Paper presentation:

Middle-late Jurassic sedimentary mélange formation related to ophiolite obduction in the Alpine-Carpathian-Dinaridic mountain range
H.-J. Gawlick & S. Missoni, 2020

Madeline Richter

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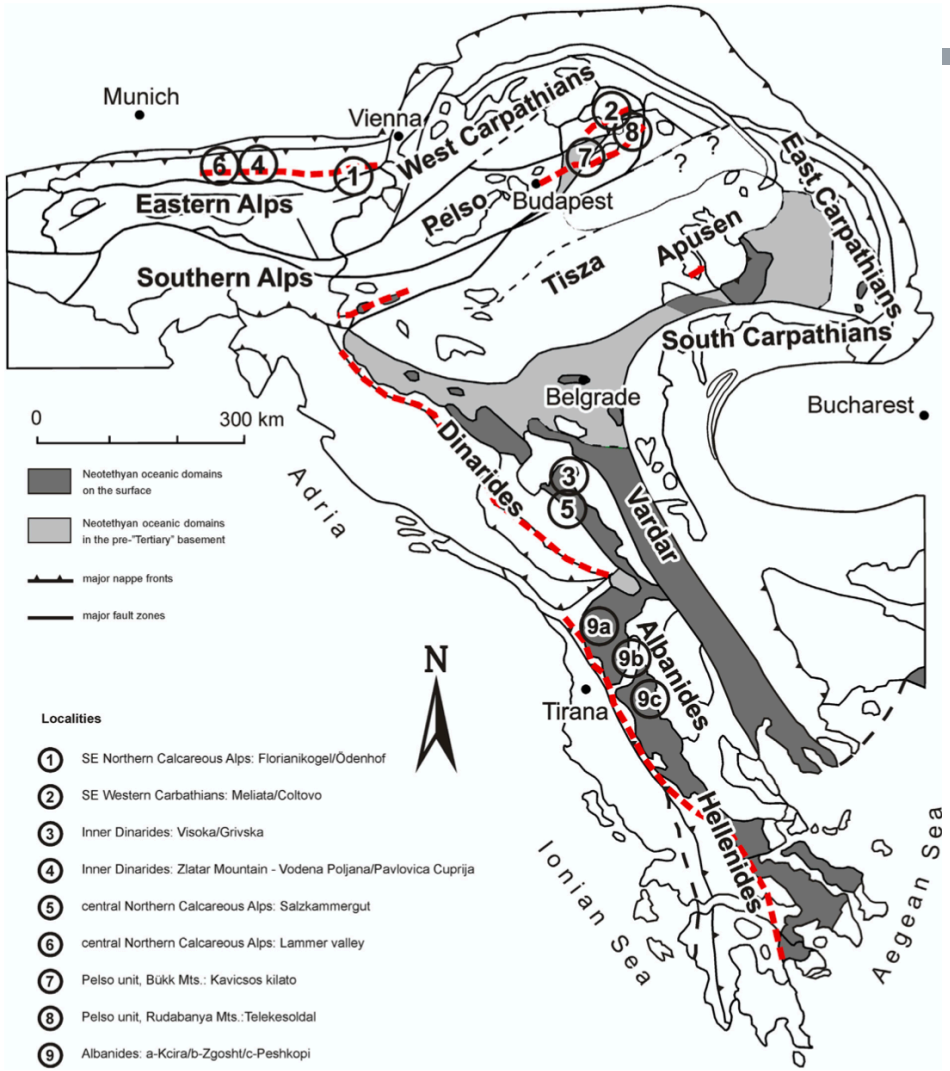
OVERVIEW

- Aim of paper
- Definitions
- Geological overview
- Triassic to Middle Jurassic passive margin of Neo-Tethys
- Middle to Late Jurassic ophiolite obduction
- Discussion
- Conclusion

AIM OF PAPER

- Provide distributions and ages of mélanges related to Alpine orogeny before the Mid-Cretaceous
- To correlate sedimentation with paleogeography
- To infer direction of obduction
- To solve the one- vs. multi-ocean mystery



DEFINITIONS

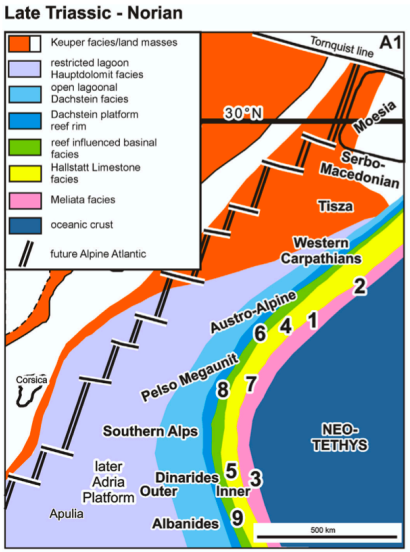
- **Mélange**
  - After Hsü (1974), Festa et al. (2010, 2012, 2016) and Shanmugam (2016)
  - In general chaotic block-in-matrix structure, mappable unit
  - Three to four types
  - Sedimentary (olistostromes, debrites), tectonic, diapiric mélanges and broken formation
  - Sedimentary:
    - Gravity driven mass transport deposits: slides, slumps, debris flows, olistostromes
    - original sedimentary structures visible
    - !Turbidites are excluded!
  - Broken formation:
    - Increasing tectonisation leads to disruption of primary strucutres
    - Boudinage, veins, folds, scaly fabric, phacoids
  - Tectonic mélange:
    - Strain leads to fully mixing of units
    - Block-in-matrix structure
    - Metamorphic overprint

DEFINITIONS

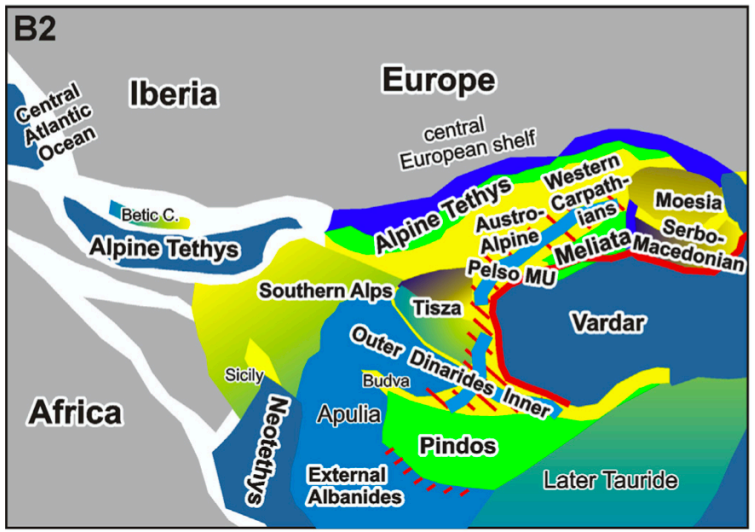
- Tethys

- Defined by Suess in 1888
- Triassic to Cenozoic oceanic system
- Striking from eastern Asia to southern/ southeastern Europe
- no Mittelmeer

Stampfli and Kozur (2006)



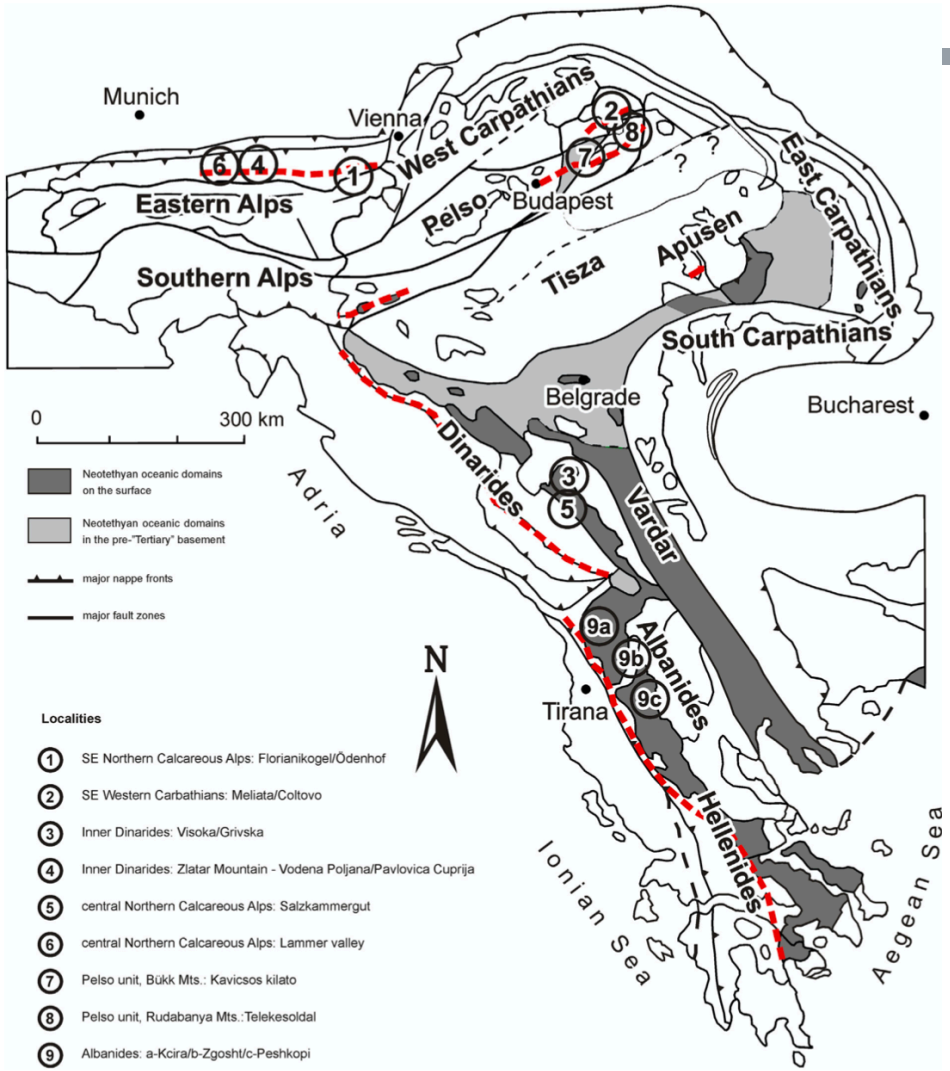
Haas et al., 1995



GEOLOGY

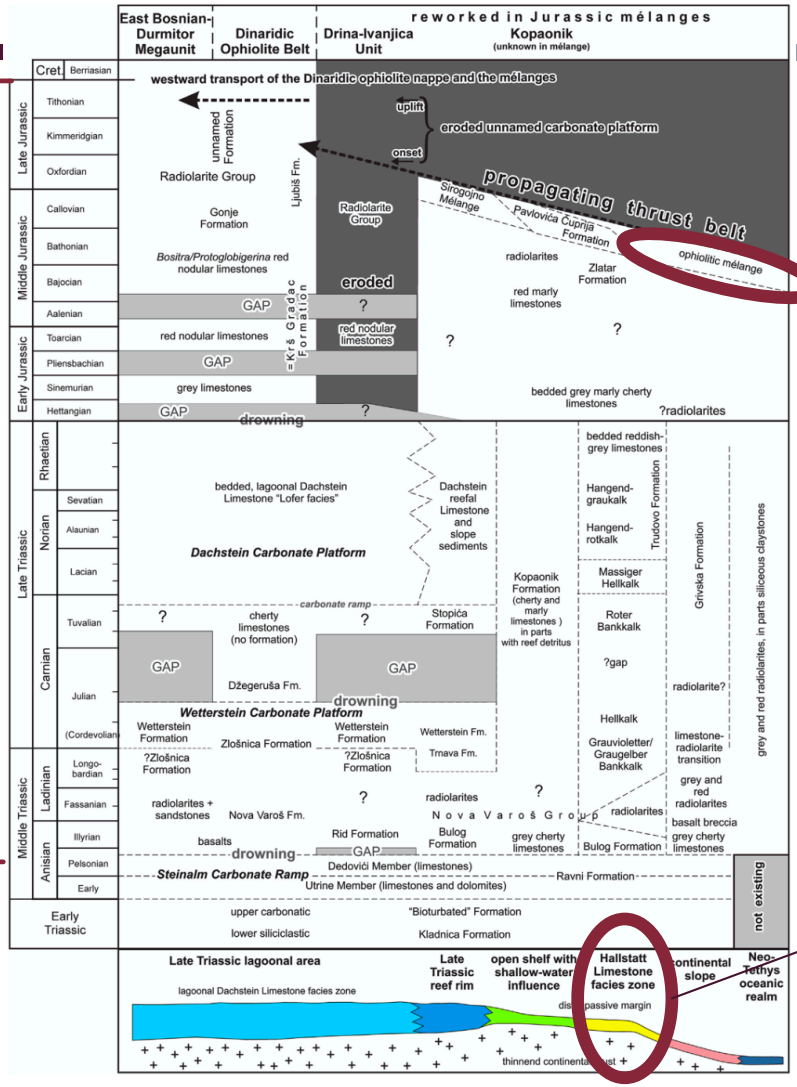
- Recent map
- paper focuses on:

1. Triassic to Middle Jurassic passive margin of Neo-Tethys AND
2. Middle to Late Jurassic ophiolite obduction correlated with the formation of ophiolitic mélanges and Hallstatt mélange



Convergence?

Rift



First evidence

Second evidence

1. OPHIOLITIC MÉLANGE

- Middle to Late Jurassic
- Meliata mélange, e.g. Coltovo
- In Alps and Dinarides non-metamorphic, in Hellenides and Albanides metamorphosed (blueschist-facies)
- Marker for the north- to northwest obductional setting
- Caused formation of trench-like basins in front of propagating nappes
- These threnches are partly oblique to obduction line
- Triassic Radiolarites dominate
- Shortening decreased during Late Jurassic: carbonate ramps and platforms at lower and upper plate

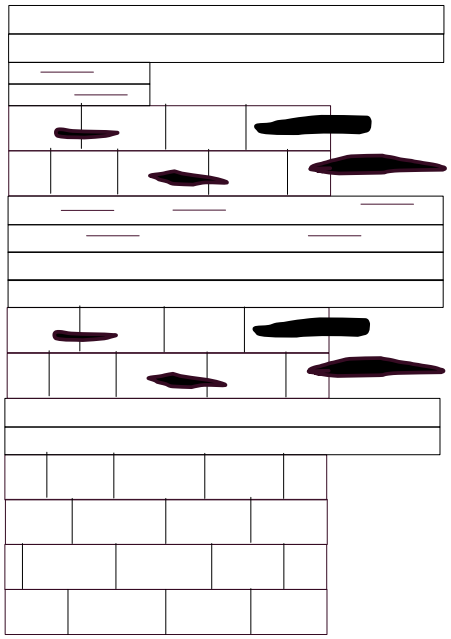
- Include reworked Middle Triassic to Middle Jurassic blocks of oceanic sediments
- Carbonate blocks are common from Hellenides to Dinarides and in Hungary (Pelso unit)
- Missing in Eastern Alps and Western Carpathians
- Successions (concluded from blocks and pebbles) are incomplete; reconstructable with blocks and pebbles
- Sedimentary succession from continental slope:

REWORKED SUCCESSION OF CONTINENTAL SLOPE

Jurassic

Late Triassic

-Norian	• Clayey, siliceous sediments, radiolaritic upsection
	• Deep water limestones with chert nodules
Middle Carnian	• Argillaceous radiolarites
Early Carnian	• Deep water limestones with chert nodules
- Late Ladinian	• Radiolarites
Middle - Late Ansian	• Deep water limestones
Middle Ansian	• Shallow water limestones



OTHER COMPONENTS

- Components from ocean floor and cover (upper and lower plate?):
  - Mainly serpeninites
  - Basalts
  - Rarely readiolarites of Middle Triassic
- Incorportation dependend on the propagation of the upper plate

2. HALLSTATT MÉLANGE

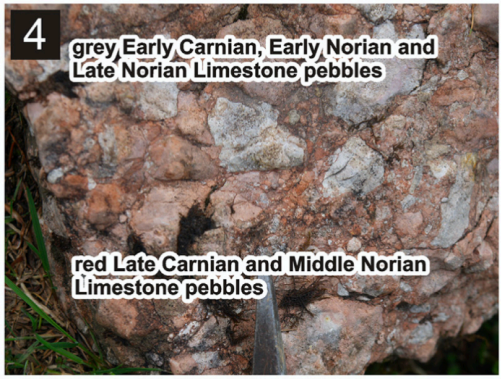
- Middle to Early Late Jurassic sedimentary mélange, basin fills
- Outer continental shelf deposits
- Two types:
  1. With components from outer shelf (Hallstatt)
  2. With components from proximal outer shelf, reef facies
  3. Continental shelf (Meliata)

- In **Serbia** : Zlatibor & Zlatar, Komarani
  - Reddish-grey, bedded, nodular limestones and massive grey limestones
  - Marly to siliceous limestones on top
  - Below ophiolites and above radiolarites
  - Blocks date until Middle Oxfordian

IN NORTHERN CALCAREOUS ALPS

- Altausee
  - Radiolaritic matrix
  - Seldomly mixed with Meliata facies
  - Below deep-marine sediments: evaporites of the Haselgebirge and shallow water limestones (Kimmeridgian)
  - Sediments like in Serbia

- Lammer valley
  - Basin during Callovian and Oxfordian
  - Late Triassic Dachstein carbonates as substratum
  - On top are reworked Dachstein reef and Hallstatt mélange
  - Hallstatt mélange: dark grey, siliceous limestones and radiolarites, siliceous-argillaceous marls, shales and limestones rich in manganese
  - Substratum and reworked deposits as km-sized block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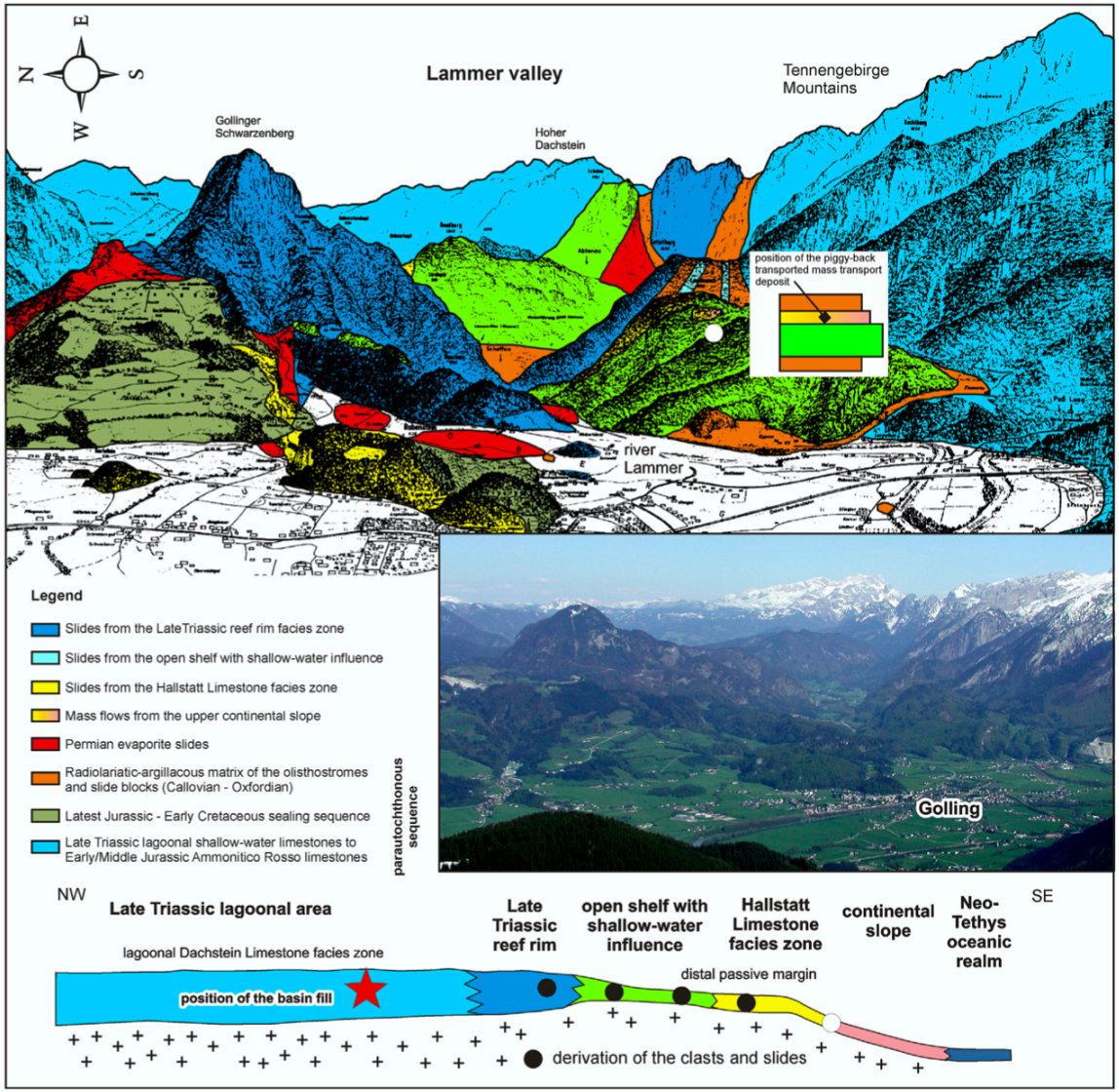
grey Early Carnian, Early Norian and Late Norian Limestone pebbles
red Late Carnian and Middle Norian Limestone pebbles


N
E
S
W
Lammer valley
Tennengebirge Mountains
Gollinger Schwarzenberg
Hoher Dachstein
position of the piggy-back transported mass transport deposit
river Lammer
Golling
Legend
Slides from the LateTriassic reef rim facies zone
Slides from the open shelf with shallow-water influence
Slides from the Hallstatt Limestone facies zone
Mass flows from the upper continental slope
Permian evaporite slides
Radiolariatic-argillacous matrix of the olisthostromes and slide blocks (Callovian - Oxfordian)
Latest Jurassic - Early Cretaceous sealing sequence
Late Triassic lagoonal shallow-water limestones to Early/Middle Jurassic Ammonitico Rosso limestones
parautochthonous sequence
NW
Late Triassic lagoonal area
SE
Late Triassic reef rim
open shelf with shallow-water influence
Hallstatt Limestone facies zone
continental slope
Neo-Tethys oceanic realm
lagoonal Dachstein Limestone facies zone
distal passive margin
position of the basin fill
derivation of the clasts and slides

IN ALBANIA

- Below Mirdita ophiolites
- Kcira, Librazhd, Peshkopi
- Late Callovian to Oxfordian
- Radiolaritic-sandy matrix of ophiolite with various Triassic blocks
- Blocks: oceanic crust, open-marine limestones,, shallow water carbonates, radiolarites, serpentinites
- The further North to Dinarides, the more continuous seems open-marine sedimentation → like Werfen Fm in Alps
- Deposited on the reef-near open shelf/ continental slope

CONCLUSION

1. Sedimentological and stratigraphic evolution is similar along the whole orogenic front from Alps to Hellenides
   - This suggests one ocean and two continents
2. Sedimentation in trench-like basins is nearly contemporaneous along Neo-Tethyan belt
   - This suggests one ocean and two continents
3. Ophilitic and Hallstatt mélanges are autochtonous fragments from Neo-Tethyan ocean and shelf, thrusted onto Adria
4. Shearing seems low in Middle-Late Jurassic
   - Primary sedimentary structures are well-preserved
   - Radiolaritic-argillaceous carbonate-clastic sediments
   - Accreationed at the frontal part

Flyschoid

Cherty Limestones To radiolarites

Hemipelagic limestones

Reworked reefal deposits in Hallstatt

Reworked clasts in ophiolitic mélange

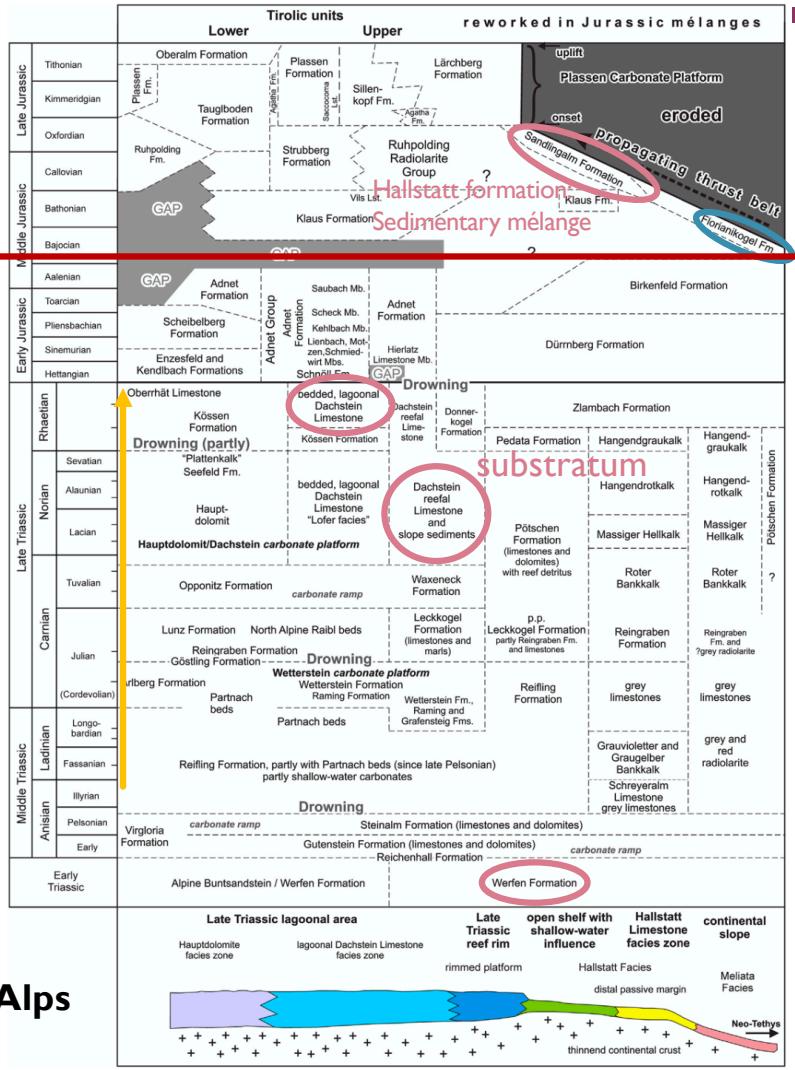
Hallstatt formation
Sedimentary mélange

substratum

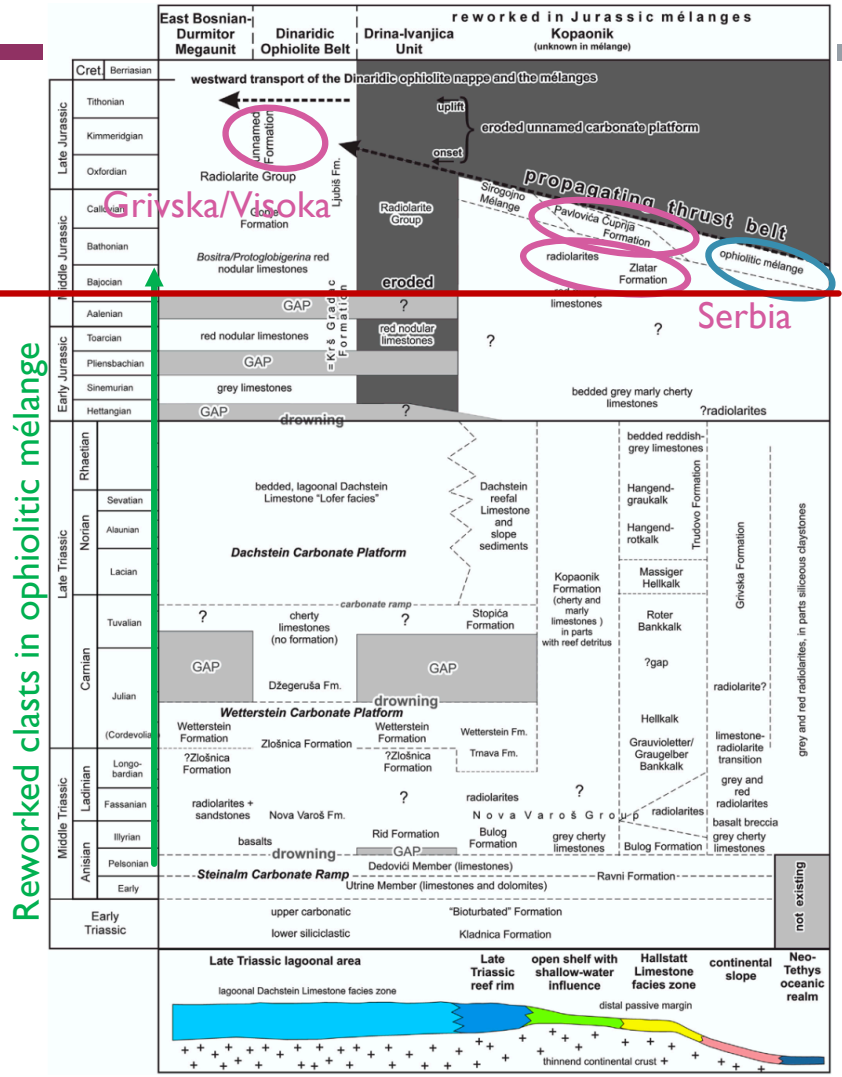
Grivska/Visoka

Serbia

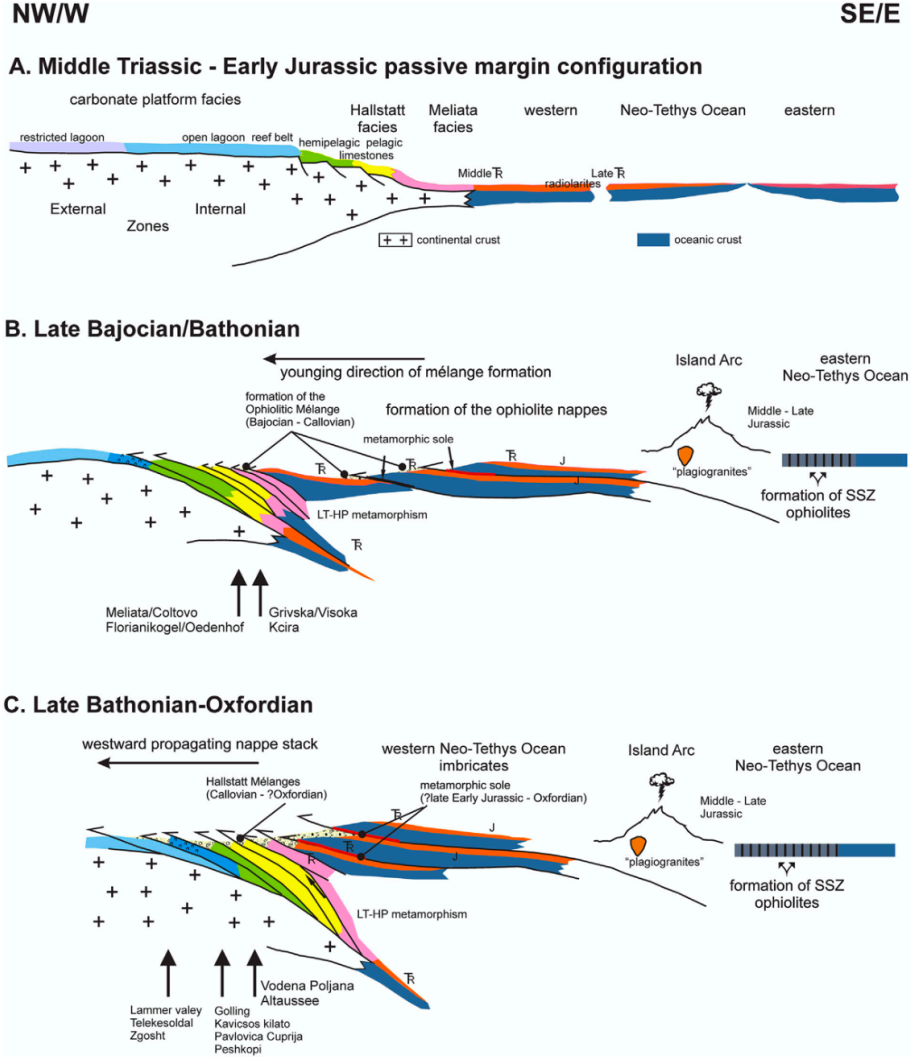
Windows in Alps & Carpathians



Alps



Dinarides


NW/W
SE/E
A. Middle Triassic - Early Jurassic passive margin configuration
carbonate platform facies
Hallstatt facies
Meliata facies
western
Neo-Tethys Ocean
eastern
restricted lagoon
open lagoon
reef belt
hemipelagic
pelagic limestones
Middle T
Late T
radiolarites
External Zones
Internal
continental crust
oceanic crust
B. Late Bajocian/Bathonian
younging direction of mélange formation
Island Arc
eastern Neo-Tethys Ocean
formation of the Ophiolitic Mélange (Bajocian - Callovian)
formation of the ophiolite nappes
metamorphic sole
Middle - Late Jurassic
"plagiogranites"
formation of SSZ ophiolites
LT-HP metamorphism
Meliata/Coltovo
Florianikogel/Oedenhof
Grivska/Visoka
Kcira
C. Late Bathonian-Oxfordian
westward propagating nappe stack
western Neo-Tethys Ocean imbricates
Island Arc
eastern Neo-Tethys Ocean
Hallstatt Mélanges (Callovian - ?Oxfordian)
metamorphic sole (?late Early Jurassic - Oxfordian)
Middle - Late Jurassic
"plagiogranites"
formation of SSZ ophiolites
LT-HP metamorphism
Vodena Poljana
Altaussee
Lammer valey
Telekesoldal
Zgosht
Golling
Kavicsos kilato
Pavlovica Cuprija
Peshkopi