



**HAL**  
open science

# Geomorphology and coral reefs habitats in southwestern Indian Ocean

Lionel Bigot

► **To cite this version:**

Lionel Bigot. Geomorphology and coral reefs habitats in southwestern Indian Ocean. École thématique. Regional thematic school on the Vulnerability of Reefs heritage DIDEM program, University of Seychelles, Seychelles. 2024. hal-04740709

**HAL Id: hal-04740709**

**<https://hal.science/hal-04740709v1>**

Submitted on 17 Oct 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Regional thematic school on the Vulnerability of Reefs heritage *DIDEM program*

*Geomorphology and coral reefs habitats in southwestern Indian  
Ocean*



June 10, 2024 – Blue Economy Research  
University of Seychelles

- 1. Introduction to coral reefs**
- 2. Geomorphology & habitats**
- 3. Case studies in Southwestern Indian Ocean (SWIO)**



# I. Introduction to coral reefs

## Coral reefs

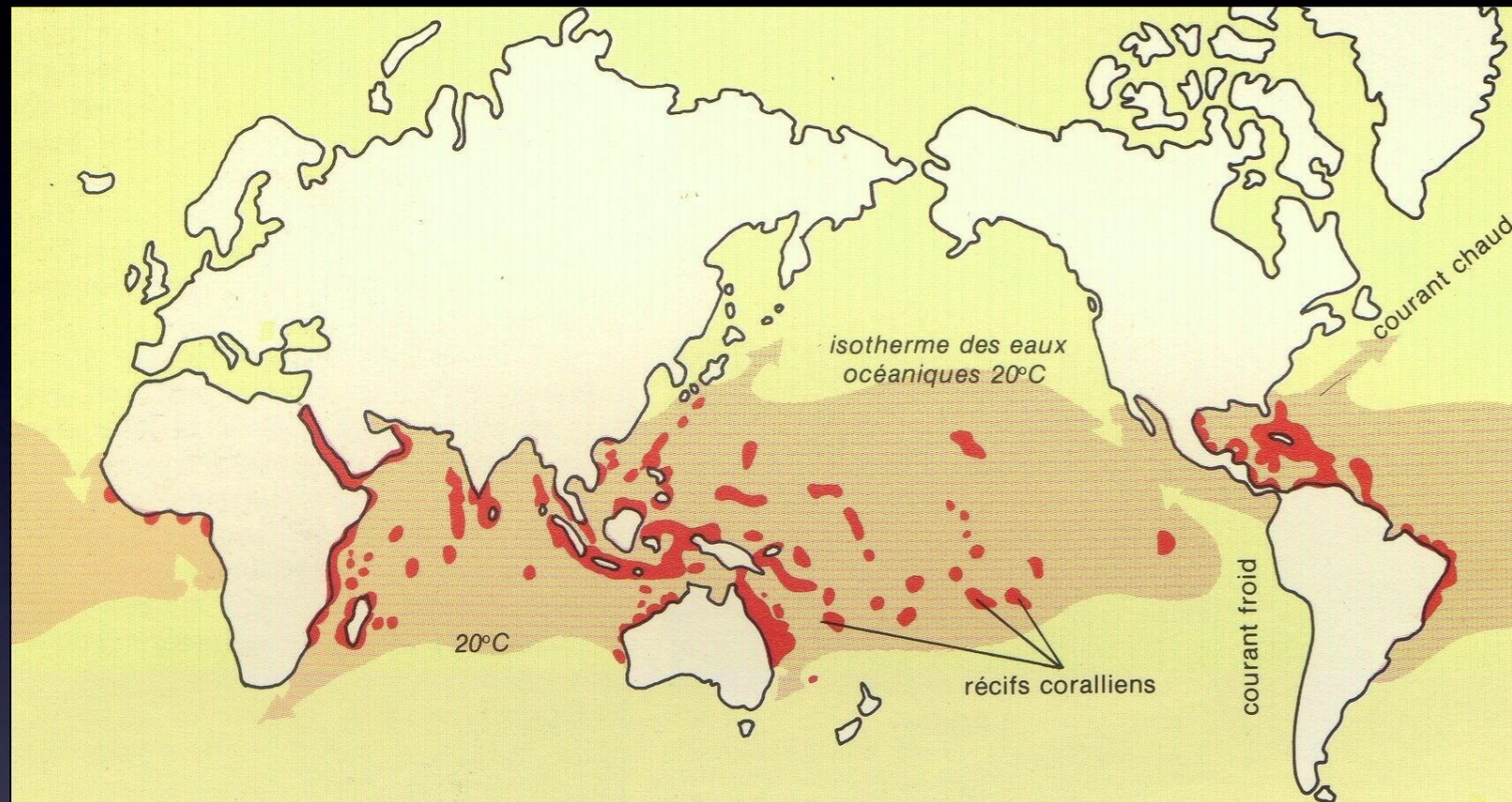
Bio-constructed ecosystems





# Coral reefs

More than 100 countries



- 15 % of world's coastlines
- 2000 reef fishes (27 % endemics), 800 corals species (7 % endemics)
- 60 % threatened by human activities
- > to 30 % of reef loss by 2050 due to climate change
- About 1/6 person in the world lives near a coral reefs !!

- Small SWIO islands (with low human impact) are ideal to studying the impact of climate change (as Seychelles coral islands, Eparses islands, ...)

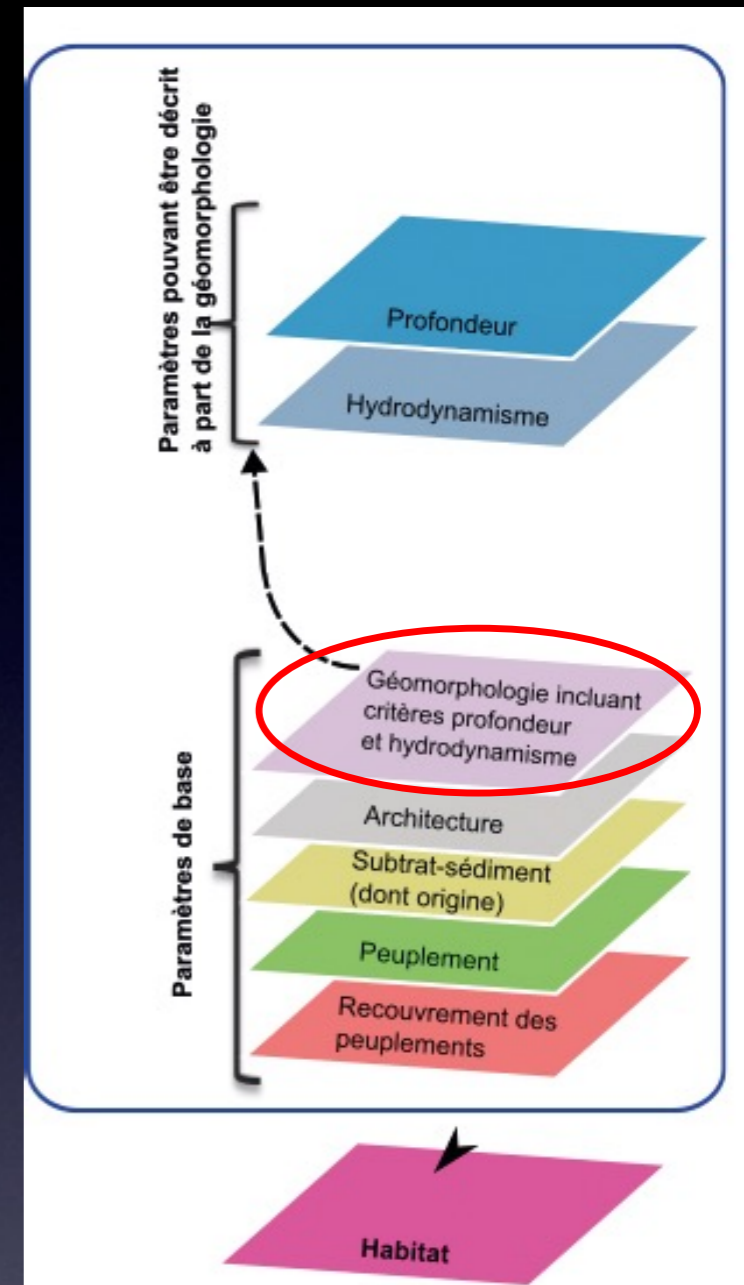
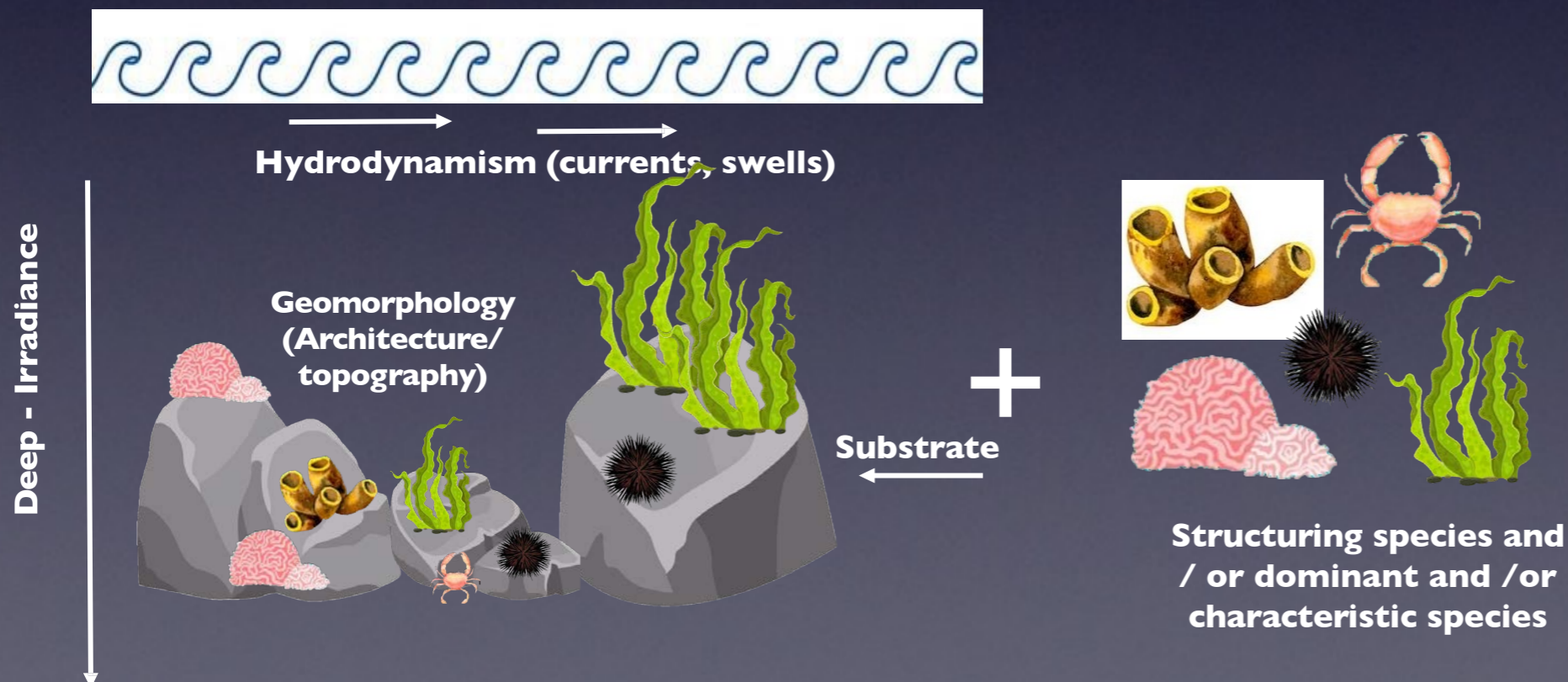
4

➔ Small coral reefs islands are “Observatories” of climate change



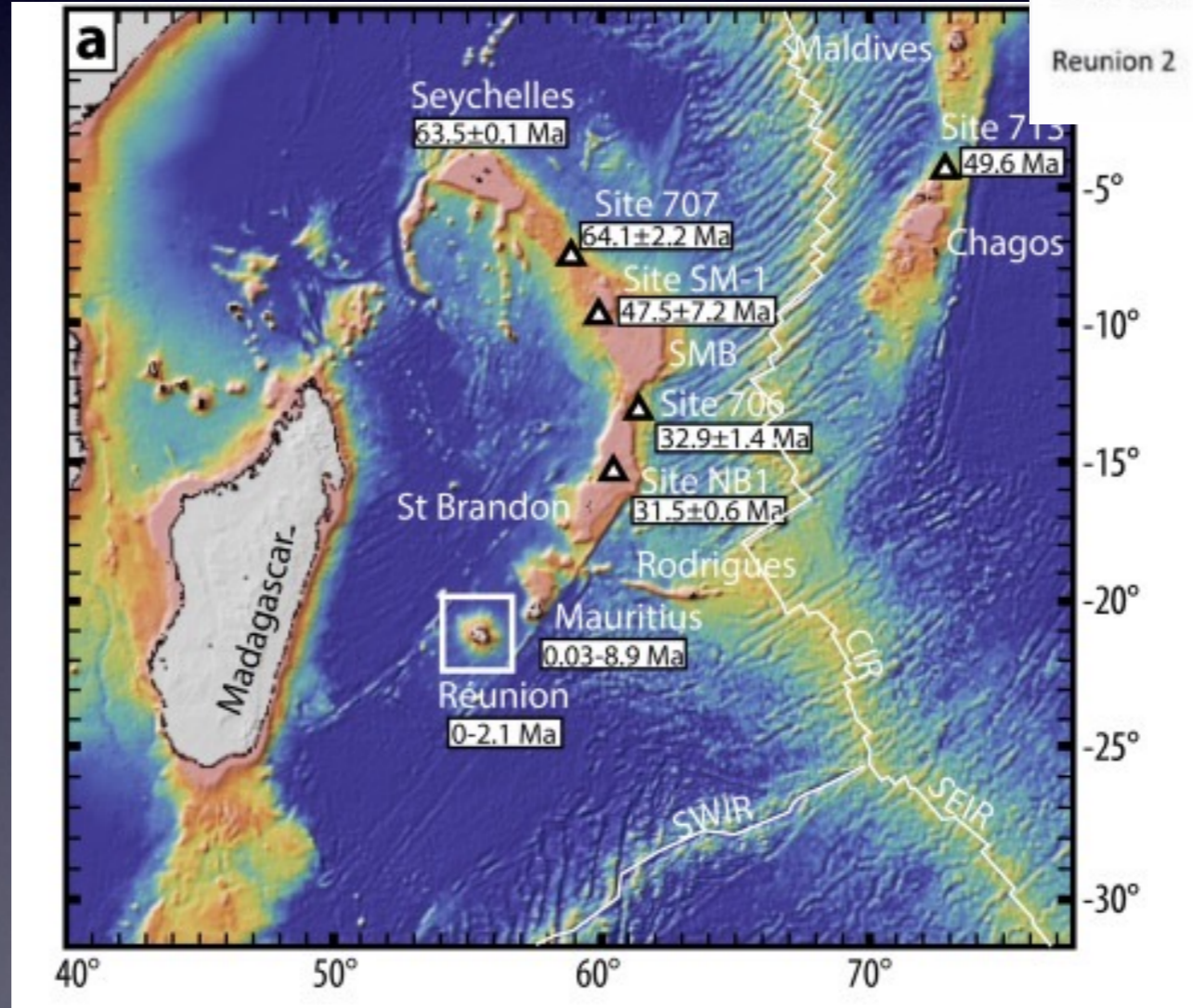
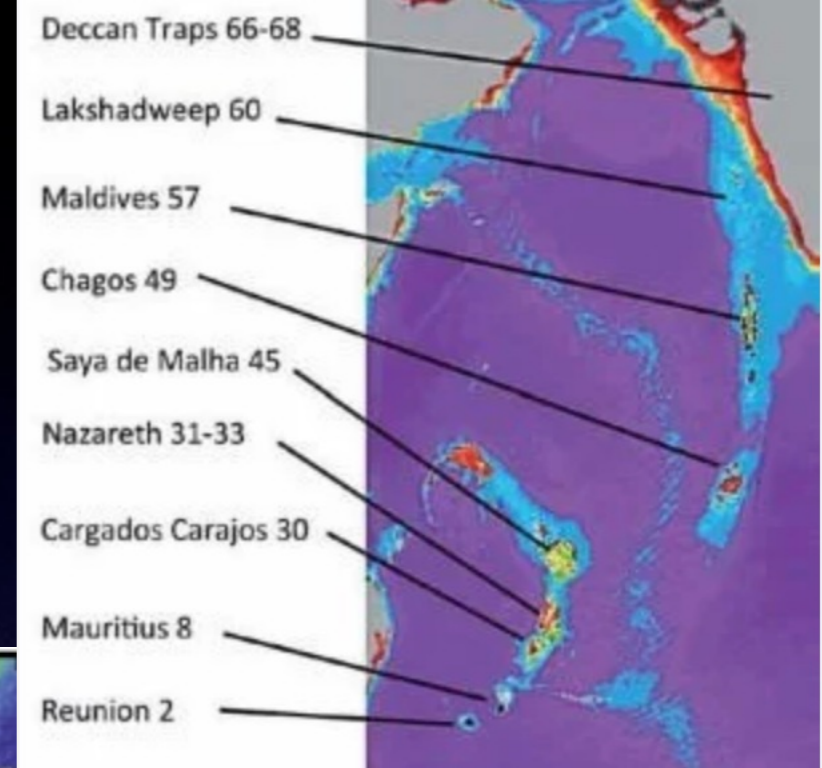
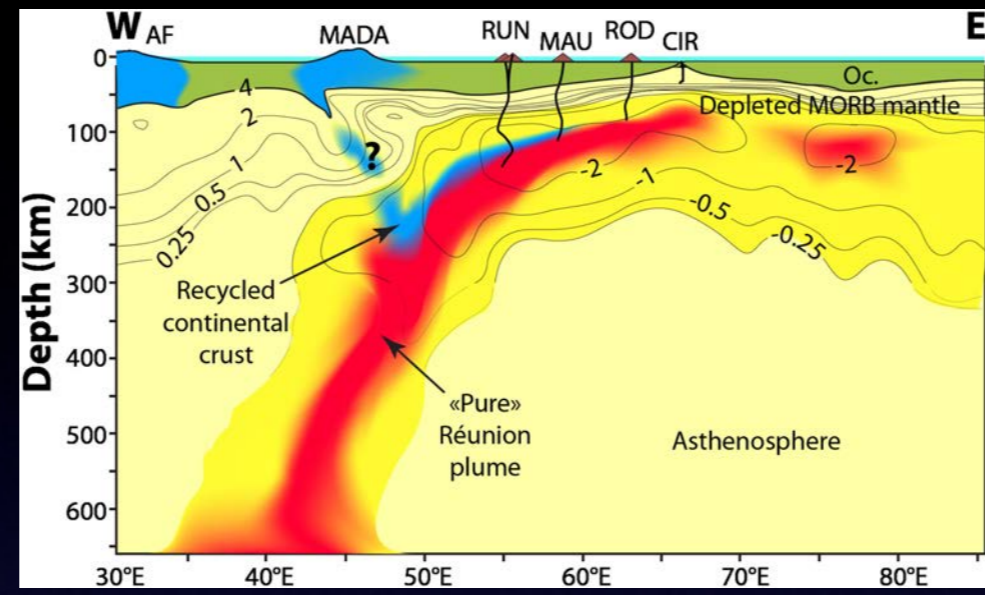
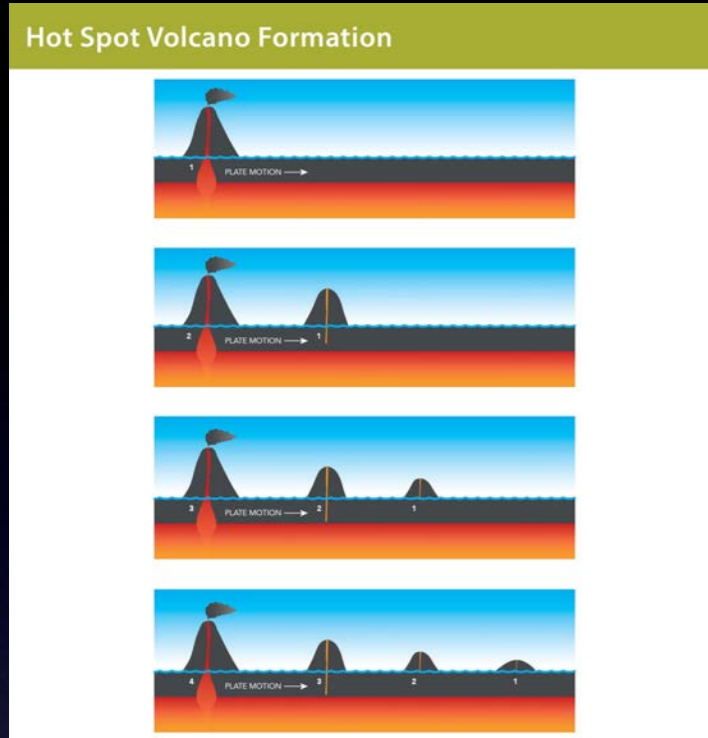
**HABITAT** => It's a superposition of different parameters :

- Physical and environmental parameters (geomorphology, deep, architecture and substrate),
- Biological communities (dominant sessile benthic macro-populations, % substrate cover, species richness, vitality, ..)





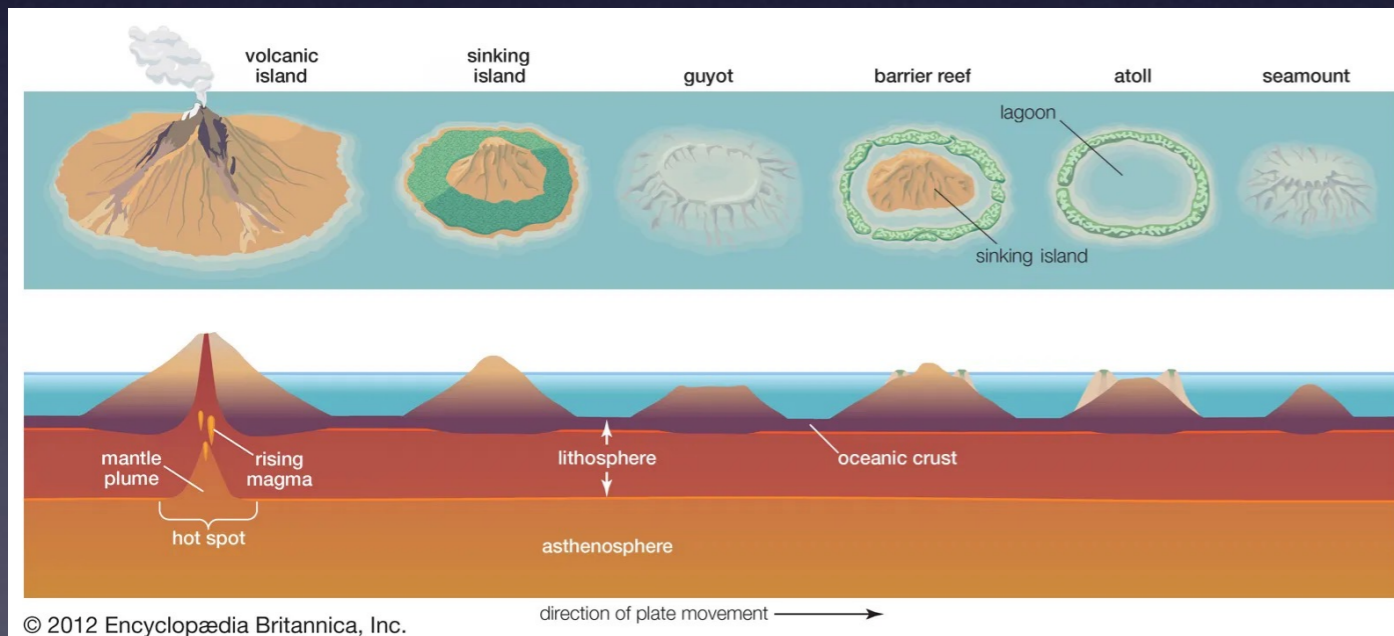
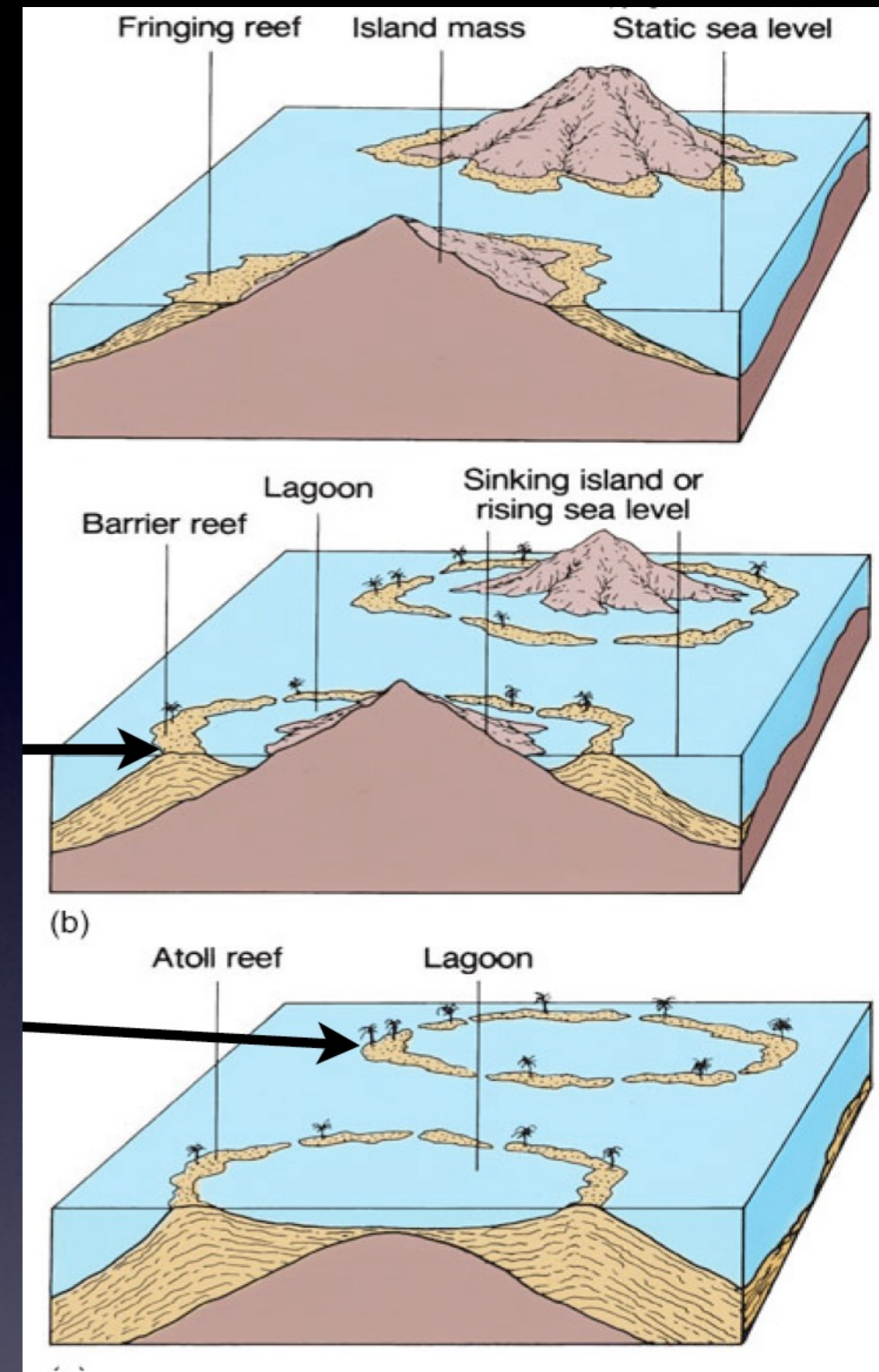
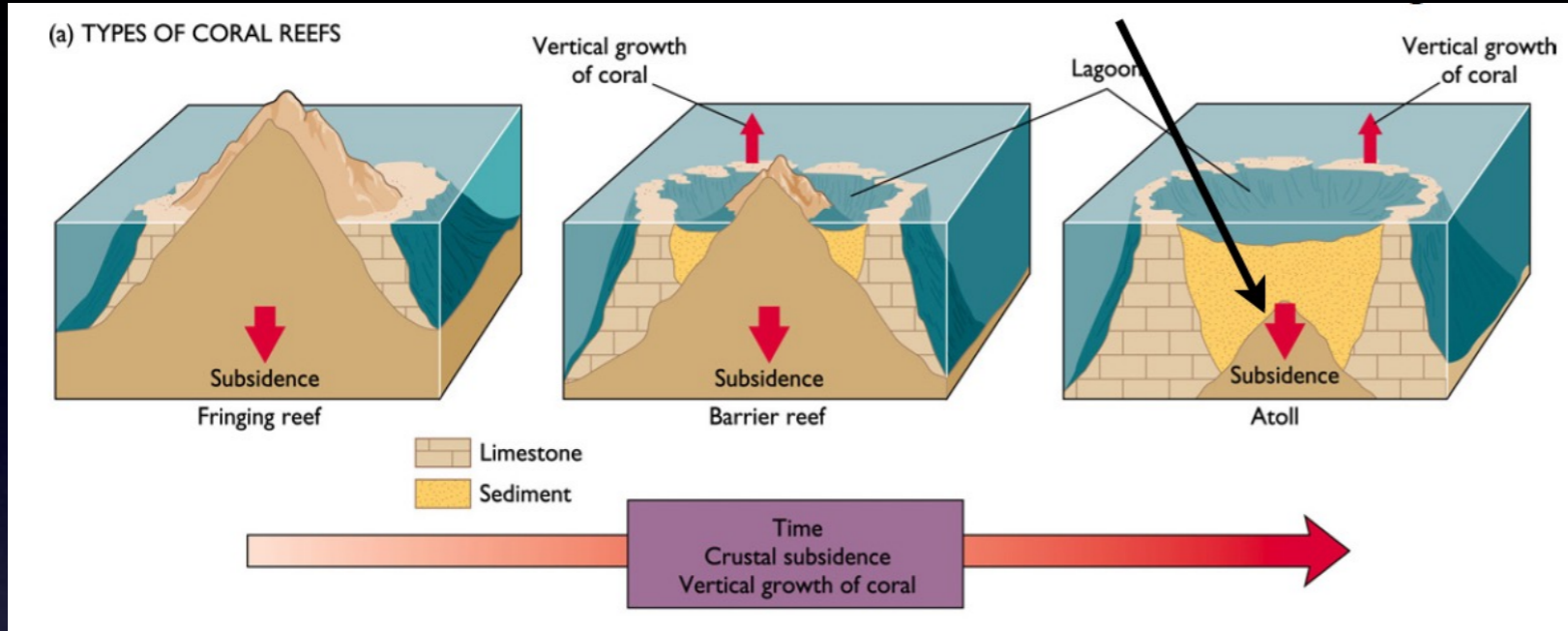
# Hot spots theory & islands « building »



- Mixed lava flow
- Gradual move of the hotspots => Shoals of Capricorne
- Various geological ages



# Coral reefs formation & typology (Darwin theory)



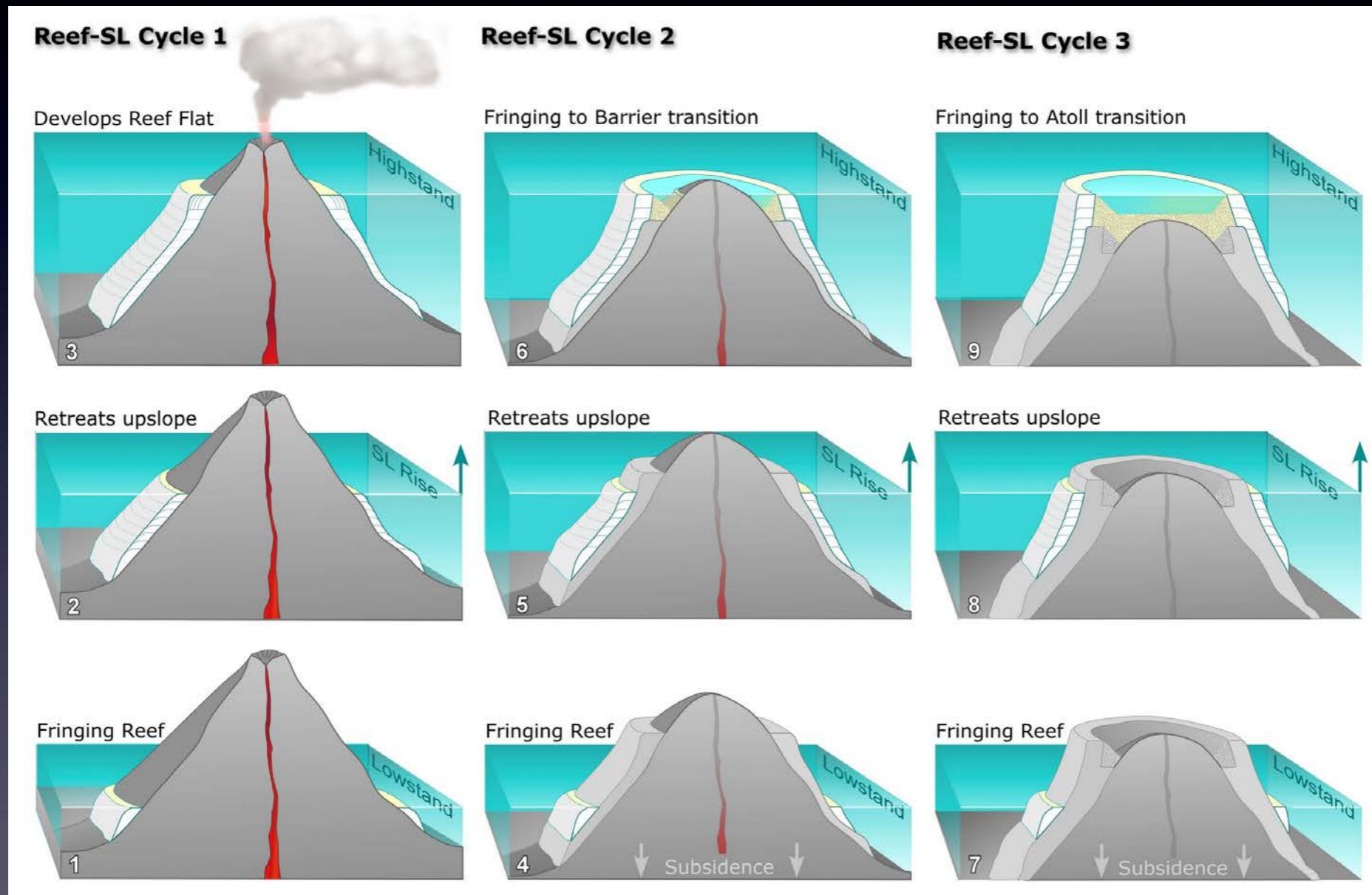
© 2012 Encyclopædia Britannica, Inc.

« First steps » of coral reef building => explained the different situations in Indian Ocean (volcano - fringing reef – guyot - barrier- atool - seamount)



# Coral reef building (more detailed ...)

« Second component » of coral reef building : Variations of sea level => glacial / interglacial periods => complex case studies across the IO (small / big islands ...)



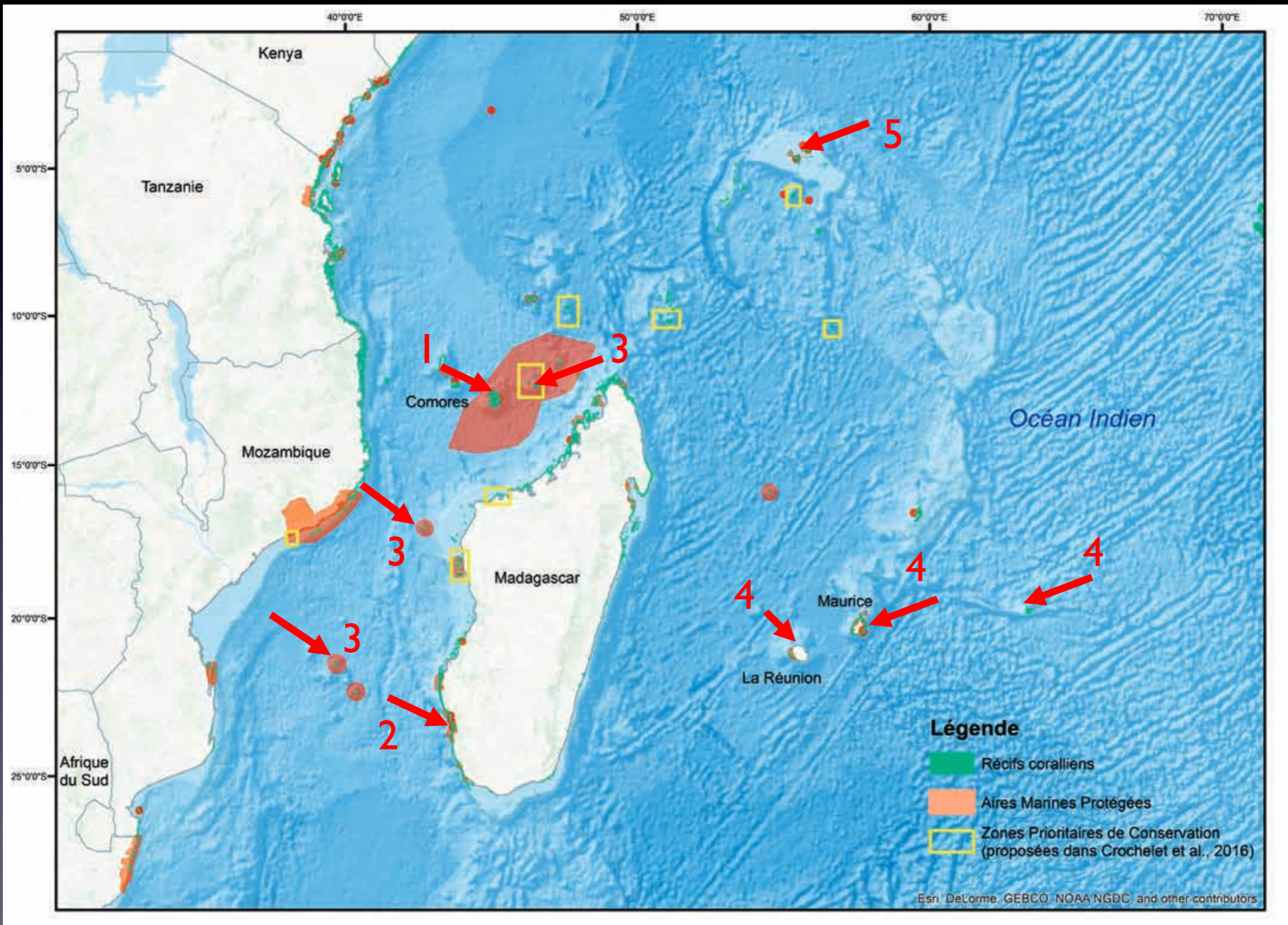
Several cycles during the Interglacial periods => building of coral follow the rise sea level / matching with subsidence of islands => « fringing » to « barrier » to « atoll » typology



### III. Case studies in Southwestern Indian Ocean (SWIO)



# Our (virtual) field trip !



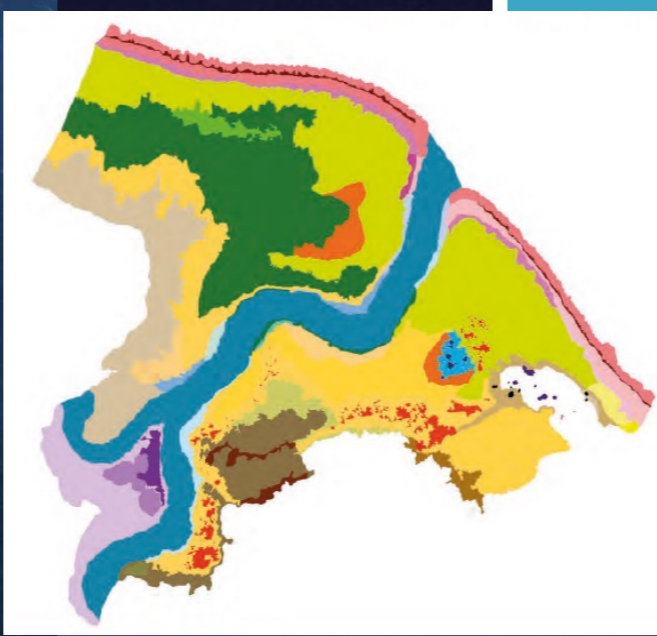
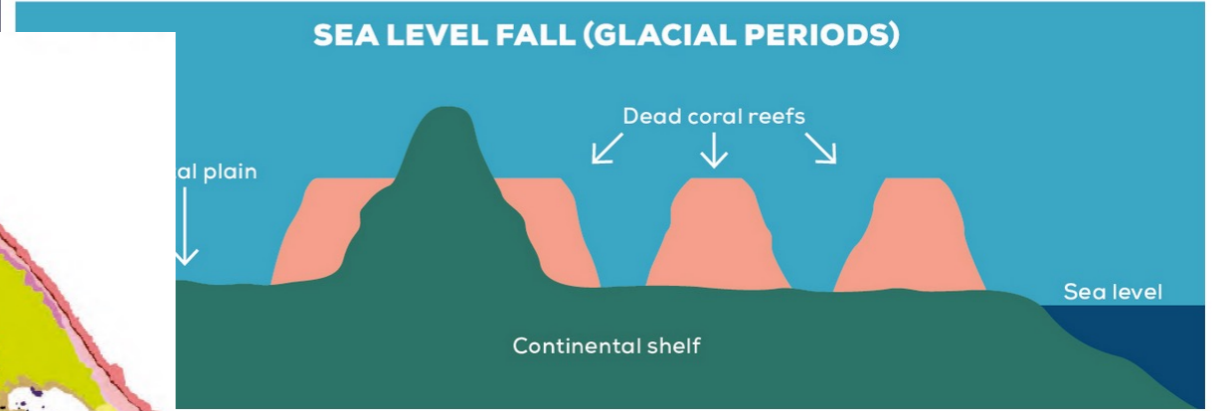
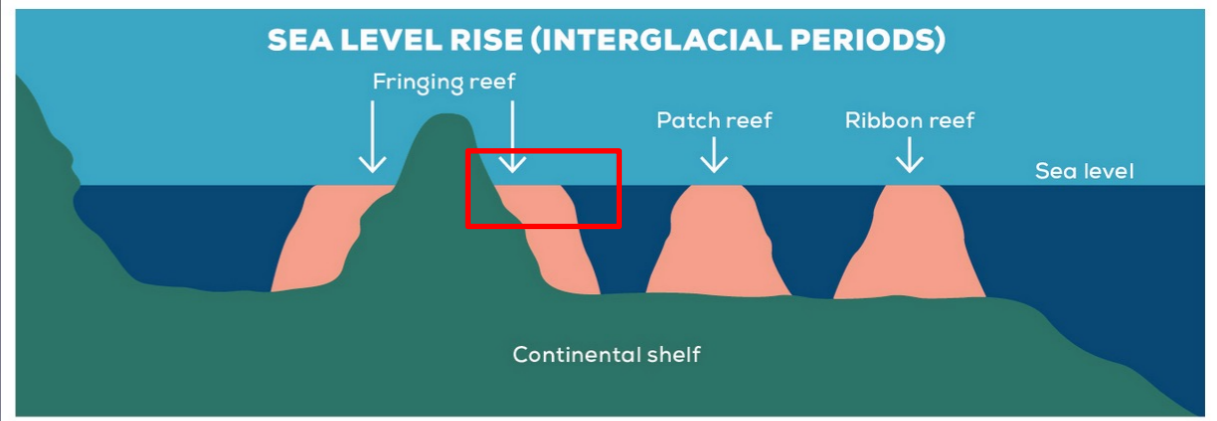
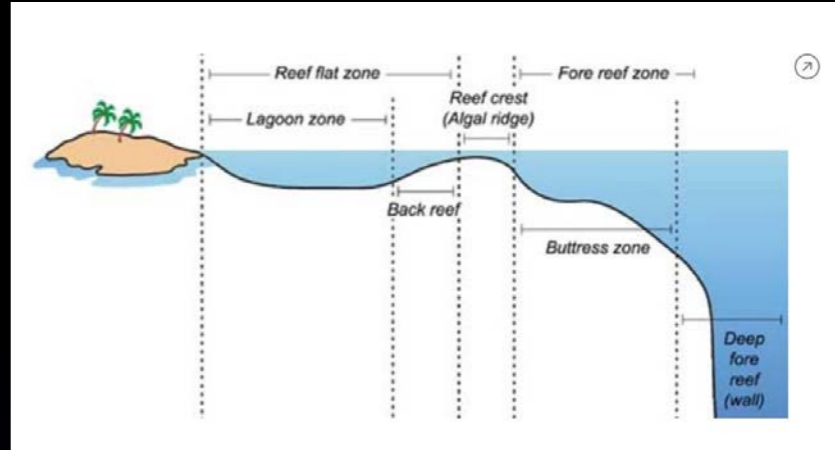


# Mayotte case study (Comoros)

Tectonic intra plate volcanism

Island (« Grande terre ») : 8 Ma (several volcanic events) / recent activity (« Petite Terre » : 750 - 100 000 ans) – island subsidence since 1,5 Ma => coral reefs

Barrier reef (increase since 125 000 ans)



Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image Landsat / Copernicus

Double barrier reef (South W): rare  
Passes (« S »): link to glacial /  
interglacial periods (Holocène - 10  
to 12 000 yrs (karst system on reef  
slope -80 m)

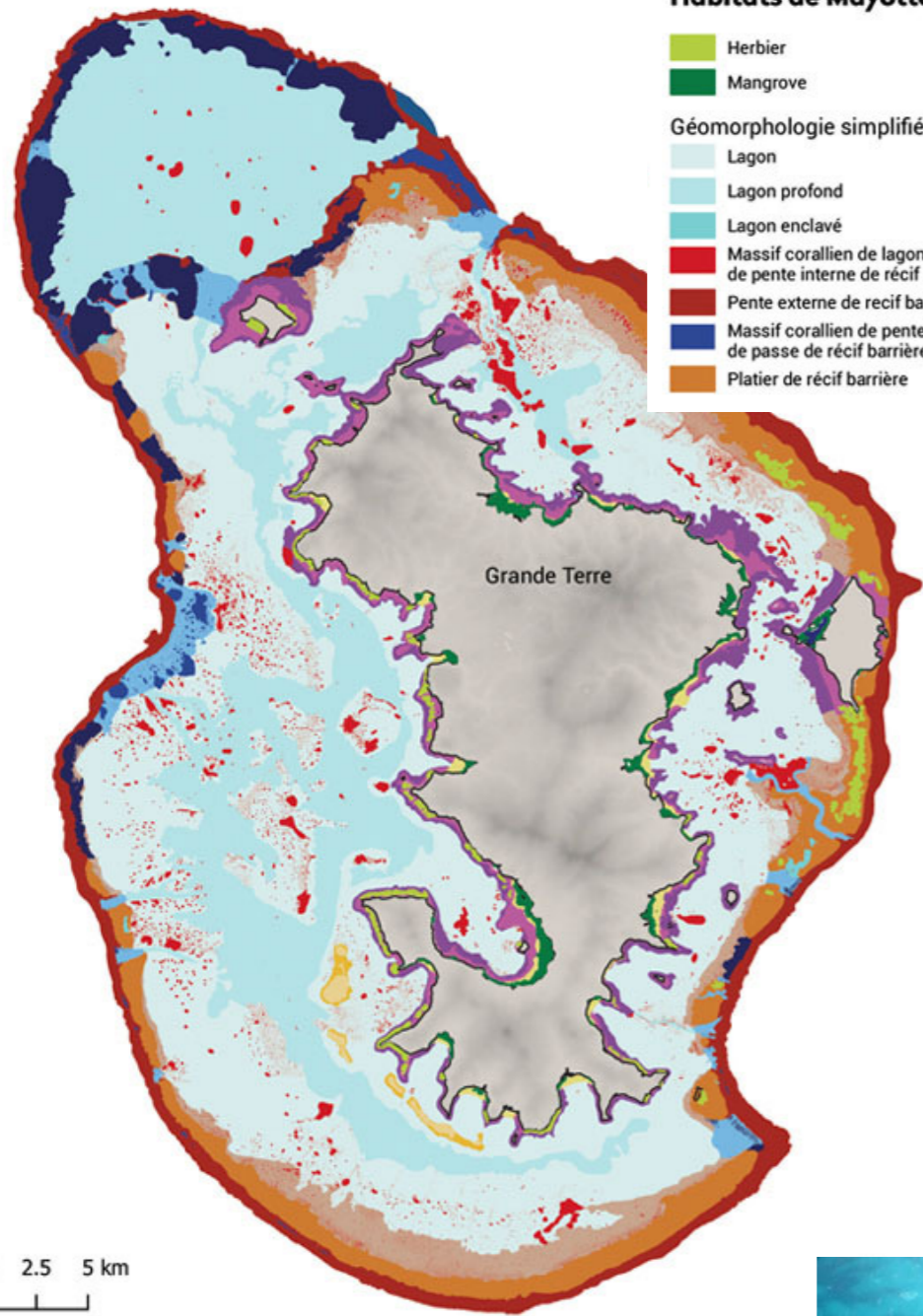




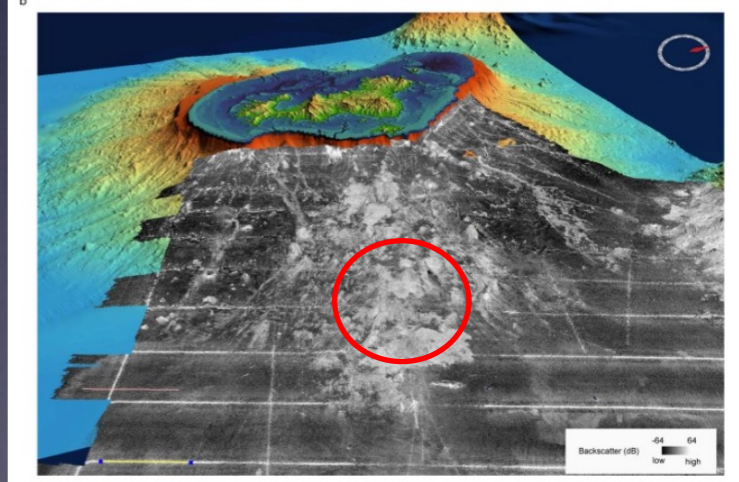
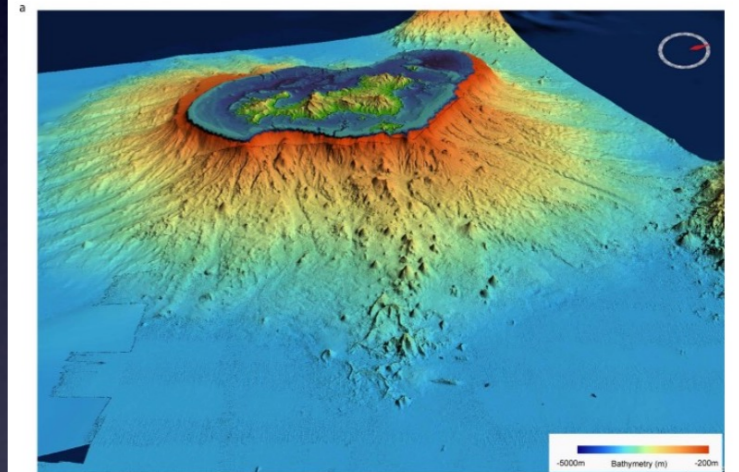
# Volcanic activity ... next with ... « Fani »

## Habitats de Mayotte

- |   |  |
|---|--|
|  Herbier  |  Platier ennoyé de récif barrière  |
|  Mangrove  |  Pente interne de récif barrière  |
| <b>Géomorphologie simplifiée niveau 3-4</b>   |  |
|  Lagon   |  Passe de récif barrière          |
|  Lagon profond   |  Pente de double barrière         |
|  Lagon enclavé   |  Platier de double barrière       |
|  Massif corallien de lagon et de pente interne de récif barrière |  Pente externe de récif frangeant |
|  Pente externe de récif barrière                                 |  Platier de récif frangeant       |
|  Massif corallien de pente externe et de passe de récif barrière |  Fond de baie                     |
|  Platier de récif barrière                                       |  Vasière                          |
|   |  Bathymétrie -500m                |



Extended Data Fig. 1 The Mayotte Ridge.



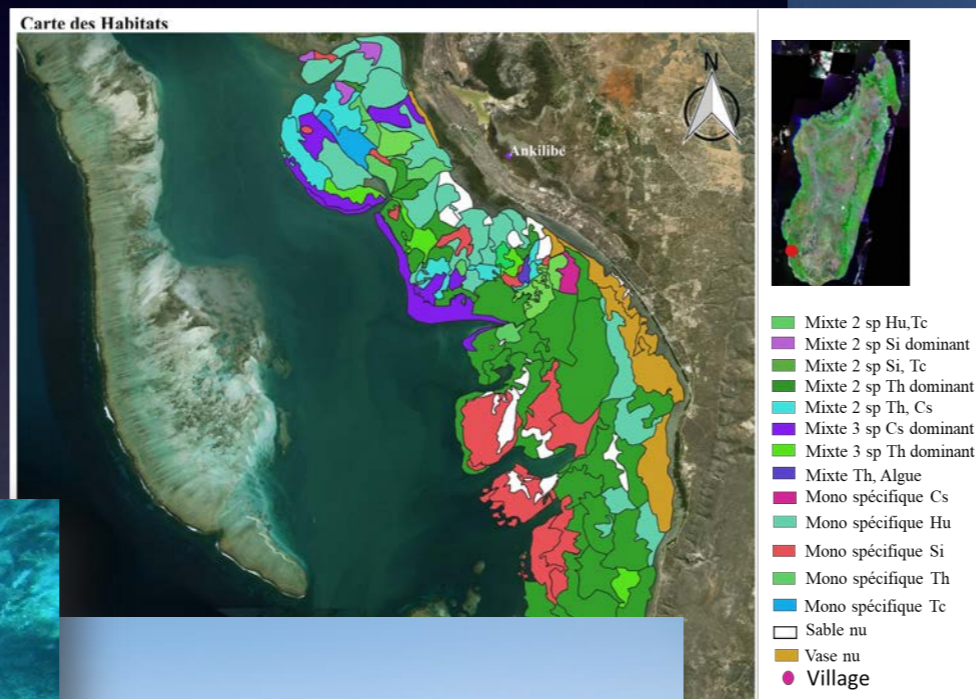
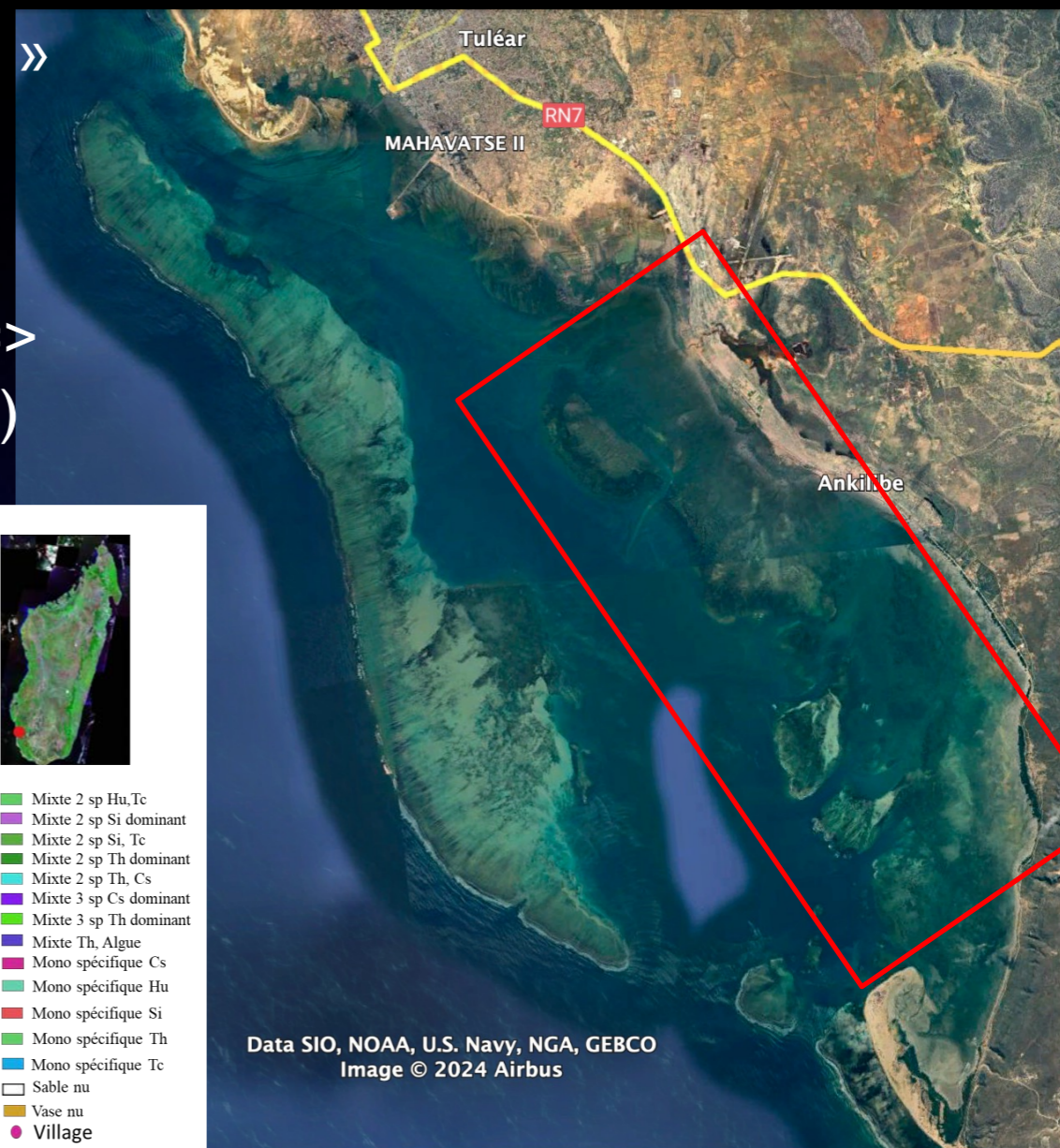


# Case study MadaG – Toliara area

Different from other islands (closer to a « minicontinental » area – 65 Ma)

Barrier reef : (« Grand récif » of Toliara) / Patch reef in south lagoon / Reef banks / Fringing reefs

Very old reef : Pléistocène (2,6 Ma) / interglacial period => actual reef > 8700 ans BP (rising water level - Flandrien)





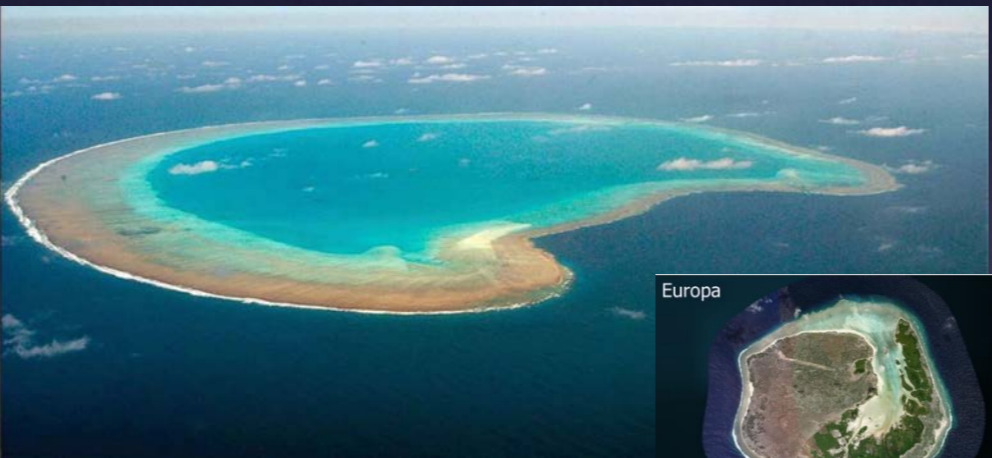
# Case study - Eparses islands

**Tromelin / La Feuillé bank** : very old guyot (43 Ma)

**Juan de Nova**: => up of old seamount « mont des Sakalaves » ) – fossil coral reef – last interglacial period (25 000) / last coral stage → around 4 km thick / North-South tilt of the bank

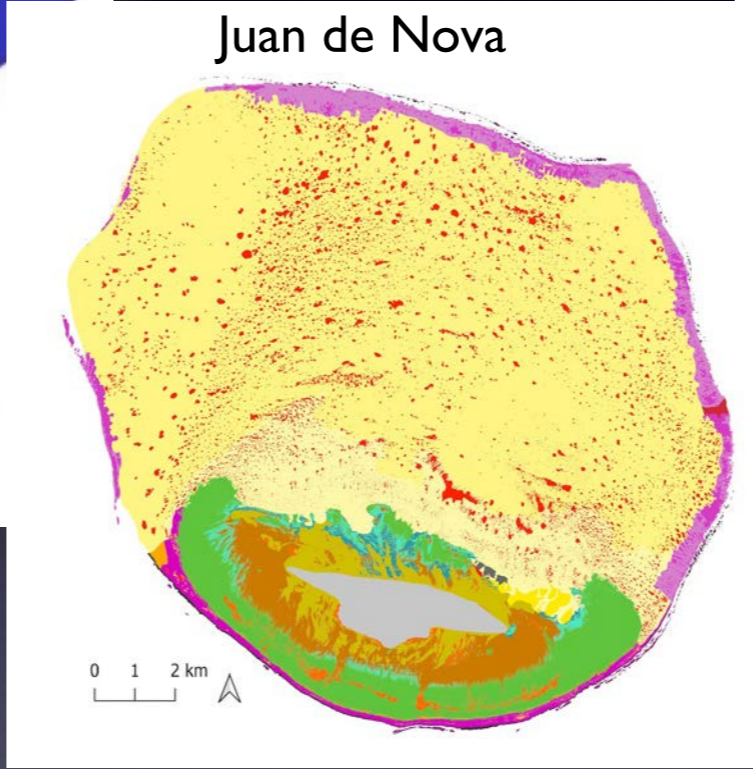
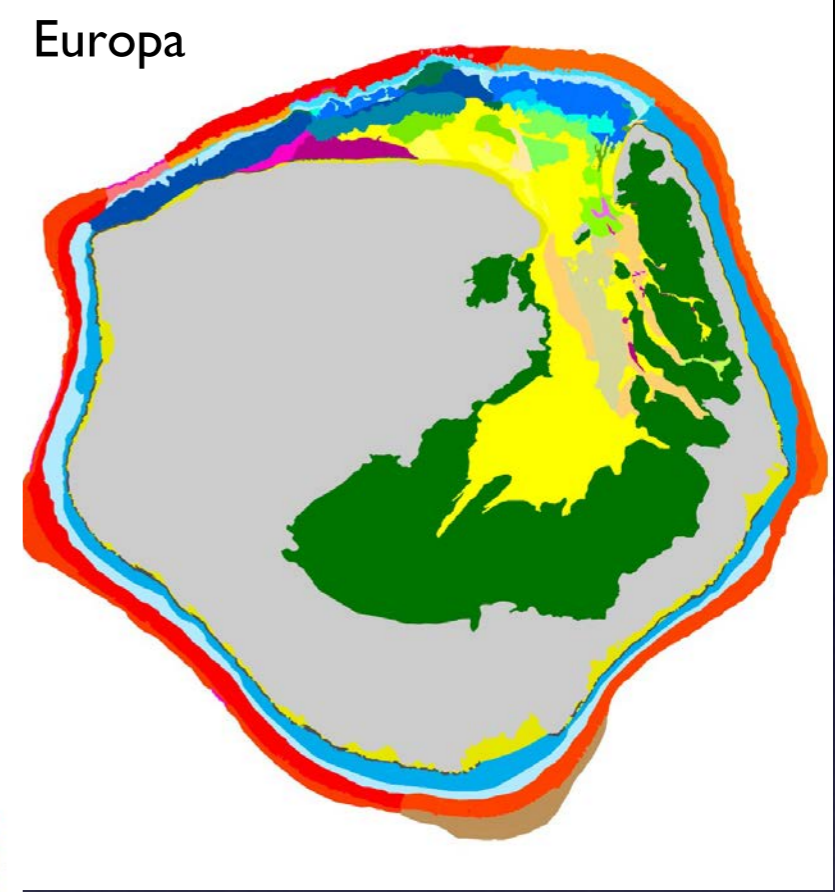
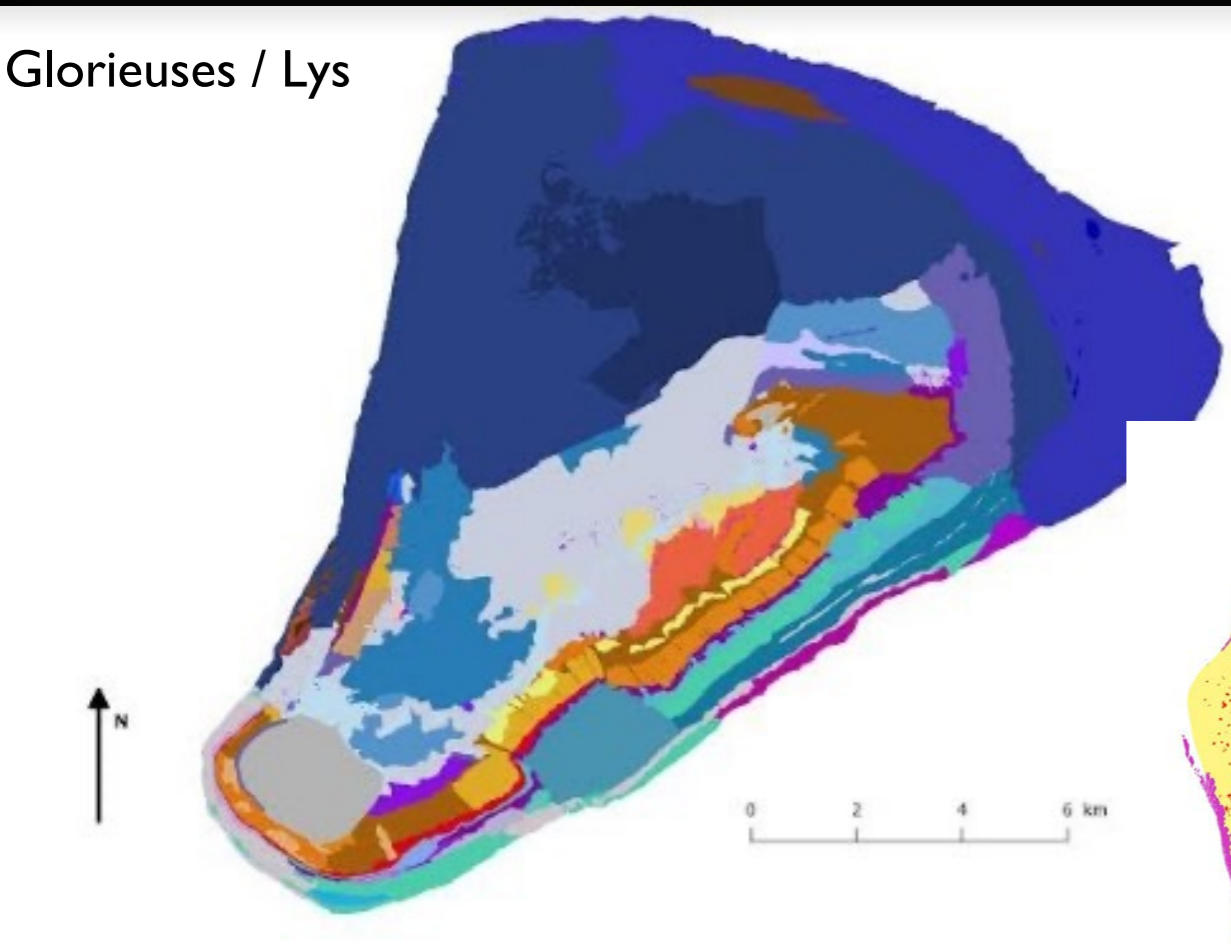
**Bassas**: atoll - 10 km / old seamount < Oligocène / Miocène 20 Ma (idem Europa)

**Glorieuses / Geyser** : up to old seamount < hotspot East-West (Glo) & / old fossil reef (rise sea level since interglacial period -125 000 yrs)





# Geomorphology & Habitats mapping can be used as biodiversity proxies of coral biodiversity (Glorieuses / Juan de Nova / Europa)

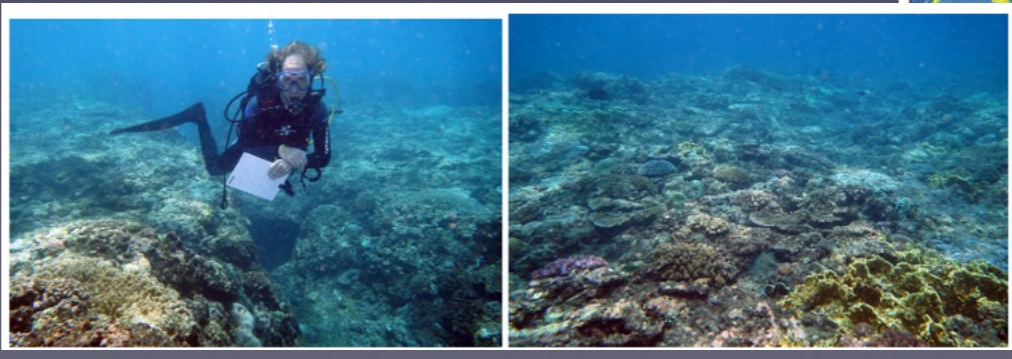
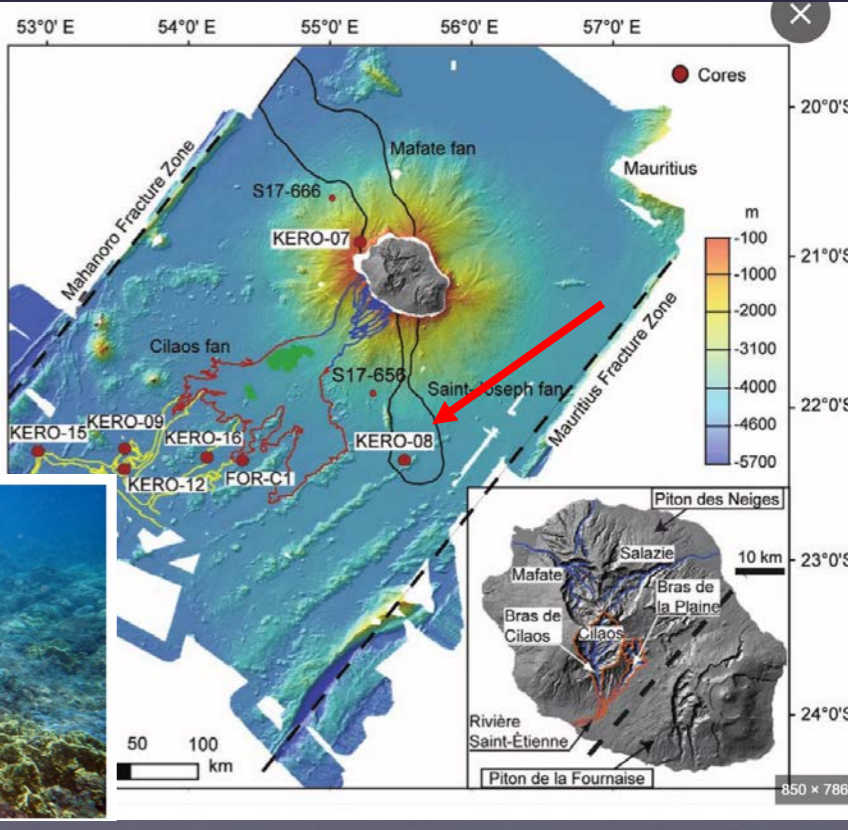
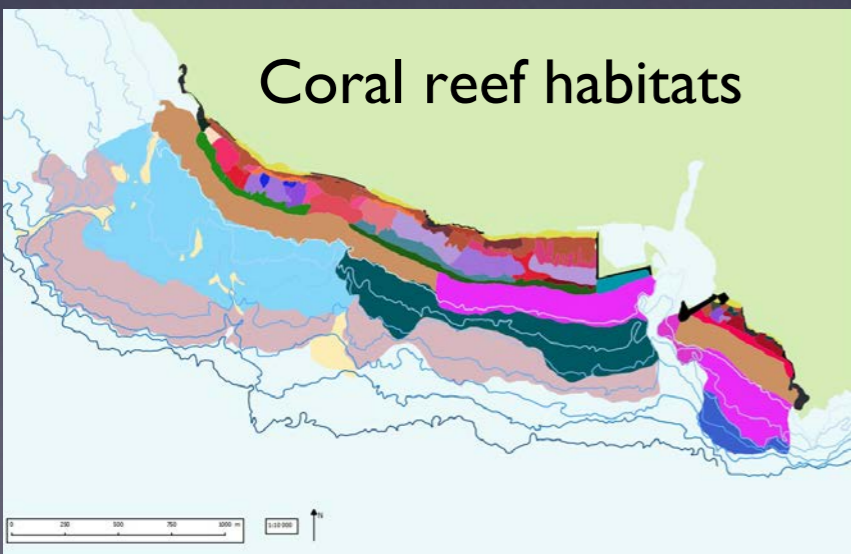
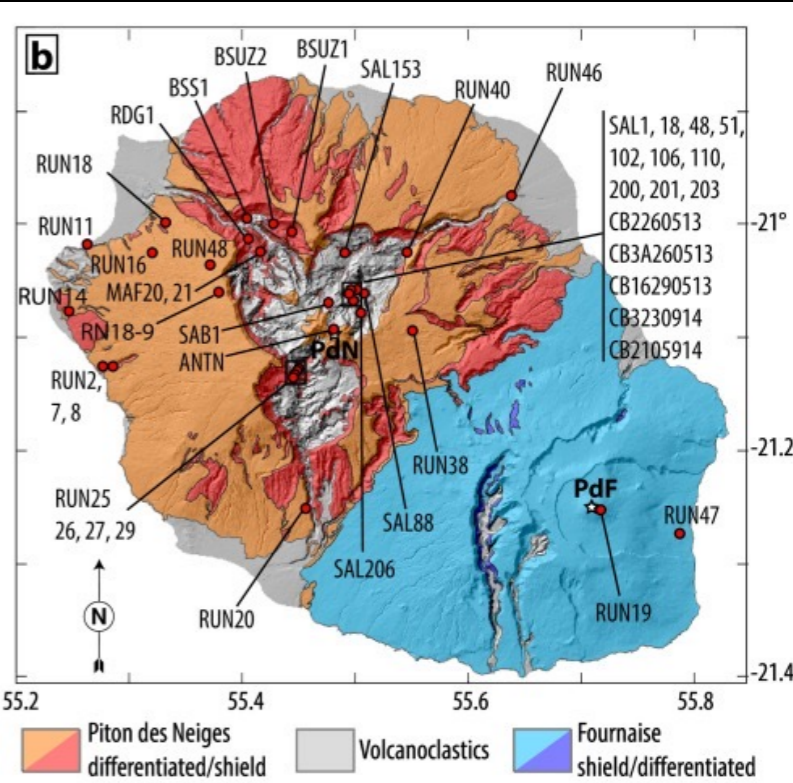
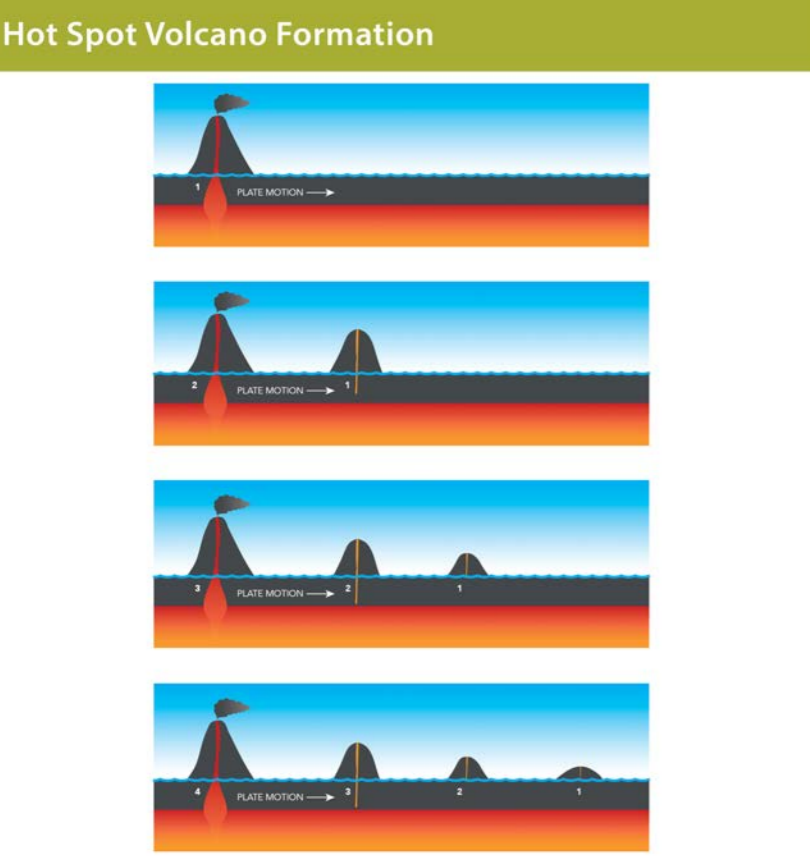




# Case study Mascareignes (Réunion / Mauritius / Rod)

**Mascarene:** Hotspot volcano building (the end of shoals Mascareignes ripple )

**Reunion :** the youngest (2 Ma : La Fournaise 4700 yrs) – coral reefs 9000 years => Fringing reefs / reef banks – a new volcano ...deep !





**Mauritius** : 8.9 Ma – coral reefs (Barrier reefs –Mahebourg / intermediate fringing reefs with cross linked channels / cay patch reefs)

**Rodrigues**: the old guyot (origin 10 Ma) / exposed to erosion ++ and hurricanes / very large fringing coral reefs / beginning of channels / lagoon)





# Case study - Seychelles

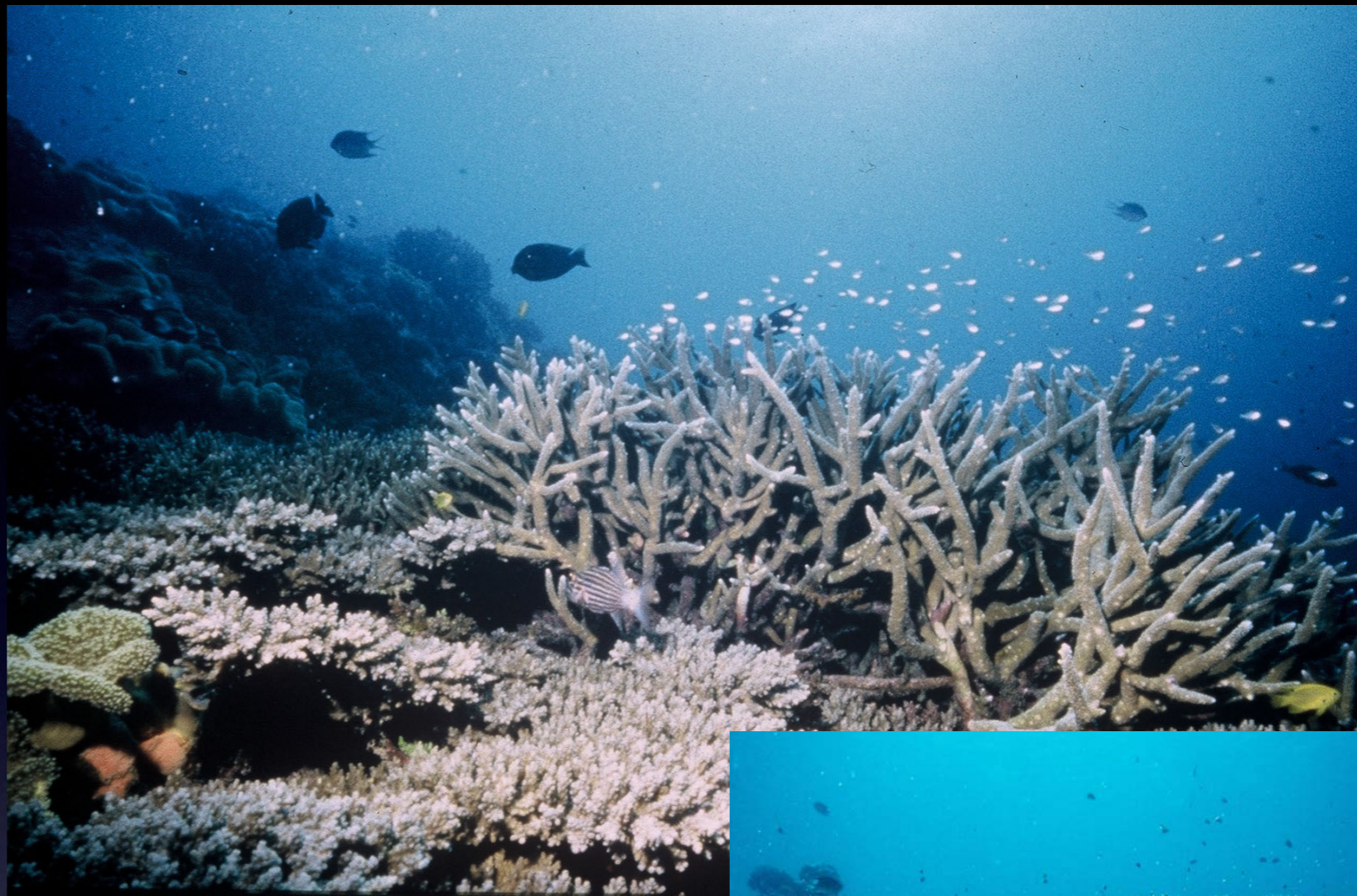
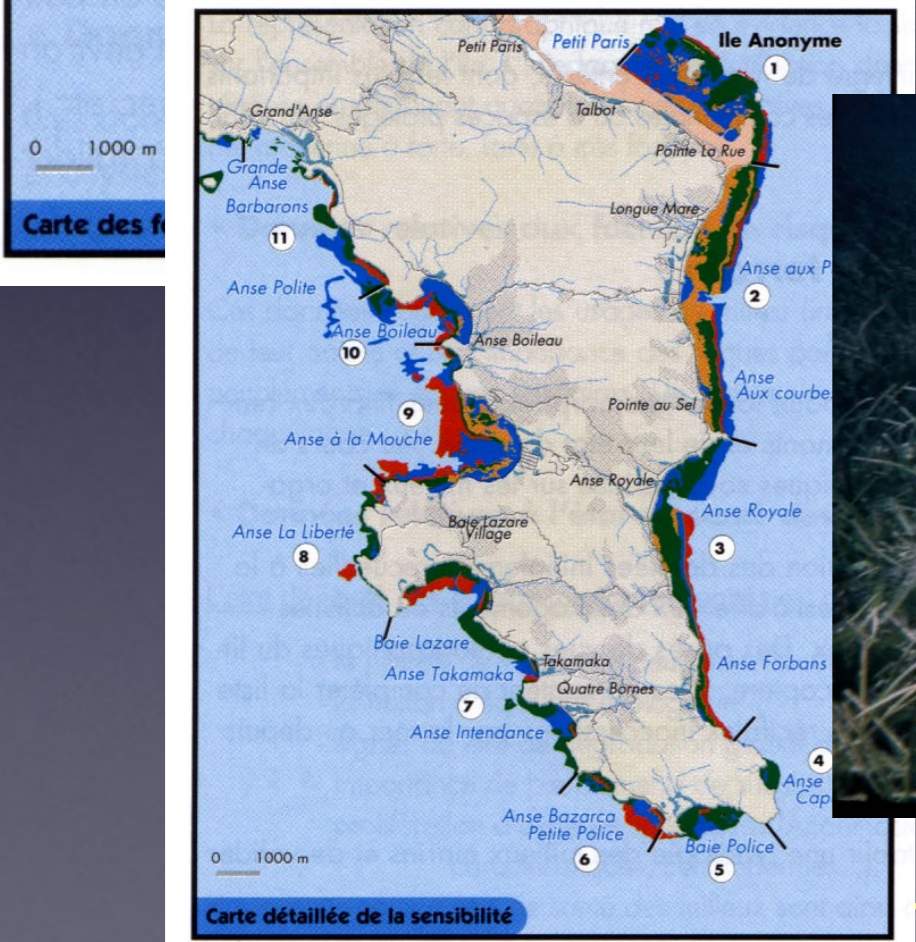
**Granitic islands** : Mahé, Praslin/La Digue, Conception, Cousin, granitic Précambrien (755 Ma), recent coral reef (about 25 m thick, 9000 yrs), global Sey bank -44 to -65 m

**Coral reef islands** : Aldabra (lagoon 5000 yrs), Cosmoledo, Farquaire, Astove, Denis, Bird - old coral reef (125 000 yrs) / Darwin theory / accumul sédiments ++ since Holocène (-8000 yrs)





# April 1997 (IOC / UE mapping)



...Before the bleaching event (1998)





**North airport / Providence:**

sediment embankments +++

=> Airport to Victoria

**Anse aux Pins / Anse Royale :** very

big mixed seagrass beds

(healthy ++)

**No bleaching areas (1997) ....**



**Main biblio. references :**

Stoddart DR, 1984 ; Rosen R.B 1971 ;

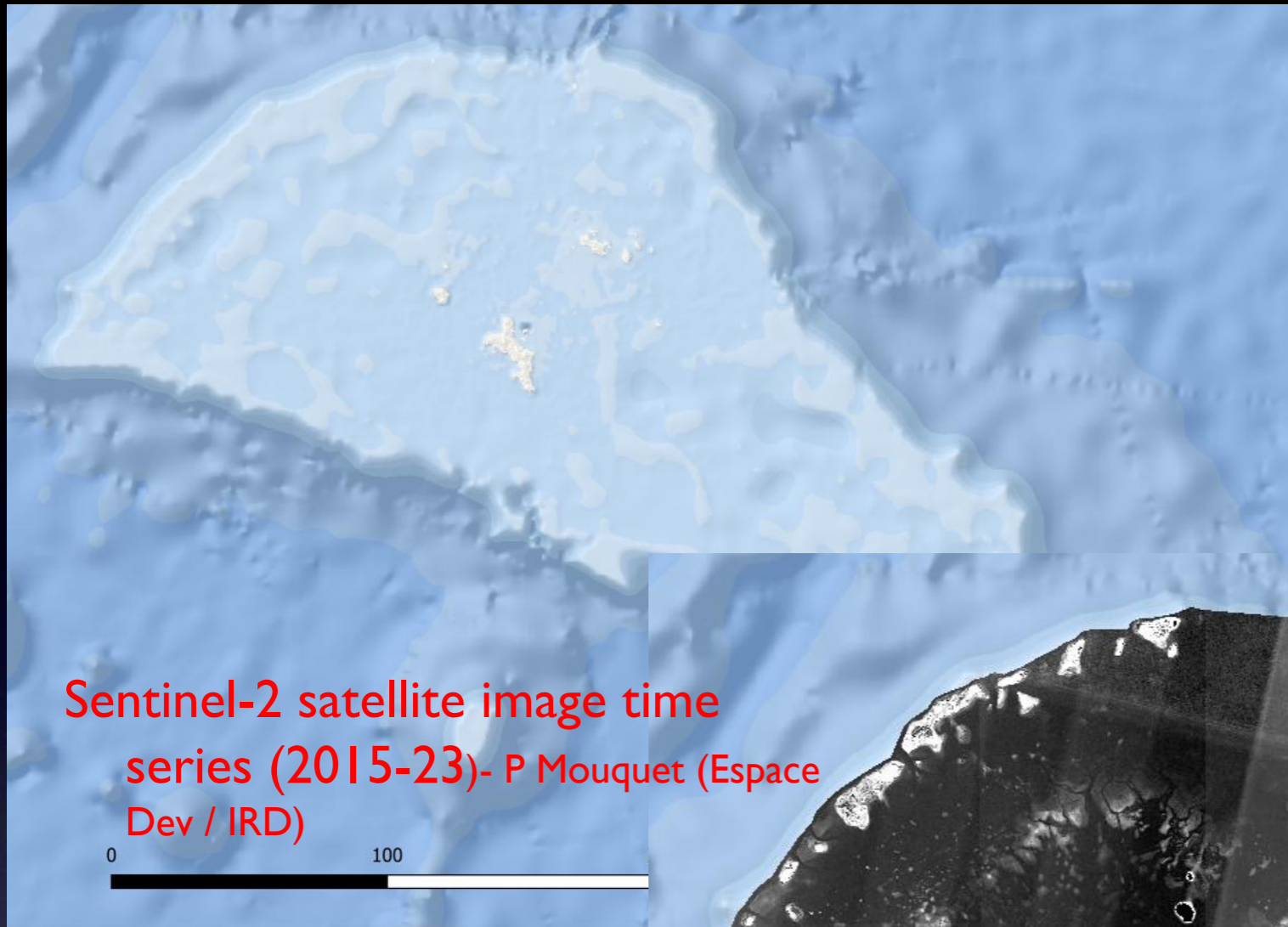
Lewis SM., 1968; Taylor JD. 1968 ;

Braithwaite CJR. Et al.1975; 2000;

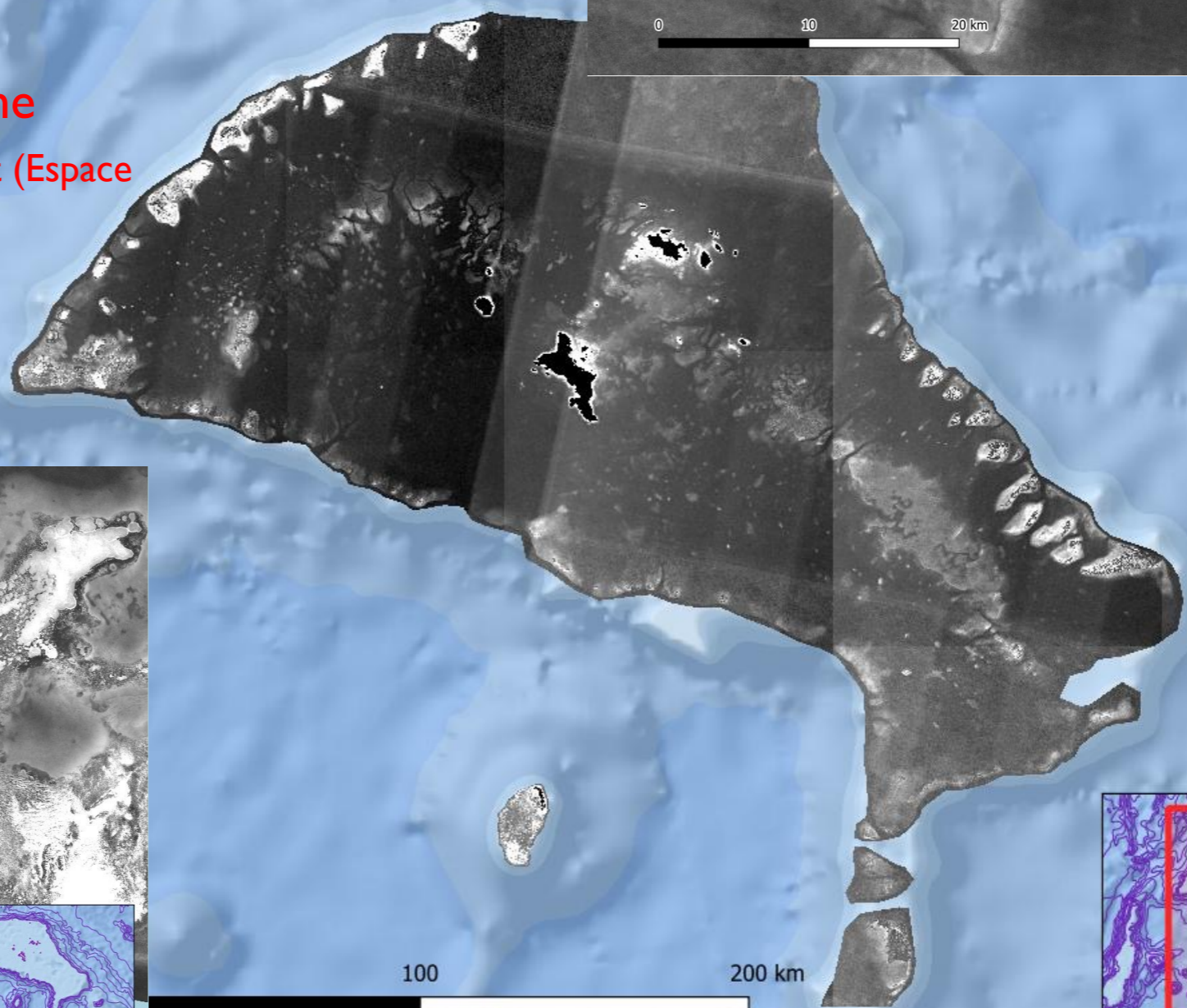
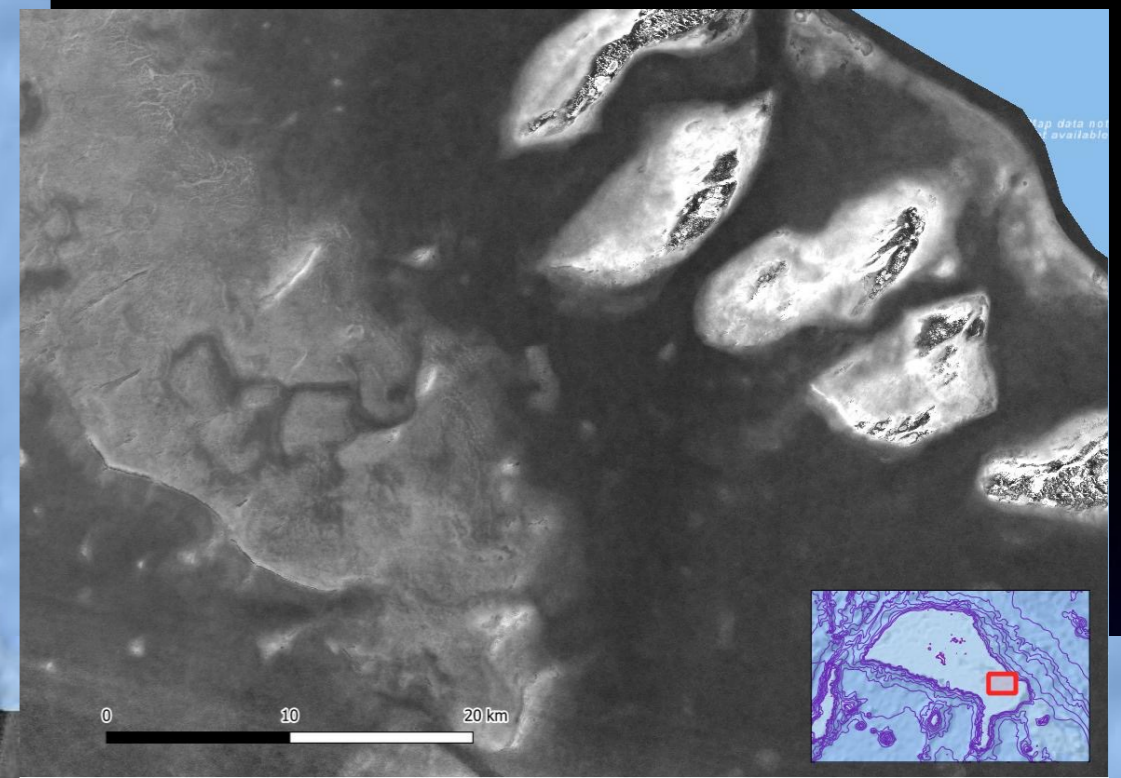
Sheppard CRC. 1998; Turner et

al. 2000; Chong-seng et al. 2014

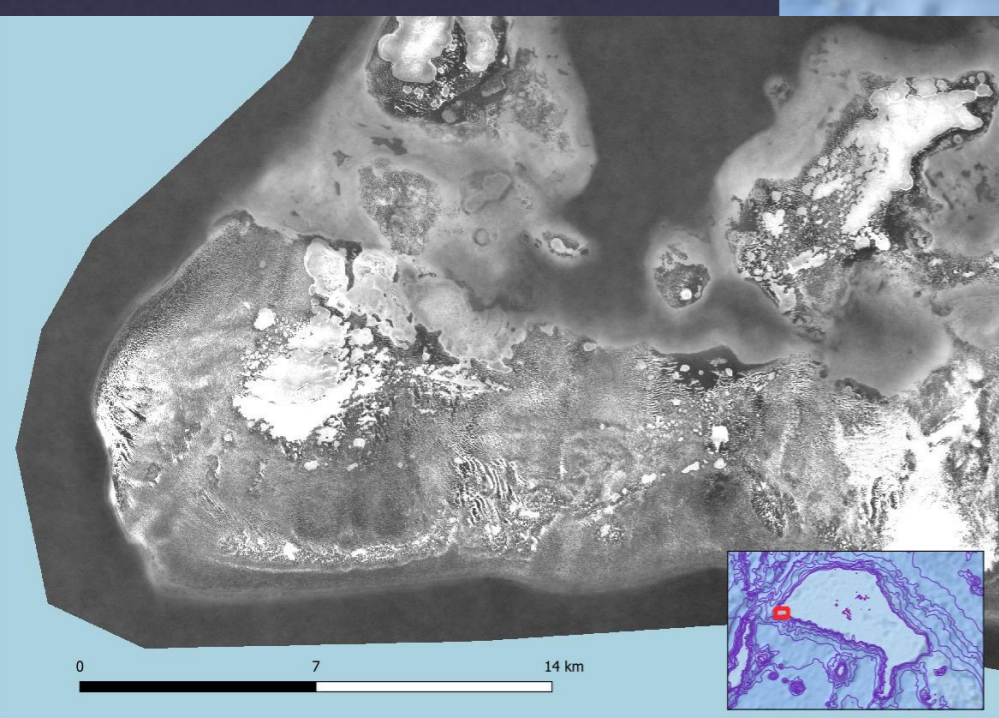




Sentinel-2 satellite image time series (2015-23)- P Mouquet (Espace Dev / IRD)

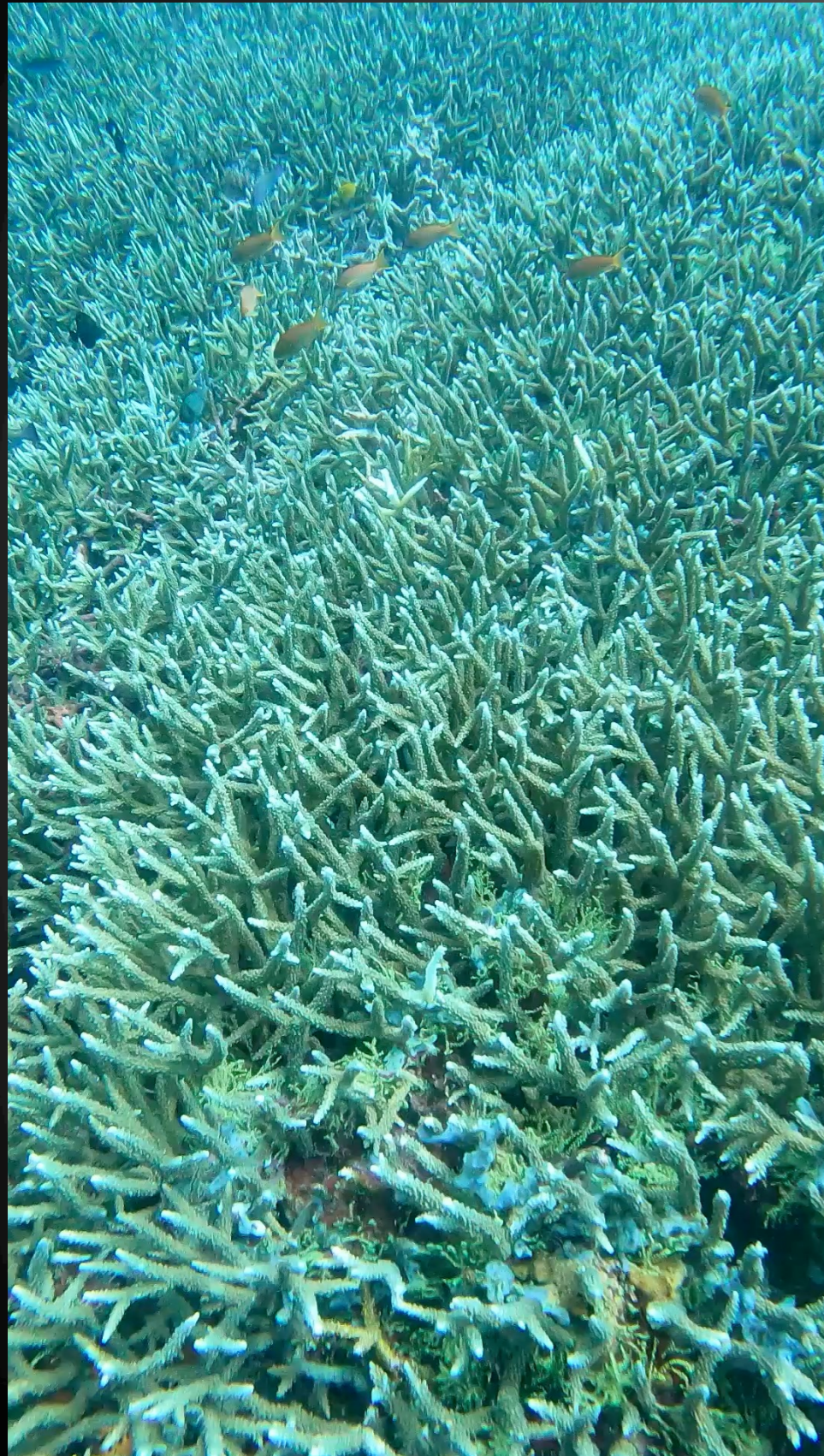


Bird / Denis: -3700 yrs





# Thank you for your attention !



Nusa Penida – Bali / Indonesia (May 2024)



Europa – Eparses islands (Nov 2016)