

# 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

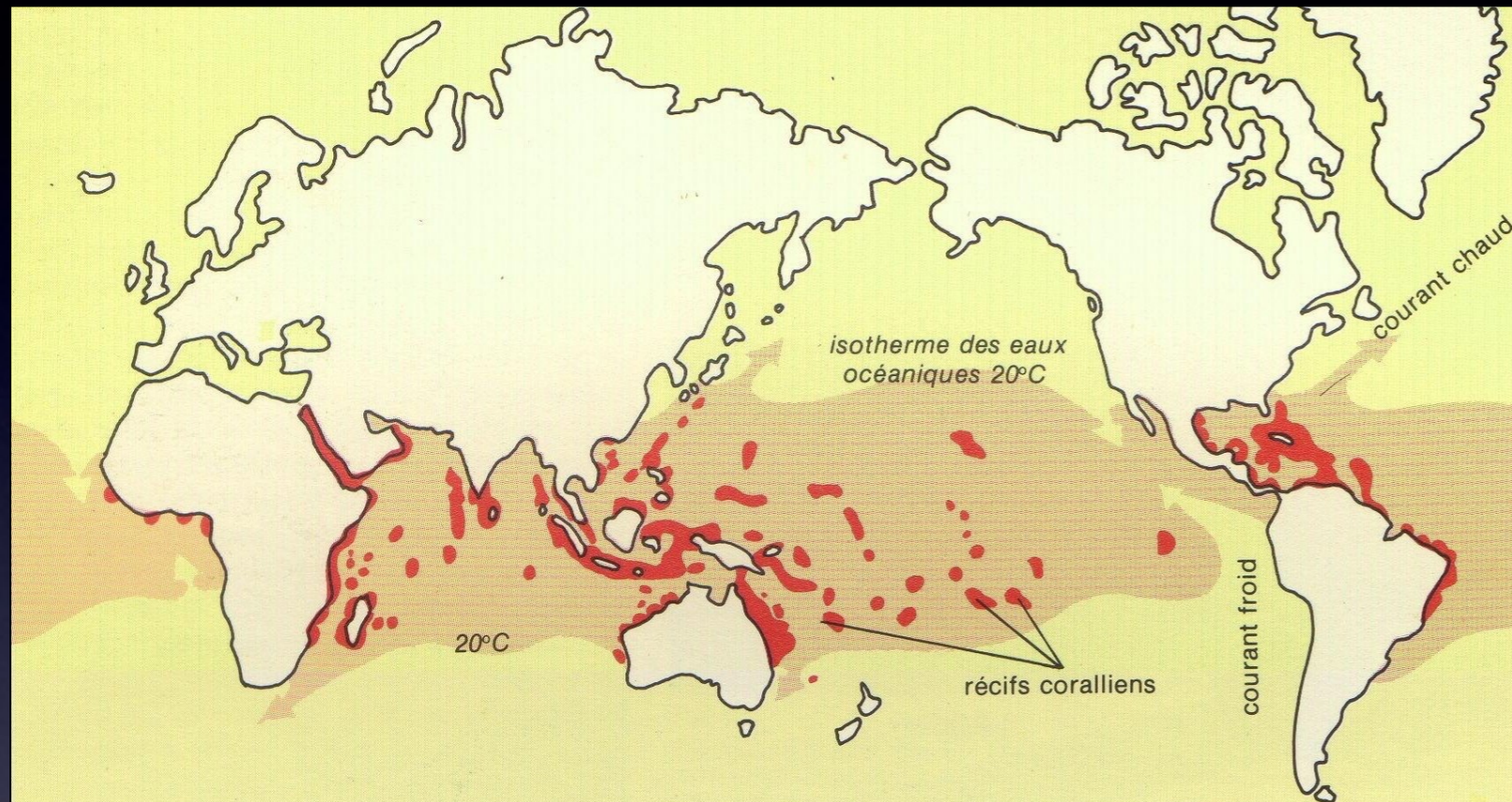
## Coral reefs

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 !!

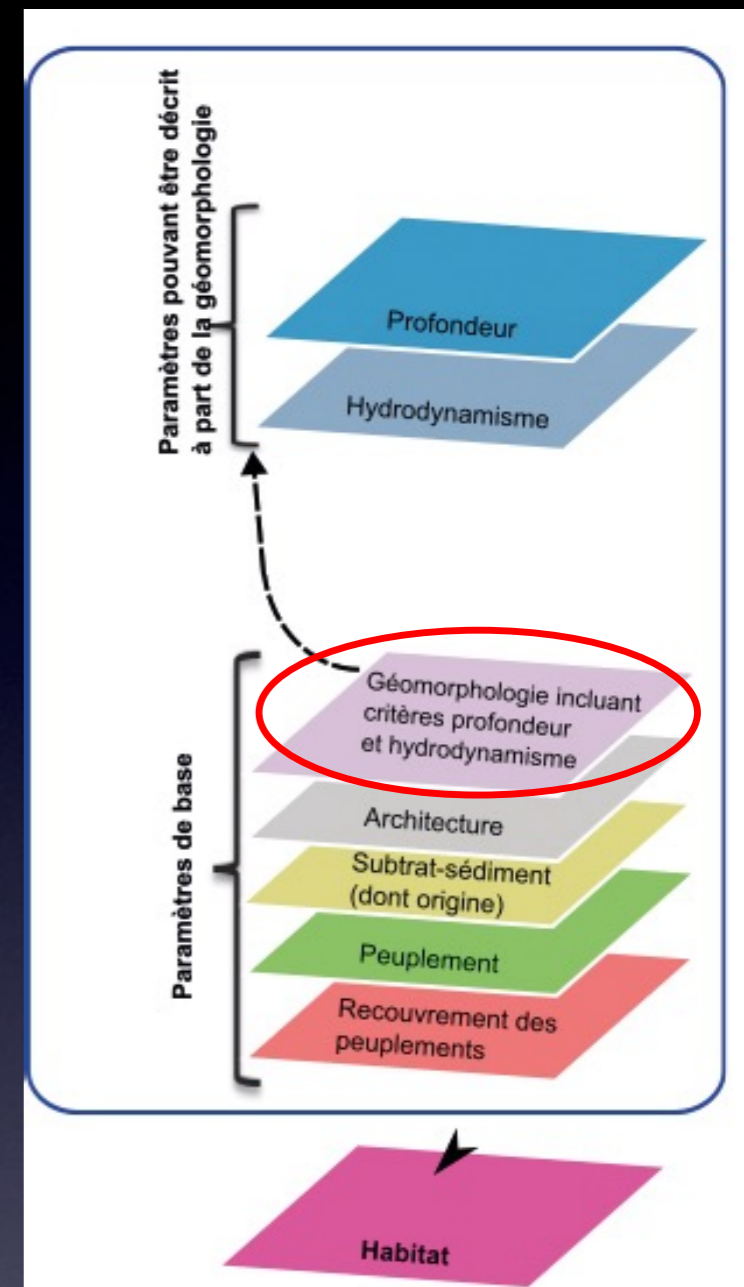
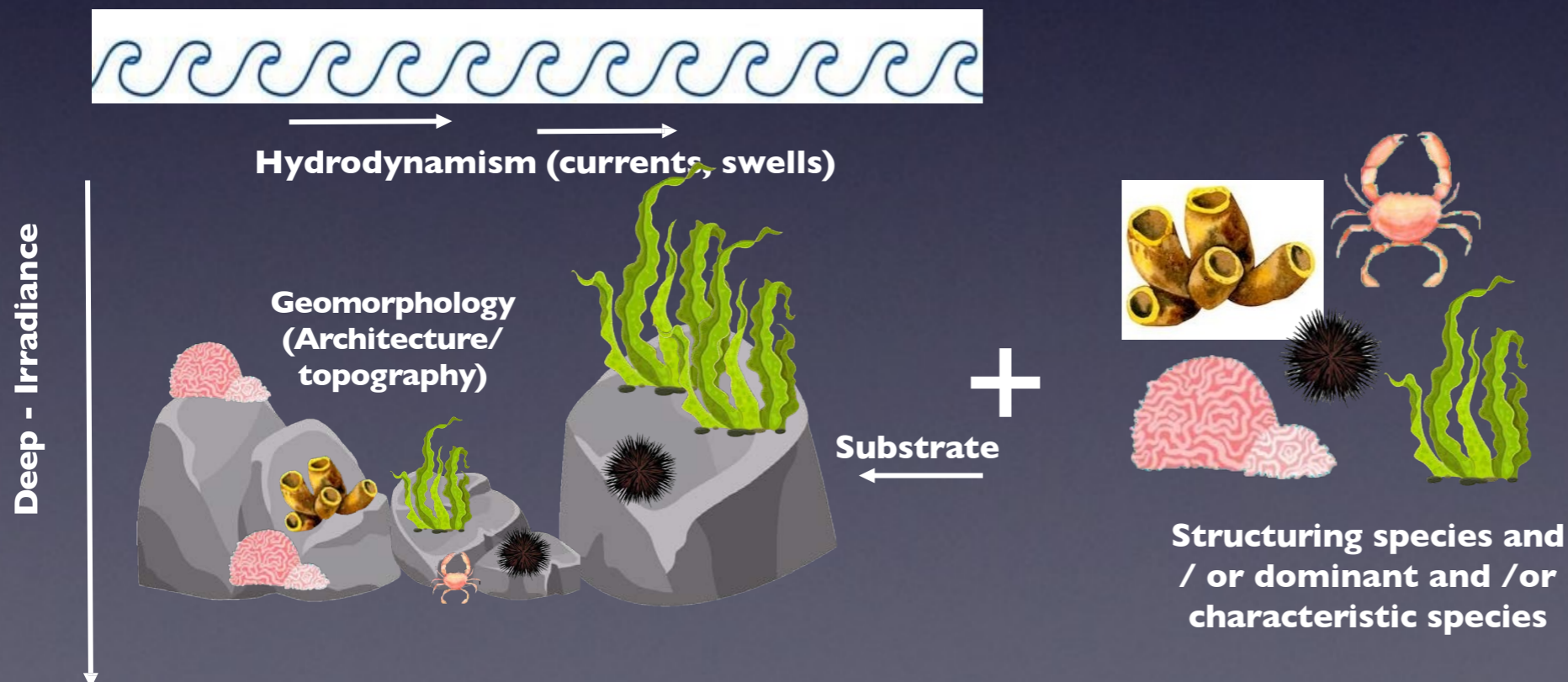
- Small SWIO islands (with low human impact) are ideal to studying the impact of climate change (as Seychelles coral islands, Eparses islands, ...)

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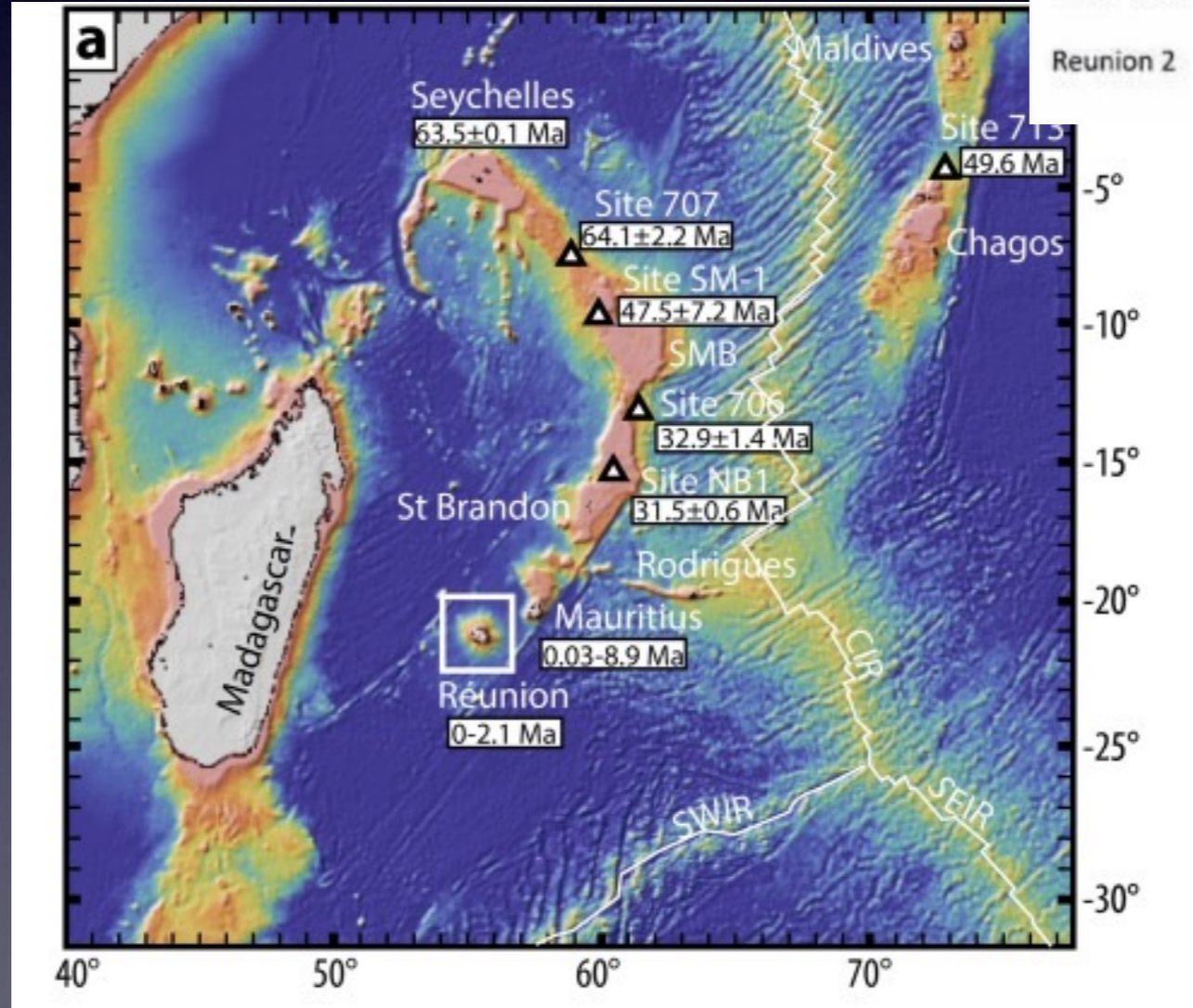
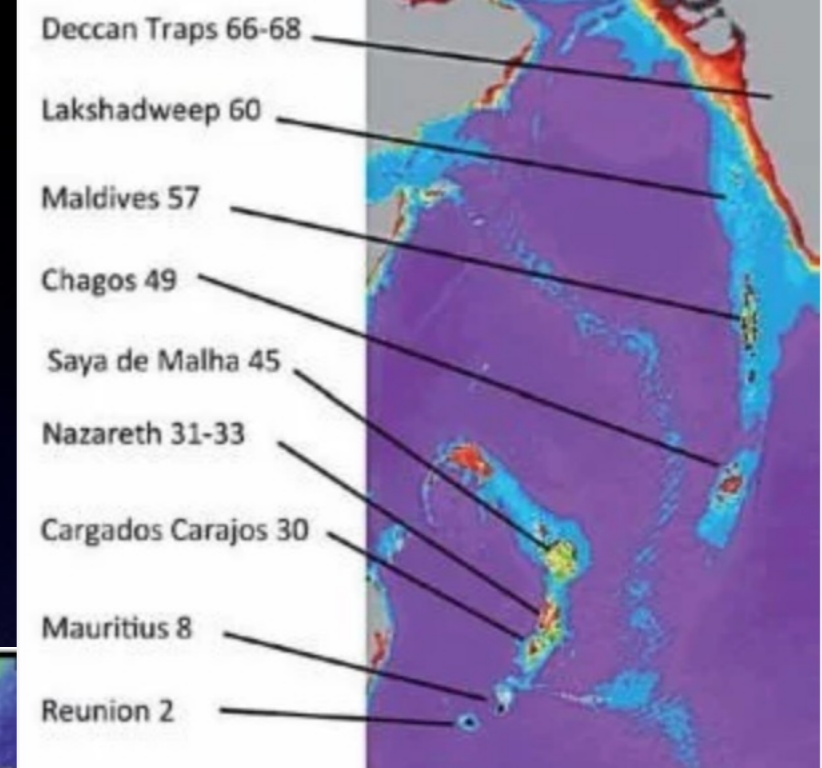
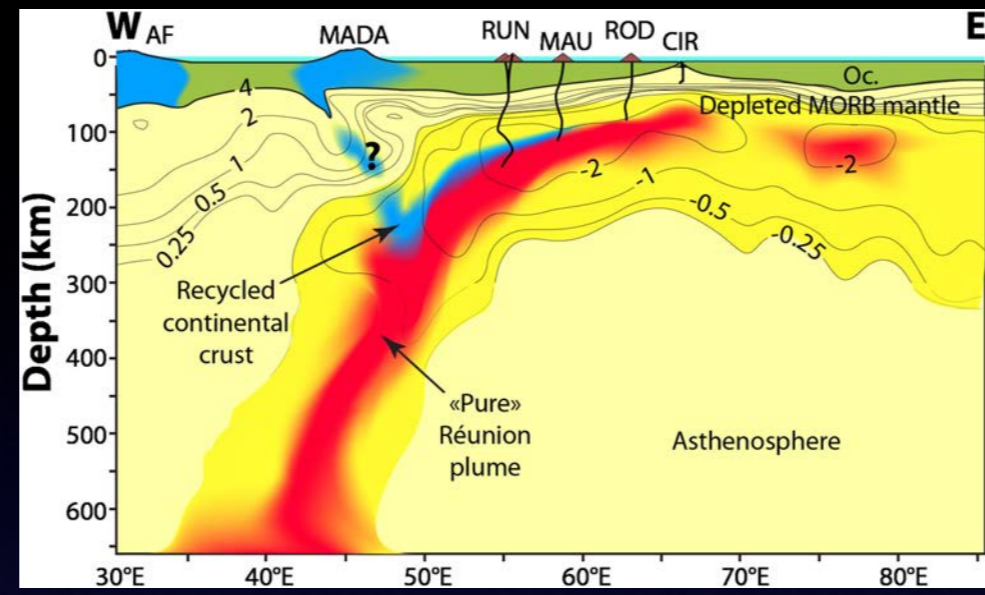
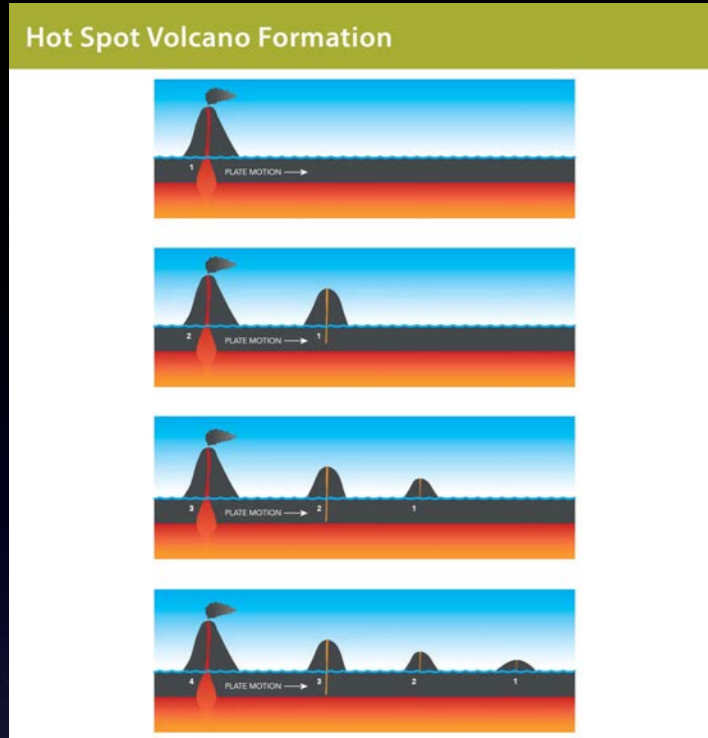
➔ Small coral reefs islands are “Observatories” of climate change

**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, ..)

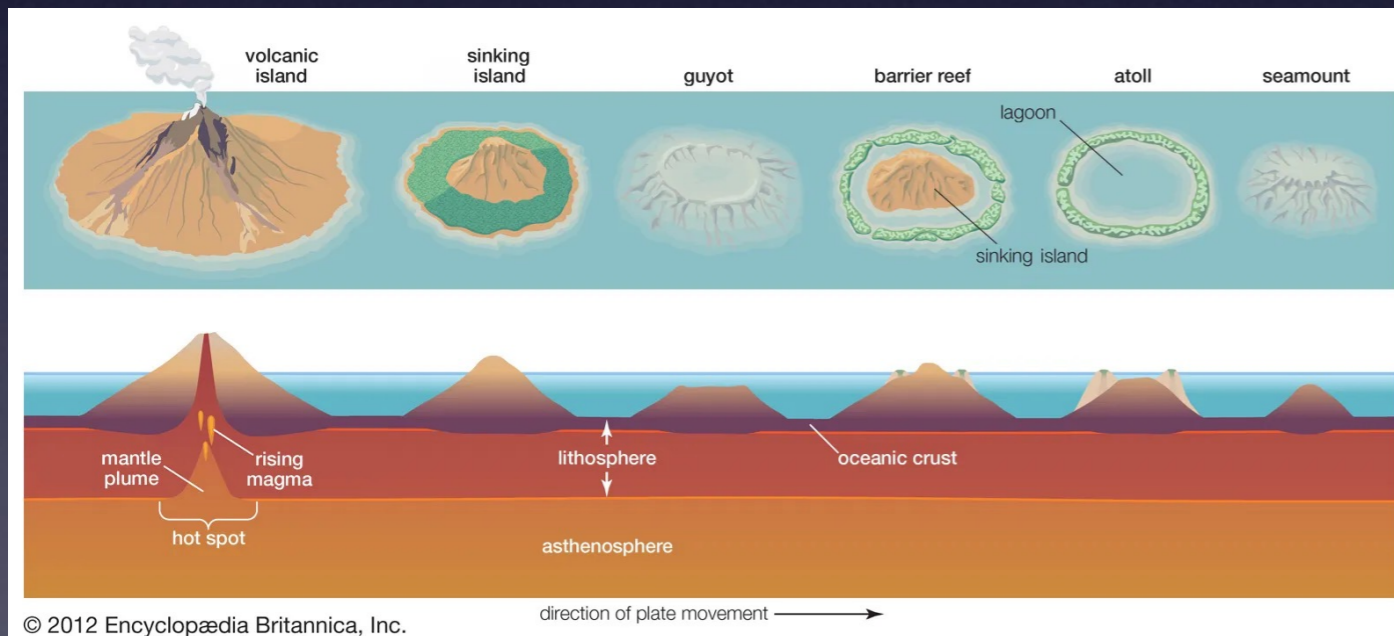
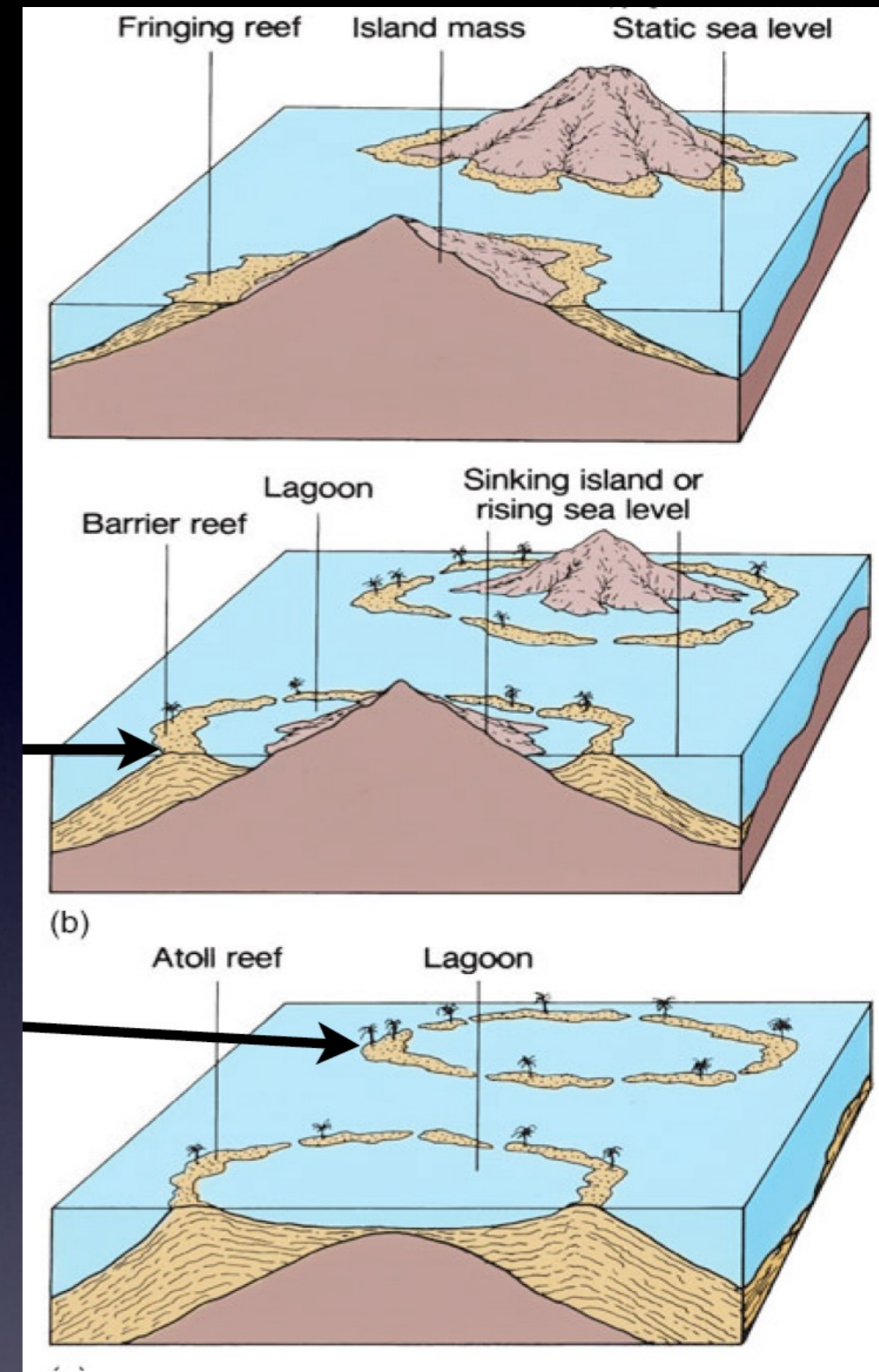
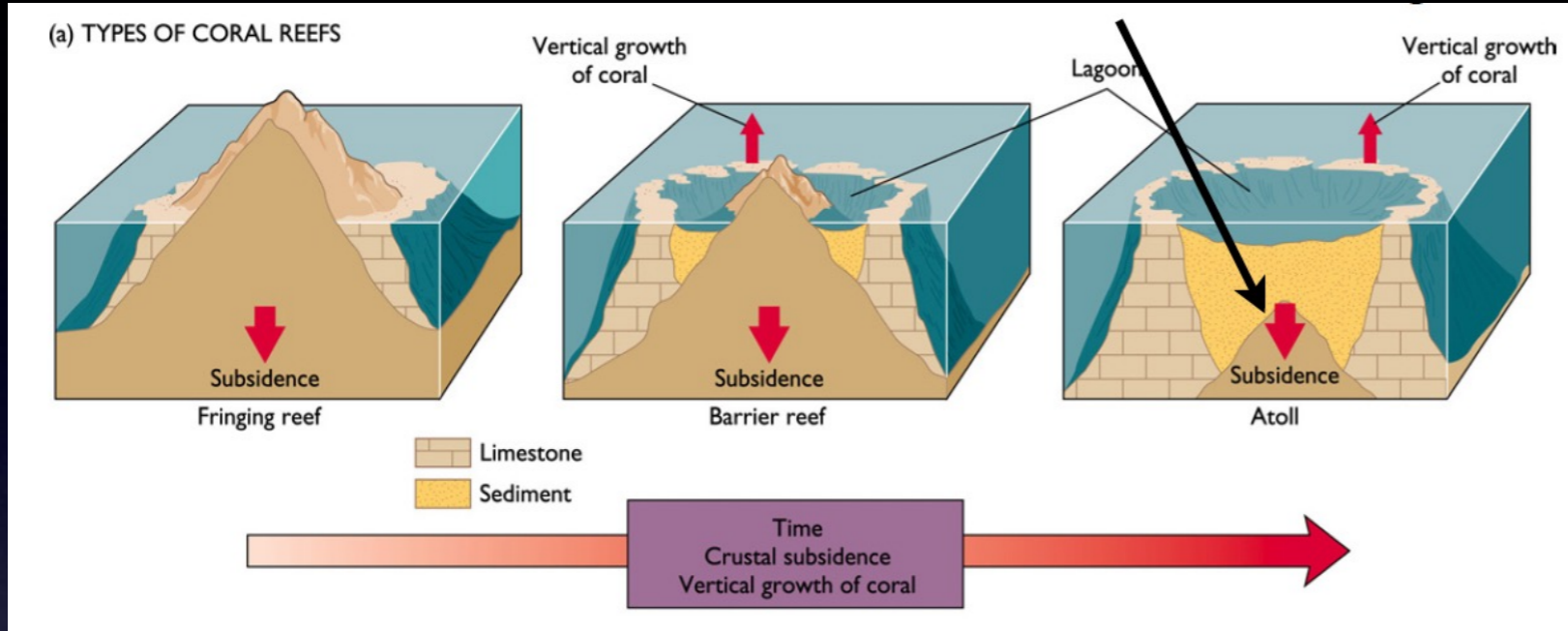


# Hot spots theory & islands « building »



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

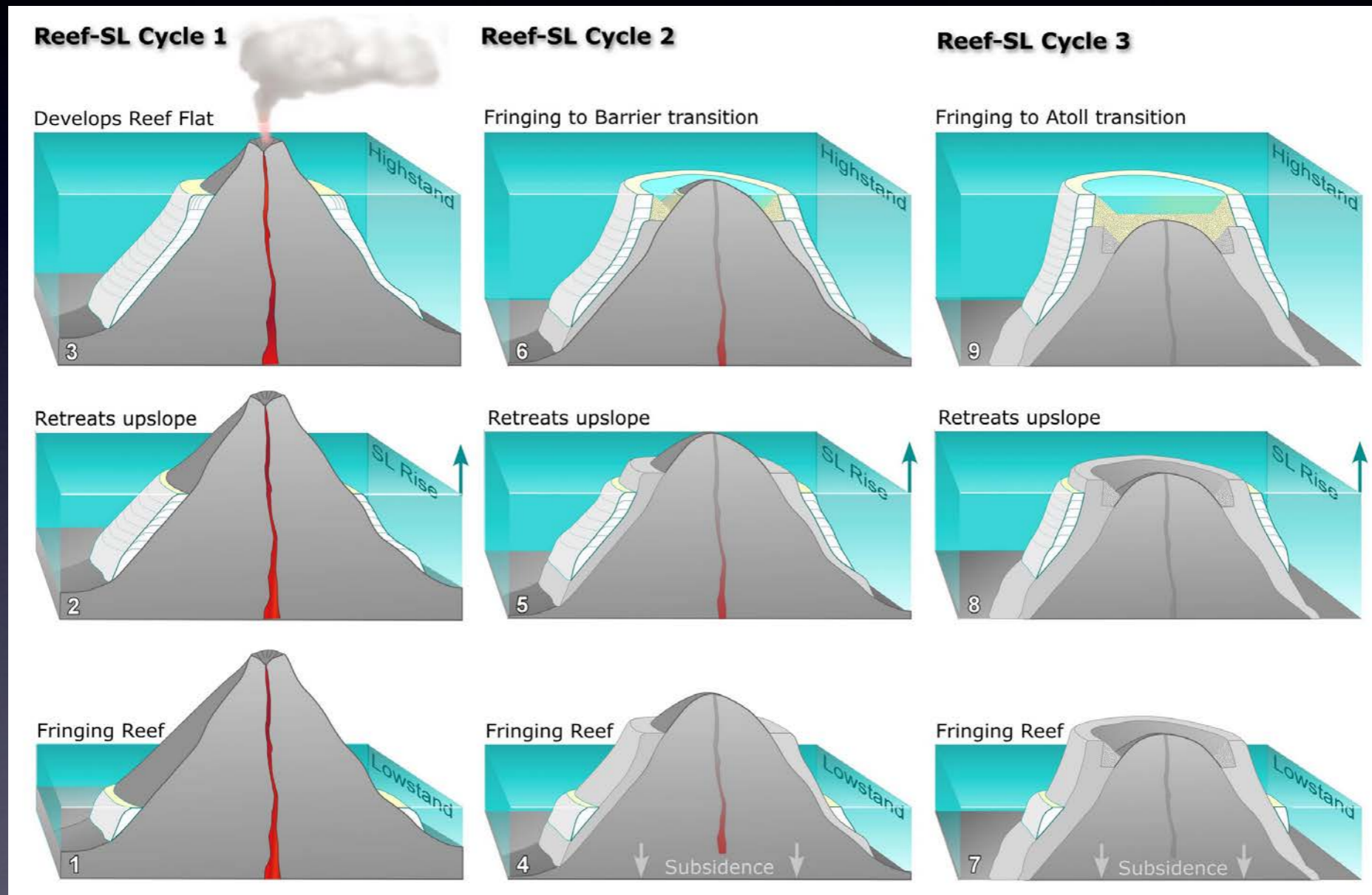
# Coral reefs formation & typology (Darwin theory)



« 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 ...)

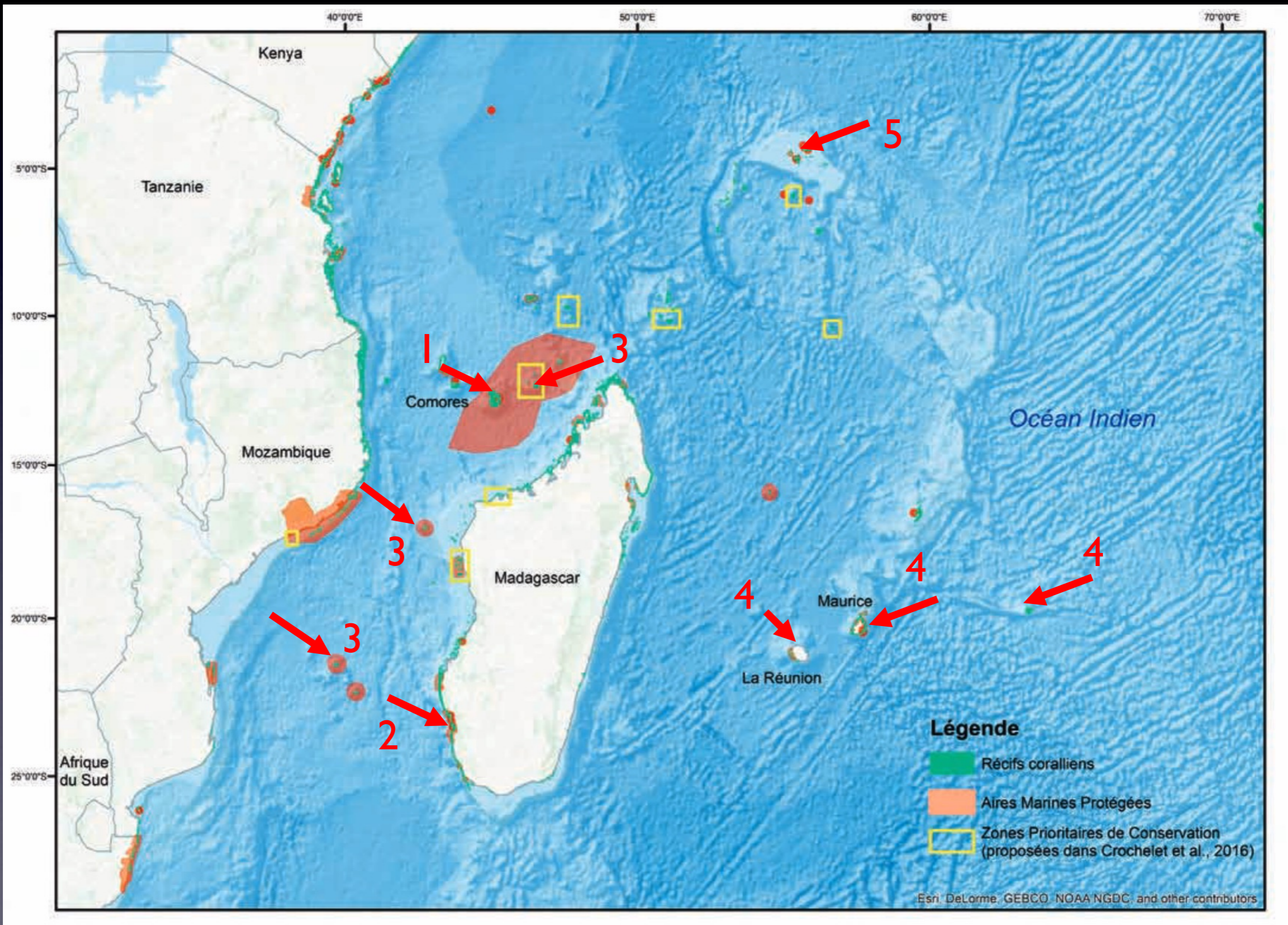


Several cycles during the Interglacial periods => building of coral follow the rise sea level / matching with subsidence of islands => « fringing » to « barrier » to « atoll » typology



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

# Our (virtual) field trip !

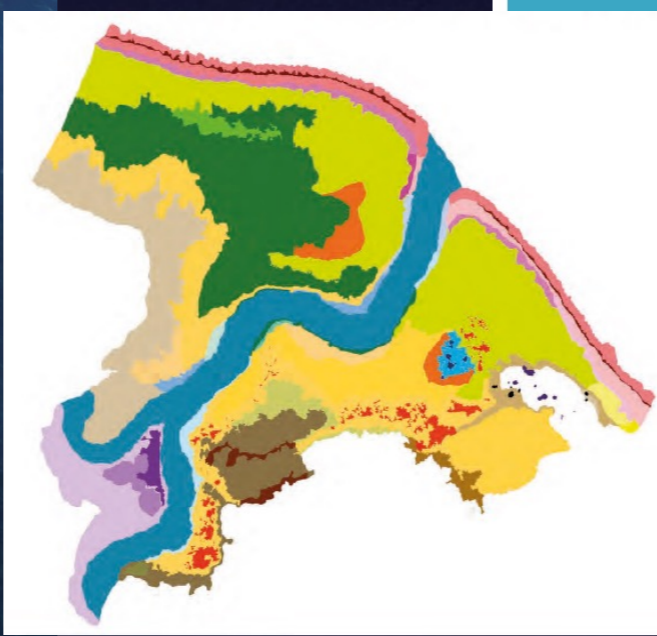
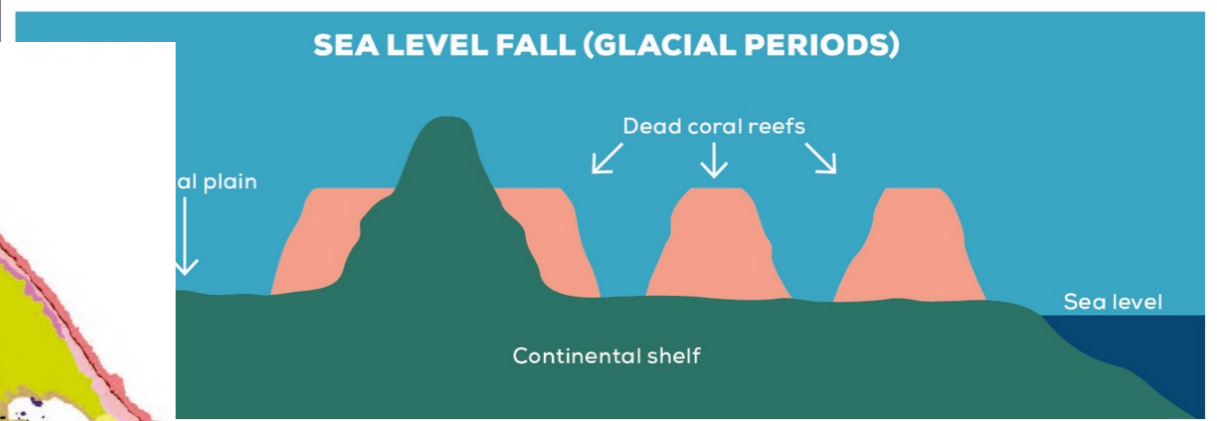
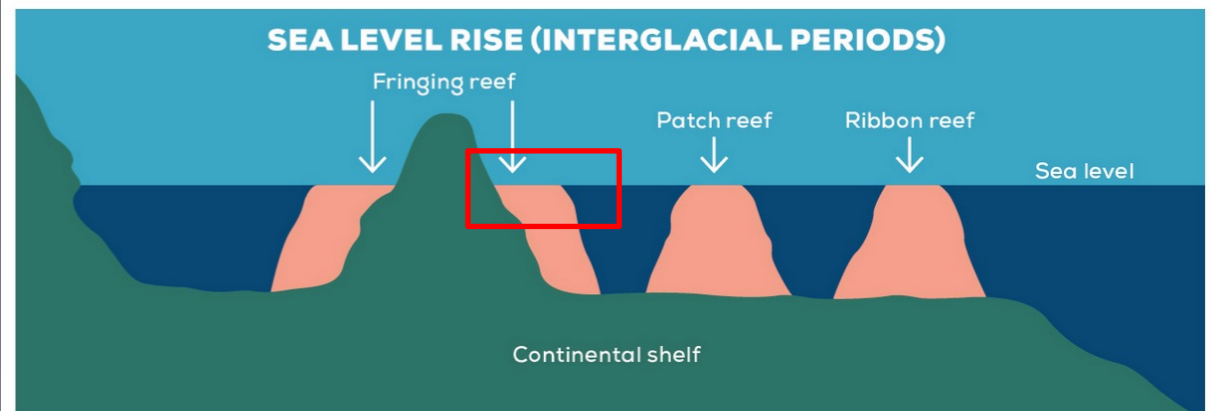
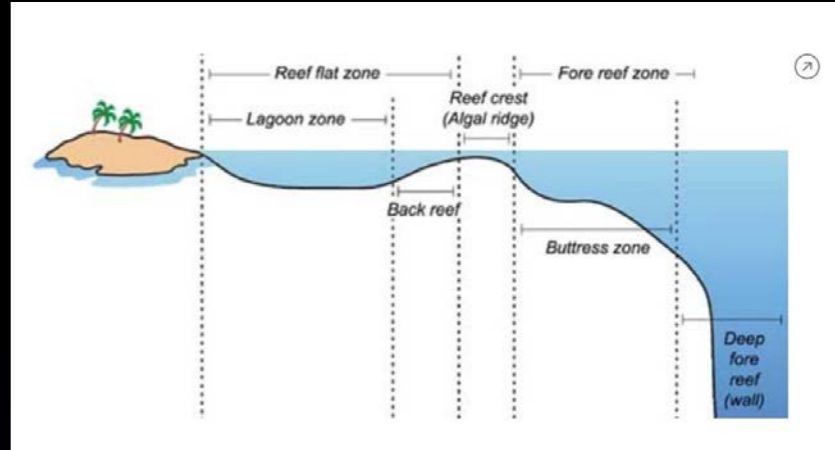


# Mayotte case study (Comoros)

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

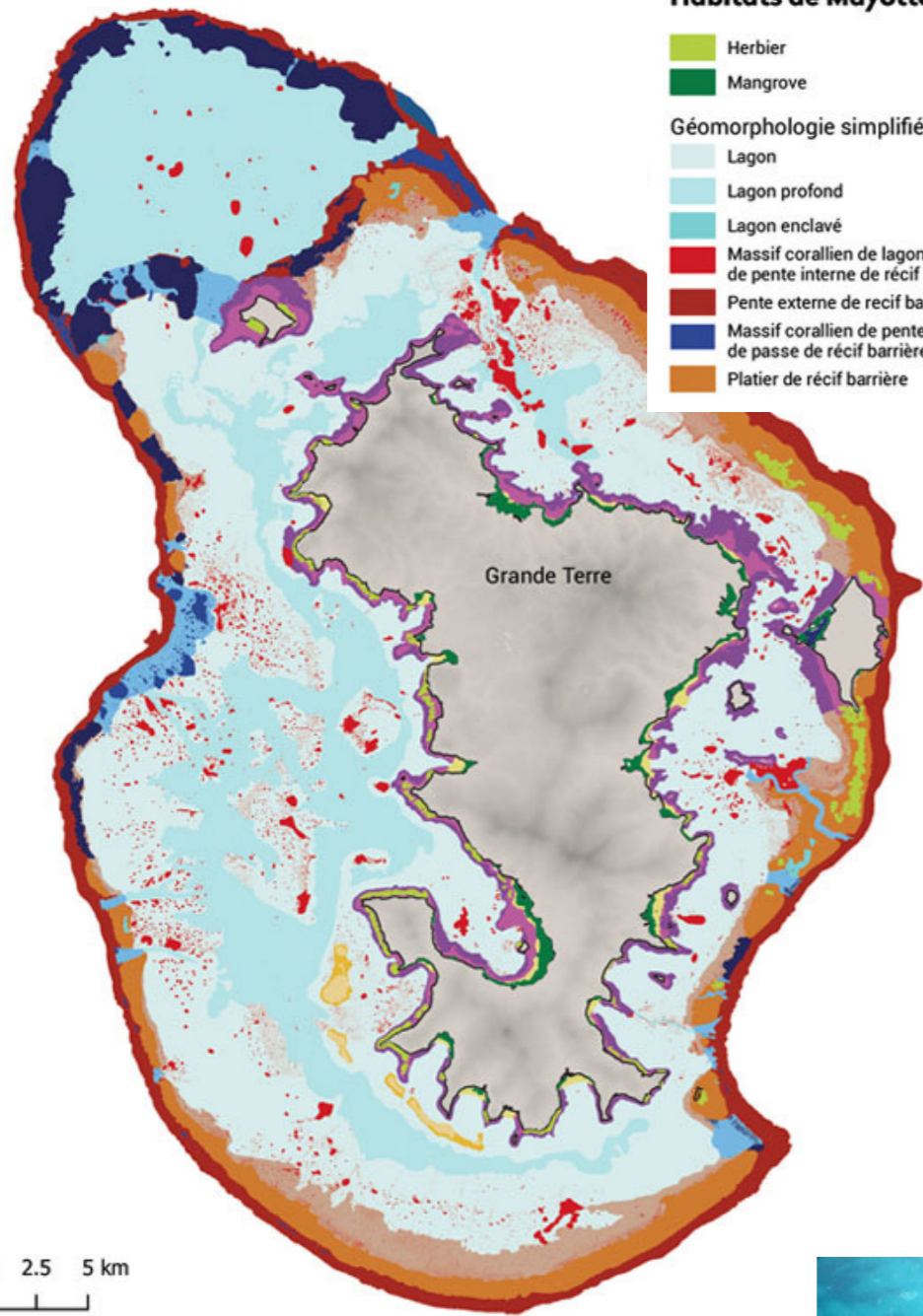
Double barrier reef (South W): rare  
Passes (« S »): link to glacial /  
interglacial periods (Holocène - 10  
to 12 000 yrs (karst system on reef  
slope -80 m)



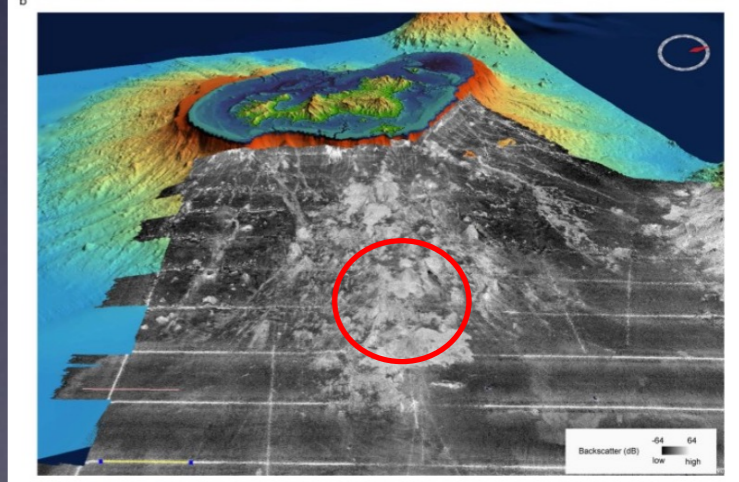
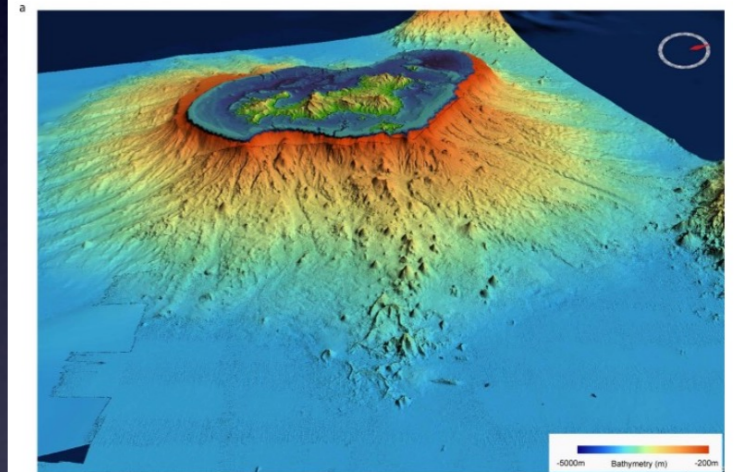
# Volcanic activity ... next with ... « Fani »

## 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.

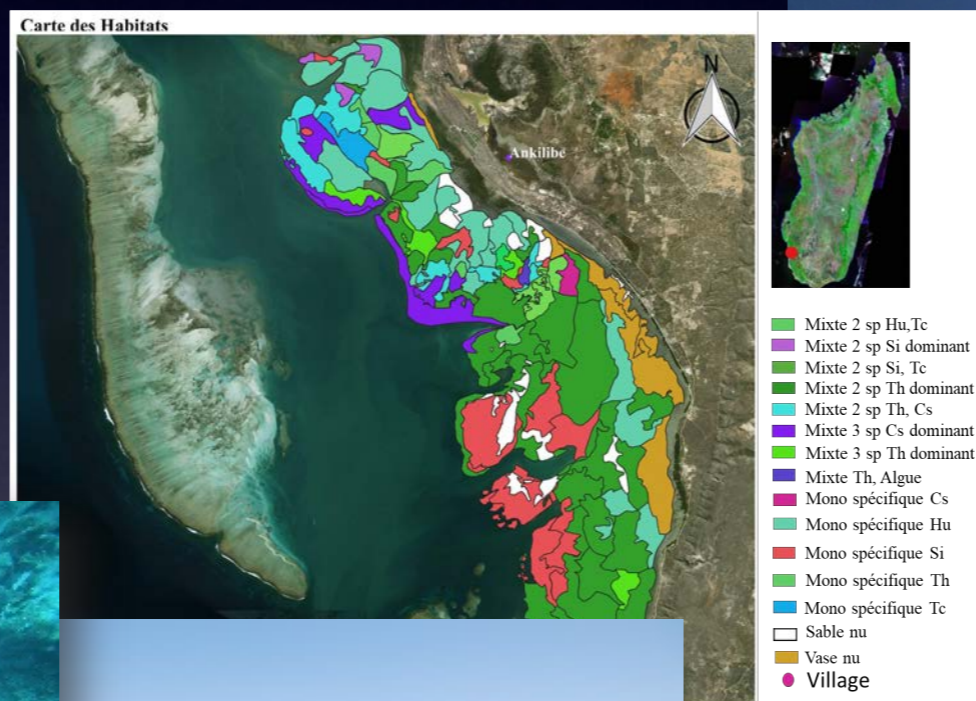
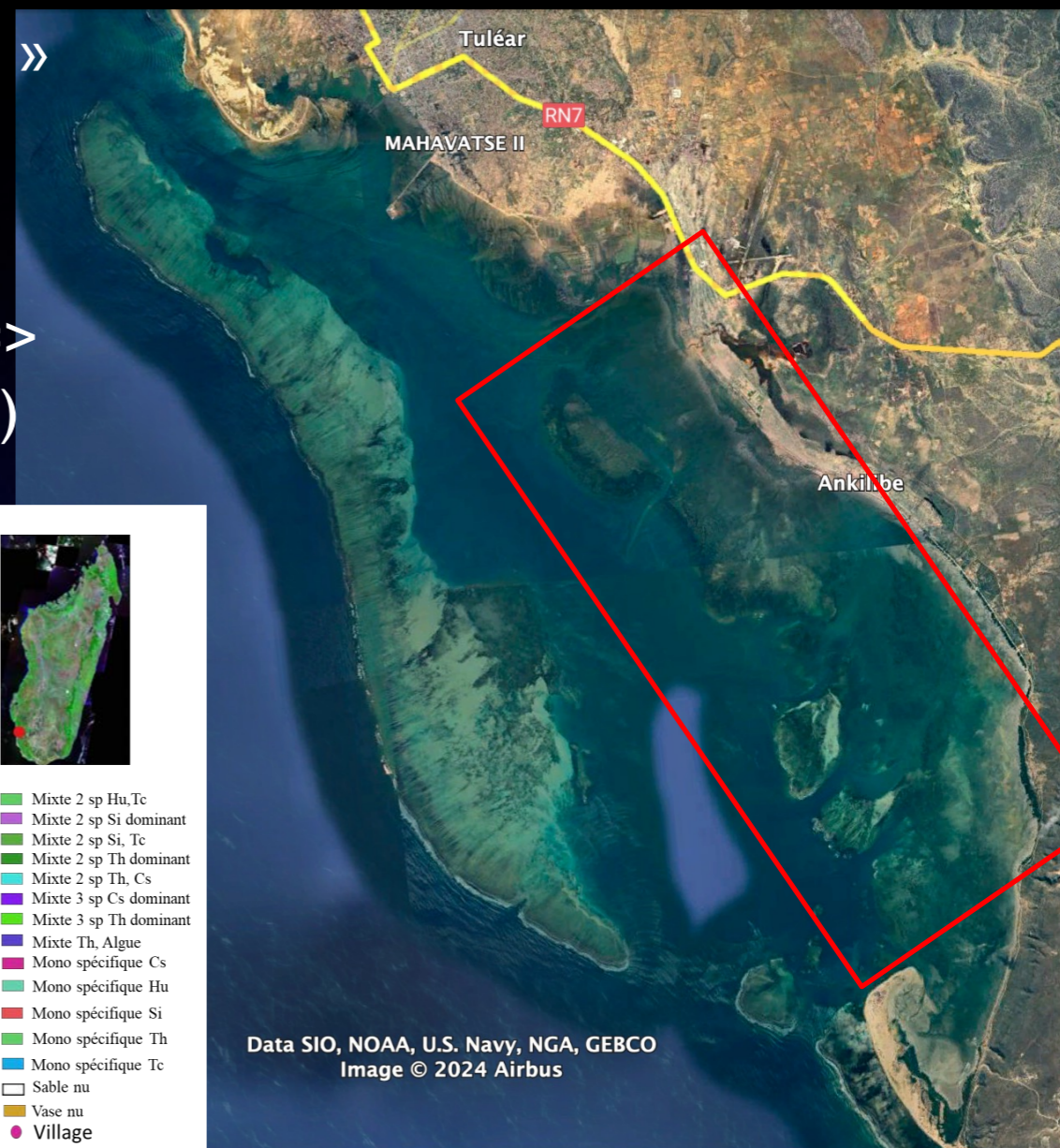


# Case study MadaG – Toliara area

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)

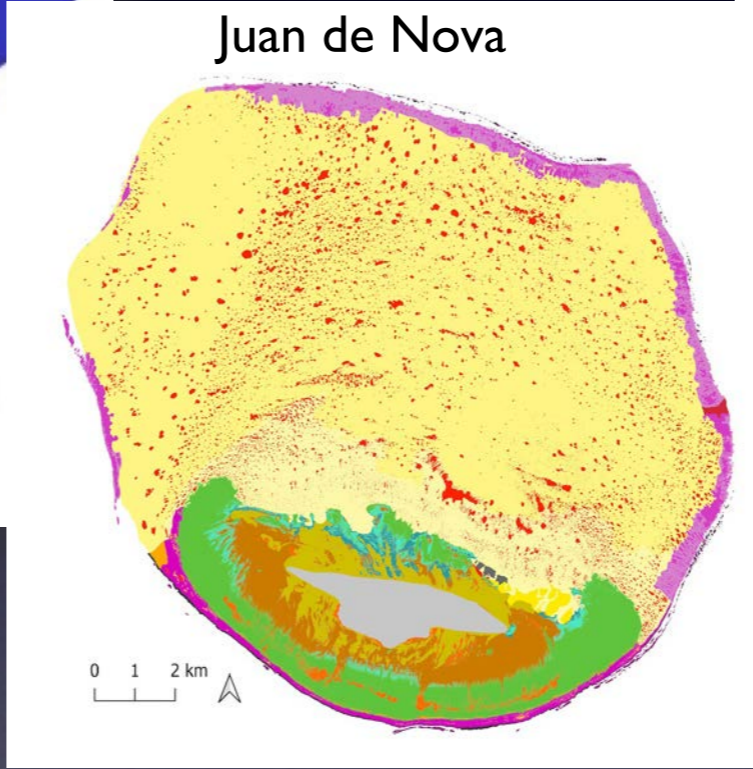
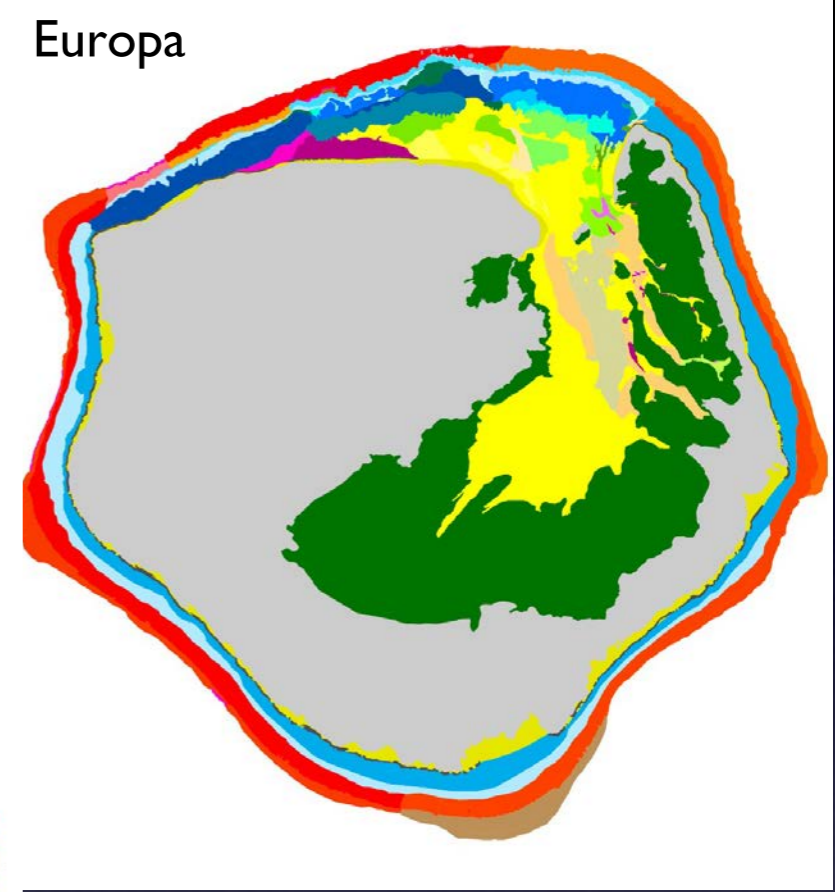
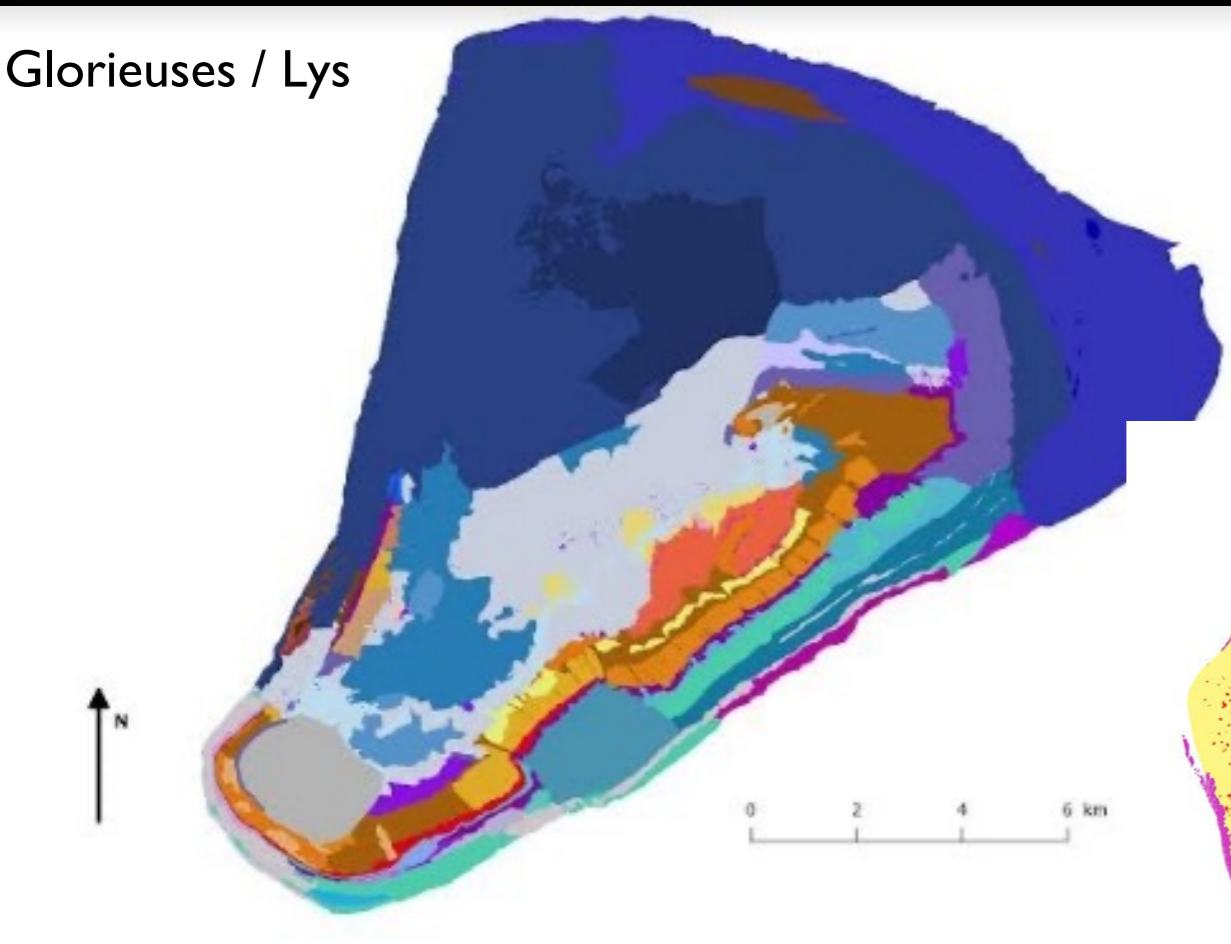
**Juan de Nova**: => up of old seamount « mont des Sakalaves » ) – fossil coral reef – last interglacial period (25 000) / last coral stage → around 4 km thick / North-South tilt of the bank

**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)



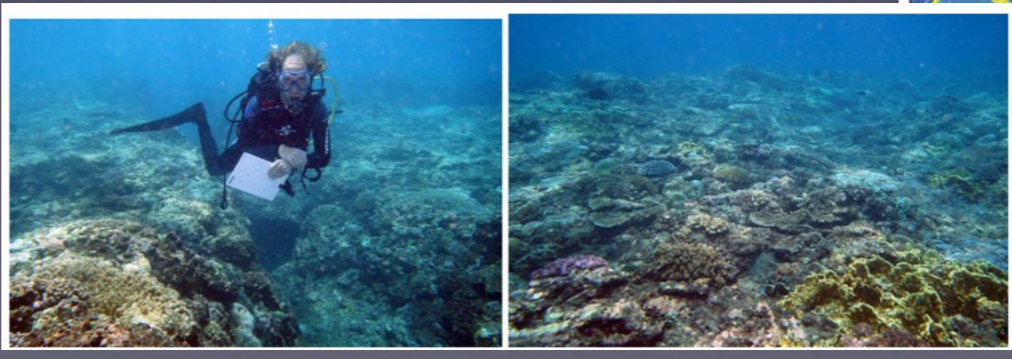
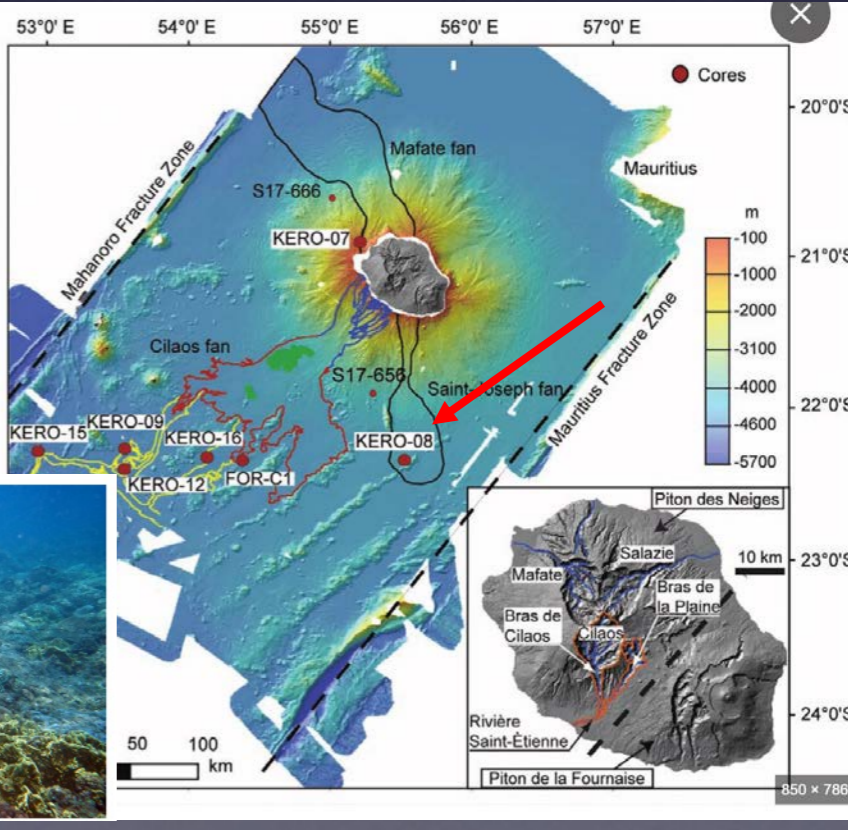
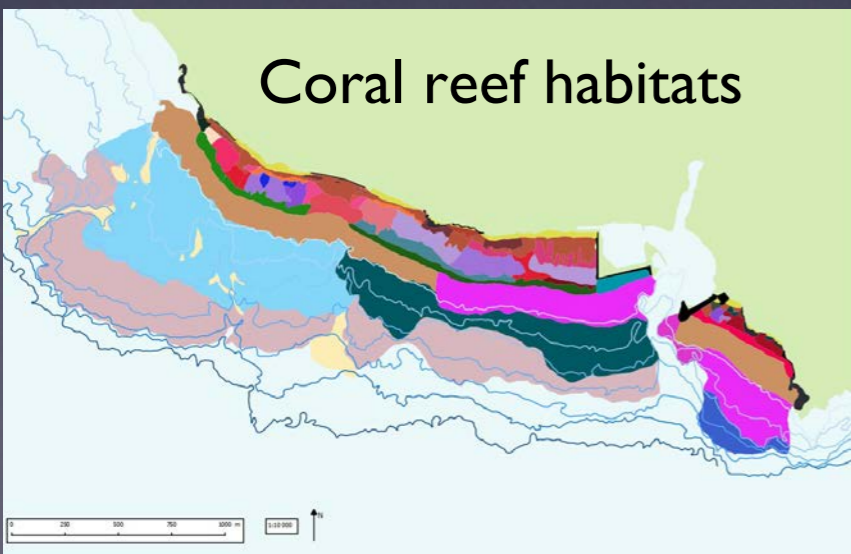
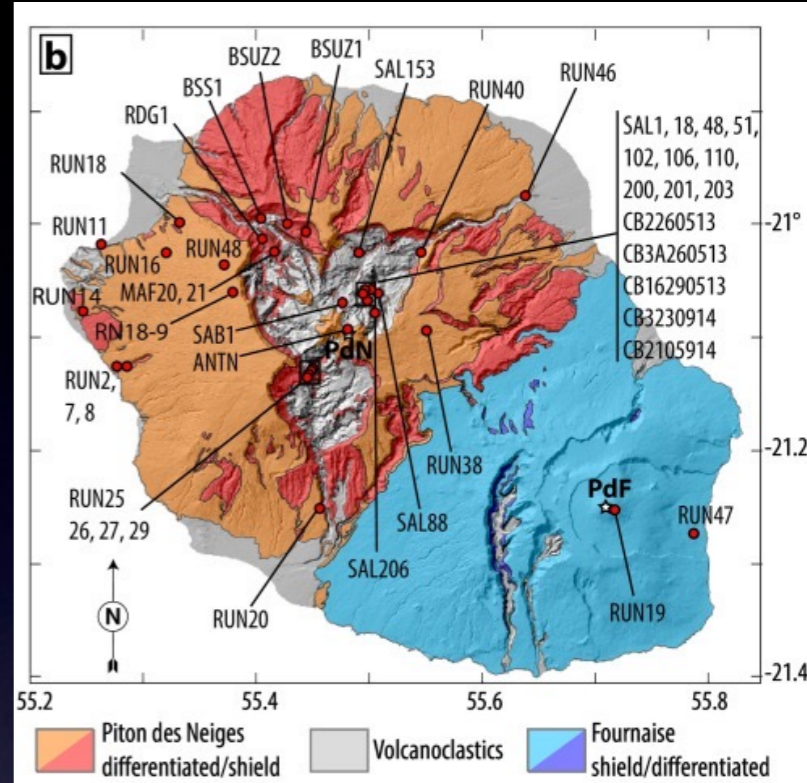
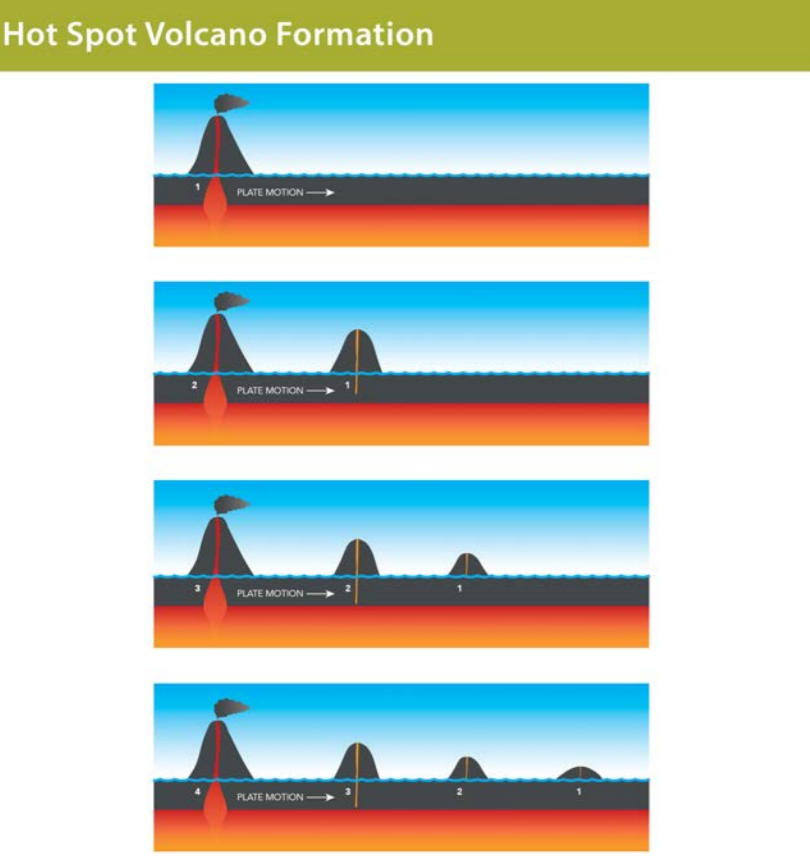
# Geomorphology & Habitats mapping can be used as biodiversity proxies of coral biodiversity (Glorieuses / Juan de Nova / Europa)



# 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)



Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
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Image © 2024 Airbus

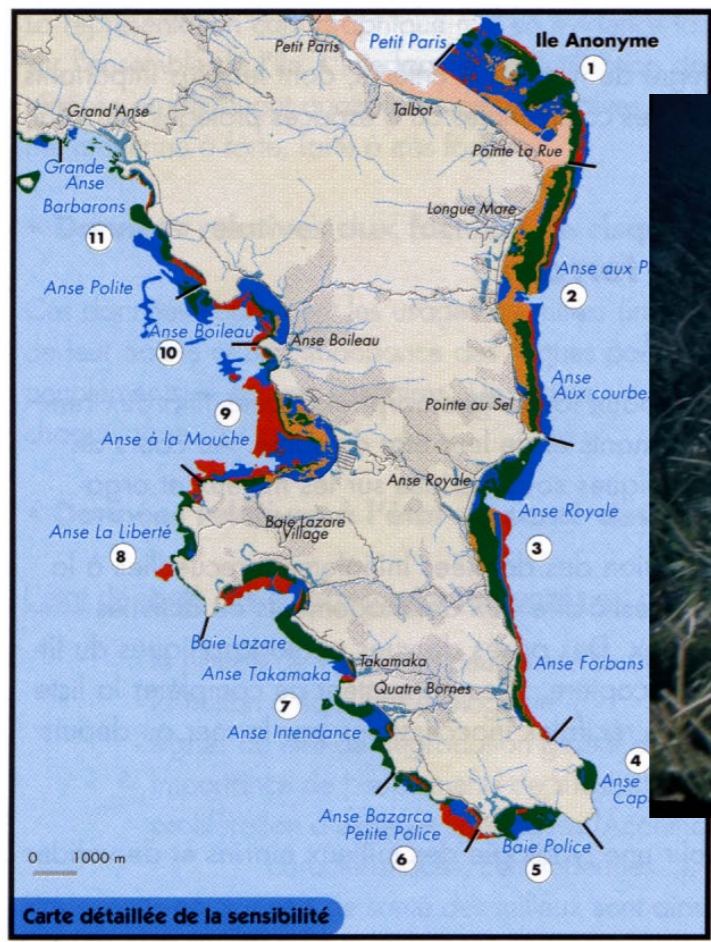
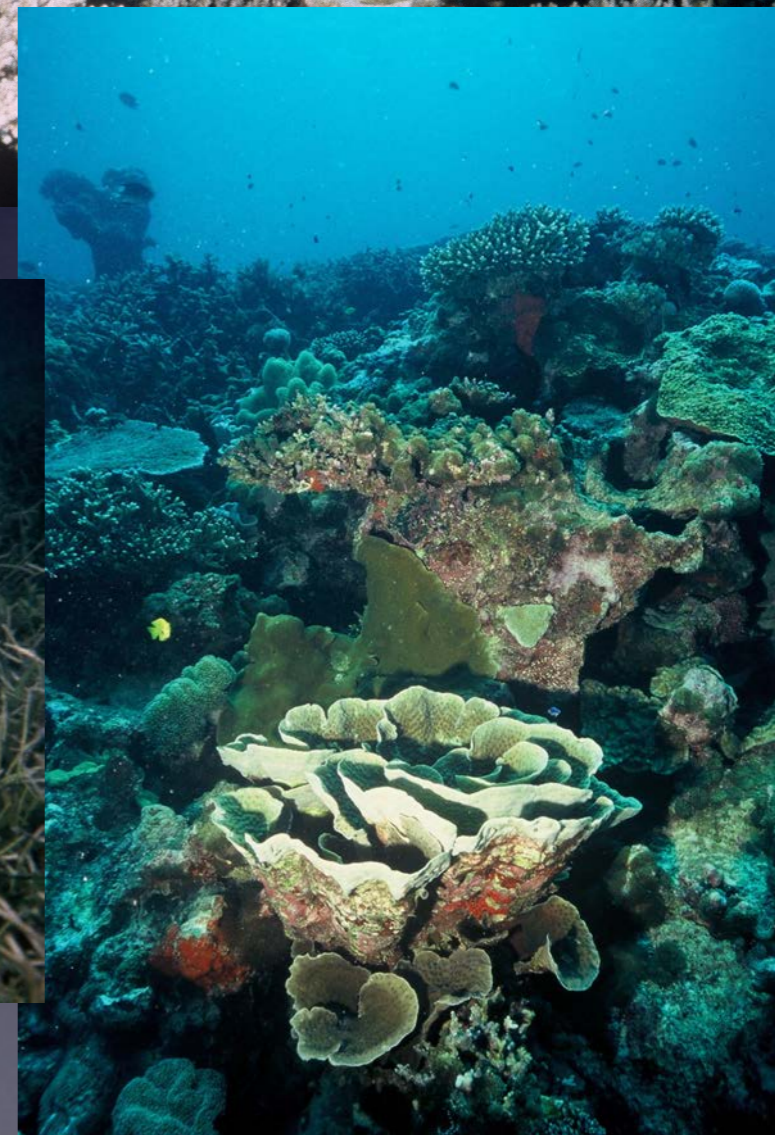
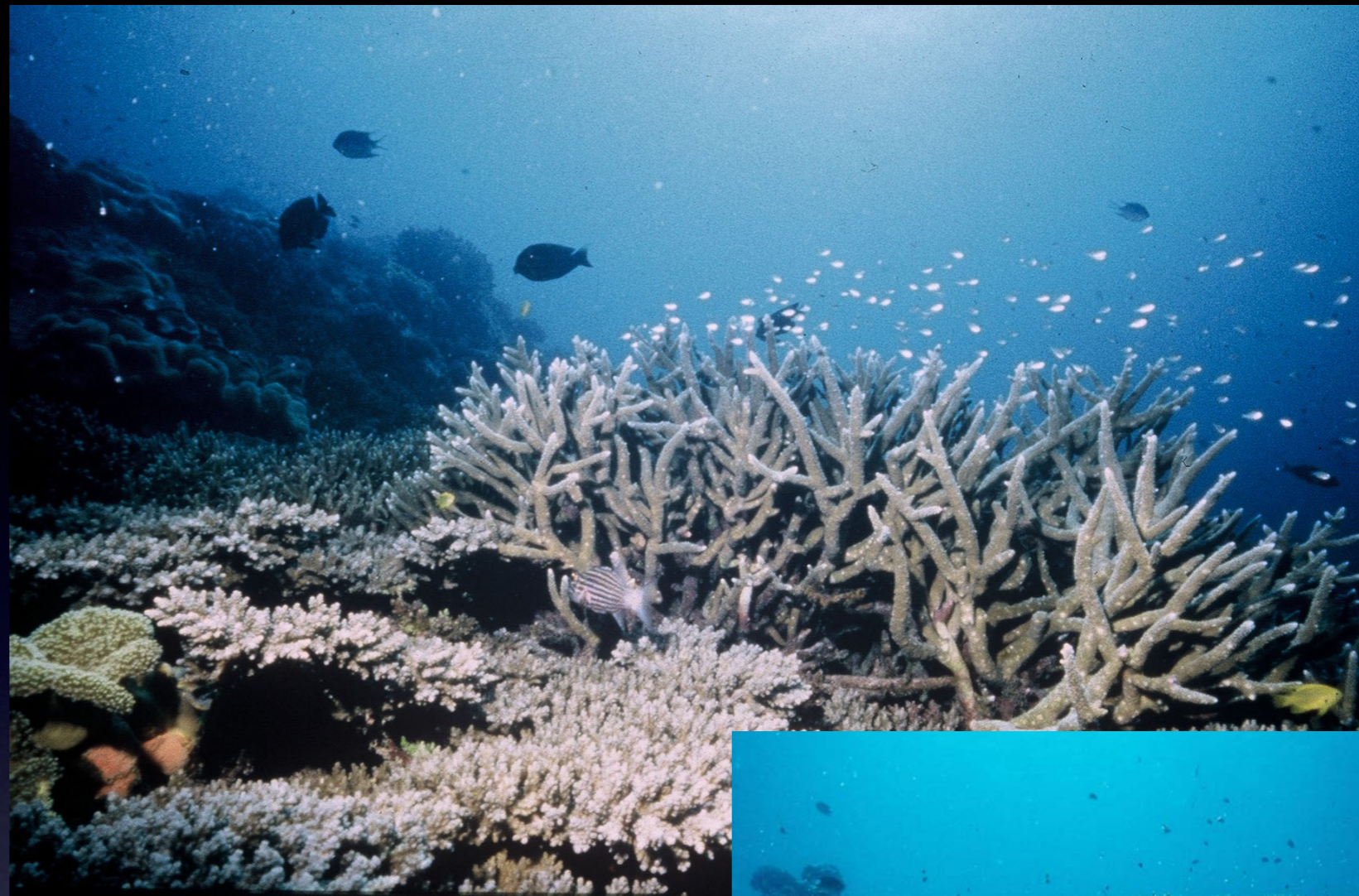


Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2024 Airbus

# 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

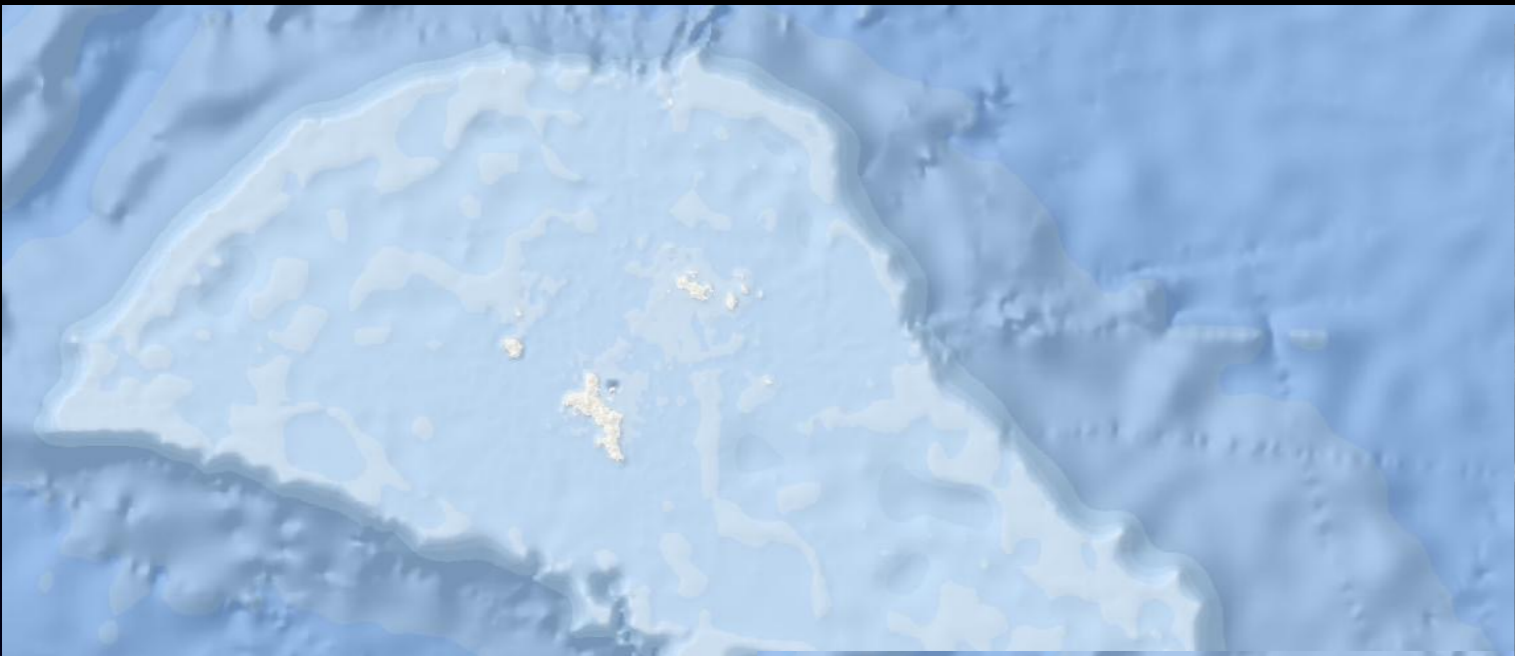
(healthy ++)

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

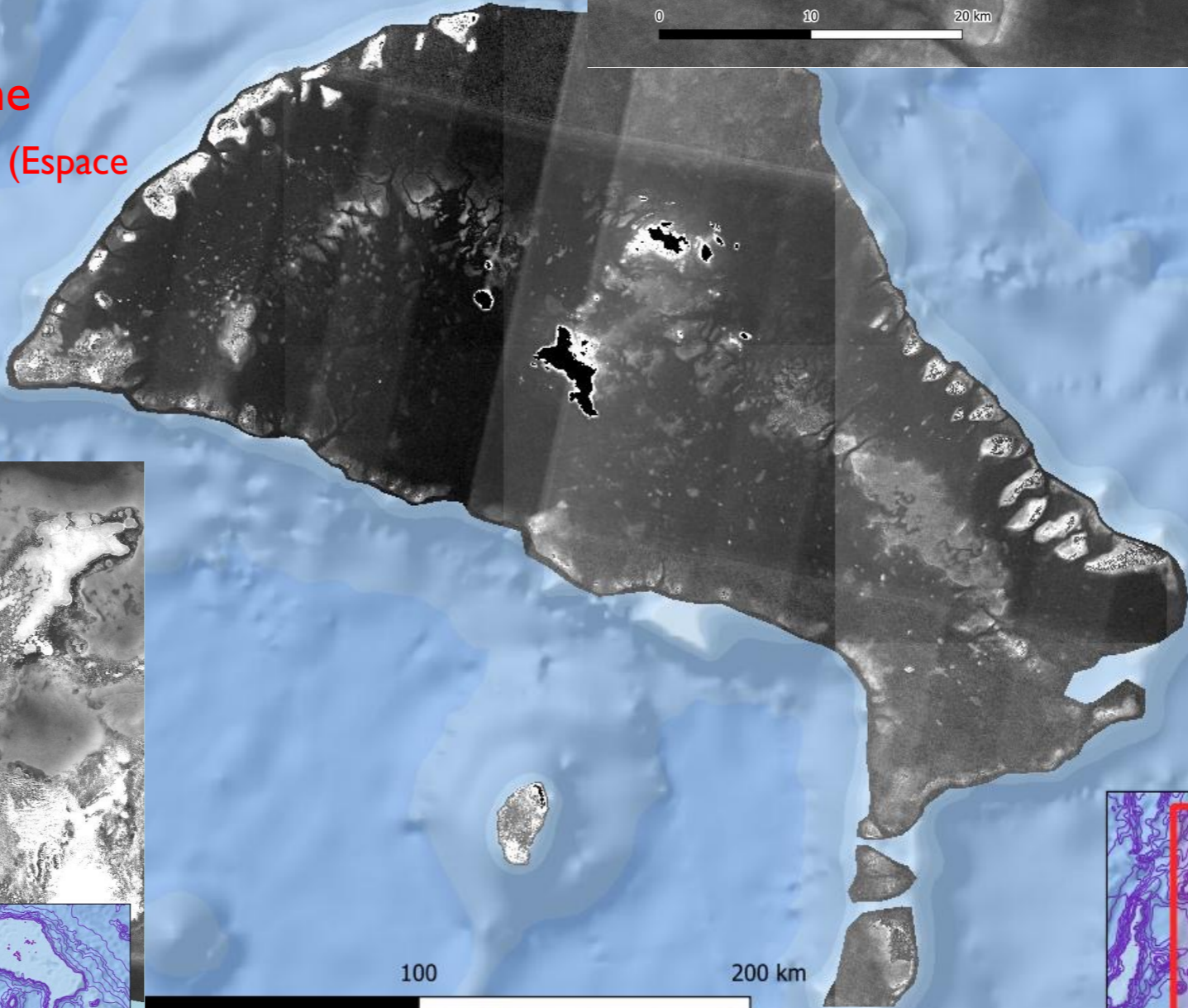
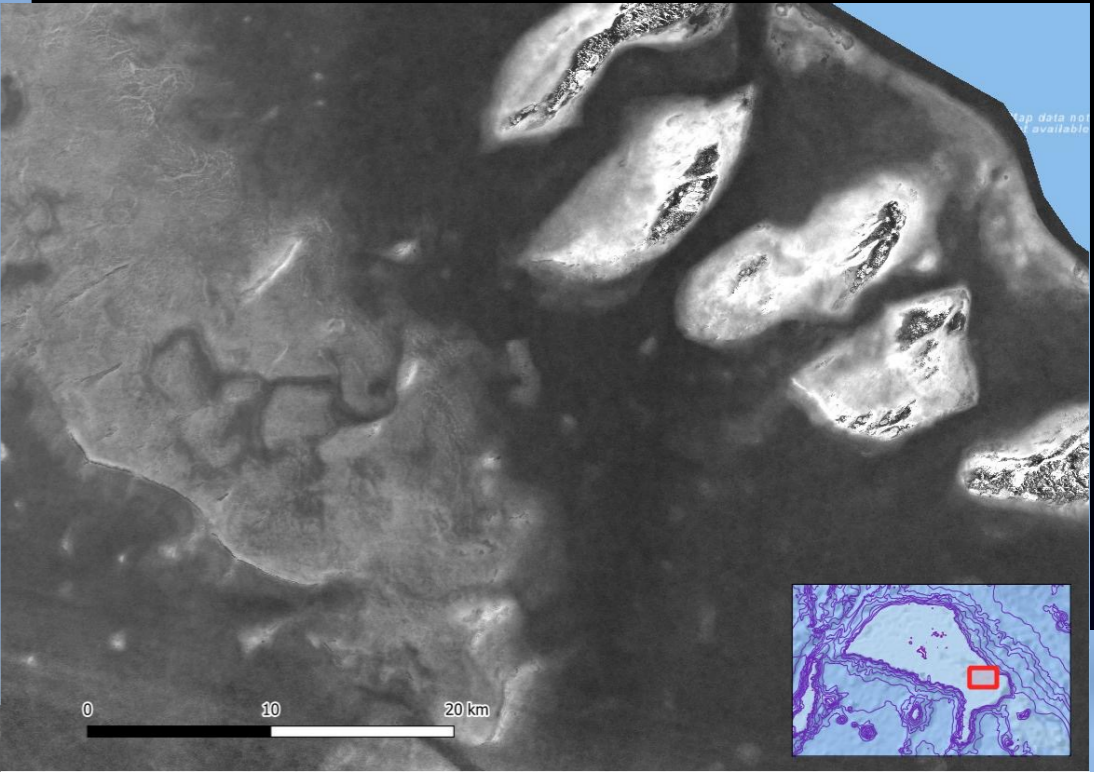
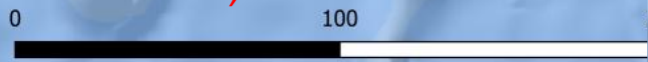


**Main biblio. references :**

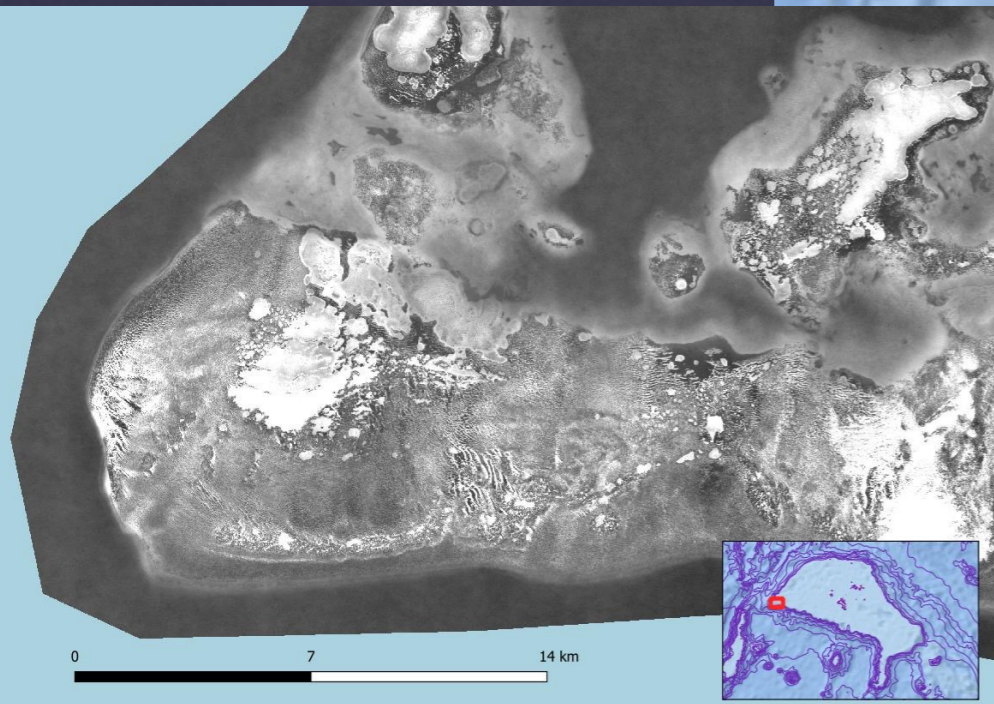
Stoddart DR, 1984 ; Rosen R.B 1971 ;  
Lewis SM., 1968; Taylor JD. 1968 ;  
Braithwaite CJR. Et al.1975; 2000;  
Sheppard CRC. 1998; Turner et  
al. 2000; Chong-seng et al. 2014



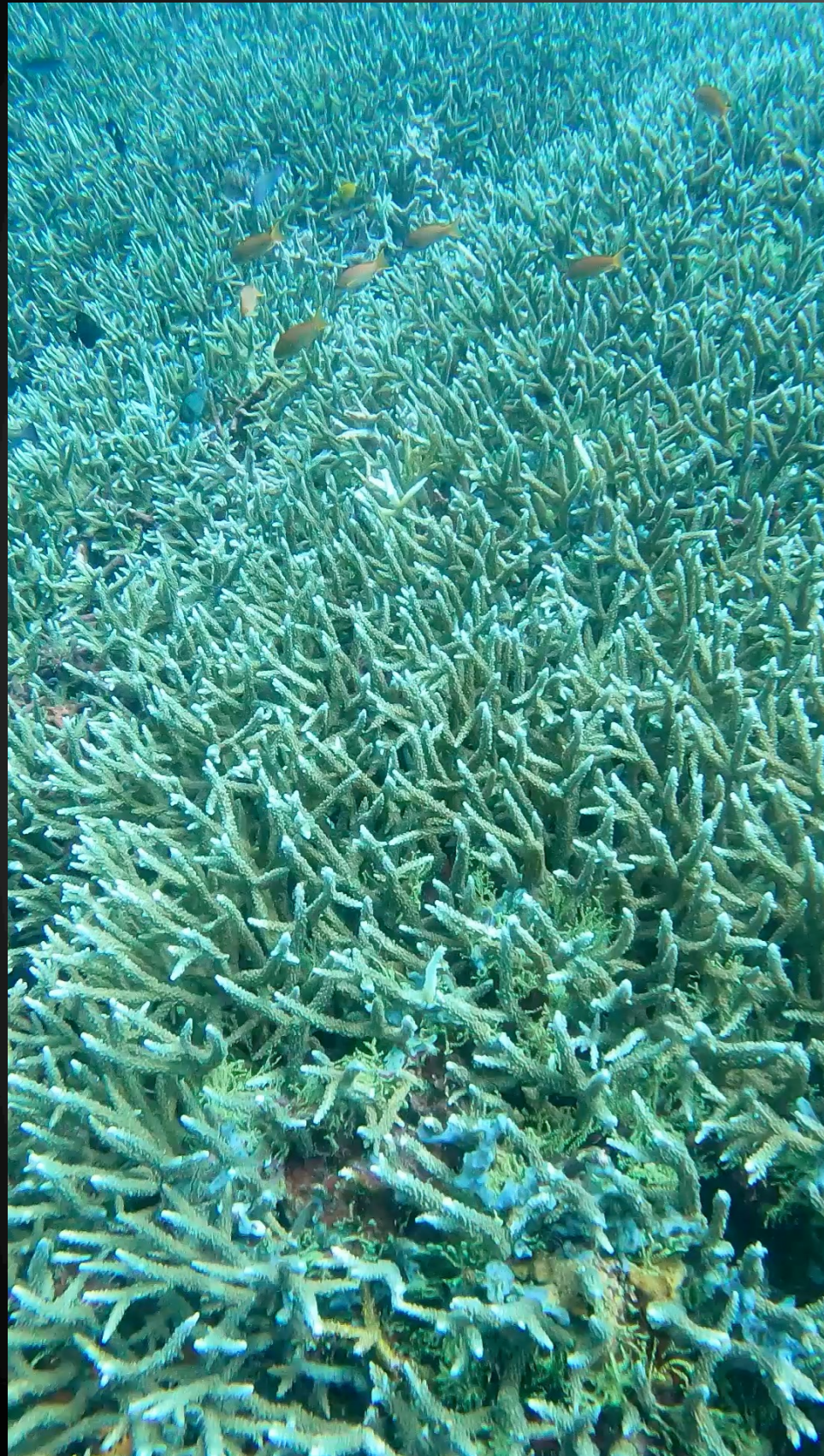
Sentinel-2 satellite image time series (2015-23)- P Mouquet (Espace Dev / IRD)



Bird / Denis: -3700 yrs



# Thank you for your attention !



Nusa Penida – Bali / Indonesia (May 2024)



Europa – Eparses islands (Nov 2016)