Tracking back Permian – Triassic sections from Oman over the Permian to Cenozoic : Geodynamic and palæogeographic implications

Vérard Christian[1, a)], Baud Aymon[2], Edward Oluwaseun[2], Bucher Hugo[2]

[1] *Earth and Environmental Sciences, University of Geneva, Rue des Maraîchers 13, CH-1205, Geneva.*

[2] *Faculty of Geoscience and Environment, University of Lausanne, Quartier UNIL-Mouline, Géopolis, CH-1015, Lausanne.*

[3] *Paläontologisches Institut und Museum, Universität Zürich, Karl-Schmid-Strasse 4, CH-8006 Zürich*

a) Corresponding author : Christian.verard@unige.ch

Abstract : We use herein the Panalesis model to understand the geodynamic and palæogeographic evolution of many stratigraphic series that we have studied in Oman. Panalesis proposes that the Permian extensive phase is associated with the Panjal Traps formation and the detachment of the Cimmerian Blocks. The analogy with the current Traps of Etendeka and Walvis Ridge made it possible to refine the positions and the palæogeography during the emplacement of these series. The formation and rotation of the Indian plate causes an arc to form north of the North Omani margin. According to Panalesis, the arc is 3880 km away from the margin, implying the formation of a ' classic ' subduction zone which brought the arc back towards the margin. The actual obduction only occurs in a second step, by ridge failure of a spreading center which jumped just behind the arc. On the East Omani margin, Panalesis suggests that the transform fault between the Africa and India plates underwent compression in connection with the collision of the Indian Promontory with Eurasia. A shortening of up to 250 km then produces the metamorphism of the Batain Nappes. Finally, we propose the presence of an oceanic plateau – the Owen Plateau – to explain that the subduction, then along the continental margin of the Arabian plate, jumped towards the current Owen Fracture Zone.

Keywords : Geodynamics, palæogeography, Oman.

1 – Introduction

In Oman, we have re-examined in detail several sections that span the Permian–Triassic Boundary (PTB) and the Lower Triassic (Edward *et al*., 2022, 2023). Although much studied (see Baud, 2023 and references therein), the palæogeography of these sections and more broadly the geodynamic history of the northern and eastern Omani margins remain debated.

Based on the Panalesis model of plate tectonics (Vérard, 2019.b), we propose here to 1) place the various sections in their palæogeographic context in the Triassic, 2) trace the palæopositions of the sections from 300 Ma to present-day, and 3) specify a credible geodynamic scenario associated with this evolution.

2 – Stratigraphy Of The Permo-Triassic Sections

The detailed study of the PTB and the Lower Triassic (Smithian – Spathian Boundary ; Edward *et al*., 2022, 2023) concerns in particular the sections of Wadi Musjah, Jebel Rabat A (Northern Omani margin) and Jebel Aweri (East Omani margin), but here we will also consider other sections (Fig.01).

Successions have been well-described in the literature (*e.g*. Pillevuit *et al*., 1997; Chauvet, 2008; Scharf *et al*., 2021 and references therein) and synthesized in Baud (2023). These descriptions made it possible to properly constrain their depositional environments and their positions in relation to the Omani passive margin (Fig.02). They will therefore not be recalled again here, and we will focus instead on the geodynamic evolution of the region.

3 – Geodynamic Evolution

3.1 – Extensive phase: Rifting and oceanization

Between 300 Ma and 290 Ma, the first traces of extension (metatuffites of 298 ± 3 Ma after Gray *et al*., 2005); see also Pillevuit, 1993; Angiolini *et al*., 2003) probably indicate the very beginning of the rifting phase between Gondwana and the Cimmerian Blocks (or Cimmeria; Şengör *et al*., 1985; Stampfli, 2000; Stampfli & Borel, 2002; Stampfli *et al*., 2002). This extension is consecutive to the formation of Pangæa (Stampfli *et al*., 2013) which saw the collision between Gondwana and Laurussia in the East being extended to the West by the subduction of PalæoTethys. However, the traction of the plate had no notable effect in the oceanic lithosphere due to its rheological profile (Cloos, 1993; Fig.03). On the contrary, as soon as the continental crust becomes thick enough (Cloos, 1993; Fig.03), a rifting zone could have occurred along the North Gondwana passive margin. The rifting was also accompanied by the arrival of a mantle plume which will give rise to the Panjal traps (Chauvet *et al*., 2008). The area between northern India and Oman is then marked by a triple junction connecting a "Madagascar branch" and a "NeoTethys branch", reminiscent in many aspects of the current Afar area. The "Madagascar branch" of the rifting will be abandoned, while the "NeoTethys branch" will develop until oceanization (in the sense of the separation of two continental crusts, possibly around 268 ± 5 Ma according to the Panalesis model). It thus corresponds to the break-up of the Cimmerians Blocks from Gondwana and the formation of two conjugate passive margins around the NeoTethys Ocean. Throughout this phase, the Panjal hotspot remained active and created a plateau that extended over the passive margin and the continent – ocean boundary (COB), and continueed into a chain of seamounts. The tail of the mantle plume was probably "captured" by the mid-ocean ridge and the seamounts (*e.g*. Jebel Kawr, Jebel Misfah), still active in the Ladinian – Lower Carnian, underwent significant thermal subsidence associated with the distance from the ridge. The evolution of the Etendeka traps (Namibia) towards the Walvis Ridge and the Tristan da Cunha hotspot can, in some respects, be considered as a current equivalent of this system (Fig.02.d).

According to the geochemistry of basalts (Lapierre *et al*., 2004), the sections of Budday'ah, Rustaq and the top of the section of Al Ajal are seamounts linked to oceanization (with OIB and/or MORB signature; their "group 1"); the sections of Ba'id, Wadi Musjah, Jebel Rabat, and the base of Al Ajal have OIB (plateau) signatures with no continental crust contamination (their "group 2"); and the sections of Wadi Aday, Wadi Al Hulw have OIB signatures with continental crust contamination (their "group 3"). In the Carnian (Fig.02.a-c), the sections considered can then be positioned in their palæogeographic configuration. The Omani margin is stable and calm until the end of the Jurassic.

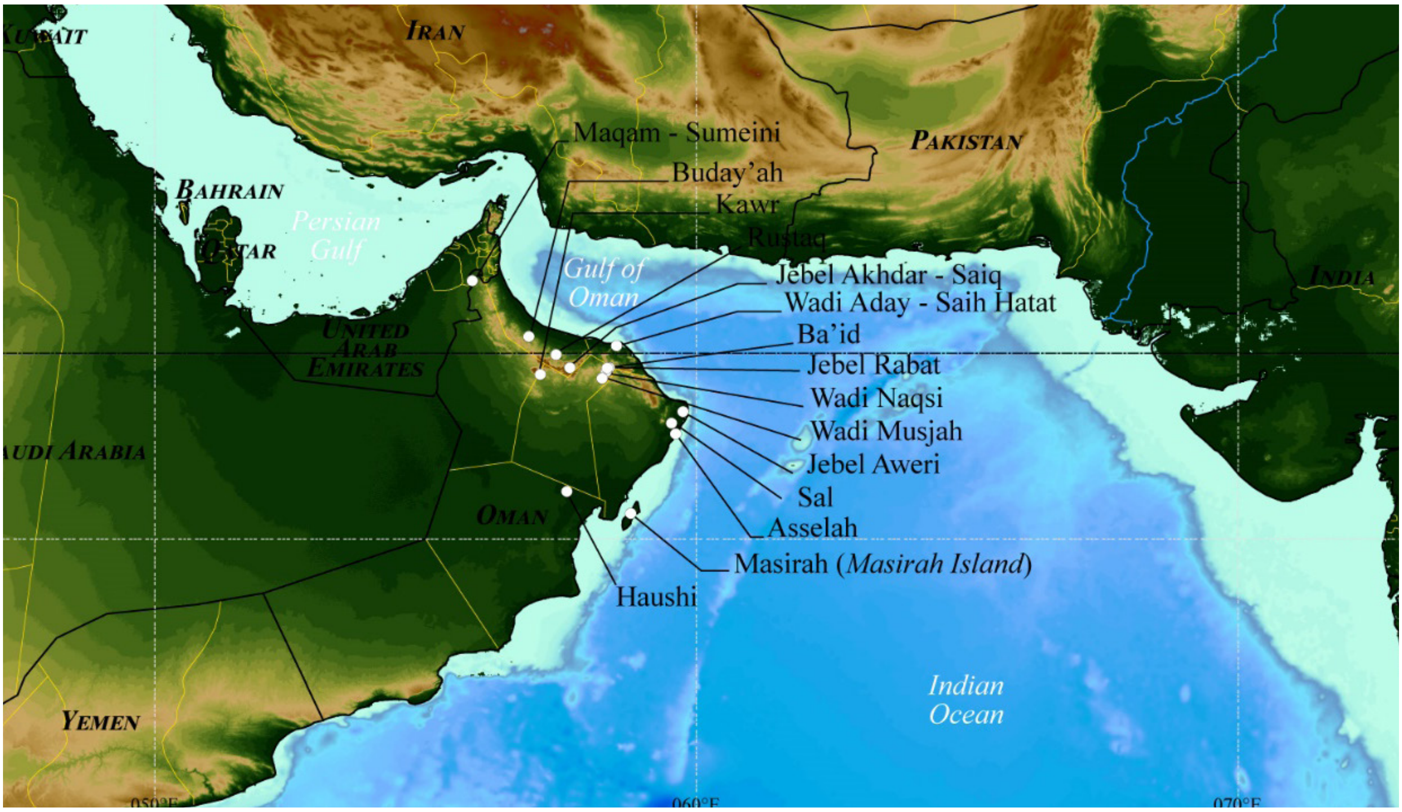

Fig. 01. Localisation of the stratigraphic series considered herein.

4 – Geodynamic change: Rotation of the Indian plate relative to the African plate

From the Callovian (König & Jokat, 2010; Mueller & Jokat, 2019), a new rifting zone is created between East and West Gondwana, and runs from the Weddell Sea, along the Mozambique Channel and the Somali Basin to the Eastern Omani margin. We can associate this rifting with the change in the stress regime caused by the subduction of the mid-oceanic ridge of the NeoTethys under Asia (Fig.04). Indeed, the traction exerted by the slab-pull is no longer accommodated by the mid-oceanic ridge, but is transmitted directly to the Gondwana plate, which is already subjected to a divergent traction by slab roll-back effect to the south.

At sea, the point of rotation between the two East and West Gondwana plates (Fig.04) is located on the old transform fault along which the Omani seamount chain was set up. This old transform fault is subject to extension to the south of the point of rotation and compression to the north, which leads to the rupture of the mid-oceanic ridge (ridge failure) and its transformation into an intra-oceanic subduction zone.

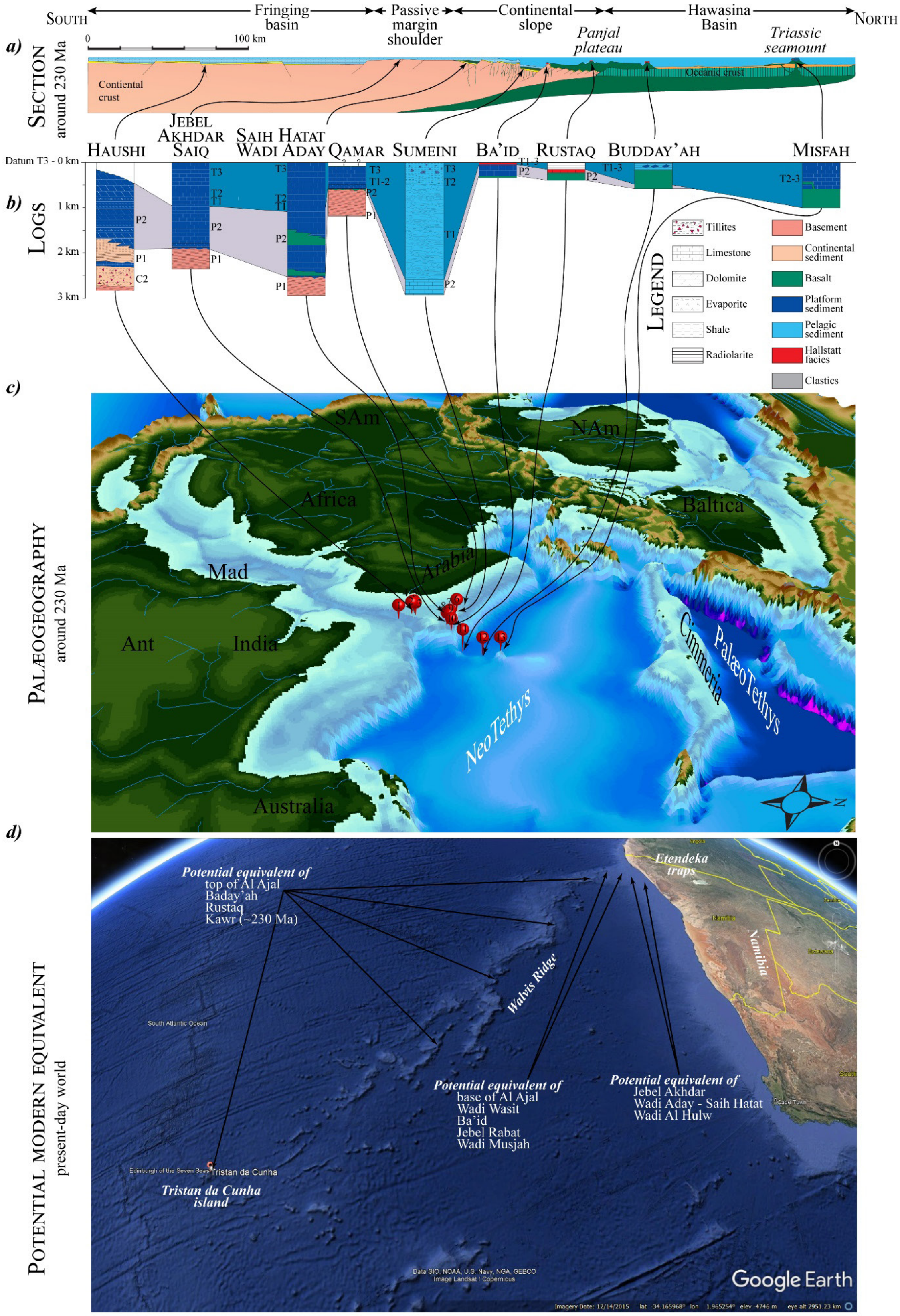

Fig. 02. a) Palinspastic reconstruction of the north-omani margin around 230 Ma; b) Synthetic logs and correlation of the sections; c) Palæogeographic reconstruction after the Panalesis (v.0) model; 1. Masirah – Mursays; 2. Asselah block; 3. Jebel Aweri; 4. Sal; 5. Haushi; 6. Maqam – Sumeini; 7. Jebel Akhdar – Saiq plateau; 8. Wadi Aday – Saih Hatat; 9. Ba'id; 10.1. Jebel Rabat; 10.2. Wadi Musjah; 10.3. Wadi Wasit (block); 11. Rustaq; 12. Buday'ah; 13. Misfah; d) Potential equivalent of the Omani system in the present-day world.

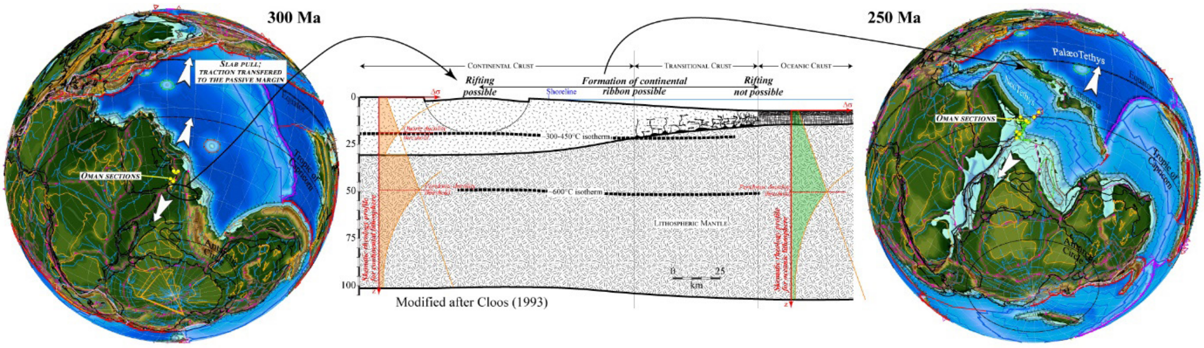

Fig. 03. Palæogeographic reconstruction around 300 Ma and 250 Ma (Panalesis.v.0), explanatory sketch of the detachment of the Cimmerian Blocks from the Gondwana margin (adapted from Cloos, 1993, *op.cit.fig*.13).

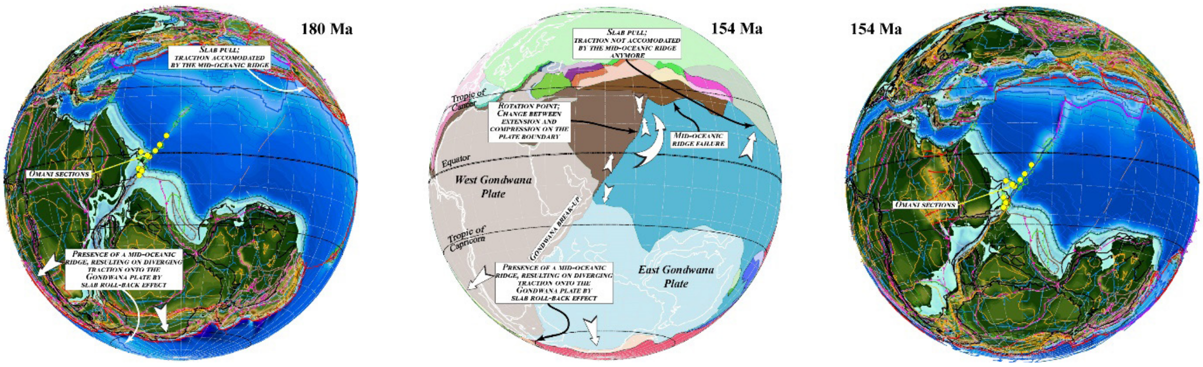

Fig. 04. Palæogeographic reconstructions around 180 Ma and 154 Ma [*i.e.* magnetic anomaly M25], and the corresponding tectonic plates (random colours) at 154 Ma (Panalesis.v.0), highlighting the change in geodynamics (subduction of the mid-oceanic ridge under Asia) linked to the break-up of Gondwana.

5 – Compressive phase of the North Omani margin : Subduction then obduction

The mid-oceanic ridge is located, according to the Panalesis model, at 3880 km off Oman. Unlike all the other models (*e.g*. Pillevuit *et al*., 1997 (their fig.2) ; Breton *et al*., 2004 (their fig.8) ; Duretz *et al*., 2016 (their fig.1a) ; Ninkabou *et al*., 2021 (their fig.2b)), when the ridge fails, it is not the Omani obduction that takes place, but a ‘ classic ’ intra-oceanic subduction (Fig.05). Indeed, when the oceanic lithosphere of the East Gondwana/Africa plate subducts under the Semail plate, the oceanic crust will be eclogitized. The lithosphere then sinks under its own weight, and a slab roll-back phenomenon can subsequently occur (Vérard, 2019.a). With the eclogitization of the crust of the lower plate however, there is hydration of the mantle under the upper plate, and the formation of an arc ; this is called intra-oceanic subduction. The slab roll-back makes it possible to bring the arc closer to the North Omani margin (*i.e*. to fill the 3880 km ; Fig.05), and a new mid-oceanic ridge is set up at the back of the arc and accompanies the movement. The Omani seamounts, located on the passage of the arc, are detached from their basement and incorporated into the accretionary prism of the subduction zone (see examples of this phenomenon in Dominguez *et al*., 2000). In our opinion, most of the major rotations defined on the basis of palæomagnetism (up to 120° according to Weiler, 2000 and Godard *et al*., 2003) occurred at this time. When the intra-oceanic arc collides with the North Omani margin in the mid-Cretaceous (Fig.06), the ridge located a few hundred kilometers behind the arc fails and allows “ the real Omani obduction ” to occur (Fig.07 ; Vérard & Stampfli, *in prep.*). The Semail plate then passes over the lithosphere carrying the intra-oceanic arc (“ fore-arc block ” in Fig.07.d3), then over the Omani passive margin. Contrary to the model of Breton *et al*. (2004), we do not believe that the rupture of the whole lithosphere at the level of the Omani passive margin is possible (see also Fig.03).

We rather favour a decoupling between crust and lithospheric mantle in accordance with the models of Shemenda (1993) and Boutelier & Chemenda (2011). Elements of the passive margin (*e.g*. Jebel Akhdar, Saih Hatat; see Fig.07.d6) undergo high degrees metamorphism at depth and then return back to the surface (see also Python *et al*., 2020). With the detachment of the slab in the Palæocene, the entire margin is uplifted and creates the exhumation structures well-described by Breton *et al*. (2004) for example. The lithosphere carrying the arc is now totally "lost". Behind, the Semail plate itself is consumed by a subduction zone under Eurasia (Iran). Nowadays, in Zagros (Fig.07.a), the Semail plate is also entirely "lost" (Fig.07.c2) but not yet completely around the Gulf of Oman (Fig.07.c1).

Finally, we also consider that the gap between the series of the Jebel Akhdar and Saih Hatat zones is indeed associated with a transfer fault ("Semail Gap Transfer Zone") as proposed by Ninkabou *et al*. (2021), but we do not associate this shift with a difference in extension of the Omani continental crust. We rather propose that this shift is the consequence of the presence or not of the oceanic plateau/ magmatic margin (the "Panjal Plateau" in Fig.02.a), which was formed in the Permian during rifting in connection with the Panjal Traps (see "extensive phase"). The Semail Gap Transfer Zone is thus for us an indicator of the maximum lateral extension (along the margin) of this hot spot volcanism (Fig.02).

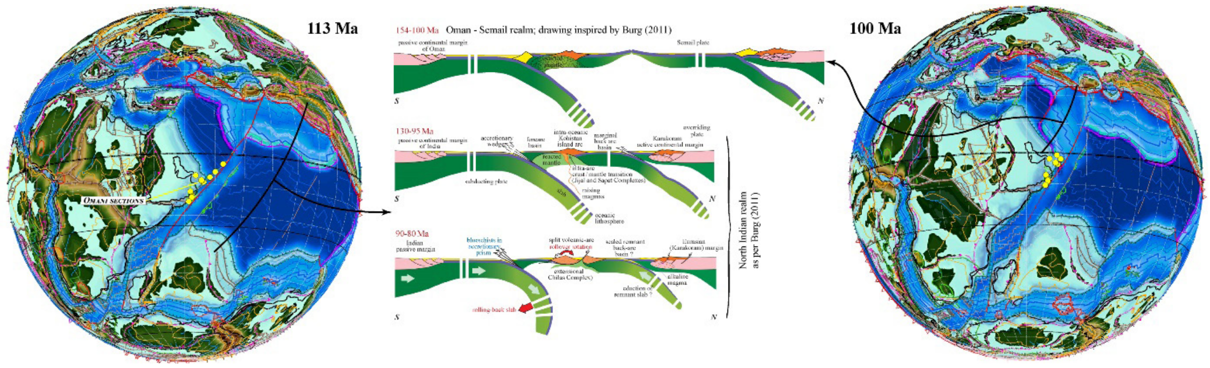

Fig. 05. Palæogeographic reconstructions (Panalesis.v.0) around 113 Ma [*i.e*. Aptian – Albian boundary, *long-normal superchron*] and 100 Ma [*i.e*. Albian – Cenomanian boundary, *long-normal superchron*]; The geodynamic scenario for the Oman – Semail region follows that of the India – Kohistan scenario proposed by Burg (2011) and used in Vérard *et al*. (2017).

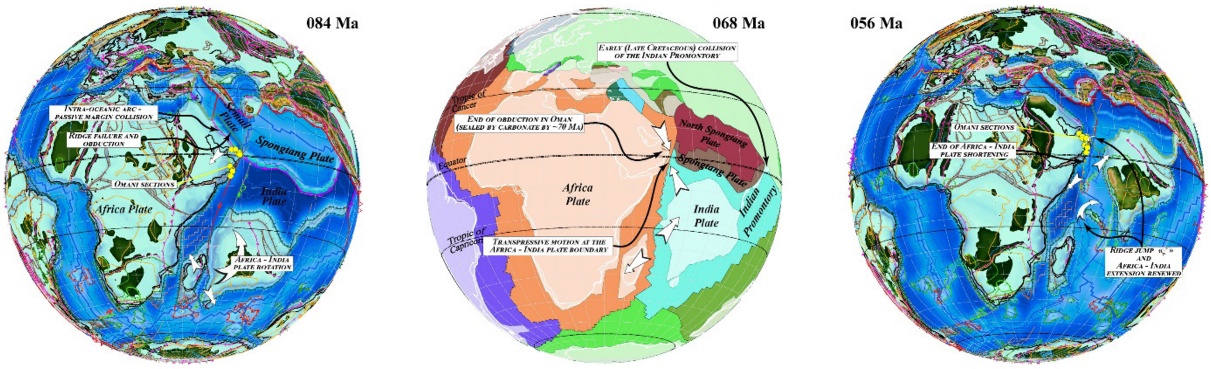

Fig. 06. Palæogeographic reconstructions (Panalesis.v.0) around 84 Ma [*i.e*. Santonian – Campanian boundary, *magnetic anomaly C34*] and 56 Ma [*i.e*. Thanetian – Ypresian boundary, *magnetic anomaly C25*]; The plate tectonics model (random colours) highlights transpression along the east-omani margin in the context of the Madagascar – India divergence and the collision of the Indian Promontory with Eurasia (Vérard *et al*., 2017).

6 – Transpressive phase of the East Omani margin

At the end of the Lower Cretaceous, the mid-oceanic ridge, which was located in the Mozambique Channel and Somali Basin, jumps and becomes located between India and Madagascar. The India plate then slides south-southeast of the Africa plate. According to the pre- and post-Long Normal Superchron marine magnetic anomalies in the Indian Ocean (specifically the M0 [Aptian] and C34 [Santonian–Campanian] anomalies ; Müller *et al*., 2008 ; Eagles & Hoang, 2013), and according to the geometries of the India and Africa plates, a transpressive motion occurs along the eastern Omani margin when India begins its northward migration (after its separation from the Antarctica plate). With the Panalesis model, we suggest that the motion of the India plate relative to the Africa plate along the East Omani margin initially corresponds to a strike-slip mouvement (' classic ' transform fault), and that the transpressive phase occurs from about 75 ± 5 Ma when the Indian Promontory (Vérard *et al*., 2017) collides with Eurasia and allows exchanges of fauna between India (the ' biotic ferry ' of Hedges, 2003) and the continent.

The East Omani margin then underwent a shortening reaching up to 250 km (perpendicular to the margin) according to Panalesis, creating the metamorphism on the Masirah Island and the Batain Mounts (Schreurs & Immenhauser, 1999). We also assume a sliding (parallel to the margin) of the order of 90 km of the *tectonic element* (see term in Vérard, 2019.a,b), which carries the sections of Massirah, Asselah, Sal, and Jebel Aweri (Fig.01).

During the Oligocene (*e.g*. Stampfli *et al*., 1991), Arabia separated from Africa by slab-pull effect under Iran. In the Indian Ocean, the Carlsberg mid-oceanic ridge extends northward through a transform fault that runs along the East Omani passive margin. With the motion of the Arabia plate and the formation of the Red Sea and Gulf of Aden rifts, this transform fault enters into compression (Fig.08). We hypothesize that an oceanic plateau – wichi we name the Owen Plateau – was formed as the northern extension of the Chain Ridge (located south of the Socotra Island) at the time of the ridge jump between the magnetic anomaly C31 (*ca*. 68 Ma) and C25 (*ca*. 56 Ma) and the abandonment of the Seychelles on the Africa plate. We propose that the transpressive boundary between the India and Arabia plates does not convert into a " true " subduction zone due to the locking of the Owen Plateau, in the style of the Ontong-Java or Hikurangi plateaus in the present-day world. In the Panalesis model, this " arc-plateau collision " however leads to a displacement, estimated at 123 km, of the *tectonic element* which carries the sections of Massirah, Asselah, Sal, and Jebel Aweri (Fig.08). The marine magnetic anomaly C05B (Langhian) proves that the mid-oceanic Sheba ridge skirts the area where we place the Owen Plateau, and branches into the current Owen Fracture Zone. This phenomenon is similar to a ' subduction jump ' from the front of the plateau locked at the East Omani passive margin towards the rear of the plateau, whose margin is a zone of rheological weakness (Vérard, *in prep.*). The Owen Fracture Zone is not, however, a " true " subduction zone (which is why one cannot really speak of a ' subduction jump ') since its movement is predominantly sinistral.

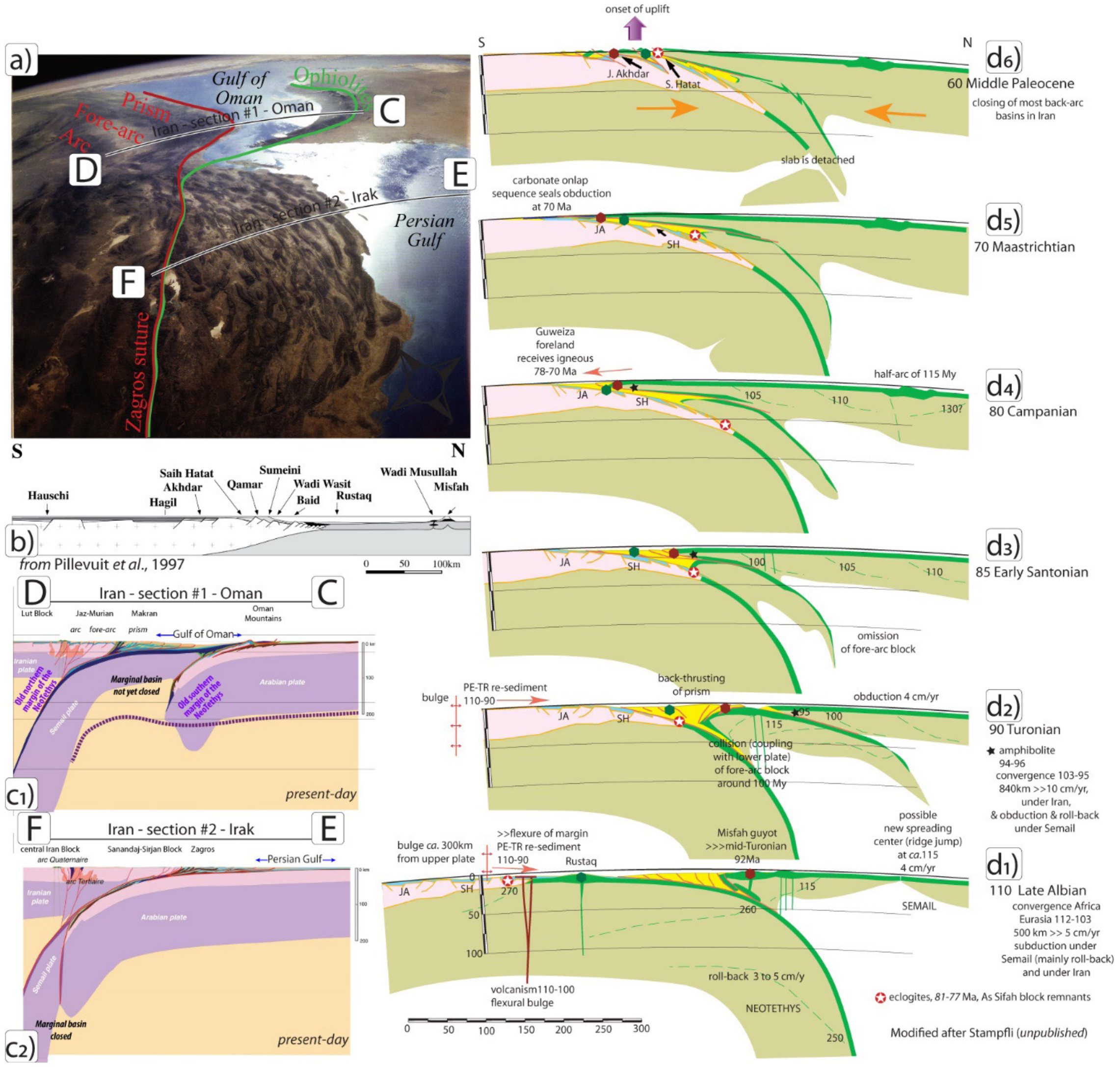

Fig. 07. Geodynamic environment related to the Omani obduction ; a) *Upper left panel* : Satellite view (towards the South-East) of the Iran – Oman area, with cross-sections (C-D and E-F) shown in c) ; b) *Middle left panel*, after Pillevuit *et al*. (1997), showing a reconstruction of the Arabian passive margin of the NeoTethys in the Permian (prior to the Cretaceous obduction) ; c) *Lower left panel* : Lithospheric cross-sections corresponding (c1) to section C-D and (c2) to section E-F shown in a) ; d) *Right panel* : Evolution model from *ca*. 110 Ma to 60 Ma after Stampfli (2005-*unpublished*).

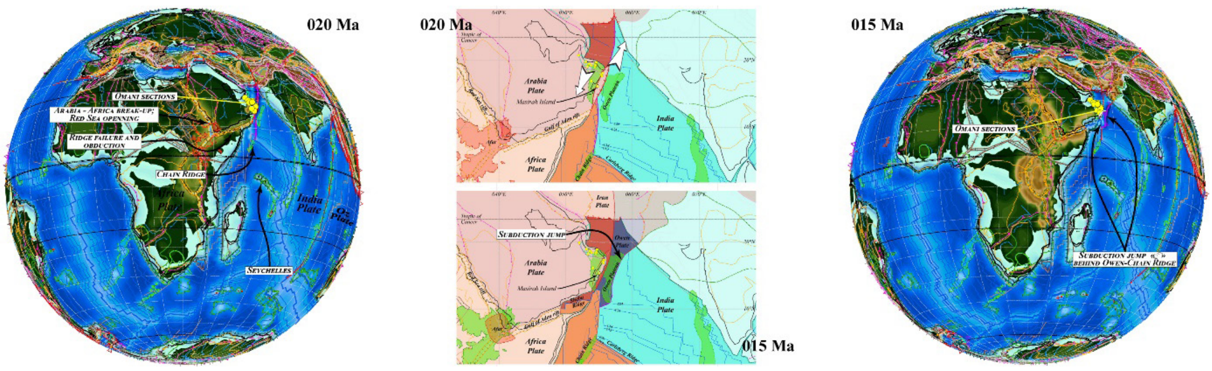

Fig. 08. Palæogeographic reconstructions (Panalesis.v.0) around 20 Ma [*i.e*. Burdigalian, *magnetic anomaly C06*] and 15 Ma [*i.e*. Langhian, *magnetic anomaly C05B*] ; The plate tectonics model (random colours) at 20 Ma and 15 Ma highlights the proposed arc – plateau collision and the subduction jump behind the Owen Plateau, as well as the associated displacement of the Masirah *tectonic element* along the east-omani margin.

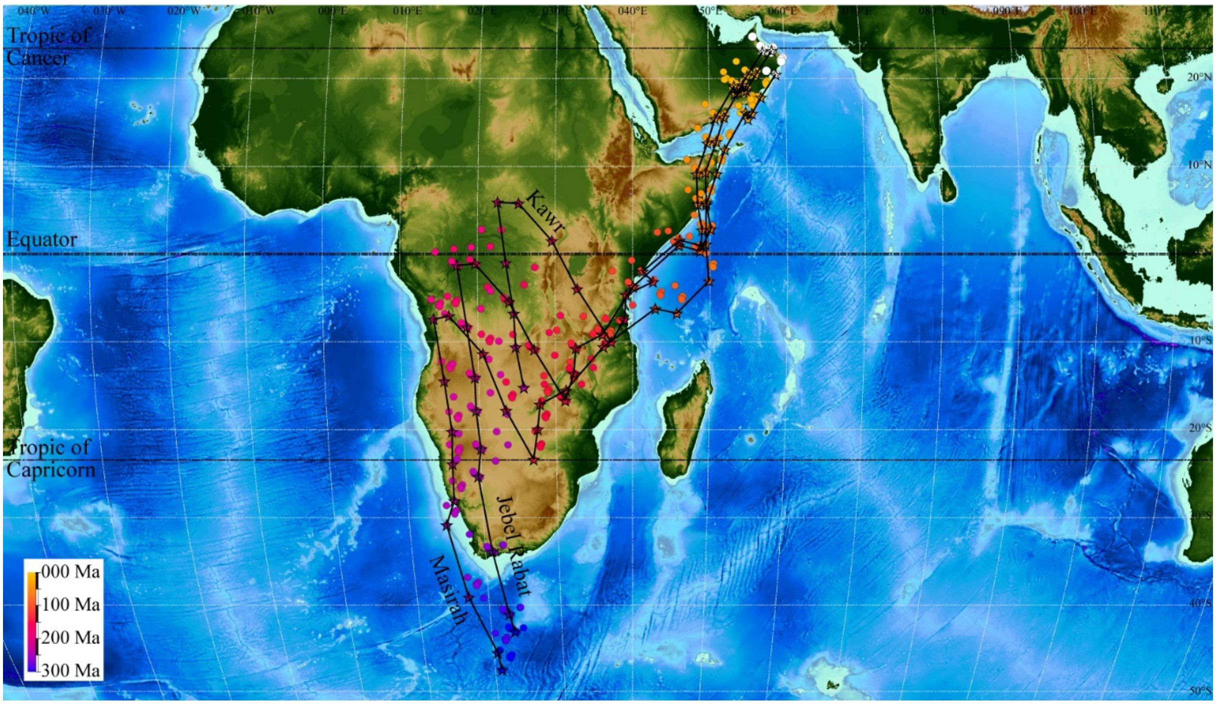

Fig. 09. Palæoposition of the considered sections from 300 Ma to present-day (see scale for colour-coded ages); for sake of clarity, only three evolution paths – for Masirah, Jebel Rabat, and Kawr – are shown.

7 – Conclusions

The analysis of various sections associated with the Panalesis global model of plate tectonics made it possible to characterize the palæopositions (Fig.09), the palæogeographies, and the geodynamic history of the northern and eastern margins in Oman. In particular, we highlight the following points:

1. Part of the sections of the North Omani margin formed on the Panjal Plateau, a plateau/ magmatic margin emplaced on the style of the Etendeka/Walvis Ridge plateau/ magmatic margin in the present-day world, explaining in particular the gap in the shortening between the Jebel Akhdar and the Saih Hatat zones, and the presence of the Semail Gap Transfer Zone of Ninkabou *et al*. (2021).
2. Unlike other models, we argue that the Omani obduction did not begin with the NeoTethys ridge failure. This ridge failure, located 3880 km from the Omani margin, caused a 'classic' intra-oceanic subduction zone. The migration of the arc by slab roll-back effect cross-cut the seamounts and basalts from the Hawasina basin and caused the strong rotations recorded by palæomagnetism. It was at the time of the arc – continent collision that the "true" Omani obduction was set up by ridge failure of a new mid-oceanic ridge formed at the back of the arc.
3. The Eastern Omani margin underwent a major phase of transpression (with up to 250 km of shortening), which formed the Eastern Ophiolites Bets of the Masirah Island and the Batain Nappes during the motion of the India plate relative to the Africa plate. The ridge jump, coeval with the abandonment of the Seychelles on the Africa plate, released the constraints on the Omani margin. We hypothesize that this ridge jump was also guided by hot spot volcanism at the Chain Ridge, which we extend to the north by an oceanic plateau, the Owen Plateau.
4. This Owen Plateau, which will have to be evidenced in the future, allows us to explain: a) the failure of the development of a "true" subduction zone from the transform fault which limited the Arabia plate and the India plate; b) the displacement of the Masirah *tectonic element* along the East Omani margin; c) the 'subduction jump' (or transpressive fault jump) on the current Owen Fracture Zone.

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References :

Angiolini, L., Balini, M., Garzanti, E., Nicora, A., Tintori, A., Crasquin-Soleau, S., Muttoni, G., 2003. Permian climatic and palaeogeographic changes in northern Gondwana : The Khuff Formation of interior Oman. Palæogeography, Palæoclimatology, Palæoecology, 191 (3–4), 269–300.

Baud, A., 2023. La transition permo-triasique sur la marge omanaise, 32 pages. *In* Société Géolologique de France (ed.) : *Destination Oman*. Géochronique, Volume spécial, 9 pages.

Boutelier, D., Chemenda, A. I., 2011. Physical modeling of arc-continent collision : A review of 2D, 3D, purely mechanical and thermo-mechanical experimental models. In Brown, D., Ryan, P. D. (Eds), Arc-Continent Collision. Frontiers in Earth Sciences, Springer-Verlag, Berlin – Heidelberg, Chapter 16, 445-473.

Breton, J.-P., Béchennec, F., Le Métour, J., Moen-Maurel, L., Razin, P., 2004. Eoalpine (Cretaceous) evolution of the Oman Tethyan continental margin : Insights from a structural field study in Jabal Akhdar (Oman Mountains). GeoArabia, 9 (2), 20 pages.

Burg, J.-P., 2011. The Asia-Kohistan-India collision : Review and discussion. In Borown, D., Ryan, P. D. (Eds.), Arc-Continent Collision, Frontiers in Earth Sciences, Springer-Verlag, Berlin – Heidelberg, 279-309.

Chauvet, F., 2008. La marge continentale sud-téthysienne en Oman : Structure et volcanisme au Permien et au Trias. PhD thesis of the University Joseph Fourier of Grenoble (Grenoble I), France, 421 pages.

Chauvet, F., Dumont, T., Basile, C., 2009. Structures and timing of Permian rifting in the central Oman Mountains (Saih Hatat). Tectonophysics, 475, 563-574 ; doi :10.1016/j.tecto.2009.07.008.

Chauvet, F., Lapierre, H., Bosch, D., Guillot, S., Mascle, G., Vannay, J.-C., Cotten, J., Brunet, P., Keller, F., 2008. Geochemistry of the Panjal Traps basalts (NW Himalaya) : Records of the Pangea break-up. Bulletin de la Société Géologique Française, 179 (4), 383-395.

Dominguez, S., Malavieille, J., Lallemand, S., 2000. Deformation of accretionary wedges in response to seamount subduction : Insights from sandbox experiments. Tectonics, American Geophysical Union (AGU), 19 (1), 192-196.

Duretz, T., Agard, P., Yamato, P., Ducassou, C., Burov, E. B., Gerya, T. V., 2016. Thermo-mechanical modeling of the obduction process based on the Oman ophiolite case. Gondwana Research, 32, 1-10 ; http ://dx.doi.org/10.1016/j.gr.2015.02.002.

Eagles, G., Hoang, H. H., 2014. Cretaceous to present kinematics of the Indian, African and Seychelles plates. Geophysical Journal International, 196 (1), 1-14 ; doi : 10.1093/gji/ggt372.

Edward, O., Leu, M., Dudit, L., Le Houedec, S., Bucher, H., Baud, A., Vérard, C., Vennemann, T., 2022. Latest Permian to Early Triassic (Spathian) integrated carbon, strontium and neodymium isotope chemostratigraphy from Oman exotic blocks. Poster P.3.3 at the 20th Swiss Geoscience Meeting in Lausanne (Switzerland), November 18-20, 2022.

Edward, O., Leu, M., Bucher, H., Le Houedec, S., Blattmann, F., Vérard, C., Adatte, T., Baud, A., Sonke, J. E., Vennemann, T., 2023-*submitted*. Evidence for variable provenance of Tethyan mercury anomalies during the Smithian – Spathian (Olenekian). Global and Planetary Change.

Godard, M., Dautria, J.-M., Perrin, M., 2003. Geochemical variability of the Oman lavas : Relationship with spatial distribution and paleomagnetic directions. Geochemistry, Geophysics, Geosystems (G3), 4 (6), 8609, 15 pages ; https ://doi.org/10.1029/2002GC000452.

Gray, D. R., Gregory, R. T., Armstrong, R. A., Richards, I. J., Miller, J. M., 2005. Age and stratigraphic relationships of structurally deepest level rocks, Oman Mountains : U/Pb SHRIMP evidence for

Late Carboniferous Neotethys Rifting. Journal of Geology, 113, 611-626.
Hedges, S. B., 2003. The coelacanth of frogs. Nature, 425, 669-670.
König, M., Jokat, W., 2010. Advanced insights into magmatism and volcanism of the Mozambique Ridge and Mozambique Basin in the view of new potential field data. Geophysical Journal International, 180, 158-180.
Lapierre, H., Samper, A., Bosch, D., Maury, R. C., Béchennec, F., Cotton, J., Demant, A., Brunet, P., Keller, F., Marcoux, J., 2004. The Tethyan plume : Geochemical diversity of Middle Permian basalts from the Oman rifted margin. Lithos, 74, 167-198 ; doi :10.1016/j.lithos.2004.02.006.
Mueller, C. O., Jokat, W., 2019. The initial Gondwana break-up : A synthesis based on new potential field data of the Africa-Antarctica Corridor. Tectonophysics, 750, 301-328.
Müller, R. D., Sdrolias, M., Gaina, C., Roest, W.R., 2008. Age, spreading rates, and spreading asymetry of the world's ocean crust. Geochemistry, Geophysics, Geosystems, 9, Q04006 ; https ://doi.org/10.1029/2007GC001743.
Ninkabou, D., Agard, P., Nielsen, C., Smit, J., Gorini, C., Rodriguez, M., Haq, B., Chamot-Rooke, N., Weidle, C., Ducassou, C., 2021. Structure of the offshore obducted Oman margin : Emplacement of Semail ophiolite and role of tectonic inheritance. Journal of Geophysical Research : Solid Earth, 126, e2020JB020187, 29 pages ; https ://doi.org/10.1029/2020JB020187.
Pillevuit, A., 1993. Les blocs exotiques du Sultanat d'Oman. Evolution paléogéographique d'une marge passive flexurale. PhD thesis of the University of Lausanne (Lausanne), Switzerland, Mémoires de Géologie, 17, 254 pages.
Pillevuit, A., Marcoux, J., Stampfli, G., Baud, A., 1997. The Oman Exotics : A key to the understanding of the NeoTethyan geodynamic evolution. Geodynamica Acta, 10 (5), 209-238 ; DOI : 10.1080/09853111.1997.11105303.
Python, M., Rospabé, M., Ceuleneer, G., Benoit, M., Duranton, E., Breton, J.-P., 2020. The distinctive peridotite of Taww, Northern flank of Jabal Nakhl, Oman. Lithos, 376-377, 105758, 17 pages ; https ://doi.org/10.1016/j.lithos.2020.105758.
Scharf, A., Mattern, F., Al-Wardi, M., Frijia, G., Moraetis, D., Pracejus, B., Bauer, W., Callegari, I., 2021. The geology and tectonics of the Jabal Akhdar and Saih Hatat Domes, Oman Mountains. Geological Society, London (UK), Memoirs, 54, 124 pages ; https ://doi.org/10.1144/M54.
Schreurs, G., Immenhauser, A., 1999. West-northwest directed obduction of the Batain Group on the easttern Oman continental margin at the Cretaceous-Tertiary boundary. Tectonics, 18 (1), 148-160.
Şengör, A. M.C., Yilmaz, Y., Sungurlu, O., 1985. Tectonics of the Mediterranean Cimmerides : Nature and evolution of the western termination of Palæo-Tethys. In Dixon, J. E., Robertson, A. H.F. (Eds.), The geological evolution of the Eastern Mediterranean, Special Publication of the Geological Society, 17, Blackwell Scientific Publications, Oxford (UK), 77-112.
Shemenda, A. I., 1993. Subduction of the lithosphere and back arc dynamics : Insights from physical modeling. Journal of Geophysical Research, 98 (B9), 16167-16185.
Stampfli, G. M., 2000. Tethyan oceans. Geological society, London, special publications, 173 (1), 1-23.
Stampfli, G. M., Borel, G. D., Marchant, R., Mosar, J., 2002. Western Alps geological constraints on western Tethyan reconstructions. Journal of Virtual Explorer, 7, 75-104.
Stampfli, G. M., Hochard, C., Vérard, C., Wilhem, C., von Raumer, J., 2013. The formation of Pangea. Tectonophysics, 593, 1-19.
Stampfli, G. M., Marcoux, J., Baud, A., 1991. Tethyan margins in space and time. Palæogeography, Palæoclimatology, Palæoecology (Palæo3), 87 (1-4), 373-409.
Stampfli, G., Borel, G. 2002. A plate tectonic model for the Paleozoic and Mesozoic constrained by dynamic plate boundaries and restored synthetic oceanic isochrons. Earth and Planetary Science Letters 196, 17-33.

Vérard, C., 2019.a. Plate tectonic modelling: Review and perspectives. Geological Magazine, 156 (2), 208-241; doi:10.1017/S0016756817001030.

Vérard, C., 2019.b. PANALESIS: Towards global synthetic palæogeographies using integration and coupling of manifold models. Geological Magazine, 156 (2), 320-330; doi:10.1017/S0016756817001030.

Vérard, C., *in preparation*. Subduction initiation: Nothing spontaneous. Tectonophysics, 33 pages.

Vérard, C., Stampfli, G. M., *in preparation*. From the UNIL to the PANALESIS model: Development of concepts, tools and scenarios for a comprehensive global modelling of the Neoproterozoic and Phanerozoic Earth. Earth- Science Reviews, special publications, 34 pages.

Vérard, C., Stampfli, G., Borel, G., Hochard, C., 2017. The Indian Promontory: A bridge between plate tectonics and life evolution models. Universal Journal of Geoscience, 5 (2), 25-32; DOI: 10.13189/ujg.2017.050202.

Weiler, P. D., 2000. Differential rotations in the Oman Ophiolites: Paleomagnetic evidence from the southern massifs. Marine Geophysical Researches, 21, 195-210; https://doi.org/10.1023/A:1026760331977.