Ethiopian Flood Basalt Province: 2. The Ogaden Dyke Swarm

(1 : Dyke swarms of Northwestern Ethiopia, poster)

Daniel MEGE

Planetology and Geodynamics Lab, Nantes, France

Peter PURCELL

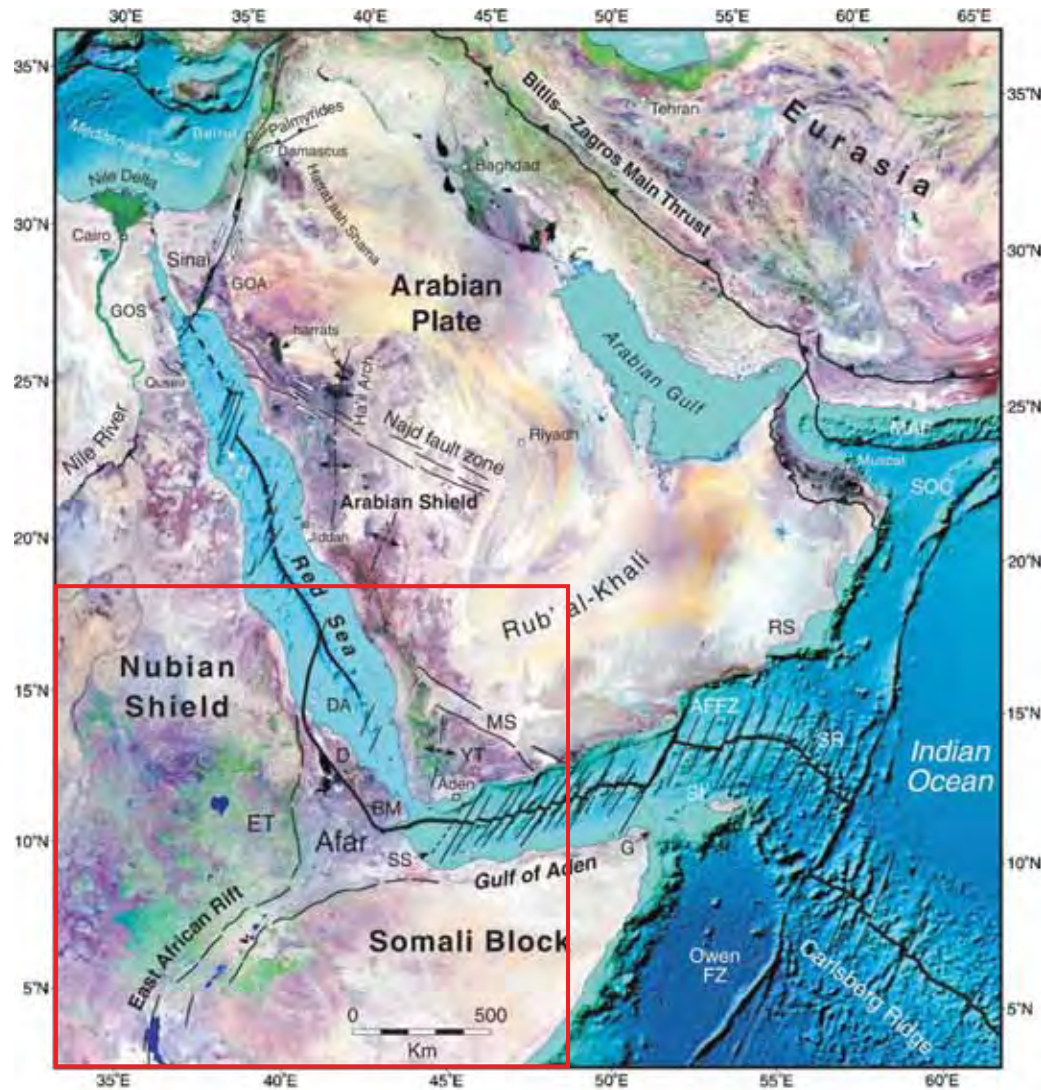P & R Geological Consultants, Scarborough, Australia

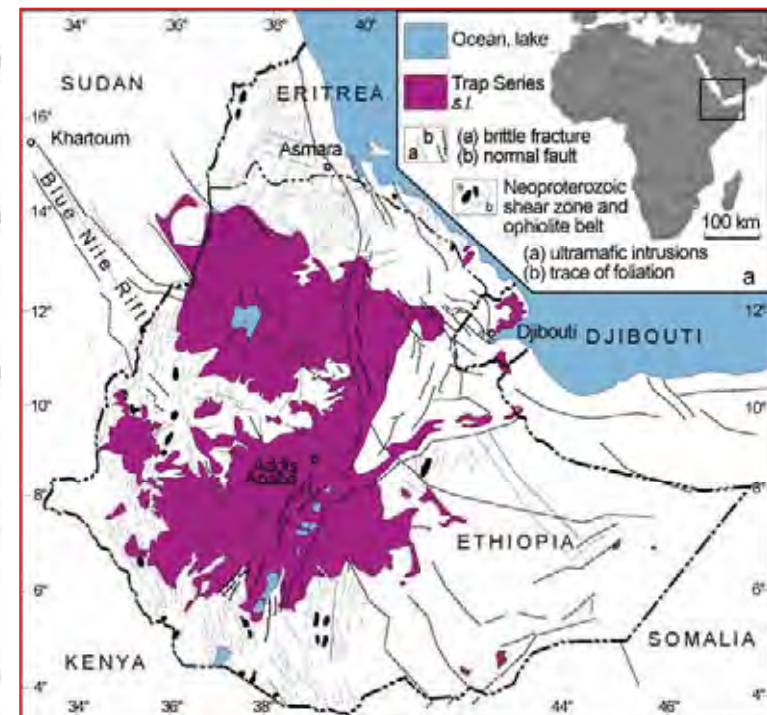*with first radiochronology results obtained by*

Fred JOURDAN

Western Australia Argon Isotope Facility, Curtin University of Technology, Perth, Australia

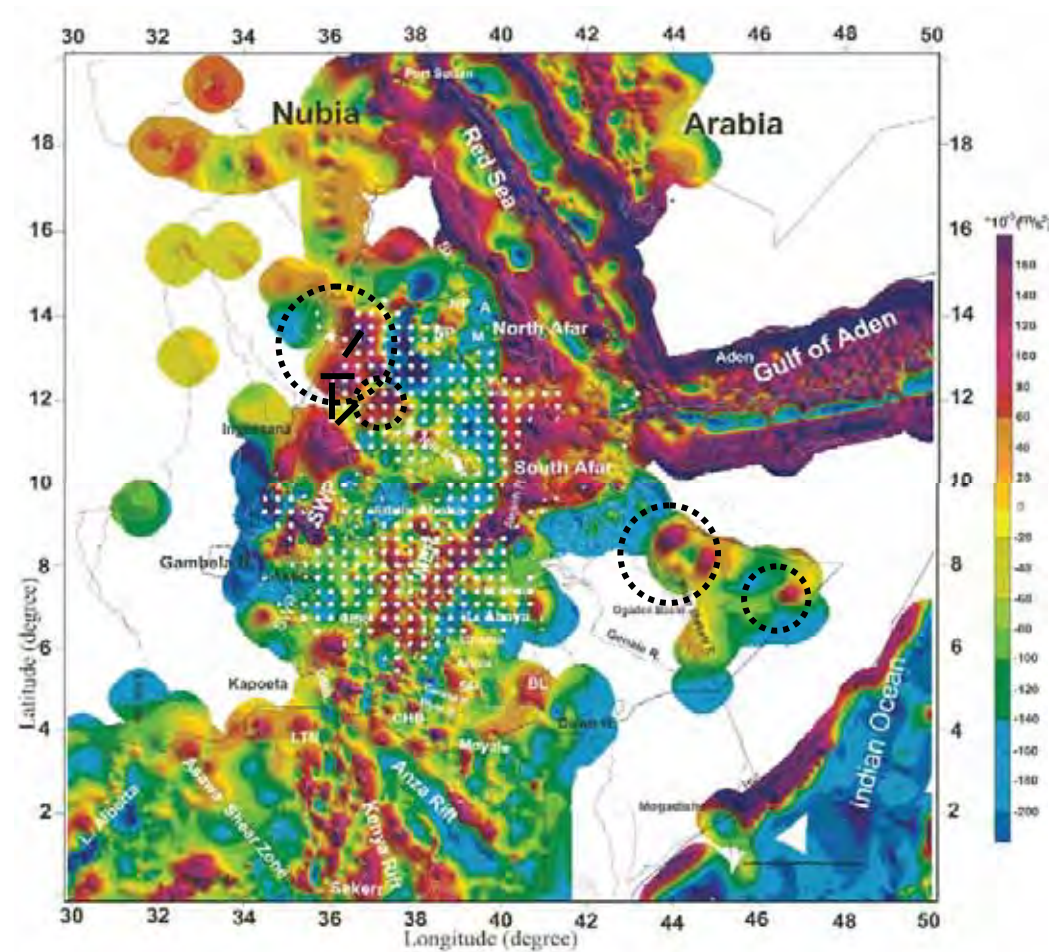# Ethiopian Flood Basalt Province

Bosworth et al., 2005

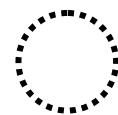Mège and Korme, 2004

Where are the magma sources?

No reservoir or chamber
identified to date.

modified after Woldetinsae, 2005

residual gravity
(isostatic regional field – Bouguer anomaly)

White dots: Trap Series
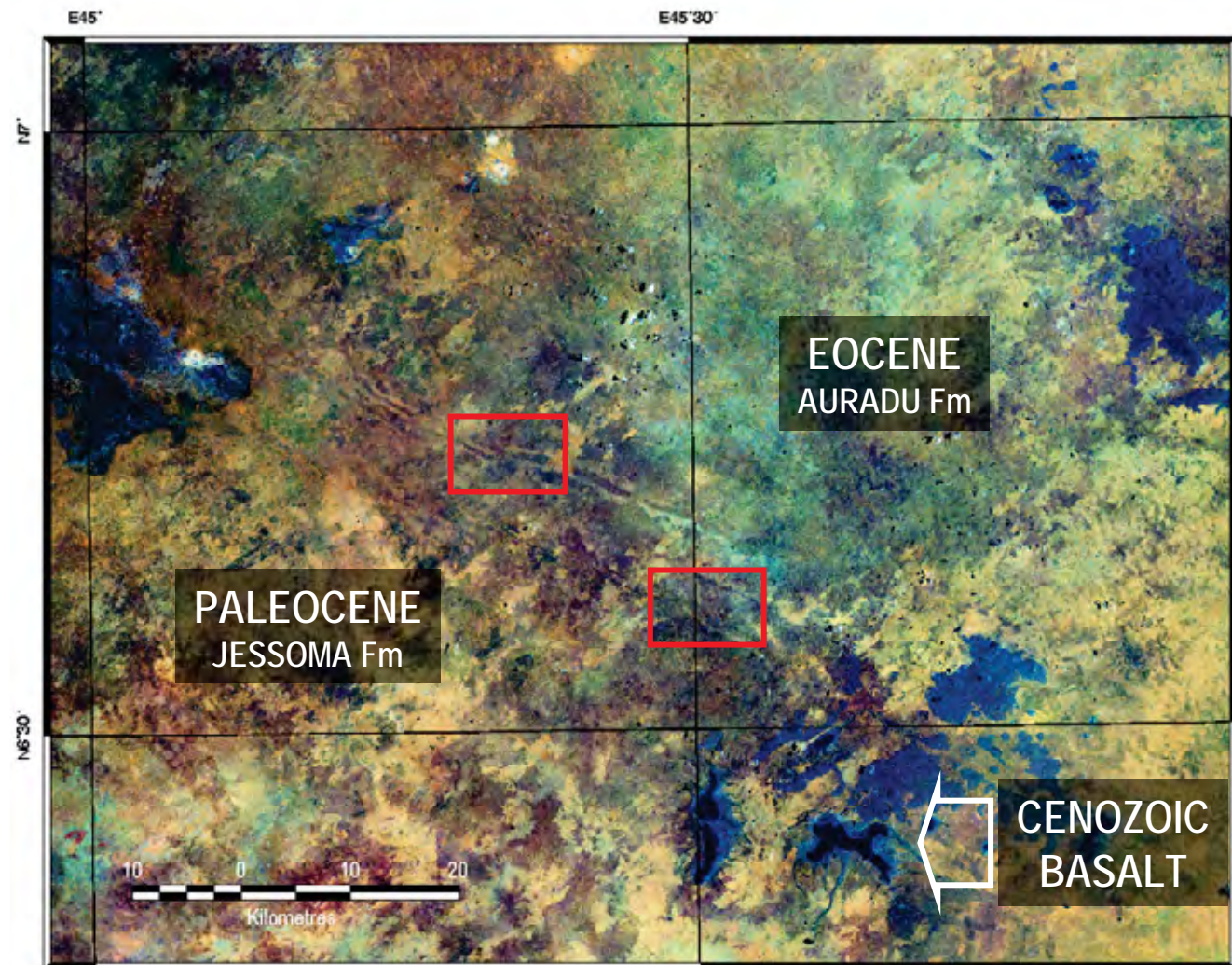
*positive anomalies
uncorrelated with shield volcanoes*

main 30 Ma-old mafic dyke swarms
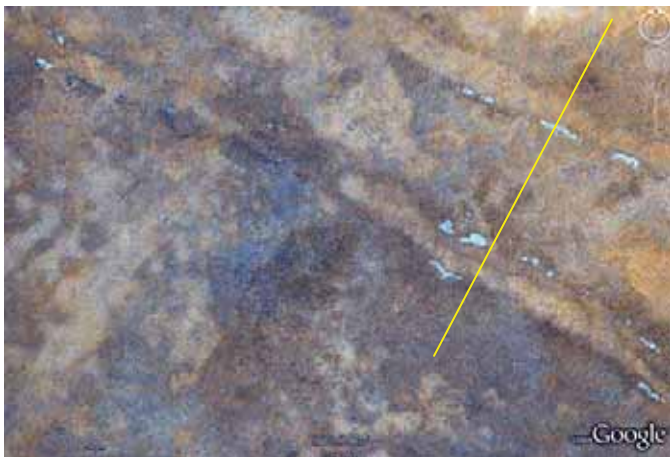
The Ogaden region of eastern Ethiopia
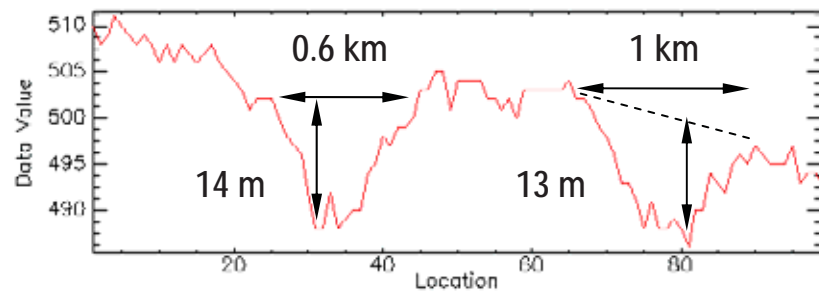
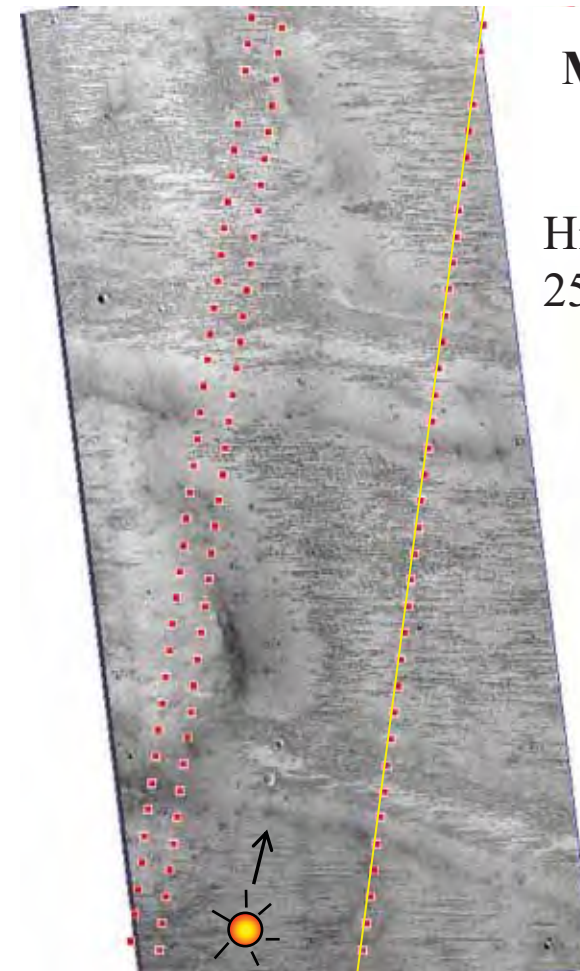# The Ogaden region in eastern Ethiopia

EARTH

GeoEye, 74 cm/pixel
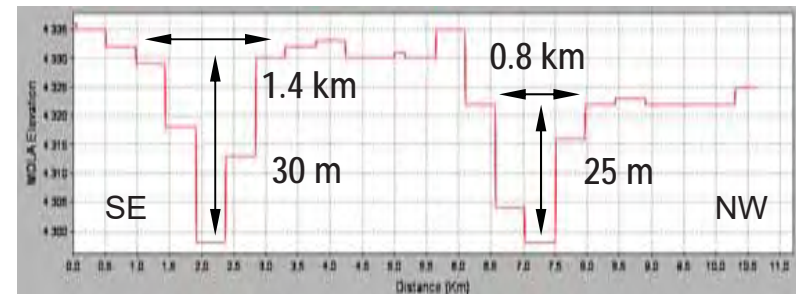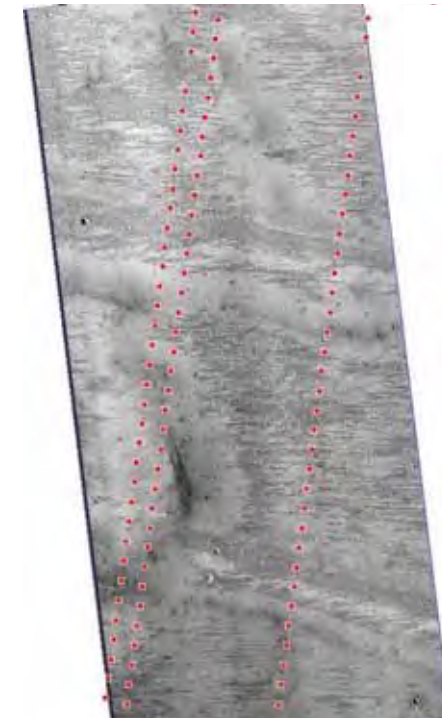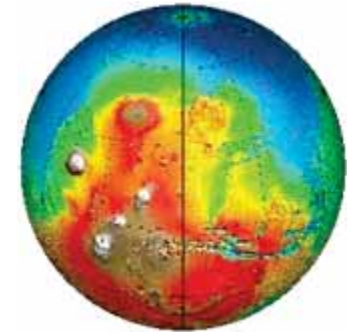
Spot 5, 2.5 m/pixel

SRTM, 5 m/pixel (v)

MARS

HiRISE
25 cm/pixel

MOLA, 37.5 cm/pixel (v)

Syria Planum dyke swarm
Tharsis dyke swarm

Alba Patera
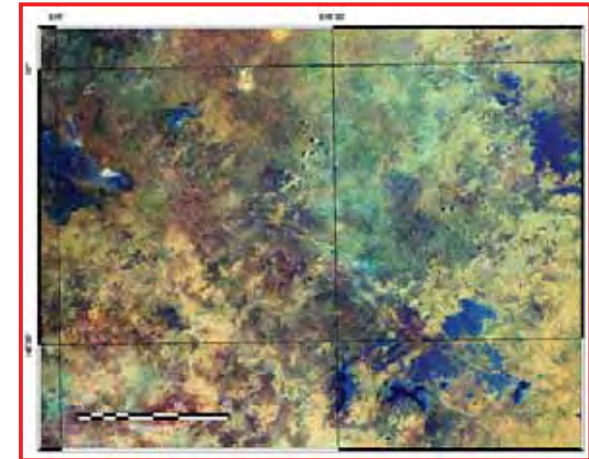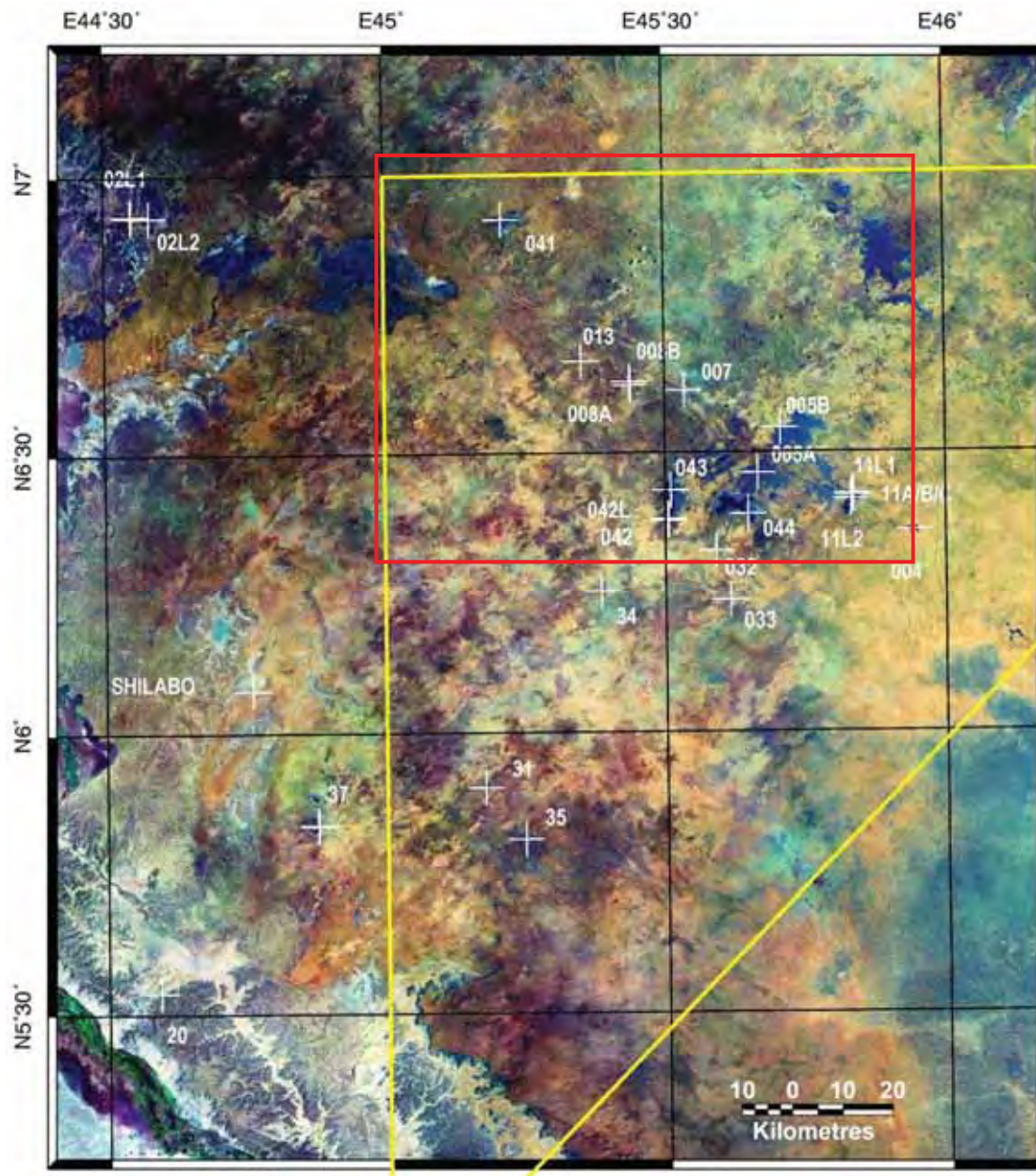
Olympus Mons

Ascreus Mons

1000 km

Pavonis Mons

Arsia Mons

Syria Planum
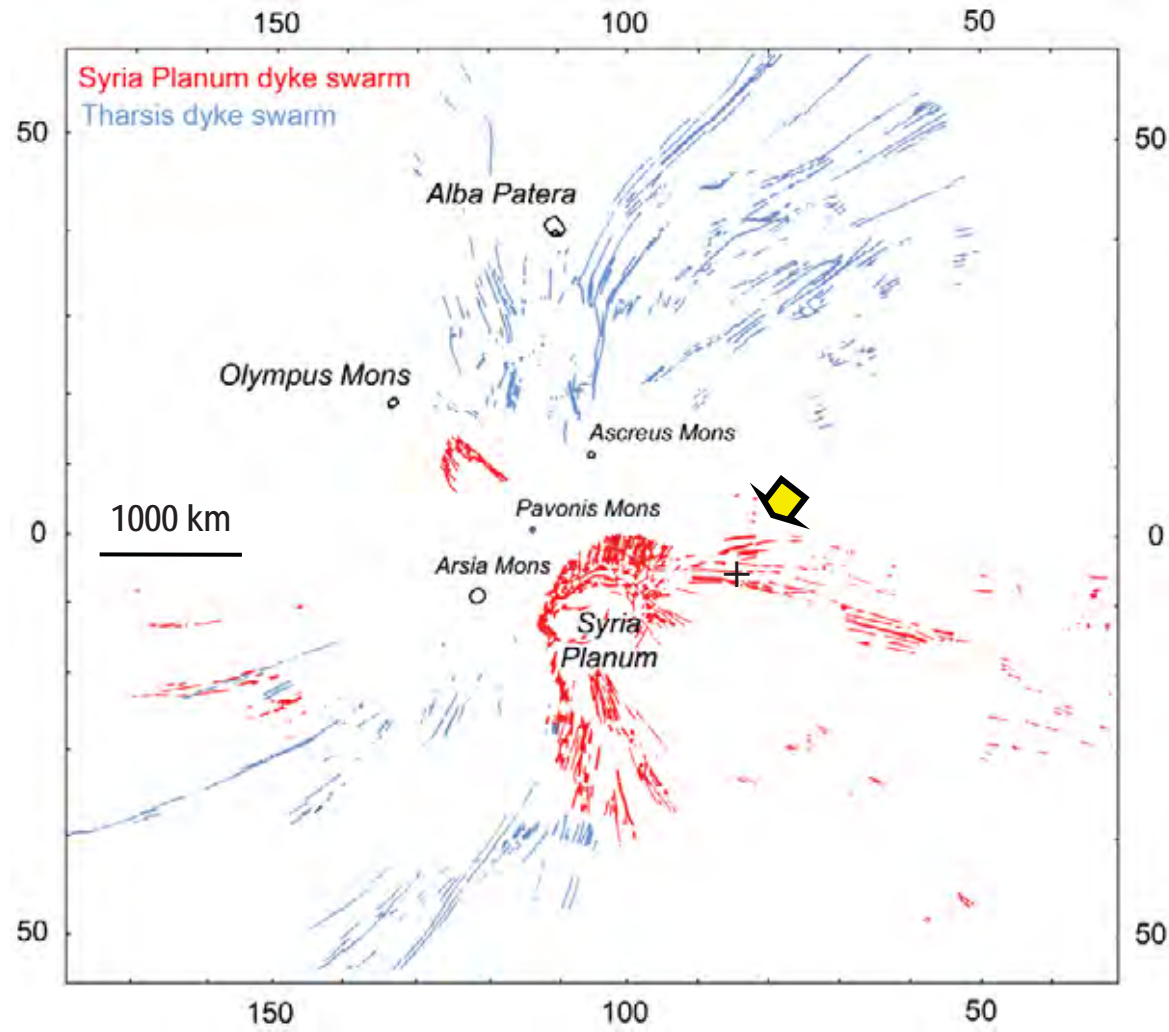
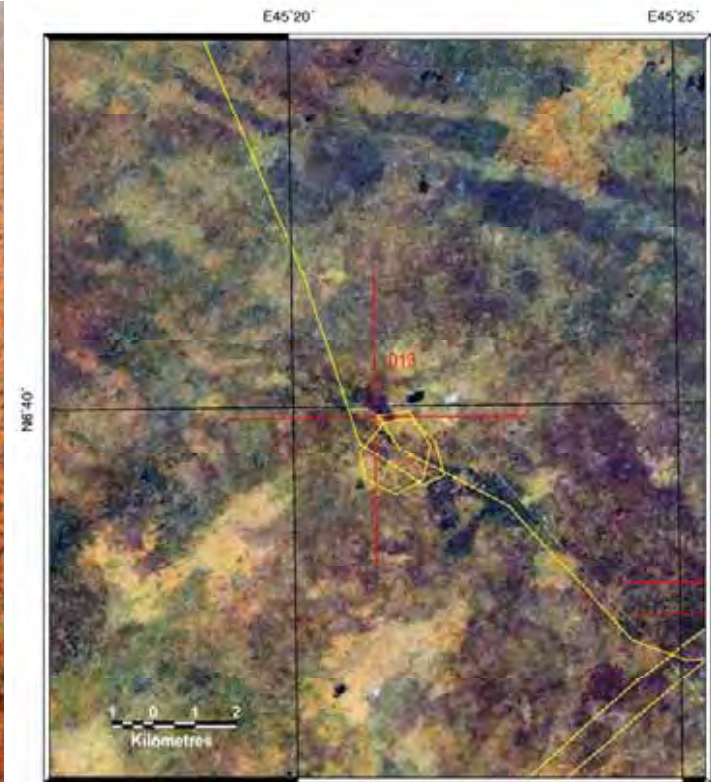*Mège and Masson, 1996 + IDC-3 (1995)*

Such linear troughs have been interpreted on Mars as possible surface consequence of non-emergent dyke emplacement by several research groups.

flyby and landing sites

Pexco Exploration (East Africa) N.V.
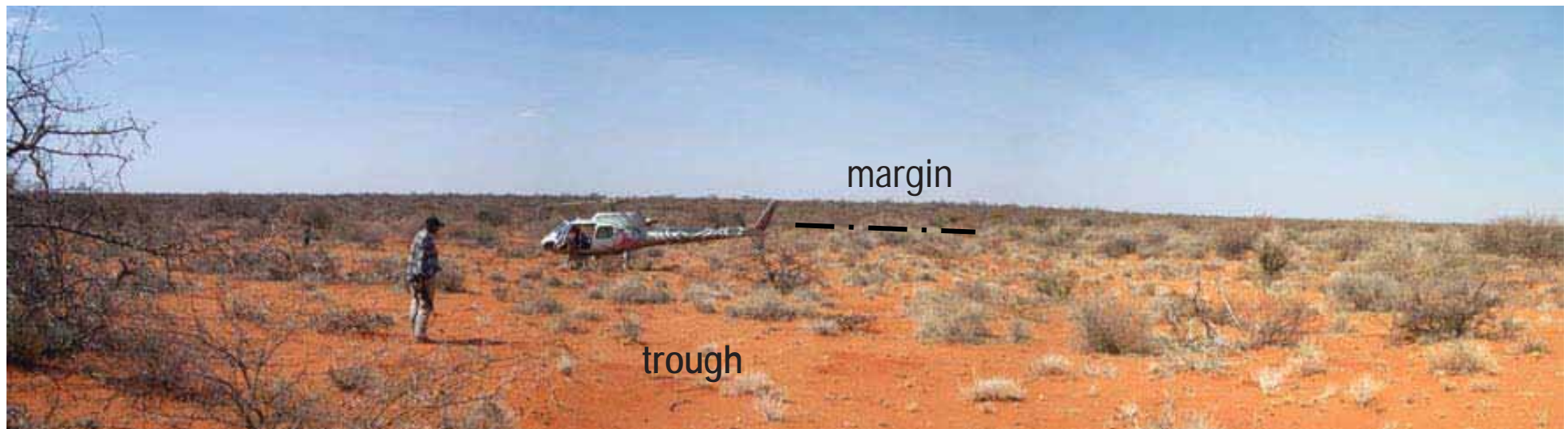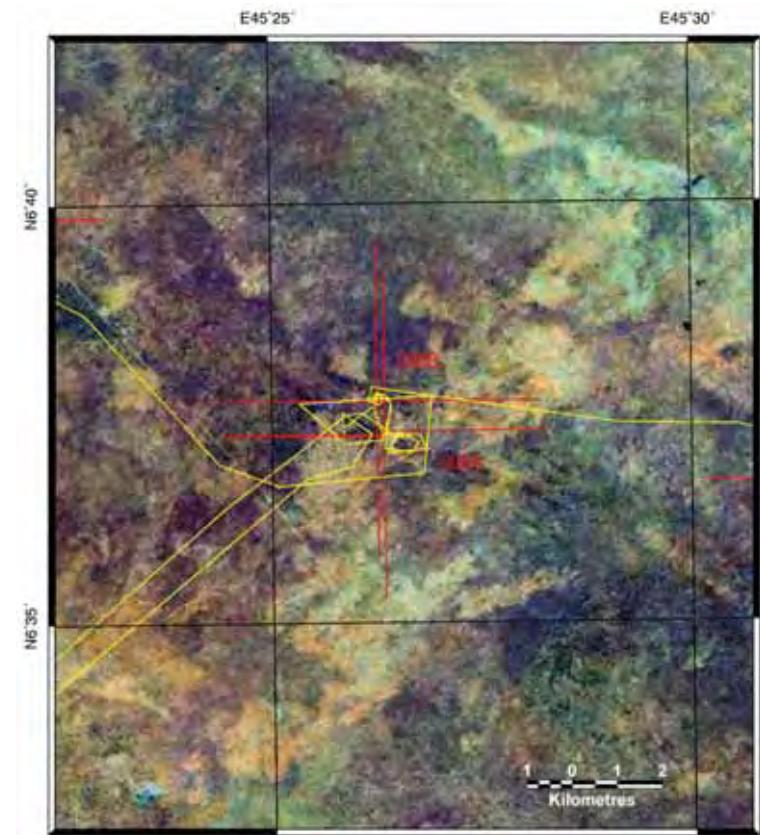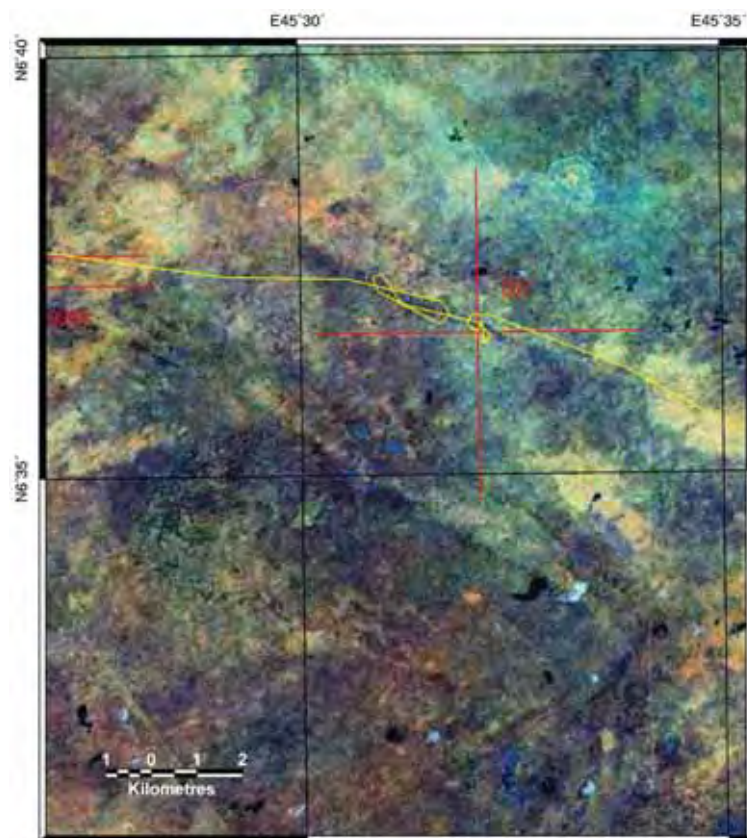Geological reconnaissance survey
September 2008

site 13

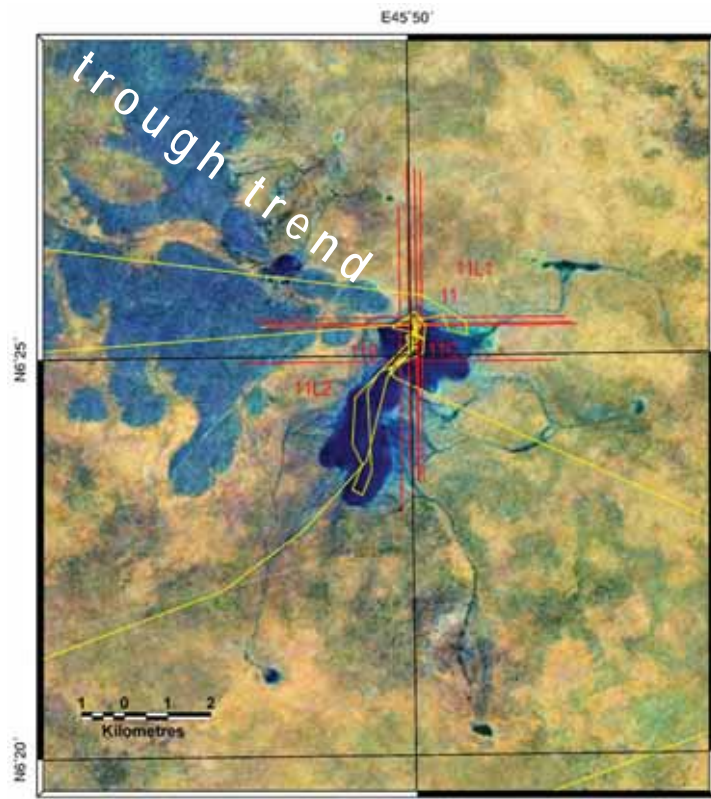3 observation sites along one of the linear troughs

site 8

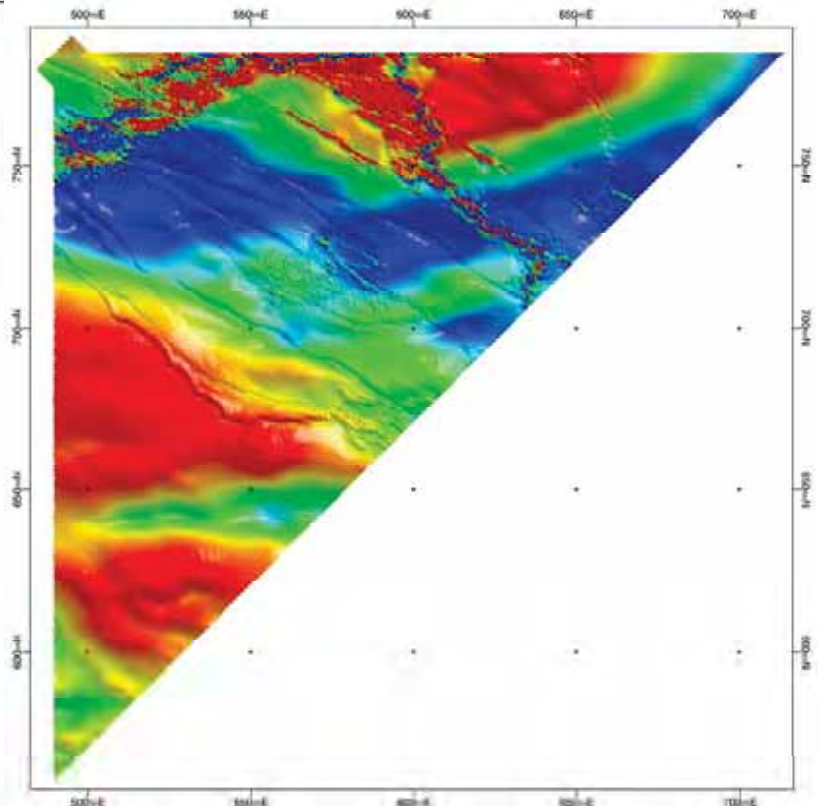densely vegetated margin
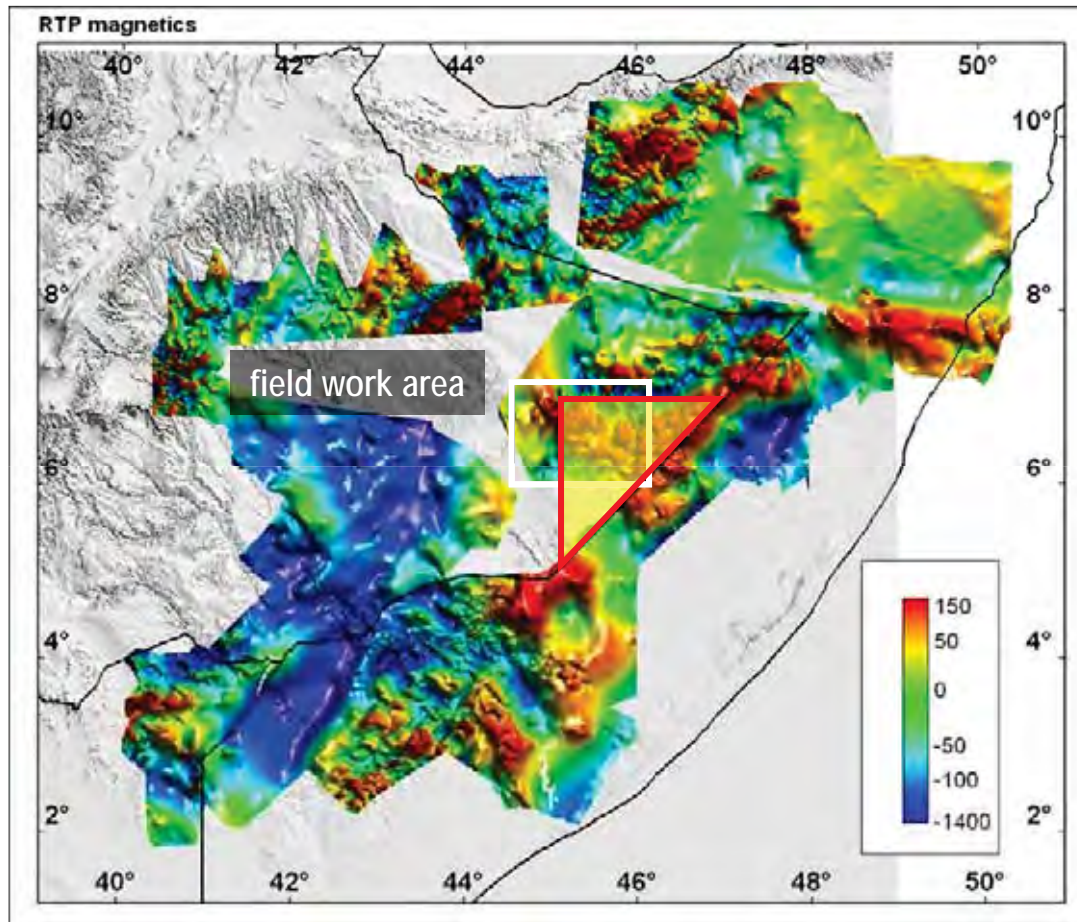
margin

trough

site 7

trough margin

Dyke outcrop
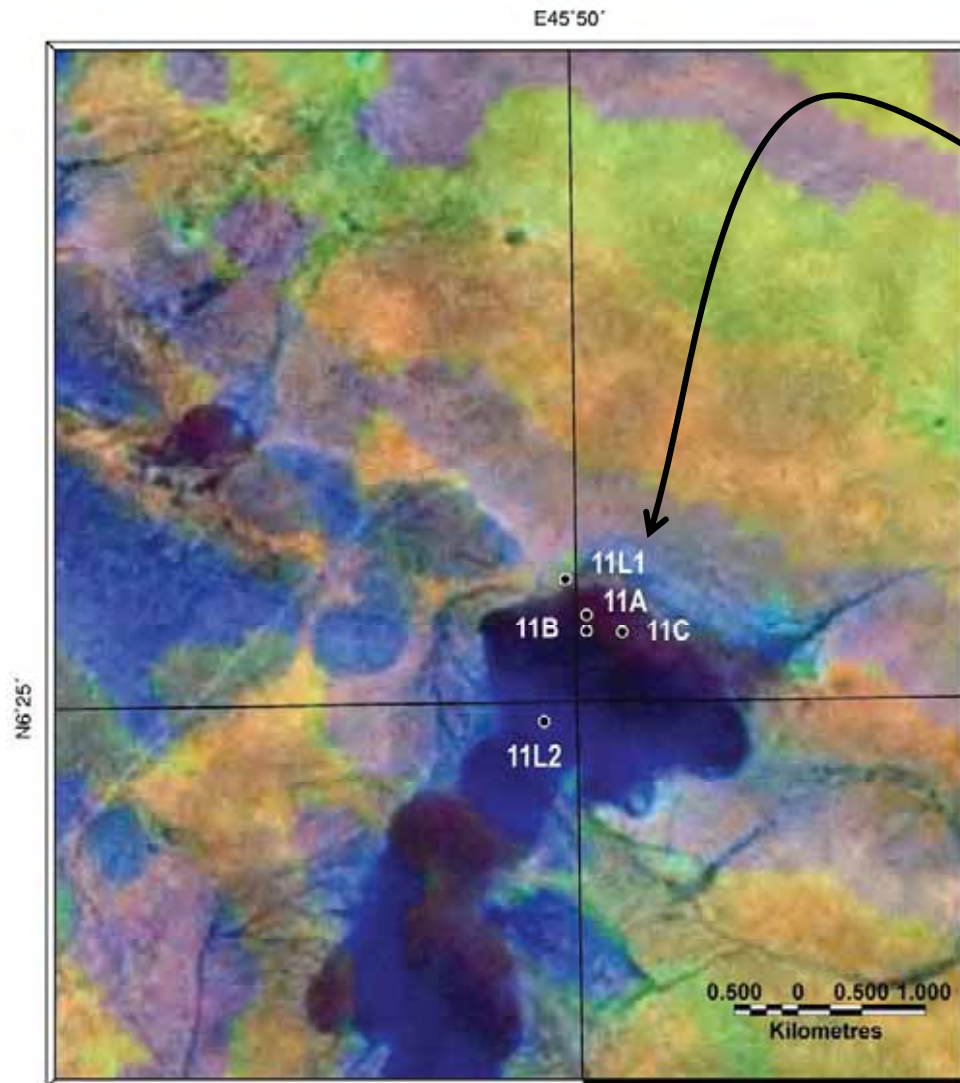at the SE end of the
studied trough

Aeromagnetic data

New magnetic data
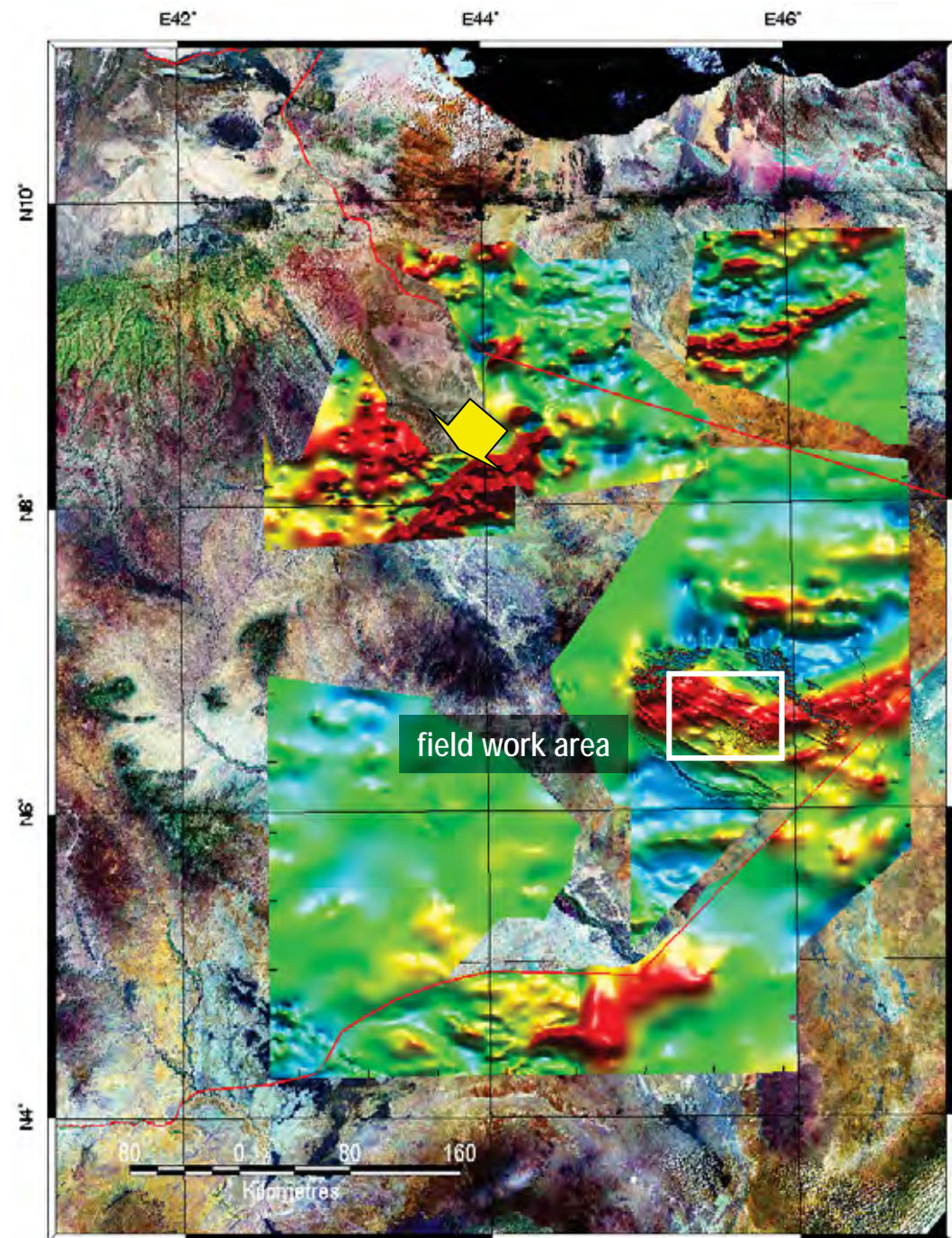(Pexco, February-March 2008)

- dykes
- buried flows

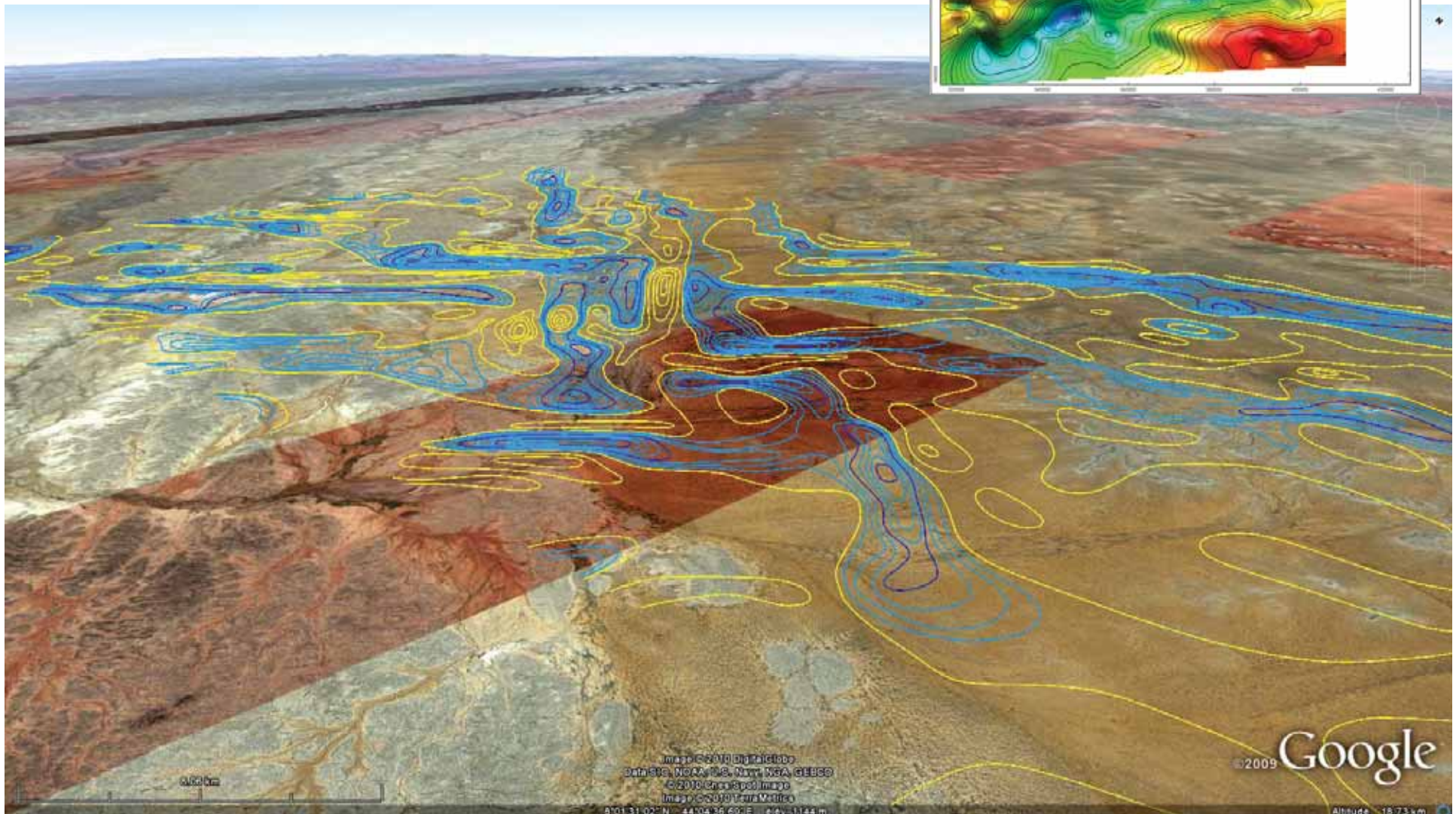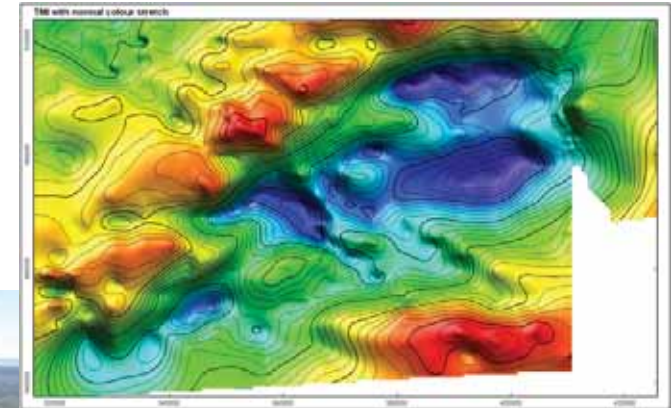# Aeromagnetic data

reverse polarity

Aeromagnetic data:
back to the 70's

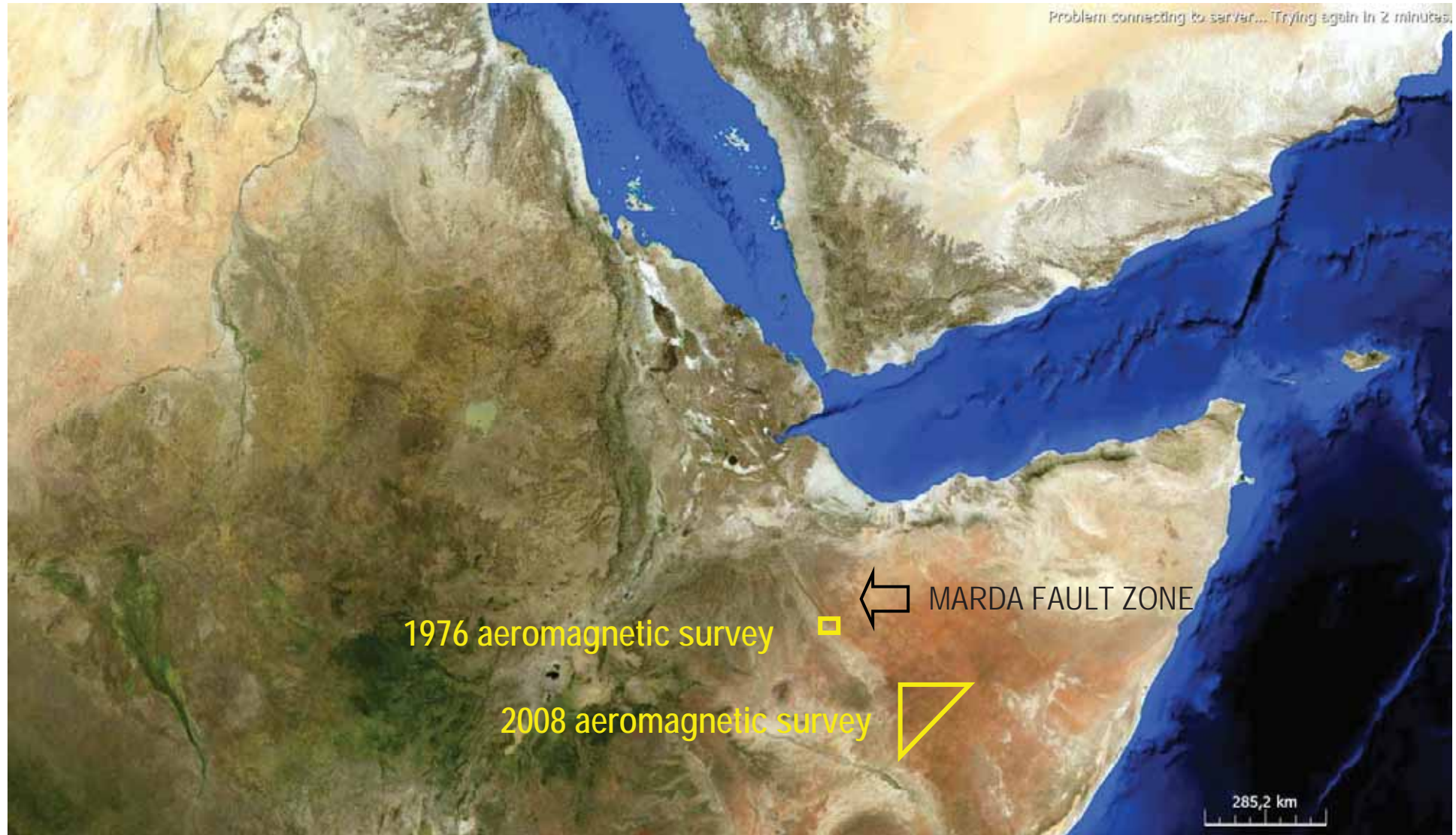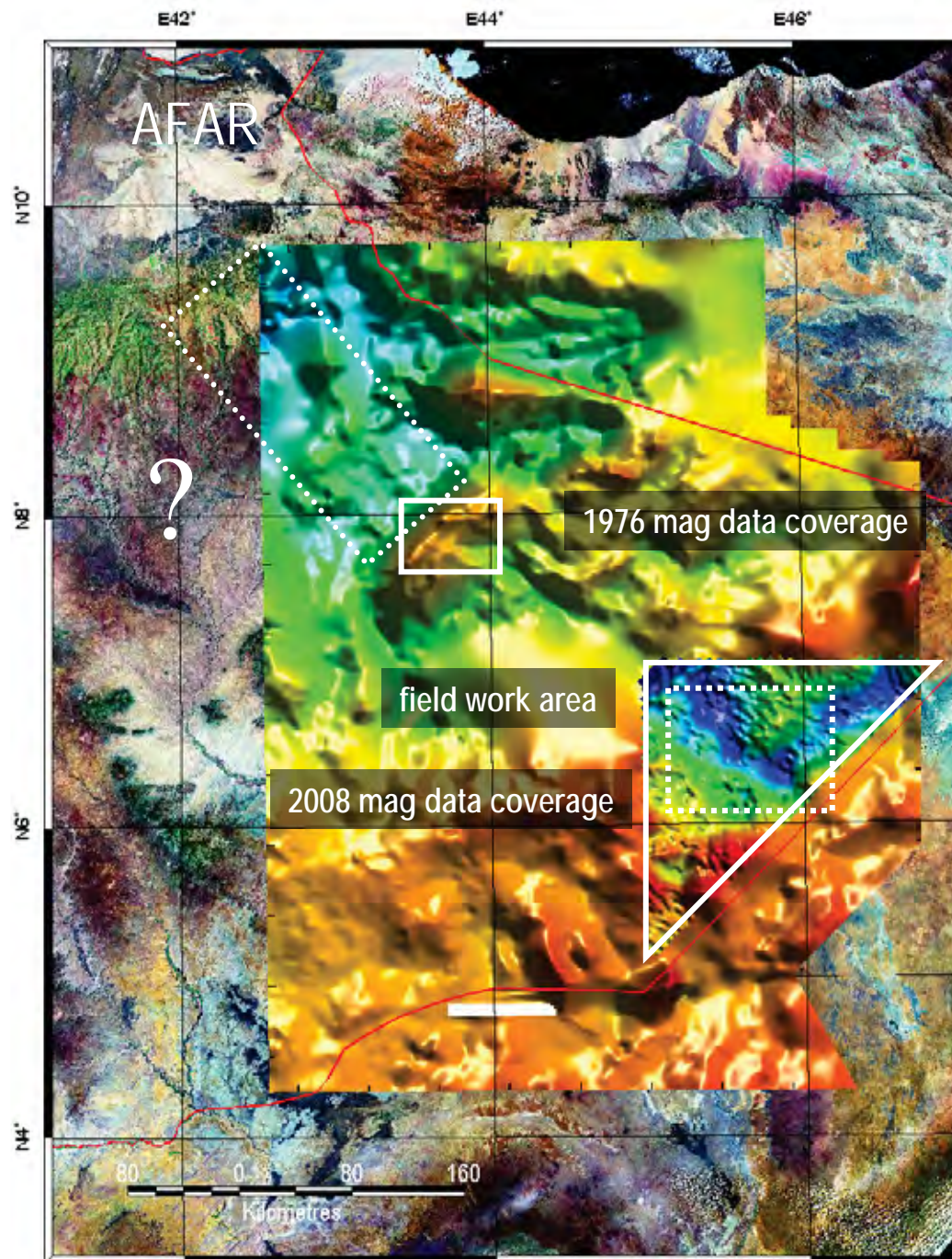# Aeromagnetic data: back to the 70's

Whitestone Ethiopia Petroleum, Harar aeromagnetic survey (1976)
Second vertical derivative map

The Marda Fault Zone: in the axis of the southern Red Sea

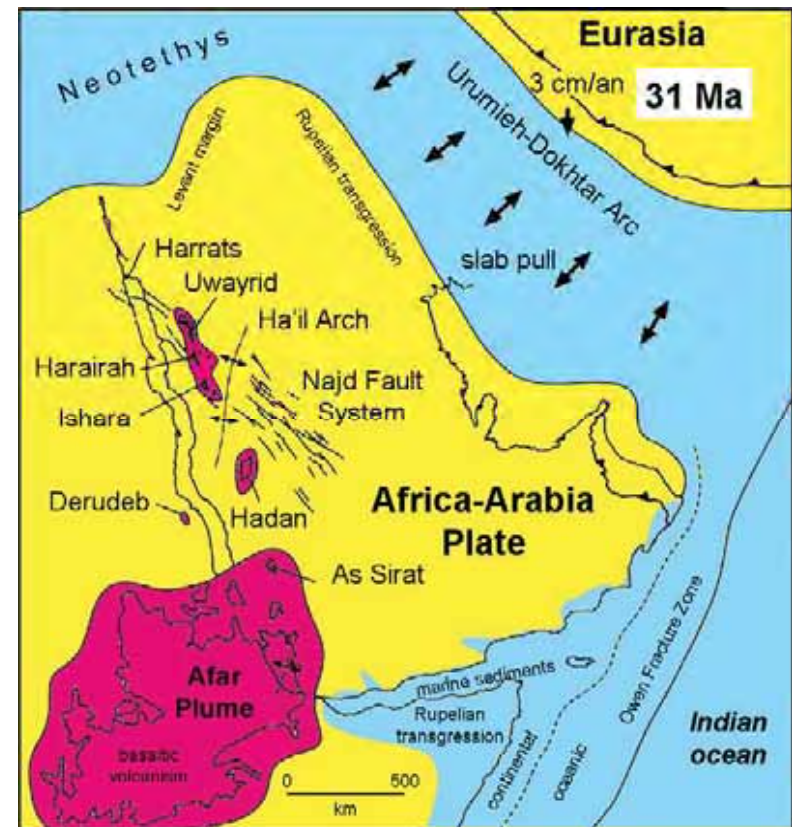Gravity data

New Bouguer gravity data
(Pexco, February-March 2008)

- The dyke trend can be traced across the magnetic data gaps

- It may be followed along the Marda Fault Zone to the southern Afar margin

Dyke dating

Preliminary Ar-ages obtained at
Western Australia Argon Isotope Facility

W3.4

29.95 ± 1.88 Ma

W1.1

28.18 ± 4.31 Ma
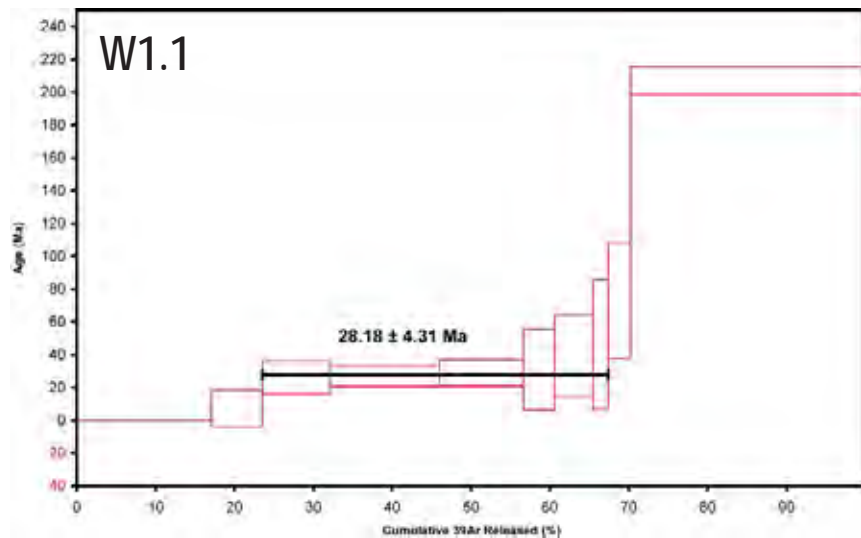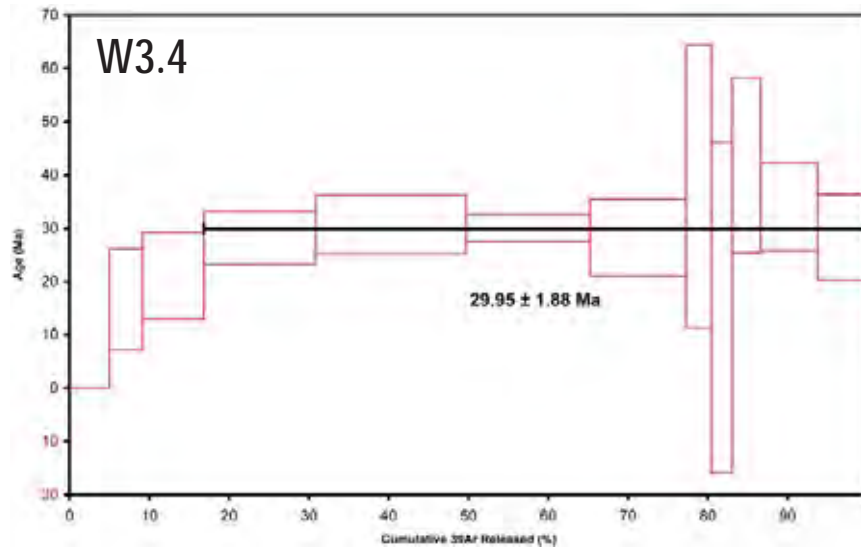
Bosworth et al., 2005

Regional implications
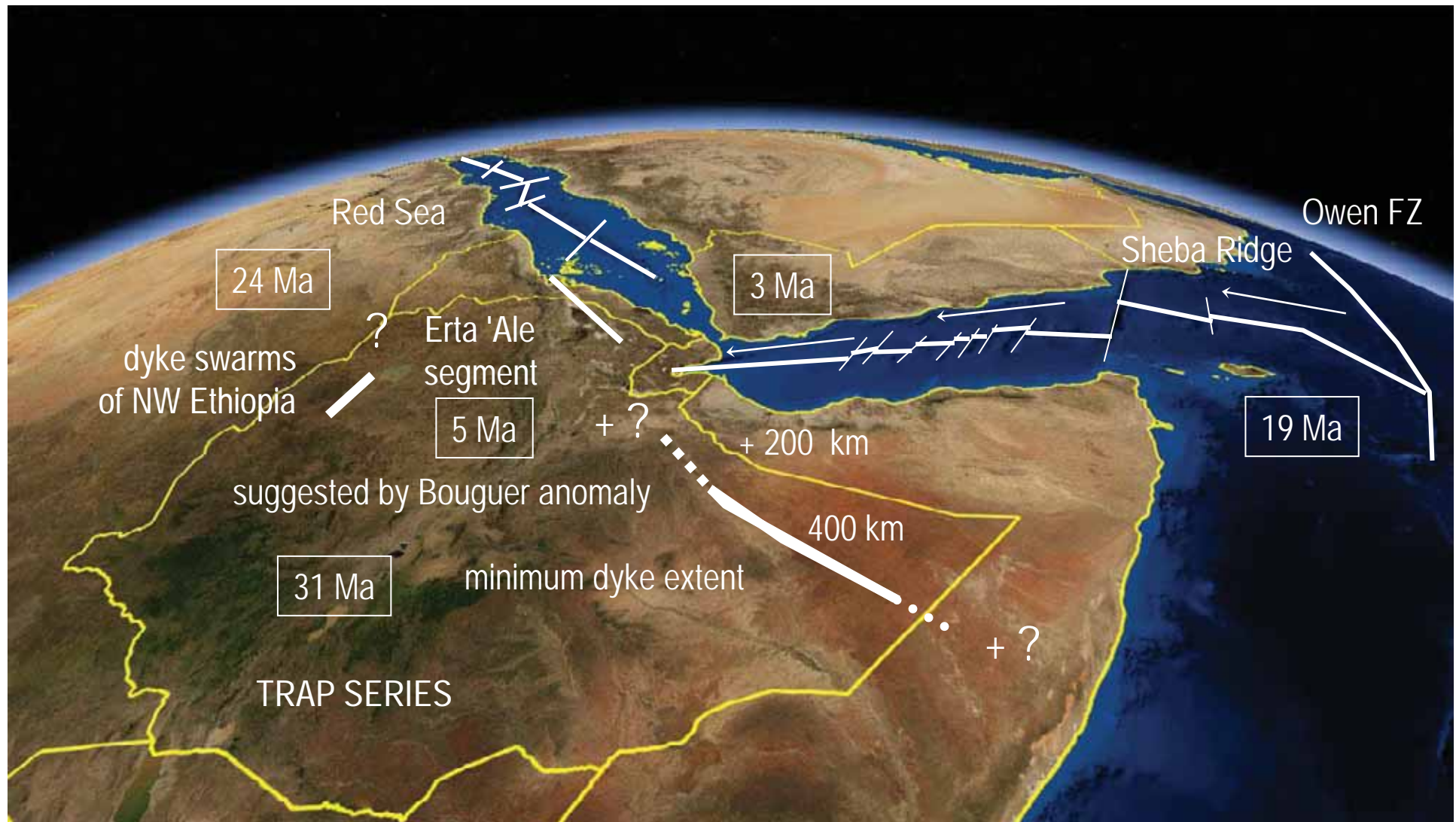
Dyke trough formation

Classical model: graben

Mastin and Pollard, 1988

Observed topography (SRTM90)

One of the main troughs follows both a negative magnetic anomaly and closed depressions. The closed depressions are karstic.
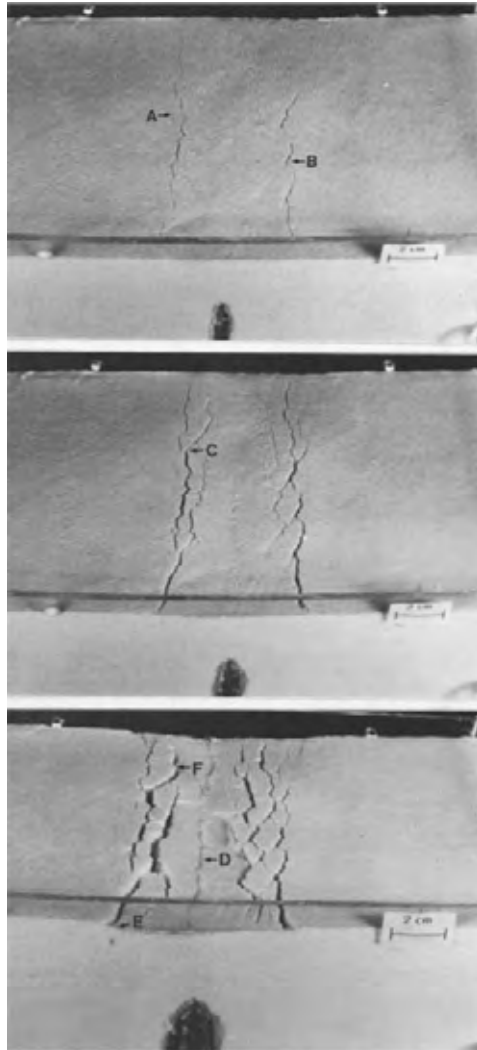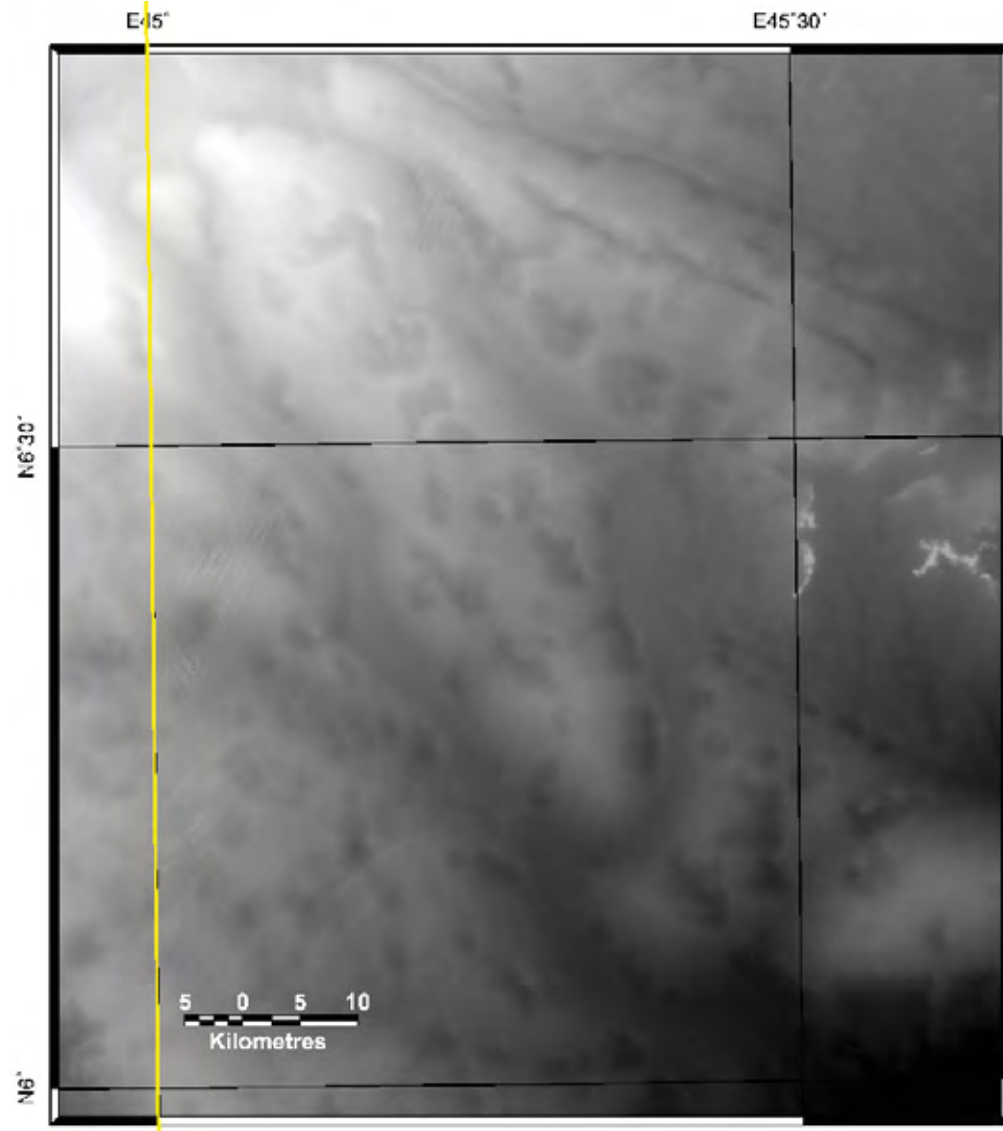

along-strike topographic profile

site 33
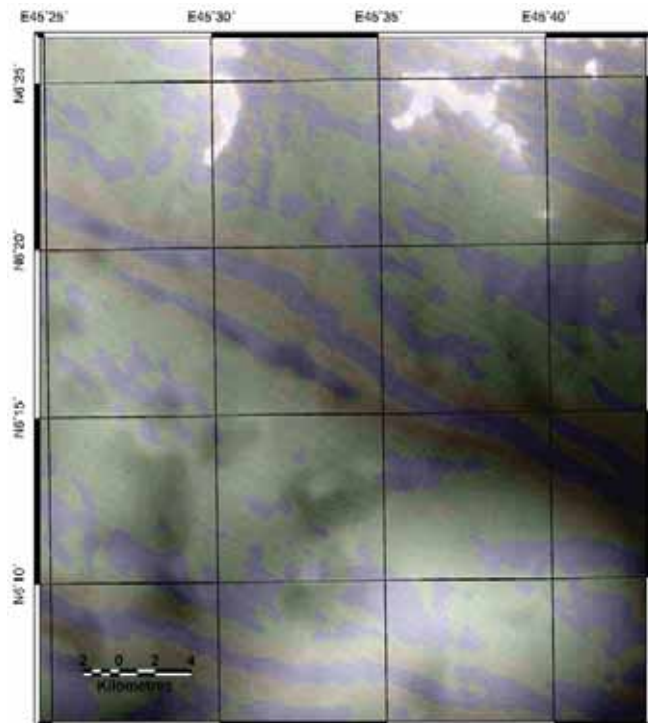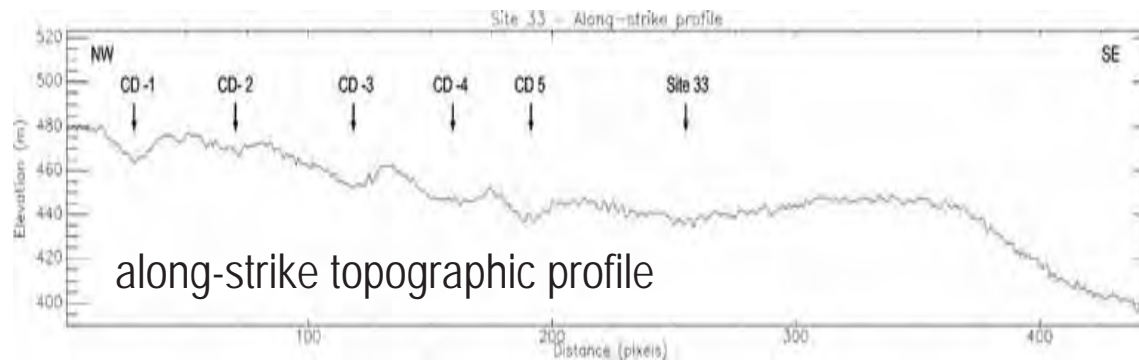
topography + magnetic anomaly
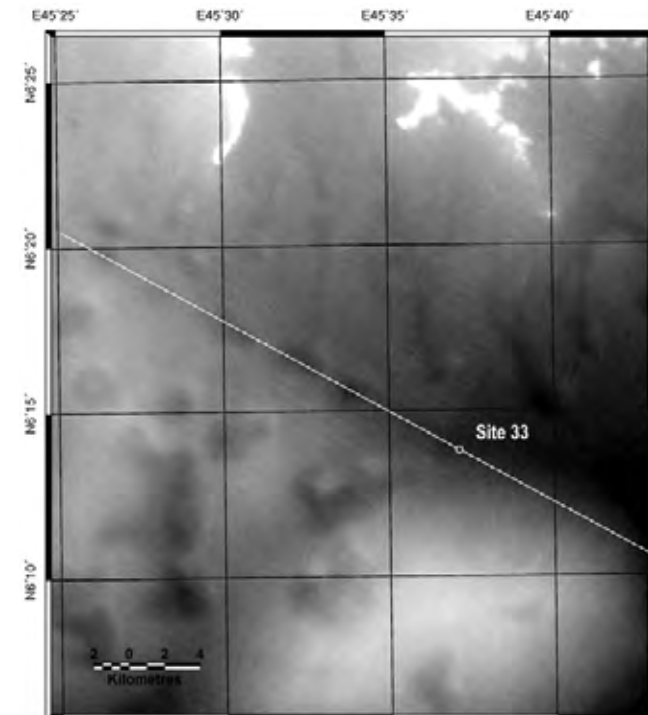
topography

Host rock (Eocene limestone and chert) has been modified around the troughs!

It is slightly higher, hence stronger,
on both trough sides…

… and it displays laterite crust
instead of red sand. Soil leaching suggests
paleotopography higher than average.

Hydrothermal flow following dyke emplacement

Delaney, 1982!

short-term heat transfer
thermal pressurization flow along dyke margin

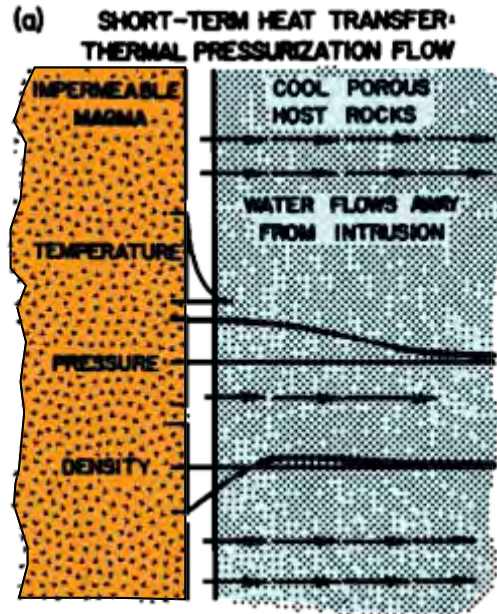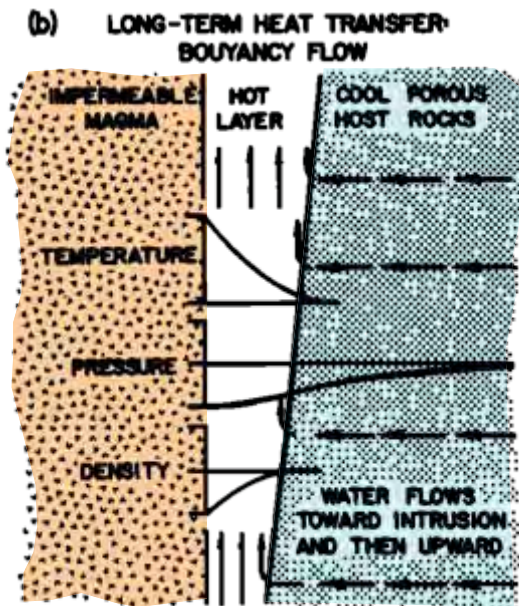*long-term heat transfer*
buoyancy flow along dyke margin

Proposed origin of linear troughs:

- hydrothermal flow along dyke margins and
- karstification controled by dyke damage zone

Conclusions

- The Ogaden dyke swarm (an IDC-6 scoop) is by far the longest swarm feeding the Ethiopian LIP.

- Identified length is currently 400 km, it is probably 600 km or more.

- The swarm is consequently one the major tectonic and magmatic elements of African Horn evolution during the Cenozoic.

- Its surface expression sheds light on mechanisms of dyke interaction with subsurface rocks in planetary crusts.

- Acquisition of magnetic data is planned in order to determine
- its total length.