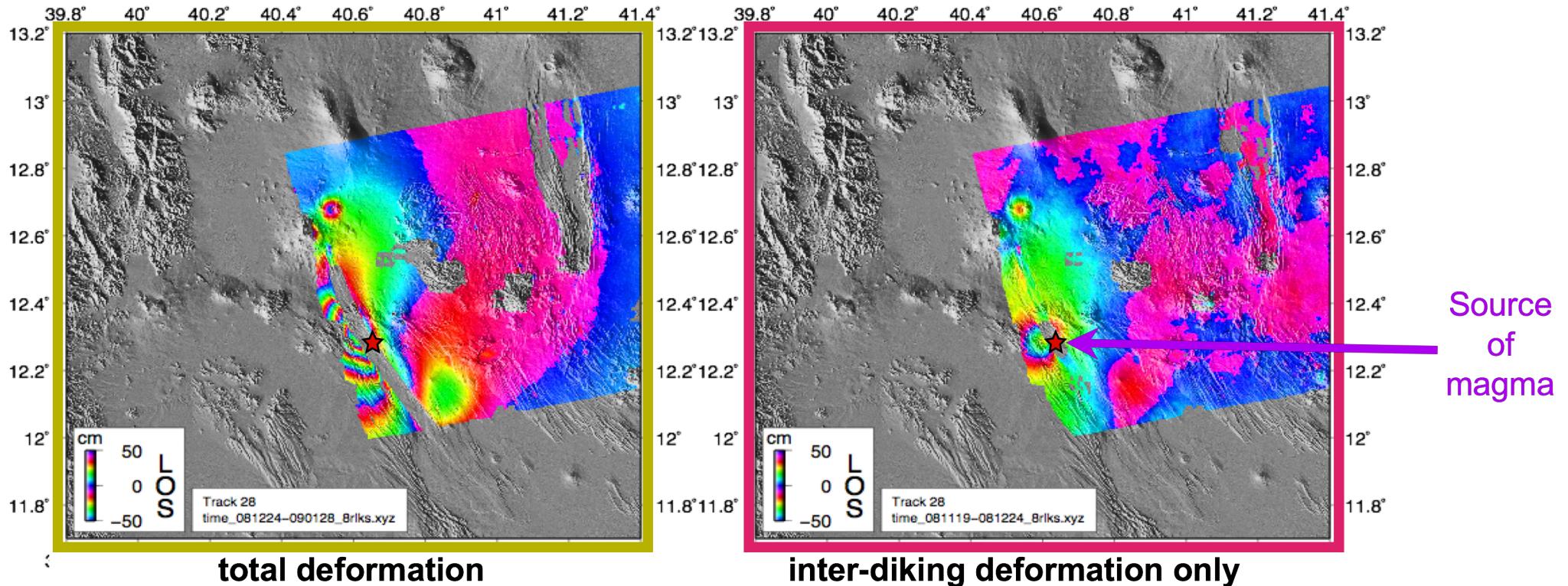


[Grandin et al., 2012,
EPSL]



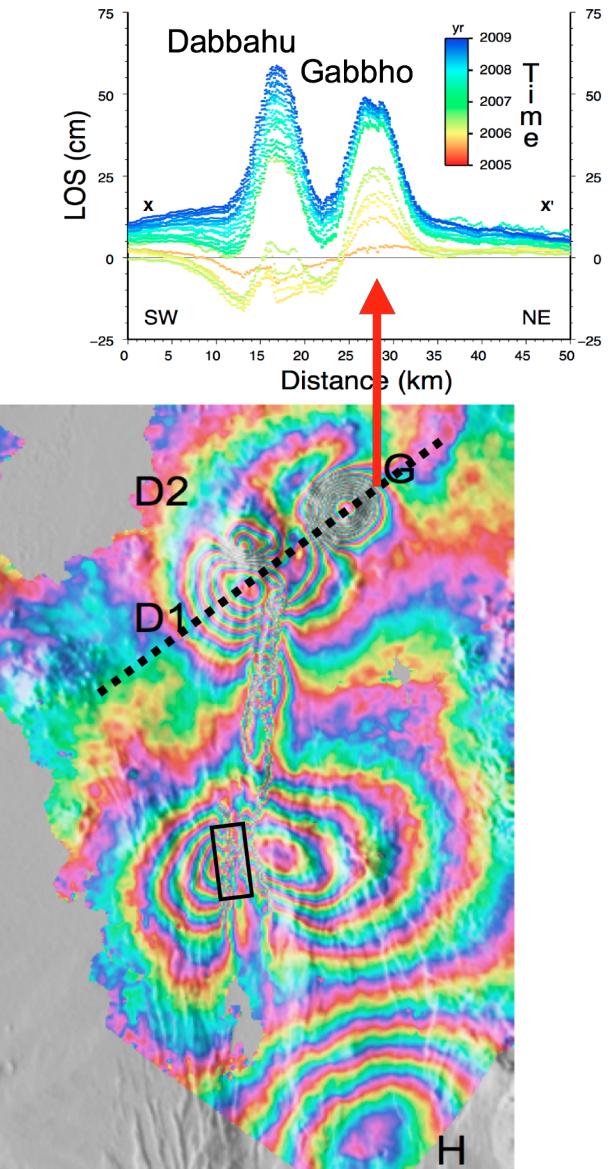


Transient deformation between dike intrusions suggest the presence of a deep (> 10 km depth) source of deformation at the centre of the segment



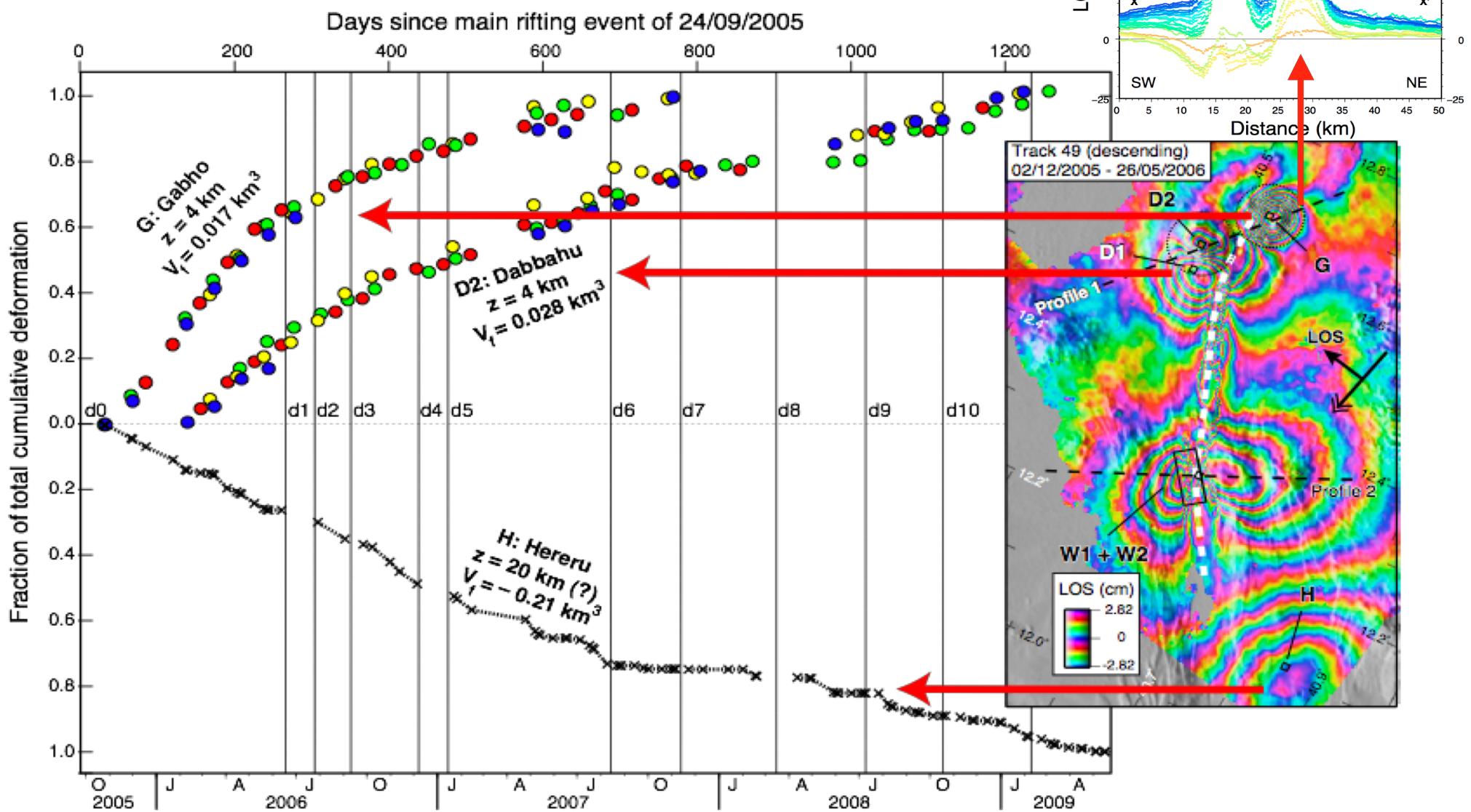
Transient deformation between dike intrusions suggest the presence of a deep (> 10 km depth) source of deformation at the centre of the segment

Post-2005, Inter-dykes deformation



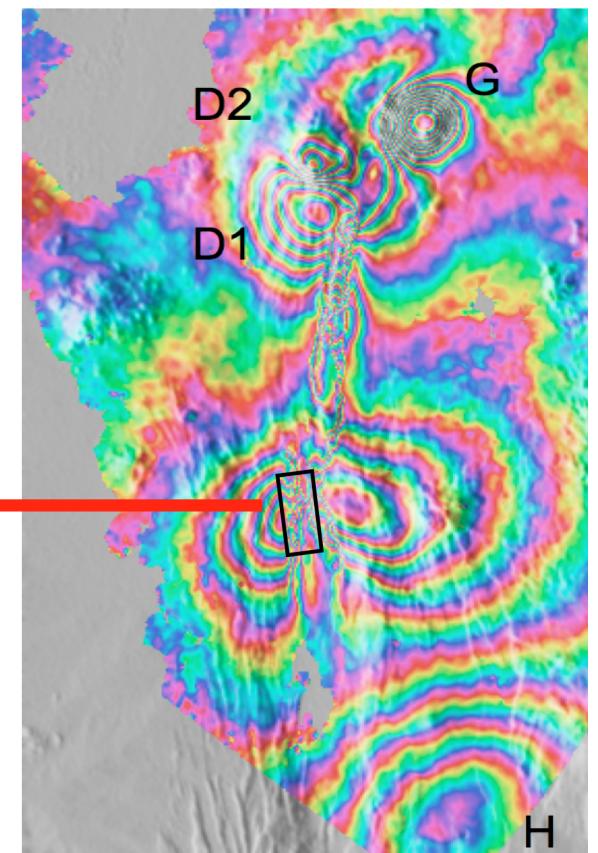
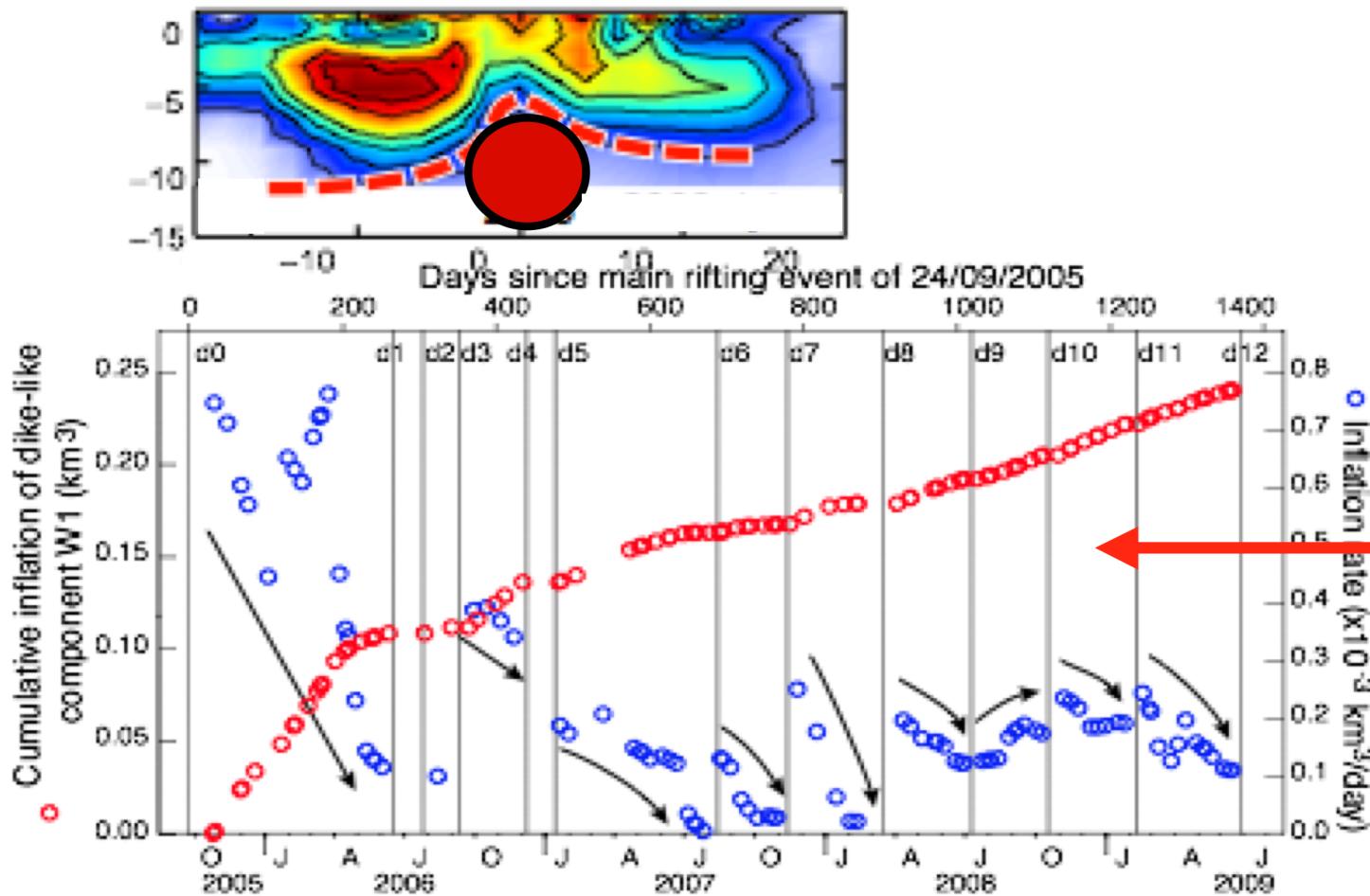
[Grandin et al., 2010a, JGR]

Post-2005, Inter-dykes deformation



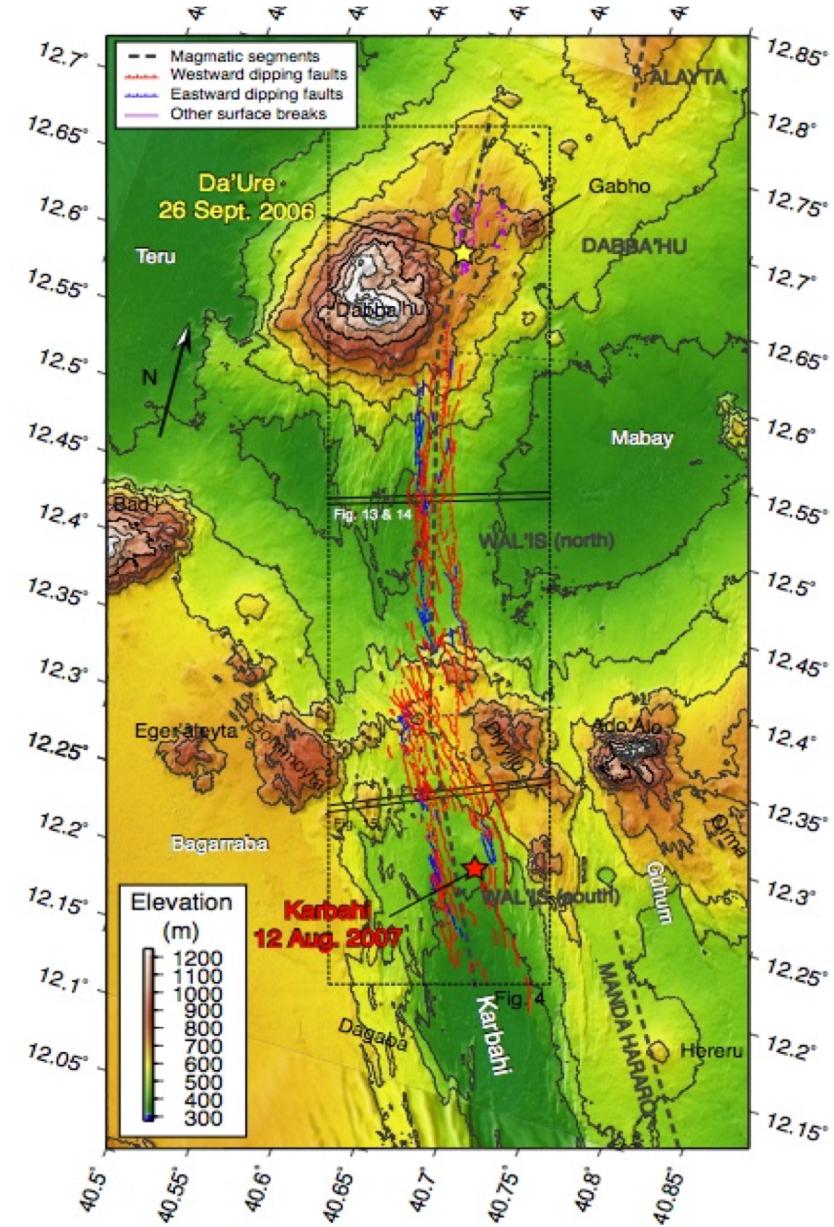
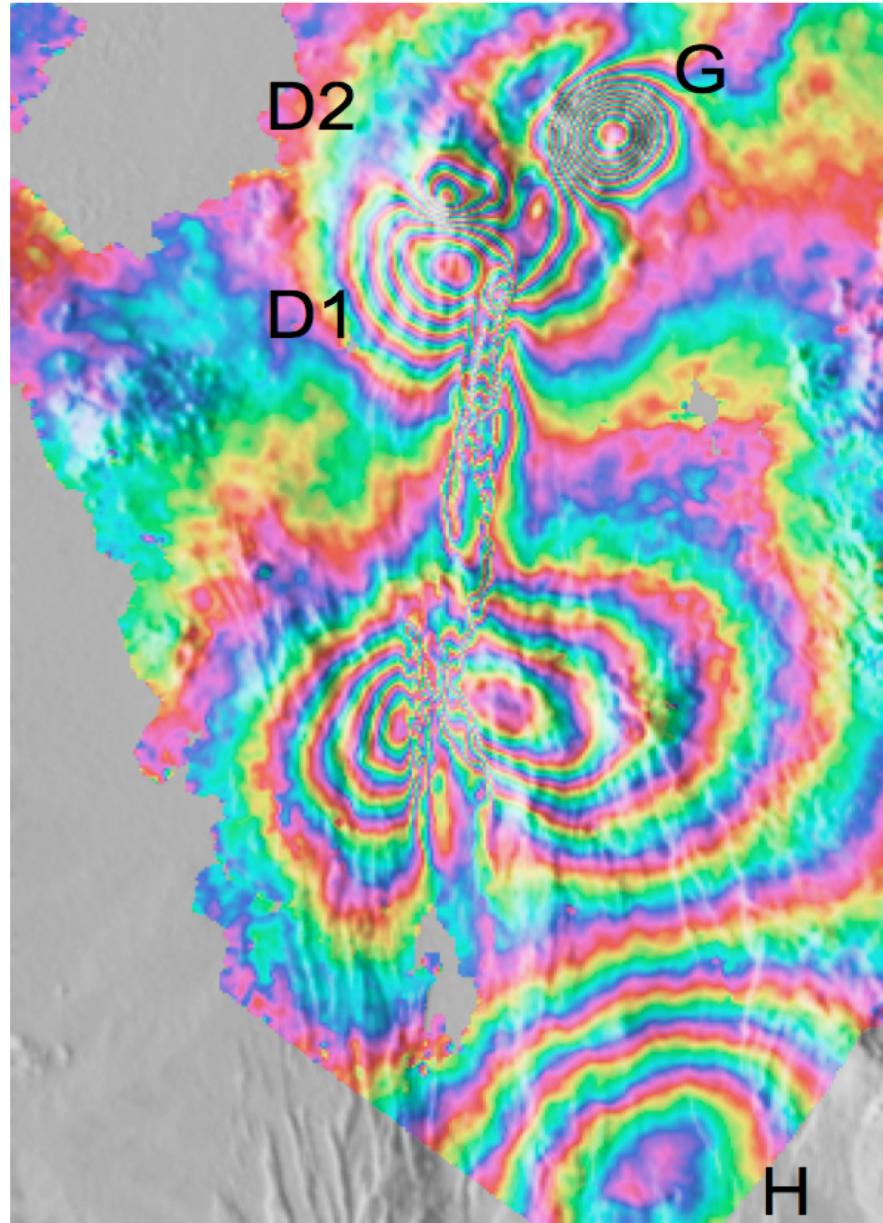
[Grandin et al., 2010a, JGR]

Elongated central magma chamber shows transient movements interacting with series of dikes injections

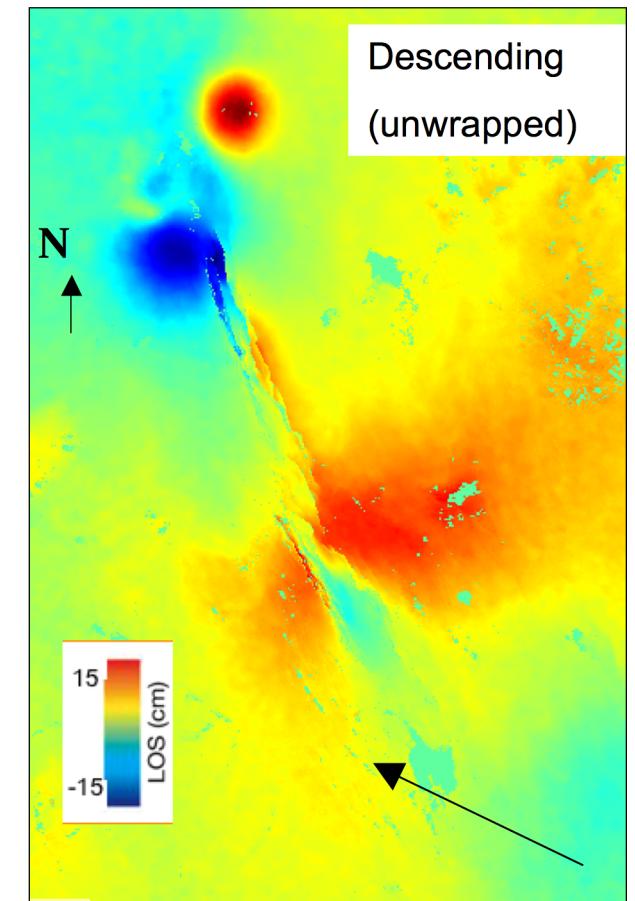
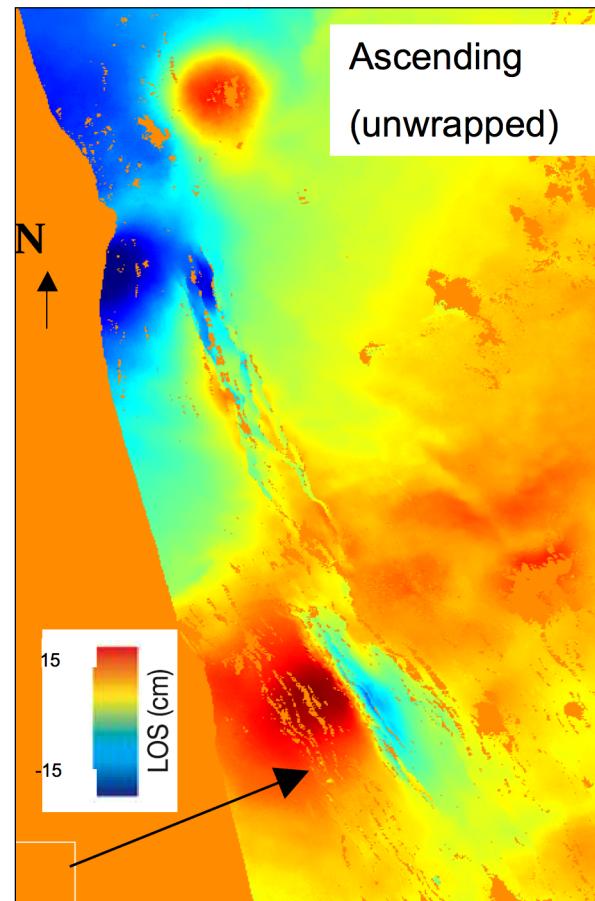
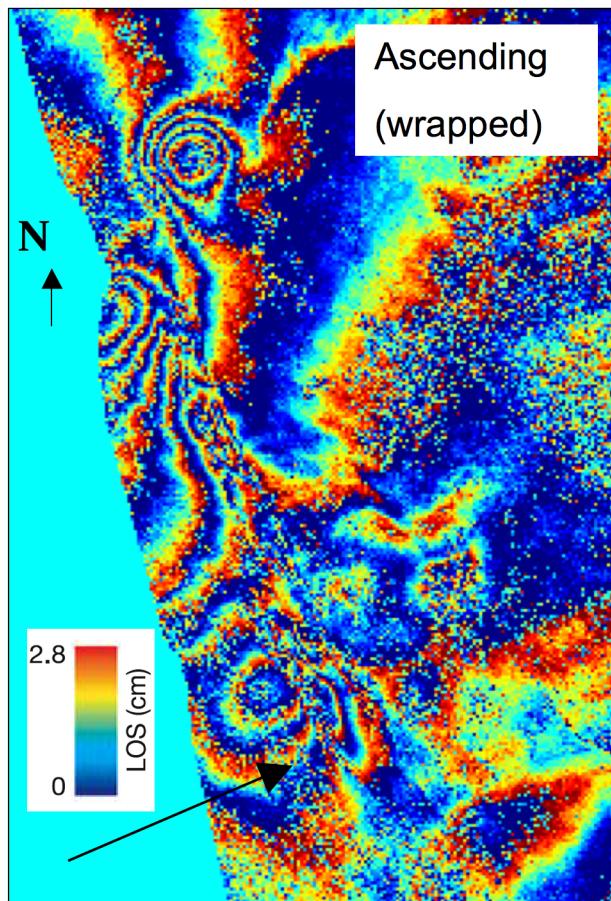


[Grandin et al., 2010a, JGR]

Do these magmatic movements trigger surface faults displacements?



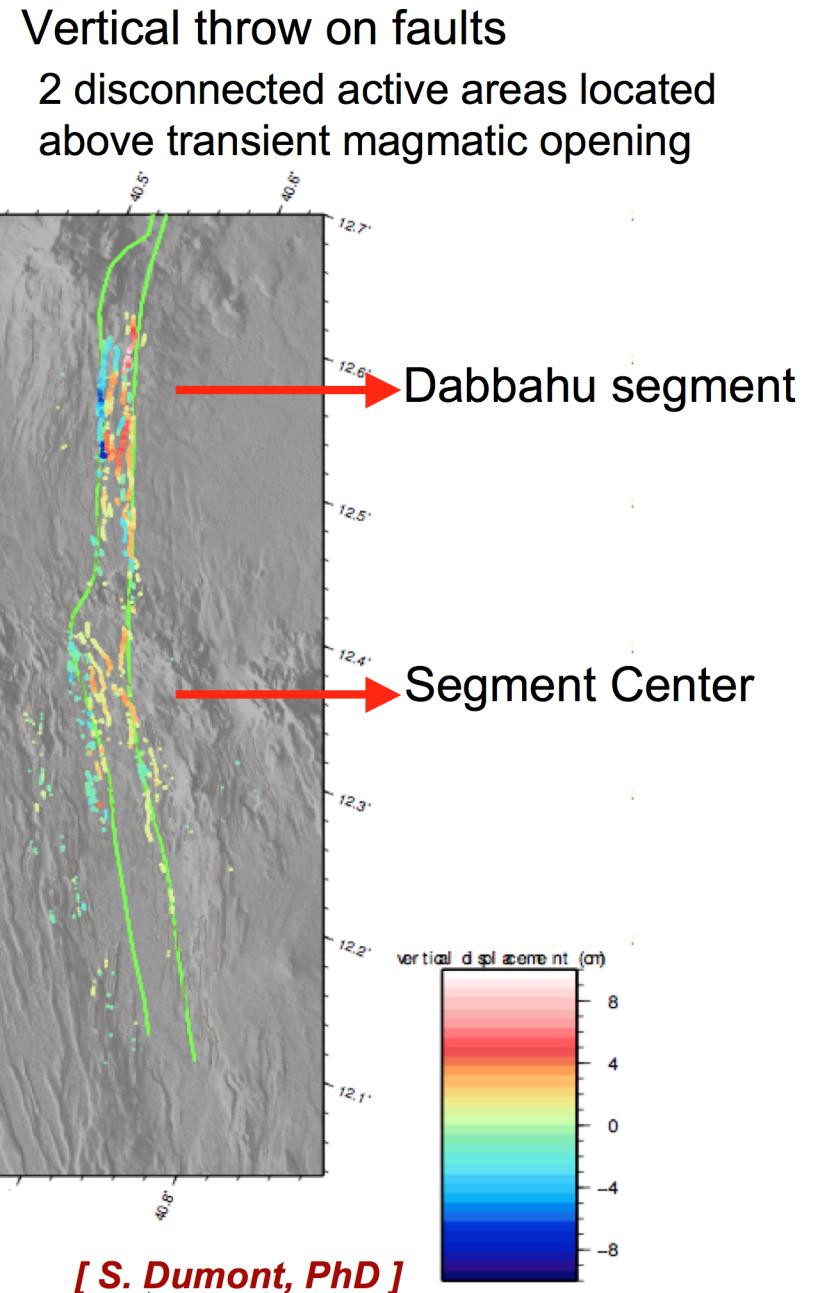
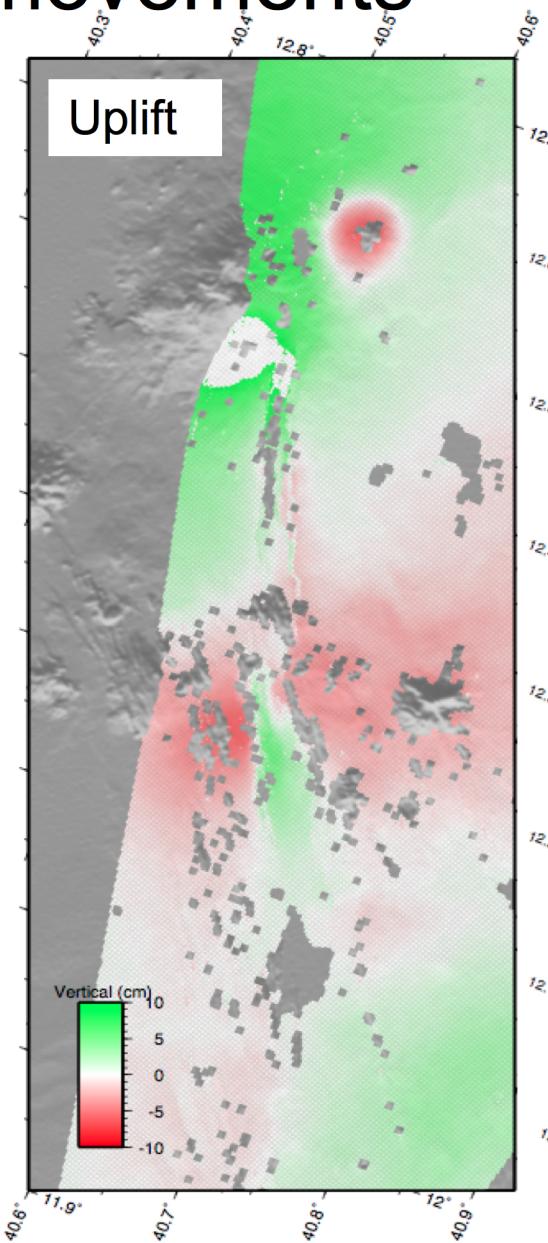
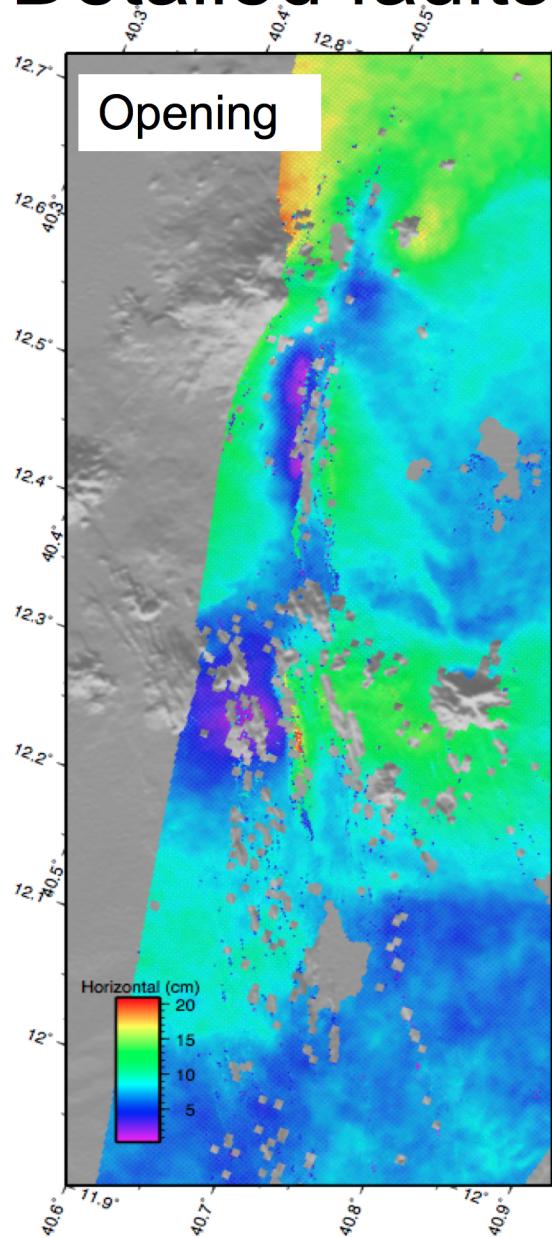
Detailed faults movements (after 2005 mega-dyke)



December 2005 - January 2006

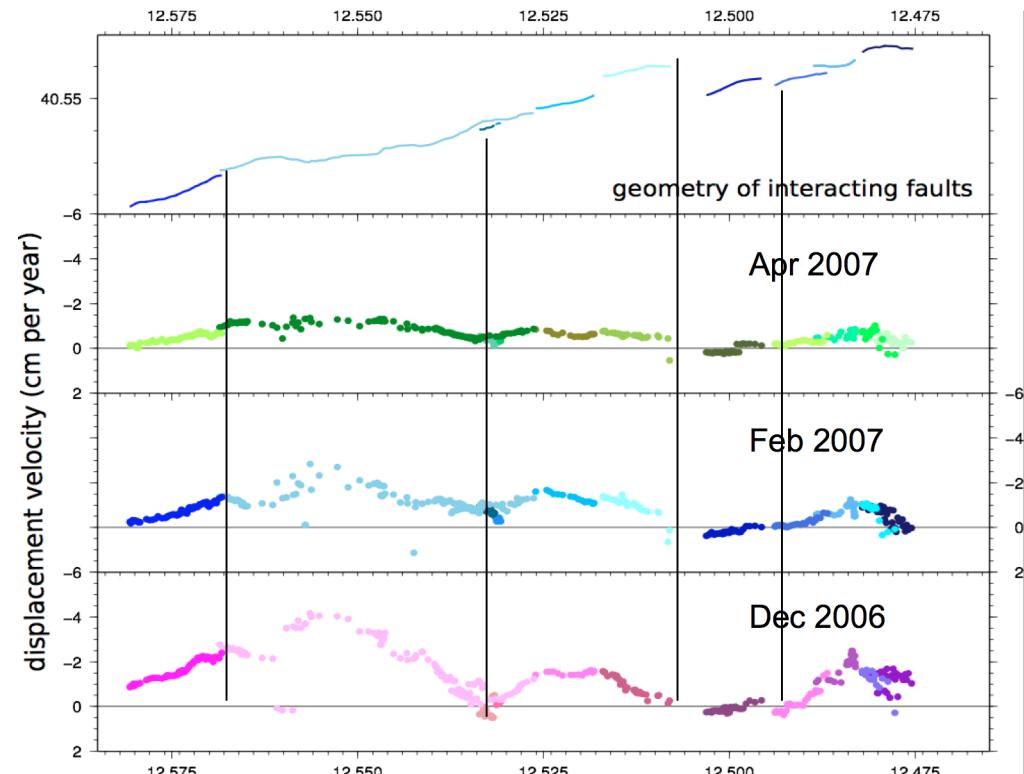
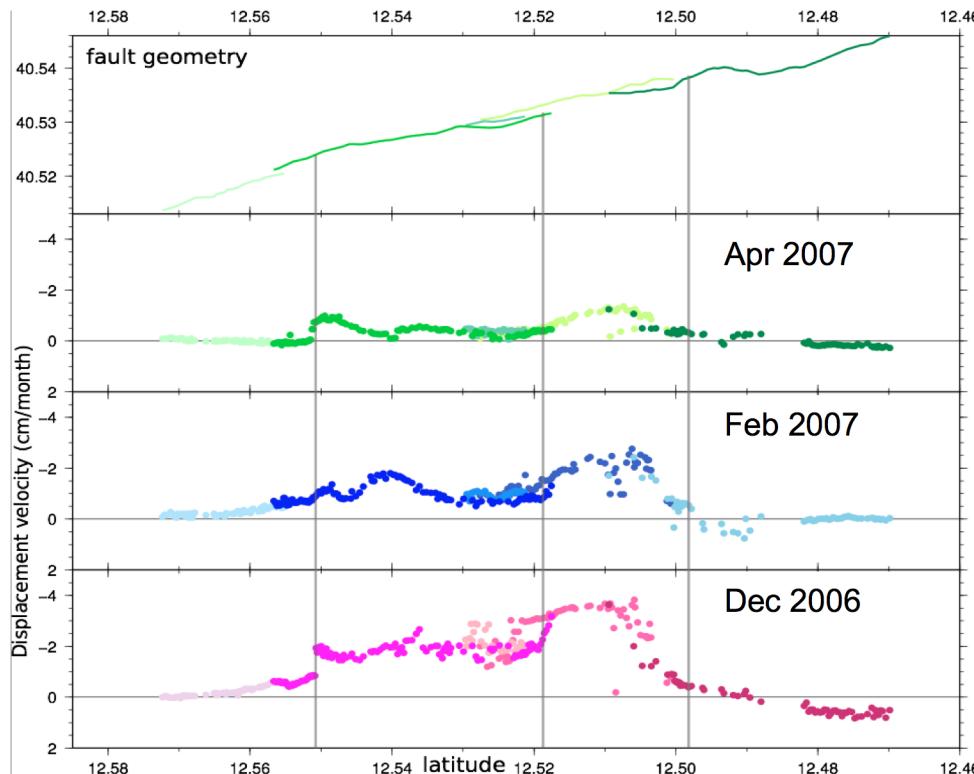
[S. Dumont, PhD]

Detailed faults movements



Detailed faults movements

- Decrease of faults activity with time (compatible with magmatic source)
- Distribution of movement along the fault:
 - persistent with time
 - controlled by fault segmentation (geometry)



Conclusions

- 2005 mega-dyke initiated the rifting episode
- Rifting episode = series of lateral magmatic injections that affect a shorter portion of the rift
- Magma chambers under Gabbho & Dabahu seem disconnected from the rifting episode
- Source of magma: at the centre of the rift
 - Compatible observations at slow-spreading MOR
 - Limited amount of magma available
 - Small overpressure of the main magma reservoir
- Large tectonic stress deficit at the onset of rifting => magma is emplaced “passively” into the dikes
- Surface faults movements triggered by magmatic processes and controlled by geometry



Thank you for your attention



Amesege'nallo'!



Gad'dege!