Reconstruction d'un arc Paléoprotérozoïque

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Université de Lomé

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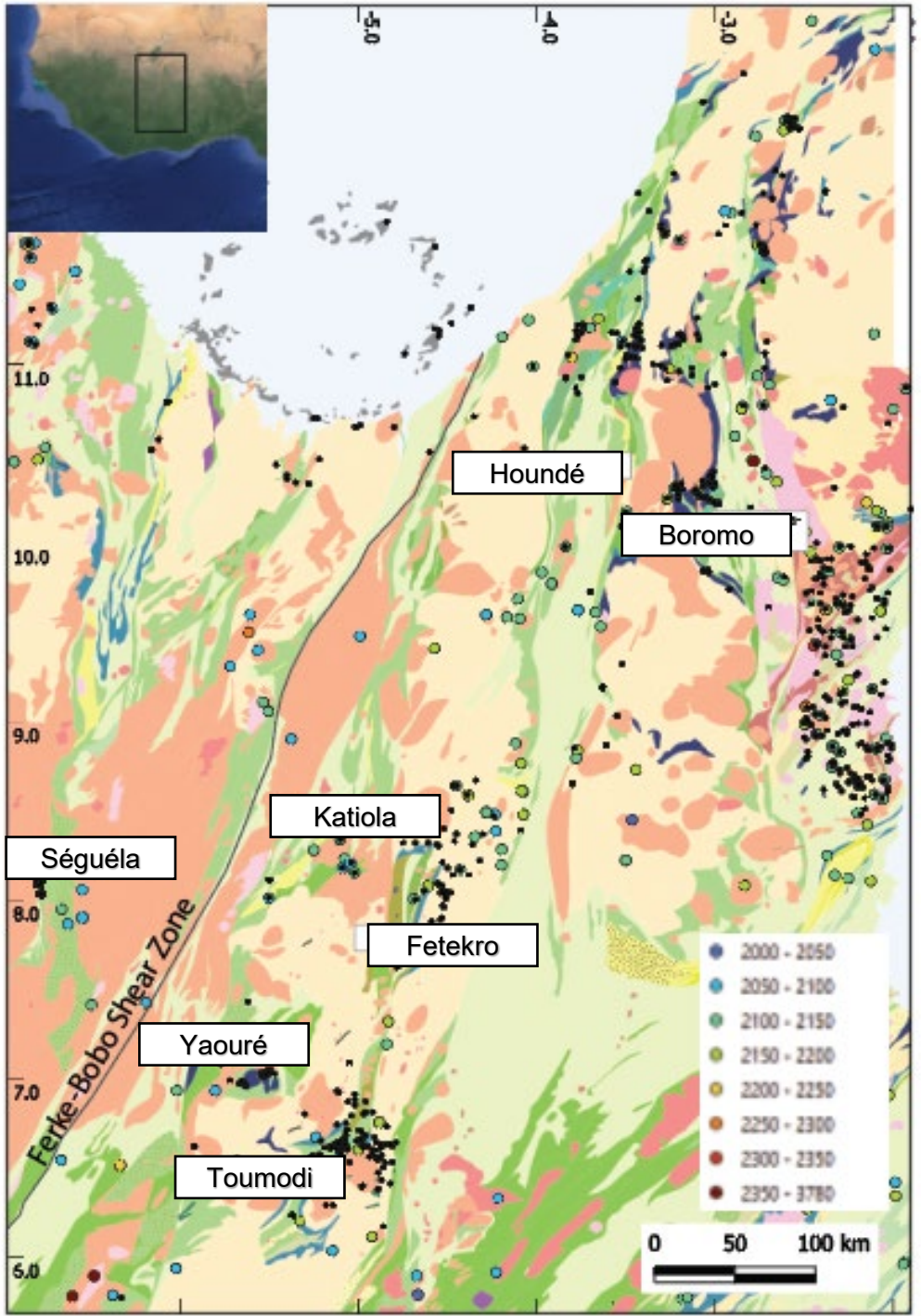
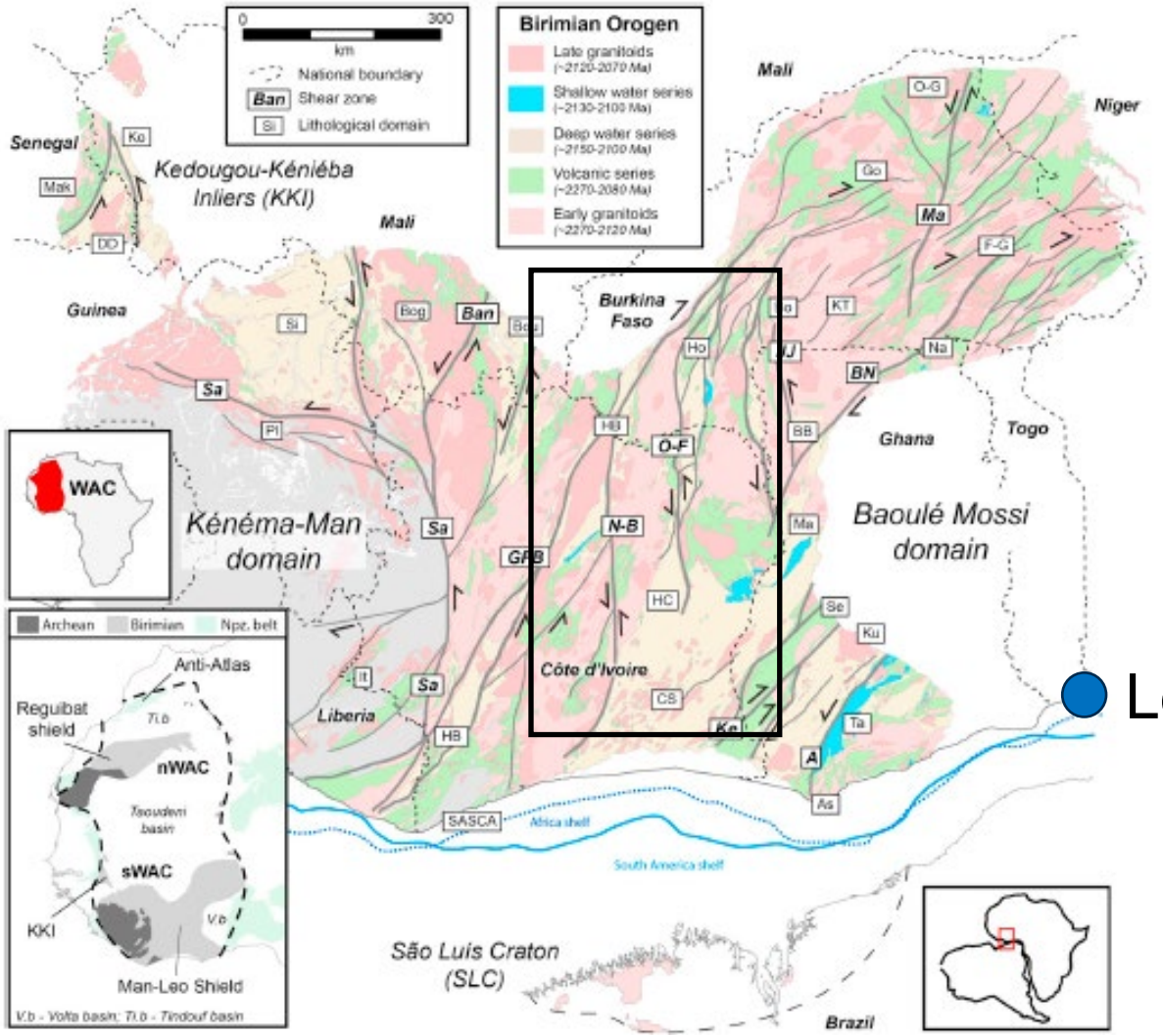
Introduction

- La transition entre l'Archéen et le début du Paléoprotérozoïque est une période cruciale dans l'histoire de la Terre
  - Grand épisode d'oxydation
  - Fin du volcanisme komatitique
  - l'élévation des continents
  - Début de la subduction généralisée et du recyclage de la croûte océanique dans le manteau?
  - Modifications des limites du manteau, de la distribution thermique?
- Avec autant de changements majeurs sur la Terre, il est important d'examiner les roches de cette période.

- La compréhension du contexte tectonique a des implications importantes pour l'exploration minérale

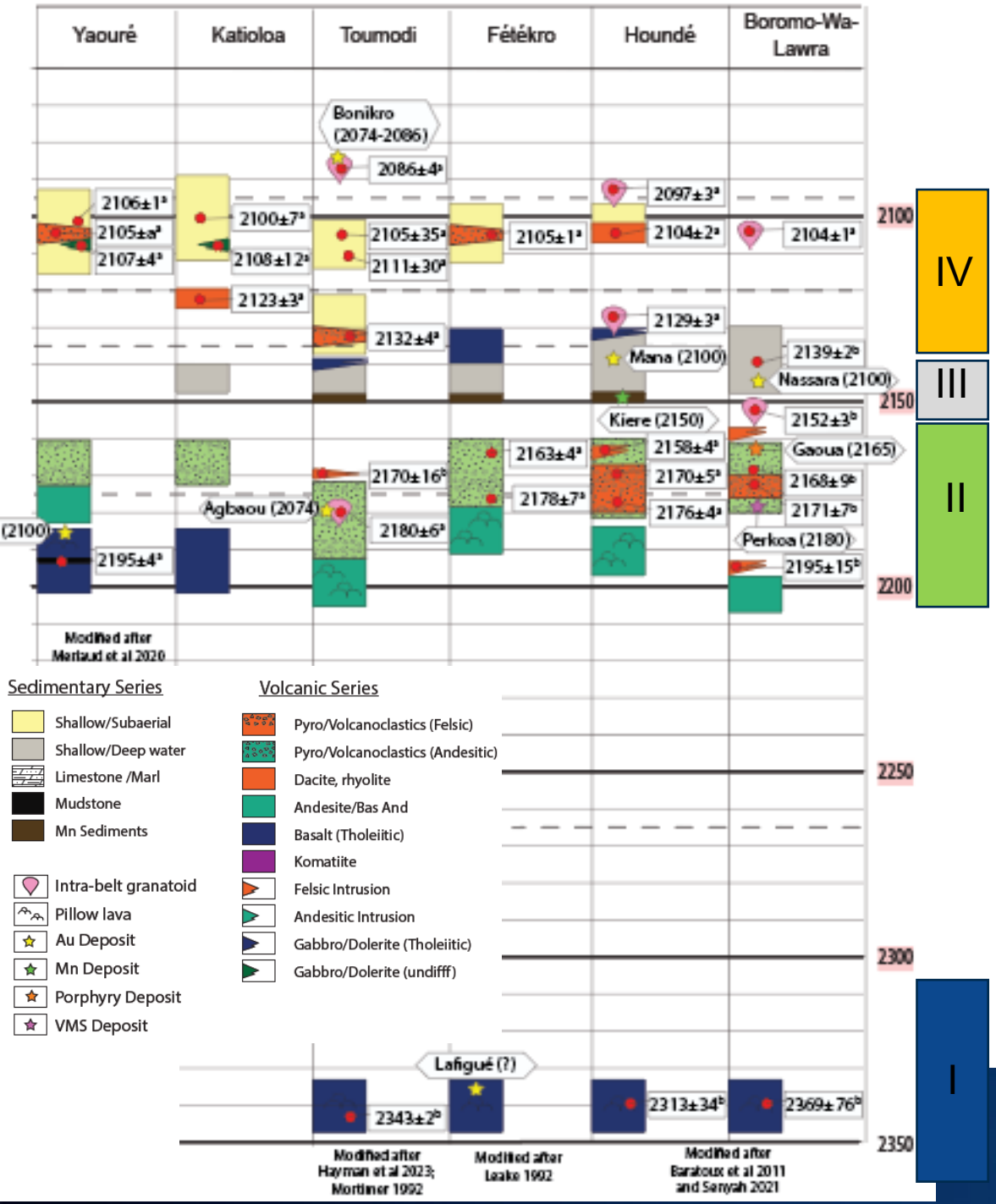
Study Area





After Grenholm et al 2019

Stratigraphy



Stage IV: Felsic volcanism (ca. 2136-2100 Ma)

Stage III: Turbidites & Tholeiitic volcanism?
(ca. 2160-2140 Ma?)

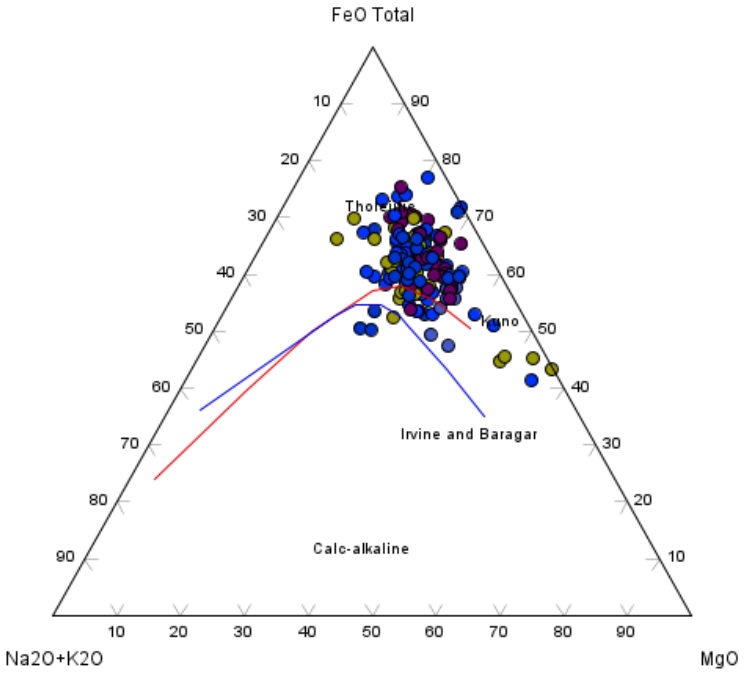
Stage II: Andesitic volcanism (ca. 2200-2160 Ma)

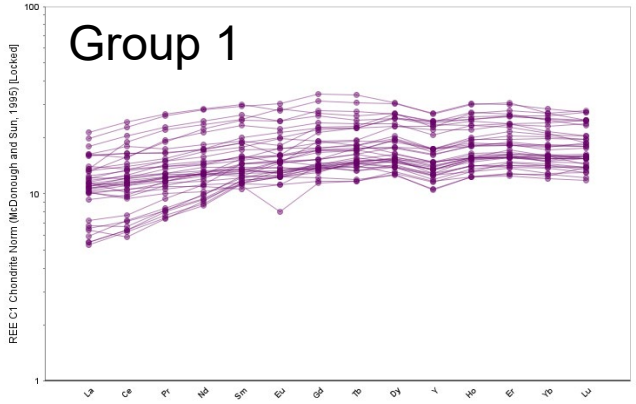
Stage I: Tholeiitic volcanism (ca. 2340-?? Ma)

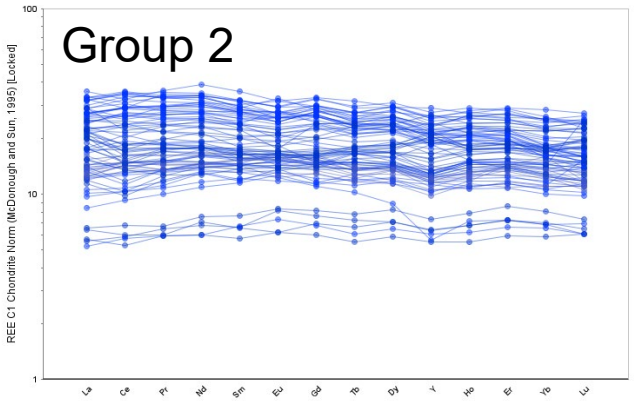
Stage I: Massive and Pillow Basalt LFA

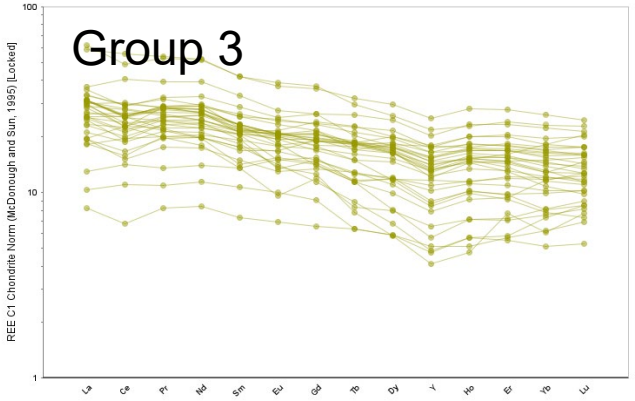
- Contacts inférieurs intrusifs avec des roches granitiques plus jeunes.
- Aucune preuve physique de l'existence d'un socle plus ancien
- Deux coulées de lave terminales
  - Les laves en coussins indiquent des éruptions à faible taux d'écoulement de magma, subaquatiques.
  - Les laves massives indiquent des taux élevés de décharge de magma.
- Gabbro et dolérite
- Rarement associées à des mudstones
- Loin de toute source de sédiments (masse continentale)

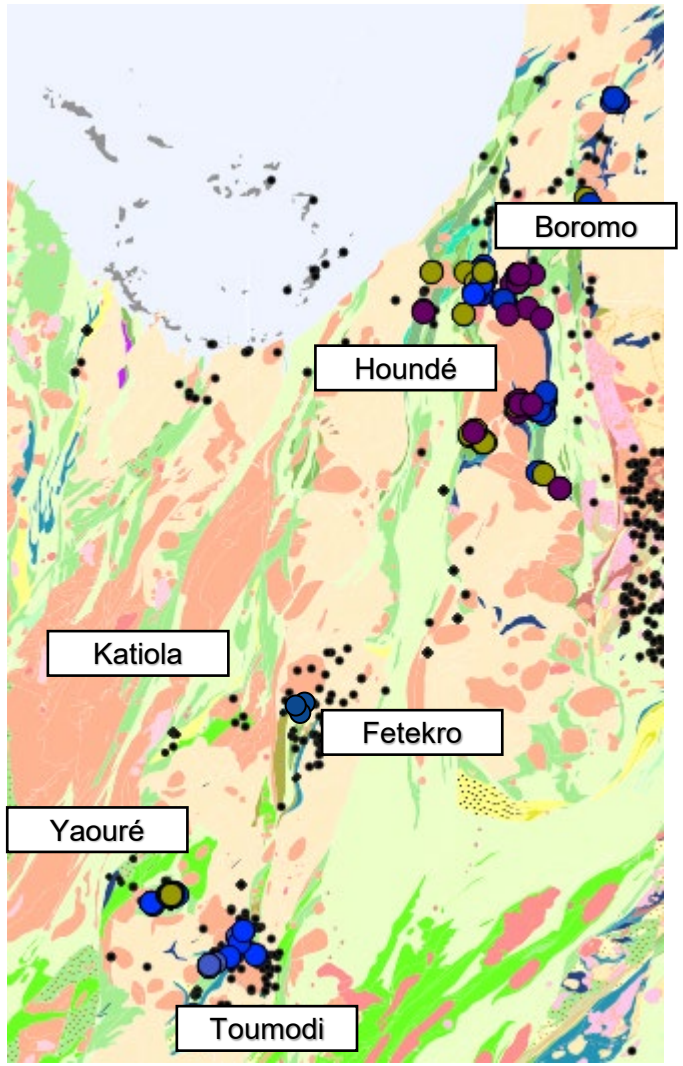
Stage I: Geochemistry











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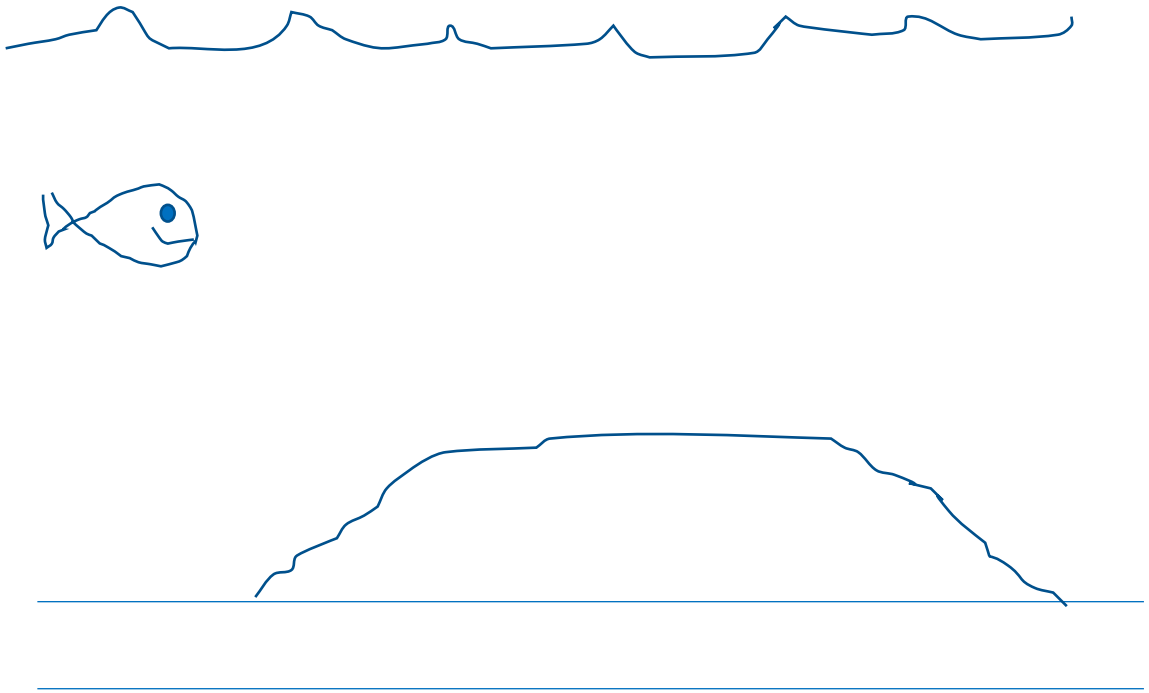
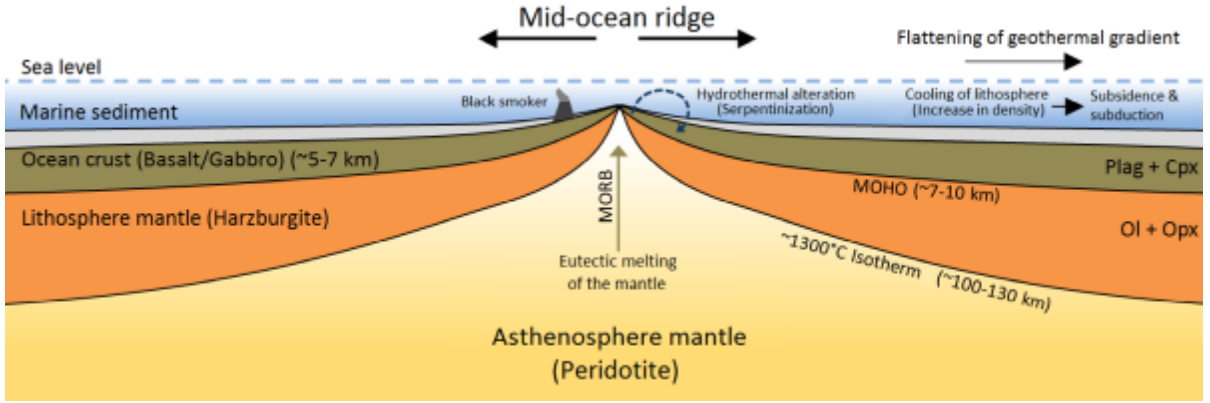
Stage I: Subaqueous Oceanic Plateau or Mid-Oceanic Ridge Basalts?



Oceanic Plateau

OR



Mid Oceanic Ridge (Wiki Commons)

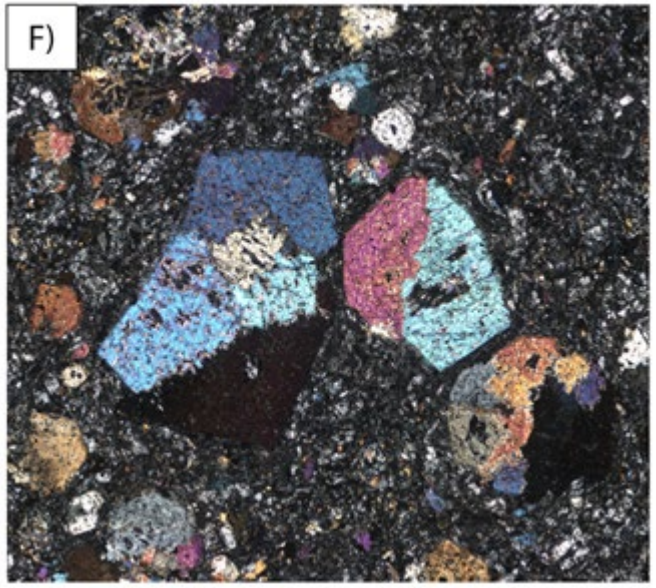
Stage II: Andesitic Volcanism

- Lithofaciès coherent
  - Massifs
  - laves en coussins
- Lithofaciès fragmentaire
  - Volcaniclastiques massifs et lités
  - Pyroclastites massives et litées

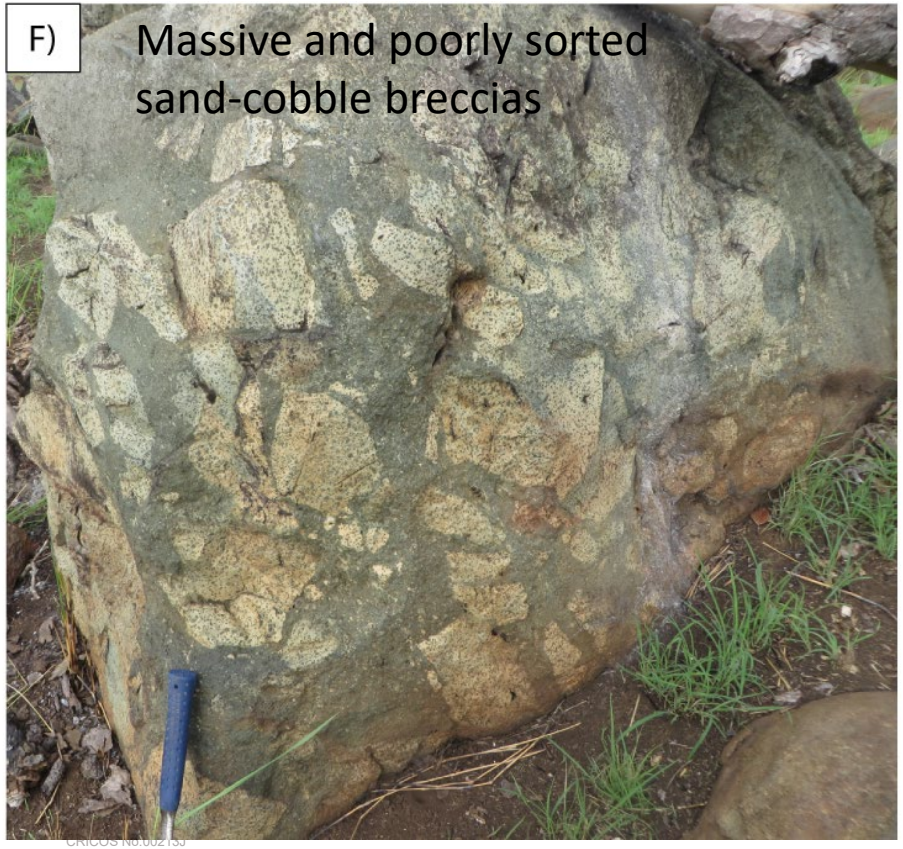
- Deux groupes géochimiques principaux :
  - andésite
  - andésite basaltique
- Lithofaciès associés
  - Rhyolite
  - Dolérite/gabbro

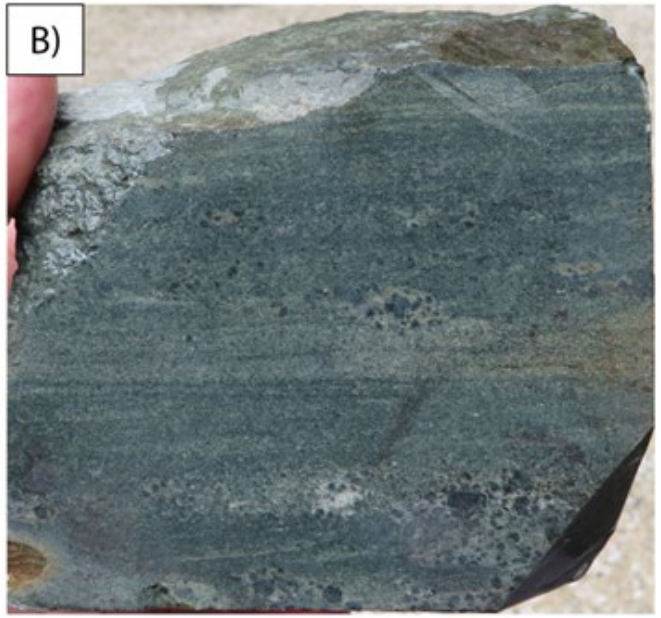
Pyroxene-porphyritic andesitic rocks

- Massifs ou en coussins
- Les cristaux de pyroxène d'une taille maximale de 1 cm sont courants dans toutes les ceintures de roches vertes.



Andesitic Volcaniclastics

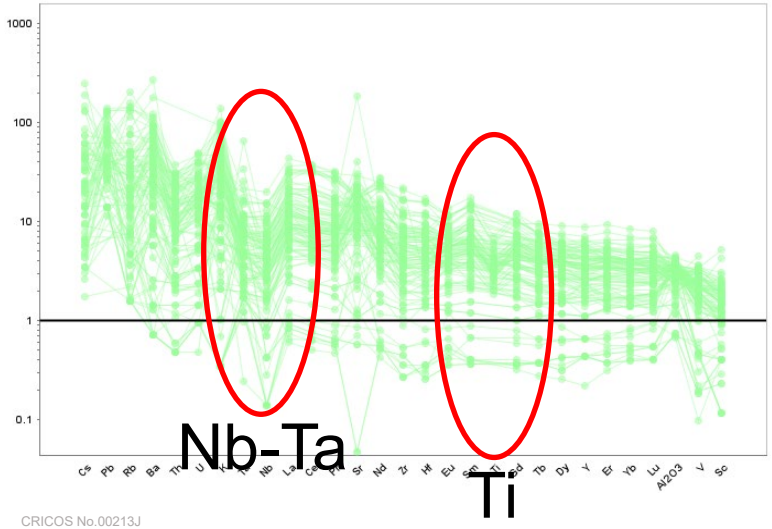




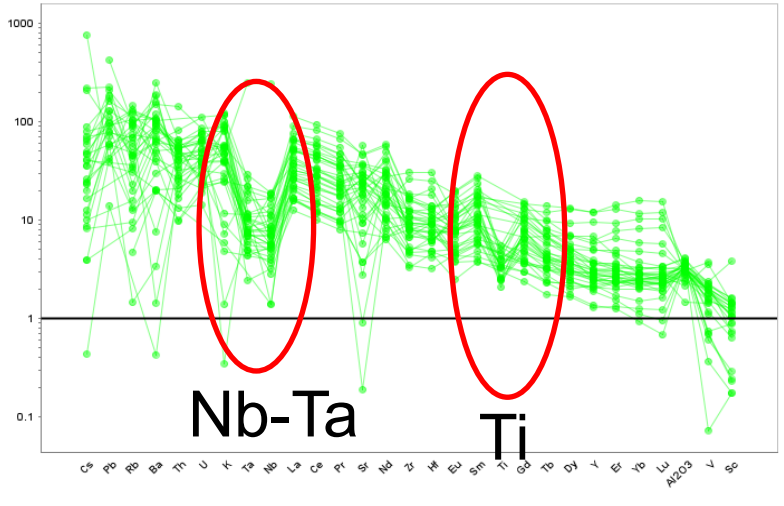
Stage II: Geochemistry

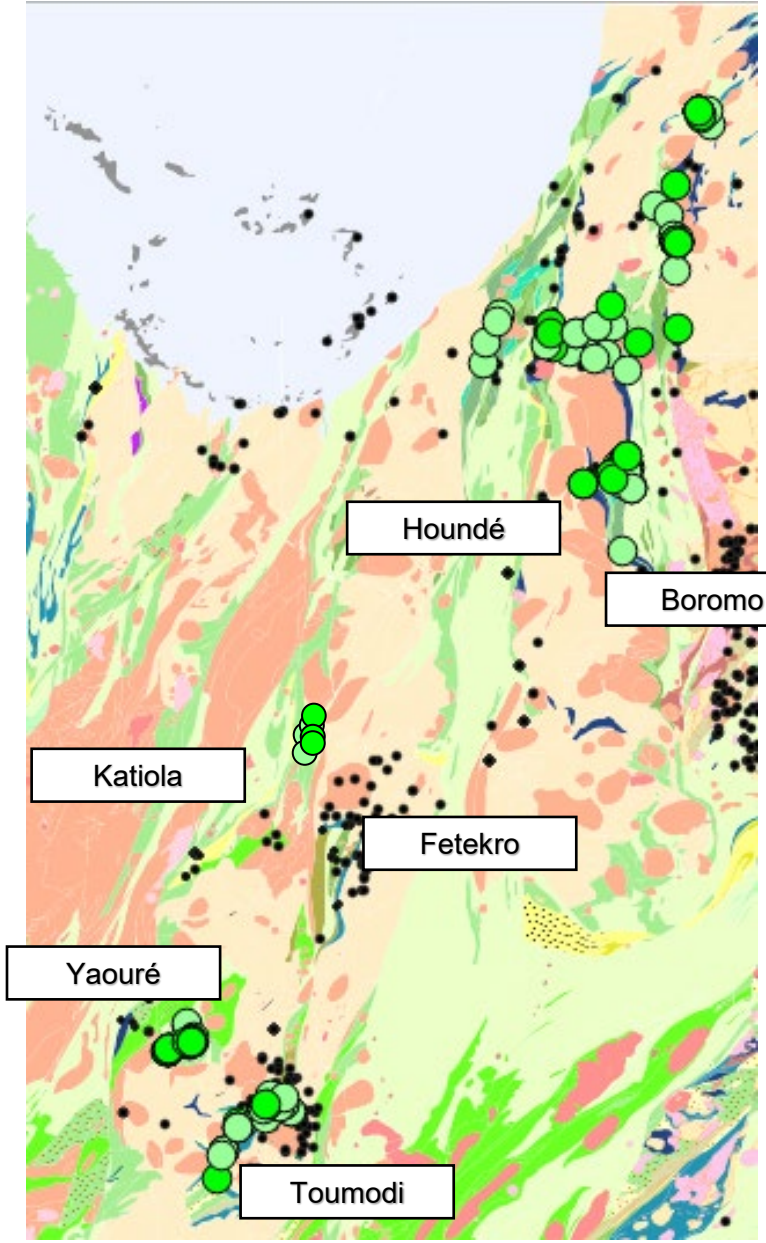
- La géochimie des oligo-éléments présente des anomalies négatives prononcées en Ta-Nb-Ti, compatibles avec une fusion du manteau par flux d'eau

Basaltic Andesite



Andesite





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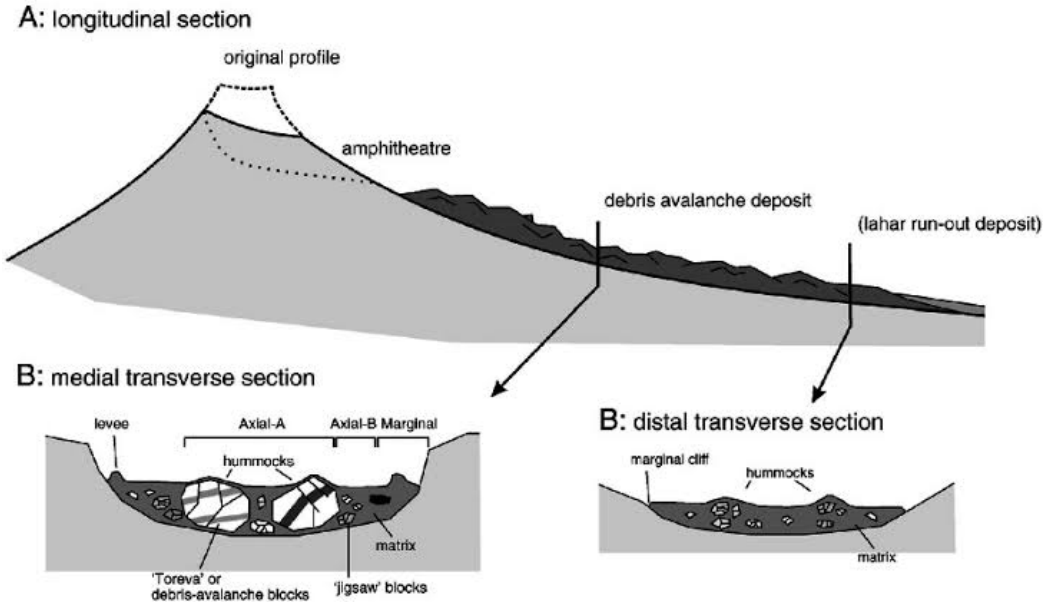
Stage II:
Construction & Destruction of intermediate volcanoes

- Stratovolcans (volcan commun pour les magmas intermédiaires), certains émergents
- cône de tuf subaérien
- Laves andésitiques subaquatiques, stratovolcans (dômes ?)

Augustine Volc. (stratovolcano)

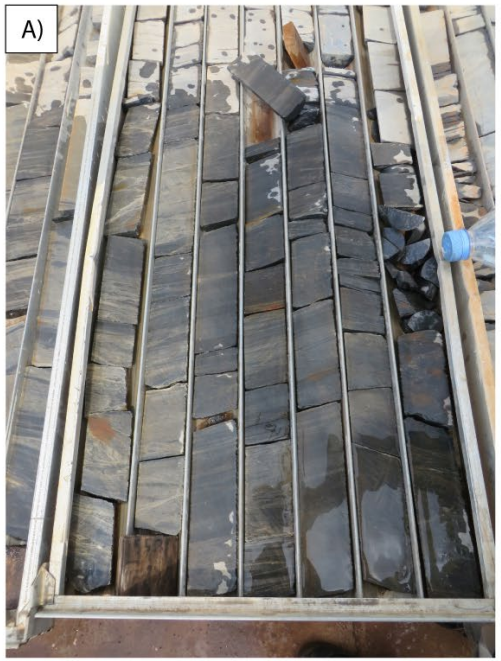


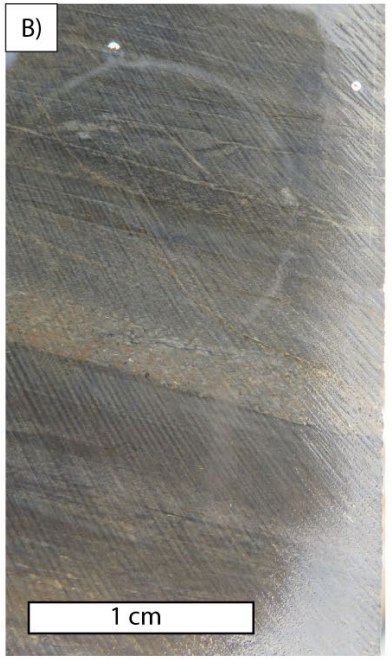
Longitudinal and cross sections (medial and distal) of a debris avalanche deposit (Manville et al 2009)

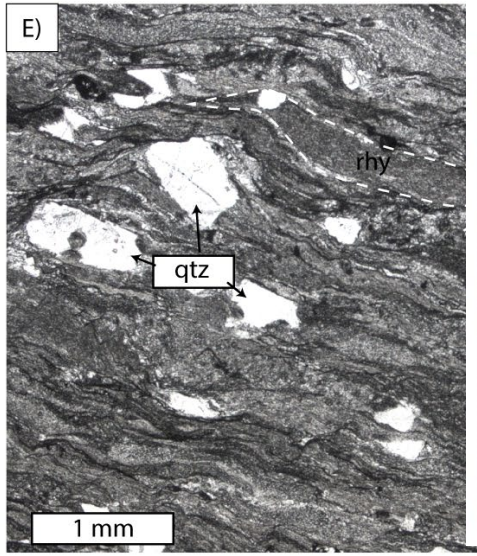
Stage III

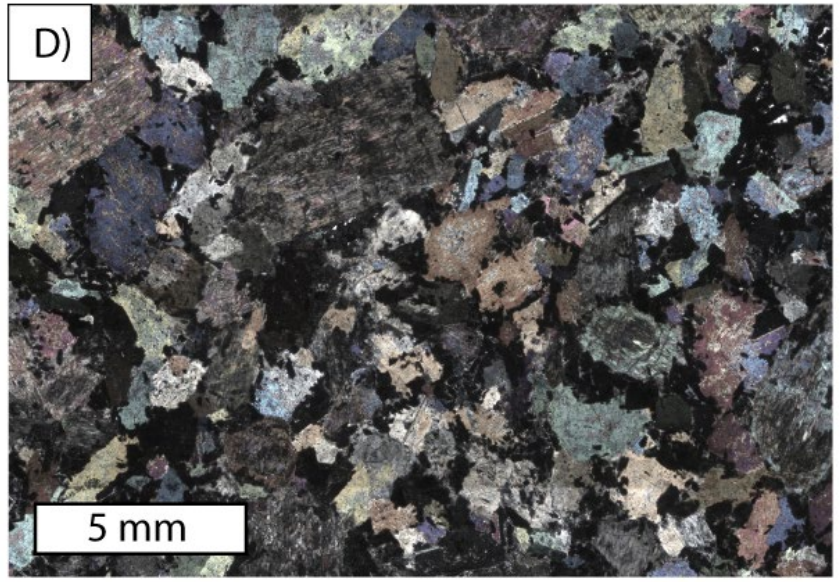
- Turbidite
- Gabbros

- Période d'extension de la séquence de submersion





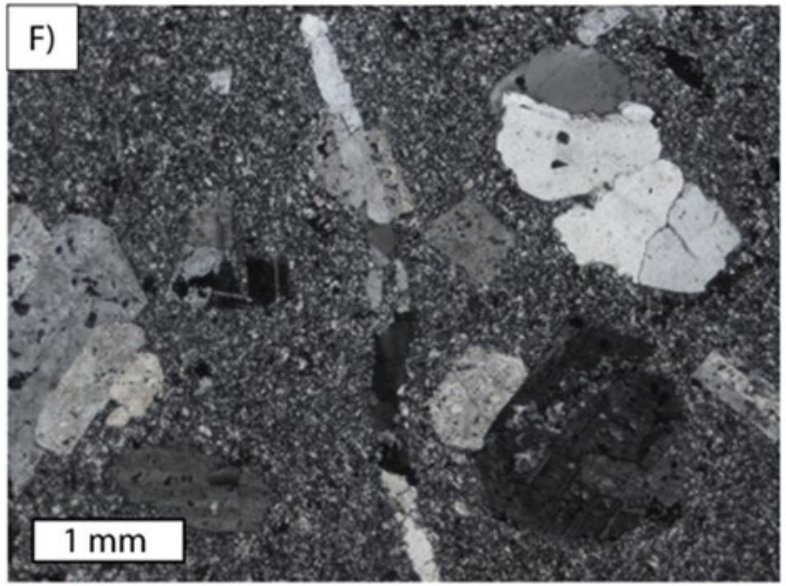




Stage IV: Felsic Volcanics

- Dacite, rhyolite
- Ignimbrites

- Limité à la partie méridionale des ceintures



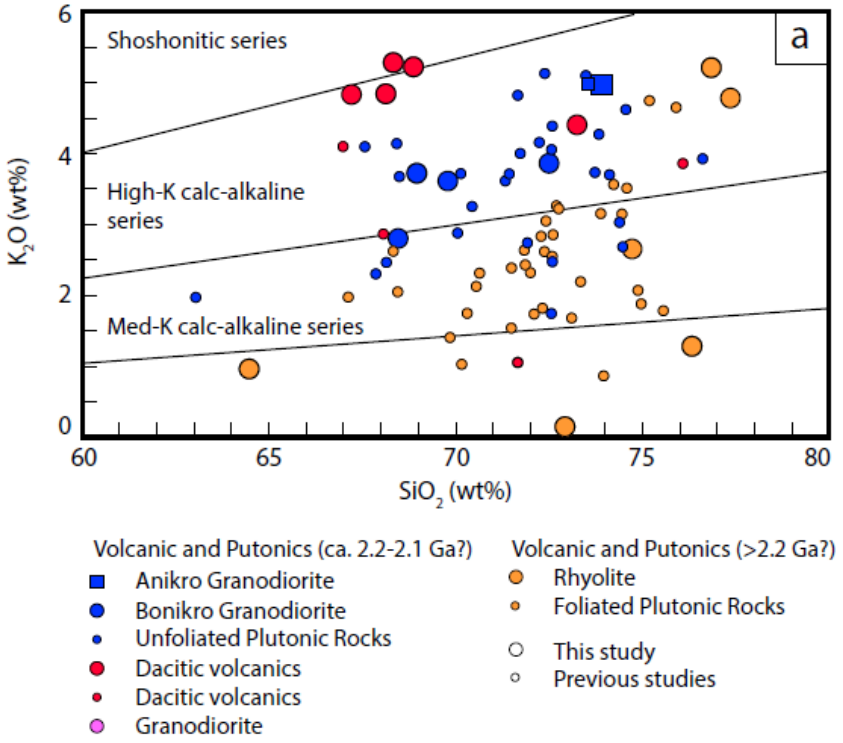
Stage IV: Quartz-rich sediments

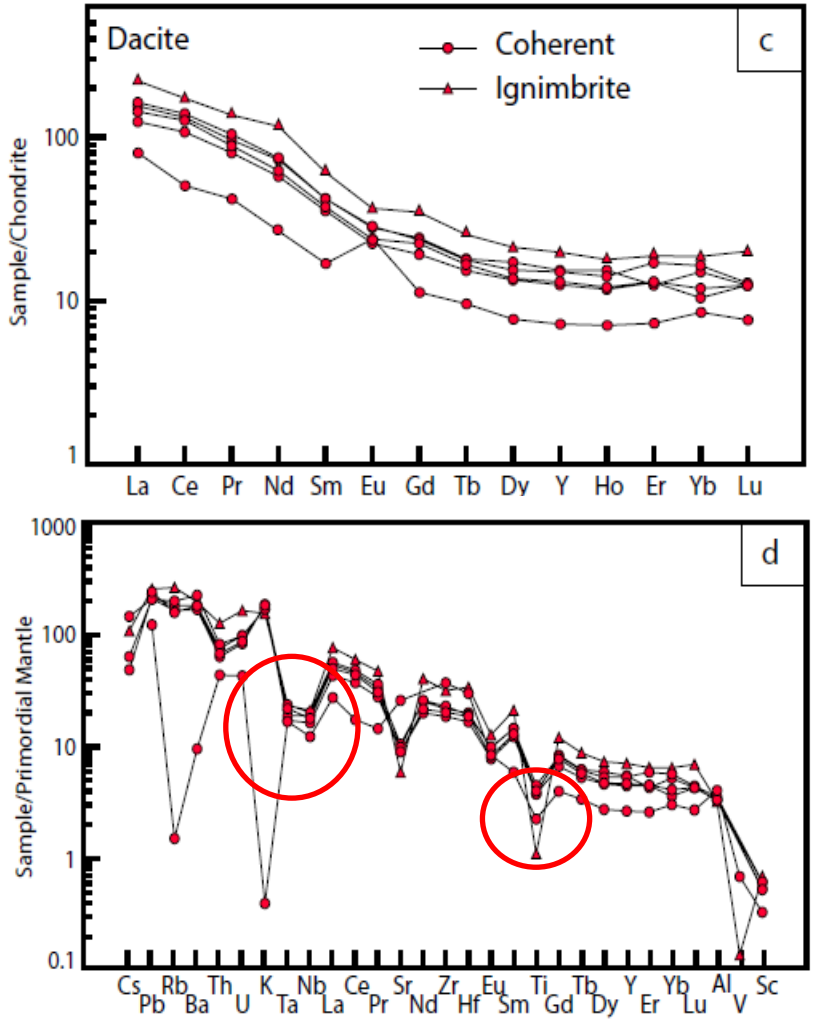
- Planéité, litage croisé, litage croisé à faible angle (anti-dunes)
- Conglomérat

- Indiquent un environnement fluvial

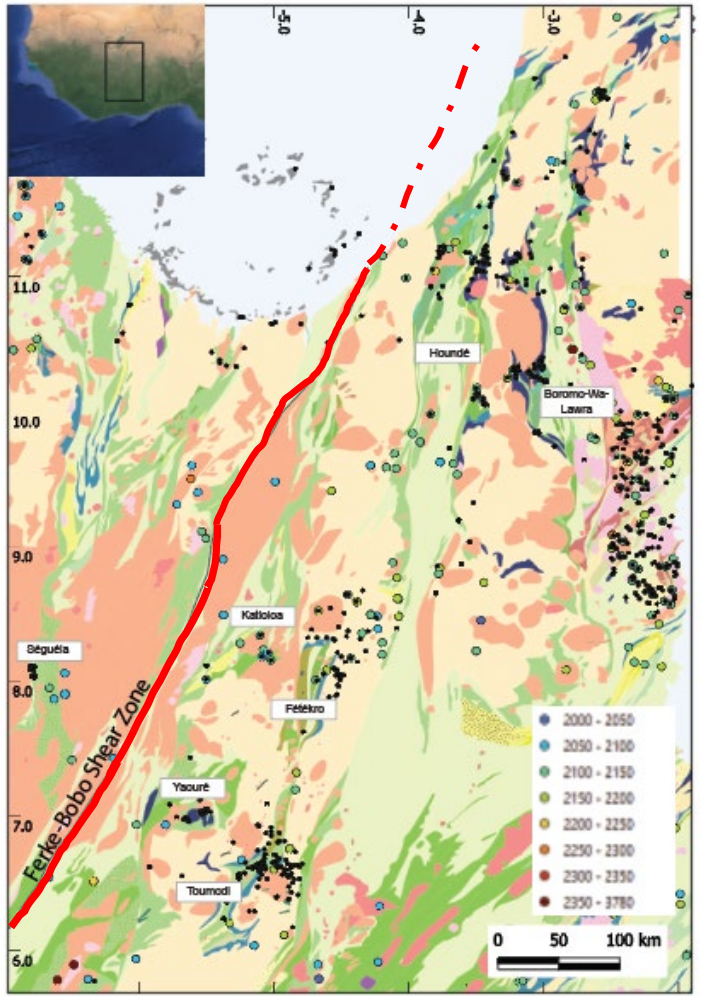
Stage IV: Chemistry

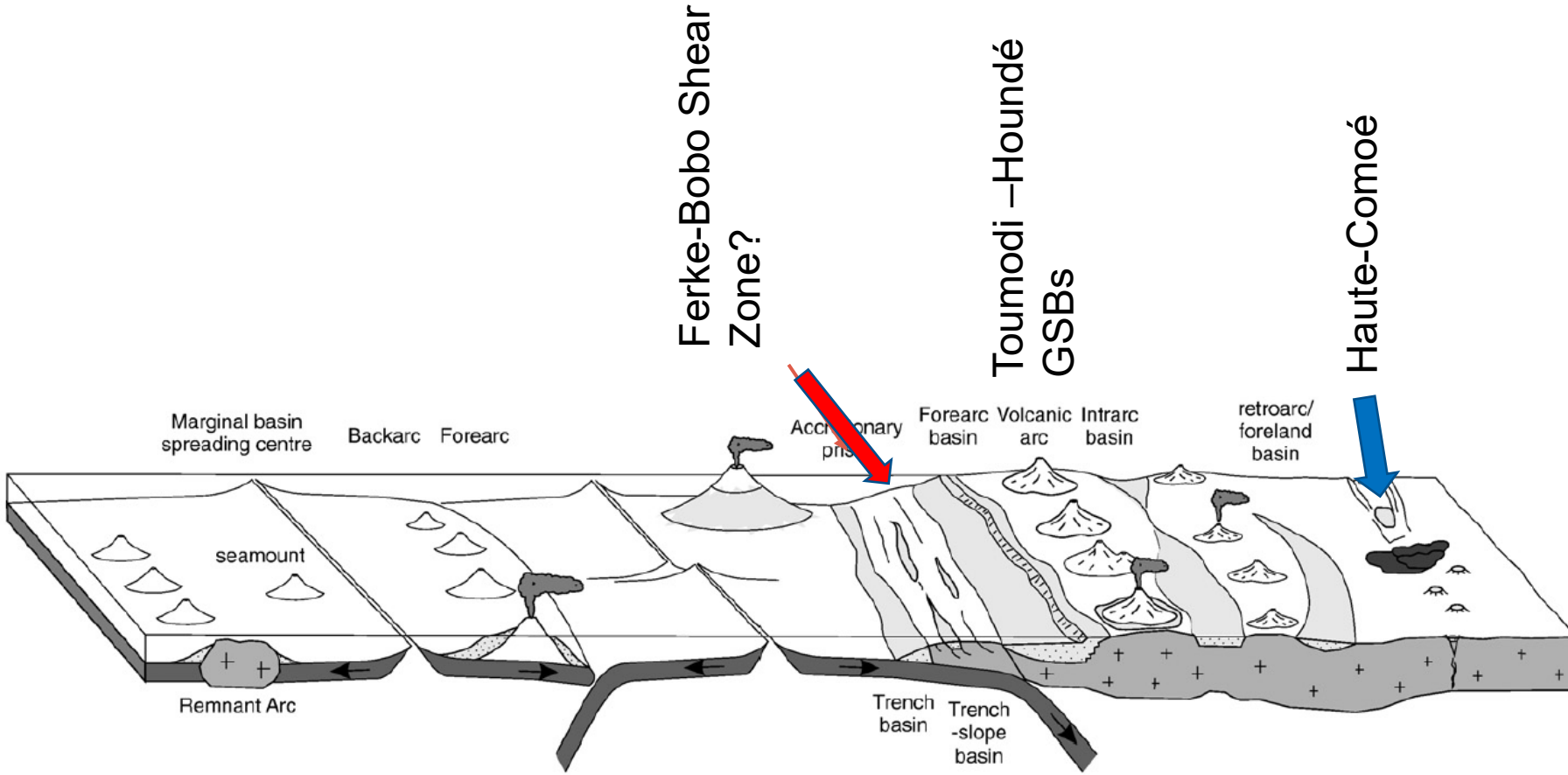
- High-K suggère une fusion dans une croûte plus épaisse et plus évoluée
- La géochimie des éléments traces montre des anomalies négatives prononcées de Ta-Nb-Ti, compatibles avec la fonte du manteau par flux d'eau





Stage IV: Toumodi-Fétékro-Houndé-Boromo Volcanic Arc





Tectonic Settings for Toumodi Belt (after Manville et al 2009)

Conclusions

- Les ceintures de roches vertes ont été construites en quatre étapes principales
    1. Volcanisme tholéiitique, eaux profondes, MORB ou Plateau Océanique vers 2343 Ma
    2. Le volcanisme andésitique représente la formation d'un jeune arc volcanique immature (environ 2200-2160 Ma)
    3. Événement de rifting intra-arc (environ 2160-2140 Ma)
    4. Le magmatisme dacitique représente une phase de construction d'arc mature (environ 2136-2100 Ma)
- Il est proposé que la subduction soit à l'est et que la zone de cisaillement Ferke-Bobo représente une zone de paléo-subduction, et que la Haute-Comoé représente un bassin d'arrière-arc.
- Implications importantes pour l’exploration minérale

Mersi

Reconstruction of a Paleoproterozic Arc

Dr Patrick Hayman

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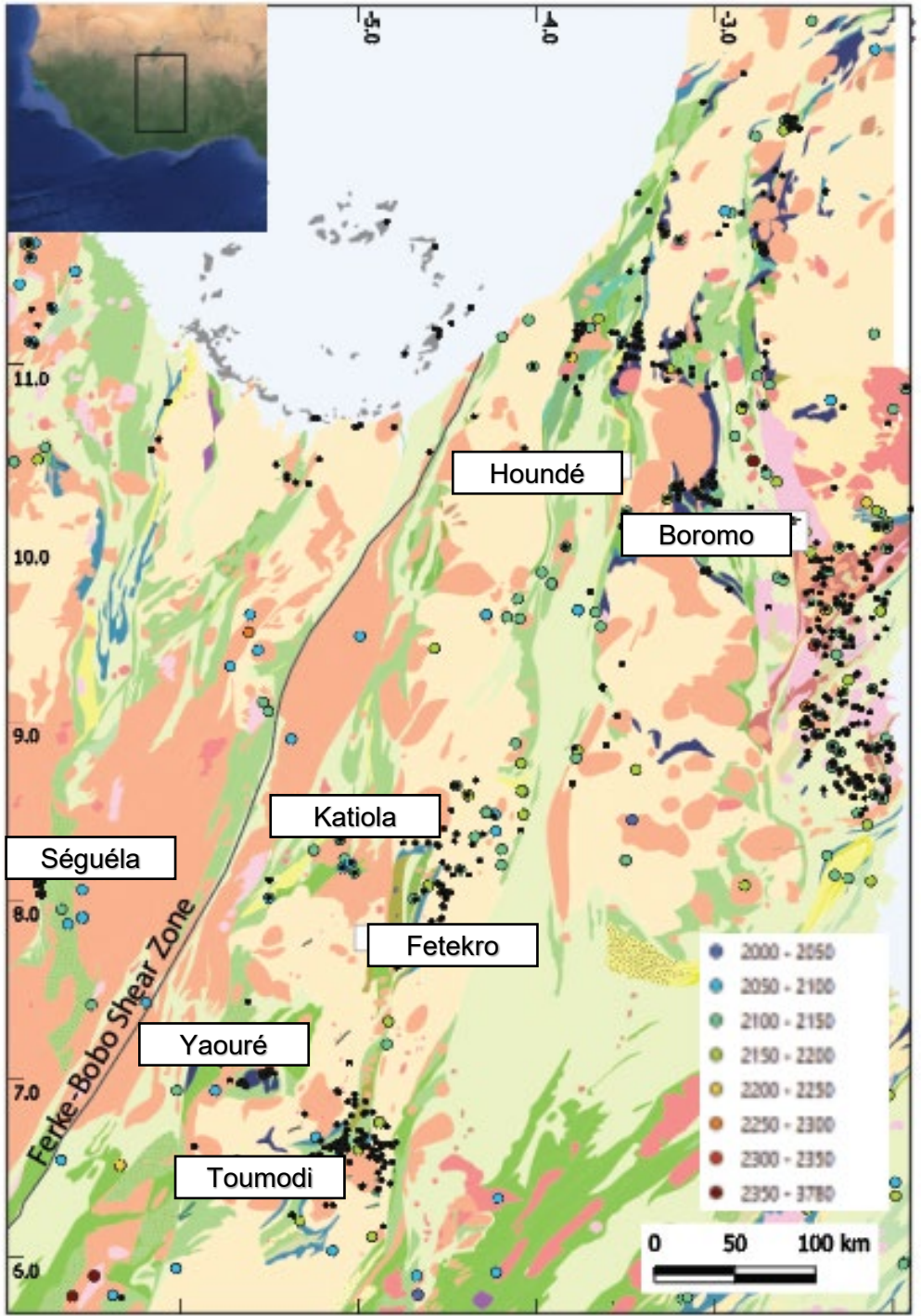
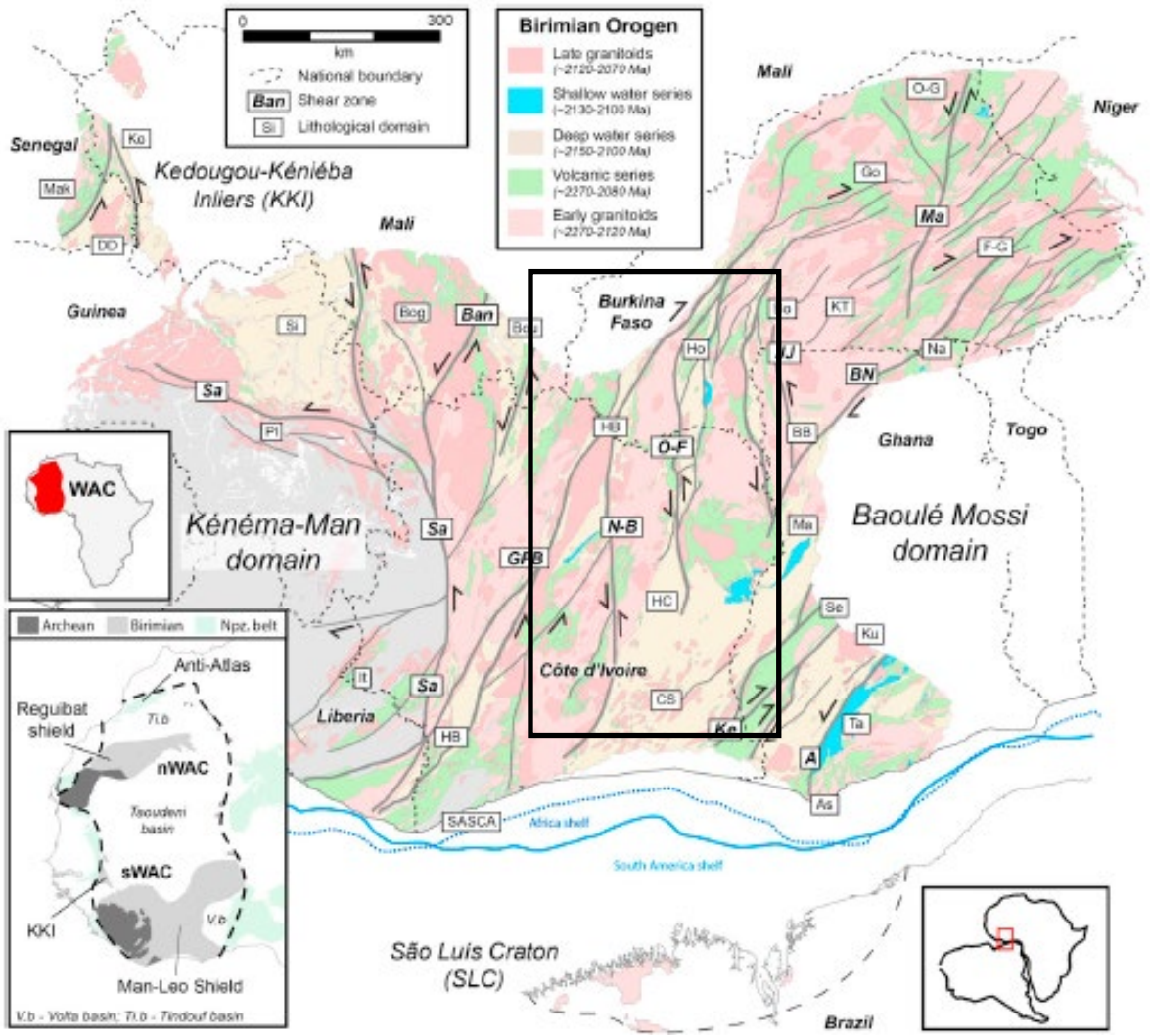
Introduction

- The transition from the Archean into the early Paleoproterozoic is a momentous time in Earth's history, e.g.:
  - Great Oxidation Event
  - End of komatiitic volcanism
  - Rise in continental freeboard
  - Beginning of widespread subduction and recycling of oceanic crust into the mantle?
  - Changes in mantle boundaries, thermal distribution??

- With so many major changes on the Earth, it is important we examine rocks from this time period

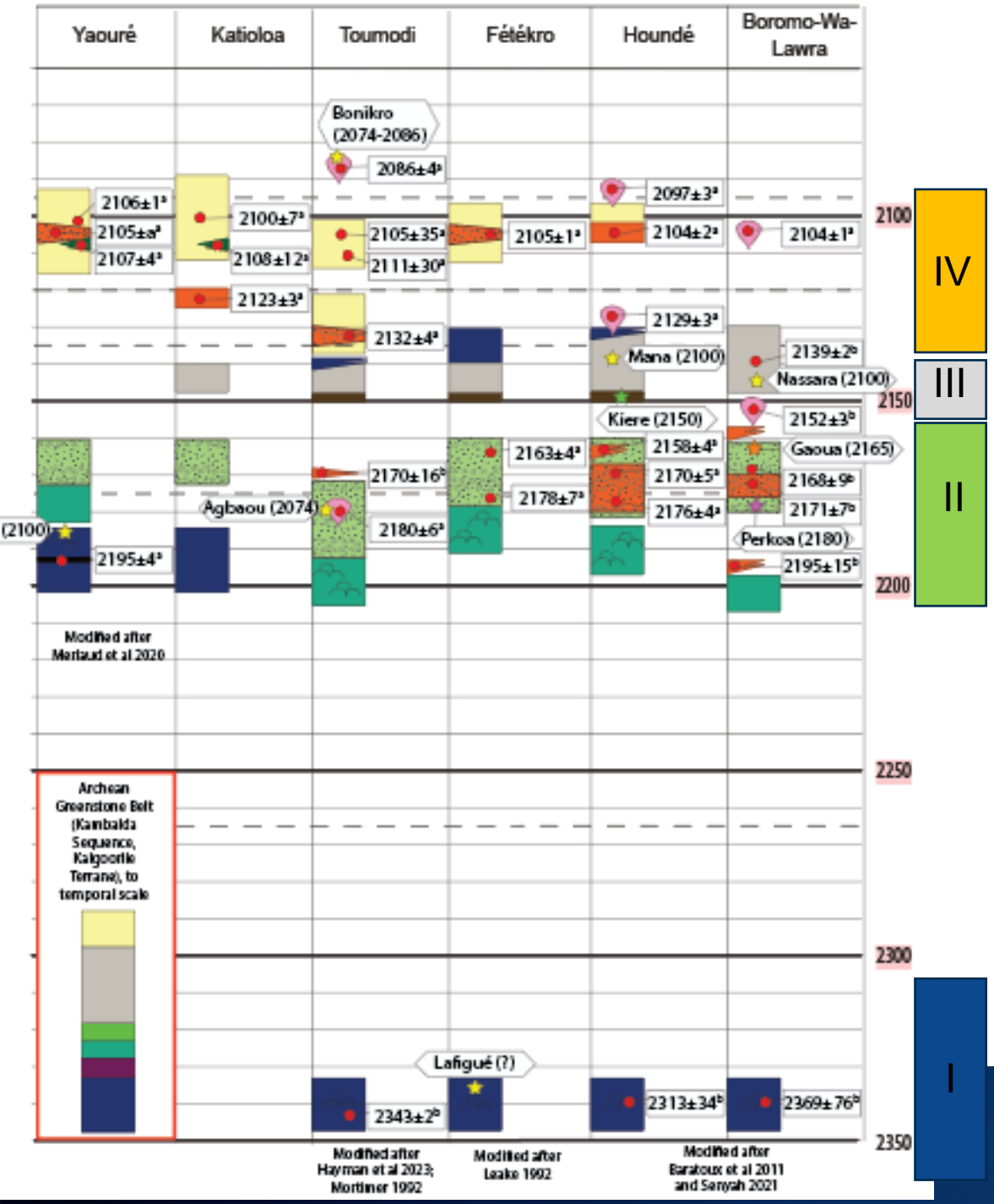
Study Area





After Grenholm et al 2019

Stratigraphy



Stage IV: Felsic volcanism (ca. 2136-2100 Ma)

Stage III: Turbidites & Tholeiitic volcanism?
(ca. 2160-2140 Ma?)

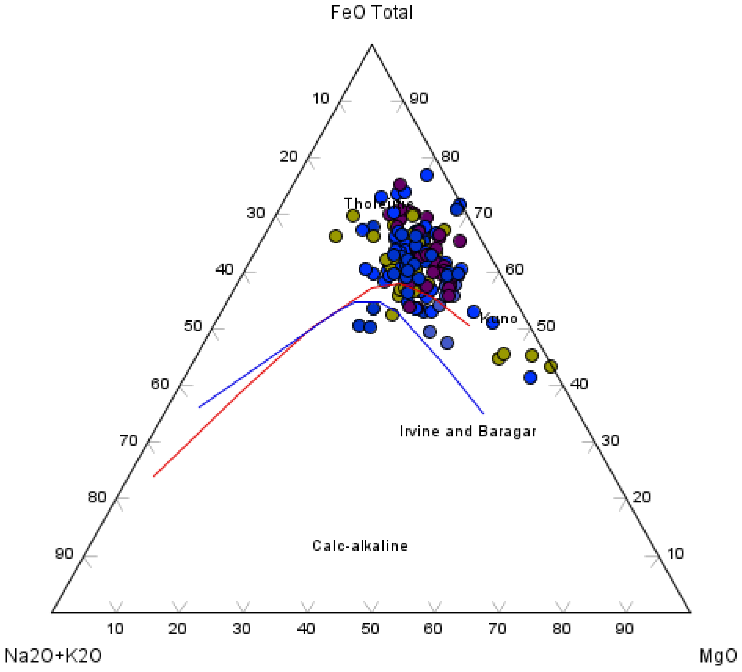
Stage II: Andesitic volcanism (ca. 2200-2160 Ma)

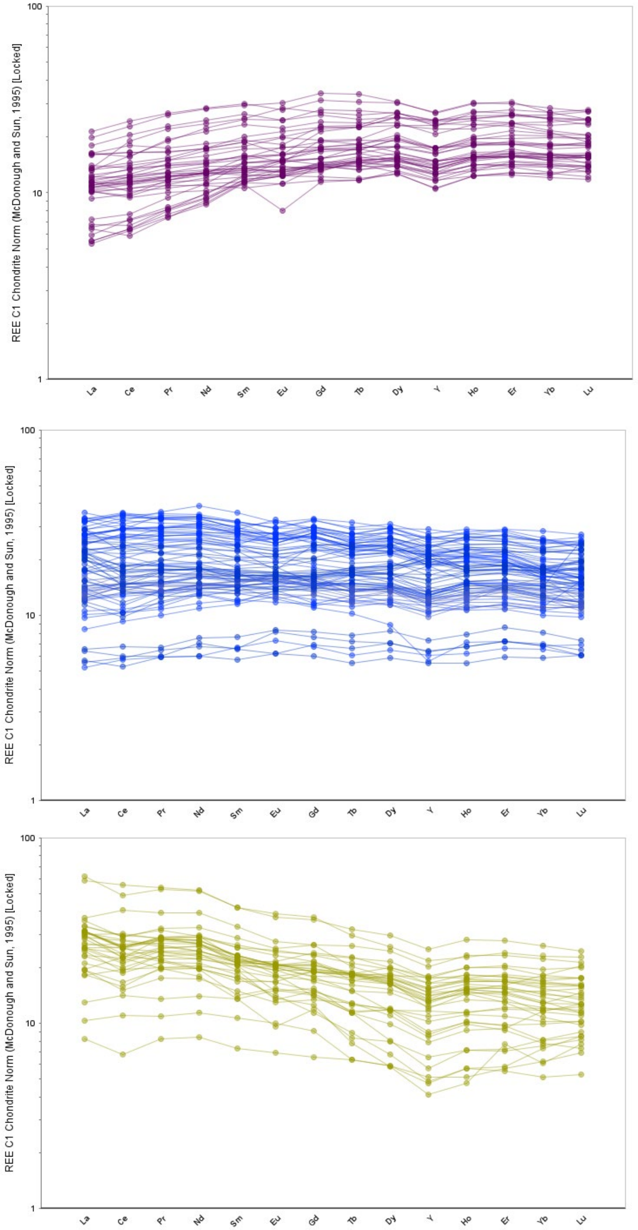
Stage I: Tholeiitic volcanism (ca. 2343 Ma)

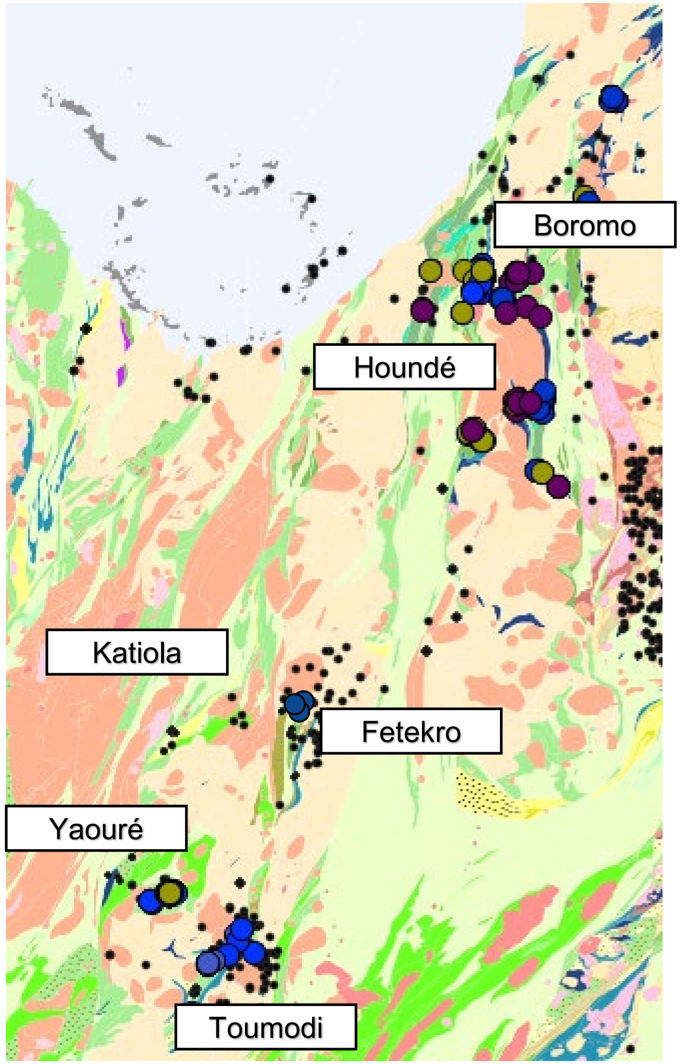
Stage I: Massive and Pillow Basalt LFA

- Lower contacts intrusive with younger granitic rocks.
- No physical evidence for older basement
- Two end-member lava flows
  - Pillow lavas indicate low magma discharge rate eruptions, subaqueous
  - Massive lavas indicate high magma discharge rates
- Gabbro & Dolerite
- Rarely associated with mudstones
  - Far from any sediment source (landmass)

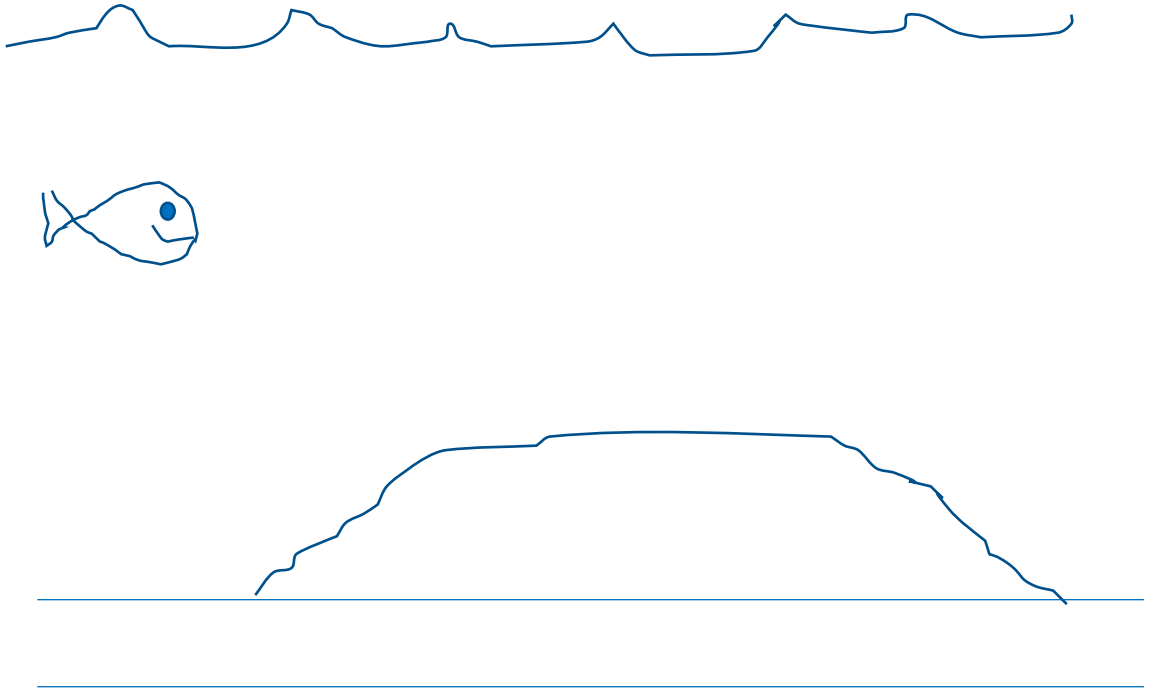
Stage I: REE Chemistry



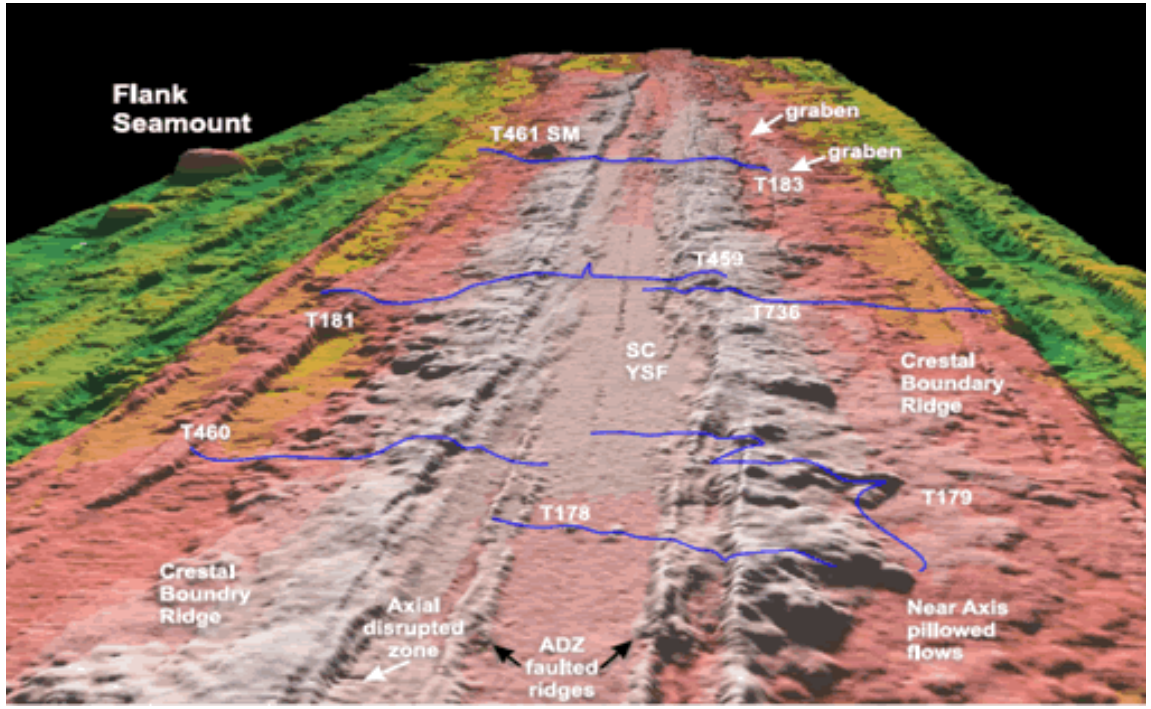




Stage I: Subaqueous Oceanic Plateau or Mid-Oceanic Ridge Basalts?



Oceanic Plateau



MORB: 3-D perspective bathymetric map of the southern Cleft Segment of the Juan de Fuca Ridge (after Stakes et al., 2006

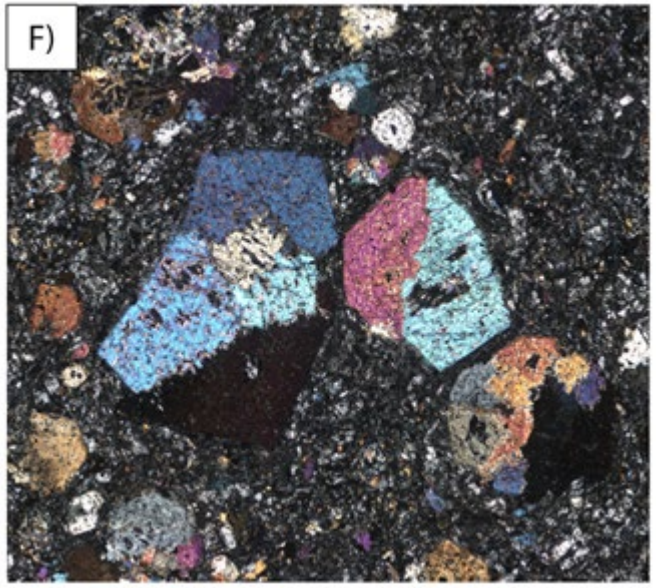
Stage II: Andesitic Volcanism

- Coherent Lithofacies
  - Massive
  - Pillowed
- Fragmental Lithofacies
  - Massive and bedded volcaniclastics
  - Massive and bedded pyroclastics
- Two main geochemical groups: andesite and basaltic andesite

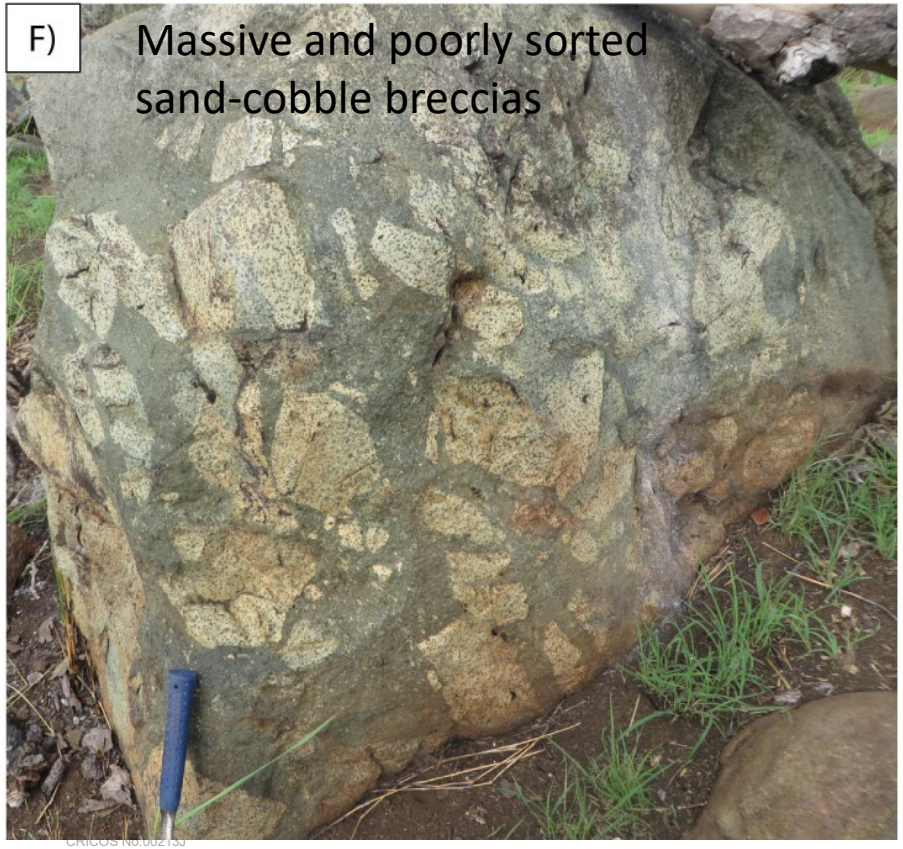
- Associated Lithofacies
  - Rhyolite
  - Dolerite/gabbro

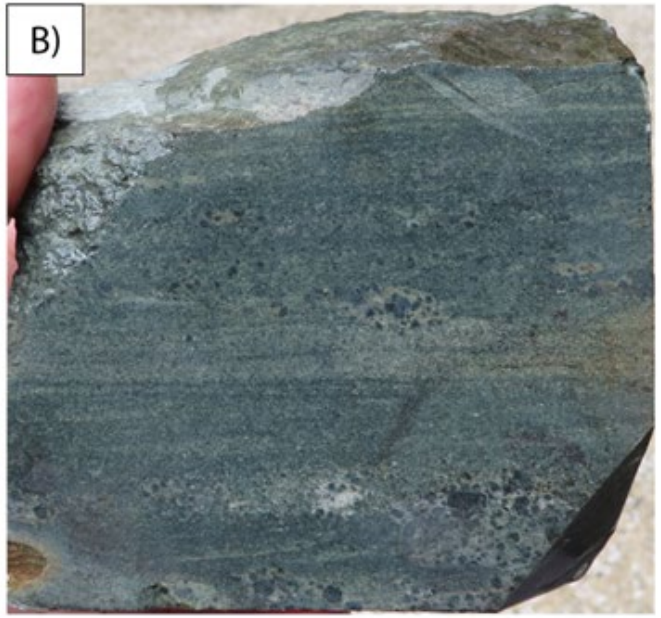
Pyroxene-porphyritic andesitic rocks

- Massive to pillowed
- Pyroxene crystals up to 1 cm (now altered to actinolite)



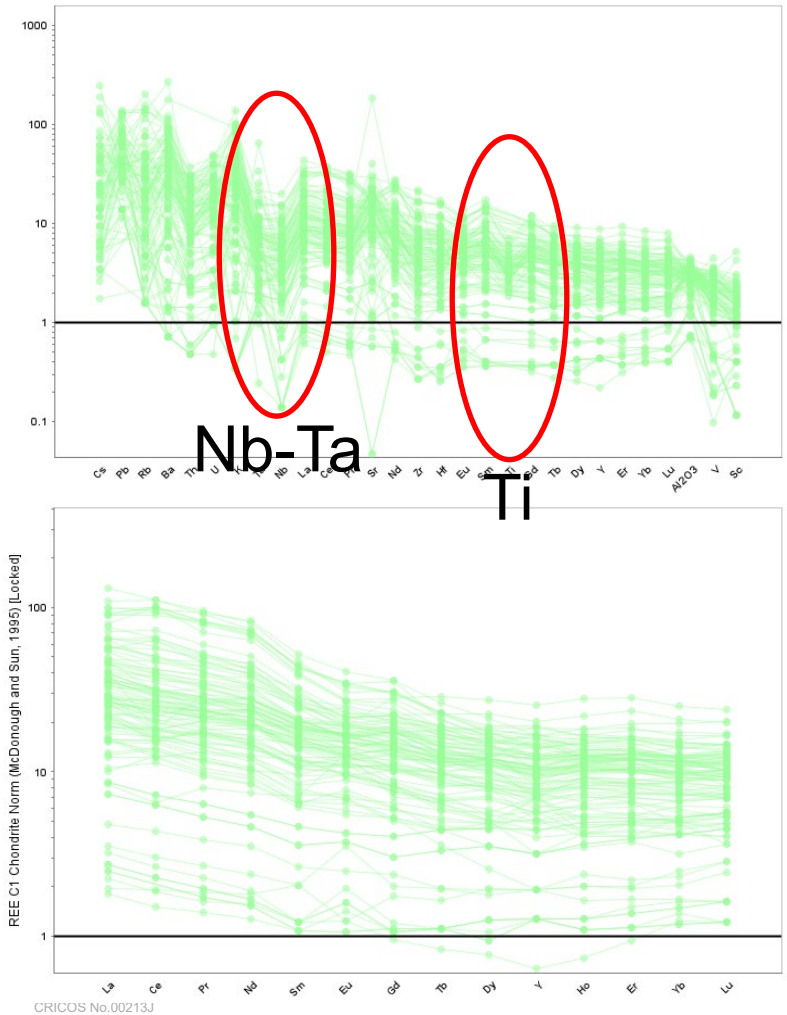
Andesitic Volcaniclastics



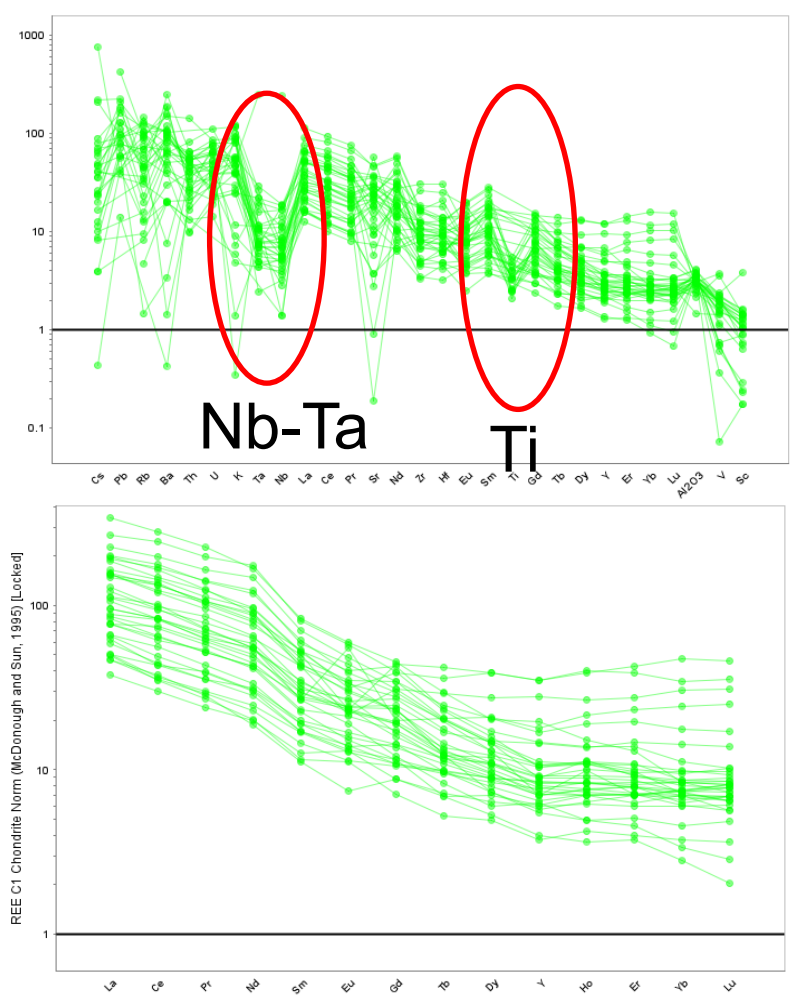


Stage II: Geochemistry

Basaltic Andesite



Andesite



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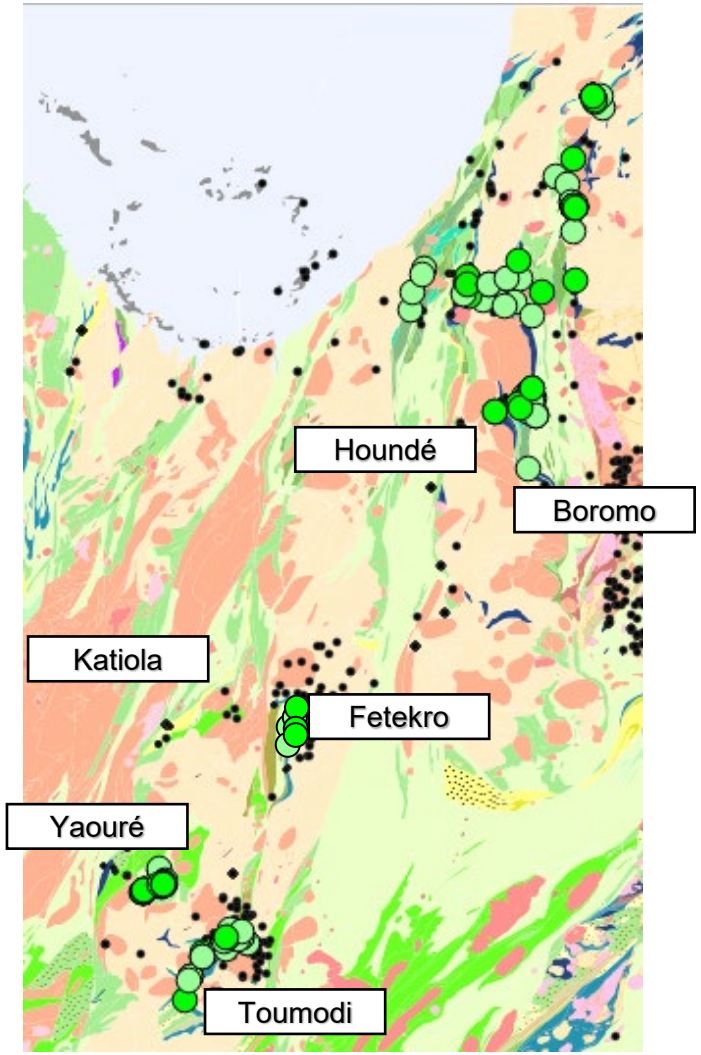


Trace element geochemistry shows pronounced negative Ta-Nb-Ti anomalies, consistent with water-fluxed mantle melting

WAXI West African Exploration Initiative

QUT

Stage II:
Construction of intermediate volcanoes

- Stratovolcanoes (common volcano for intermediate magmas), some emergent
- Subaerial tuff cone
- Subaqueous andesitic lavas, stratovolcanoes (domes?)

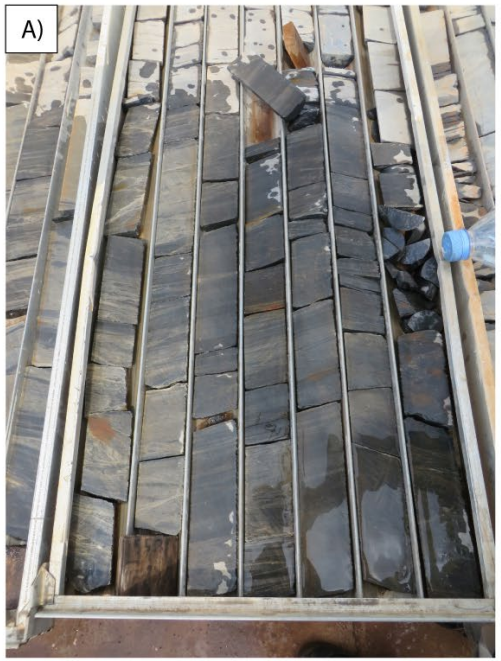
Augustine Volc. (stratovolcano)

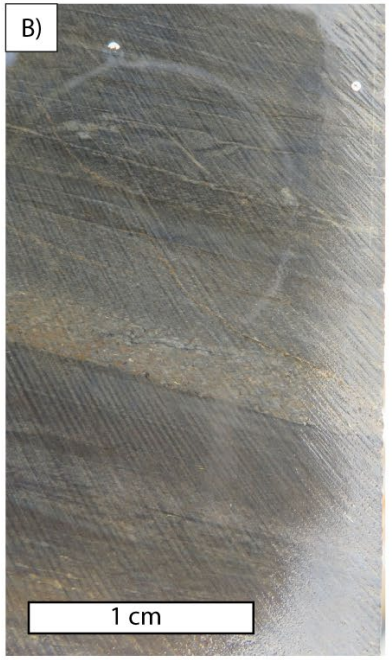
Volcán Bárcena (tuff cone)

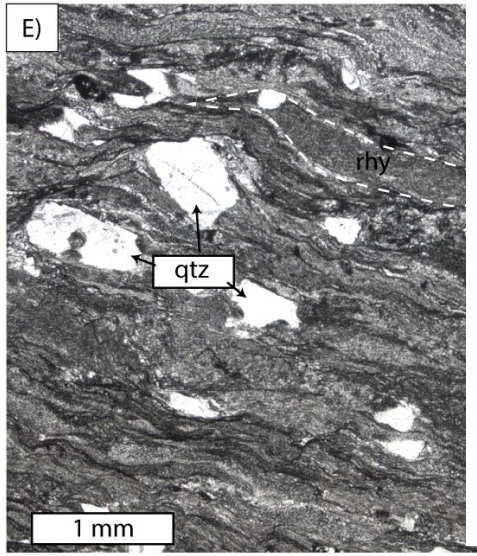
Stage III

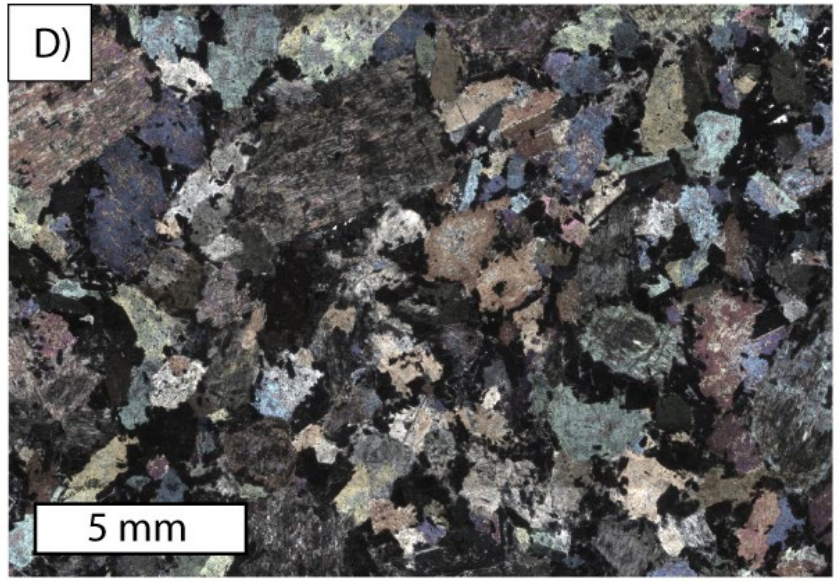
- Turbidites
- Gabbros

- Period of extension to submerge sequence



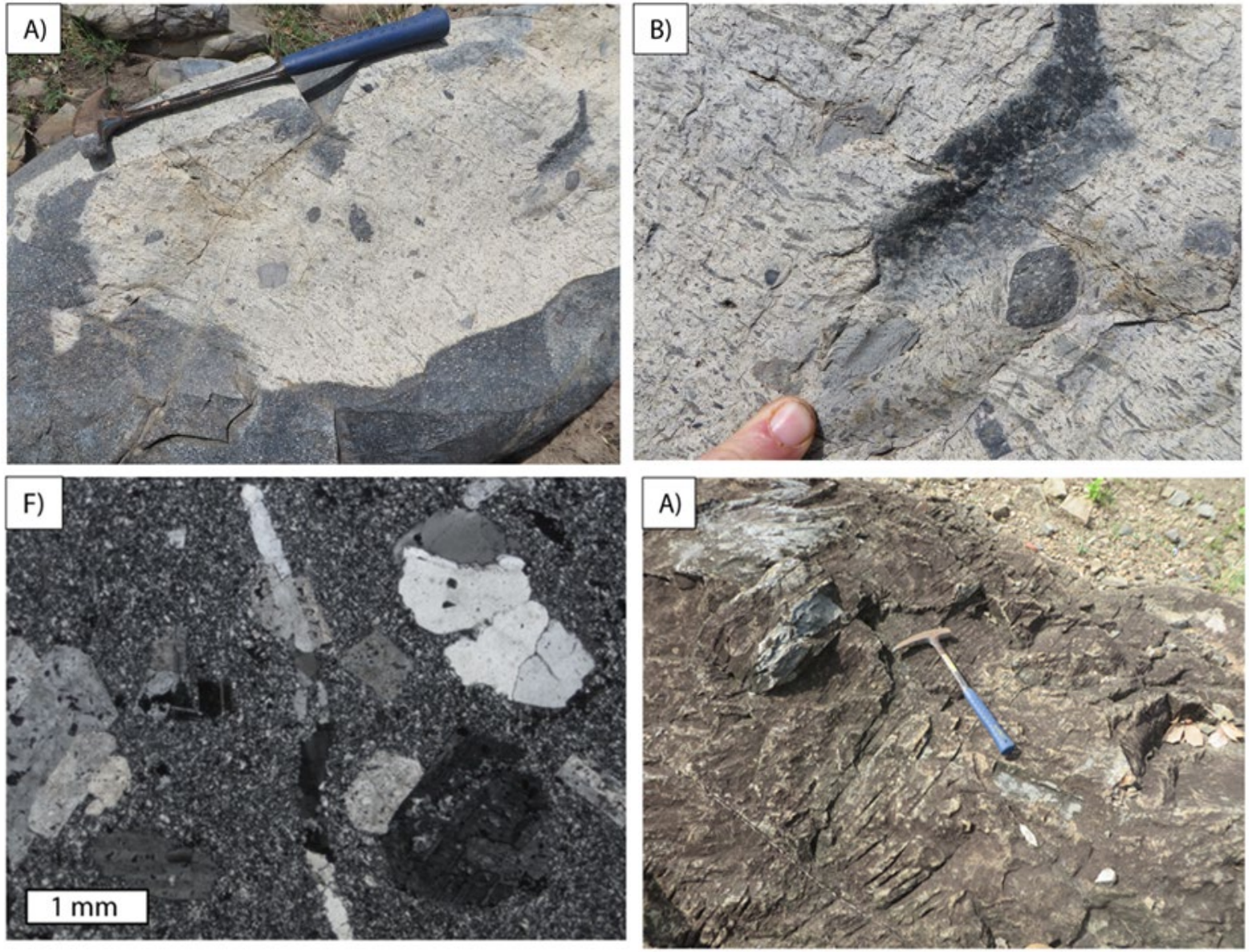






Stage IV: Felsic Volcanics

- Dacite, rhyolite
- Ignimbrites
- Restricted to Southern part of belts



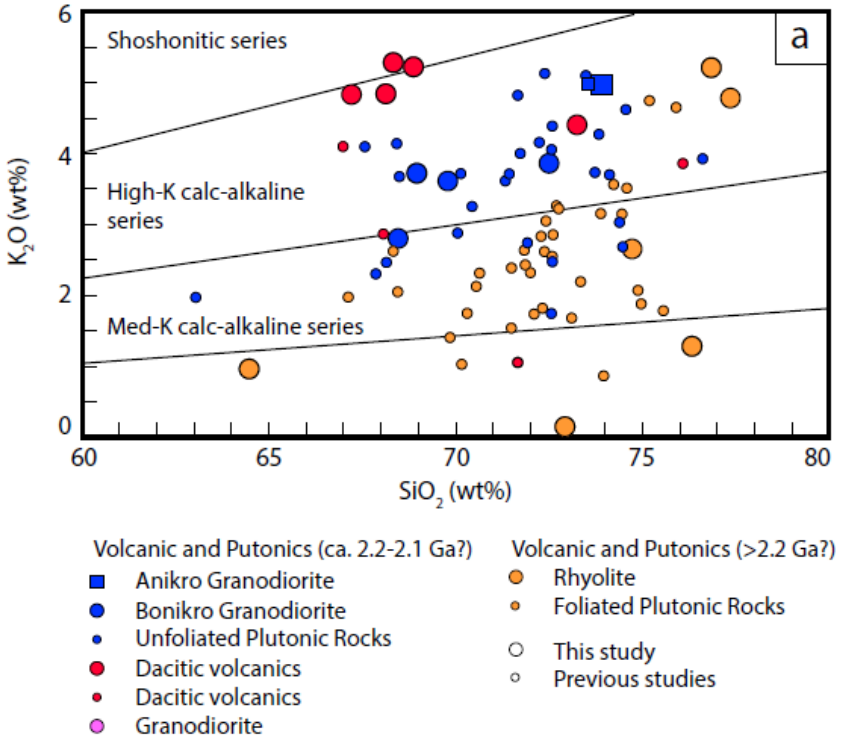
Stage IV: Quart-rich sediments

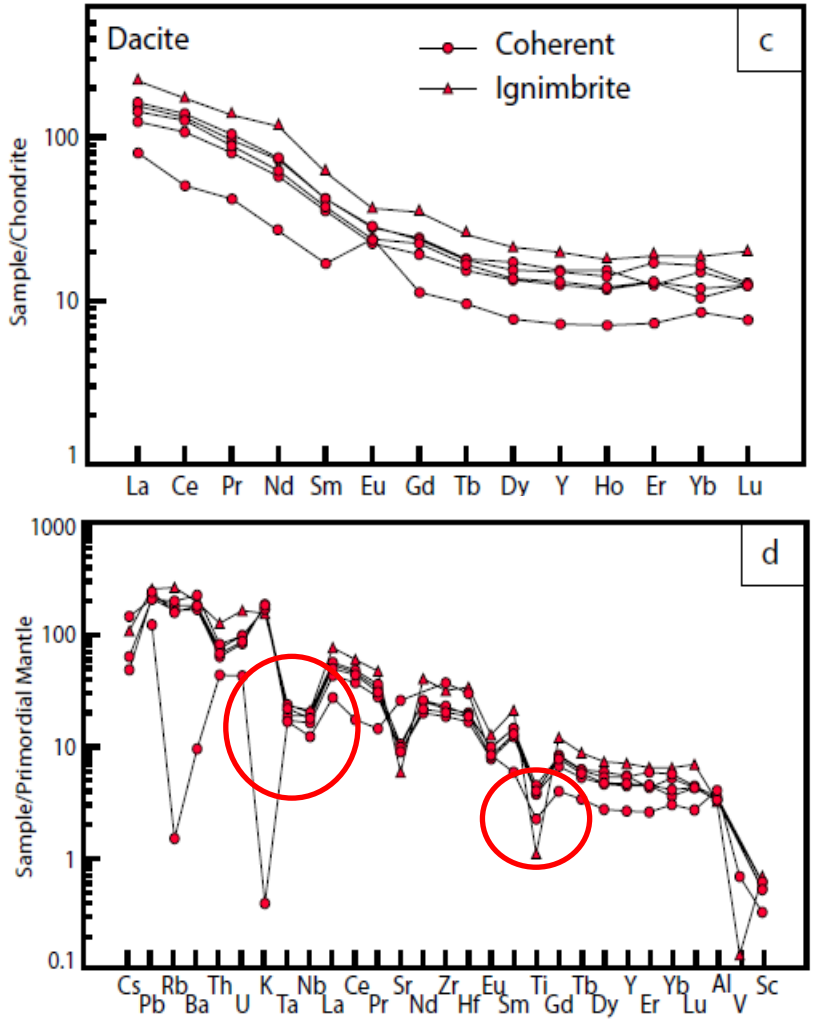
- Planar, x-bedded, low-angle cross-bedded (anti-dunes)
- Conglomerates

- Indicate fluvial environment

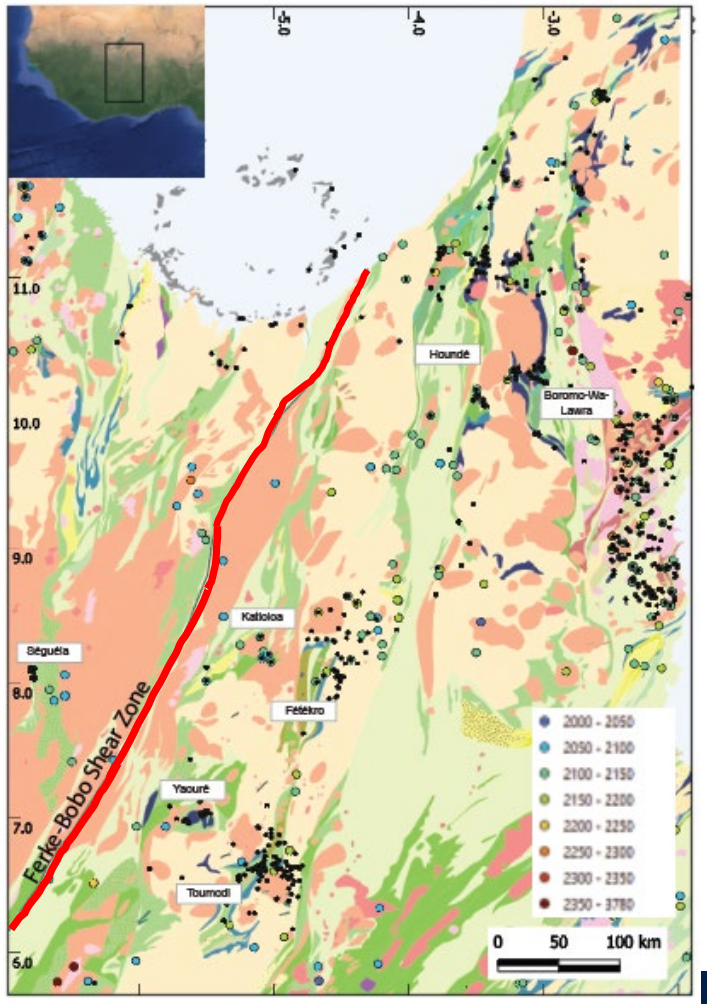
Stage IV: Chemistry

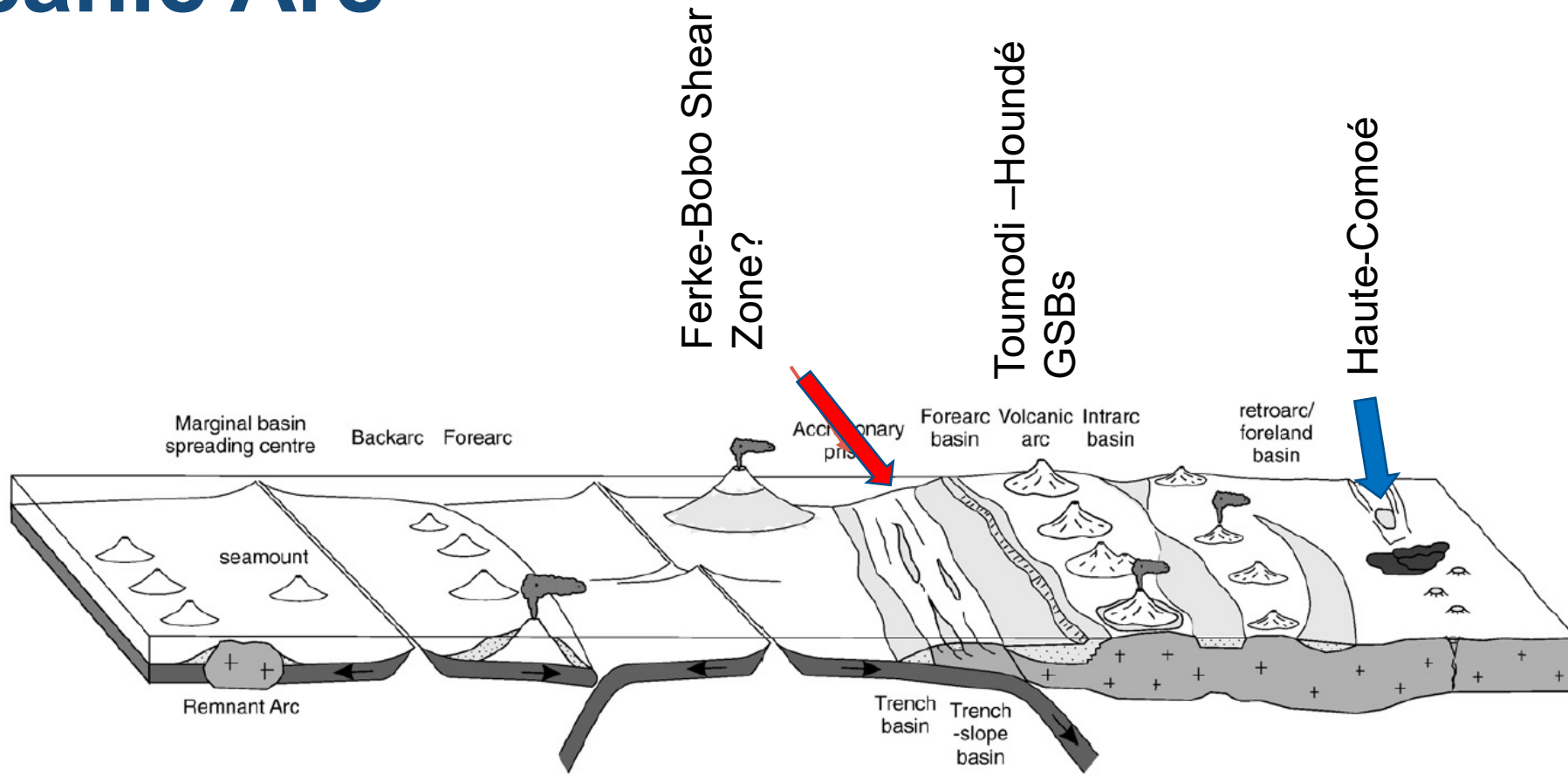
- High-K suggests melting in a thicker more evolved crust
- Trace element geochemistry shows pronounced negative Ta-Nb-Ti anomalies, consistent with water-fluxed mantle melting





Elements of the Toumodi-Fétékro-Houndé-Boromo Volcanic Arc





Tectonic Settings for Toumodi Belt (after Manville et al 2009)

Conclusions

- The greenstone belts were constructed over four main stages:
  1. Tholeiitic volcanism, deep water, MORB or Oceanic Plateau ca 2343 Ma
  2. Andesitic volcanism represents the formation of a young immature volcanic arc (ca. 2200-2160 Ma)
  3. Intra-arc rifting event (ca. 2160-2140 Ma)
  4. Dacitic magmatism represents a mature arc construction phase (ca. 2136-2100 Ma)
- Propose subduction was to the east and that the Ferke-Bobo Shear Zone represents paleo-subduction zone, and the Haute-Comoé represents a back-arc basin.