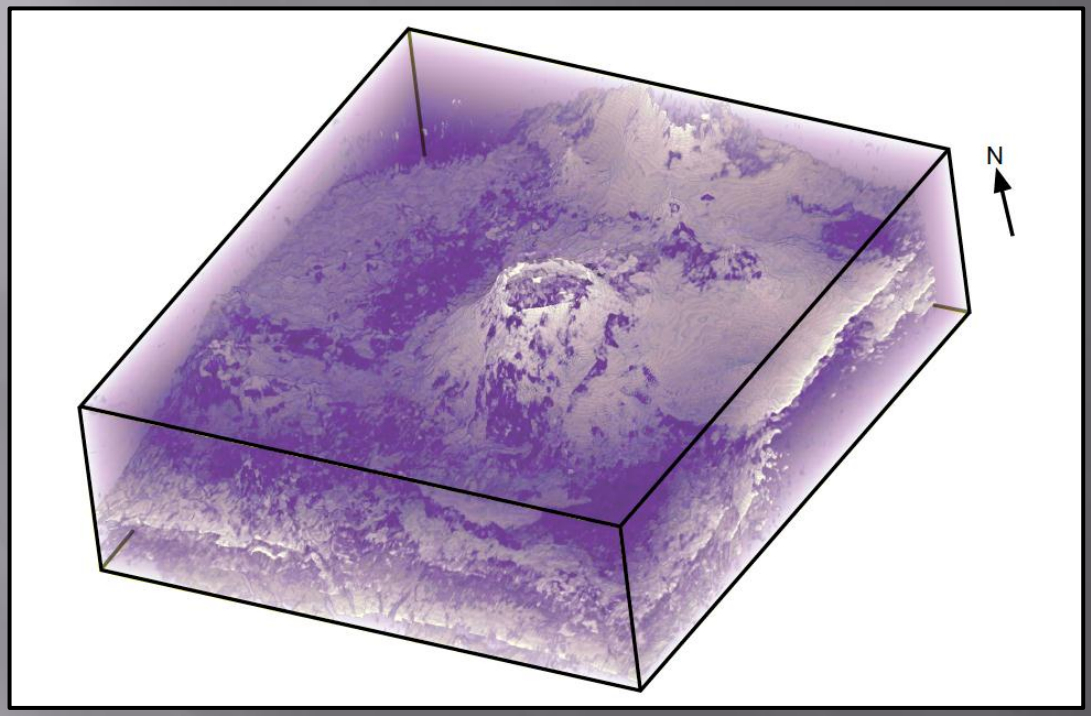
Seismic analysis of igneous systems in sedimentary basins and their impacts on hydrocarbon prospectivity



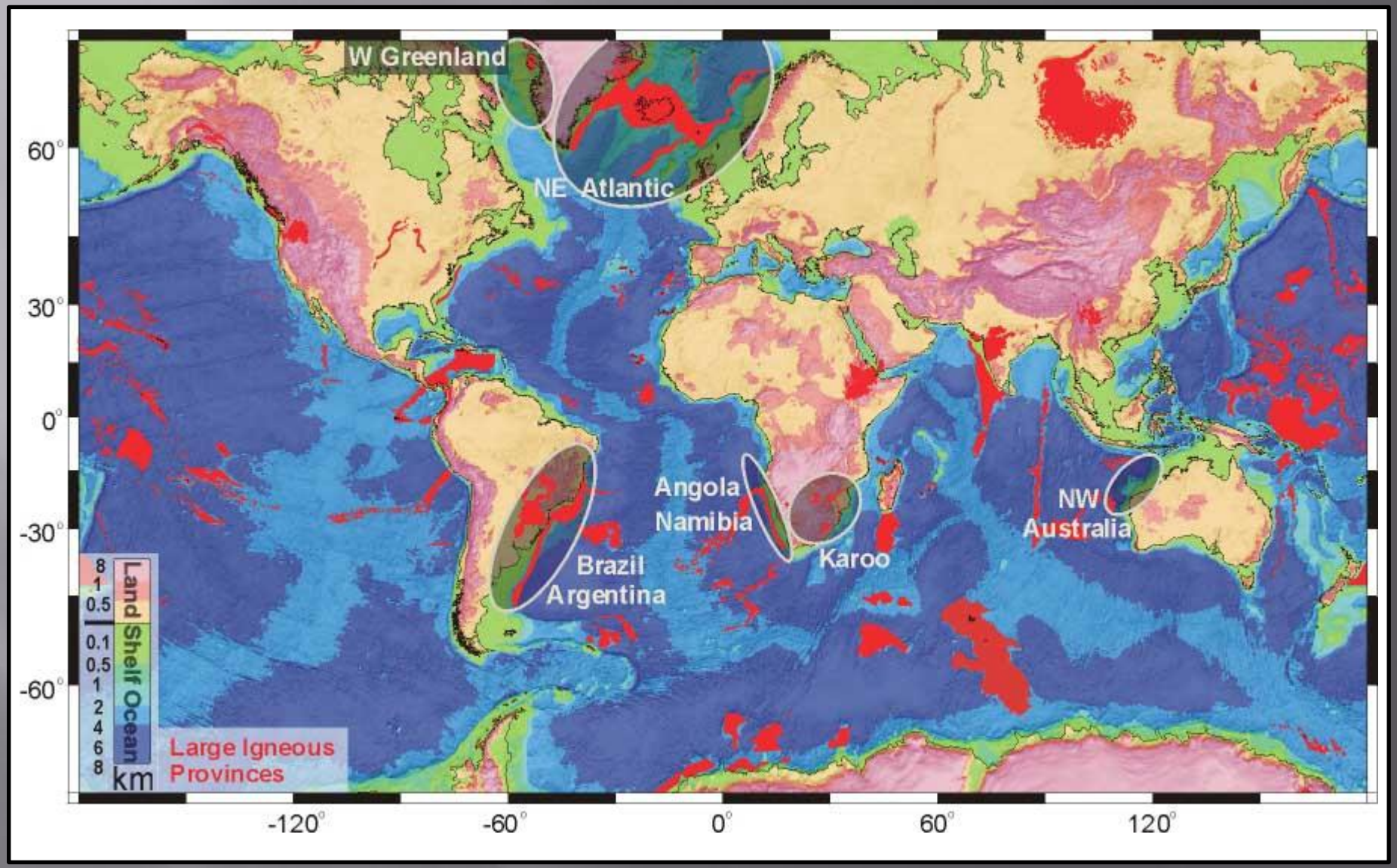
Opacity rendered image of Miocene volcanic edifice overlying the Yolla field, Bass Basin

Simon Holford[1], Nick Schofield[2], Justin MacDonald[1], Ian Duddy[3] & Paul Green[3]

[1]University of Adelaide, [2]University of Birmingham, [3]Geotrack International

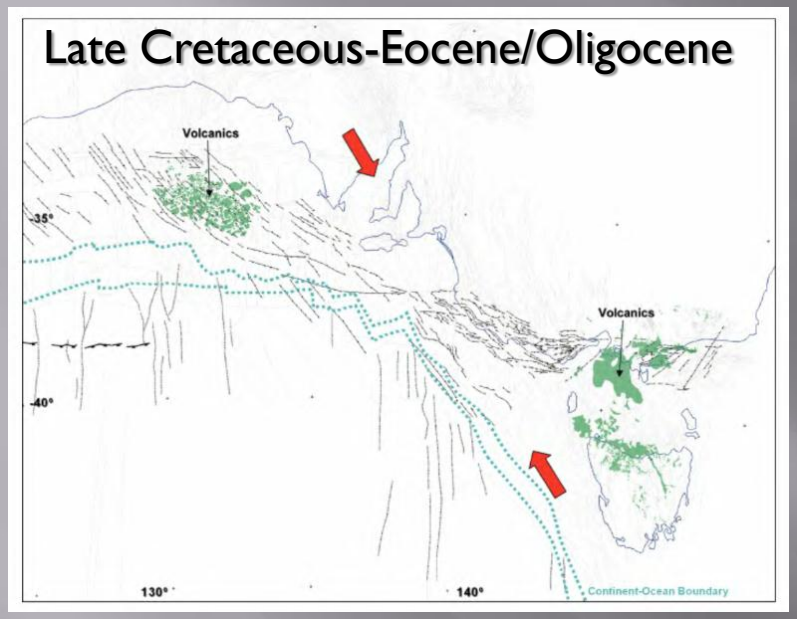
AUSTRALIAN SCHOOL OF PETROLEUM | THE UNIVERSITY of ADELAIDE | Australian Government | Australian Research Council | UNIVERSITY OF BIRMINGHAM | GEOTRACK

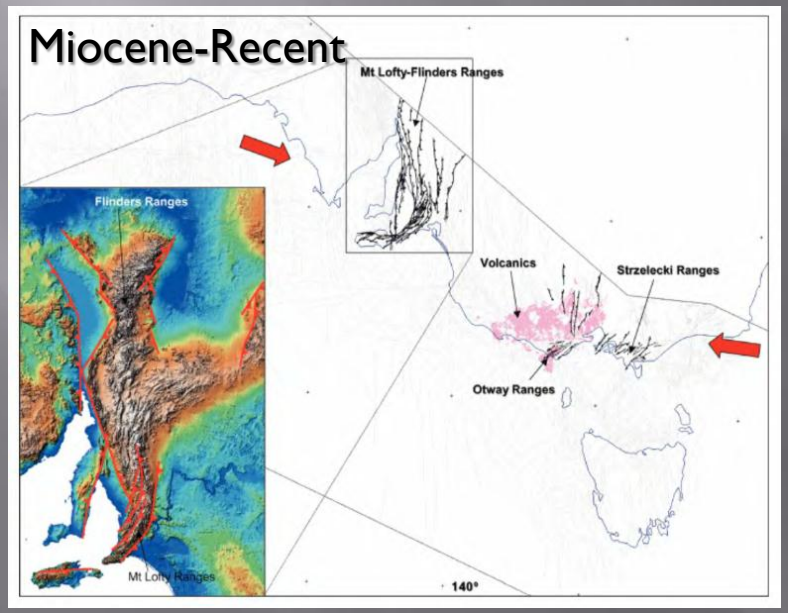
Large igneous provinces and prospective sedimentary basins



http://www.vbpr.no/homepage/div/shtml/mapvolcanicstor.shtml

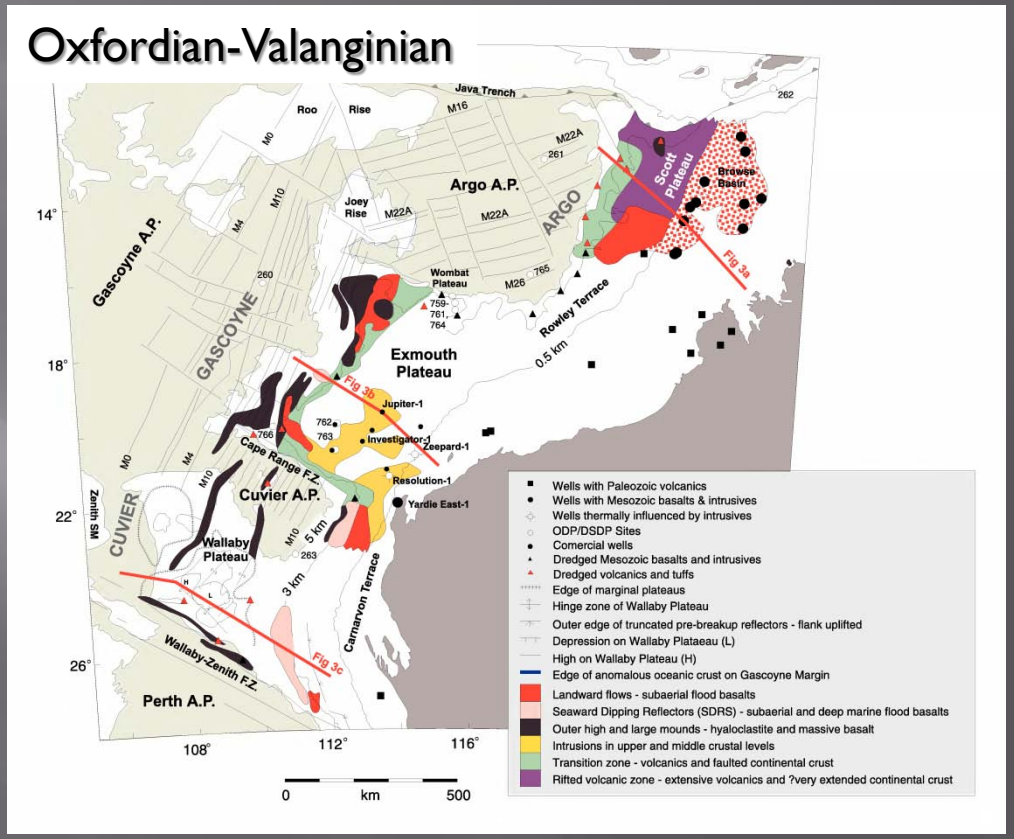
Southern Australian Margin – cold?





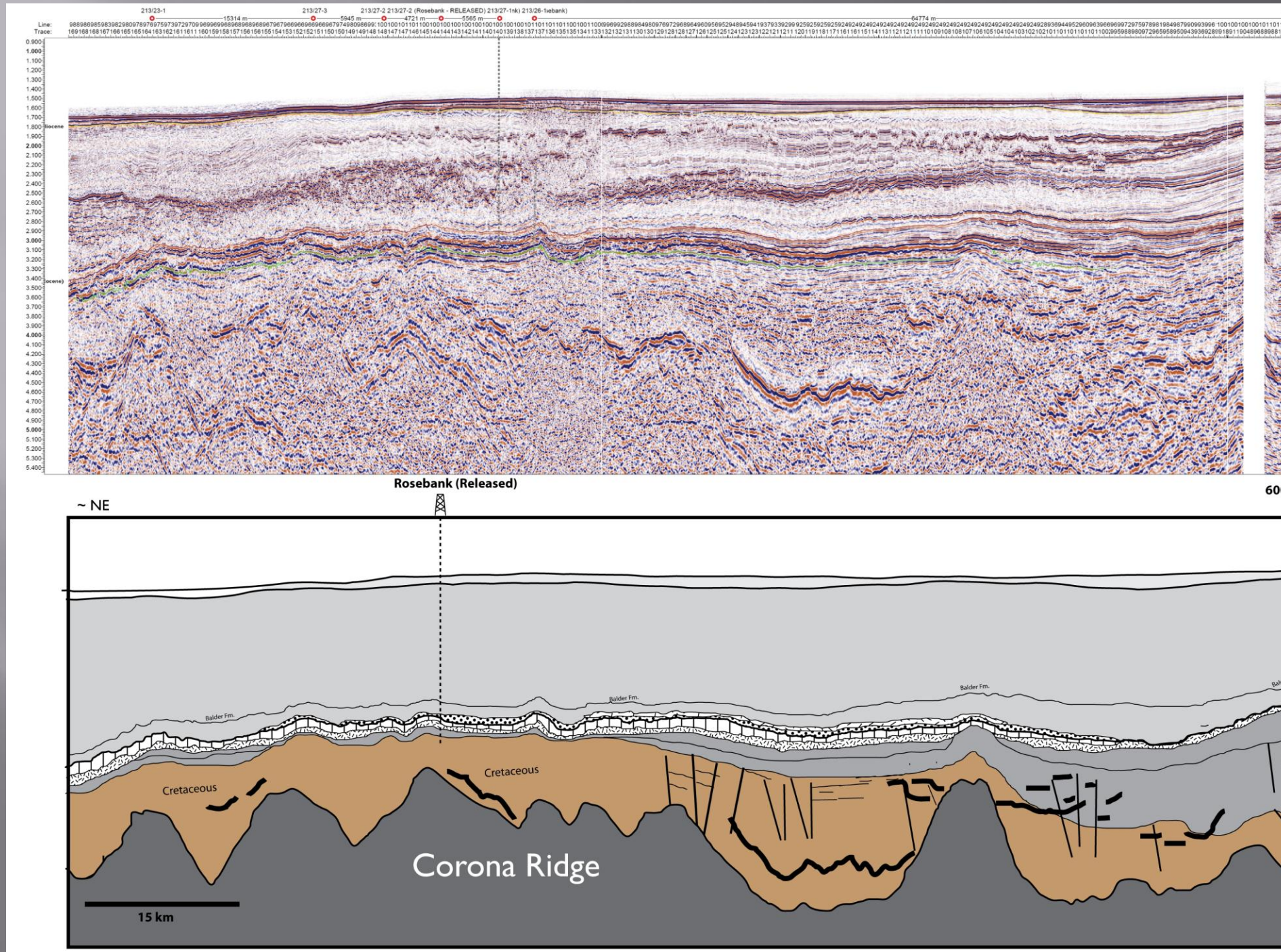
Teasdale et al. (2003)

North West Shelf – hot

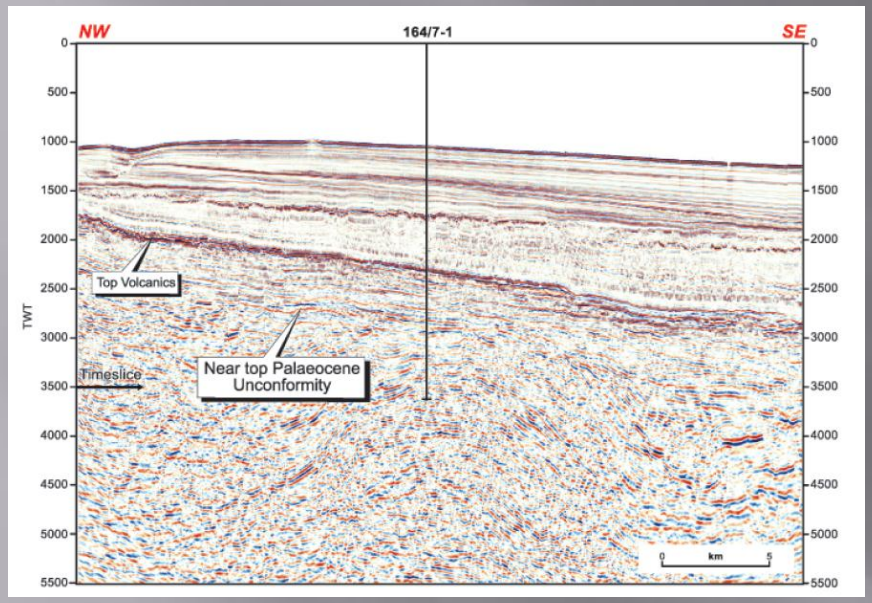


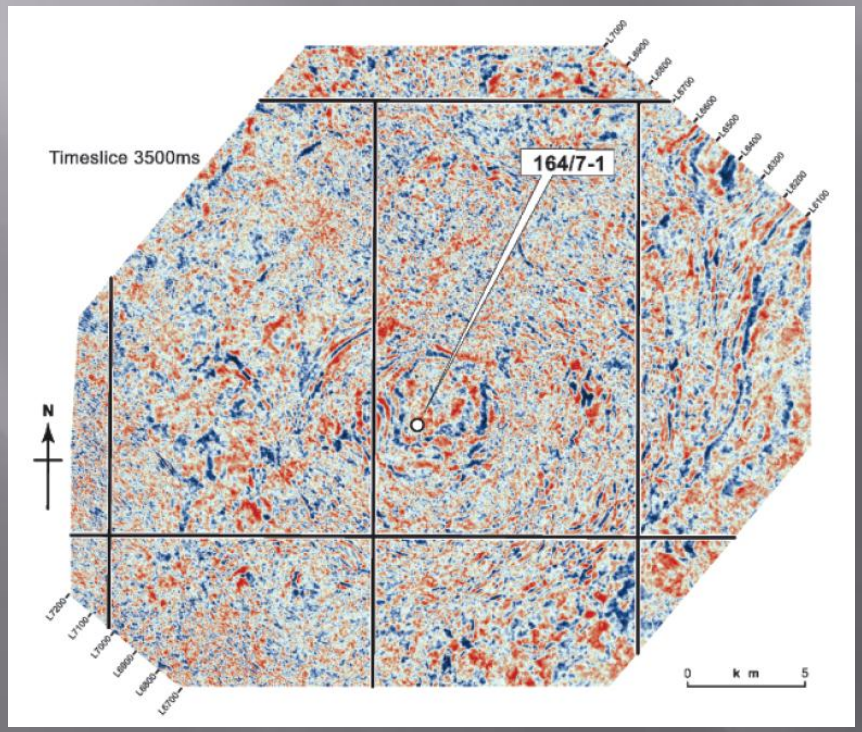
Symonds et al. (1998)

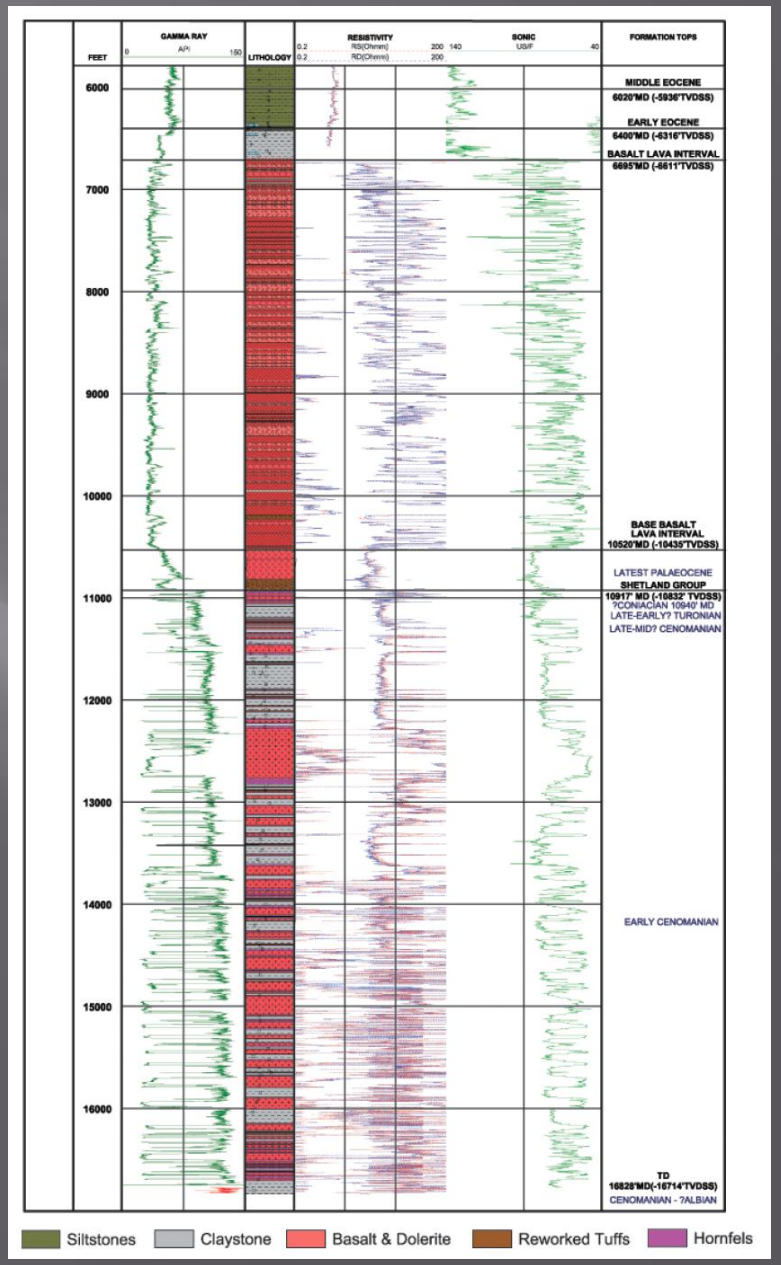
- Bowen Basin
- Sydney Basin
- Capel and Faust Basins


213/23-1
213/27-3
213/27-2 213/27-2 (Rosebank - RELEASED) 213/27-1nk) 213/26-1ebank)
15314 m
5945 m
4721 m
5565 m
64774 m
Line:
Trace:
Rosebank (Released)
~ NE
Balder Fm.
Balder Fm.
Balder Fm.
Cretaceous
Cretaceous
Corona Ridge
15 km

164/7-1, Rockall Trough

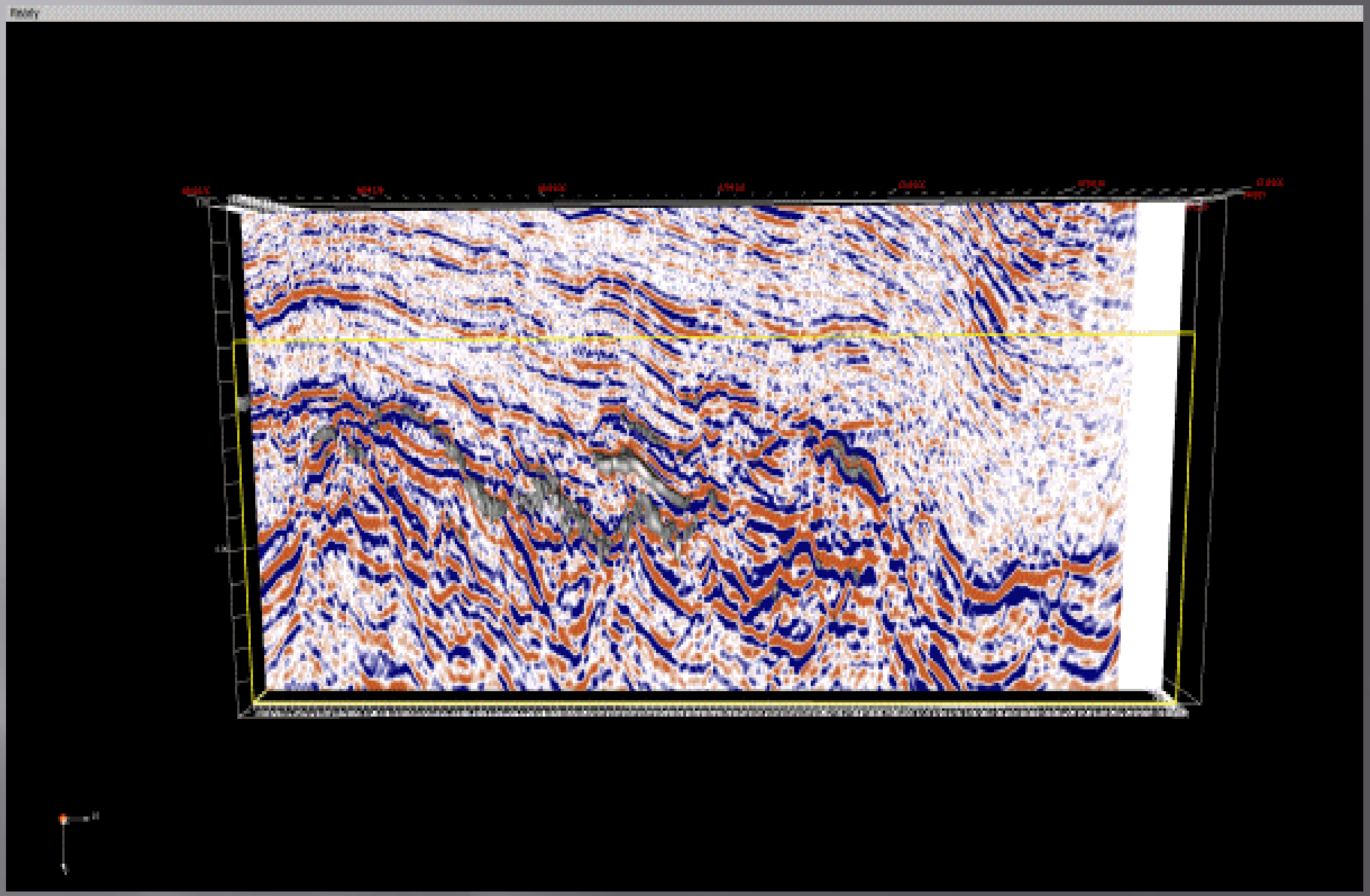


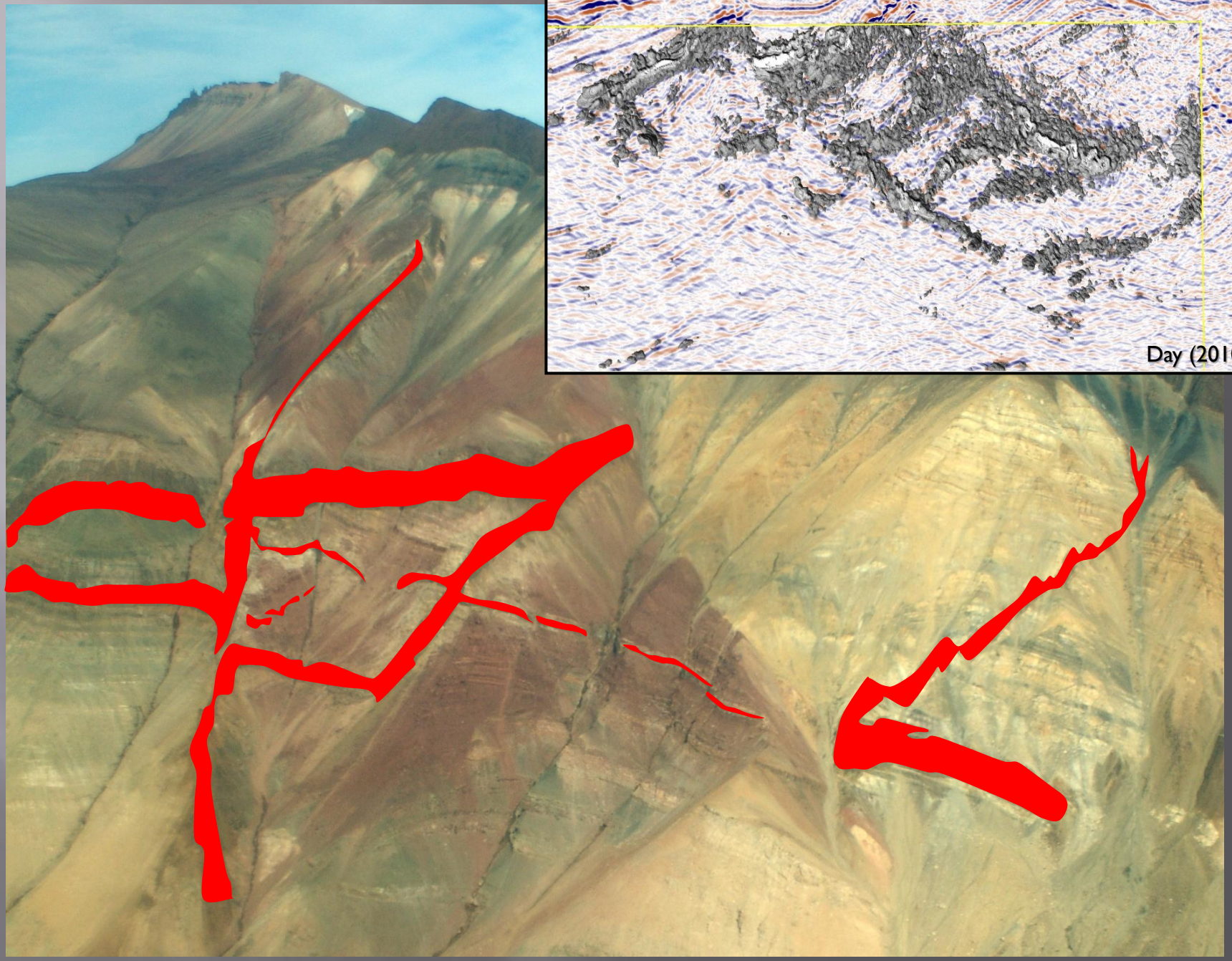




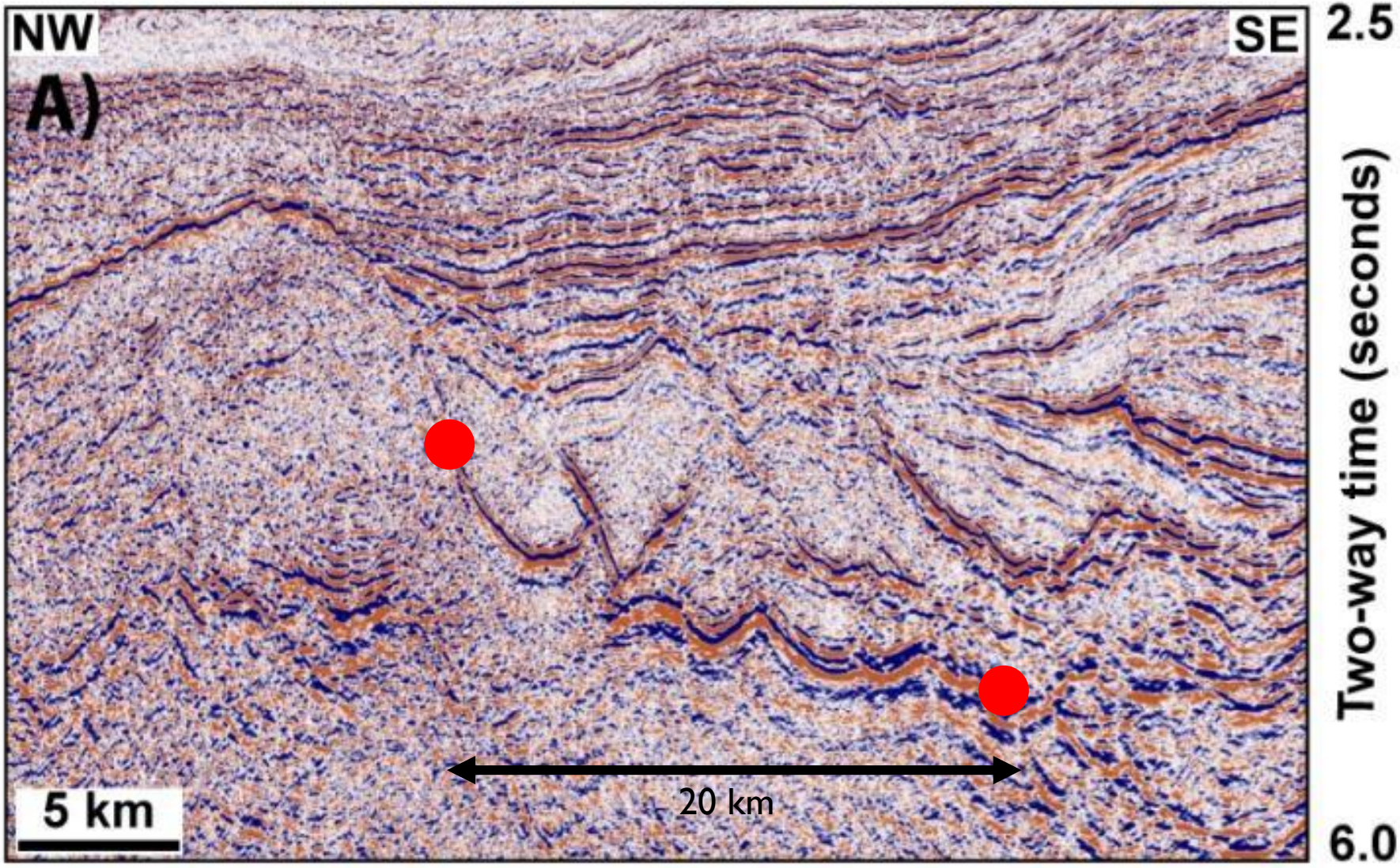
Archer et al. (2005)

1. **Reservoir**
   - Compartmentalization of hydrocarbon accumulations
   - Porosity preservation and overpressure cages
   - Hydrothermal effects/CO_2 flooding
2. **Seal**
   - Intrusions/lava flows as effective top and side seals
   - Seal bypass by intrusions/hydrothermal systems
3. **Traps**
   - Creation of four-way dip closed structures by shallow/deep intrusions
   - Sills may form trapping geometries
4. **Source**
   - Early maturation due to direct heating effects
   - Rapid burial by extrusive sequences
   - Compartmentalization of source rocks
5. **Timing & Migration**
   - Chronology of events with respect to migration critical
   - Basin modelling must integrate local and regional heat flow

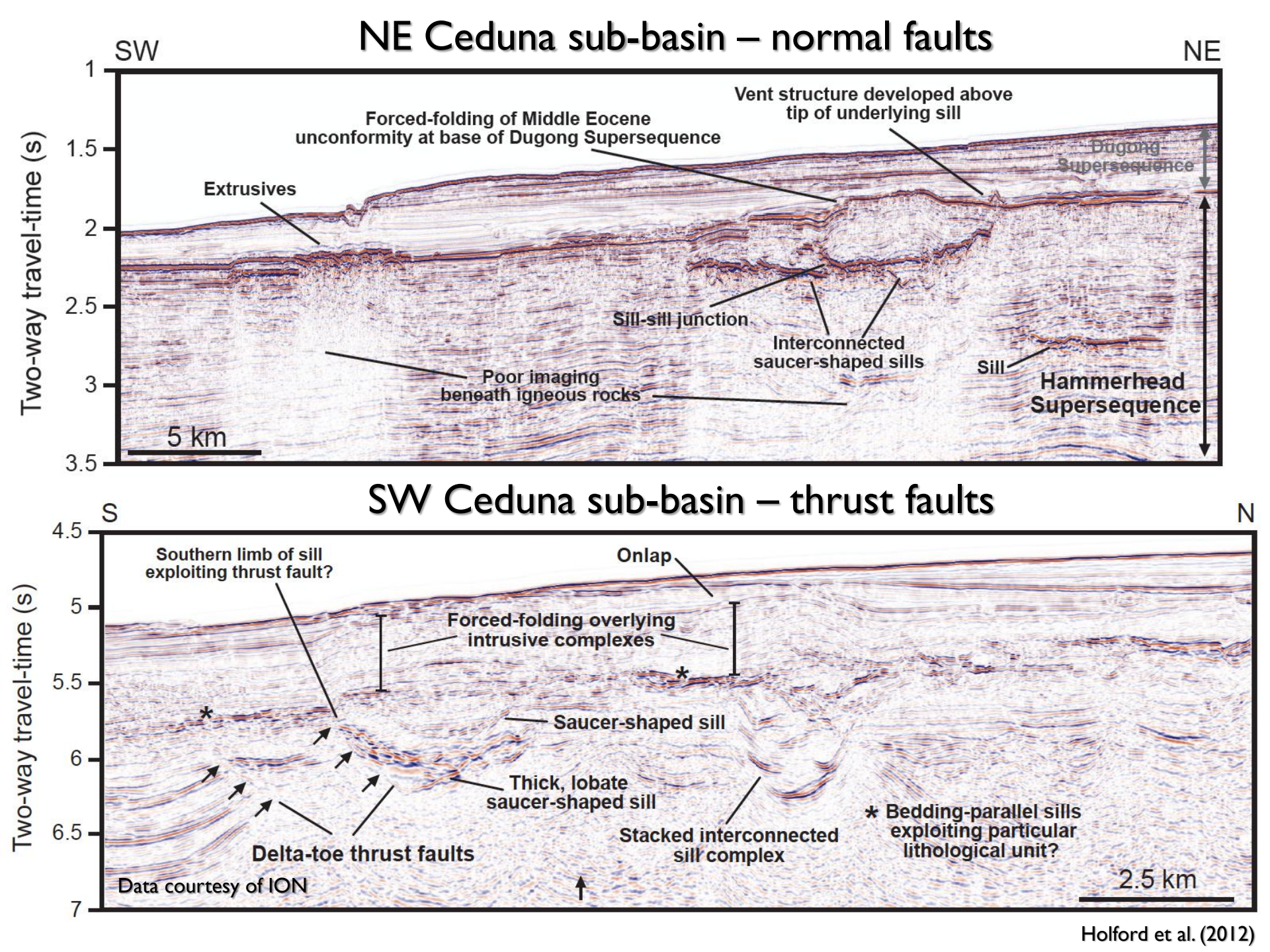



Day (2010)

Magma transport along sills and tilted fault blocks – Flett Basin, UK

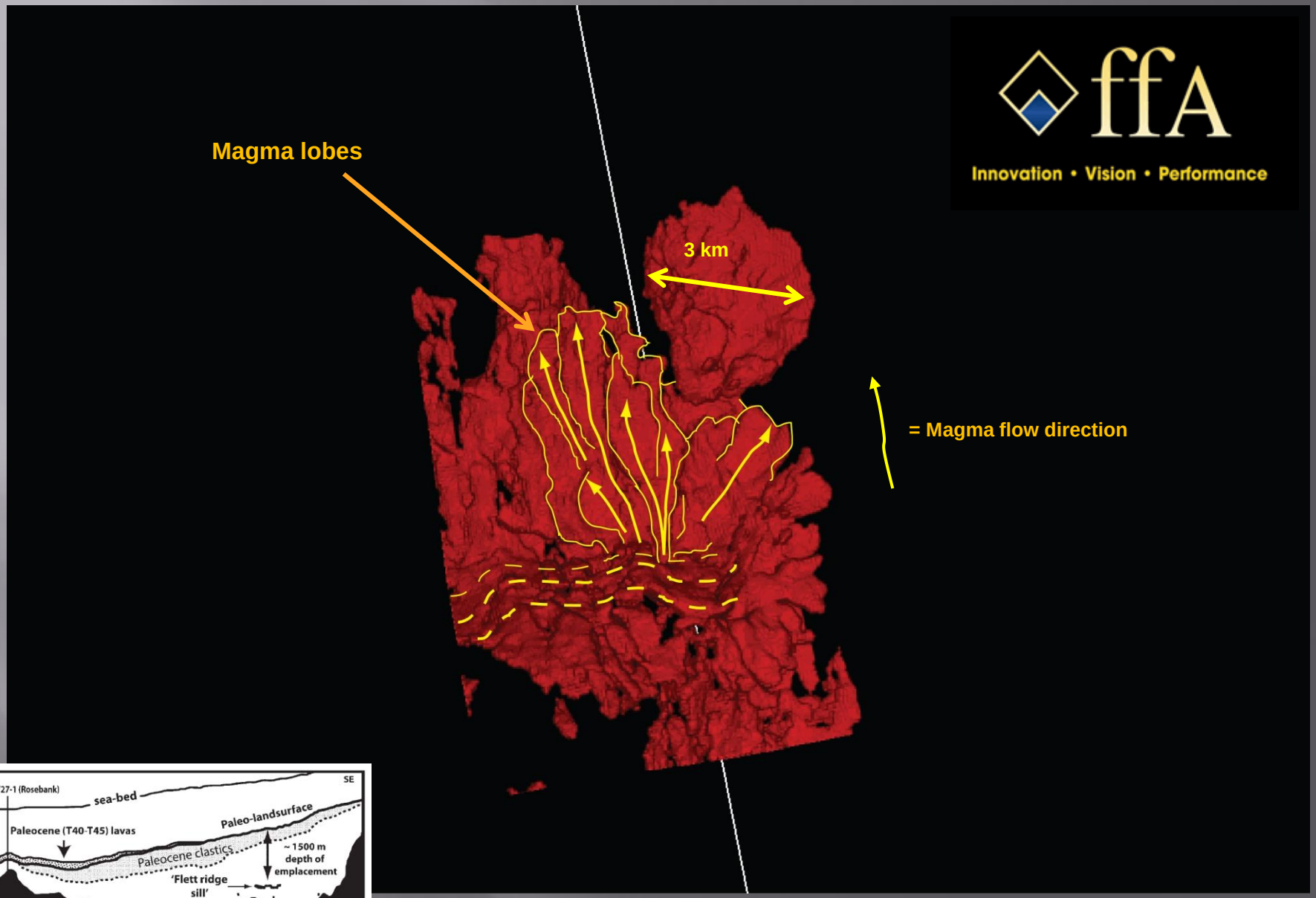


Thomson and Schofield (2008)

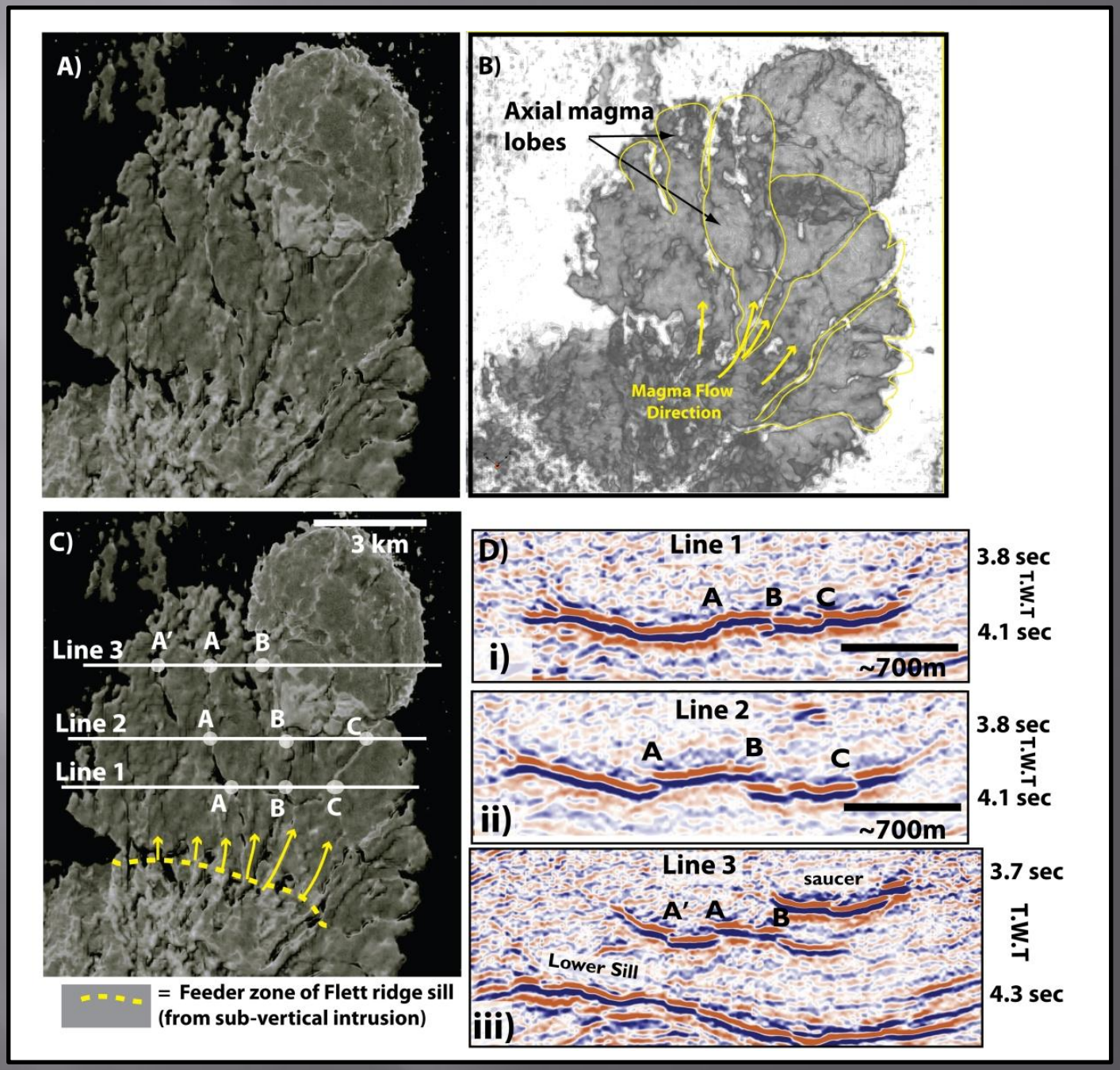


Holford et al. (2012)

3D geometry and feeding relationships of the Flett Ridge Sill, UKCS

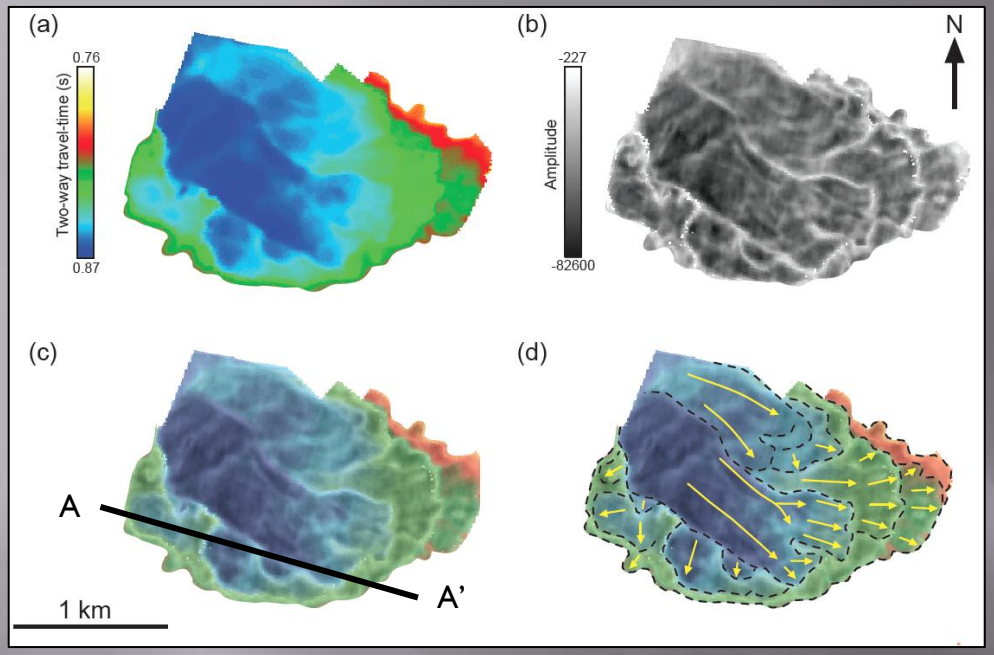


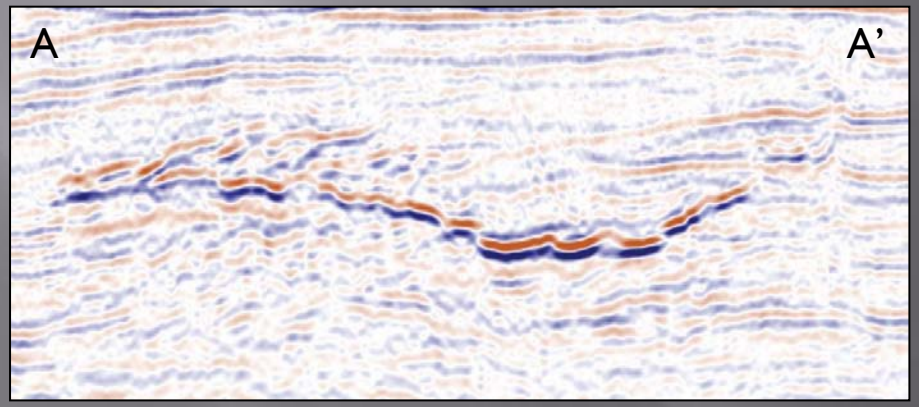
Schofield et al. (2012)

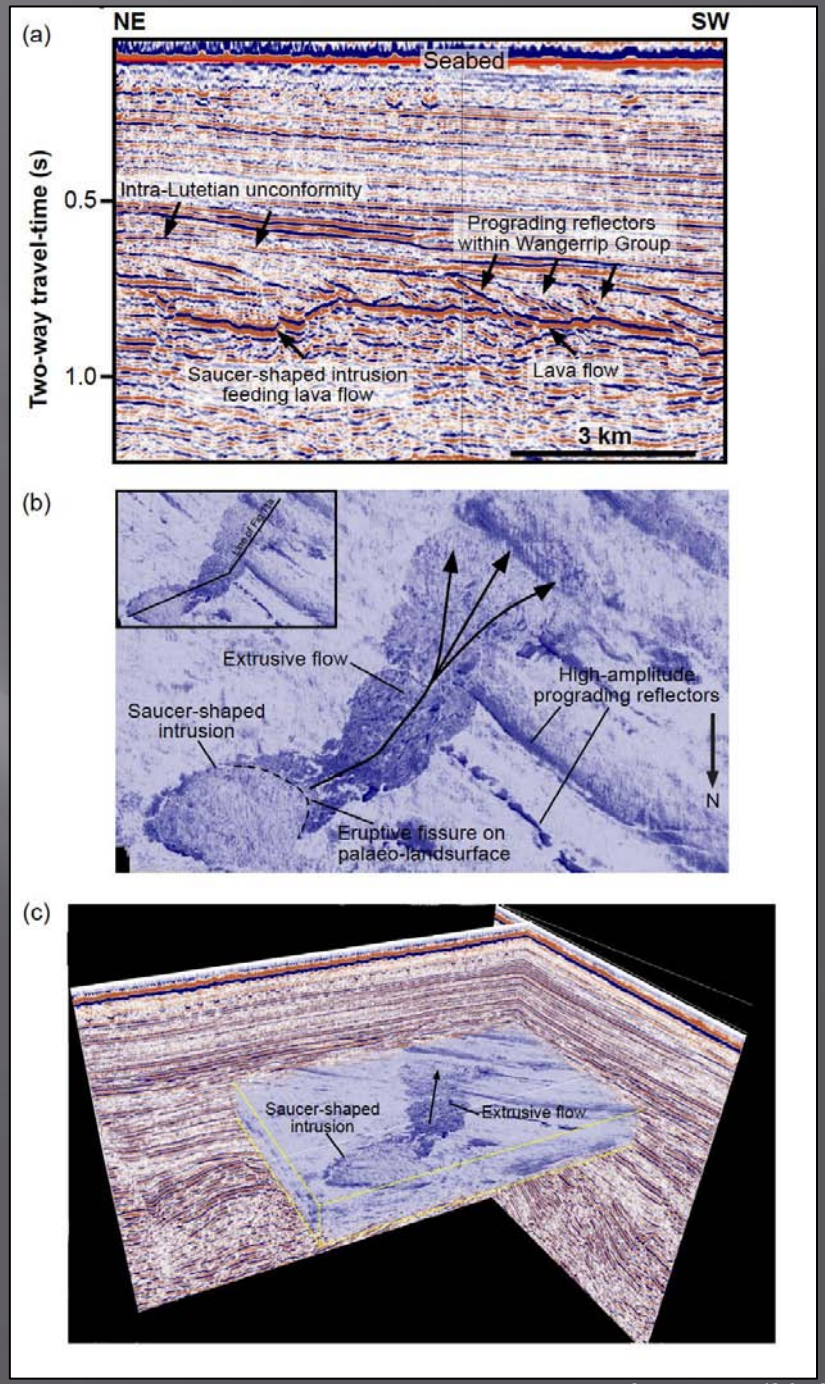


Schofield et al. (2012)

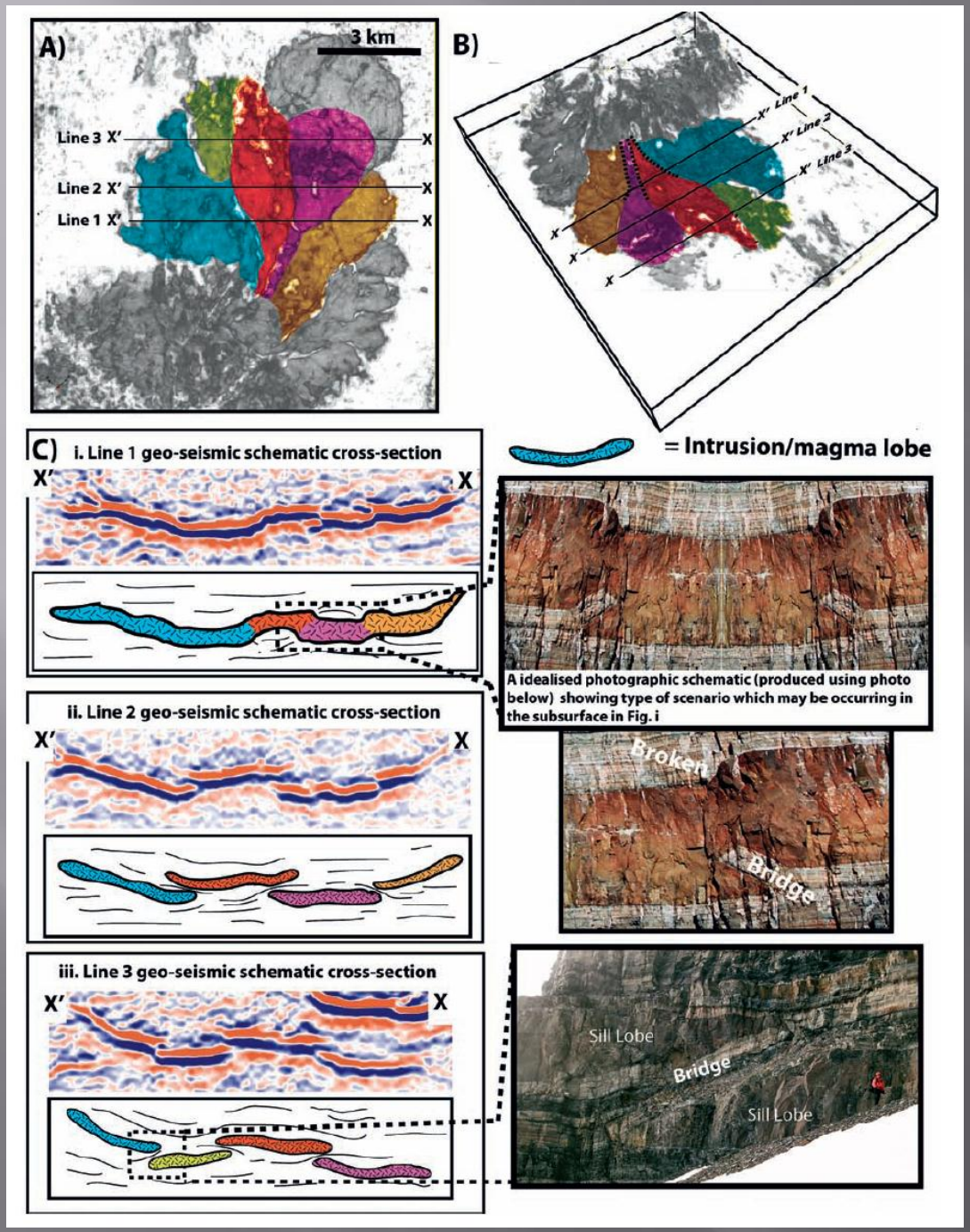
Eocene sill, Otway Basin





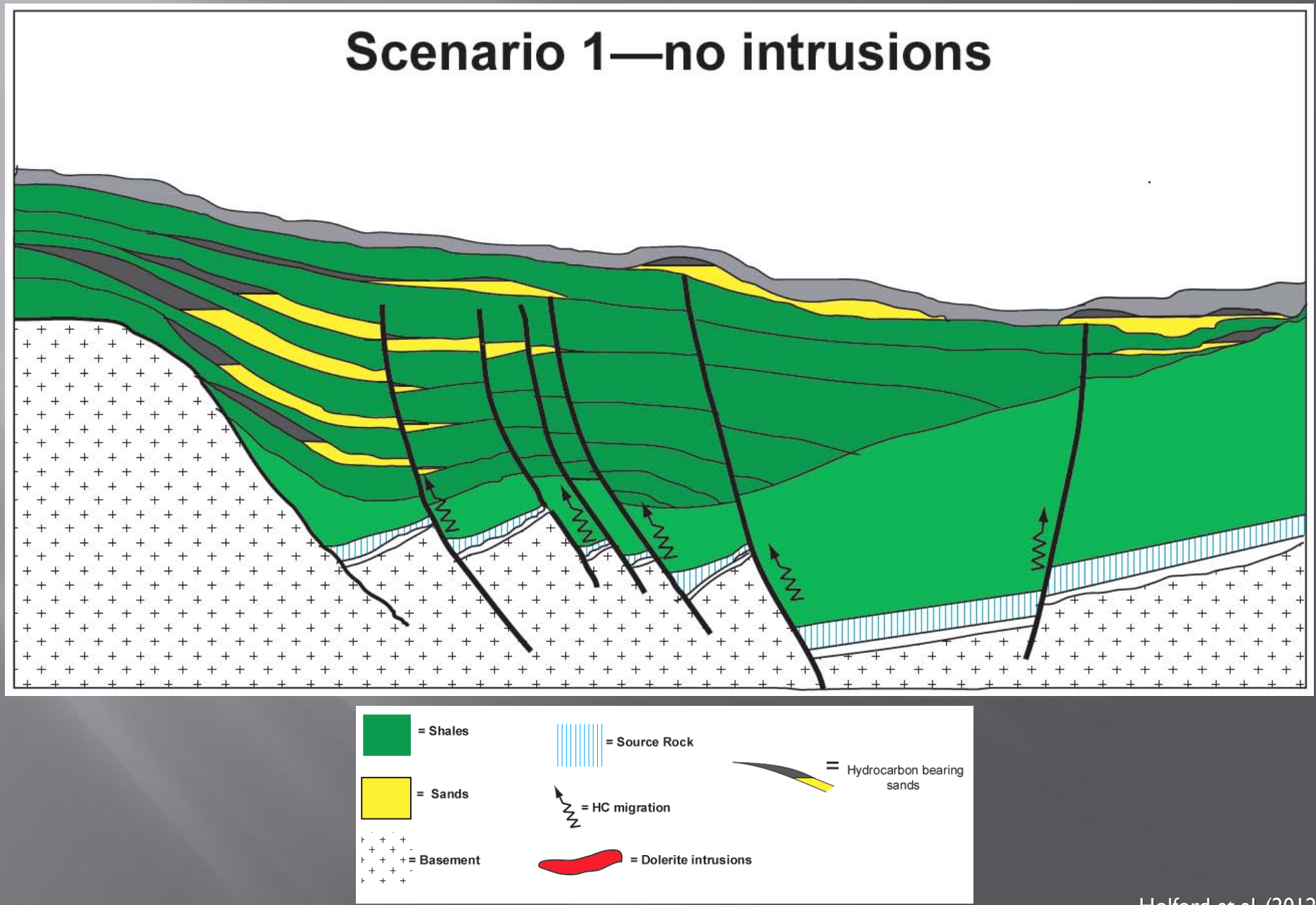


Holford et al. (2012)



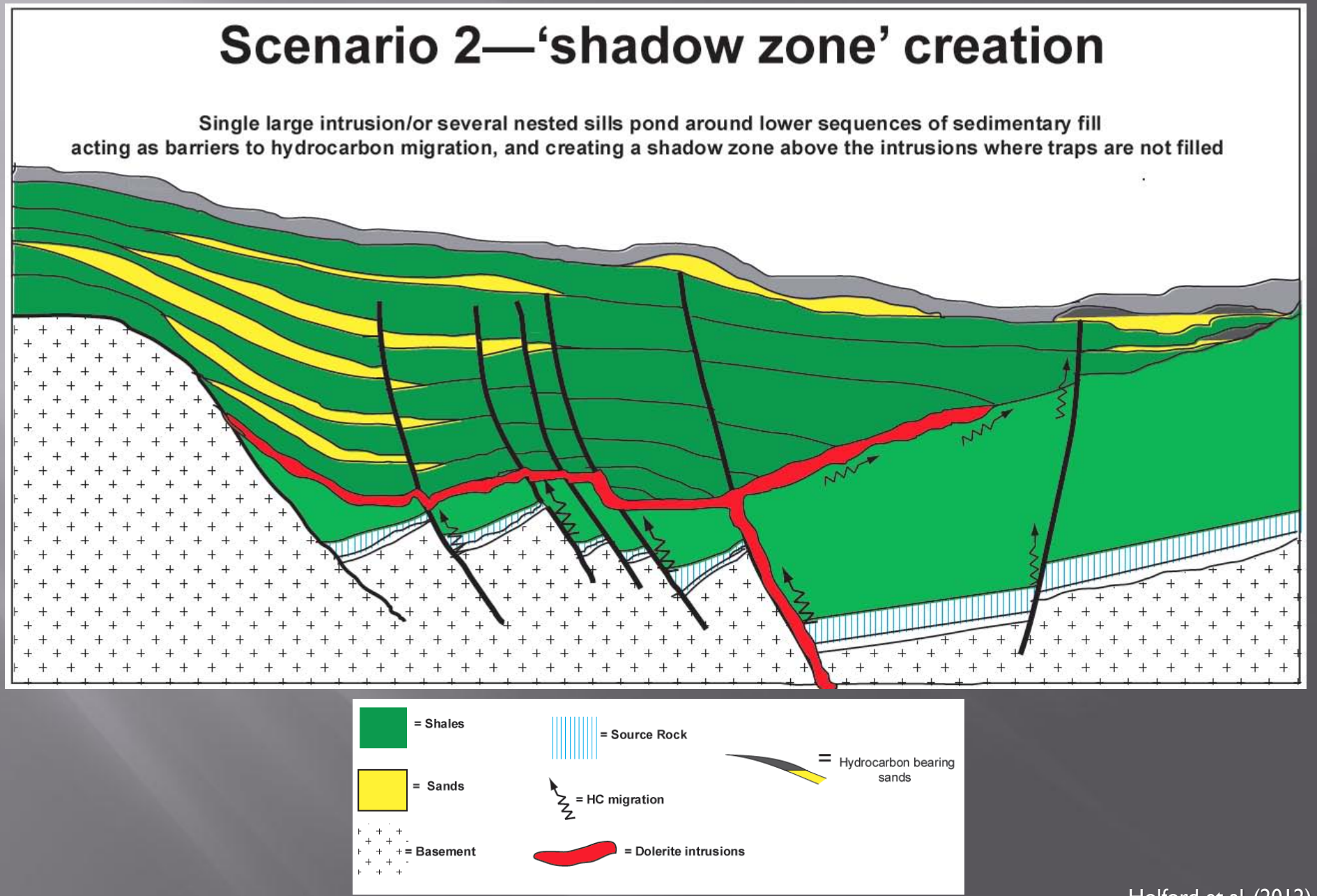
- Networks of shallowly-intruded sills and dykes may compartmentalize basin fill
- However, shallow intrusions are not continuous sheets or barriers of rock
- Host rock bridges may form important permeability pathways
- Potentially analogous to relay ramps formed between faults

Scenarios for igneous compartmentalization



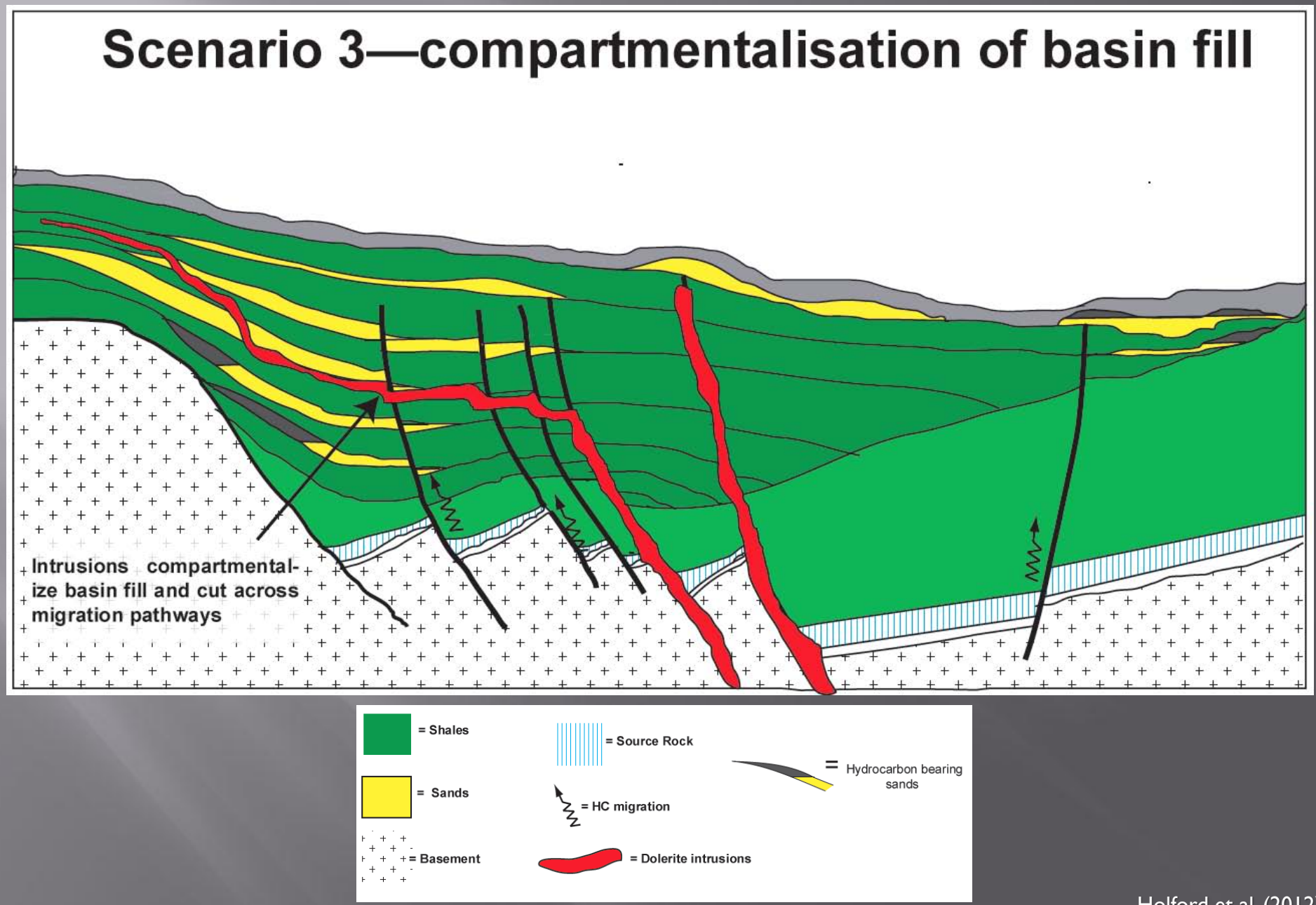
Holford et al. (2012)

Scenarios for igneous compartmentalization



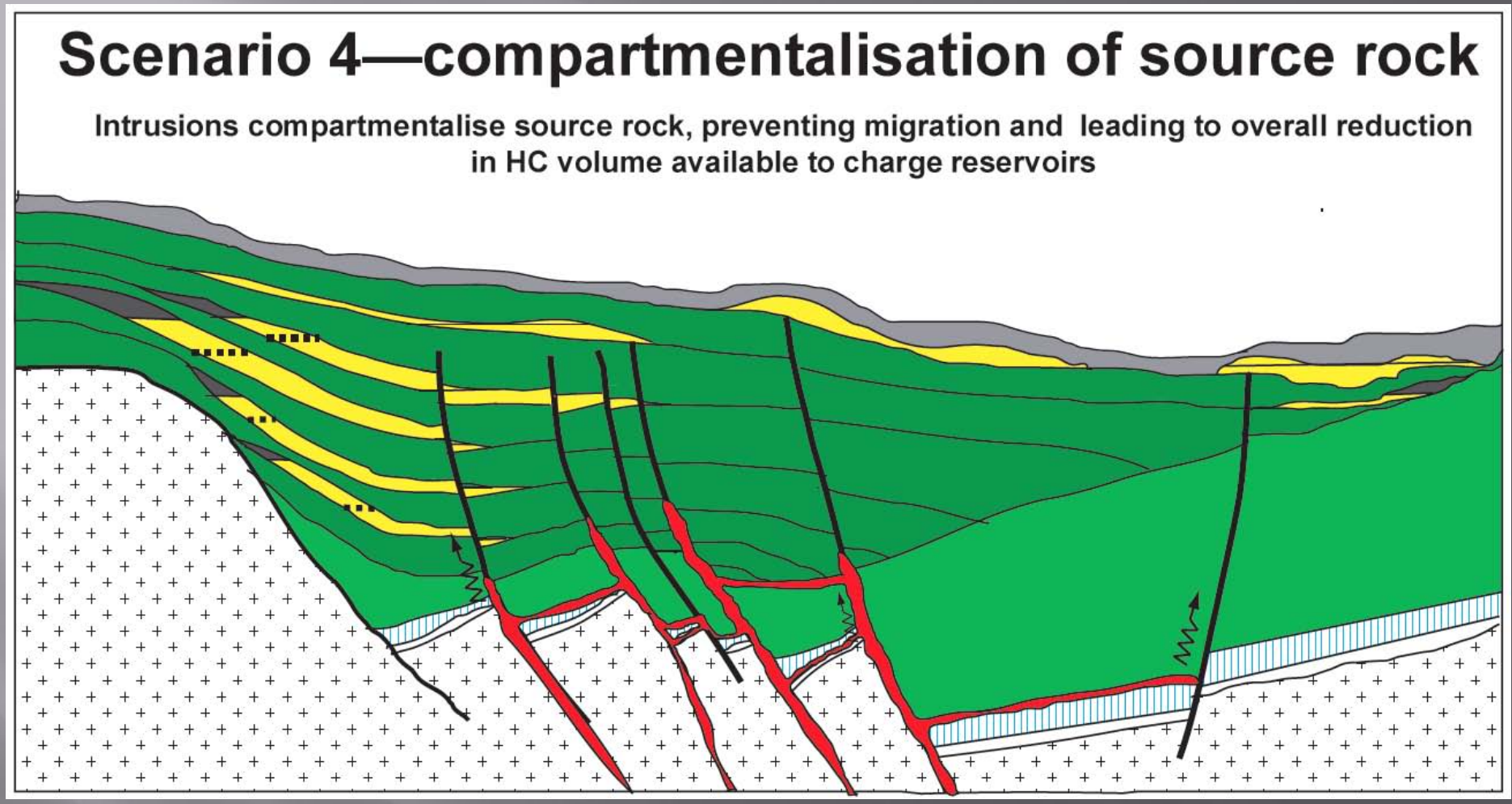
Holford et al. (2012)

Scenarios for igneous compartmentalization



Holford et al. (2012)

Scenarios for igneous compartmentalization



Holford et al. (2012)

Conclusions

- Igneous rocks are a key geological uncertainty in passive margin basins
- Igneous activity can impact all elements of the petroleum system
- 3D seismic data have shown that subvolcanic plumbing systems comprise interconnected networks of sheet intrusions
- Intrusions can compartmentalize and isolate reservoirs, with implications for migration efficiency and overpressuring
- Host rock bridges between magma lobes may provide permeable pathways through sheet intrusions

Acknowledgments

- Australian Research Council (DP0897612) (funding to SH)
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- ION, PGS, DPI Victoria, DMITRE (data)
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