Novelly discovered post-mid-Eocene sinistral slip in the eastern Oman Mountains: widely distributed shear with wrench-fault assemblage related to Arabia-India convergence

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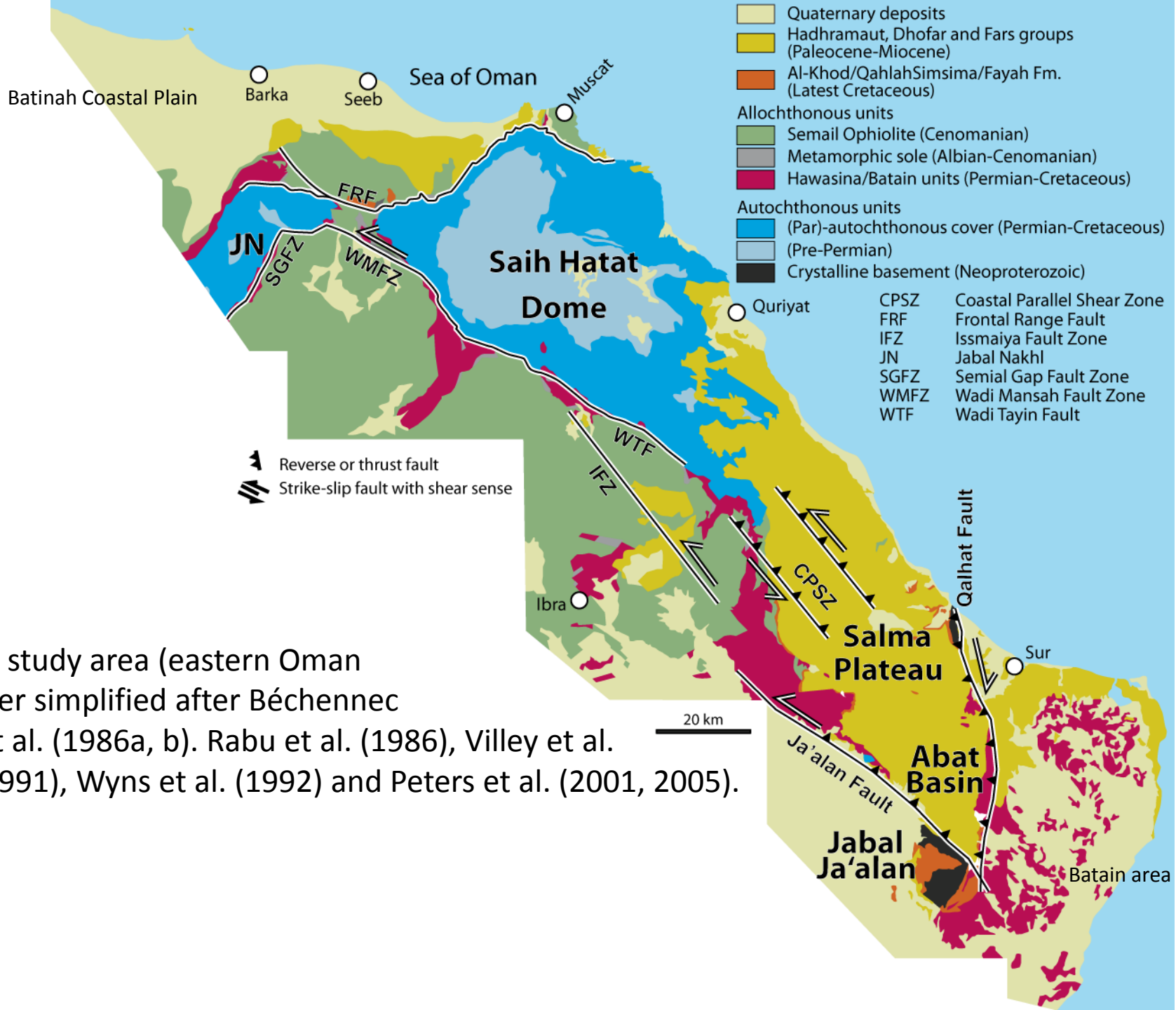
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Geological Setting

The Oman Mountains were shaped by the SW-directed obduction of

- the Semail Ophiolite,
- deep-sea rocks (Hawasina) and
- trench-facies rocks (Haybi)

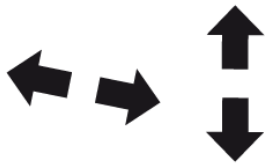
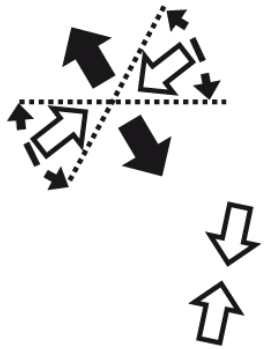
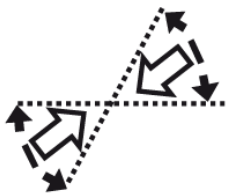
onto Arabian autochthonous shelf carbonates during the Late Cretaceous.



Geological map of the the study area (eastern Oman Mountains), simplified after simplified after Béchennec et al. (1986), Le Métour et al. (1986a, b). Rabu et al. (1986), Villey et al. (1986a, b), Roger et al. (1991), Wyns et al. (1992) and Peters et al. (2001, 2005).

Geological Setting

The resulting obduction orogen was overprinted by significant post-obductional extension from the latest Cretaceous to early Eocene and late Eocene to Oligocene/Miocene.

Southeastern Oman Mountains		Batain area	
Time	Stress directions	Stress directions	Time
Tectonic Stage 1 Late Cretaceous to early Eocene extension Fournier et al. (2006)			Latest Maastrichtian to Paleocene Schreurs and Immenhauser (1999)
Tectonic Stage 2A Late Lutetian to Miocene extension - stage A Tectonic Stage 2B Late Lutetian to Miocene extension - stage B Fournier et al. (2006) Scharf et al. (2020b)			Late Eocene Conjugated sets of normal faults (NNE-SSW and E-W directed) Peters et al. (2001)
Tectonic Stage 3 Late Oligocene to early Miocene shortening E-W to NE-SW Pliocene N-S shortening Fournier et al. (2006)			Early Miocene (Fournier et al., 2006) to late Miocene-Pliocene folding Schreurs and Immenhauser (1999)

Stress directions in the Southeastern Oman Mountains and the Batain area. Time of Tectonic Stage 2 of Fournier et al. (2006) was adjusted using data of Scharf et al. (2020b).

Problem

The Oman Mountains, between the eastern Batinah Coastal Plain and the Sur area display numerous ~N/S-oriented folds and contractional faults. These structures overprinted mid-Eocene to at least Oligocene/Miocene formations (i.e., the Seeb to Barzaman formations). The cause of this deformation was unclear.

Open syncline in the Rusayl Embayment (SSE of Seeb). View to the N, parallel to fold axis, 23°31'31.81"N / 58°12'9.26"E

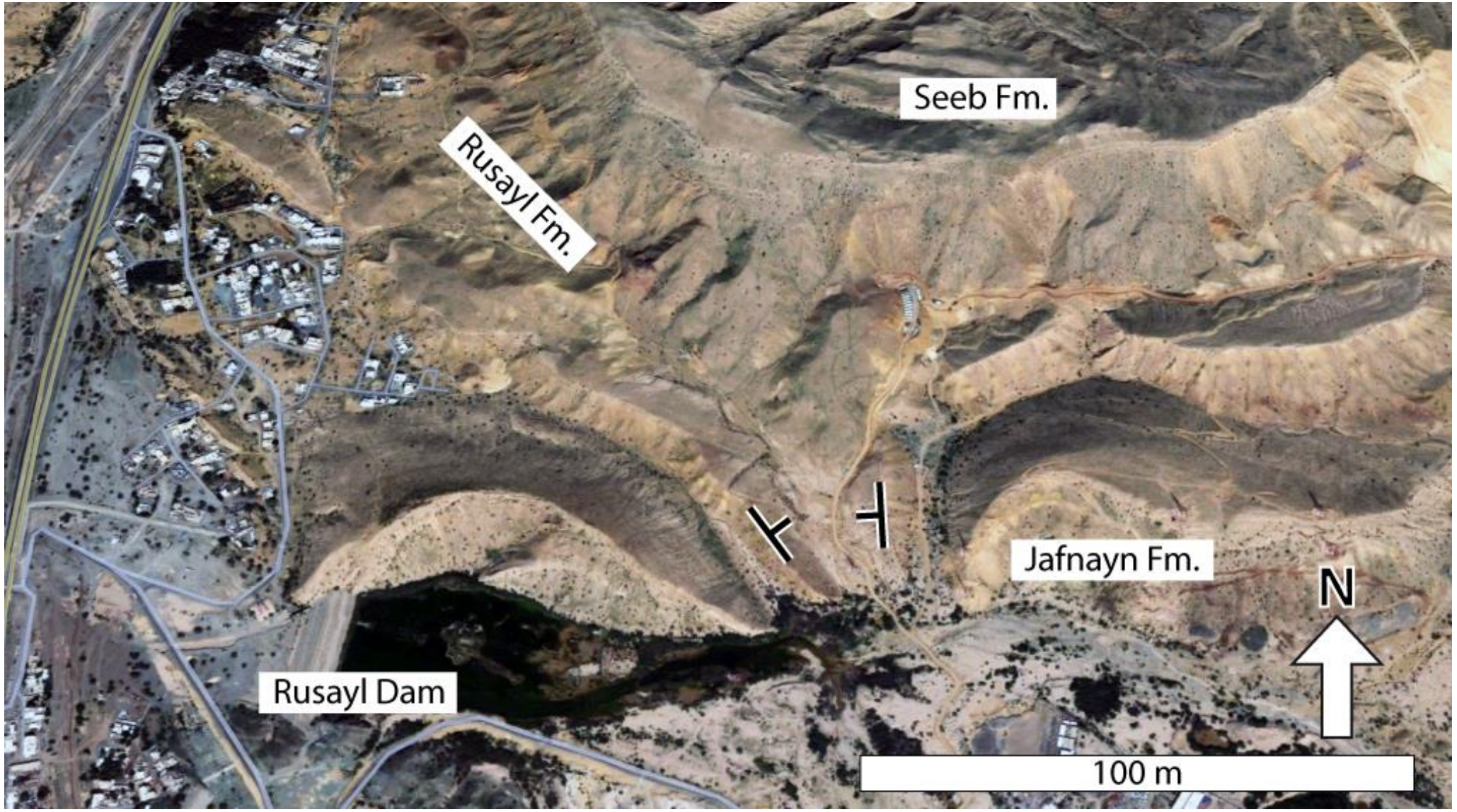
Example of a syncline

Rusayl Fm. Eocene
Jafnayn Fm. Paleo-/Eocene



Problem

Apple Map image of the same syncline as on the previous slide



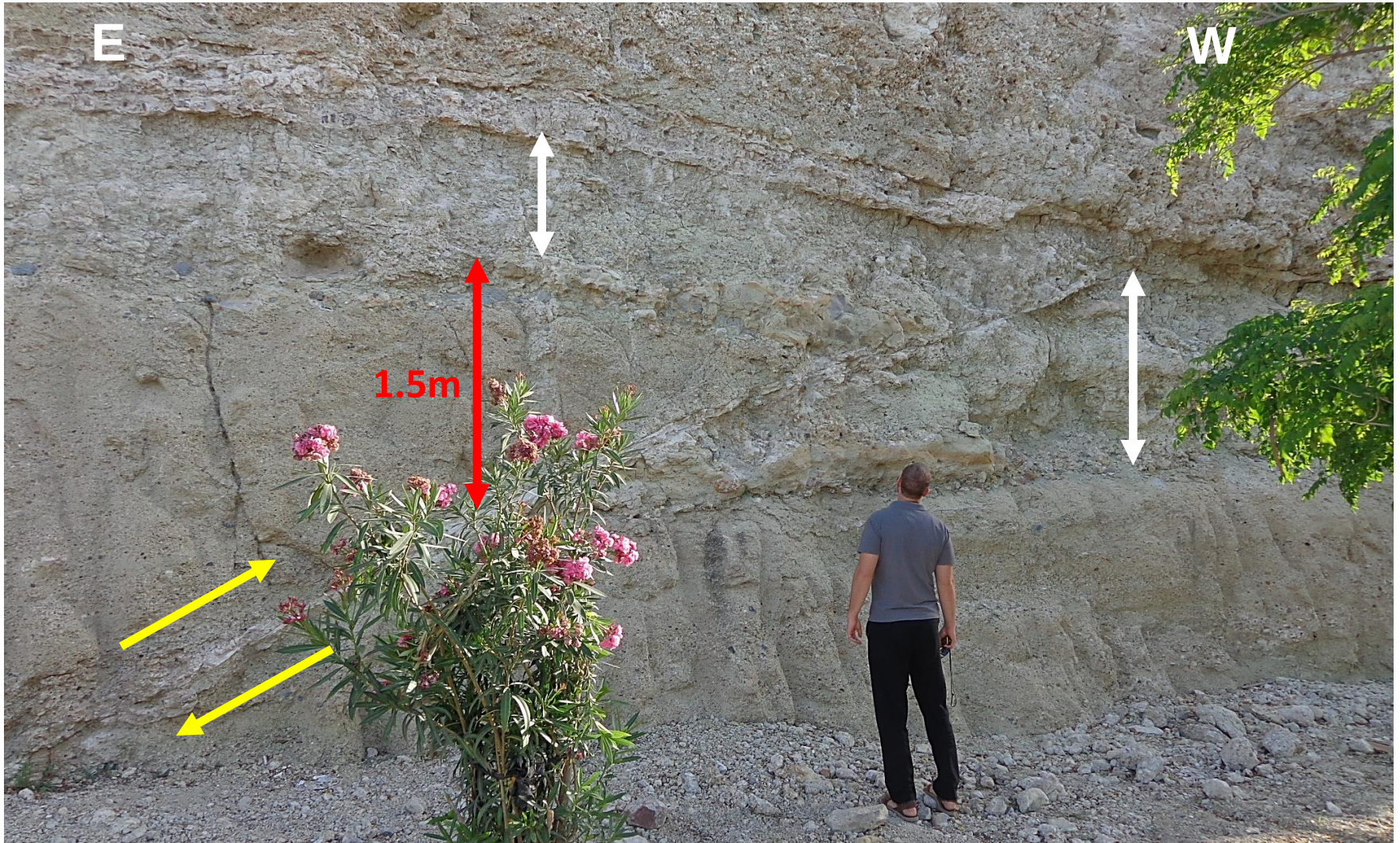
Syndepositional, E-dipping thrust with dip-slip slickenlines, 23°35‘24“N / 58°09‘40“E

Red arrow indicates vertical displacement

White arrows indicate bed thickness in-crease to the West and, thus, synde-positional fault activity.

Example of a thrust

Oligocene/Miocene Barzaman Fm.



The thrust‘s syndepositonal nature constrains the age of the deformation between the upper Oligocene (Chattian) and the Lower Miocene (Aquitanian), i.e. 28.1-20.44 Ma.

For more evidence on this thrust see also Appendix 1!

Problem

The Oman Mountains, between the eastern Batinah Coastal Plain and the Sur area display also strike-slip faults, cutting through overprinted mid-Eocene to at least Oligocene/Miocene formations (i.e., the Seeb to Barzaman formations). The cause of this deformation was also unclear.

Calcitized sinistral strike-slip fault S of Seeb (eastern part of SQU campus), 23°35‘16“N / 58°10‘33“E

NW-SE-striking left-lateral fault with horizontal slickenlines (135/01).

Example of a strike-slip fault

Oligocene/Miocene Barzaman Fm.

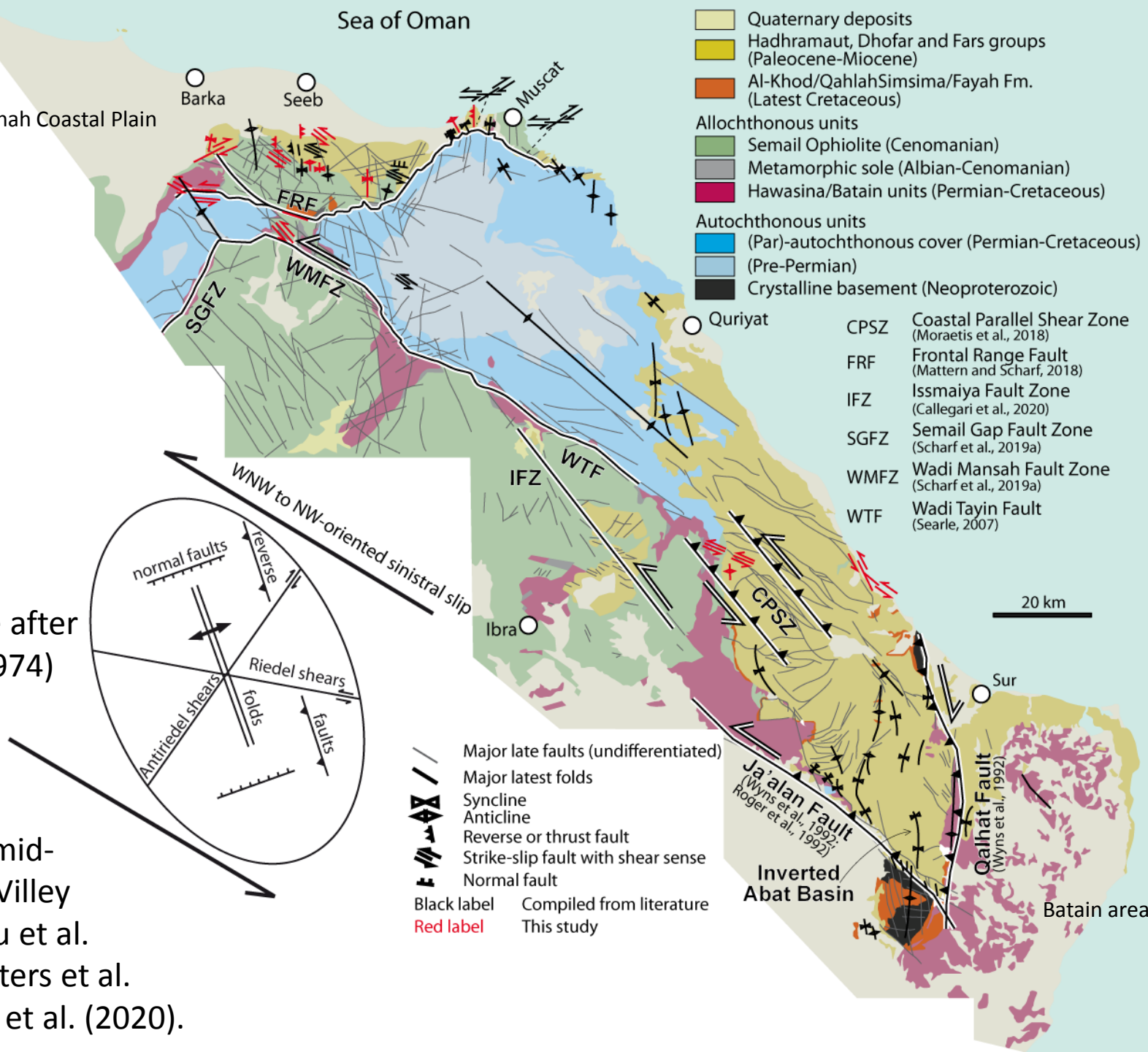


Results/interpretation

All the post-mid-Eocene ~N-S contractional and ~NW-SE sinistral structures match a sinistral wrench fault assemblage *sensu* Harding (1974).

The southwestern zone of the study area is marked by numerous left-lateral faults. This zone may correlate with a Permo-Triassic major extensional fault, active during the Pangea rifting. We introduce the name "Hajar Shear Zone"´(HSZ) for this deformation belt.

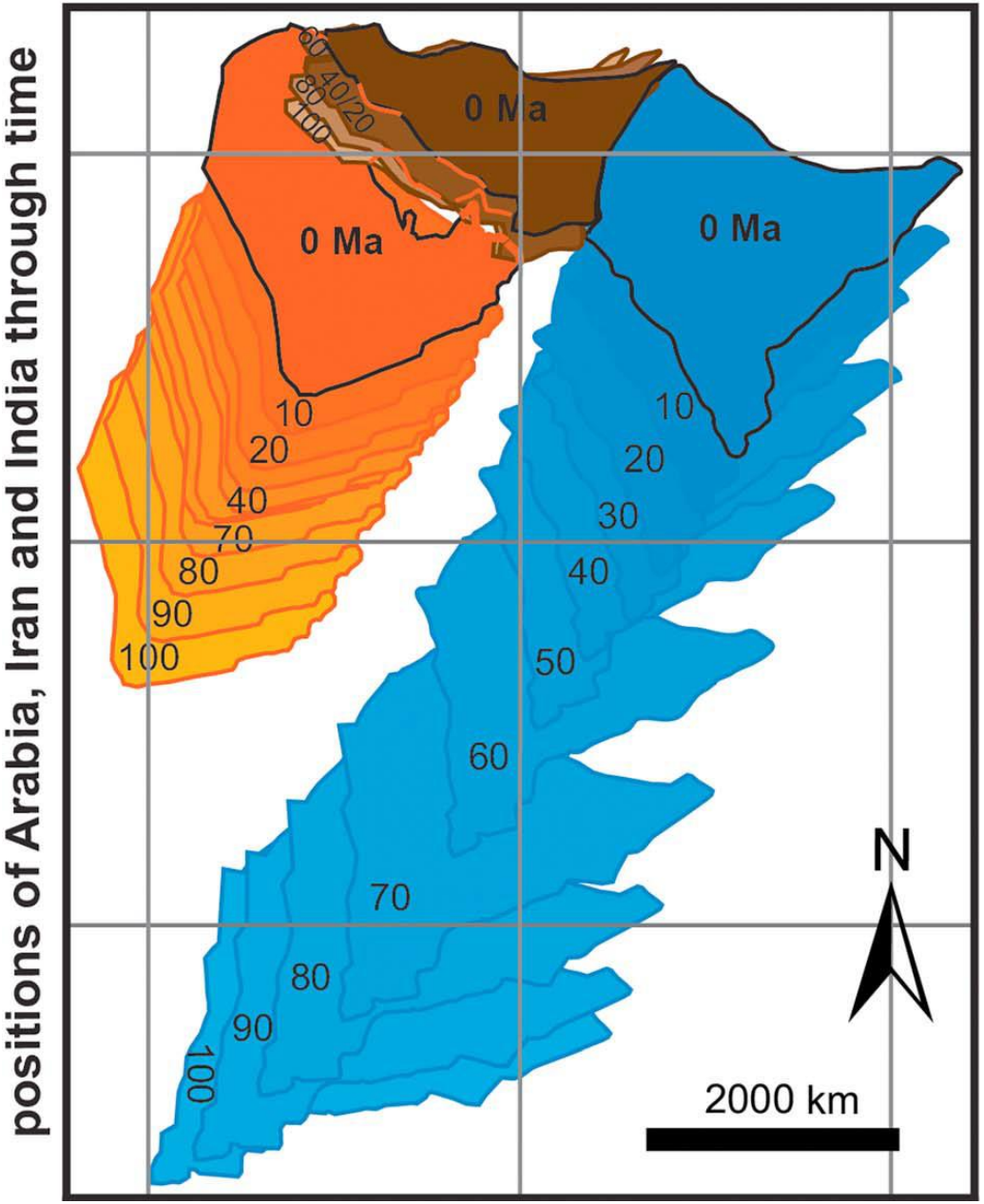
Strain ellipse after Harding's (1974)



Structural map of eastern Oman, depicting post-mid-Eocene structures after Béchennec et al. (1986), Villey et al. (1986a, b), Le Métour et al. (1986a, b), Rabu et al. (1986), Wyns et al. (1992), Roger et al. (1991), Peters et al. (2001, 2005), Moraetis et al. (2018) and Callegari et al. (2020).

Results/interpretation

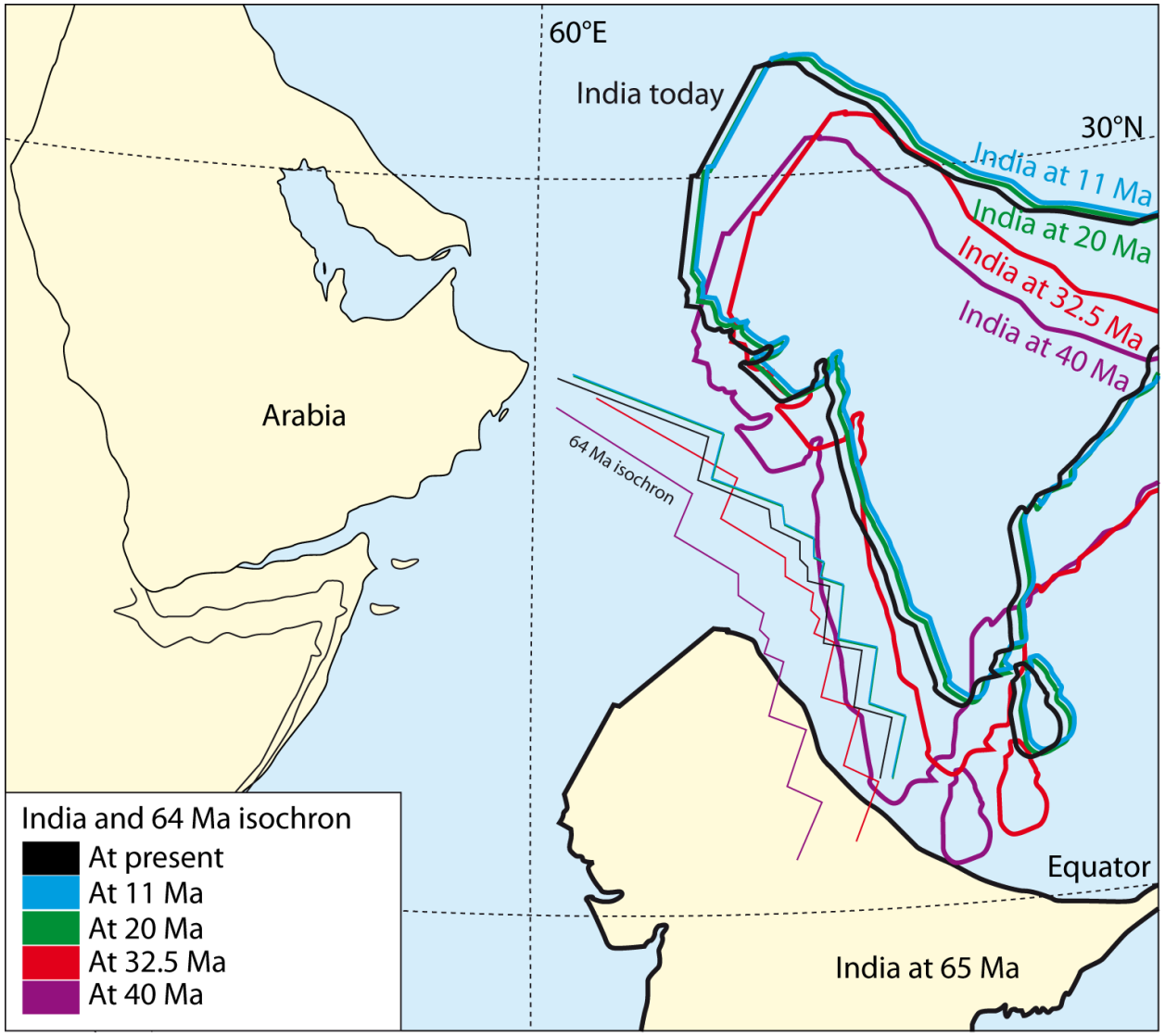
The cause for the NW-directed sinistral shearing is the overall E/W-directed convergence between the Arabian and Indian plates during the Cenozoic.



GPlate reconstruction of plate motions from 100 Ma to present-day (Grobe et al., 2018)

Results/interpretation

We carried out a detailed GPlate reconstruction focusing on the time of the activity of the syndepositional thrust between 32.5 and 20 Ma which revealed an



GPlate reconstruction of plate motions from 65 Ma to present-day.

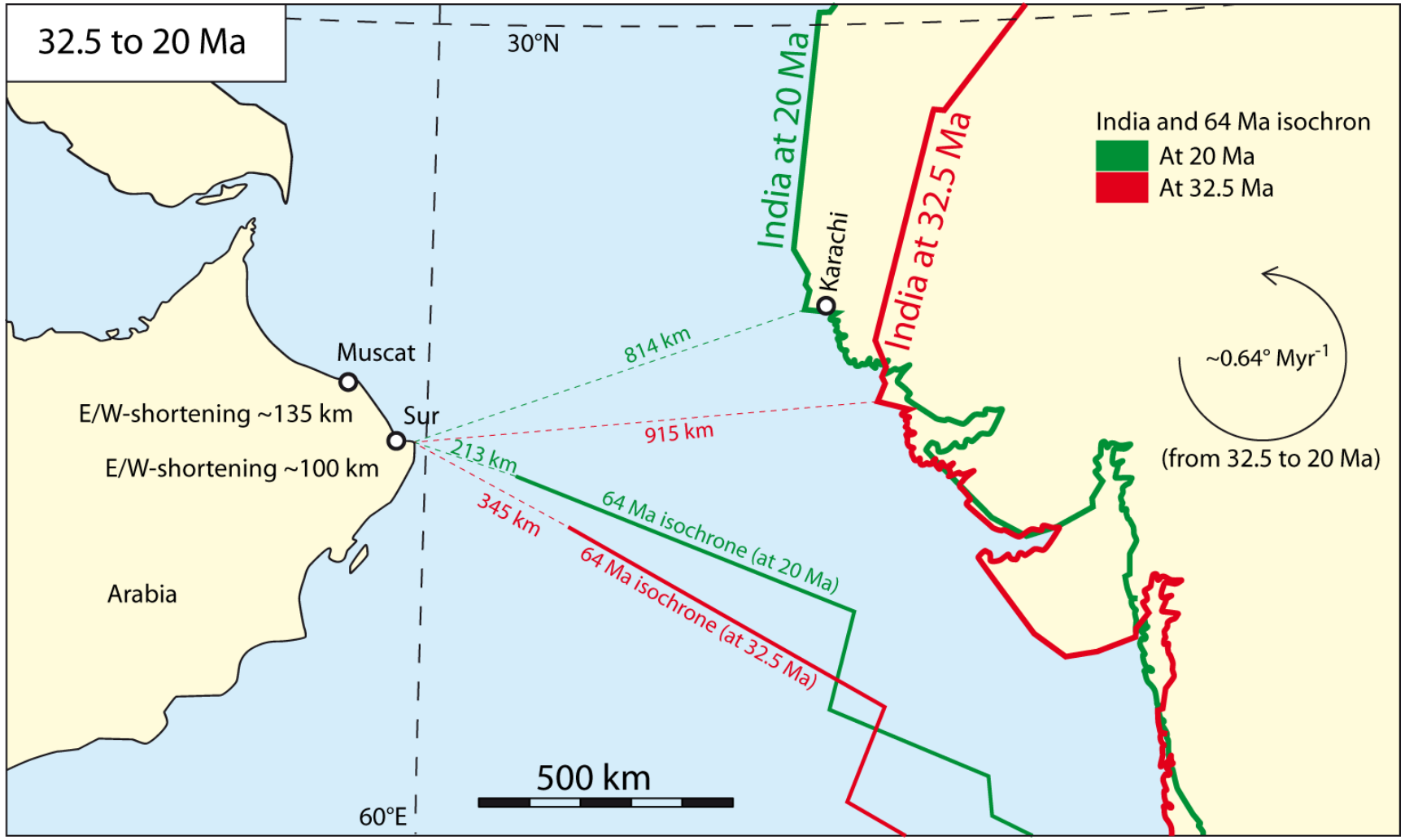
Results/interpretation

Between 32.5 and 20 Ma, India rotated counterclockwise, resulting in plate convergence. Amounting to ~E/W-shortening between both plates of ~100 km; based on δ E/W component of isochones

~135 km; based on δ E/W component of continental shapes and

~8° counter-clockwise rotation of India with respect to fixed Arabia (8°/12.5 Ma = 0.64°/1 Ma).

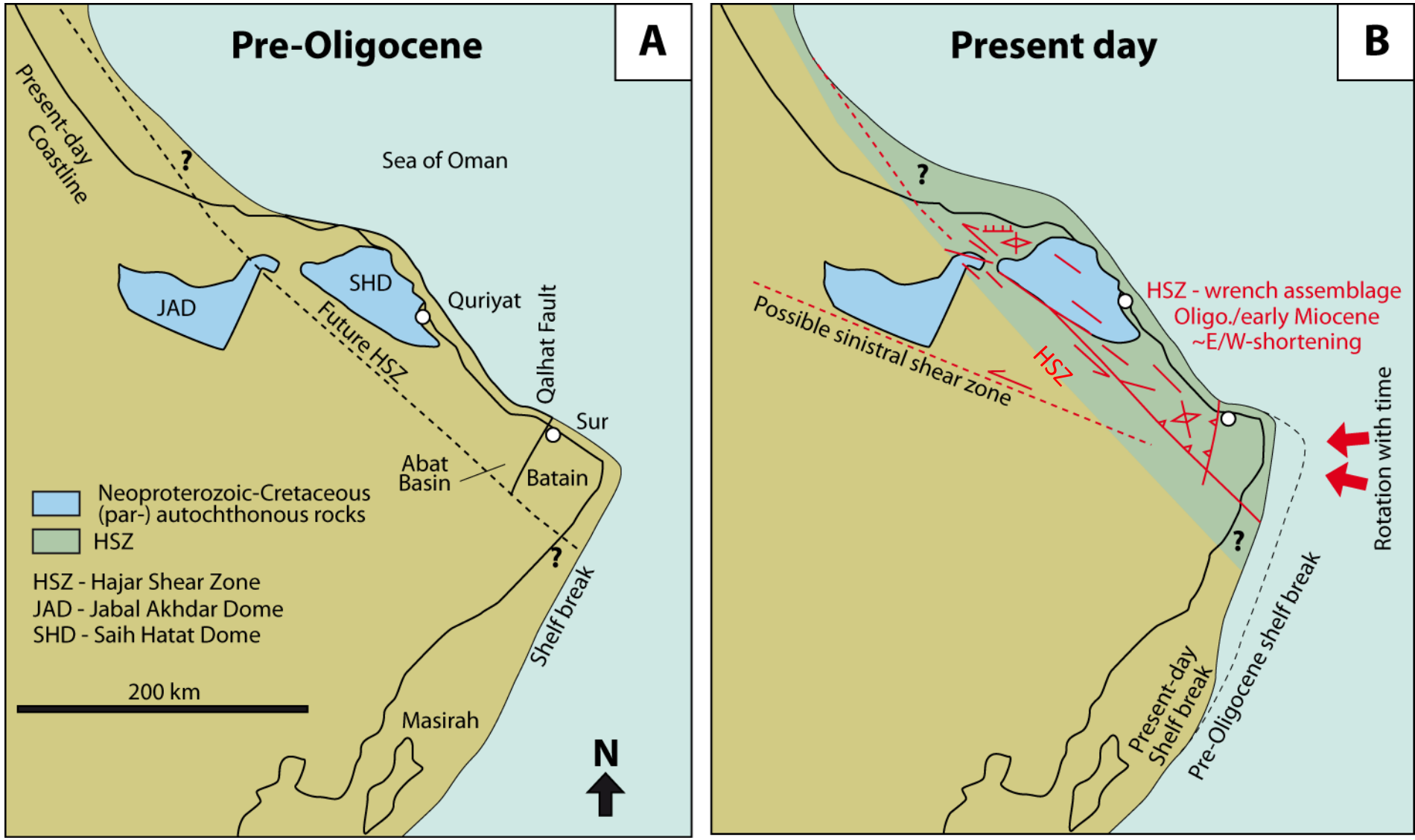
Some of the shortening may have been absorbed offshore Oman across the Owen Basin and/or along the continental/oceanic transitions of both plates.



GPlate reconstruction of plate motions from 32.5 Ma to 20 Ma.

The India-Arabia convergence created a sinistral shear zone and related wrench assemblage.

It is likely that below the HSZ, a pre-existing ~ NW-striking fault zone exists.



Outline of eastern Arabia. (A) before and (B) after activity along the HSZ.

On behalf of my colleagues and myself

Shukran! Thank you! Danke!



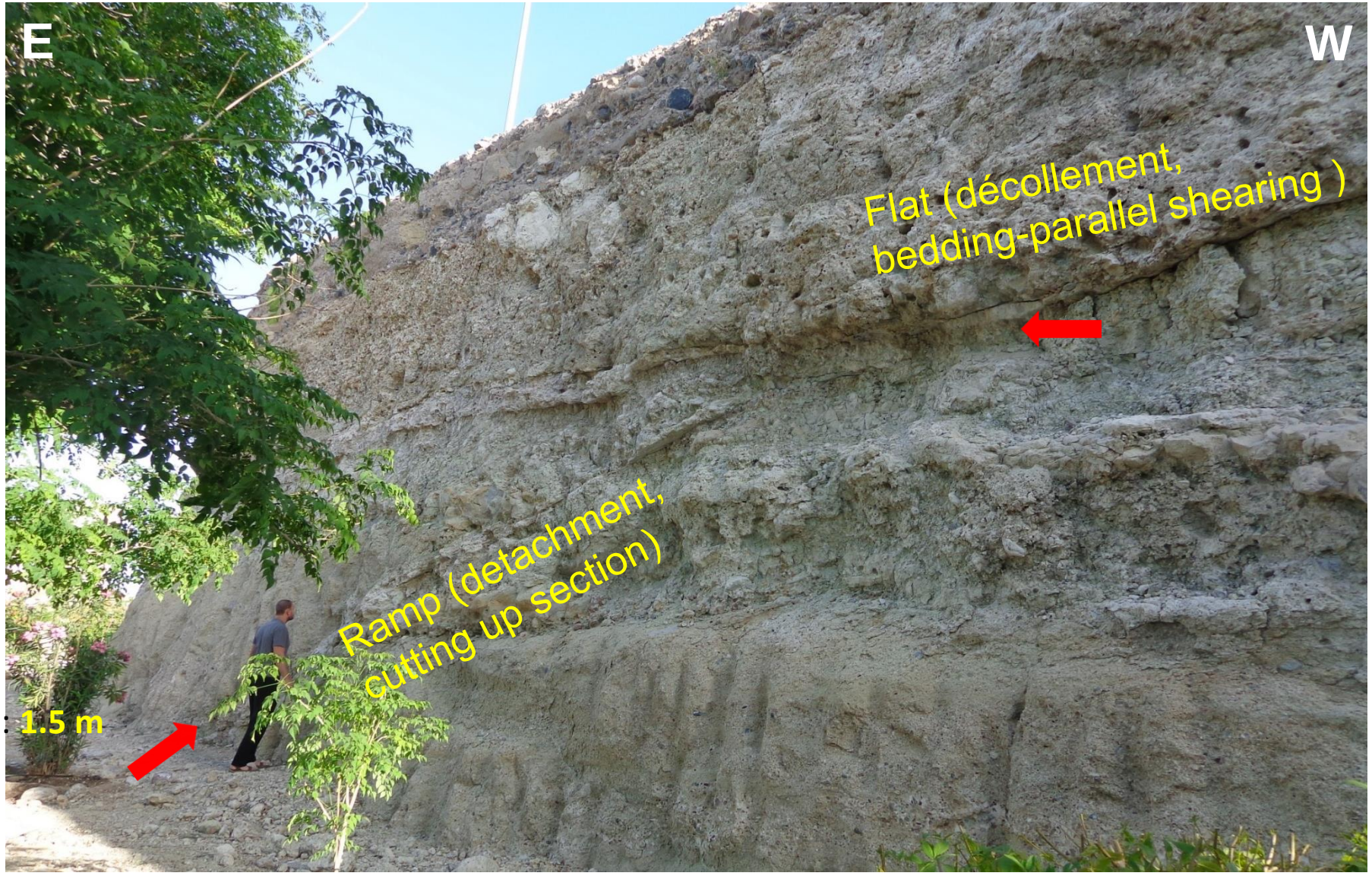
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Appendix

Oligocene/Miocene Barzaman Fm.

Note syndepositional thrust with ramp and flat!

Eastern segment



Oligicene/Miocene Barzaman Fm.

Note syndepositional thrust with flat and ramp!

Middle segment



Appendix 1C

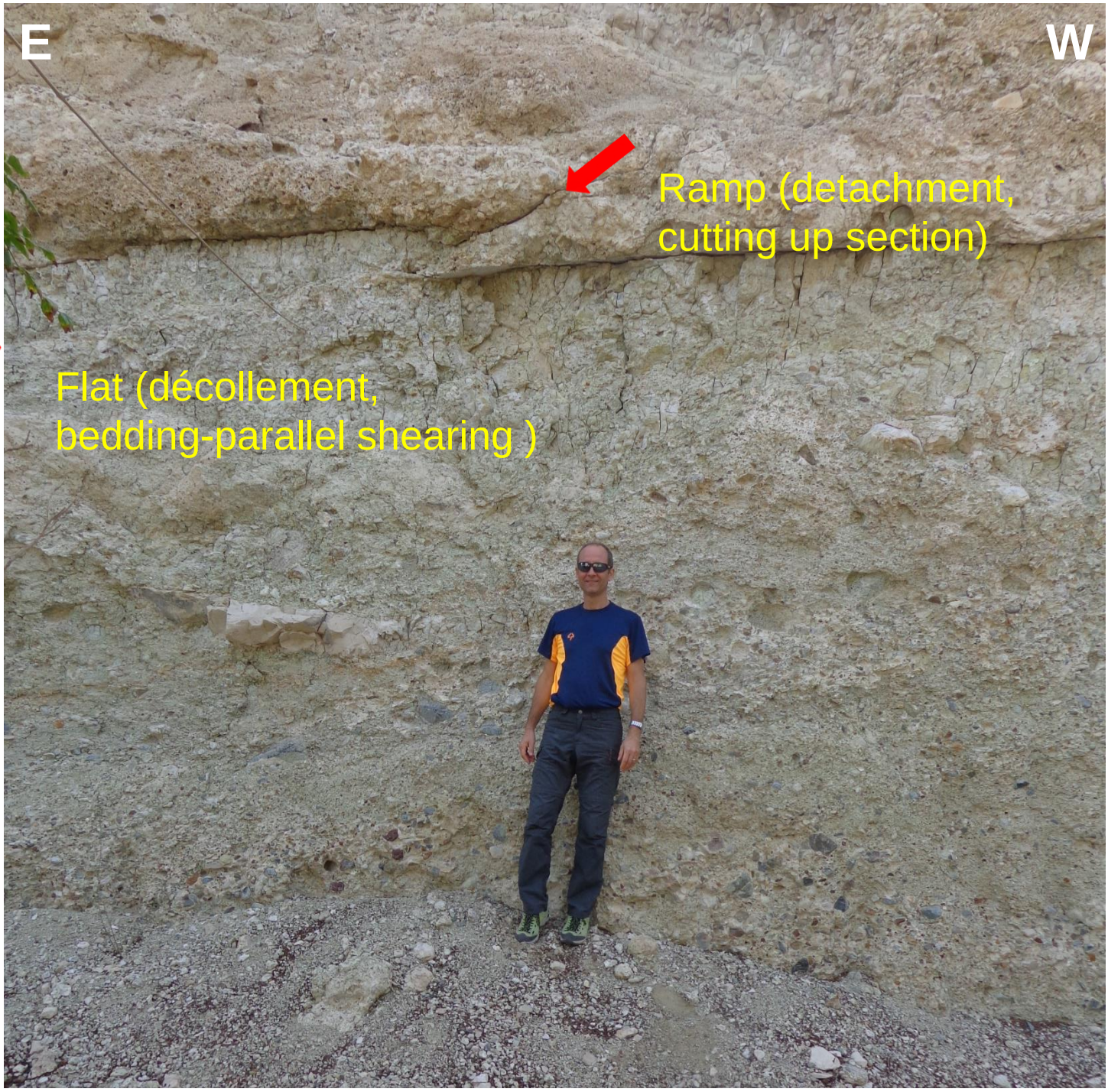
Oligocene/Miocene Barzaman Fm.

Note syndepositional thrust!

Westernmost segment

Note minimal vertical displacement (30 to 0 cm)!

Also note the deminishing vertical displacement from the from East (1.5 m) to the West (30-0 cm)! This inidicates the syndepositional nature of the Thrust.



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