

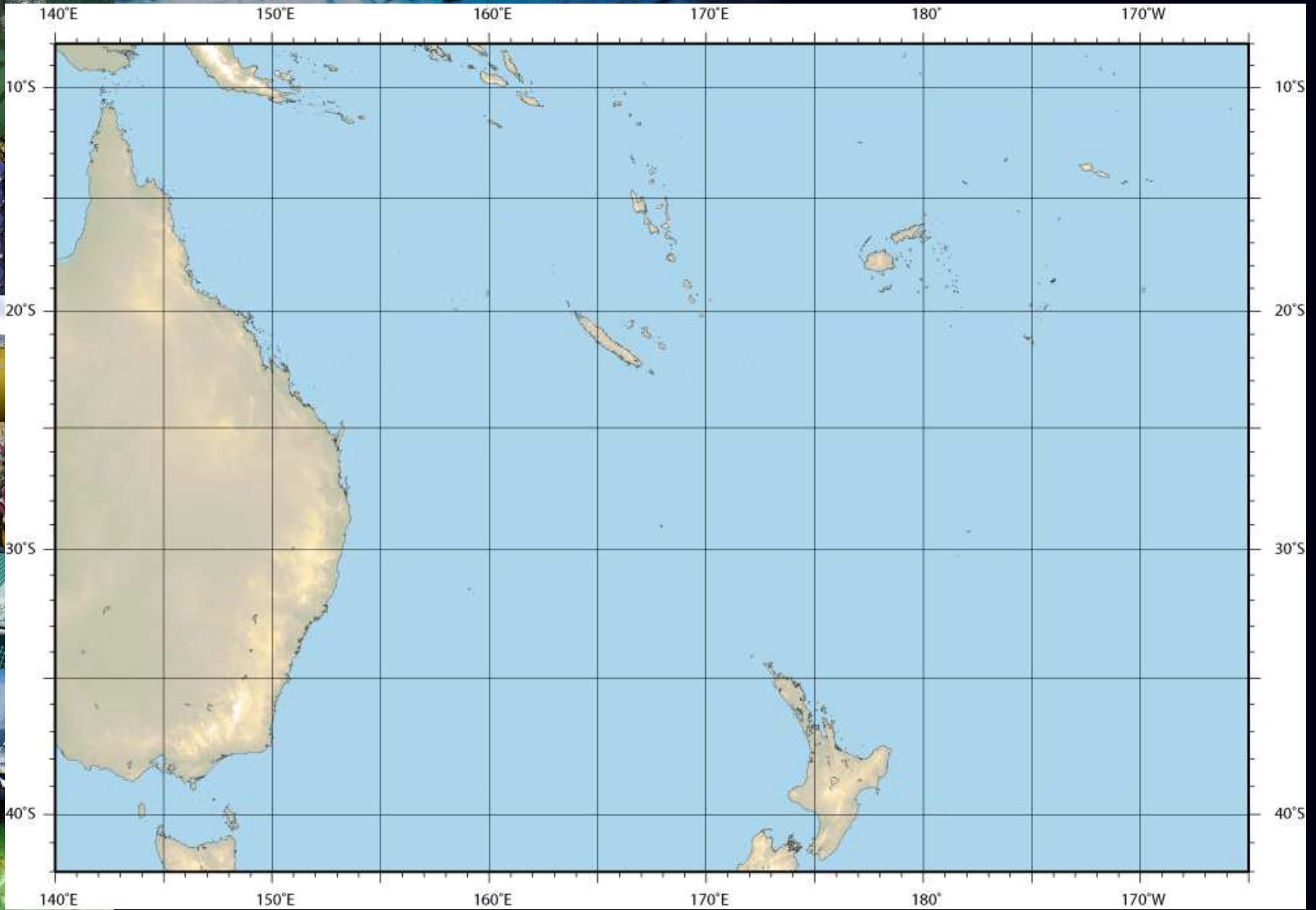
Géodiversité Marine de Nouvelle-Calédonie

Origine et Enjeux

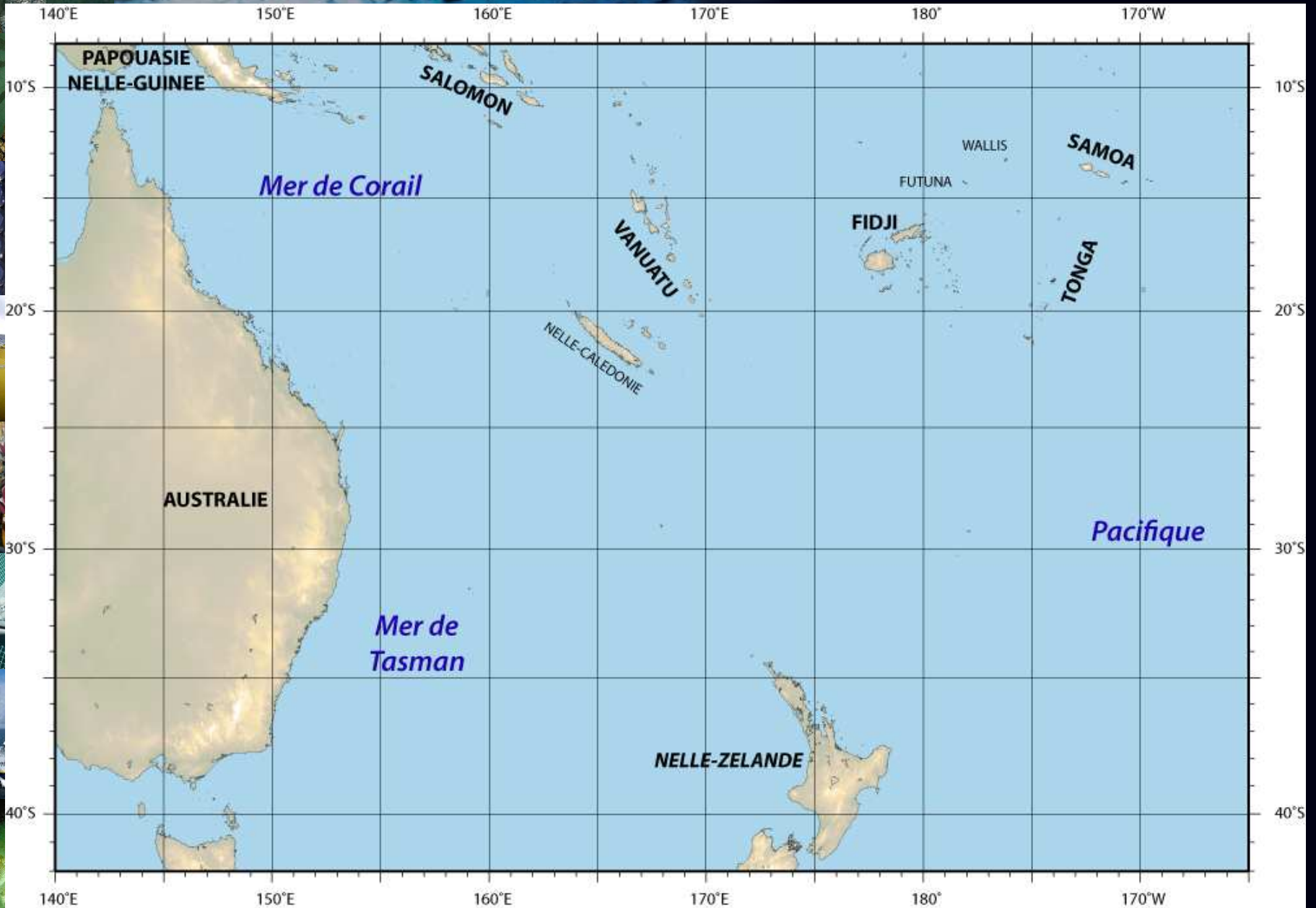
Par le groupe de Géologie Marine de Nouvelle-Calédonie:

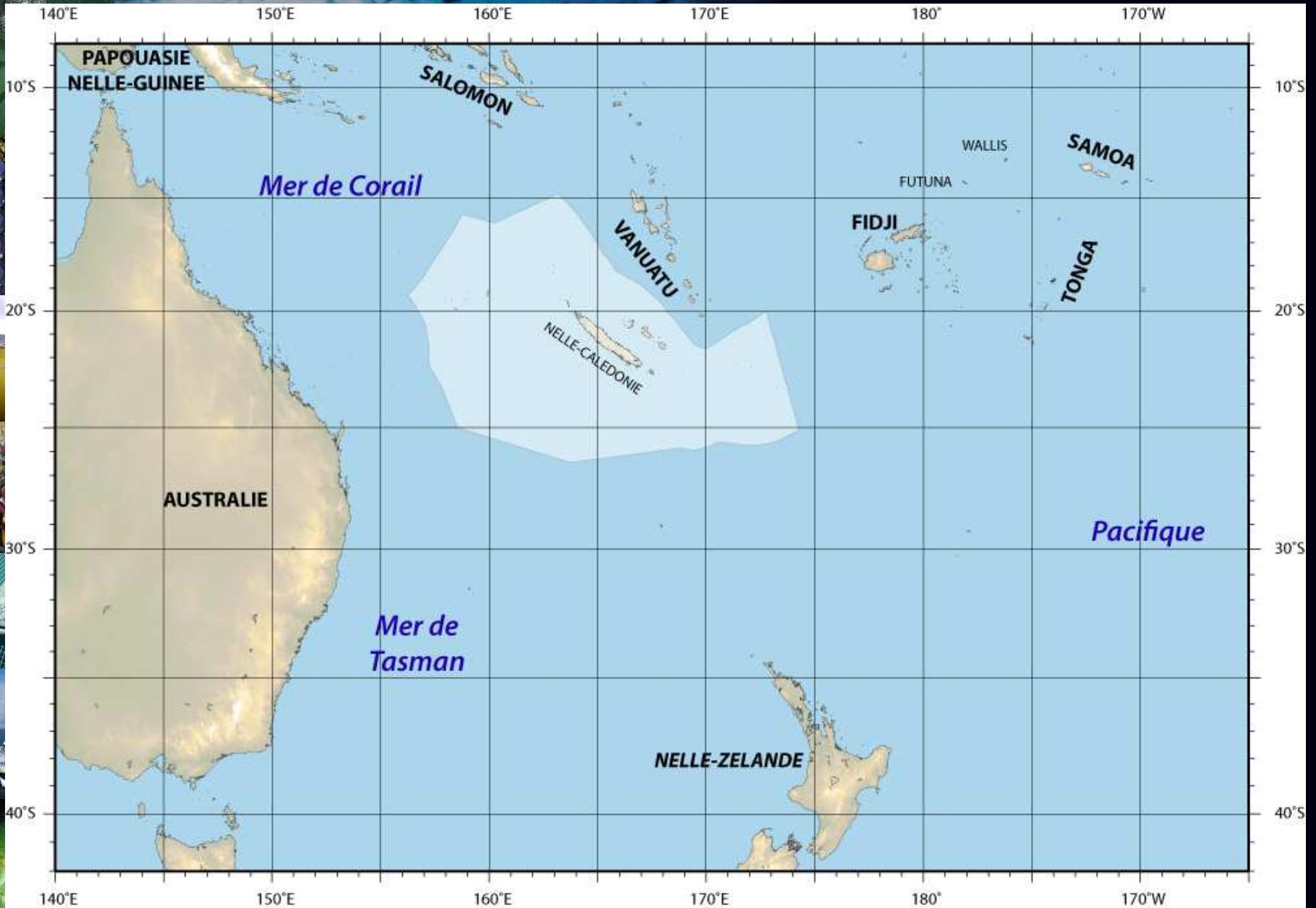
**Julien Collot (SGNC), Caroline Juan (Zonéco),
Boris Marcaillou (IRD), Martin Patriat (Iframer), Bernard Pelletier (IRD),
Pierrick Rouillard (Zonéco)**

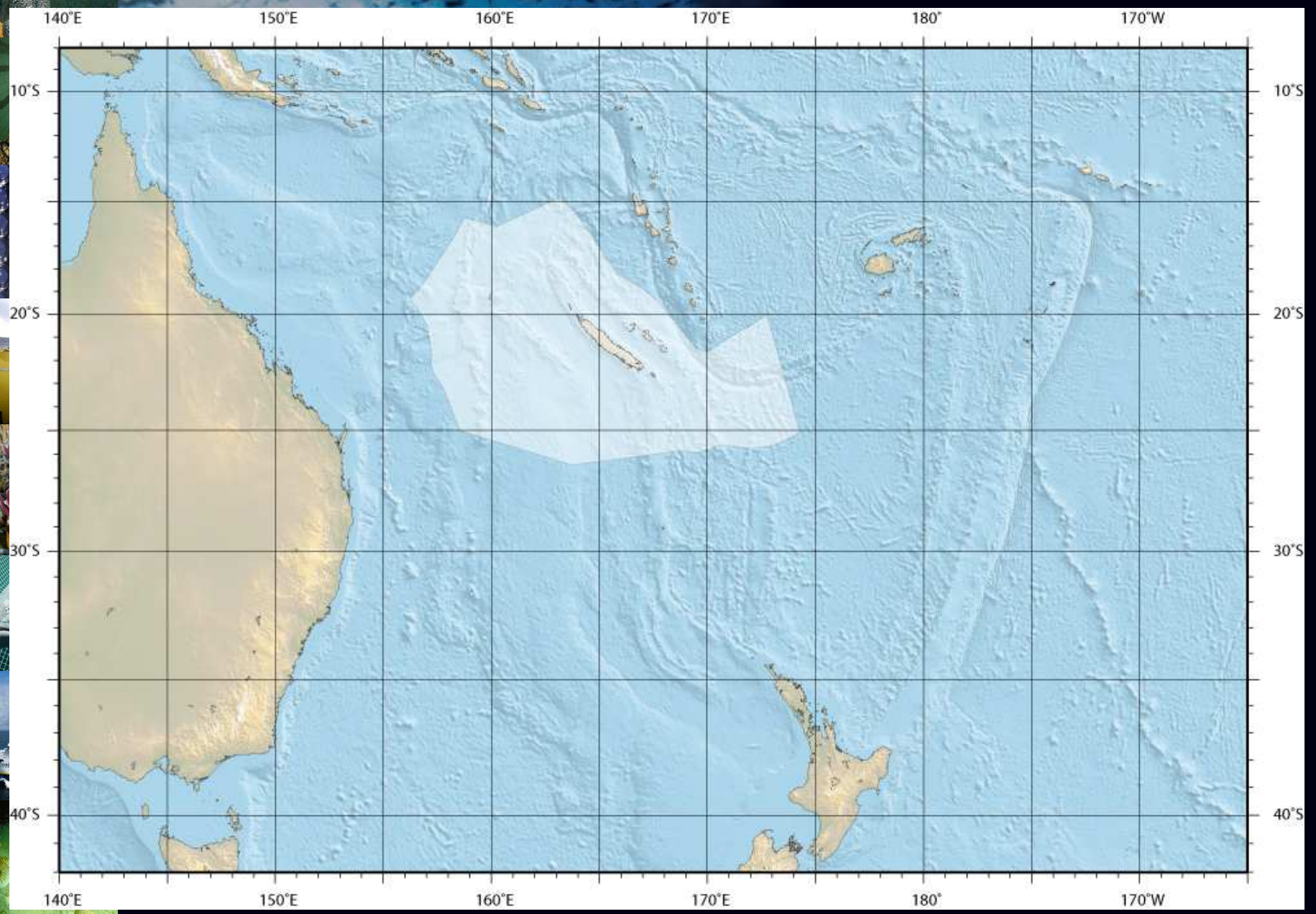
Ifremer

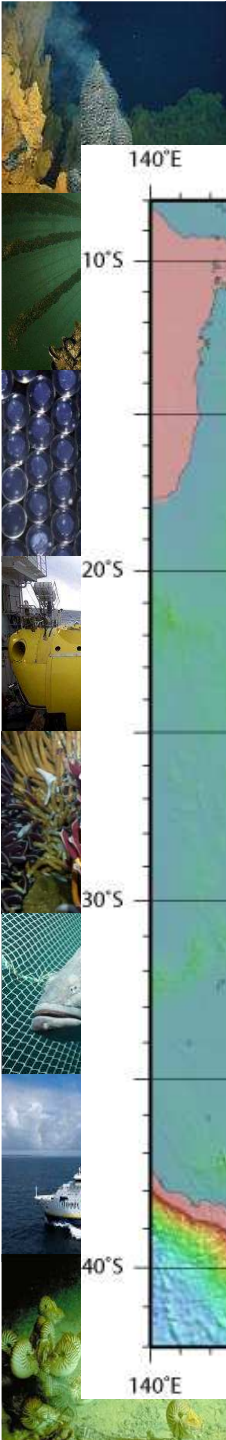
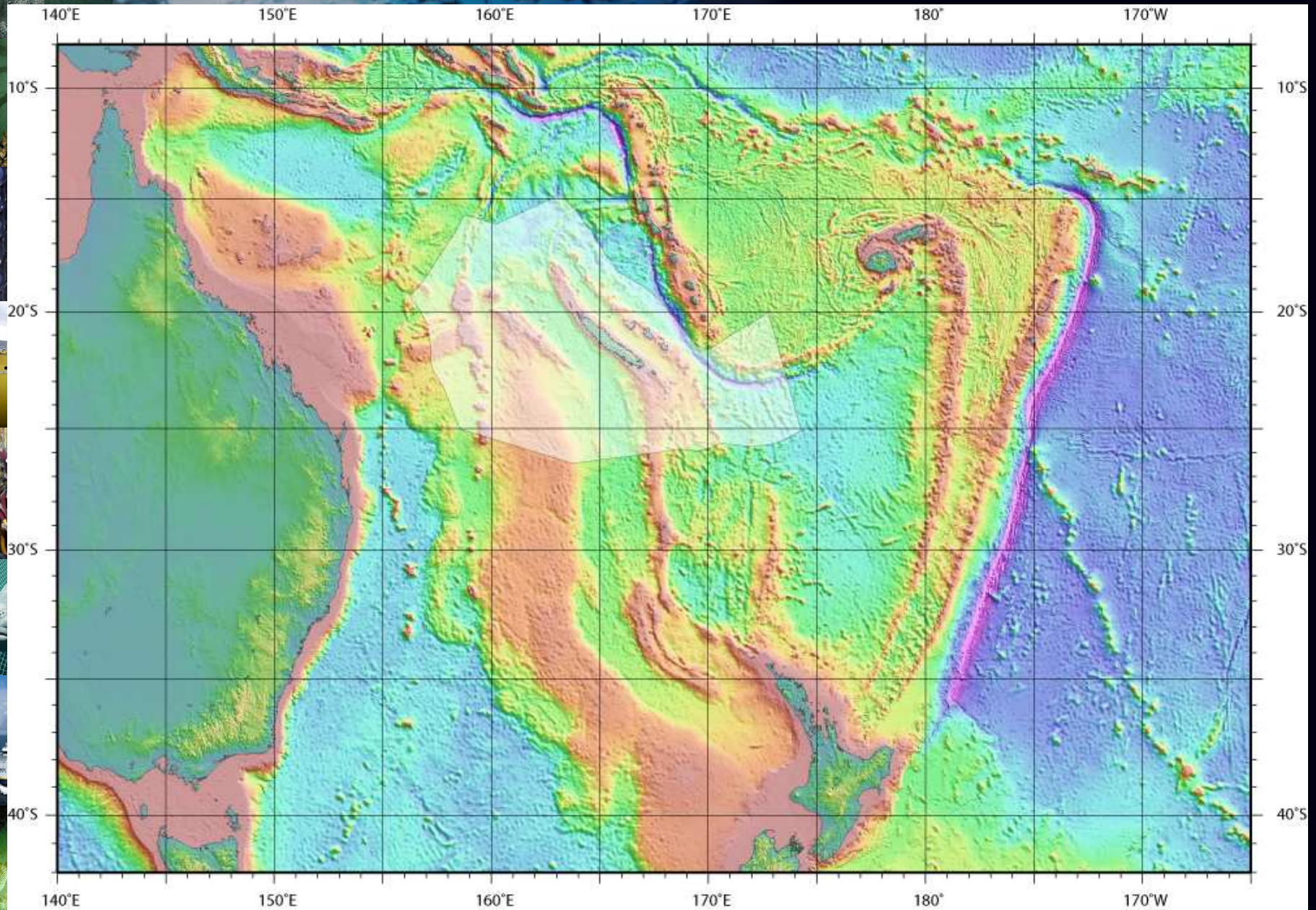


Ifremer









Géodiversité Marine de Nouvelle-Calédonie

Origine et Enjeux

I) Géologie du domaine marin de Nouvelle-Calédonie

Histoire géologique depuis la fragmentation du Gondwana

Outils, Historique

Organisation en NC

Questions et Recherches en cours (TECTA, VESPA ...)

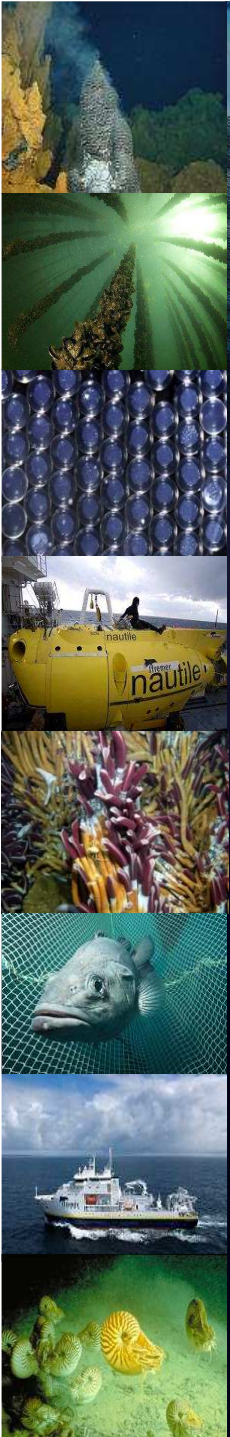
II) Enjeux

Quelles ressources ?

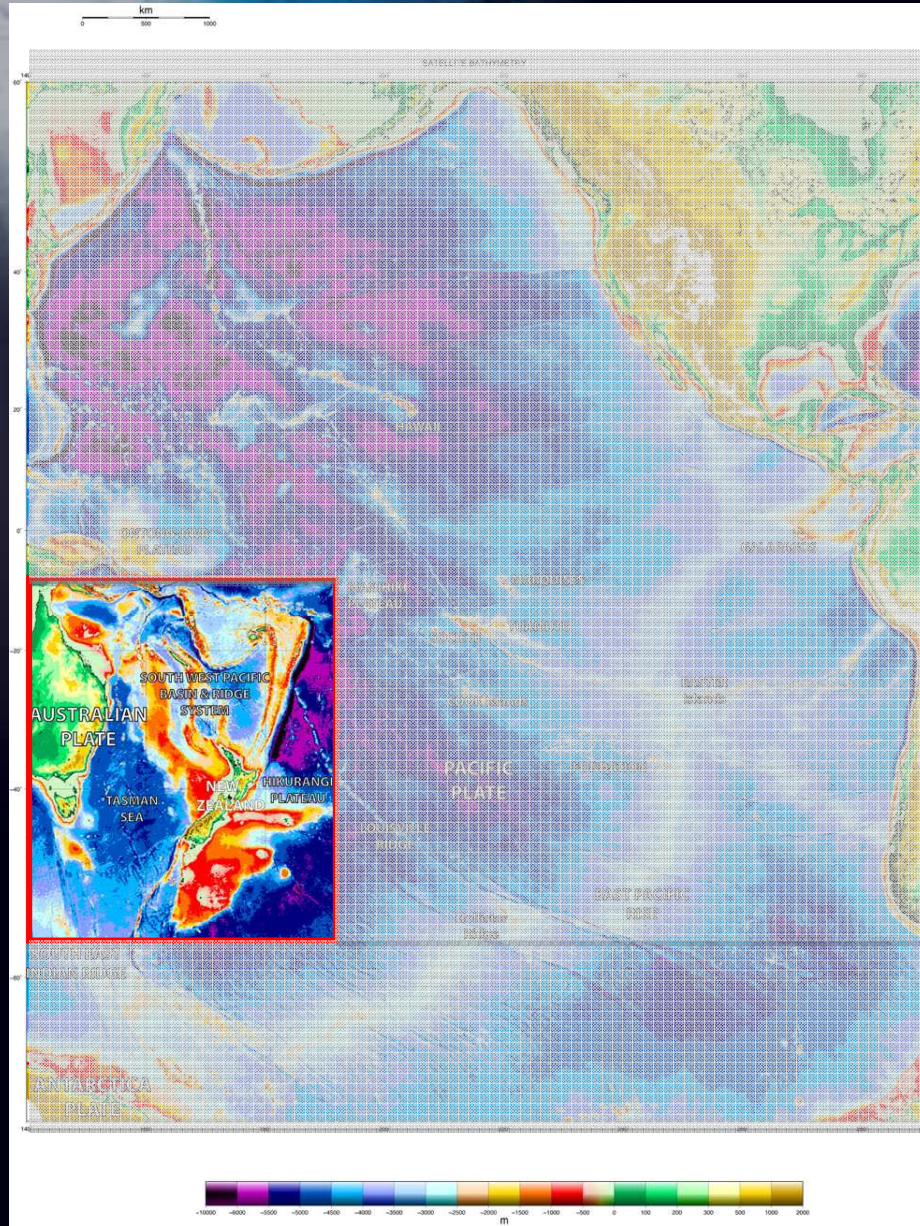
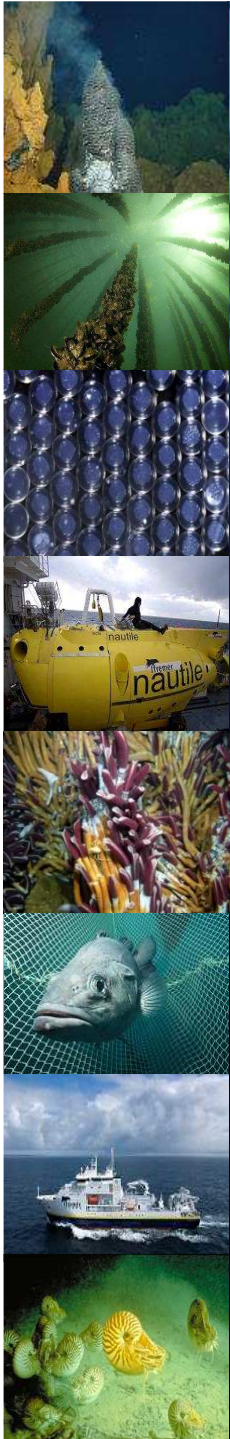
Ressources hydrocarbures

Ressources minérales profondes

Autres enjeux (Risques Naturels, Environnement ... ?)



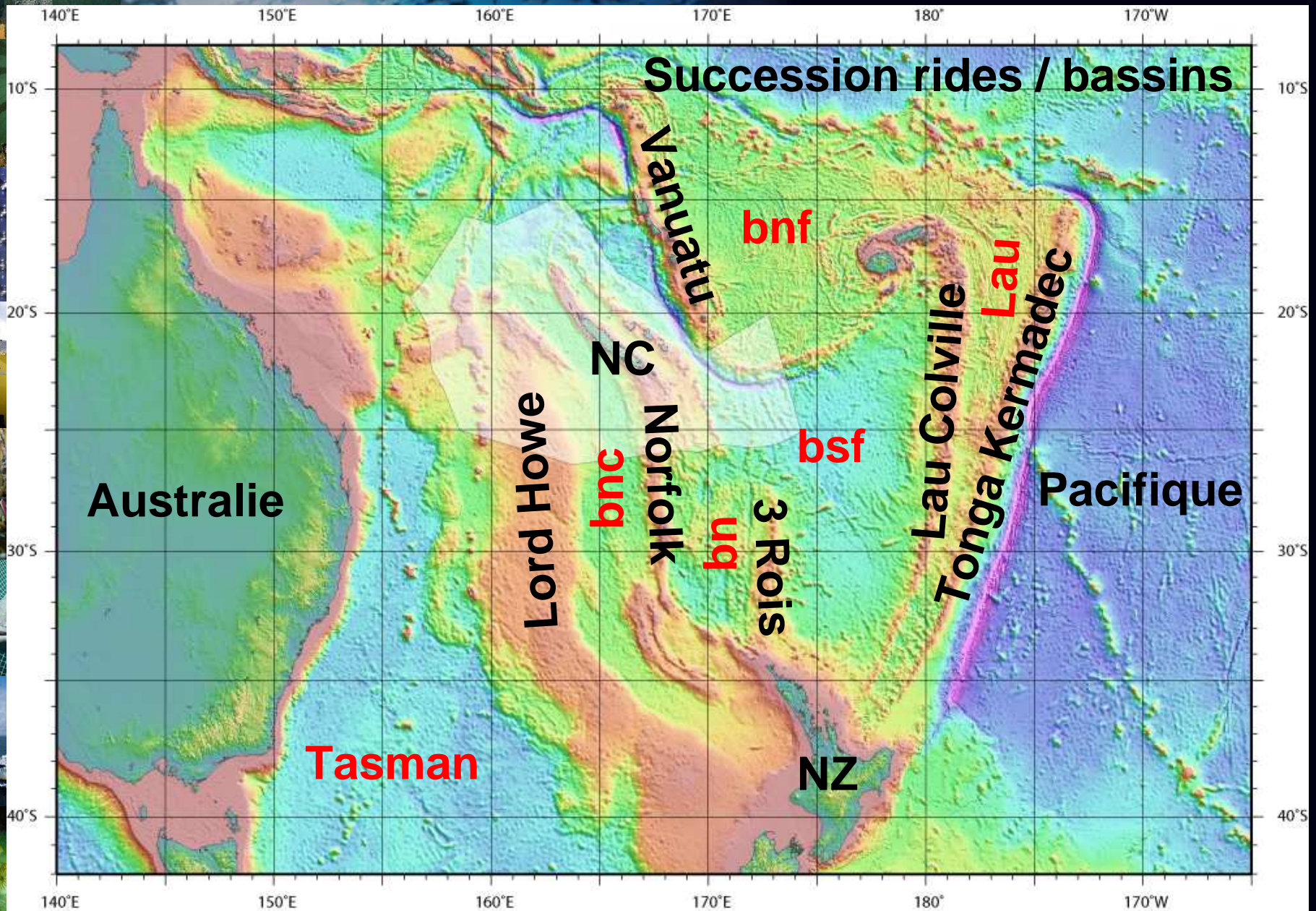
Le Pacifique



Recreated sea floor topography
Smith & Sandwell, 1997

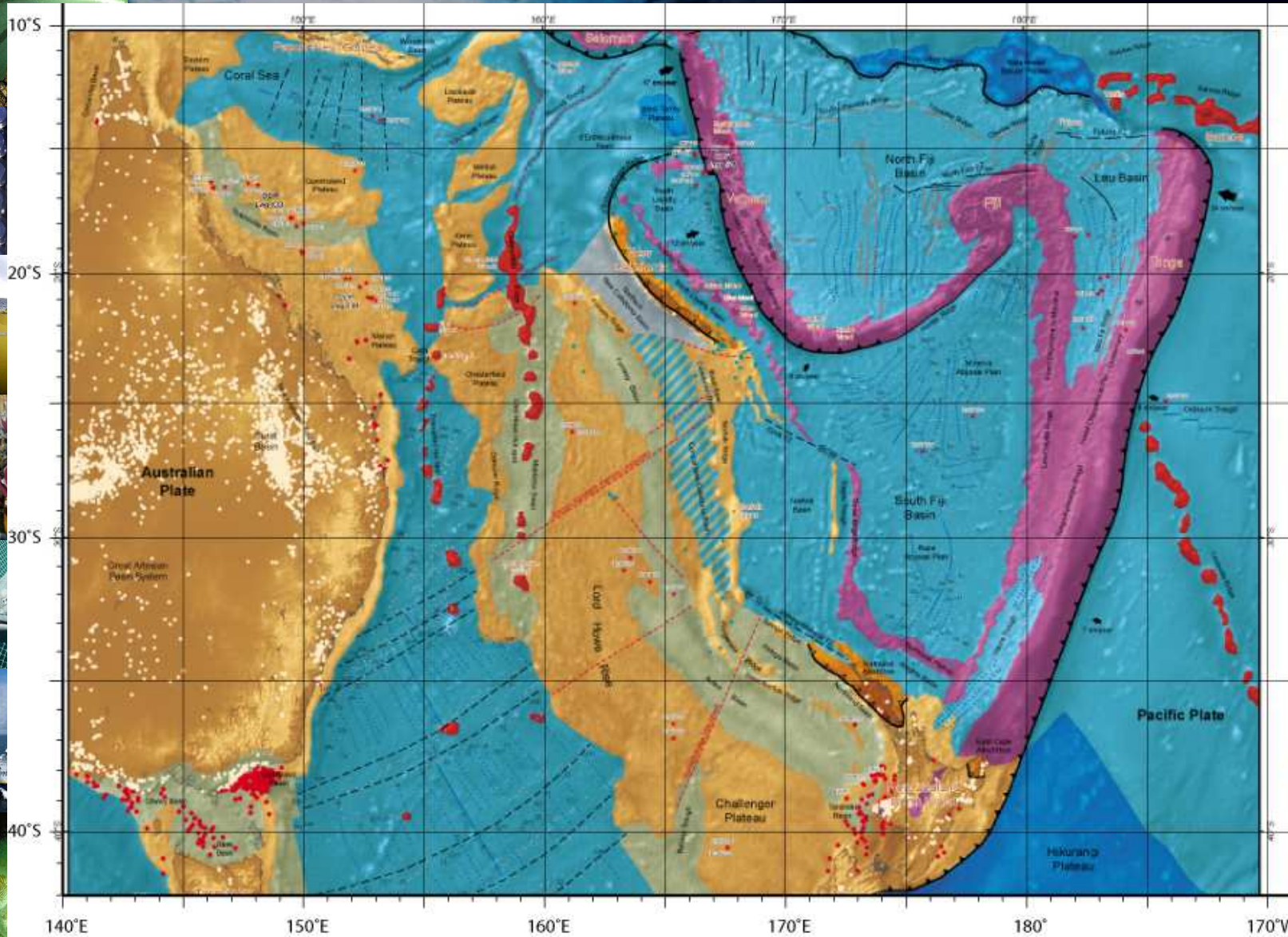
La situation actuelle

Ifremer

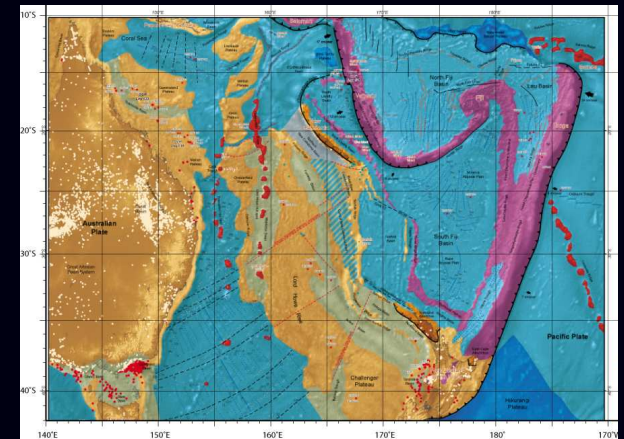
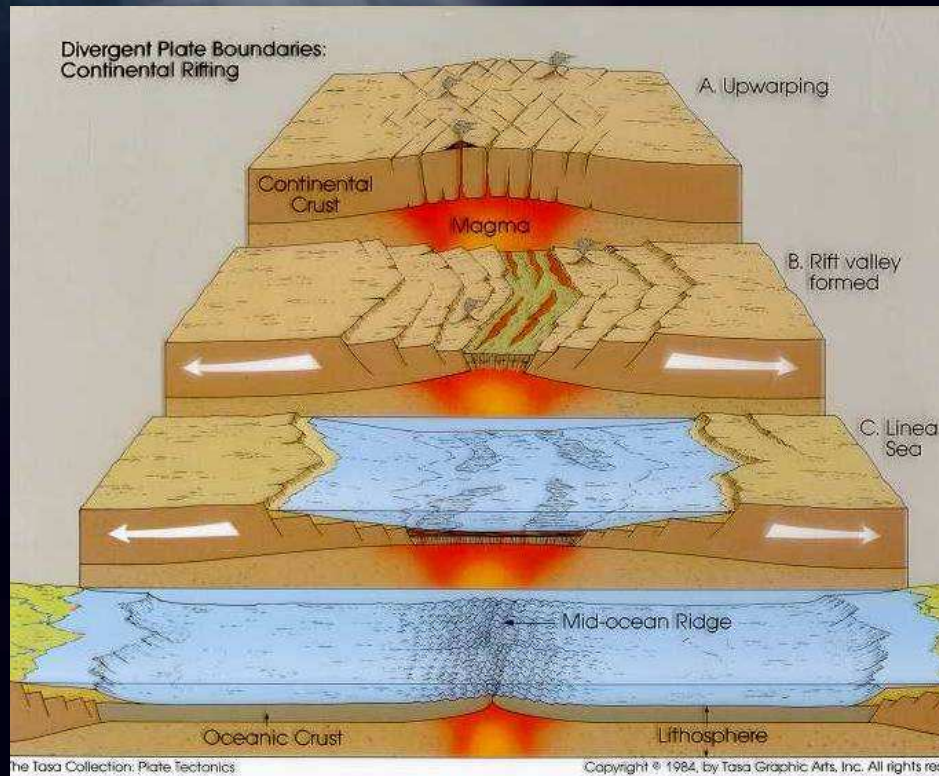
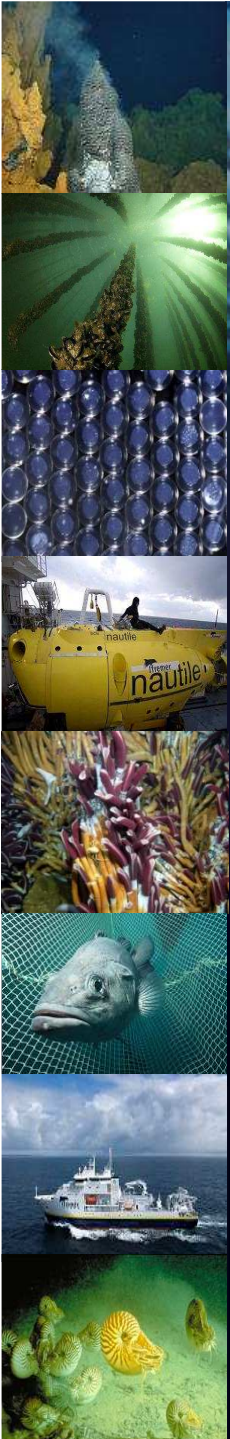


La situation actuelle

Ifremer

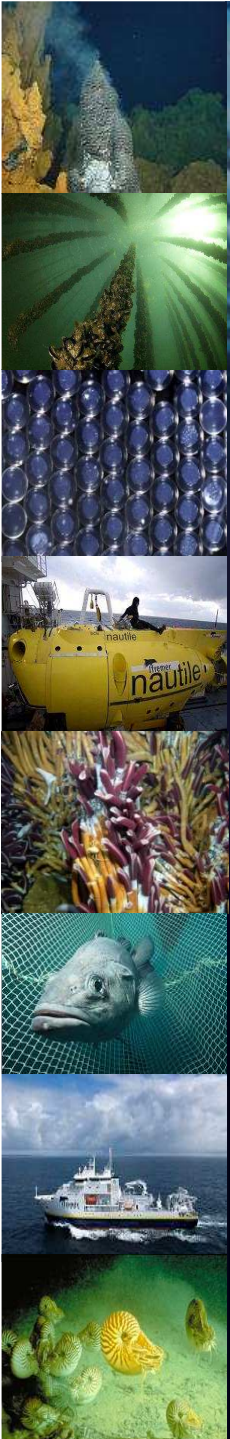
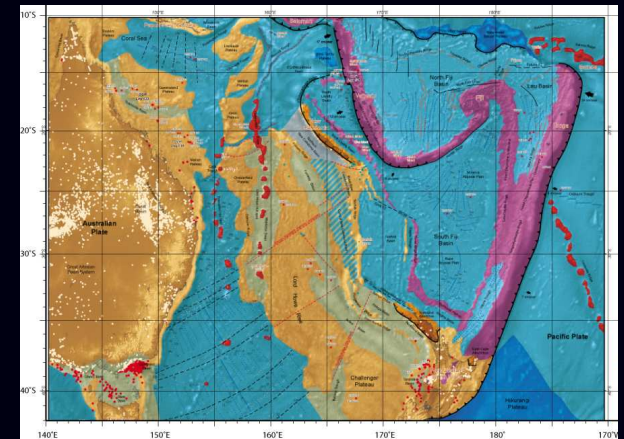
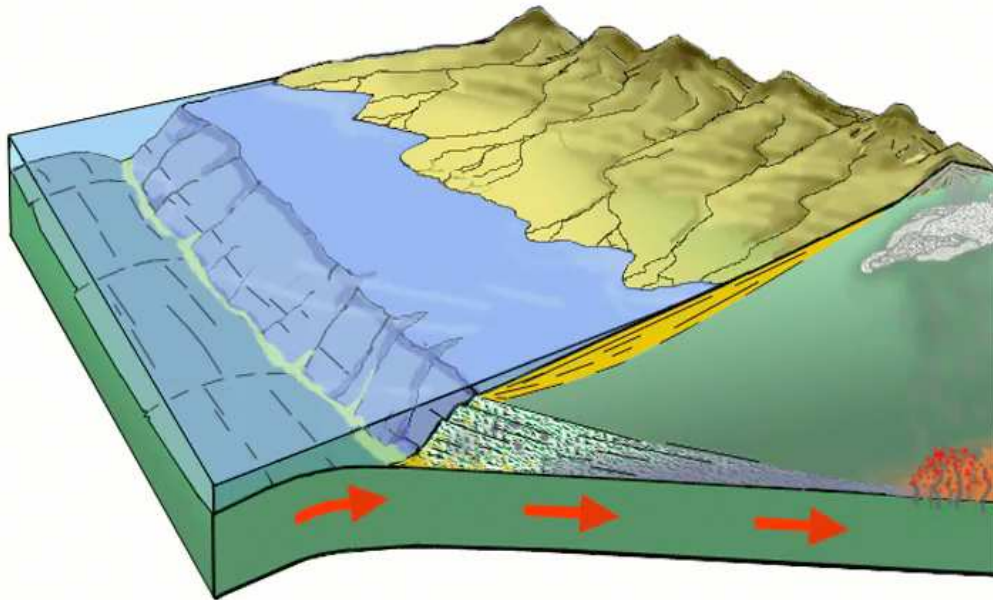


Lithosphère continentale et océanique

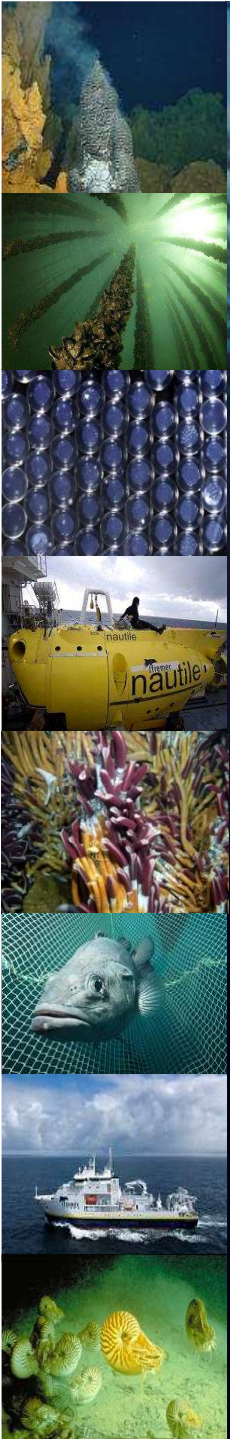
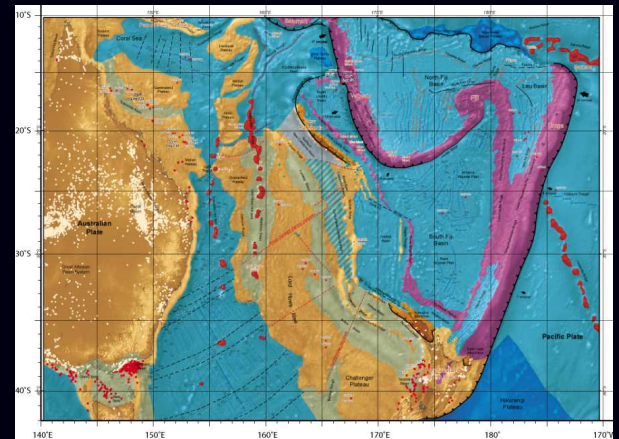
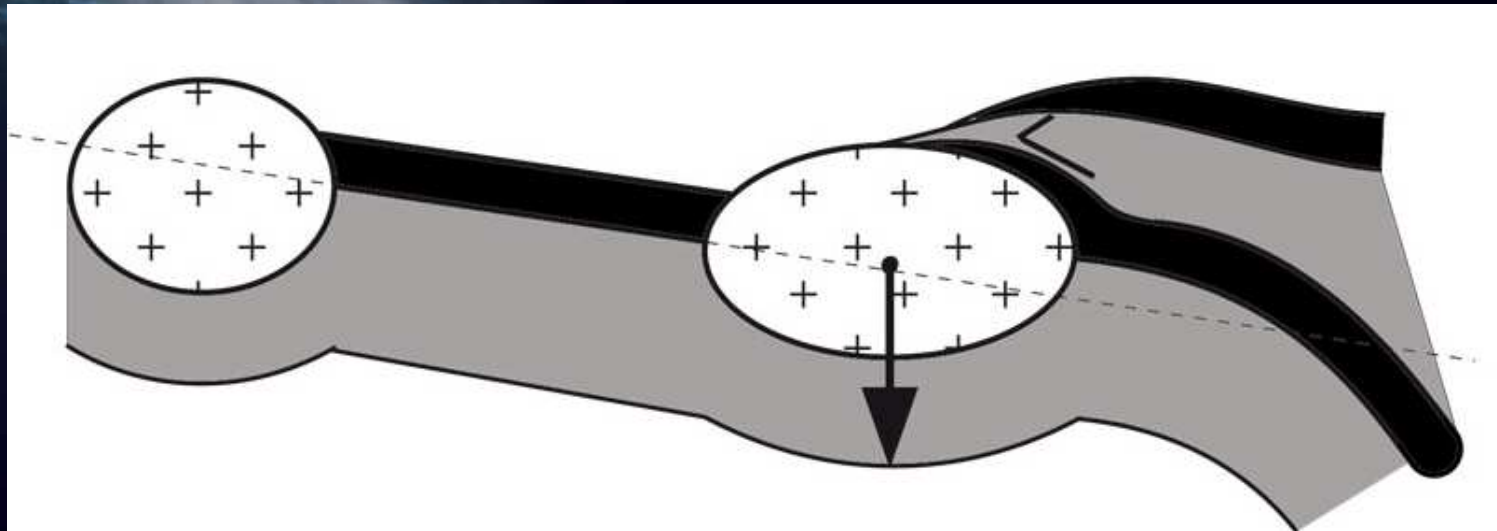


Subduction et arcs volcaniques

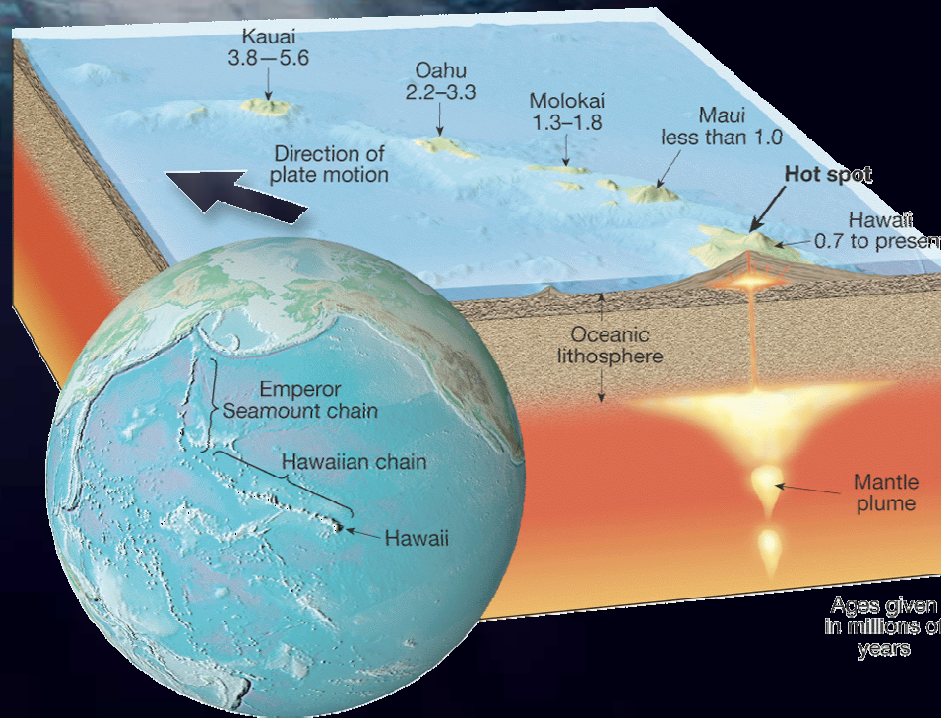
Animation subduction



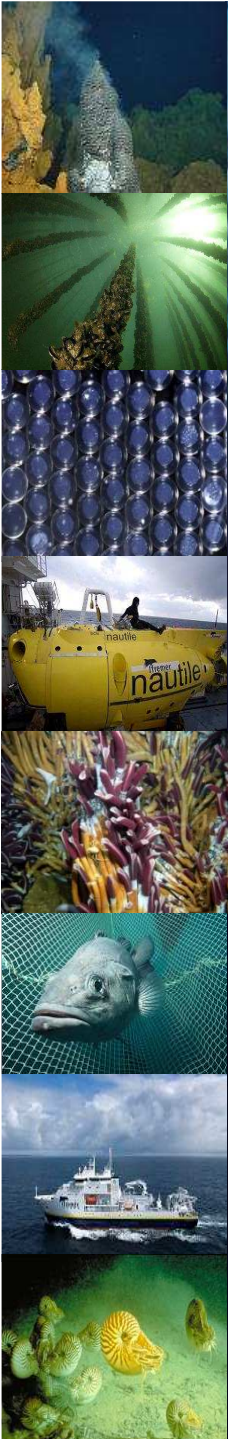
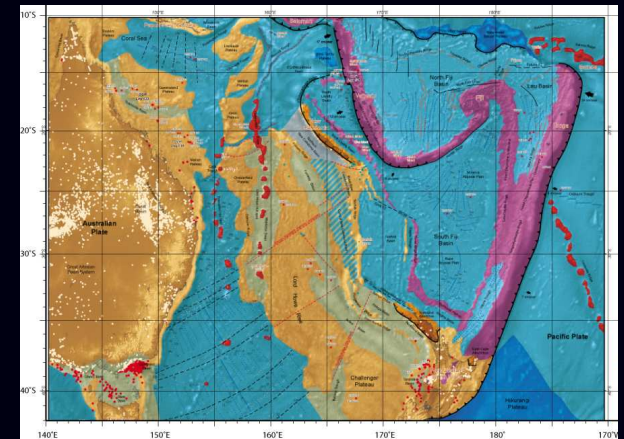
Lithosphère océanique obductée



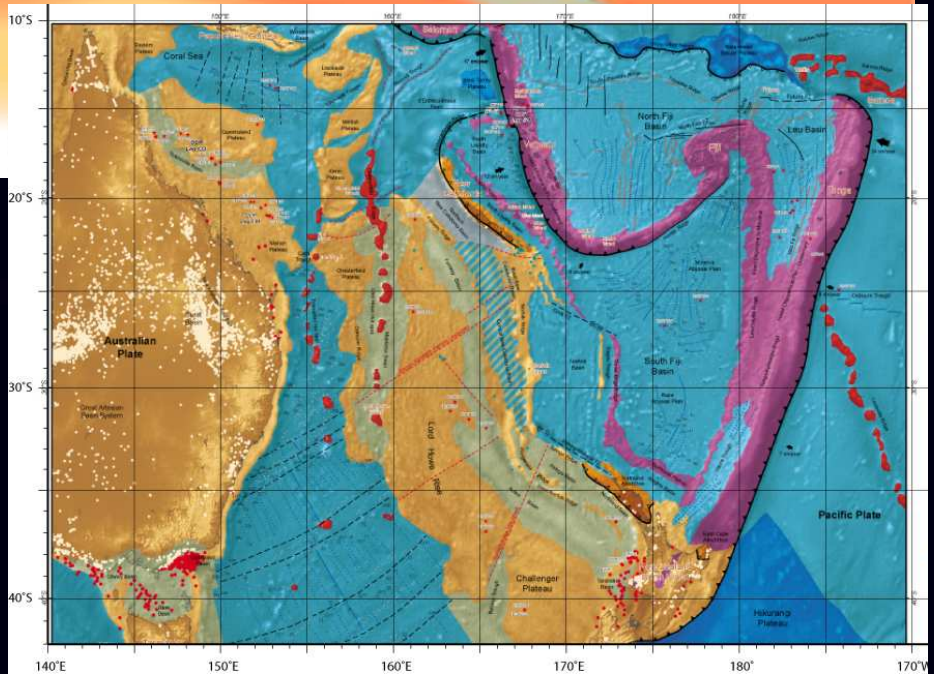
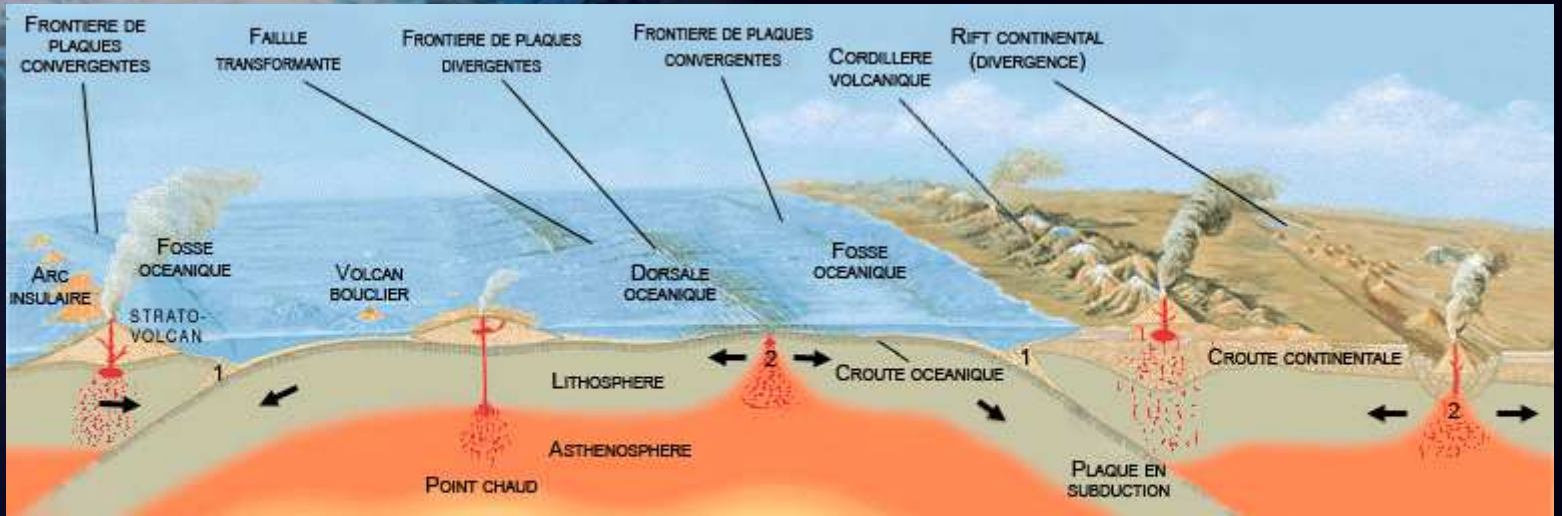
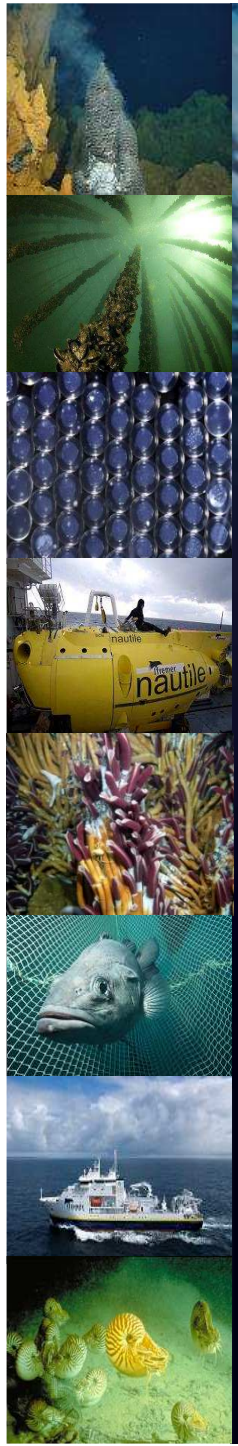
Points chauds



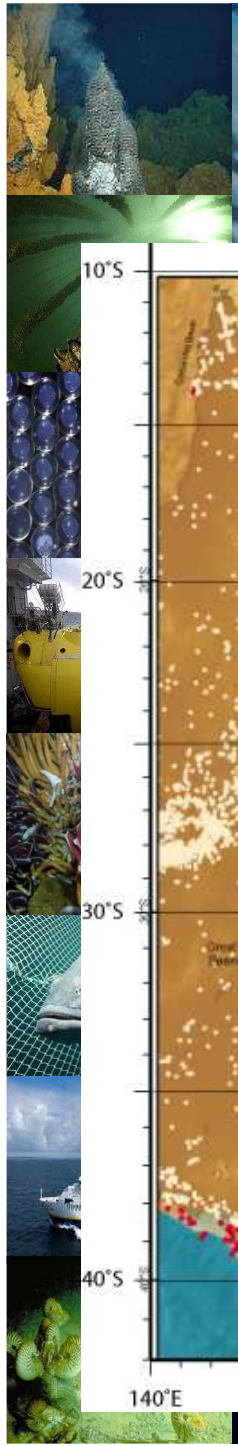
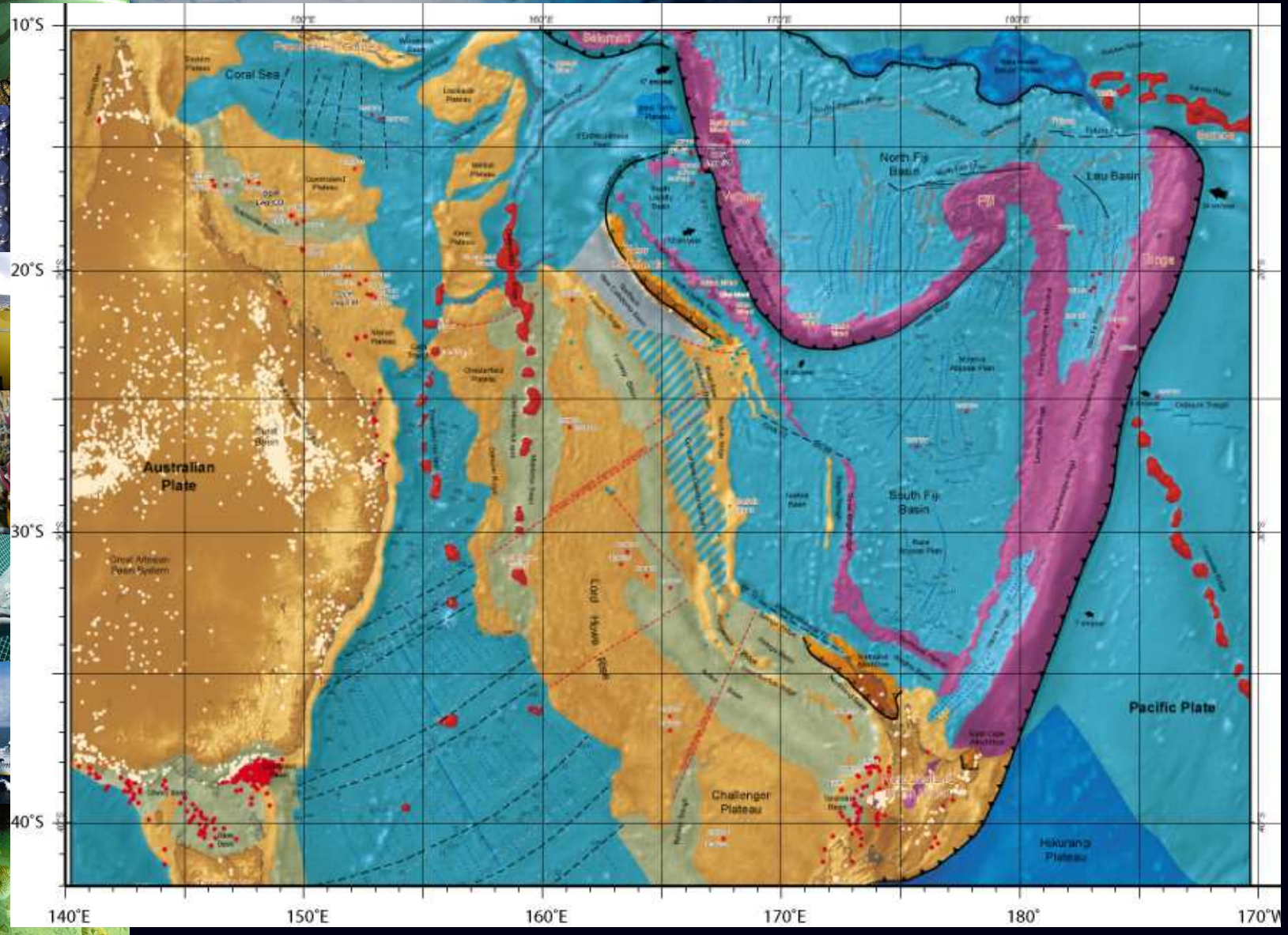
Ages given in millions of years



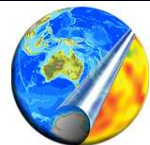
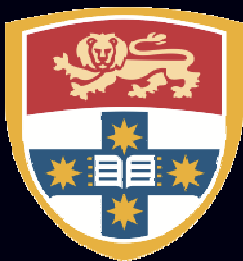
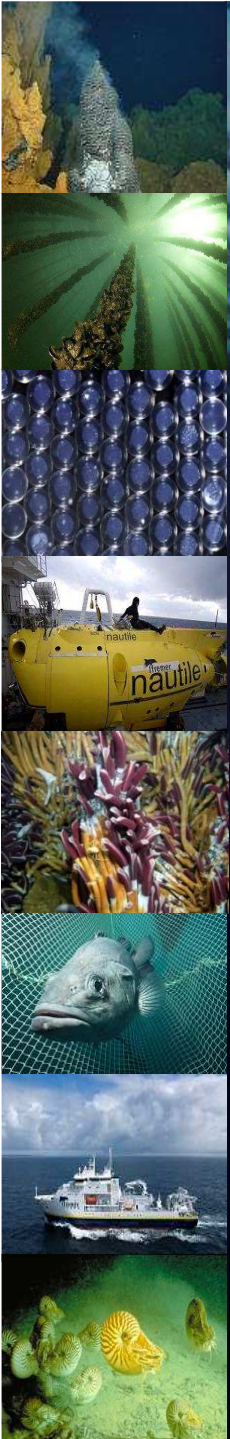
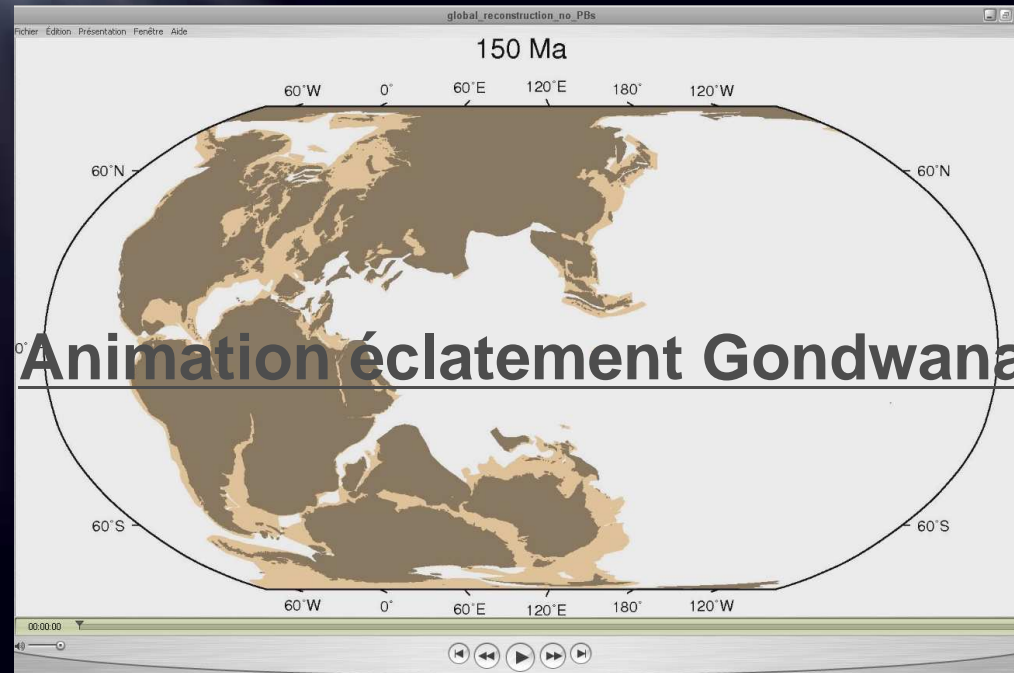
Géodiversité exceptionnelle



D'où vient cette géodiversité ?



La tectonique des plaques globale



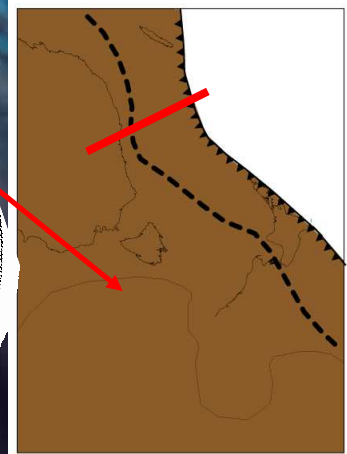
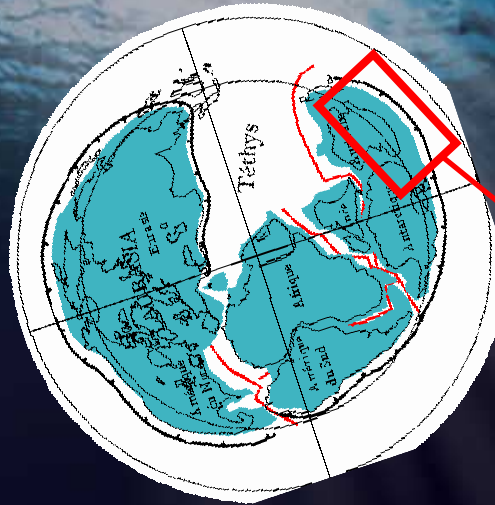
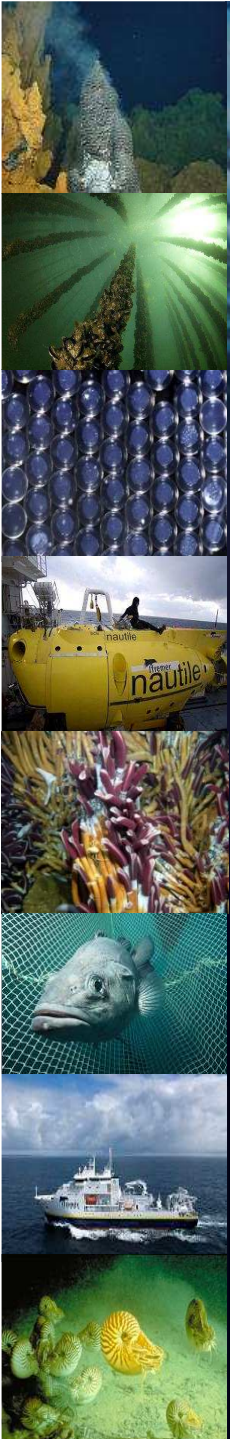
Earth **BYTE**

Linking observations to kinematic and dynamic models

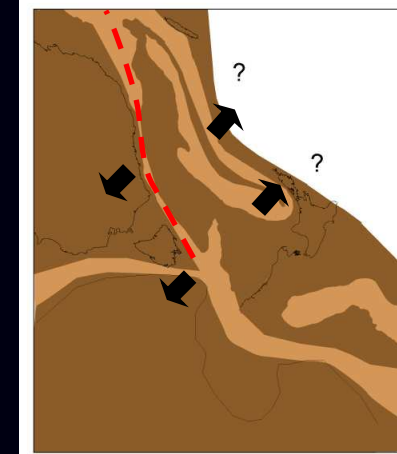
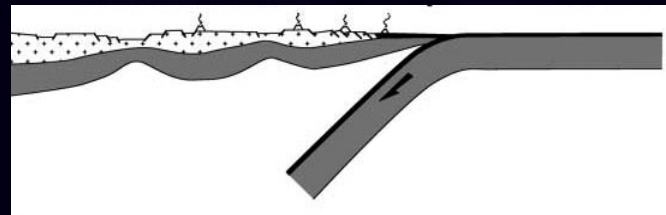
<http://www.earthbyte.org/>

Phases Tectoniques

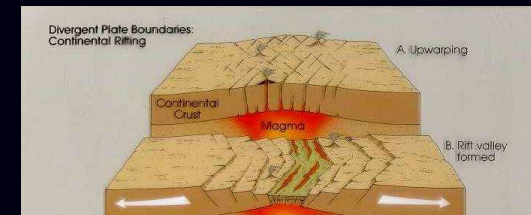
lfremer



Phase 1
Subduction
Autour du Gondwana

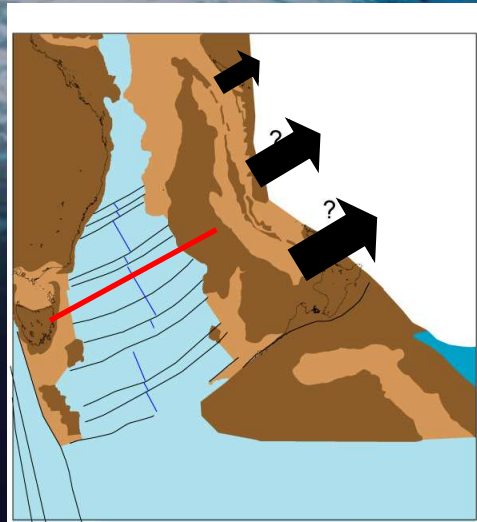
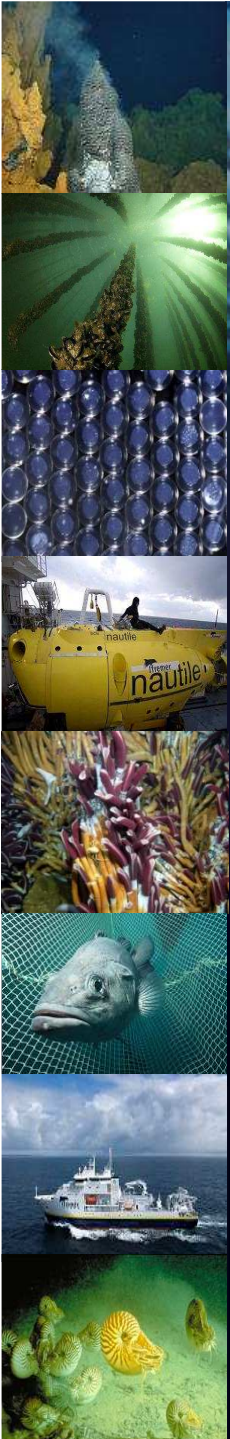


Phase 2
Extension
généralisée

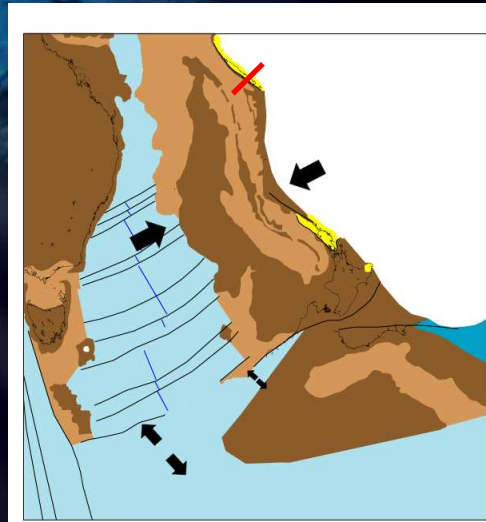


Phases Tectoniques

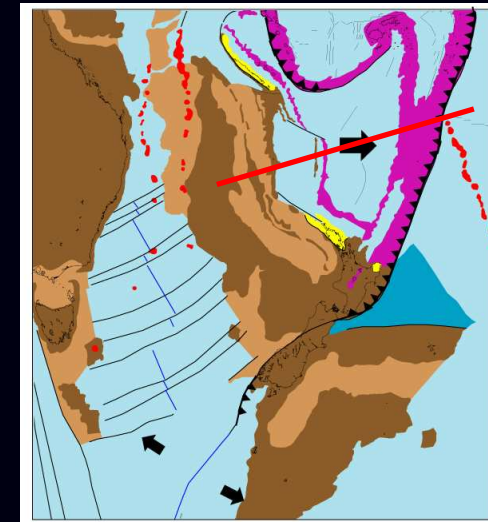
lfremer



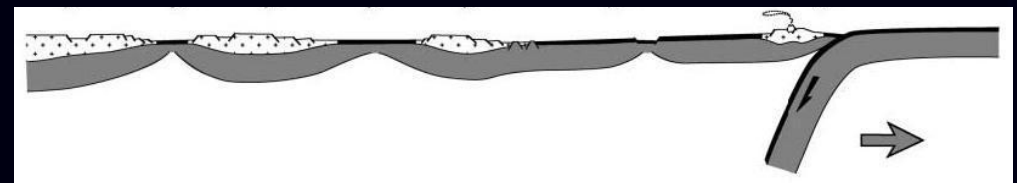
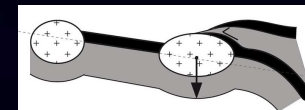
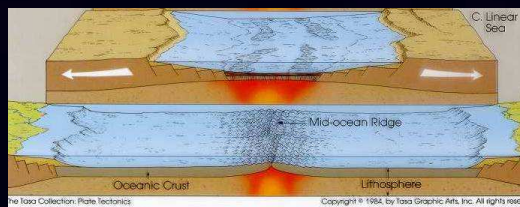
Phase 3
Océanisation
Mer de Tasman

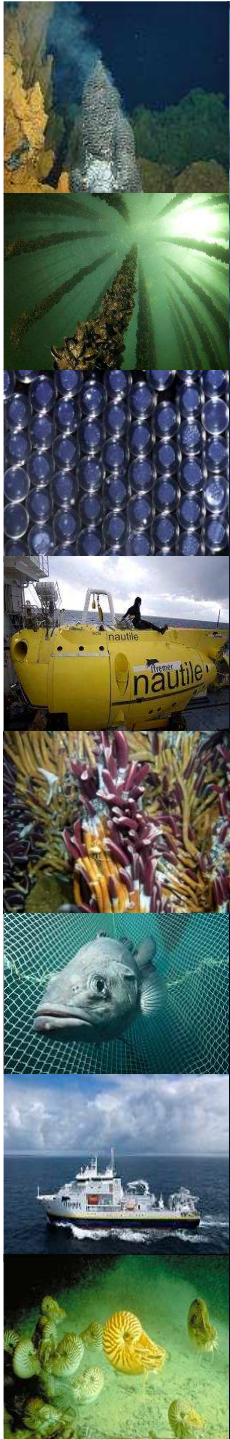


Phase 4
Compression

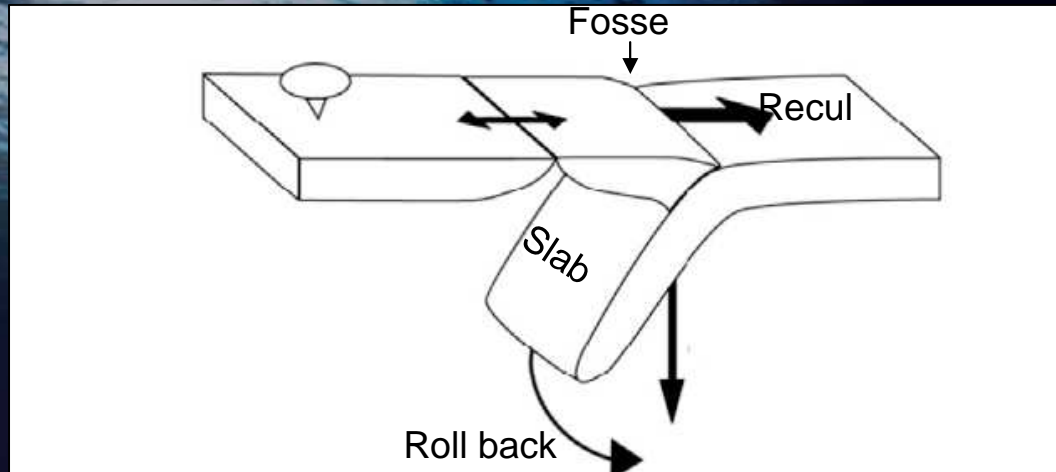


Phase 5
Recul de la zone de
subduction





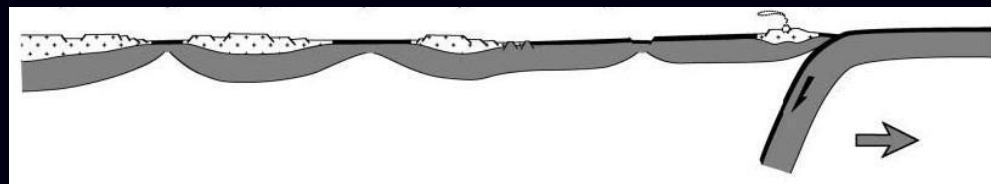
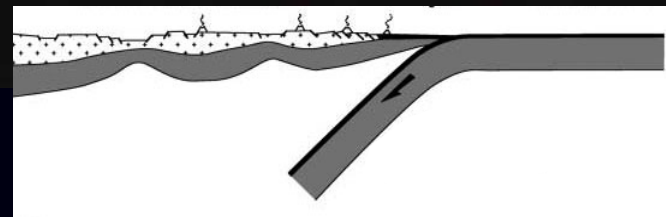
Moteur de ce recul ?



Heuret (2005), modifié



Animation Roll Back



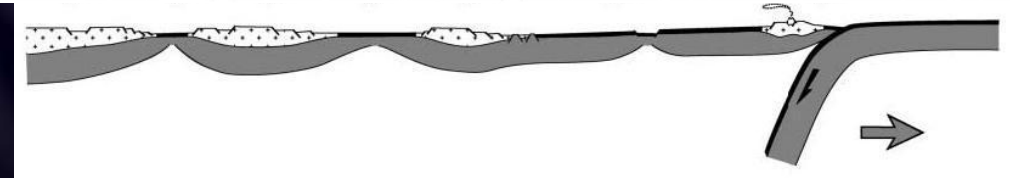
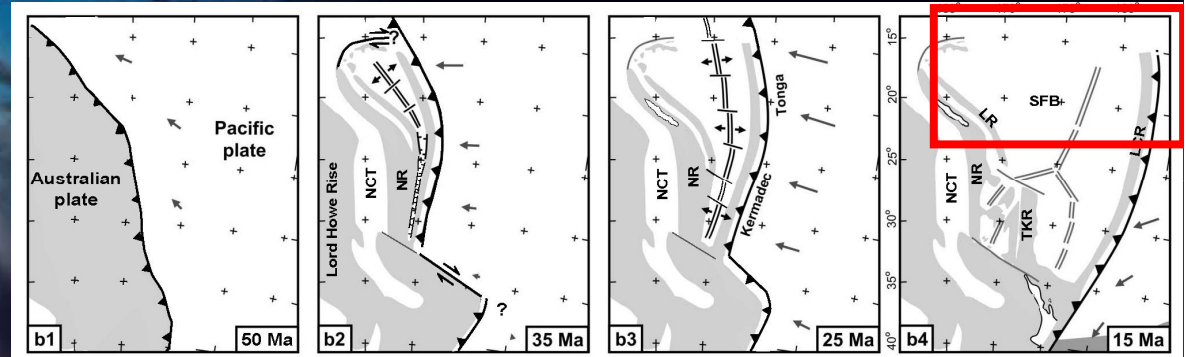
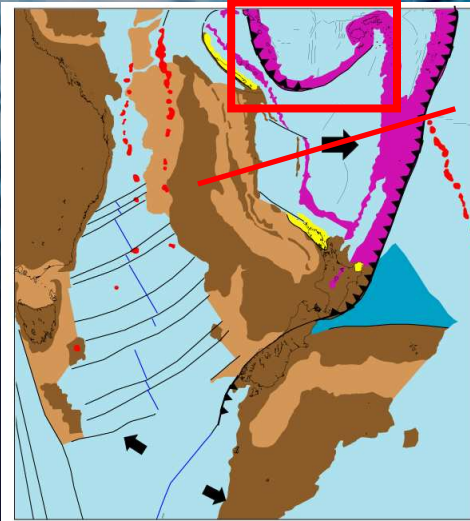
lfremer

**Processus de
Recul de la
fosse
par
Rollback du
Slab**

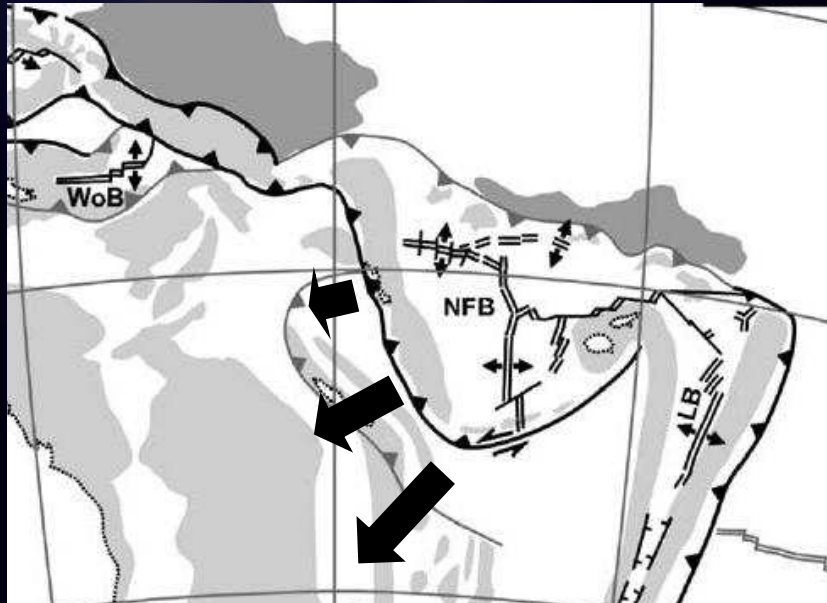
Phases Tectoniques

lframer

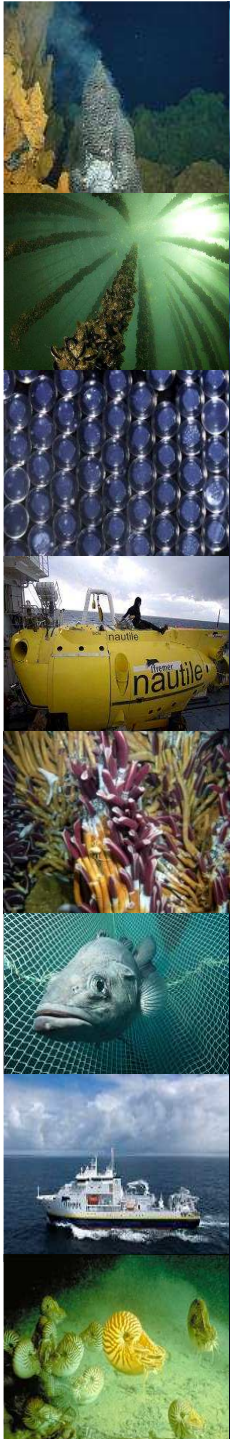
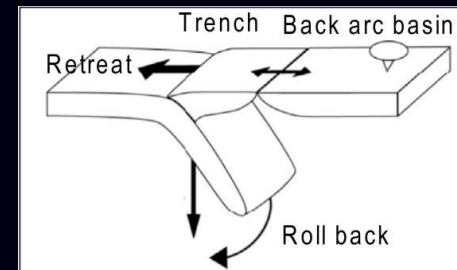
Recul Tonga Kermadec



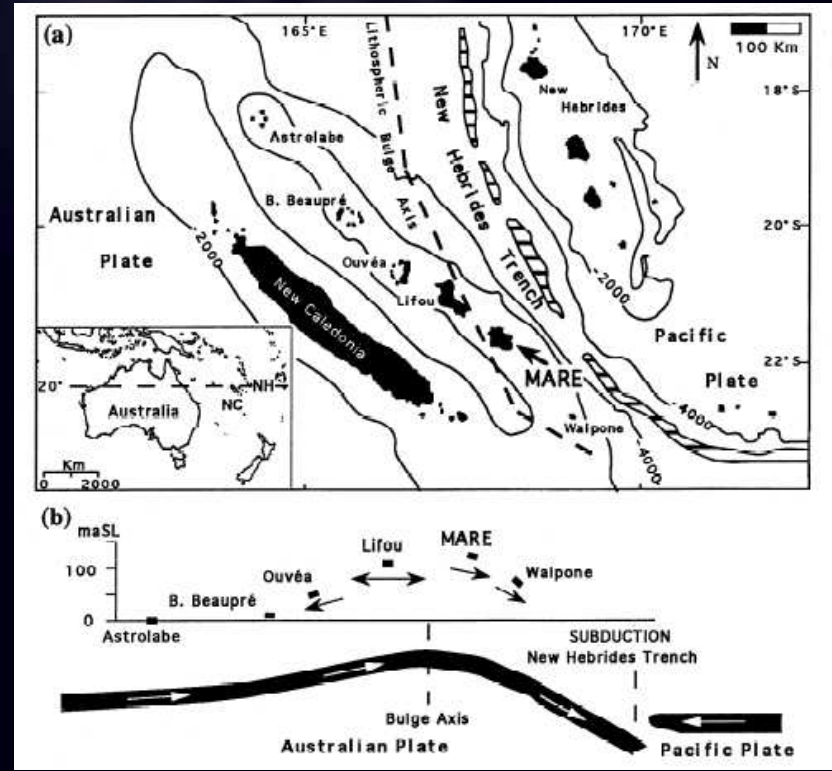
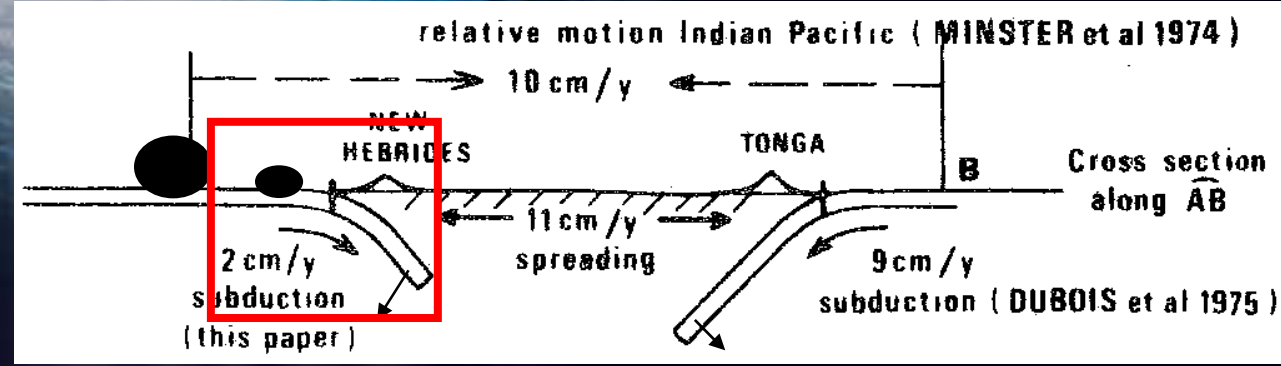
Recul de la zone de subduction



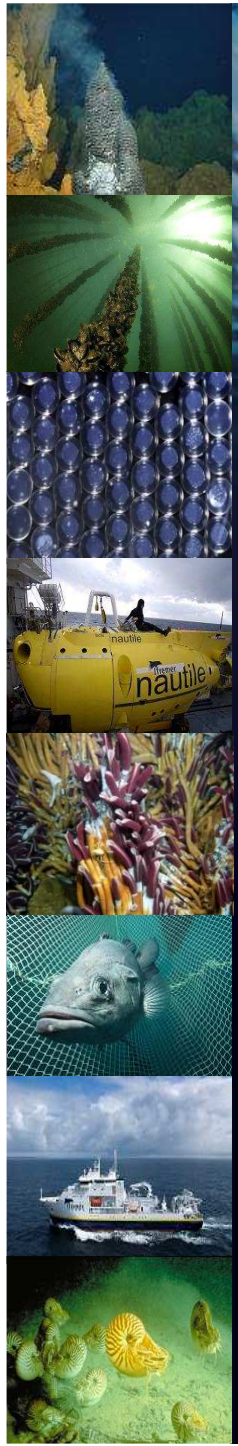
Recul subduction Vanuatu



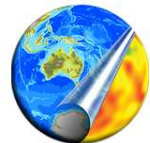
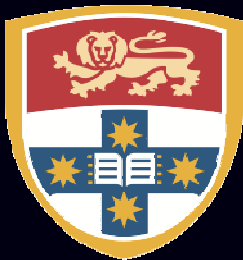
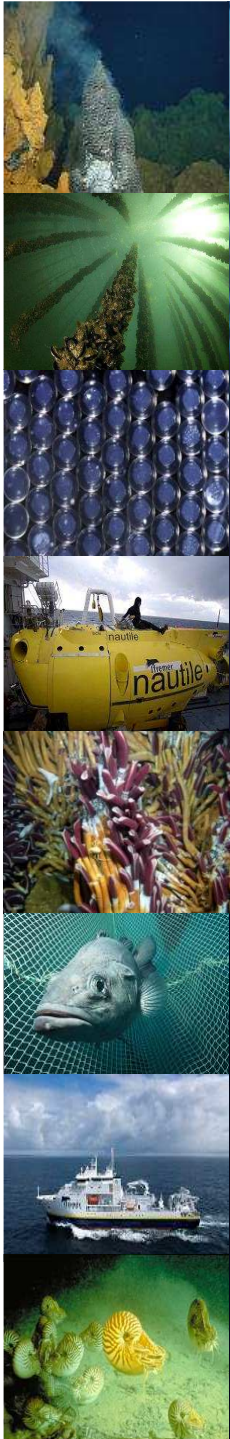
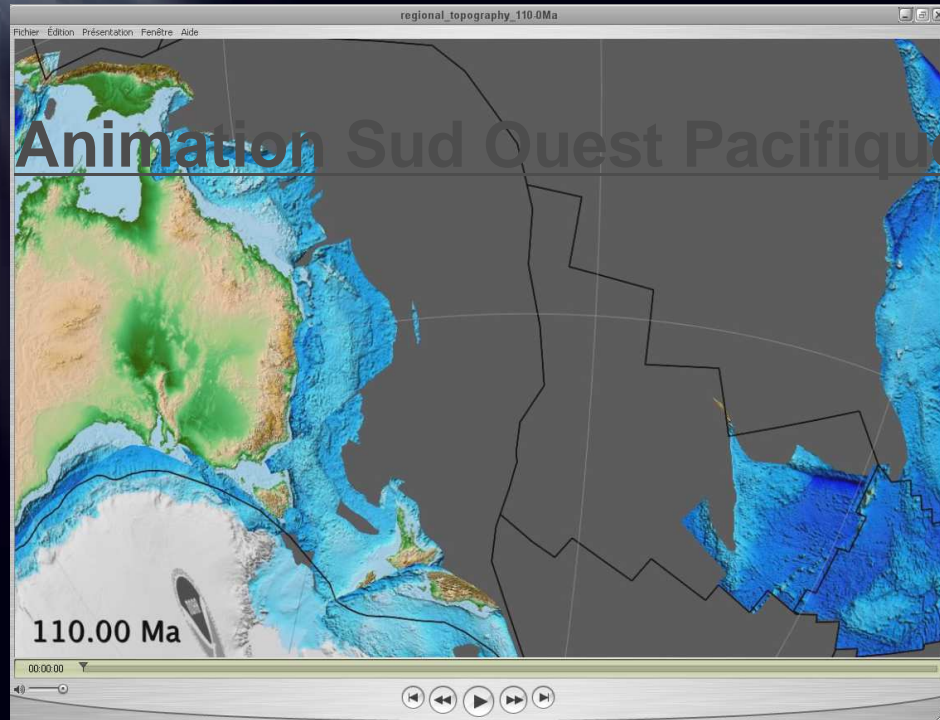
2 subductions se faisant face !



Soulèvements des Loyautés



Modèle de tectonique des plaques du Sud Ouest Pacifique

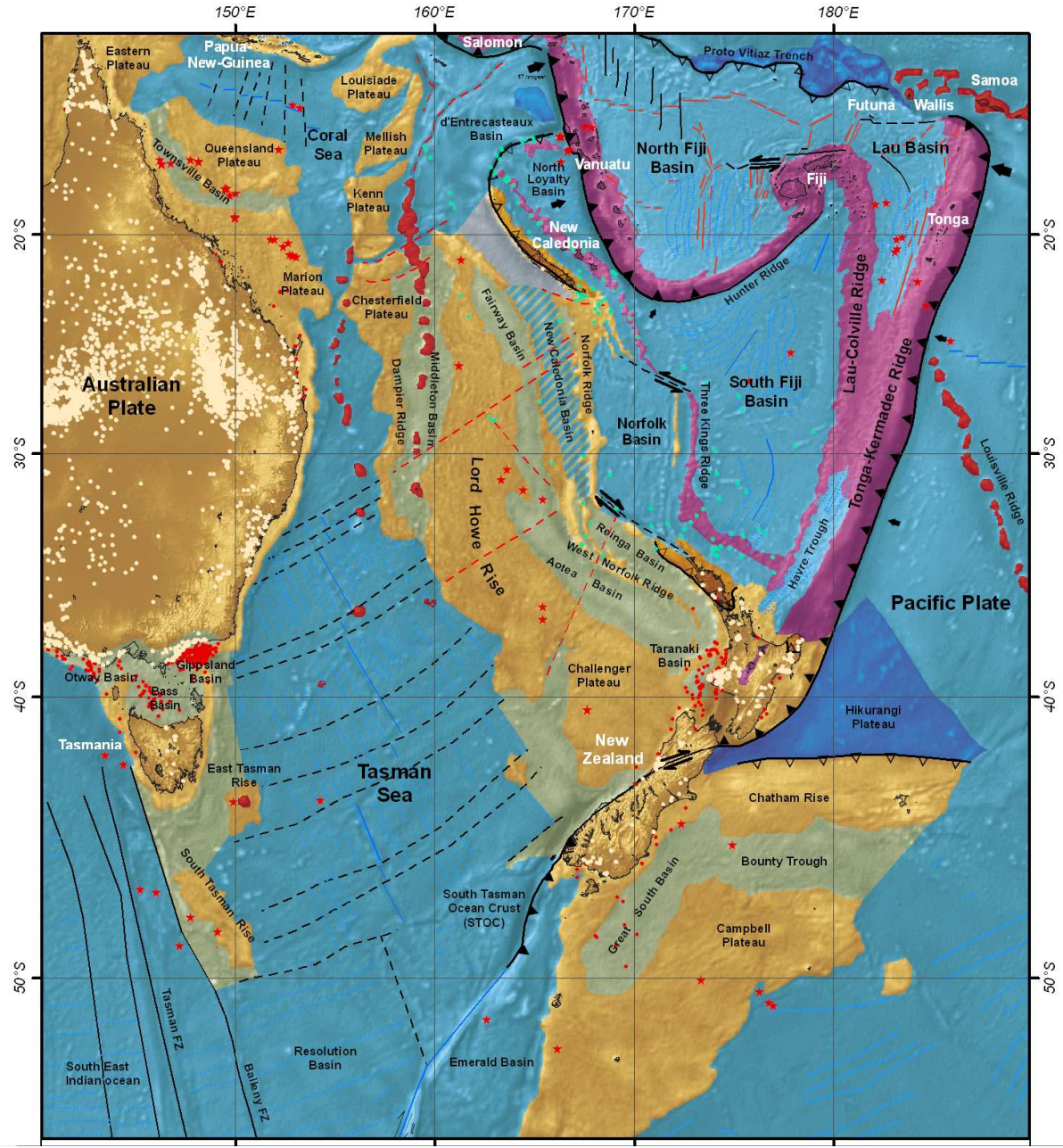


Earth **BYTE**

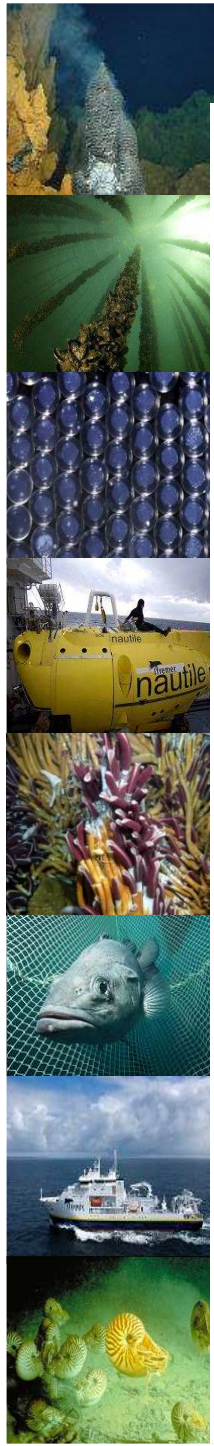
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<http://www.earthbyte.org/>

Nature of basement



**MARGE
CONTINENTALE
FRAGMENTEE
ET
SUBDUCTIONS**



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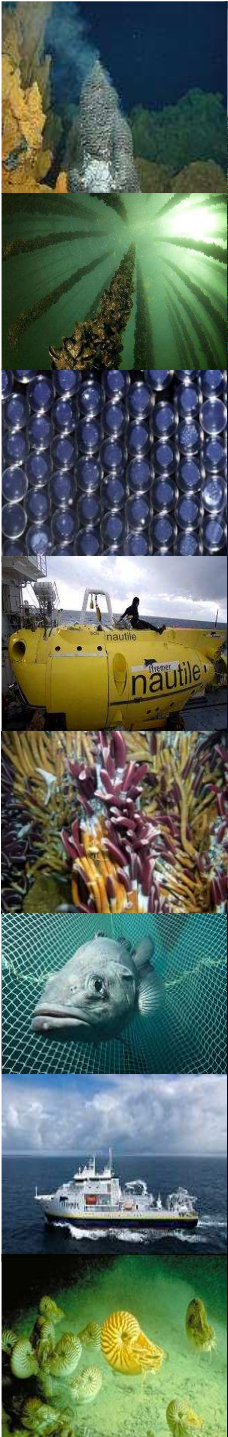
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Quelles ressources ?

Ressources hydrocarbures

Ressources minérales profondes

Autres enjeux (Risques Naturels, Environnement ... ?)



Les Moyens - Navires

Ifremer



N/O L'Atalante
L 85 m, l 16 m
30 scientifiques



N/O Pourquoi Pas ?
L 108 m, l 20 m
40 scientifiques

Ifremer

Sous-marin *LE NAUTILE*



Observations détaillées, mesures et échantillonnage
(roches, sédiments, fluides, organismes)



Engins Téléopérés: ROV

Ifremer

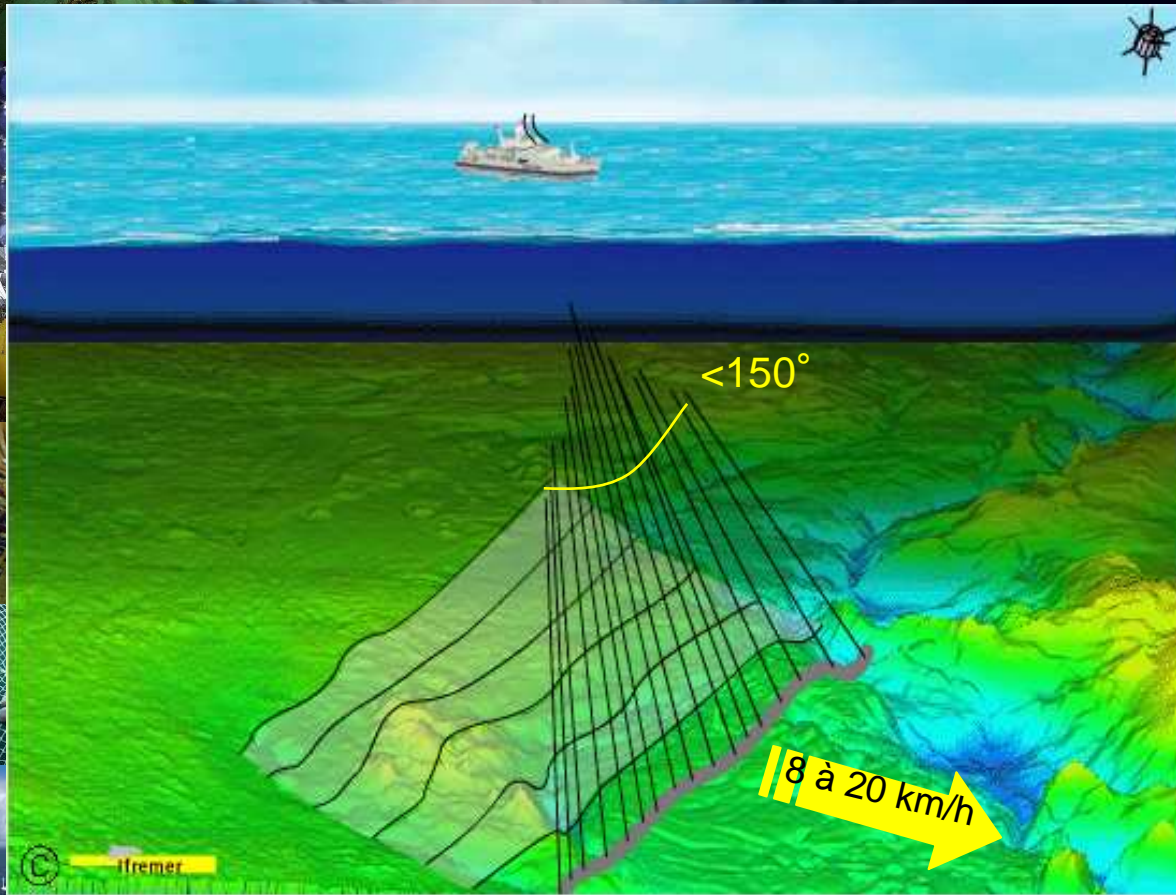


VICTOR

Two modules :

- Exploration and sampling
- Detailed observation, measurements and sampling (Rocks, Sediments, Fluids, Animals)

Cartographie par sondeur multifaisceau



Bathymétrie

Réflectivité, Nature des fonds

Précision de la sonde variable

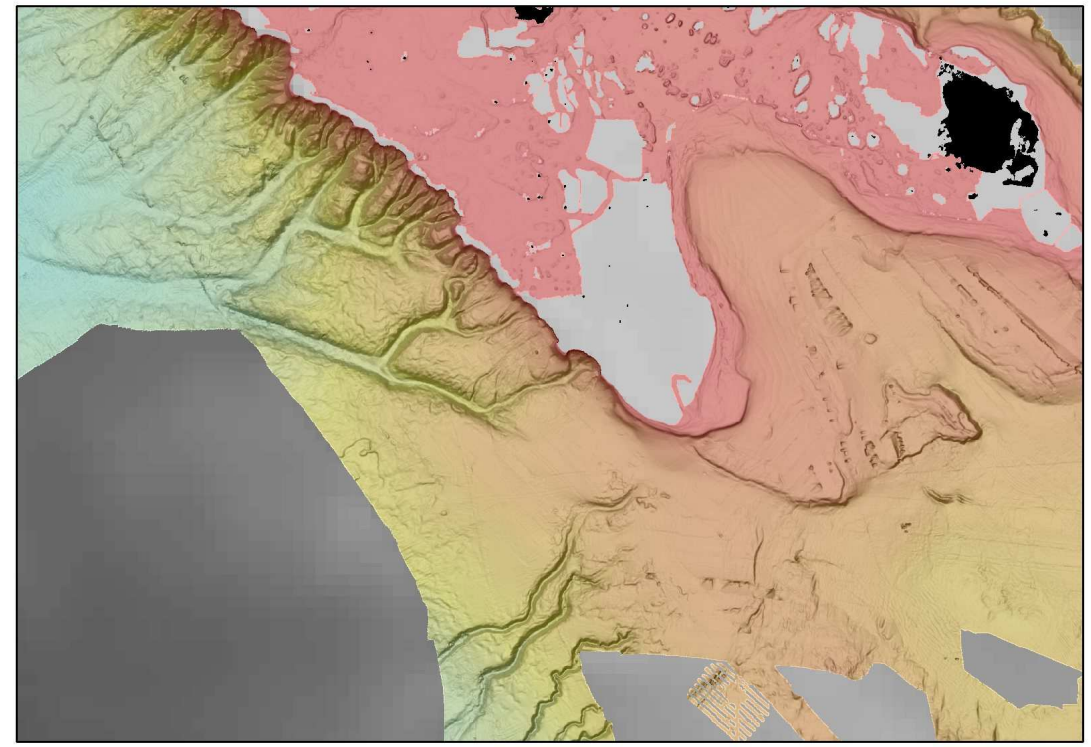
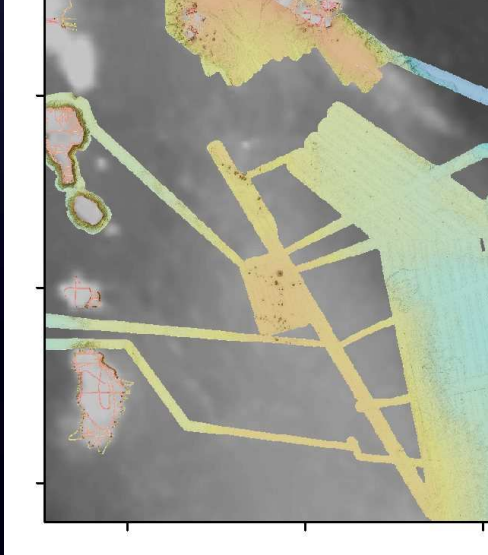
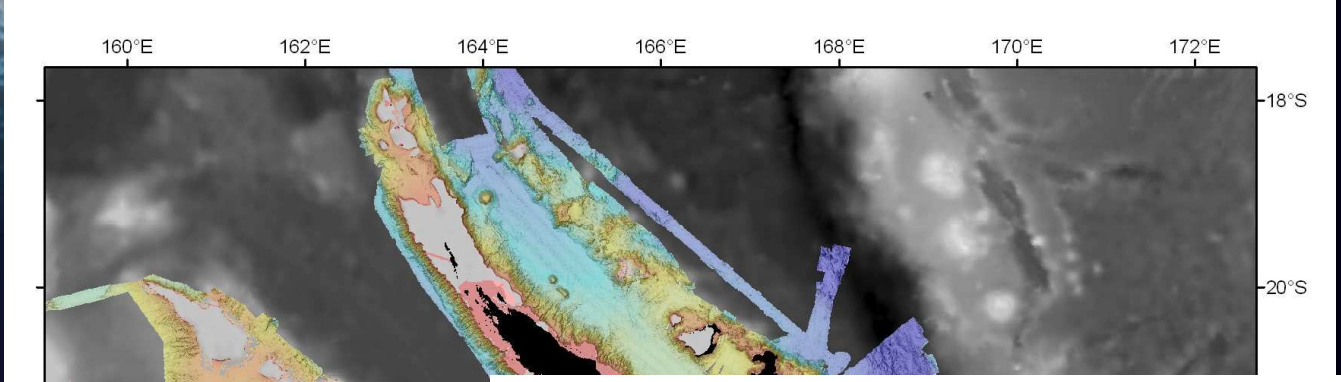
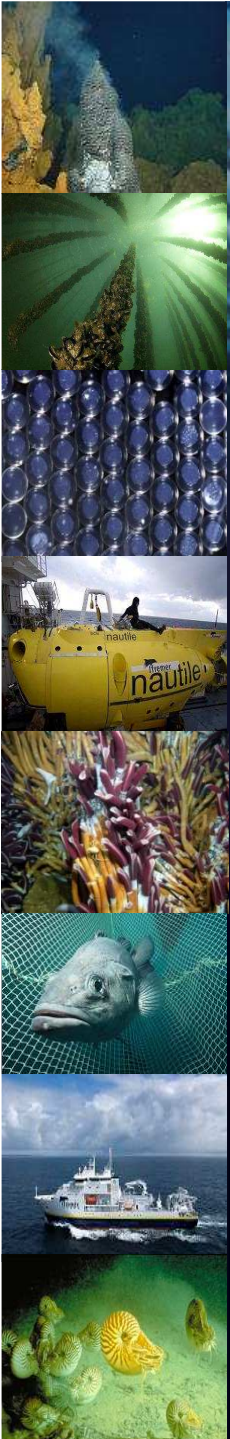
Largeur couverte:
~15km à 4000m

Vitesse faible

Surface des océans couverte
en 4 à 5 siècles

Sondeur « coque »

Couverture multifaisceau



Engins autonomes: AUV

Ifremer

ASTERIX

Mesures près du fond (70m)

Meilleure définition (microbathymétrie ~1m ...)



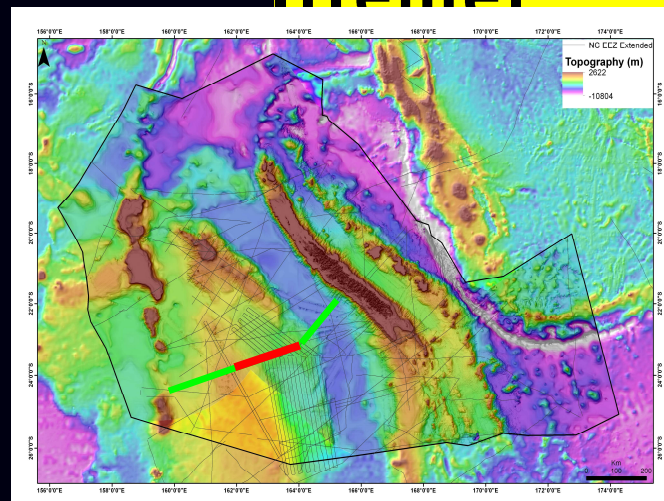
SISMIQUE

Source : canons à air
Récepteur : Flûte (100 m à 10 km)
Pénétration : Plusieurs km



Imagerie du sous-sol

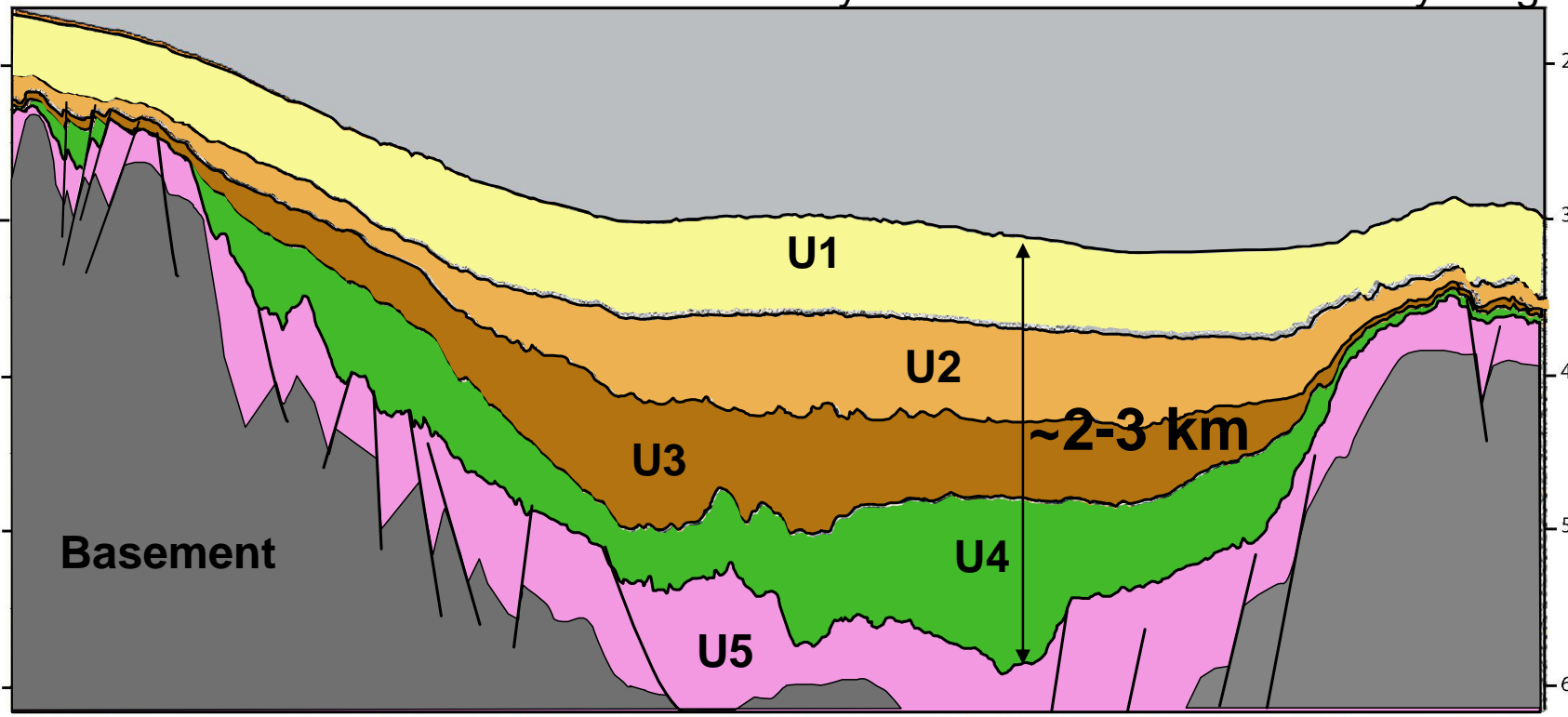
- U1 : Post Rift 3
- U2 : Post Rift 2
- U3 : Post Rift 1
- U4 : Rift unit
- U5 : Pre-rift unit



Lord Howe Rise

Fairway Basin

Fairway Ridge



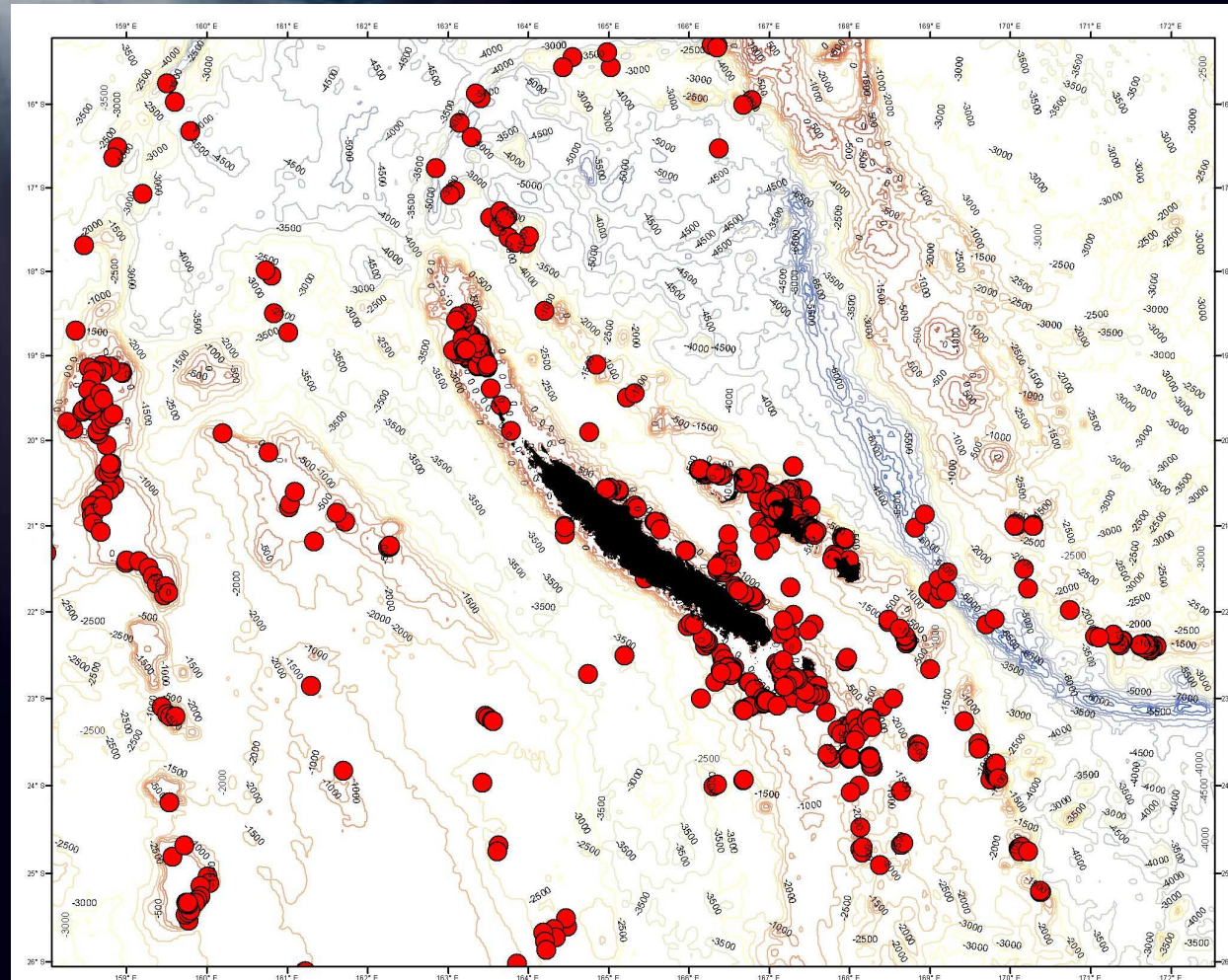
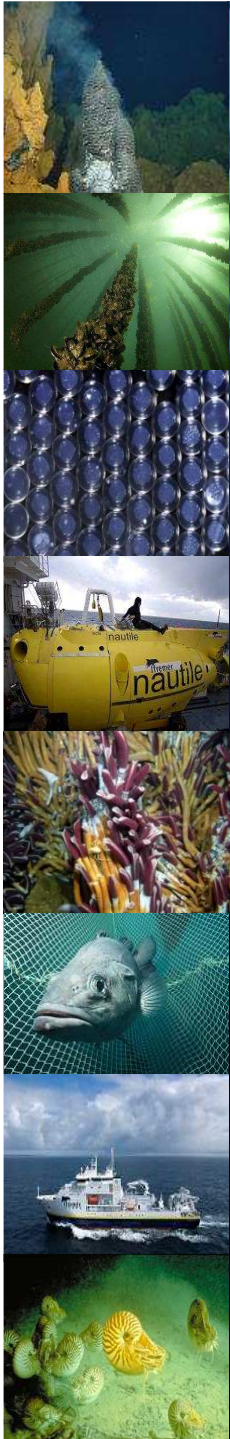
Prélèvements, dragages

Ifremer



Prélèvements, dragages

Ifremer



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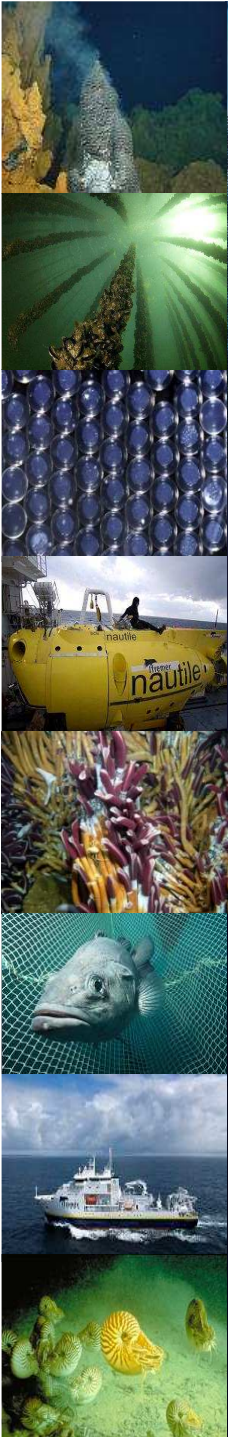
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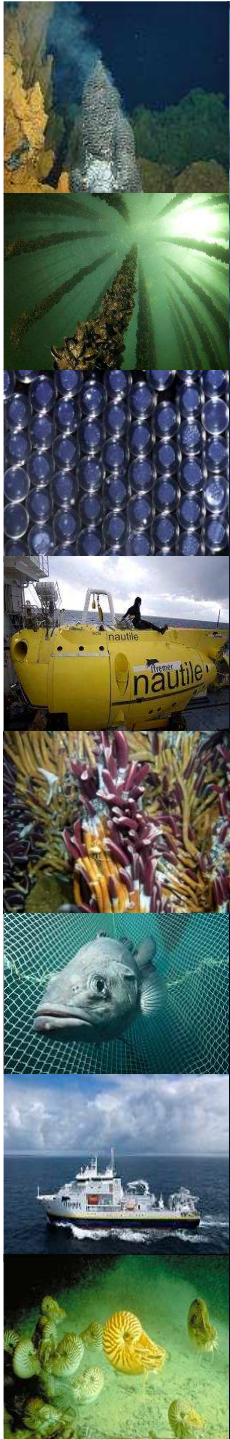
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Les Géosciences Marines en Nouvelle-Calédonie



x1



x2



x1



x2

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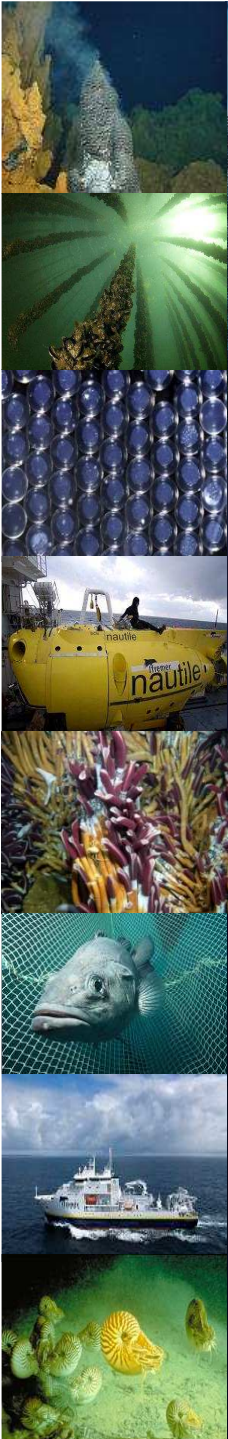
II) Enjeux

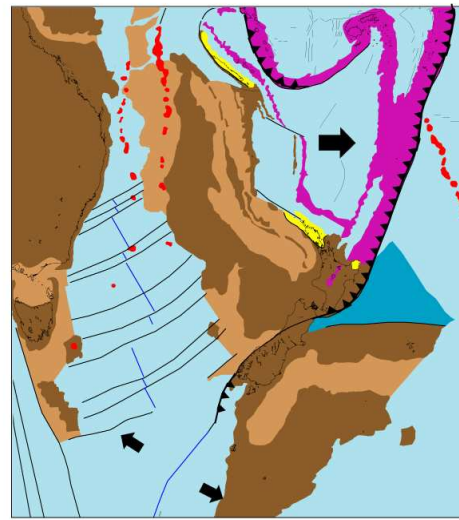
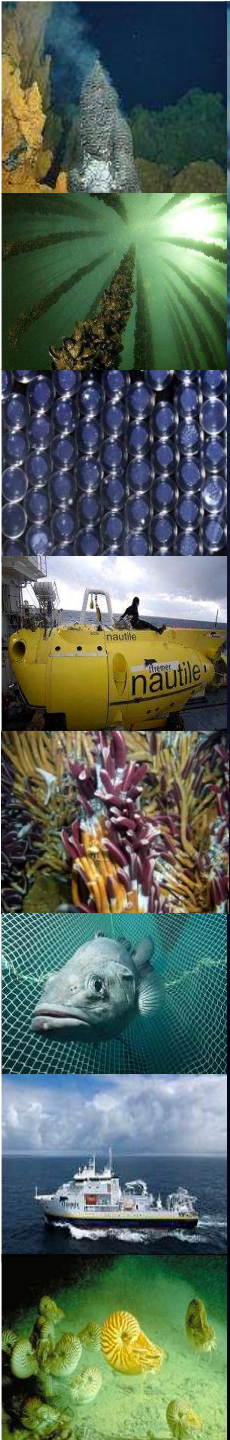
Quelles ressources ?

Ressources hydrocarbures

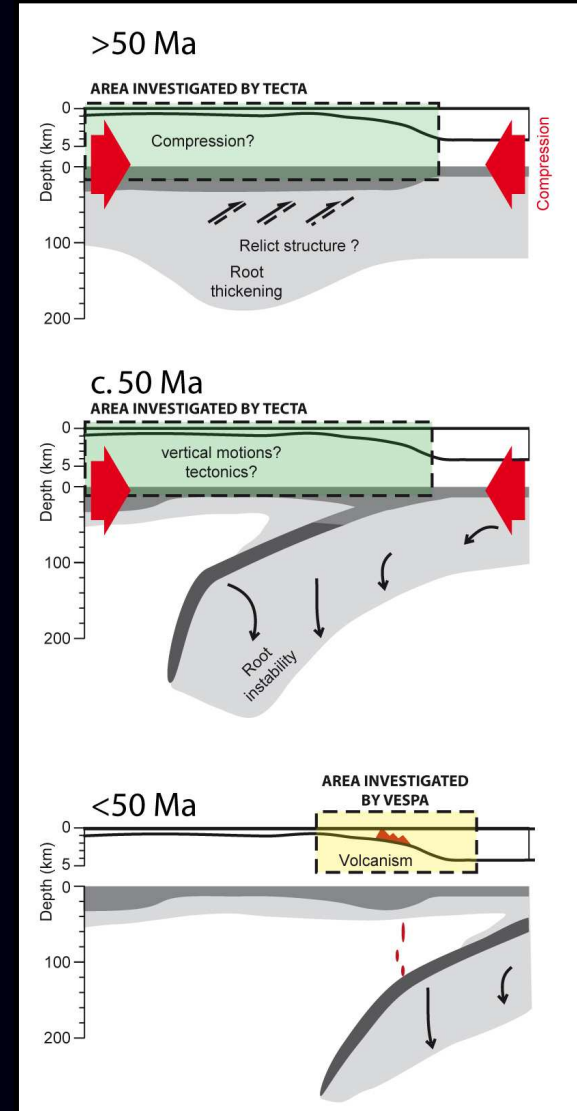
Ressources minérales profondes

Autres enjeux (Risques Naturels, Environnement ... ?)





Laboratoire naturel
exceptionnel pour
comprendre les
mécanismes d'initiation
d'une subduction

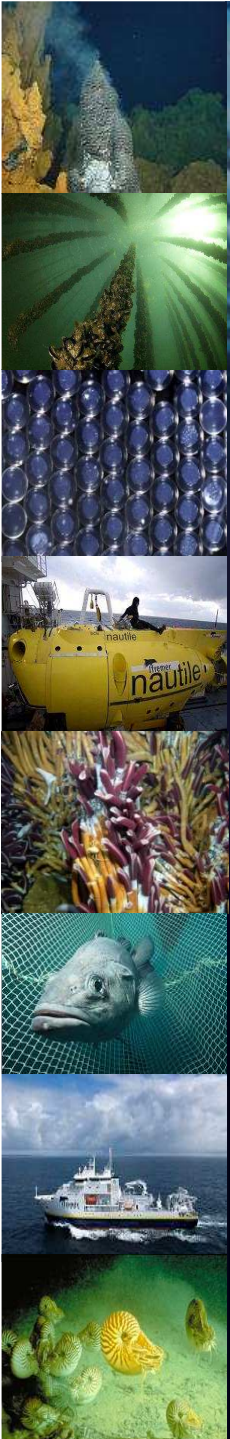


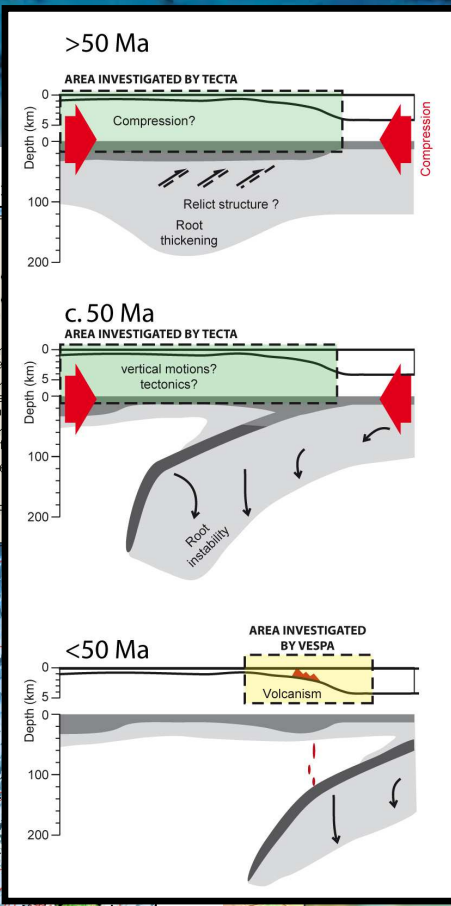
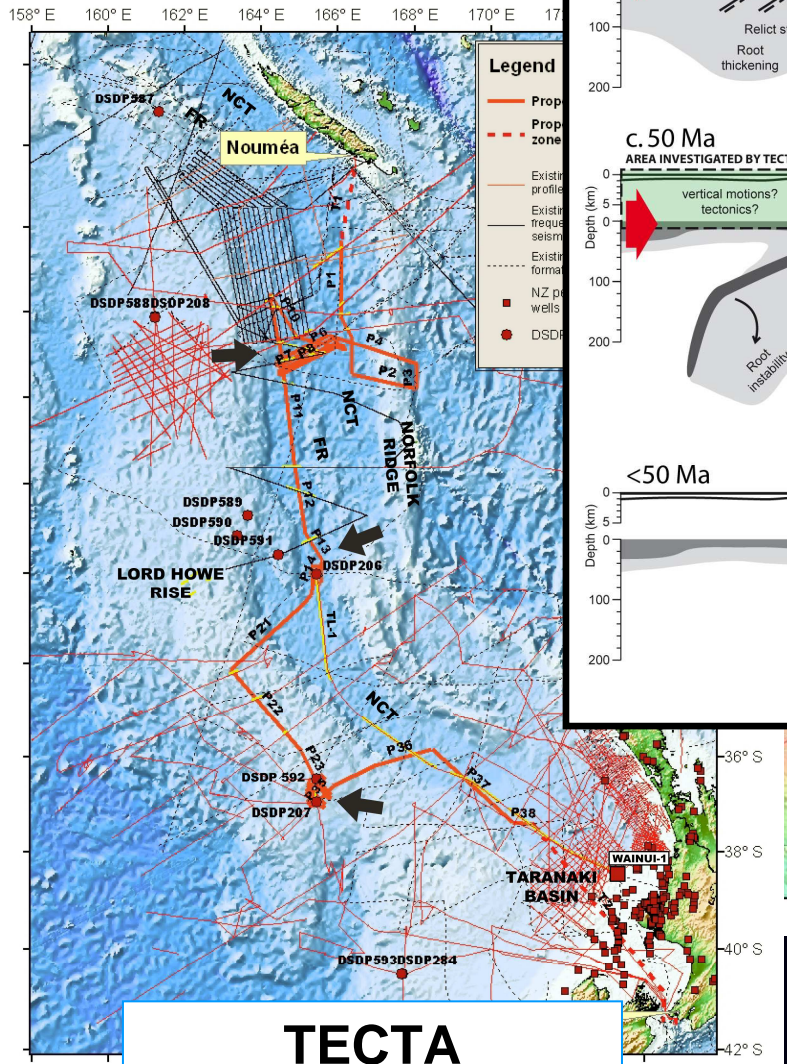
Comment s'initie une subduction ?

Campagne océanographique Atalante TECTA
(Tectonic Evolution of the Cenozoic in the
Tasman Area) – classée P1 par CNFH

Campagne océanographique Atalante VESPA
(Volcanic Evolution of the South Pacific Area)
- classée P1 par CNFH

Demande de forage profond SIPC (Subduction
Initiation and Paleogene Climate) – en cours
d'évaluation par IODP





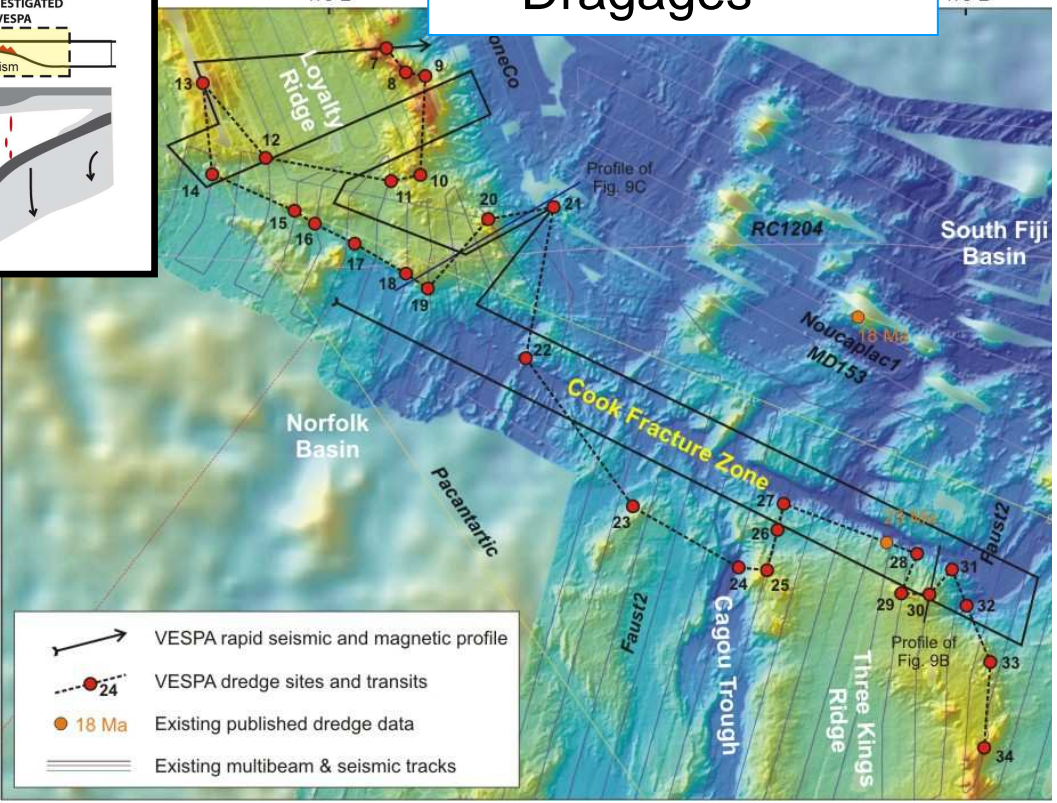
Sur N/O L'ATALANTE Programmées en 2015 ?

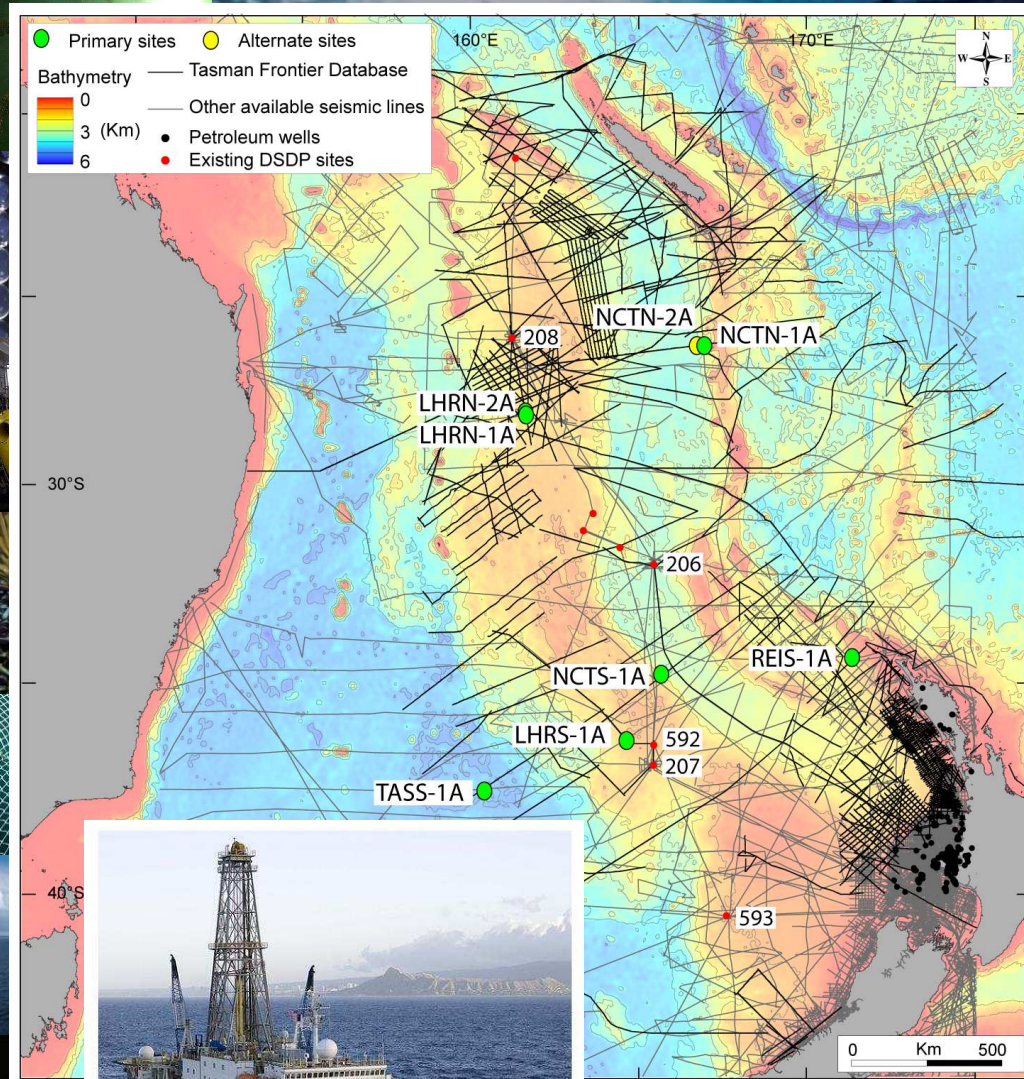
VESPA

- 24 jours
- Dragages

TECTA

- 33 jours
- Sismique





Collect paleogene sediments

Tectonics

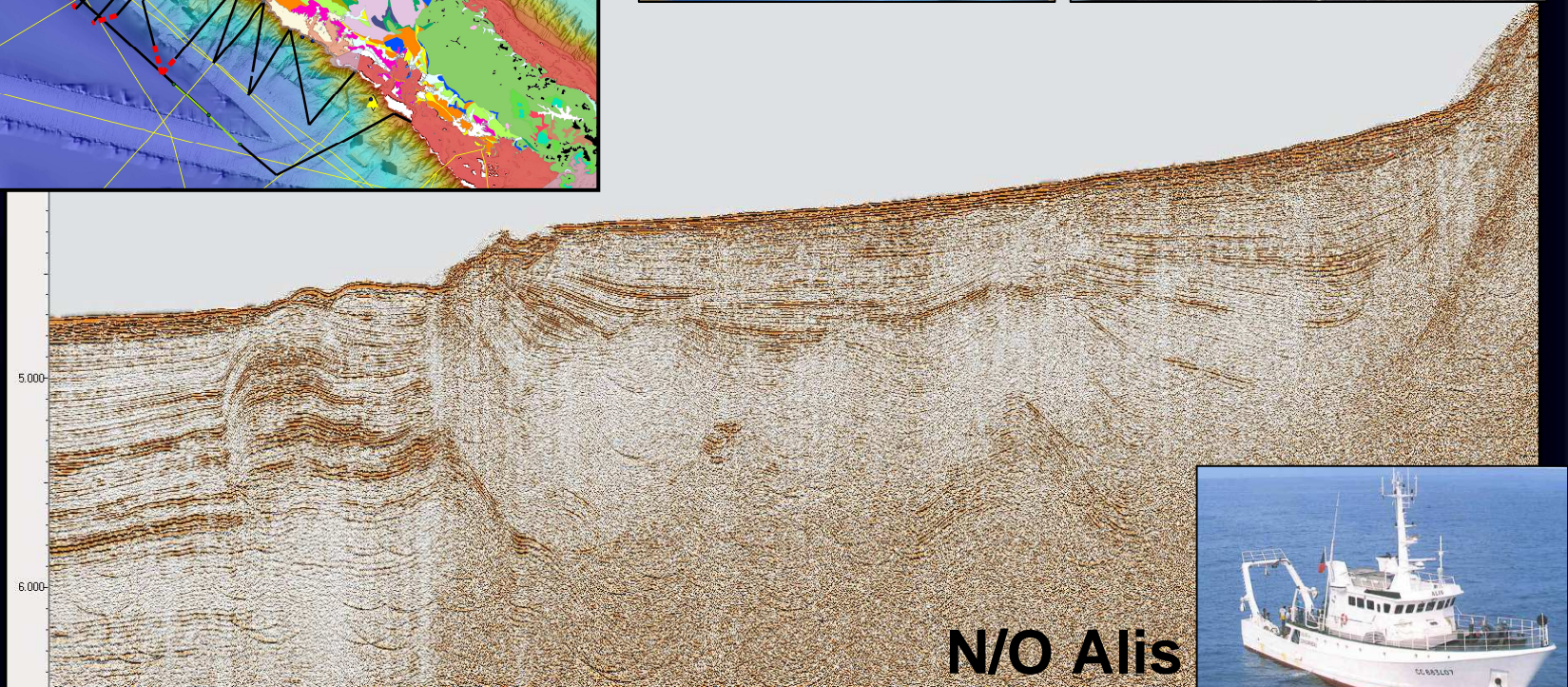
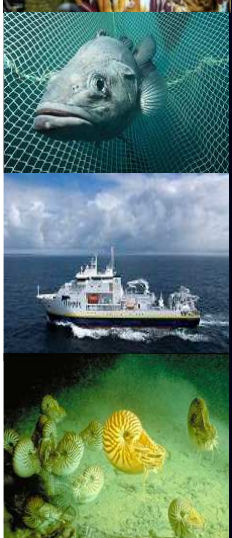
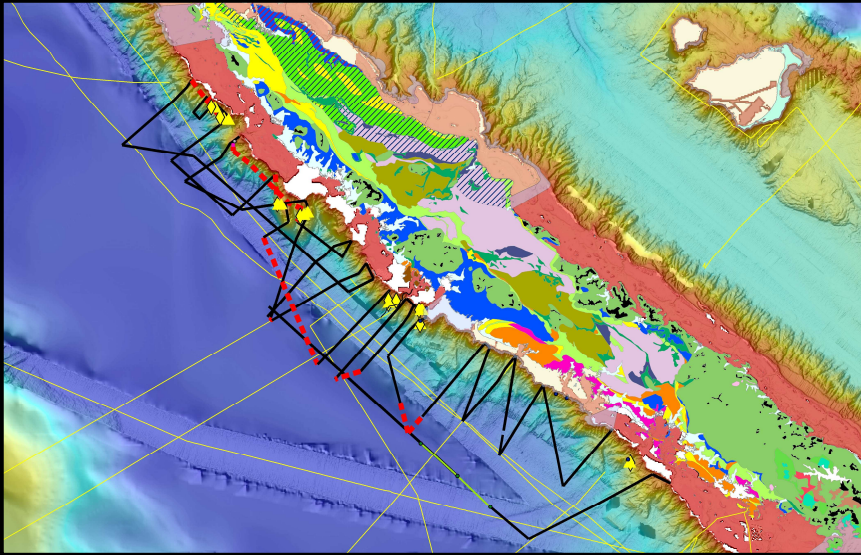
- Constrain vertical motion (confirm sea level indicators)
- Date TECTA phases (uplift, subsidence, contraction)
- Test new SI geodynamic models

Paleoceanography, Paleoclimate

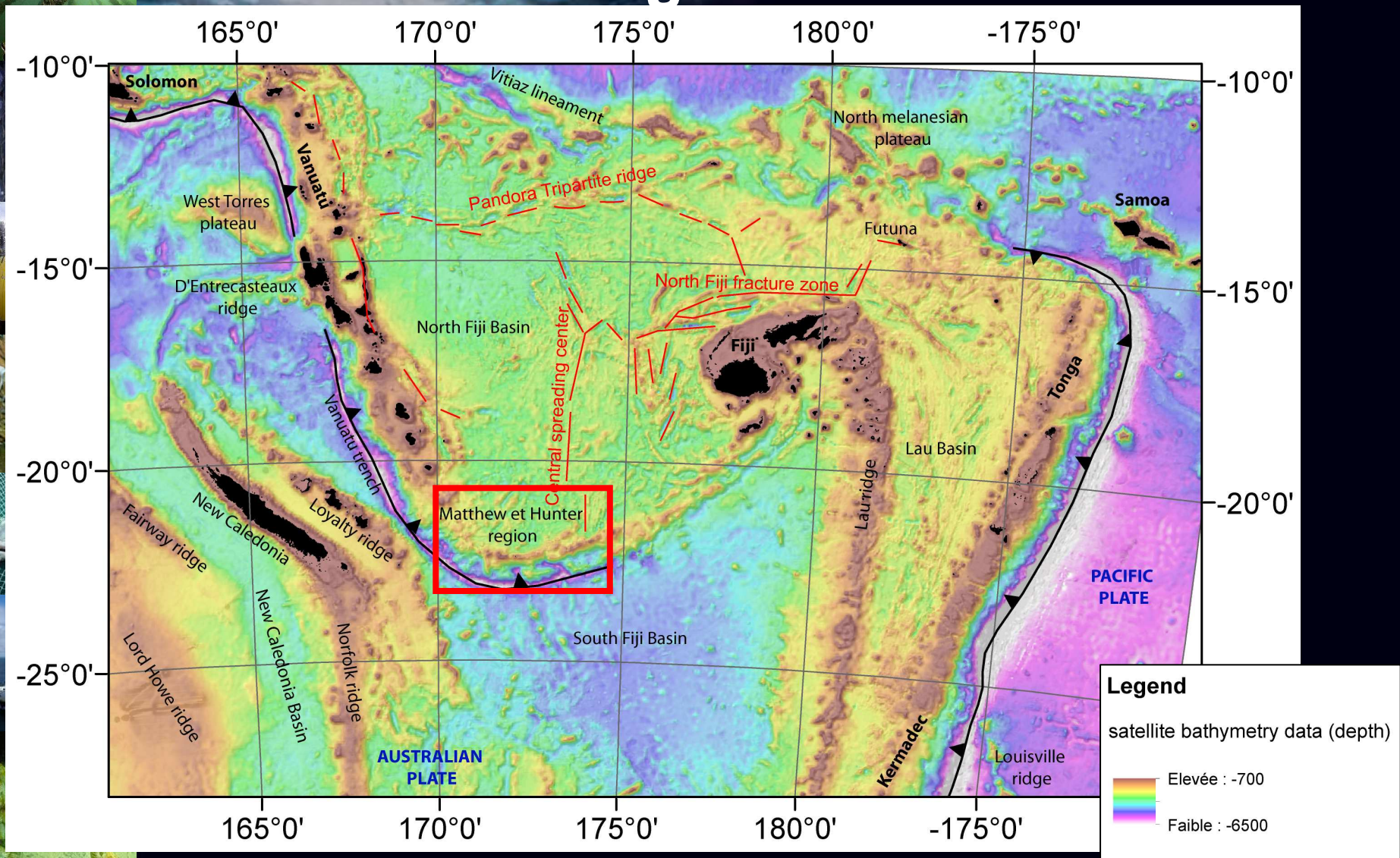
- Early paleogene greenhouse climate
- Why was the Eocene so warm in the SW Pacific ?

Navire de forage Joides Resolution

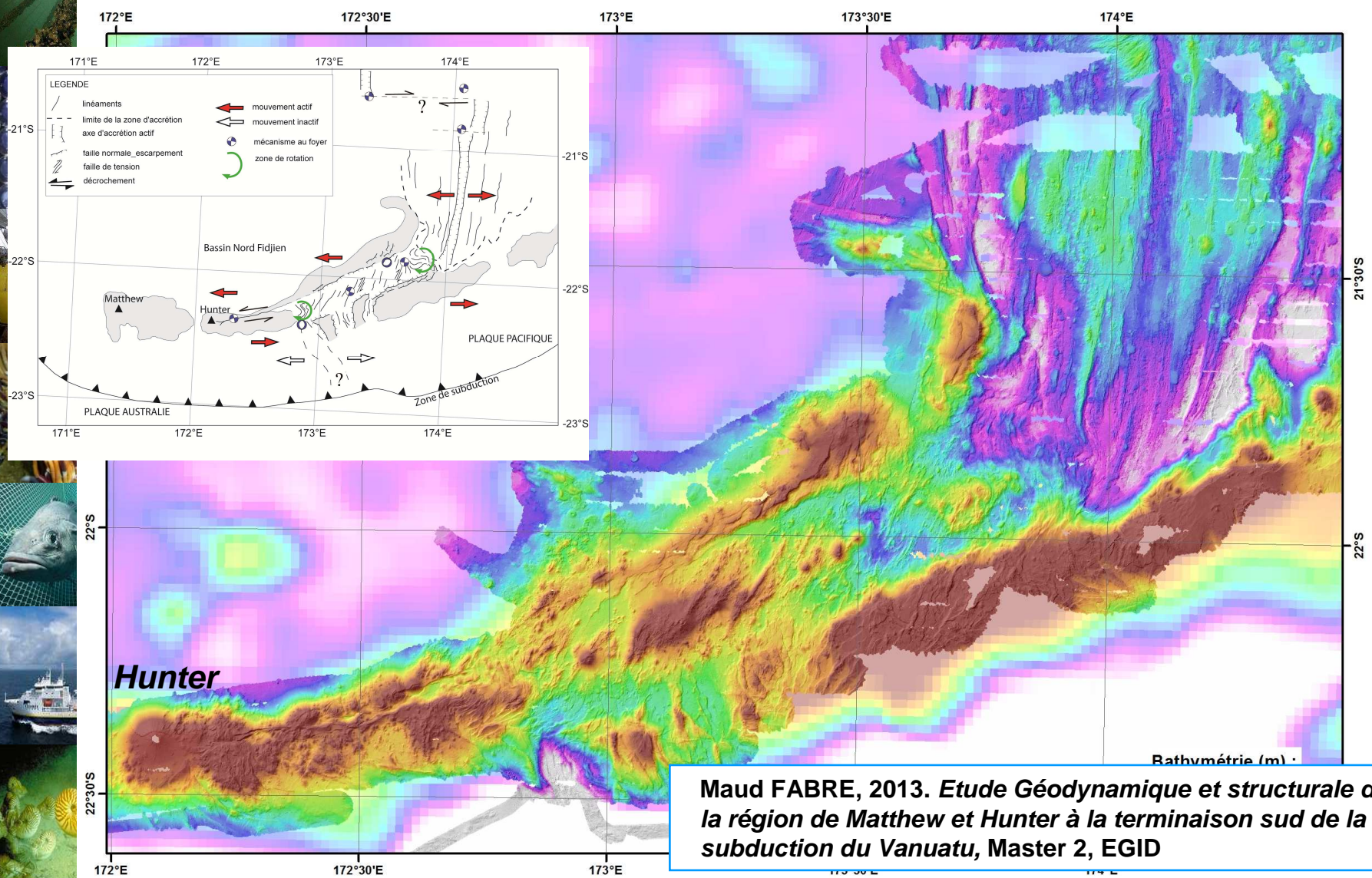
Investigating Post Obduction Deposits



Tectonique et hydrothermalisme des marges actives



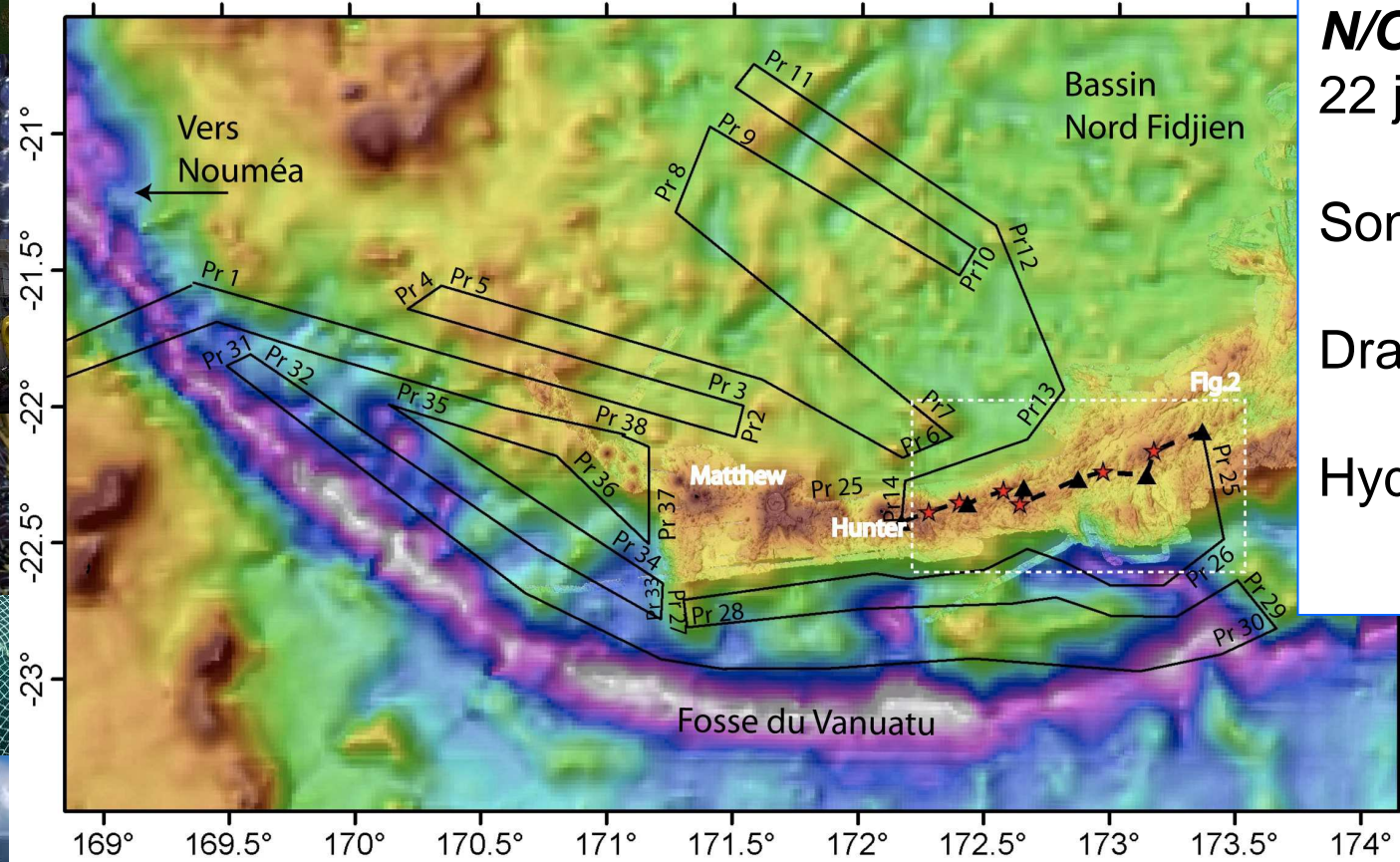
Tectonique et hydrothermalisme des marges actives



Maud FABRE, 2013. *Etude Géodynamique et structurale de la région de Matthew et Hunter à la terminaison sud de la subduction du Vanuatu*, Master 2, EGID

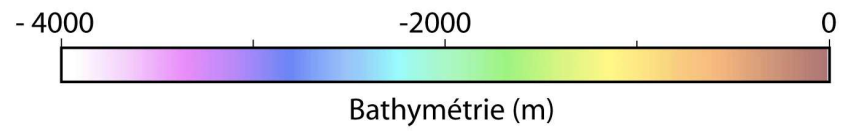
Campagne CARAVAN

CARactérisation de la terminaison Sud de l'Arc des VANuatu



N/O L'Atalante
22 jours
Sondeur multifaisceau
Dragages
Hydrothermalisme

- ★ Dragage
- ▲ Bathysonde Rosette
- Navigation Cartographie
- - - Navigation Hydrothermalisme



Géodiversité Marine de Nouvelle-Calédonie

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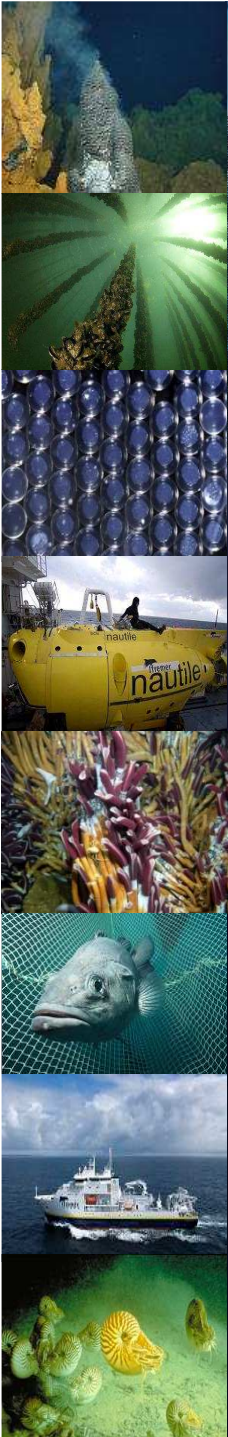
II) Enjeux

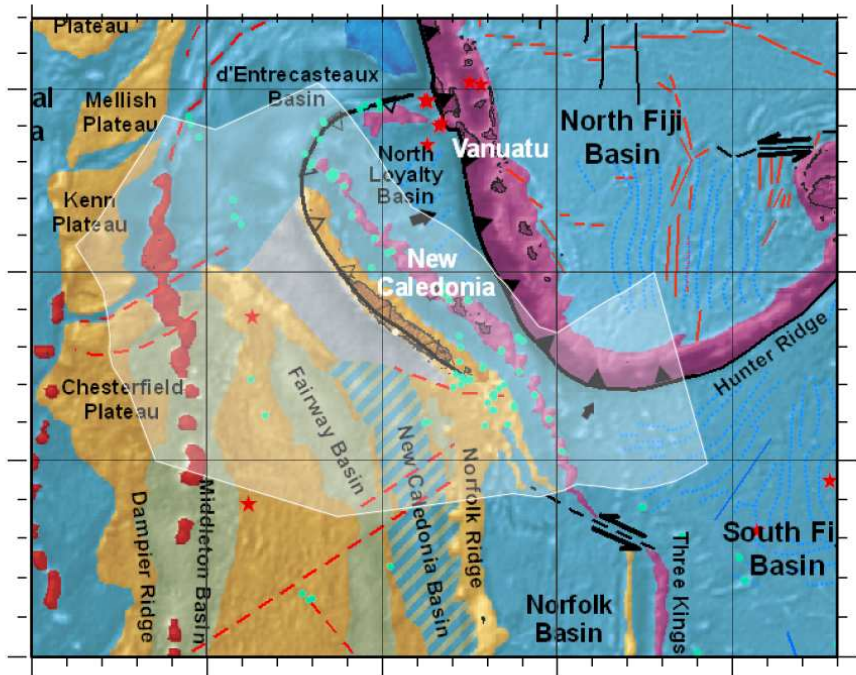
Quelles ressources ?

Ressources hydrocarbures

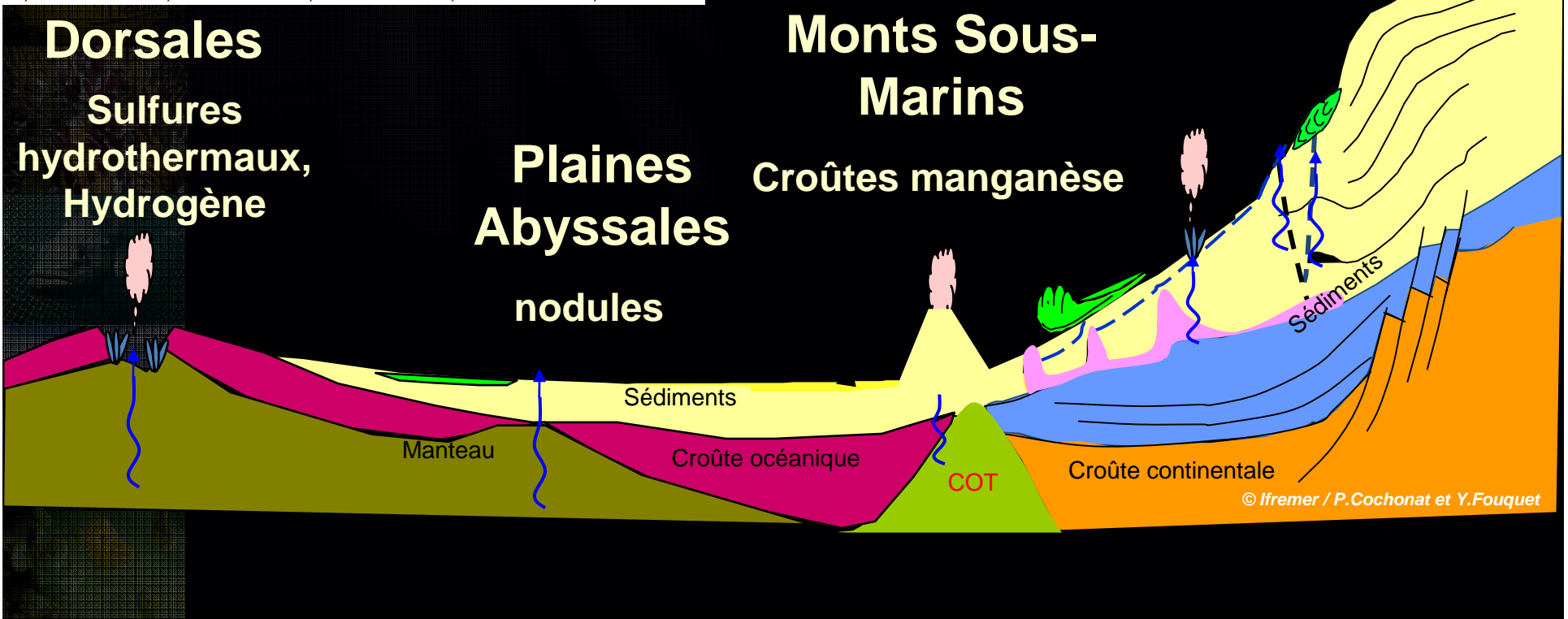
Ressources minérales profondes

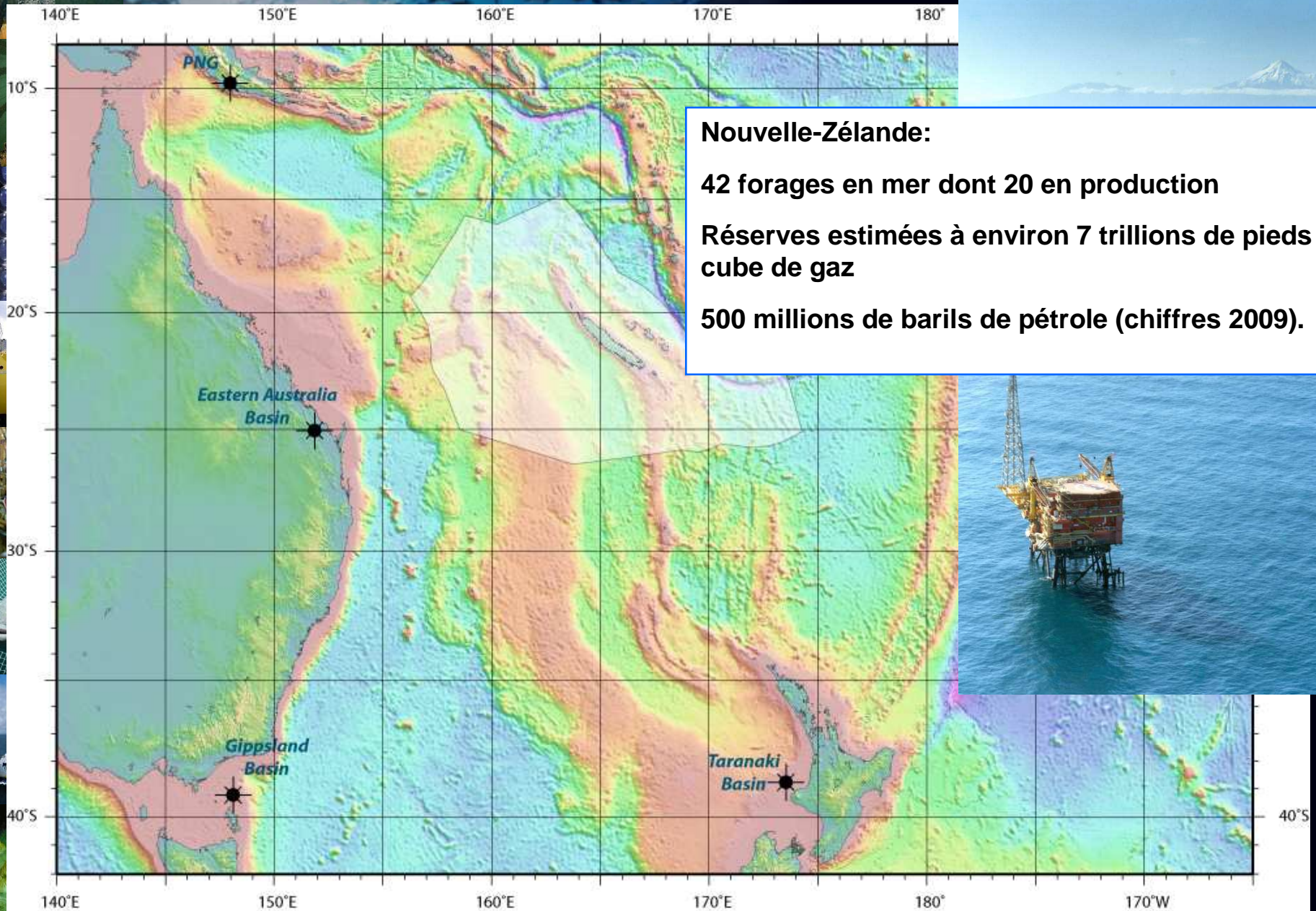
Autres enjeux (Risques Naturels, Environnement ... ?)





Marge, Plateau
Hydrocarbures, hydrates
sables, granulats,
placers...





Comment se forment les hydrocarbures ?

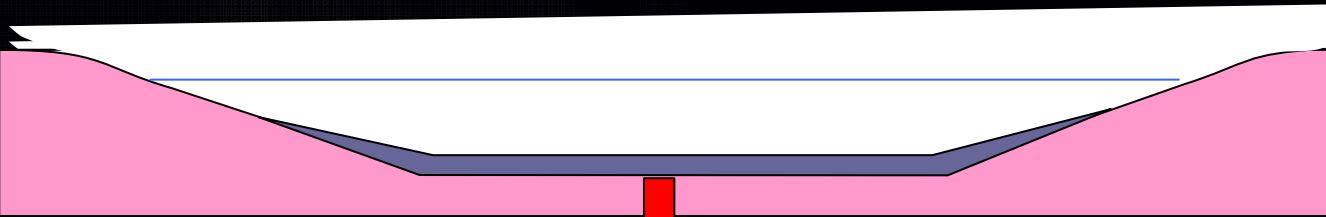
l'ère

MO

MO

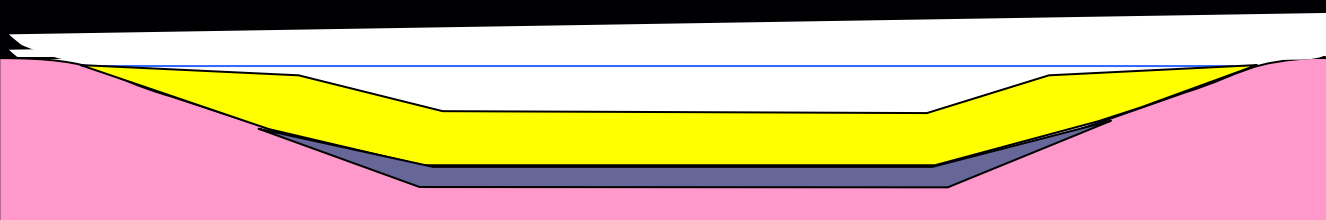


Rift



Sables

Sables



Post-rift

Comment se forment les hydrocarbures ?

l'fremer

Argiles

Argiles



Enfouissement + 7° C

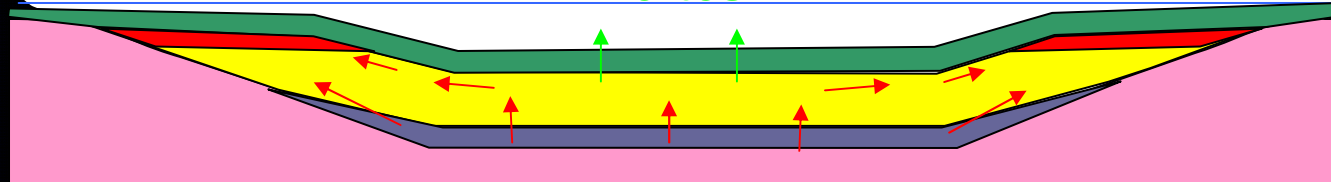


Génération et migration
d'hydrocarbures

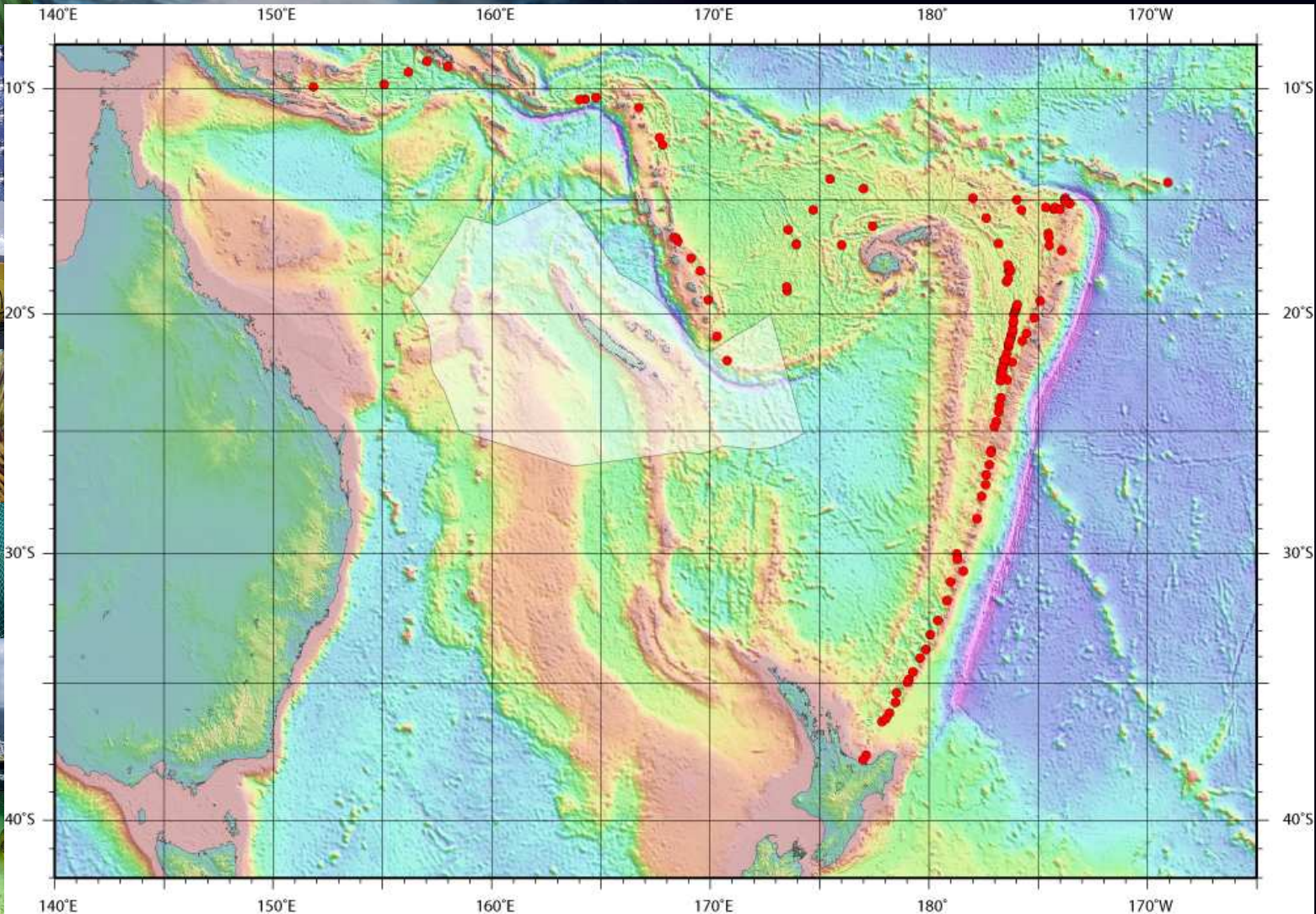
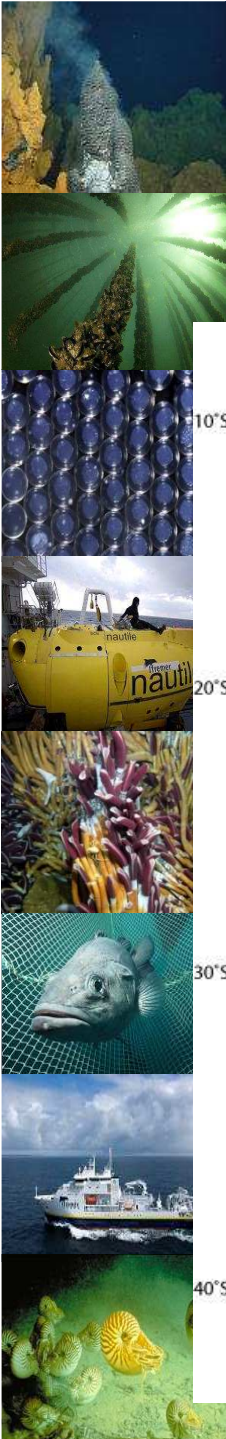
Piégeage

Pertes

Piégeage



MINERALISATIONS PROFONDES



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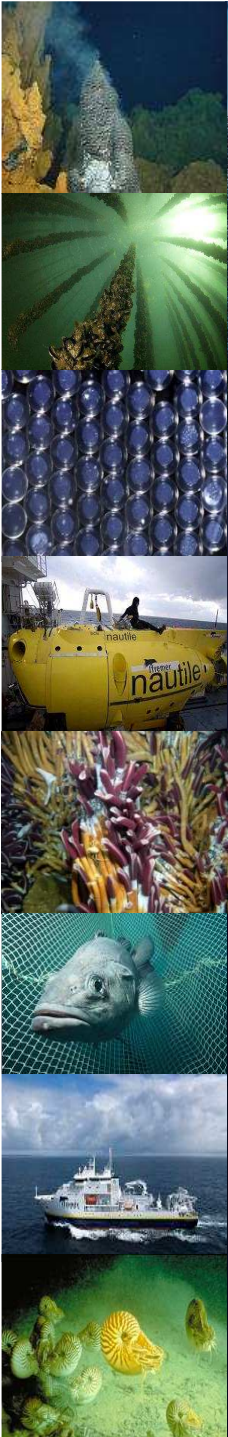
II) Enjeux

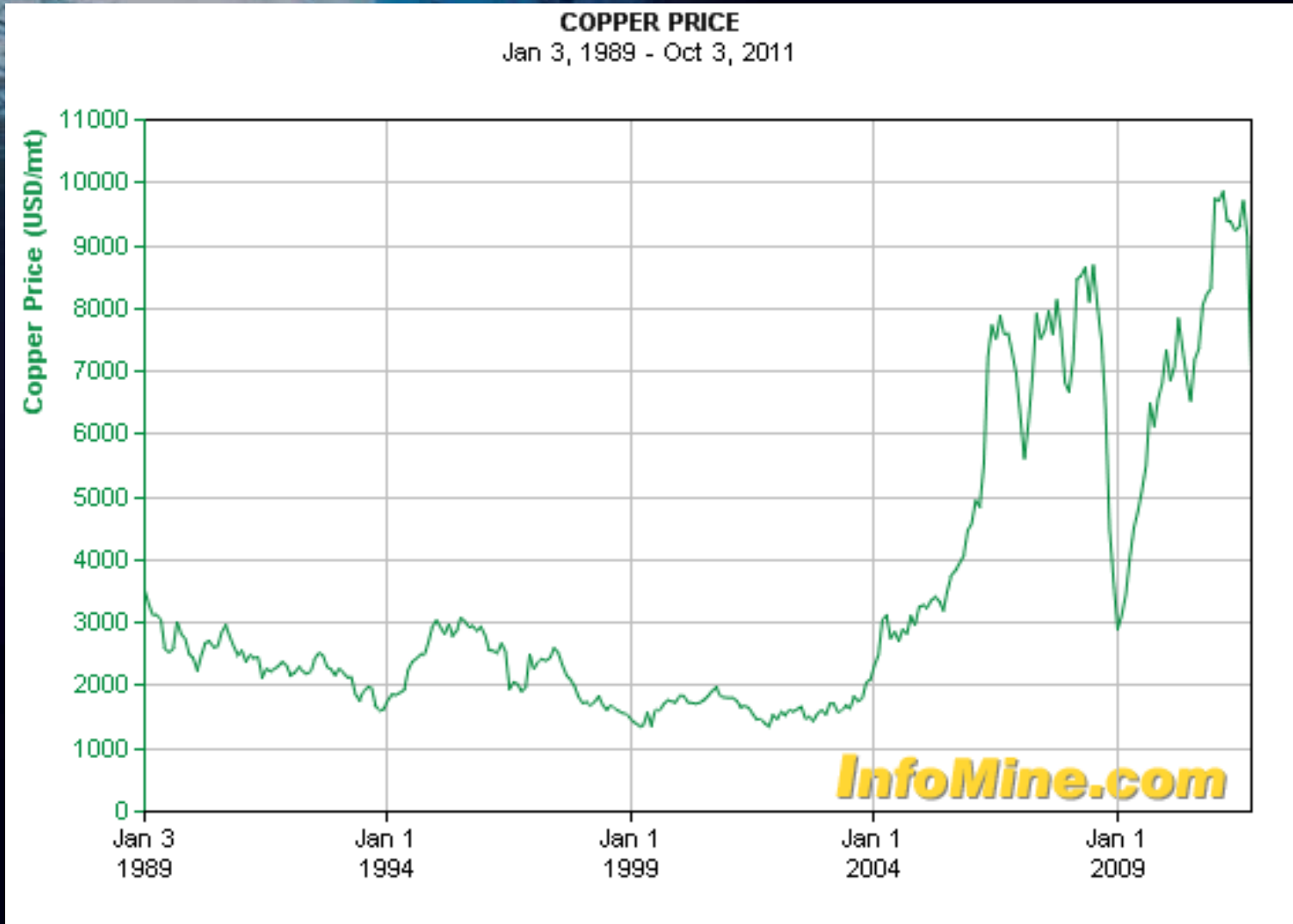
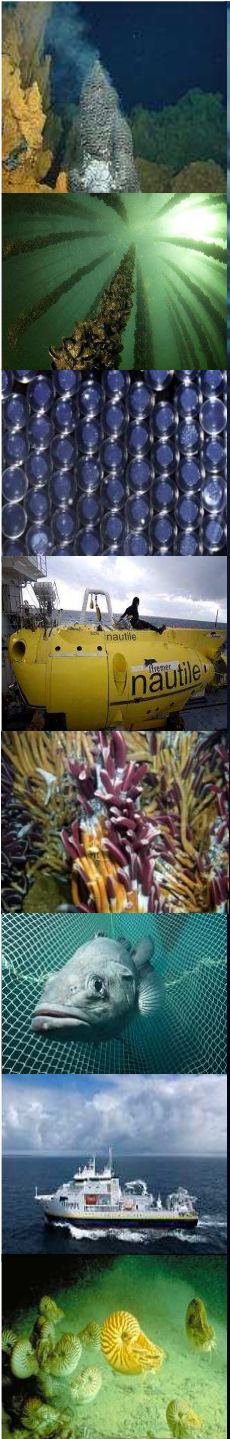
Quelles ressources ?

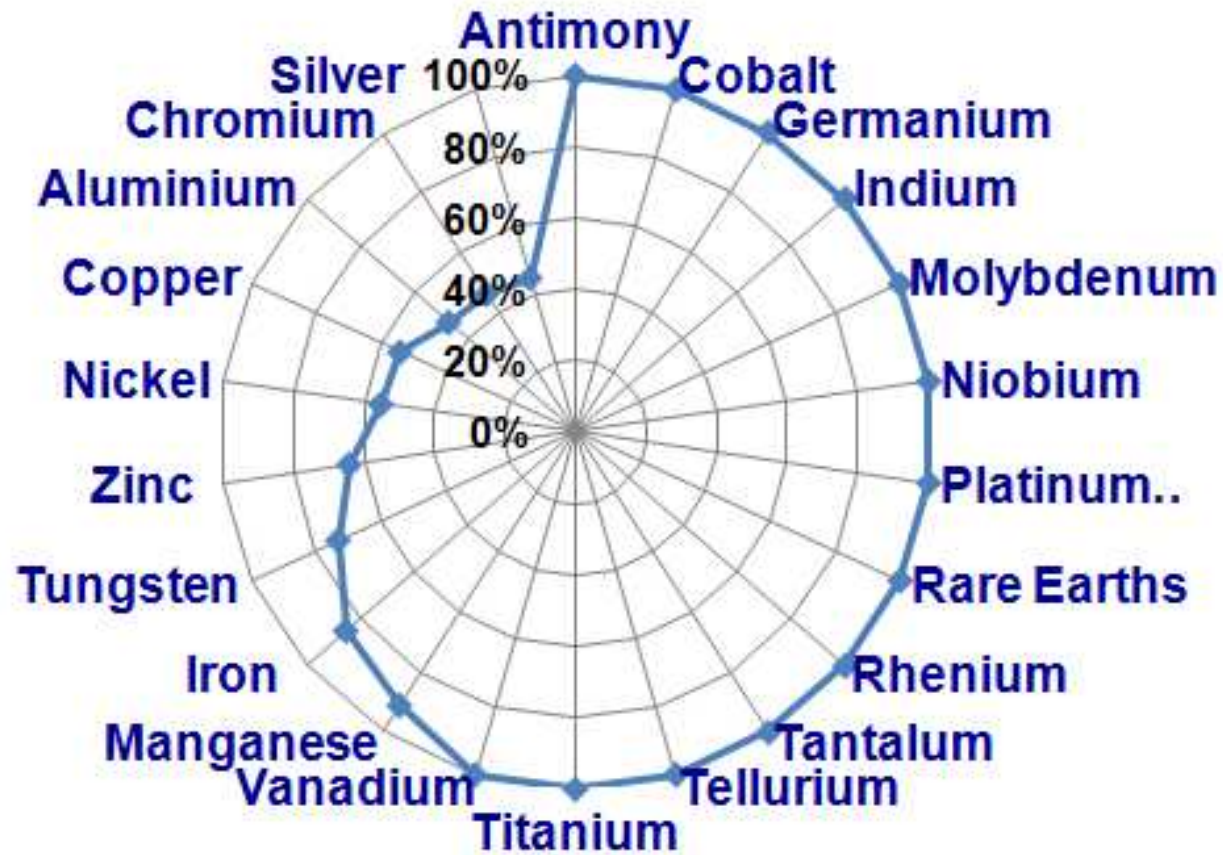
Ressources hydrocarbures

Ressources minérales profondes

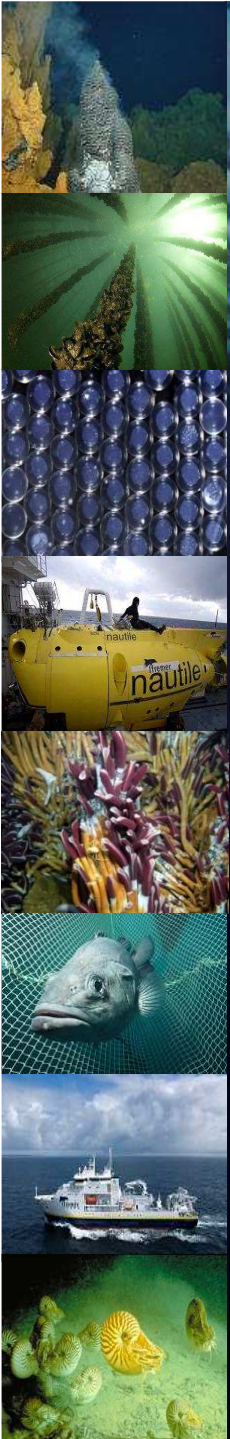
Autres enjeux (Risques Naturels, Environnement ... ?)



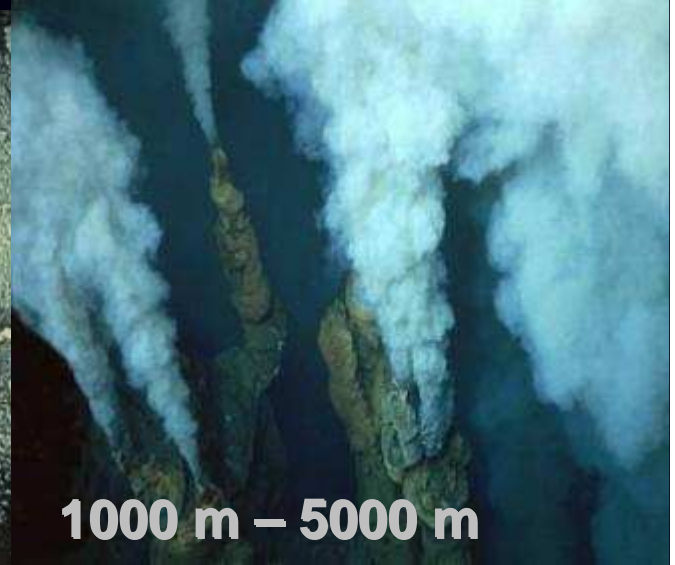
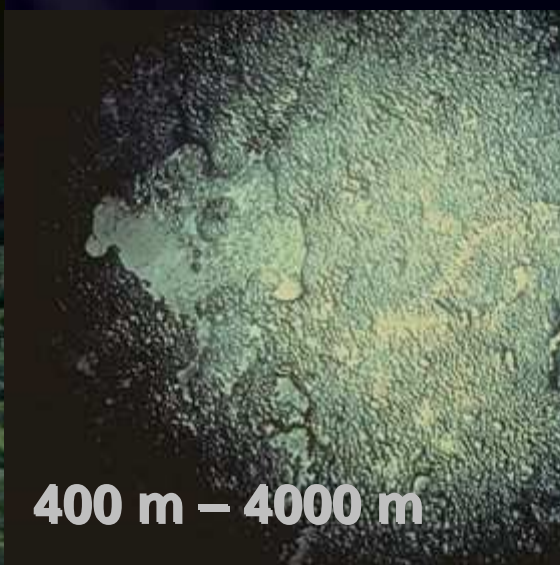




- Métaux de base : Cu, Fe, Zn, Pb
- Métaux de haute technologies
- Métaux pour les énergies vertes

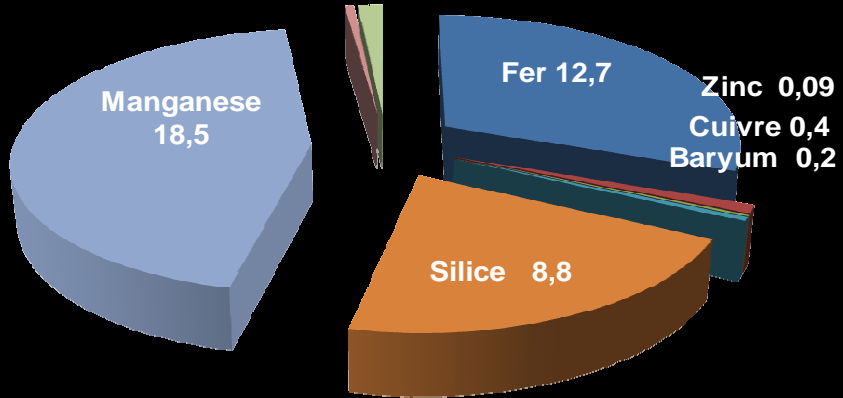


lfremer

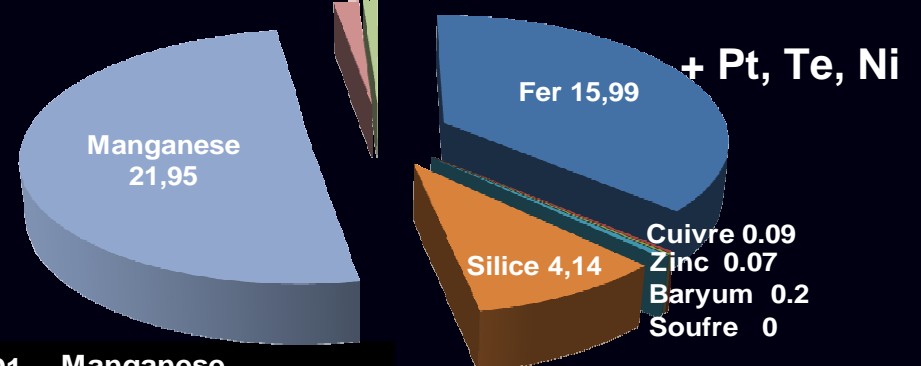




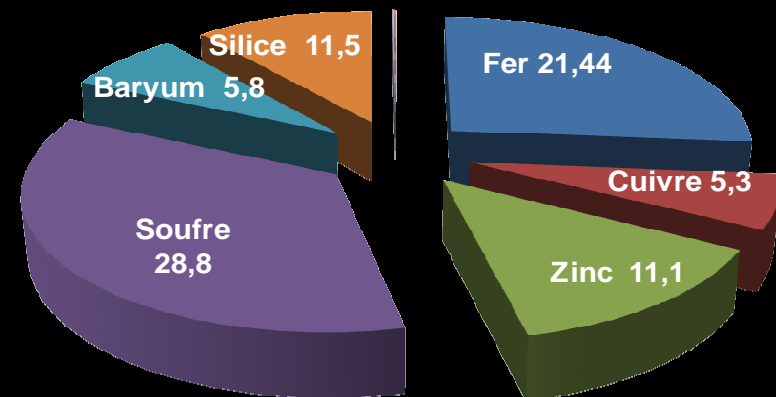
Nickel 0.63
Cobalt 0.24



Cobalt 0.69
Nickel 0.41

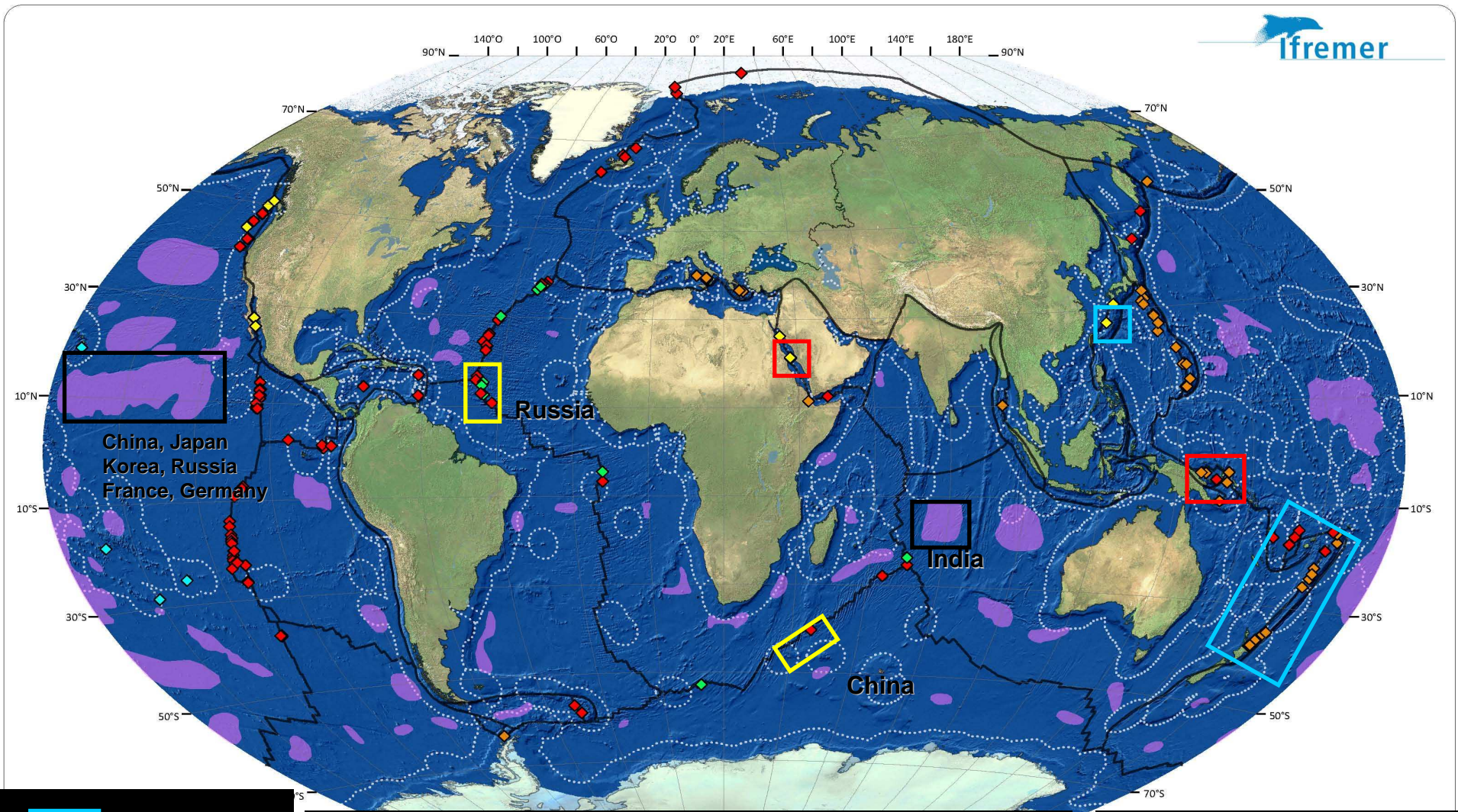


Nickel 0.01 Manganese 0.09
Cobalt 0.05



+ Au, Ag, Pb, Co
In, Ge, Se, Co, Cd,
Bi, Te, Ga, Ge
+ Hydrogène





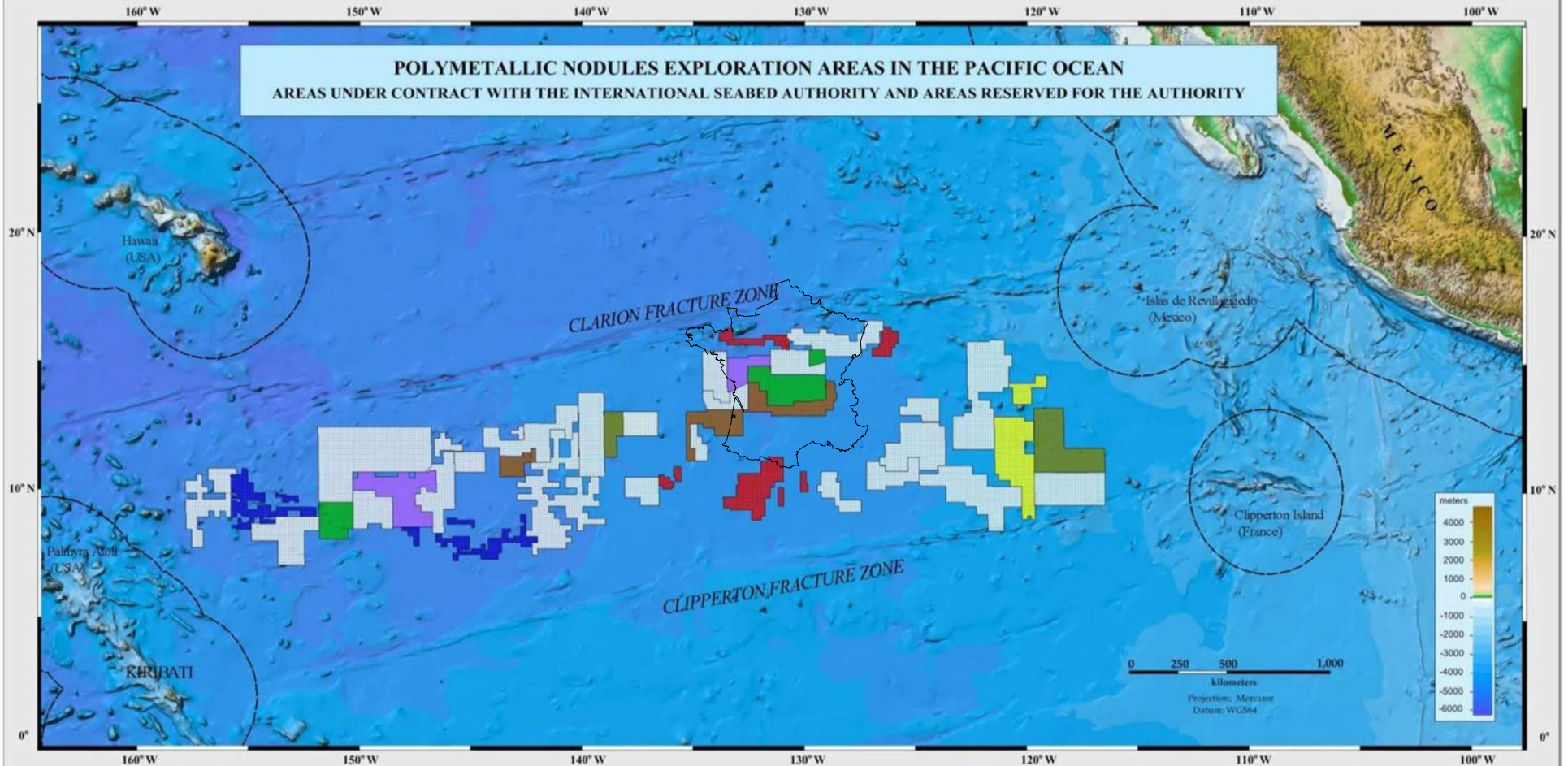
Exploration licenses
in EEZ : Sulfides

Mining licenses EEZ :
Sulfides 2010-11

Nodules

Sulfides
(July 2011)

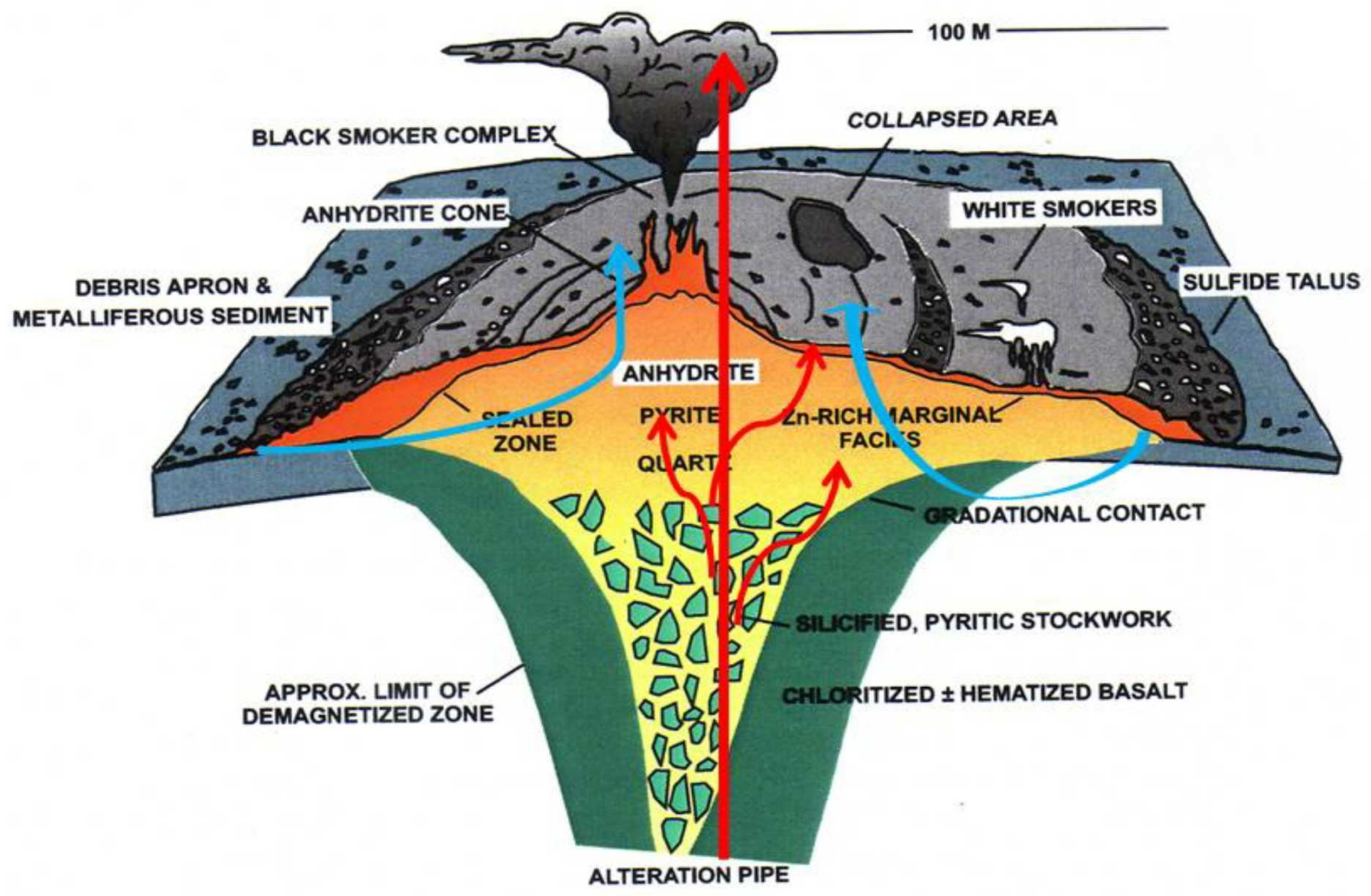




Legend

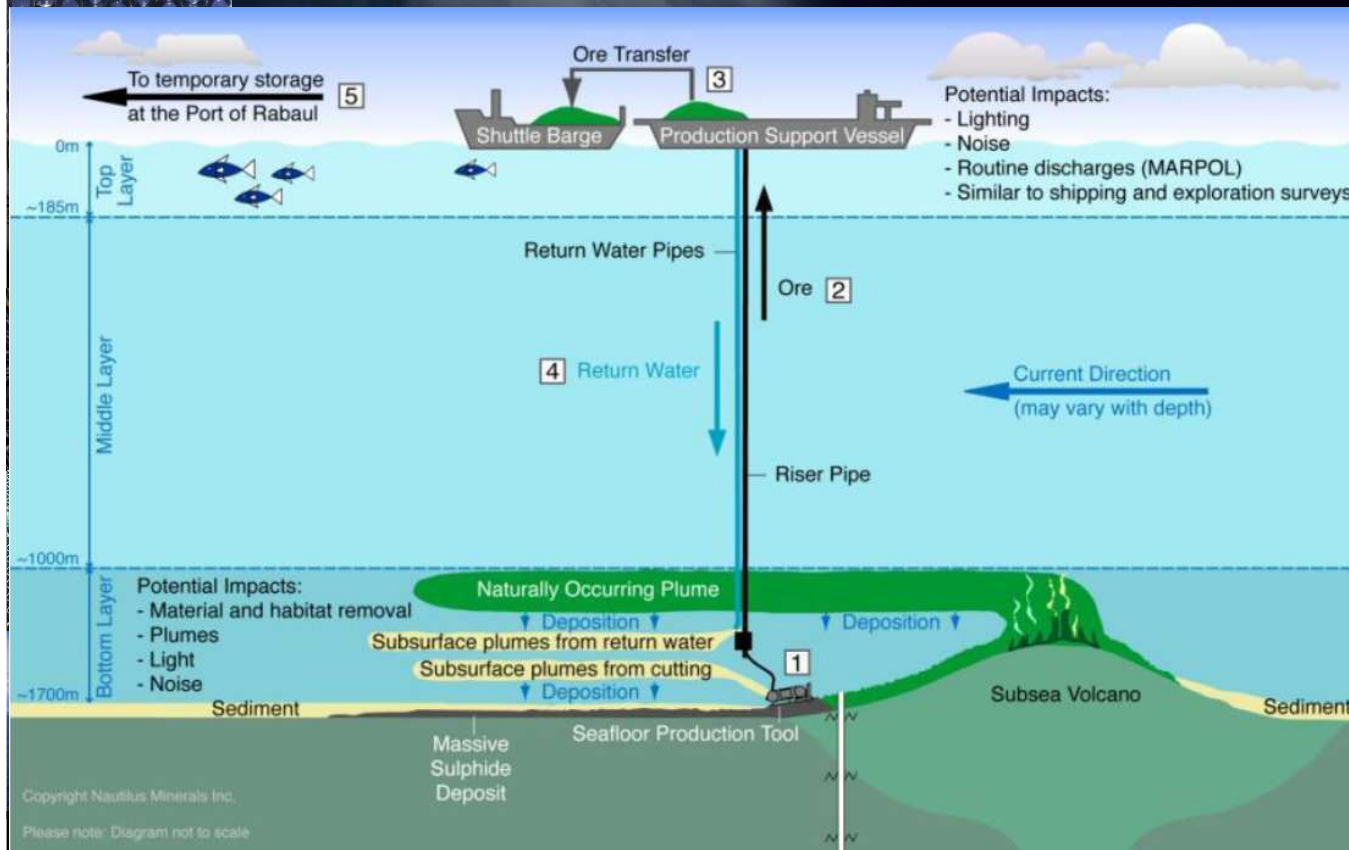
■ Contractor Areas	 Reserved Areas
■ COMRA (China)	 Limits of Exclusive Economic Zones
■ DORD (Japan)	
■ Government of Korea	
■ IFREMER (France)	
■ Interoceanmetal	
■ Yuzhmorgeologia (Russian Federation)	
■ FIGNR (Germany)	





Impact potentiel: Nature, échelle

Impacte directe : extraction = destruction totale des habitats
 Impacte indirecte : plumes de particules = ???



Sulfures Massifs

(3-5 ans)

Impacte Directe :
 < 50 km²

Impact Indirecte :
 ??

Nodules

(15 ans)

Impacte Directe:
 10 000 km²

Impact Indirecte:
 20 000 – 50 000 km²

Environnements Profonds

Sites hydrothermaux

Plaines abyssales

Monts sous-marins

Dépôts sulfurés

Nodules

Croûtes Mn

Ecosystèmes hydrothermaux
Forte biomasse, Faible diversité,
Fort endémisme

Faunes sédimentaires
Faible biomasse, Forte diversité
Faible endémisme

Faunes des Mts sous-marins
Biomasse et diversité variables,
Endémisme variable?



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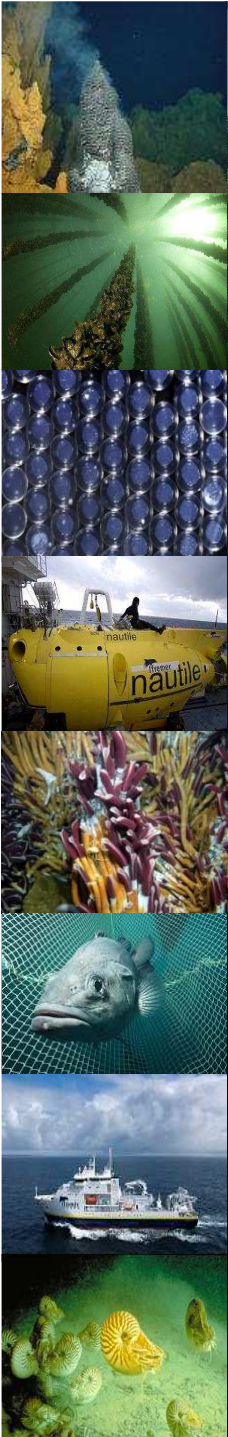
II) Enjeux

Quelles ressources ?

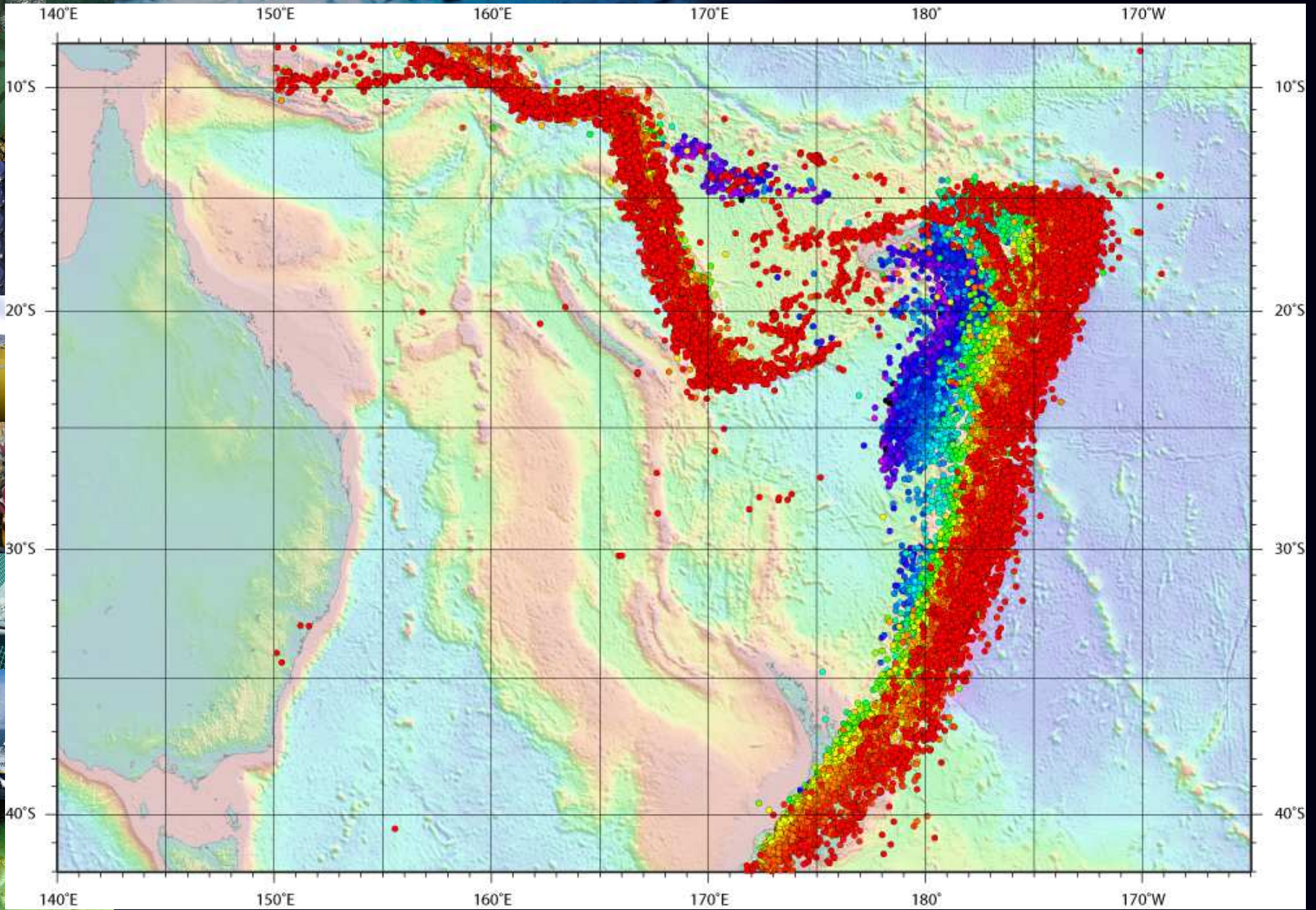
Ressources hydrocarbures

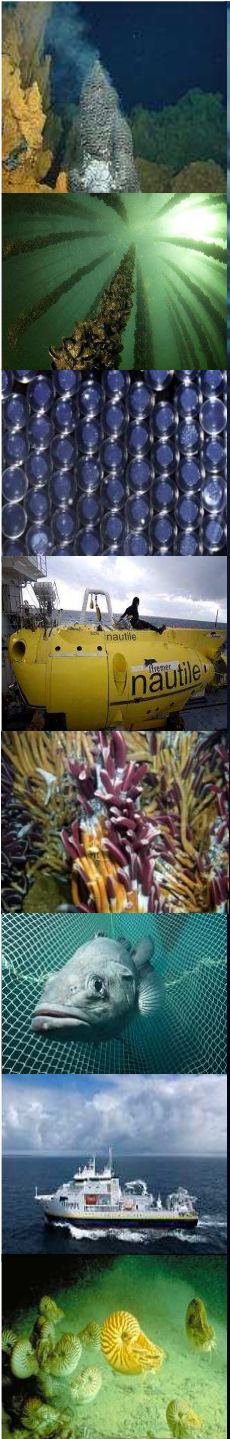
Ressources minérales profondes

**Autres enjeux (Risques Naturels,
Environnement ... ?)**

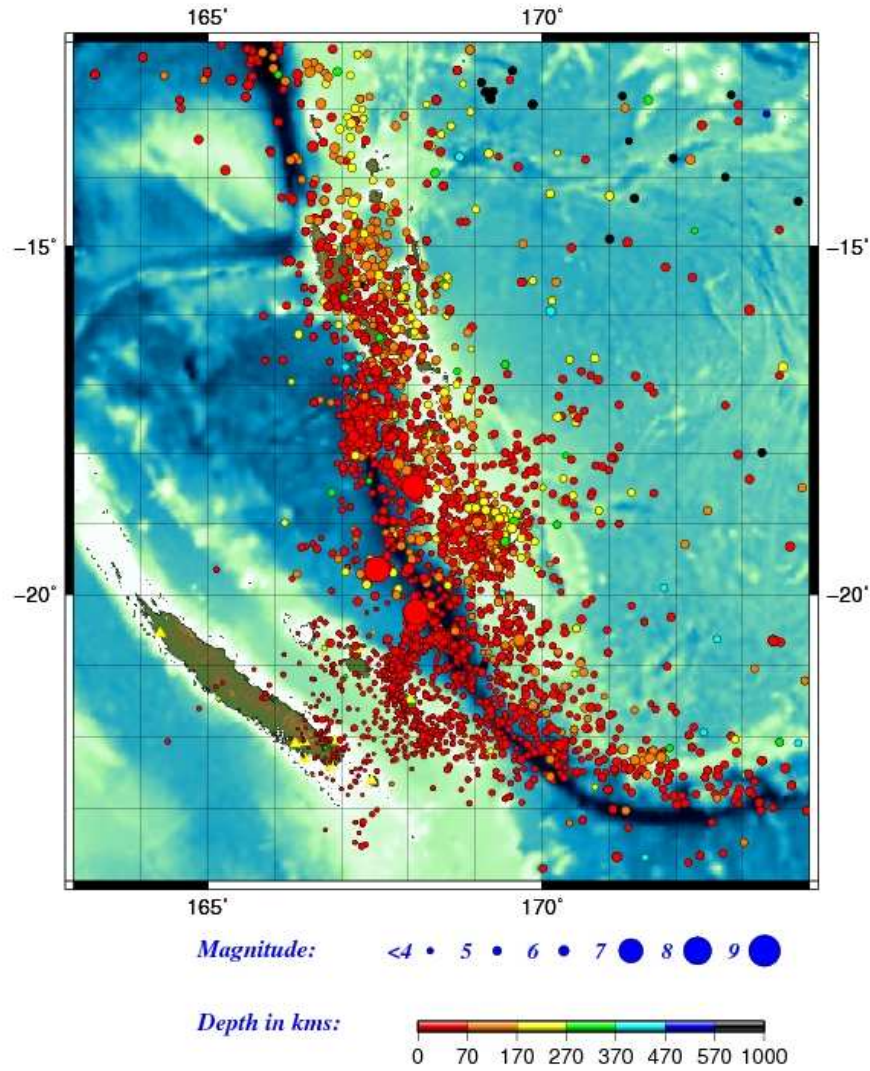


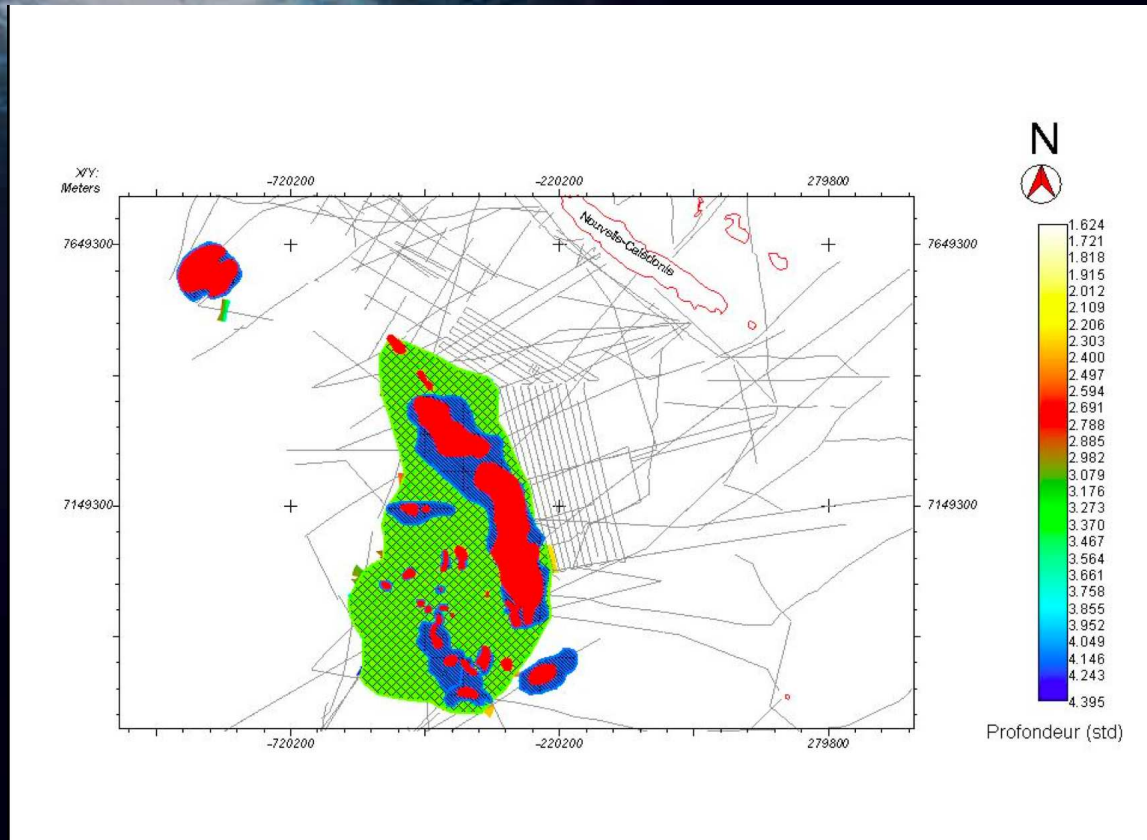
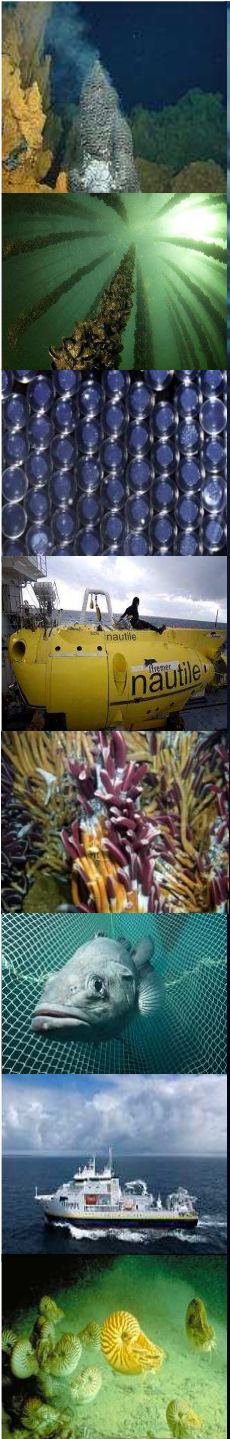
Ifremer





New Caledonia seismic network – New Caledonia & Vanuatu
2010/11/08 – 2013/11/13





CONCLUSIONS

Domaine Marin exceptionnel

ZEE gigantesque et 1/3 peu profonde
Diversité géologique

Conséquences

Ressources ? (hydrocarbures, minéralisations profondes)

Responsabilités préservation

Environnement (actuel et passé), Risques Naturels ...

