Passive-Margin Allochthonous Salt Canopies Emplaced within an Alpine Fold-and-Thrust Belt: Example from the Betic Cordillera of Spain*

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Abstract

Geological surface data, exploration well log data and seismic 2D data indicate that large volumes of evaporites, mostly salt, but also gypsum and anhydrite, were emplaced during passive-margin development of the Tethys in southern Iberia, today part of the Guadalquivir Allochthon of the Central and Western Betic Cordillera (Southern Spain). Syn-tectonic sediments, remnants of mini-basins, and re-deposited evaporites within deep-water strata suggest that the main emplacement of the salt canopies took place during Late Cretaceous and Paleocene time. This resulting age is much older than the Miocene to Pliocene emplacement of the Guadalquivir Allochthon. Mostly allochthonous salt bodies occupying the higher and commonly frontal structural thrust sheet of the Betic Cordillera compose this unit. Late Neogene (late Miocene to Pliocene) Alpine compression within the Betic fold-and-thrust belt strongly deformed the allochthonous salt system. During this event, the Guadalquivir Allochthon formed a thrust sheet that was emplaced above the Jurassic-Cretaceous inverted, passive margin (formed by the Pre- and Sub-Betic Nappes). The Triassic section of the Guadalquivir Allochthon (>2 km thick salt unit) strongly differs from the underlying sub-autochthonous Triassic section of the Sub-and Pre-Betic units, which is formed by limestone and evaporite strata indicative of pre-, syn- and post-rift sabkha type sedimentation. Passive-margin Triassic salt structures can also be found in the antithetic North African margin along the Rif and Tell belts, in Morocco, Algeria, and Tunisia. Compared to the Betic Cordillera in Spain, this margin had a less mature allochthonous canopy system with an older age of emplacement, because it probably occurred during the early Late Cretaceous.

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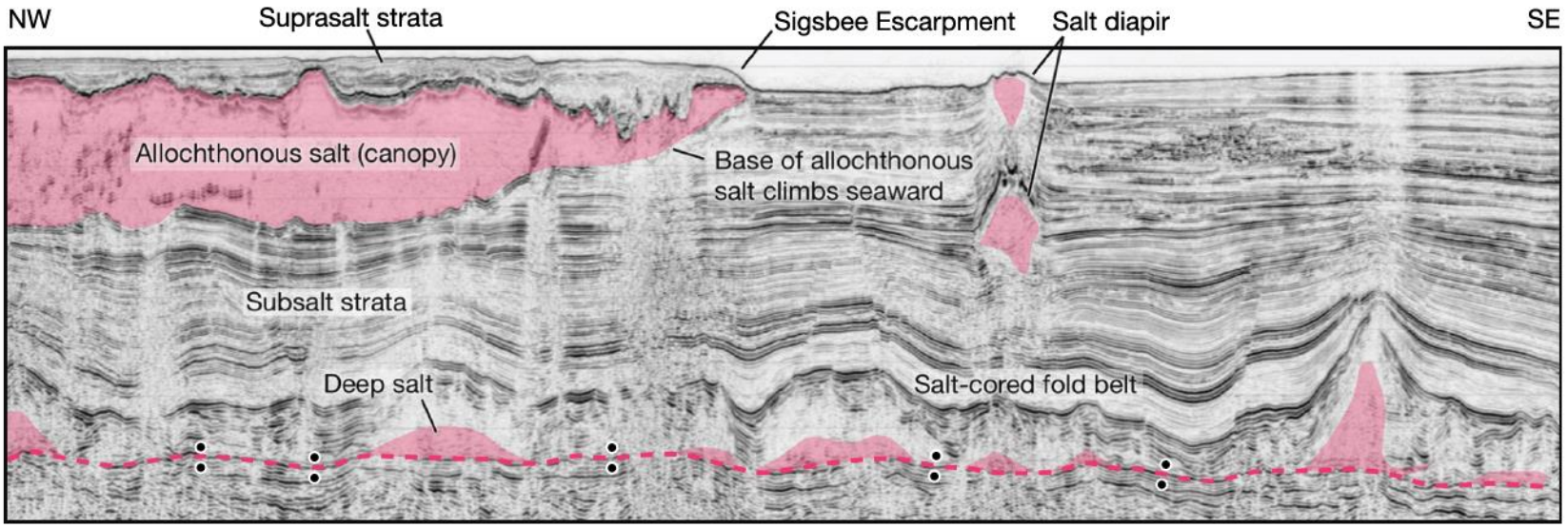
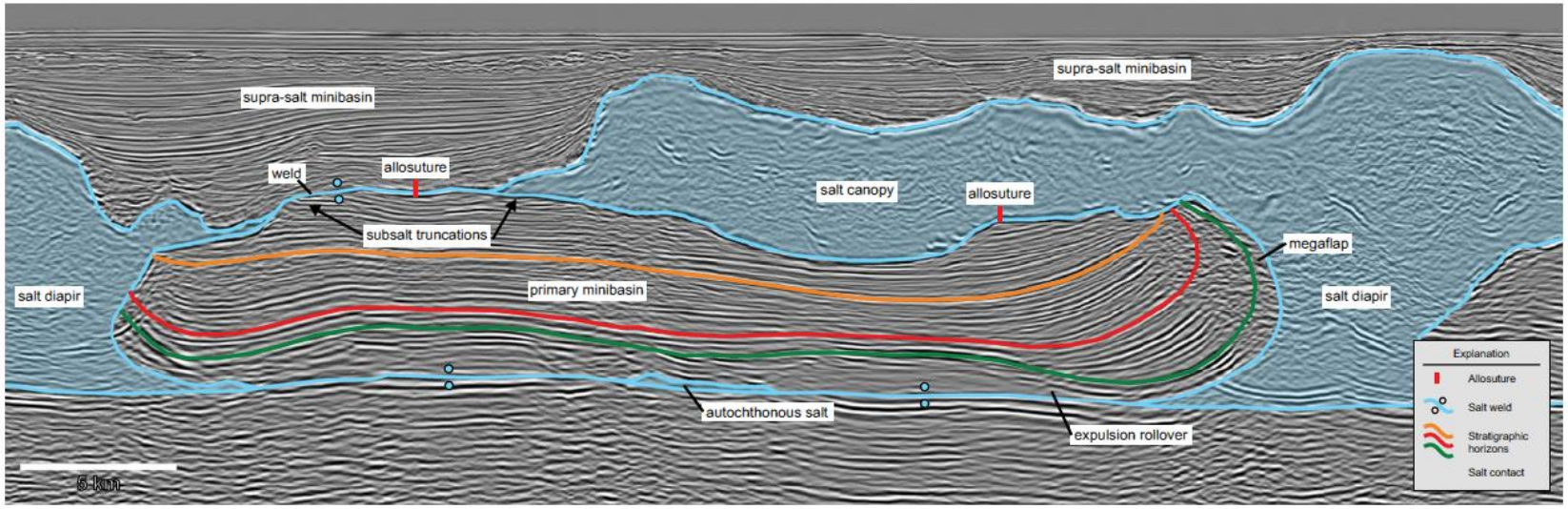
Repsol USA The Woodlands Texas
Granada University, Spain

AAPG 2015 ACE Denver, June 2015

Allochthonous Salt Canopies

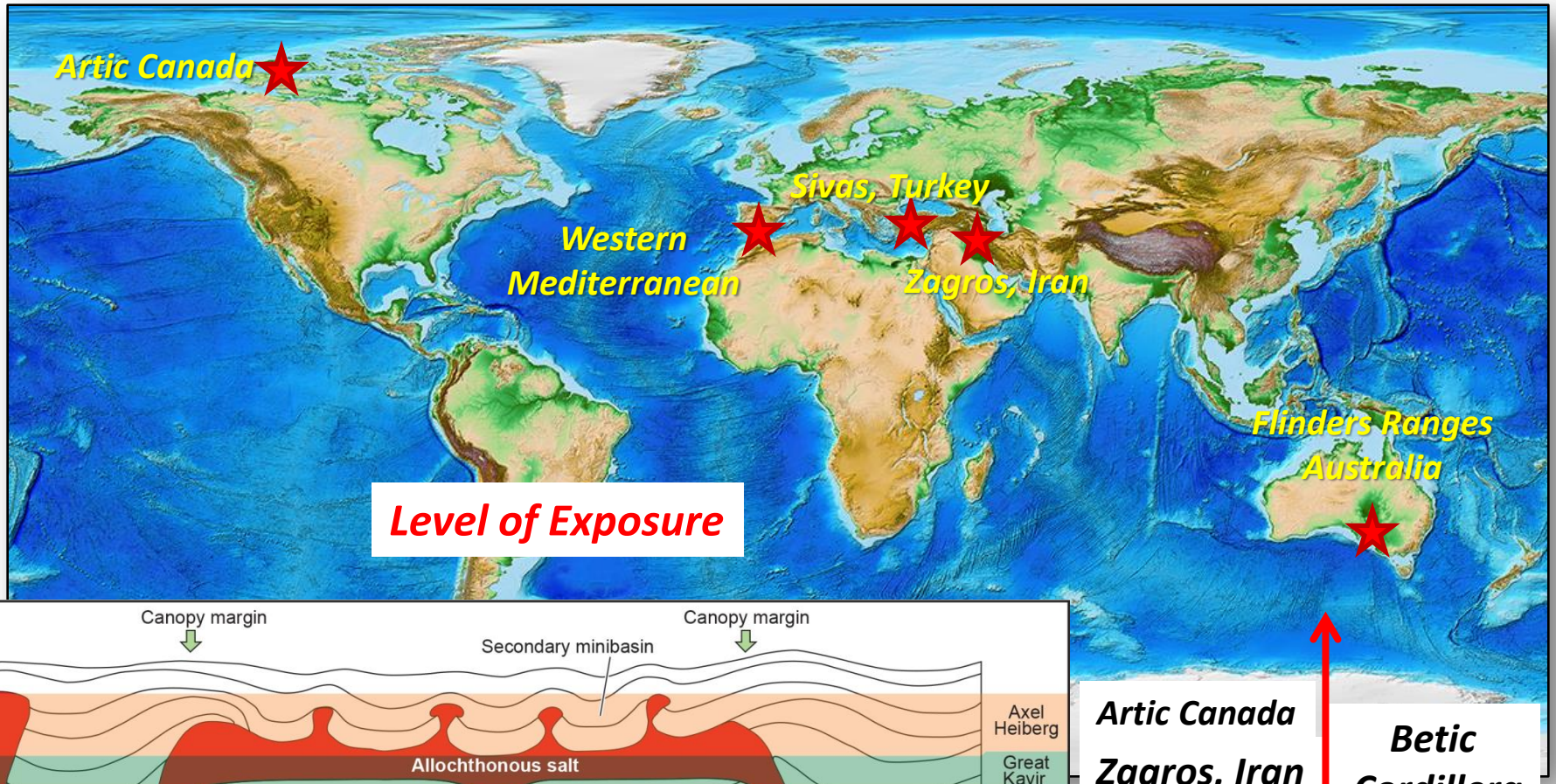


Dooley et al. 2013



Hearon et al. 2014

Surface Studies of Salt Canopies



Artic Canada

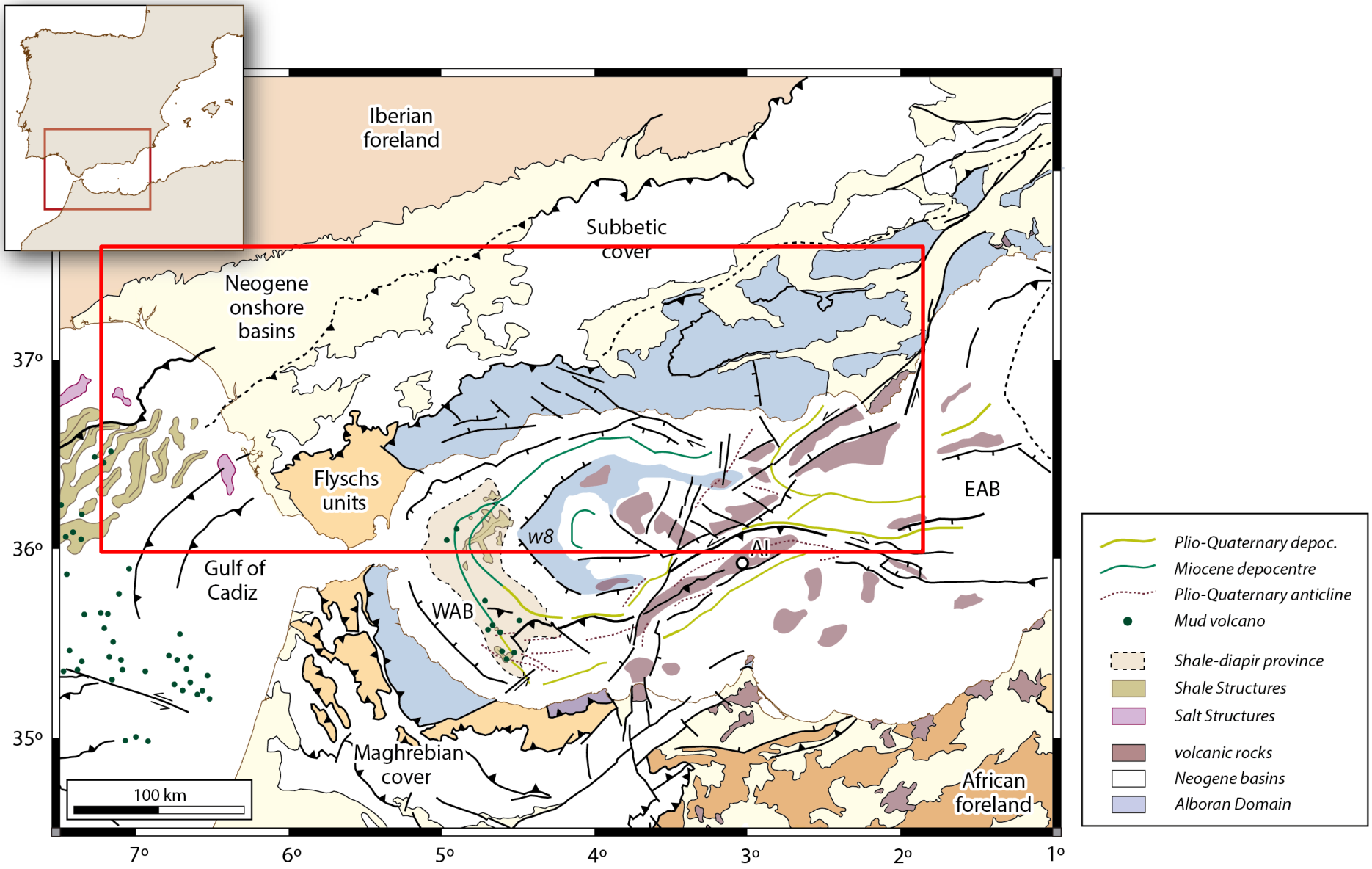
Zagros, Iran

Sivas, Turkey

Betic Cordillera

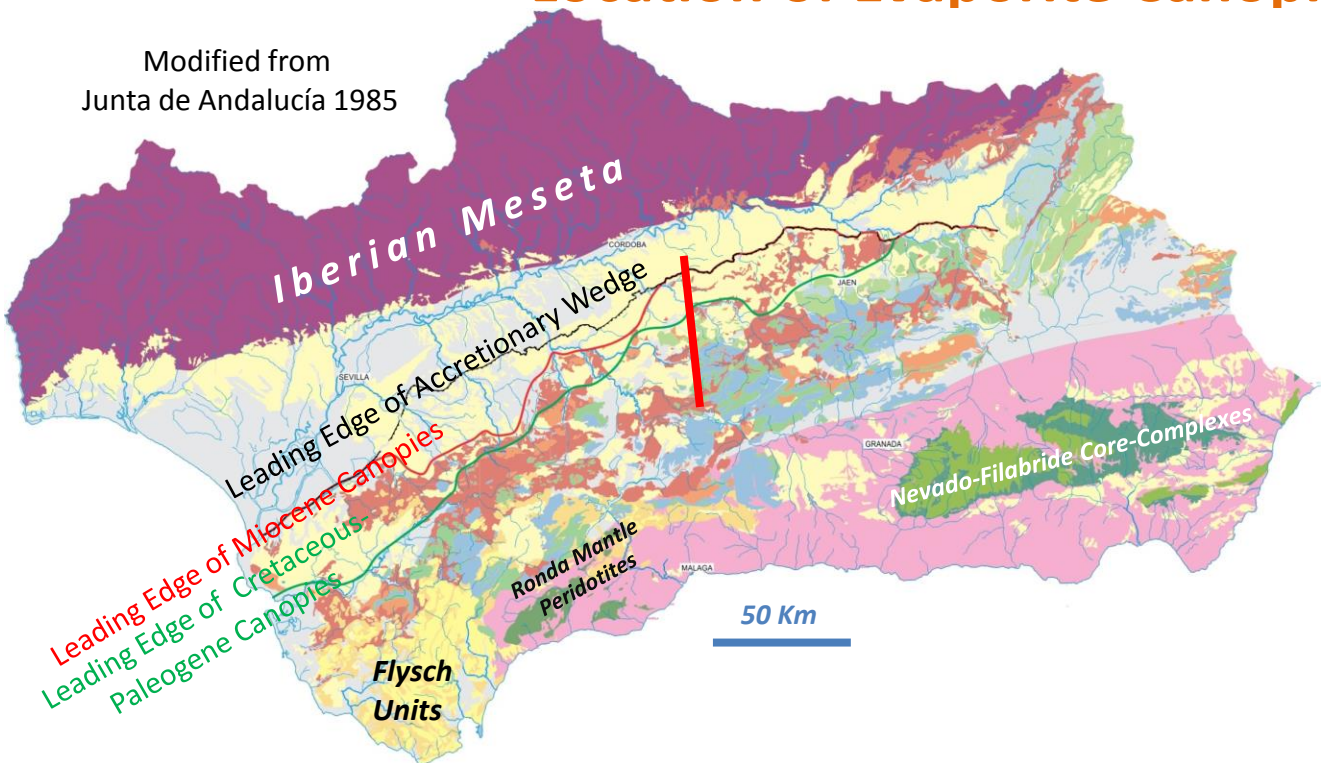
Harrison & Jackson 2014

The Gibraltar Arc, Western Mediterranean

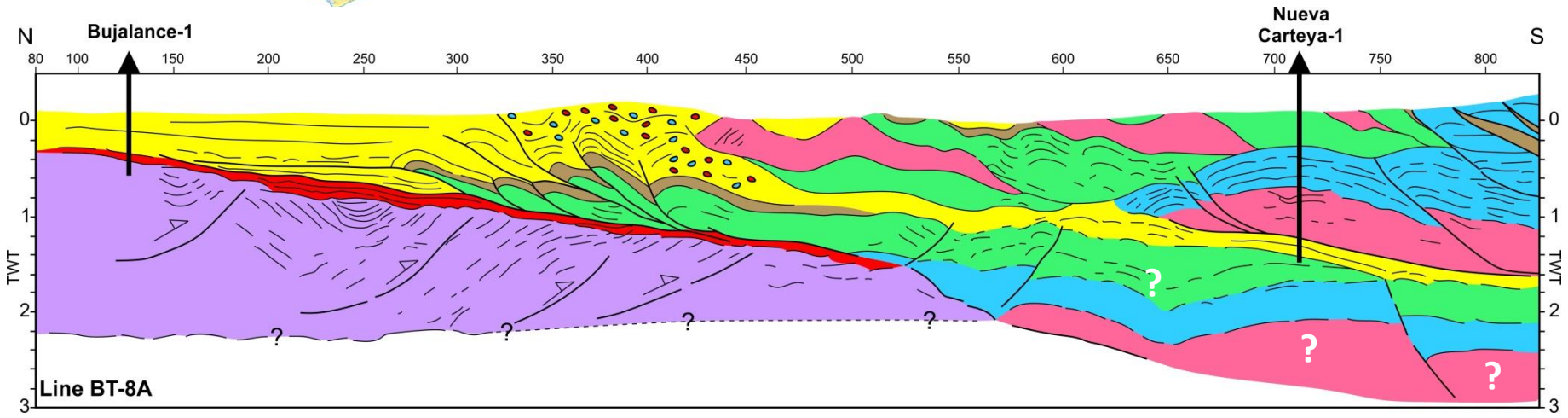


Geologic Map of the Betic Cordillera : Location of Evaporite Canopies

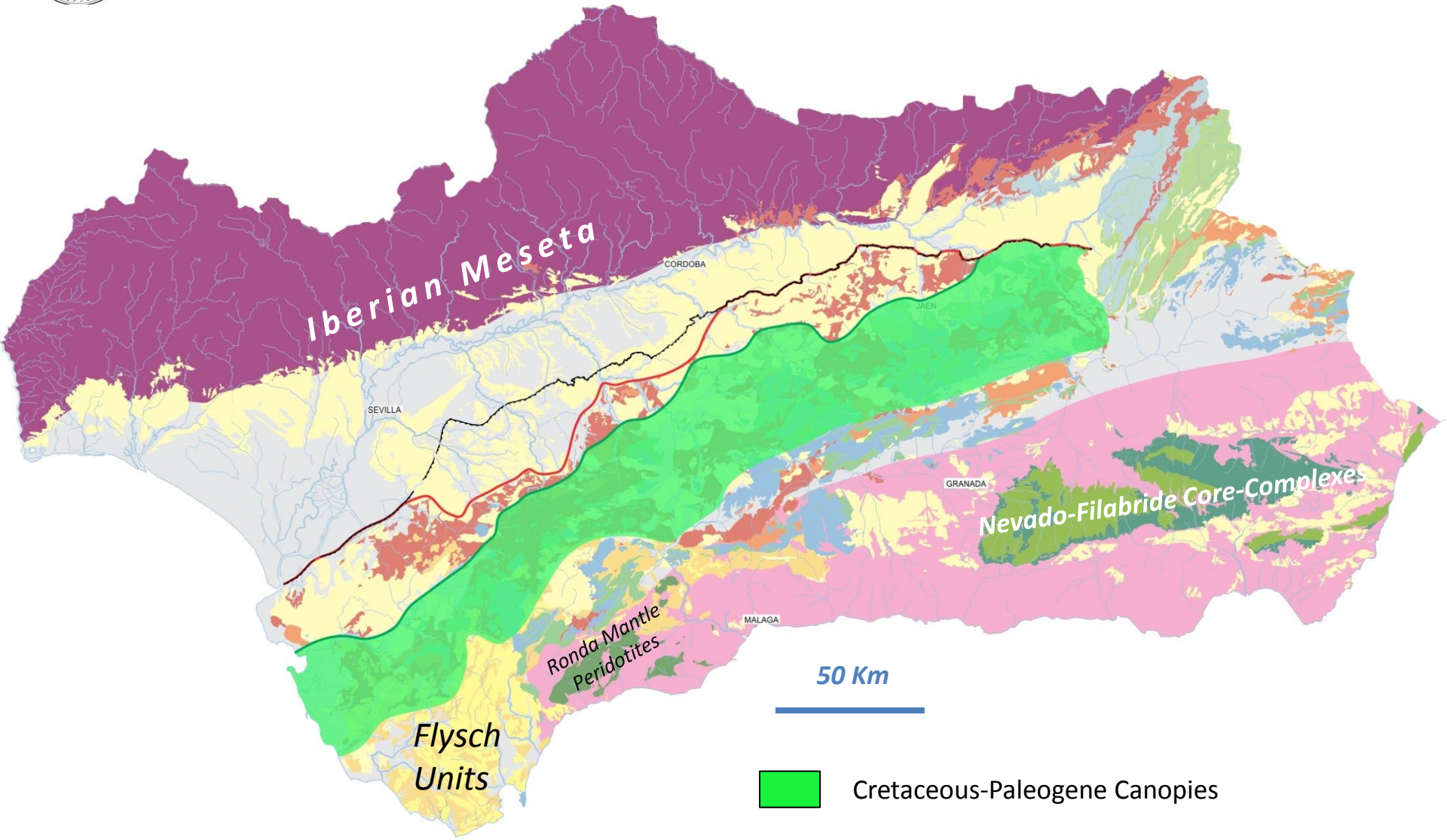
Modified from
Junta de Andalucía 1985



- Neogene
- Accretionary Wedge "Olistostrome"
- Paleogene
- Cretaceous
- Jurassic
- Triassic Evaporites
- Triassic Red-Beds
- Hercynian Basement

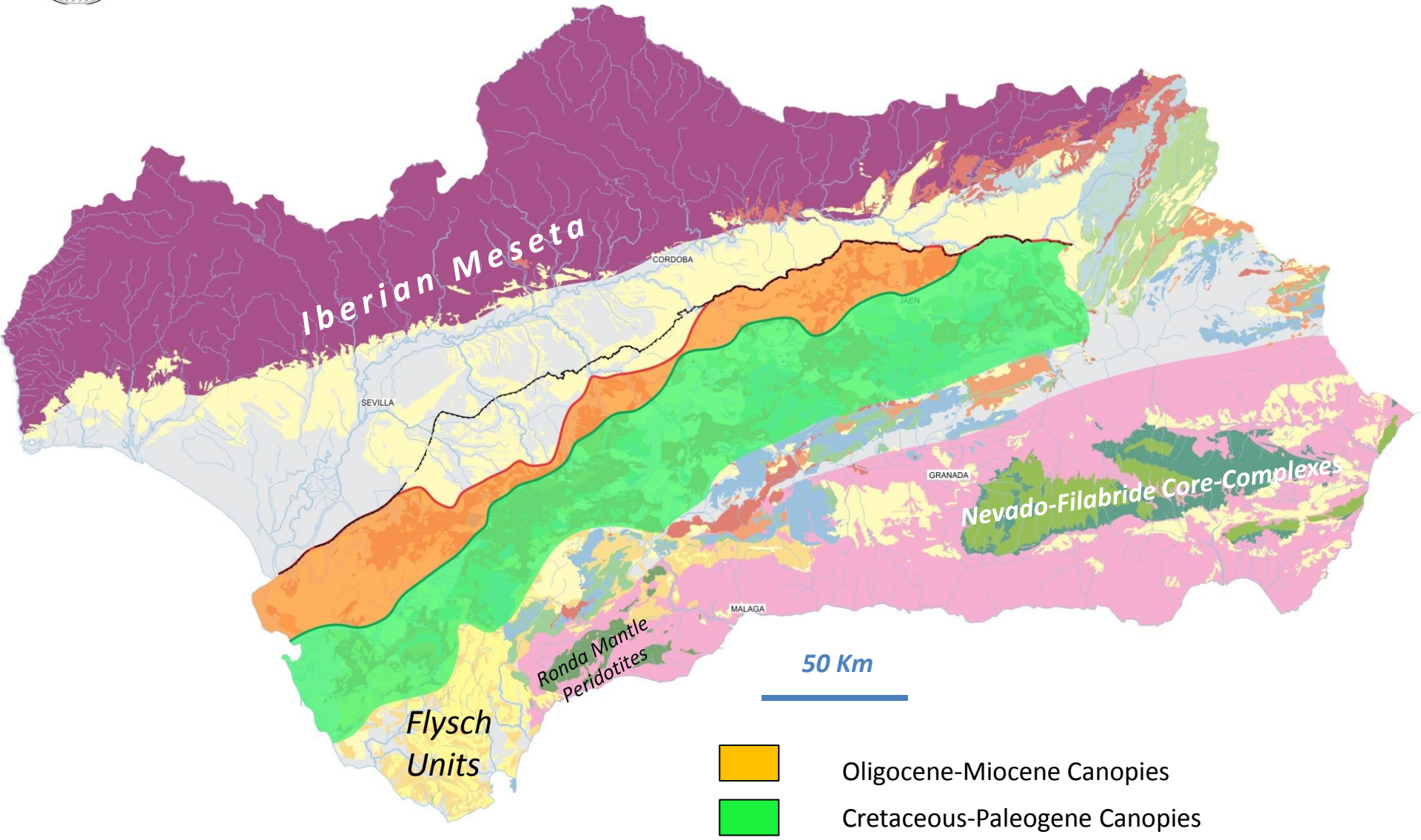


Cretaceous-Paleogene Canopies



Modified from Junta de Andalucía 1985

Oligocene-Miocene Canopies



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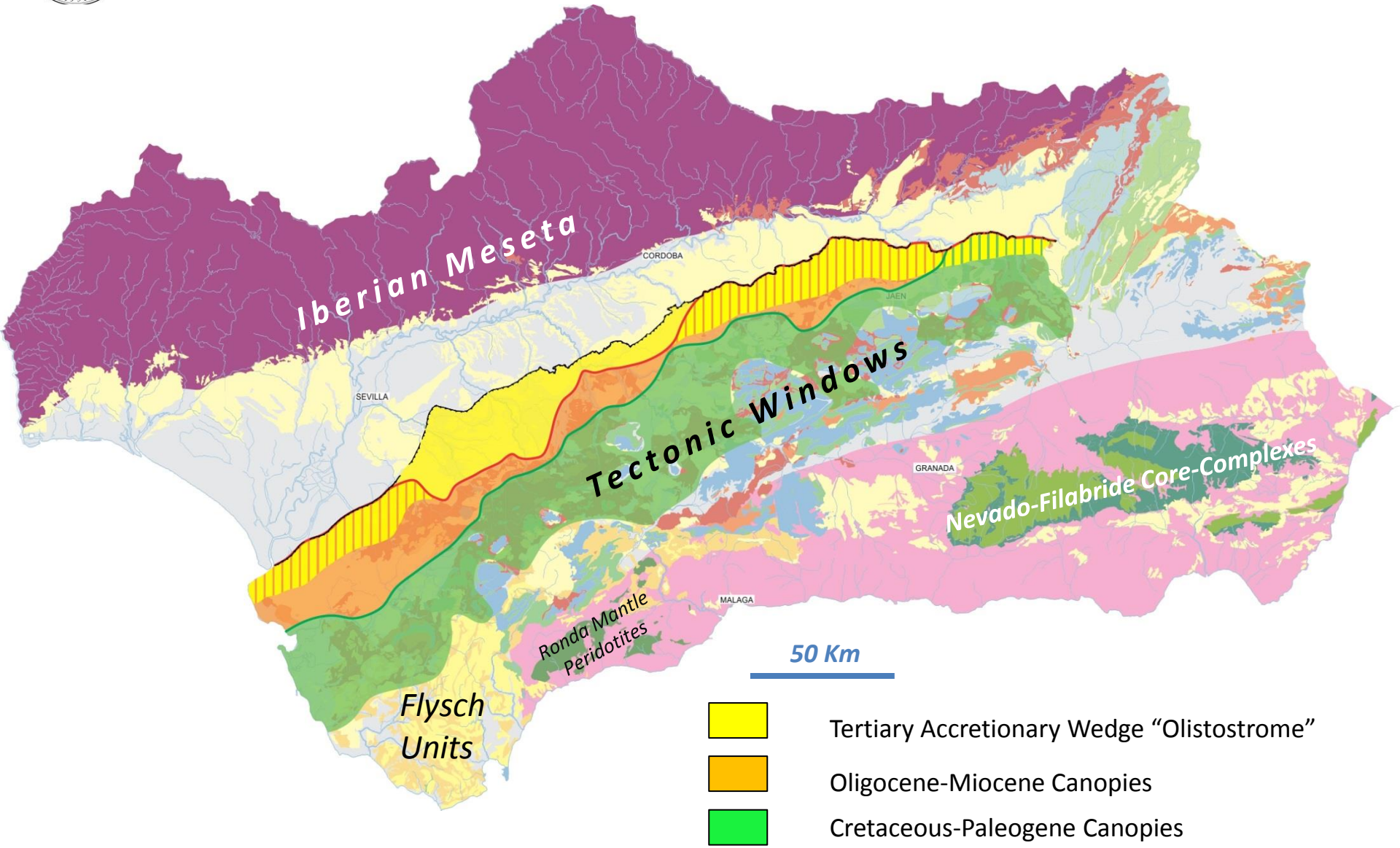
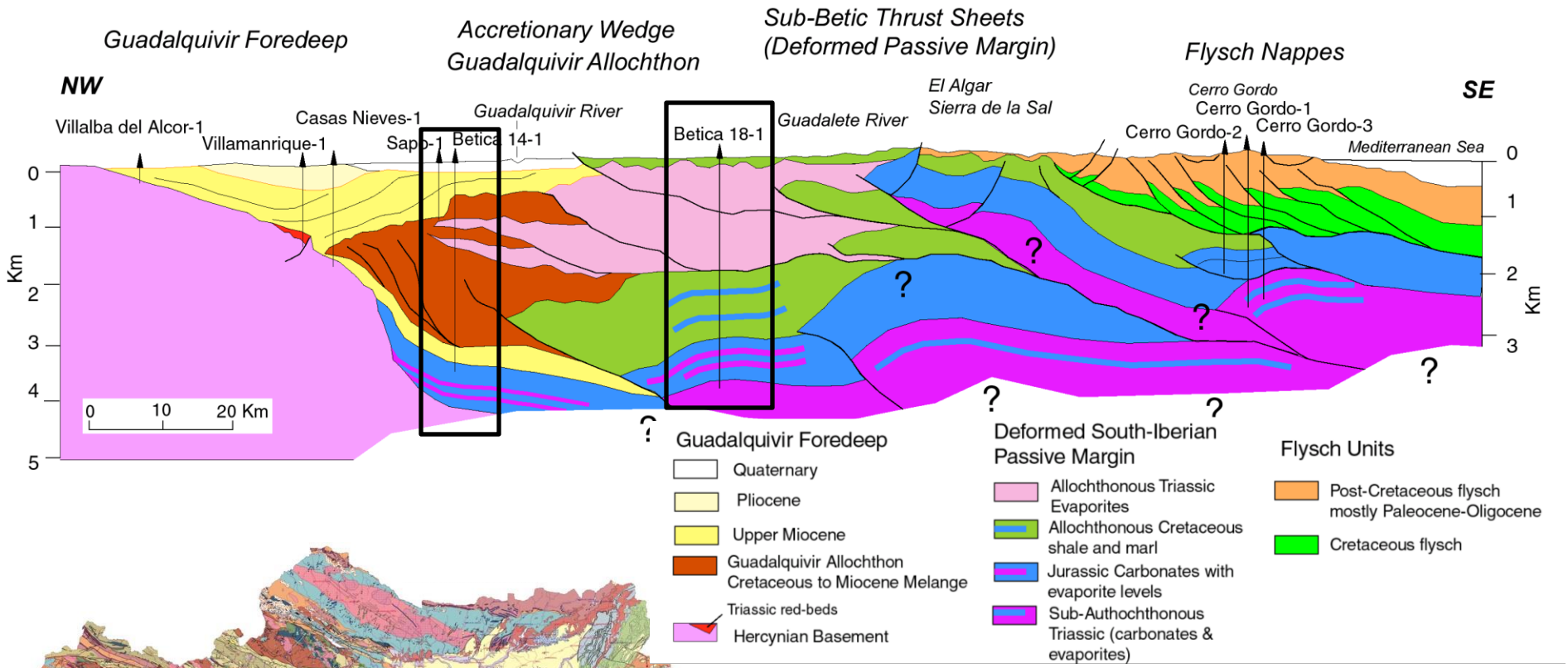
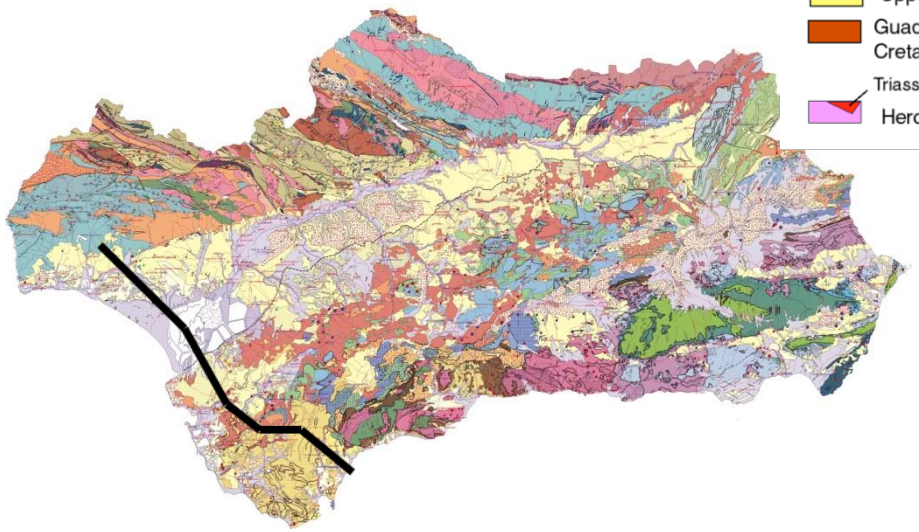
Envelopment Thrusting & Accretionary Wedge



Modified from Junta de Andalucía 1985

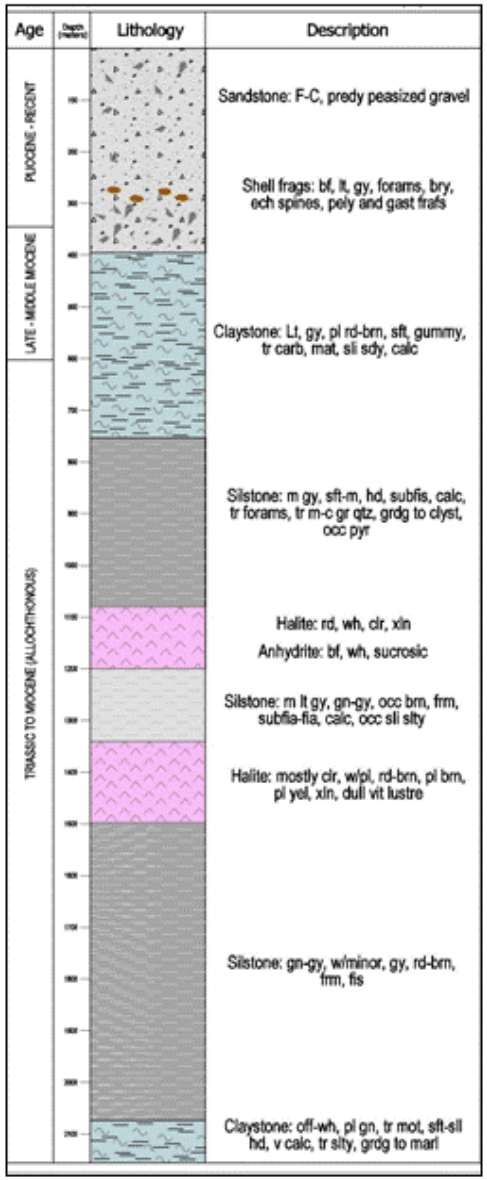
Cross section through the Western Betic Cordillera



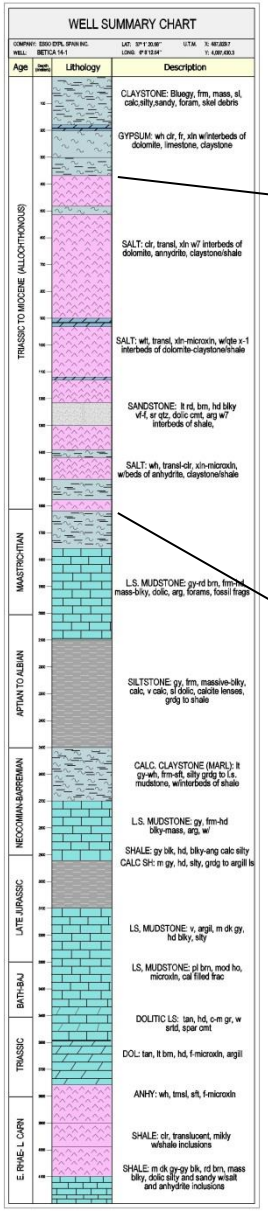


Wells Betica-14-1 and Betica 18-1

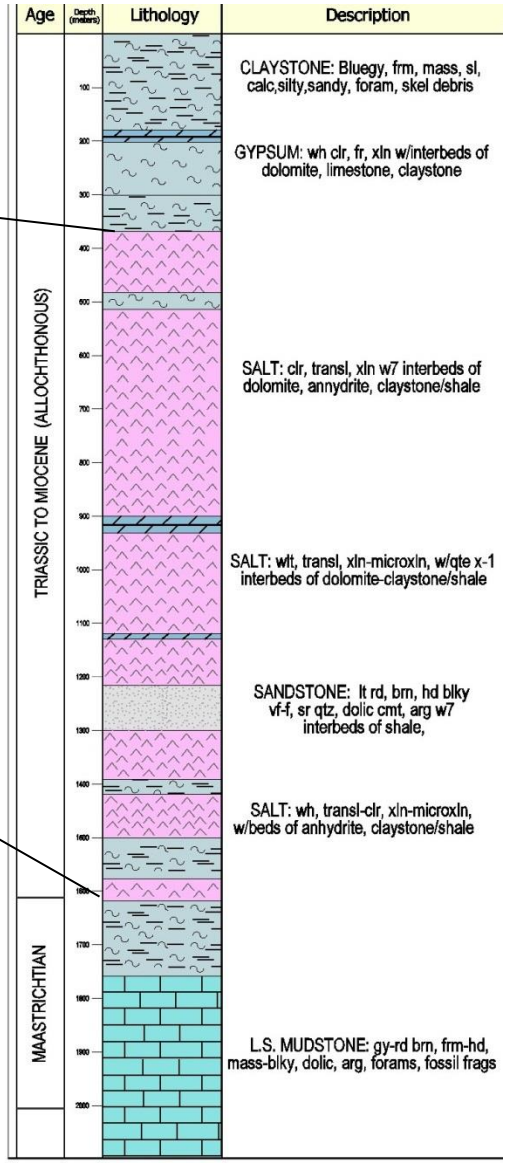
Betica 14-1



Betica 18-1

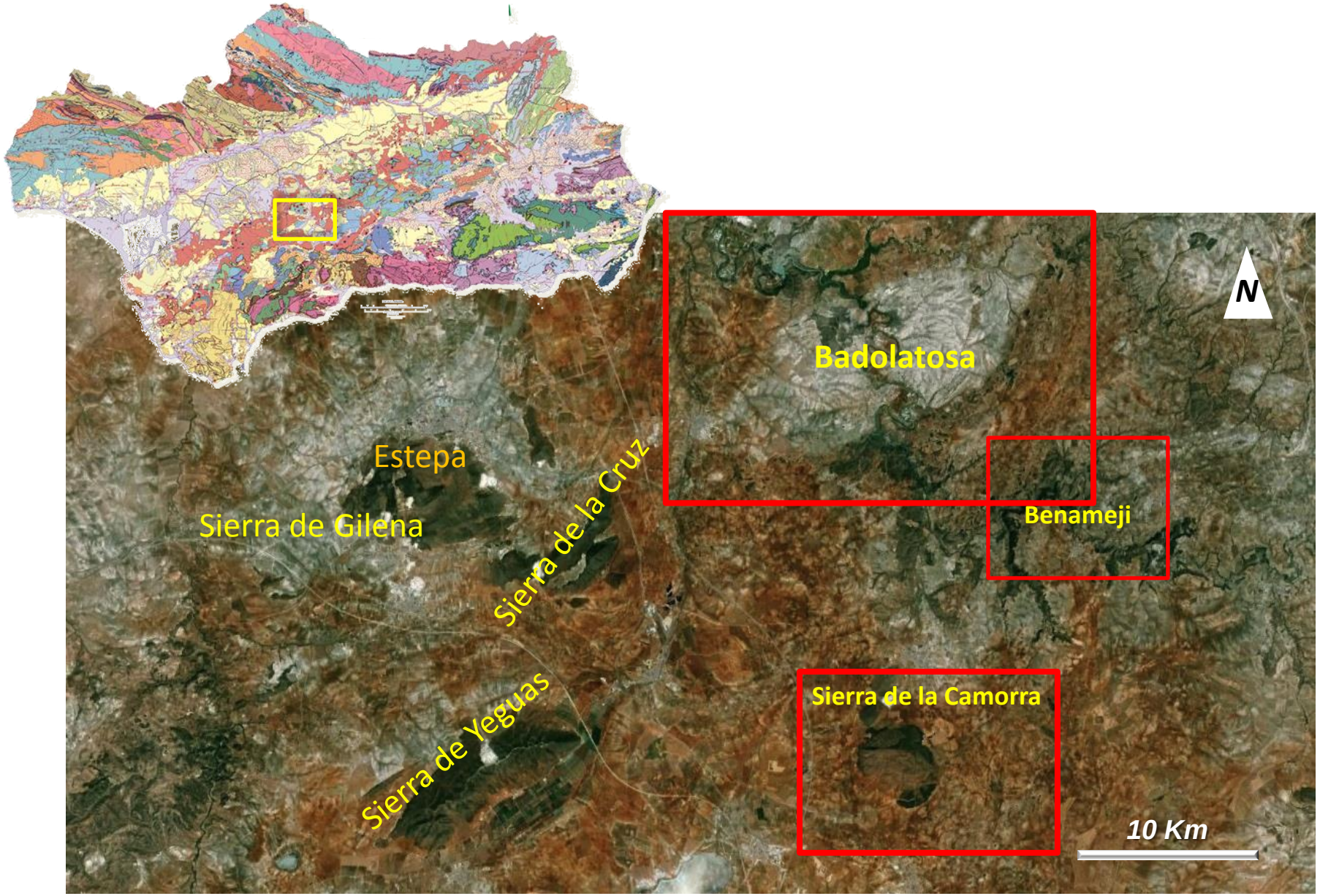


Betica 18-1 Close-up

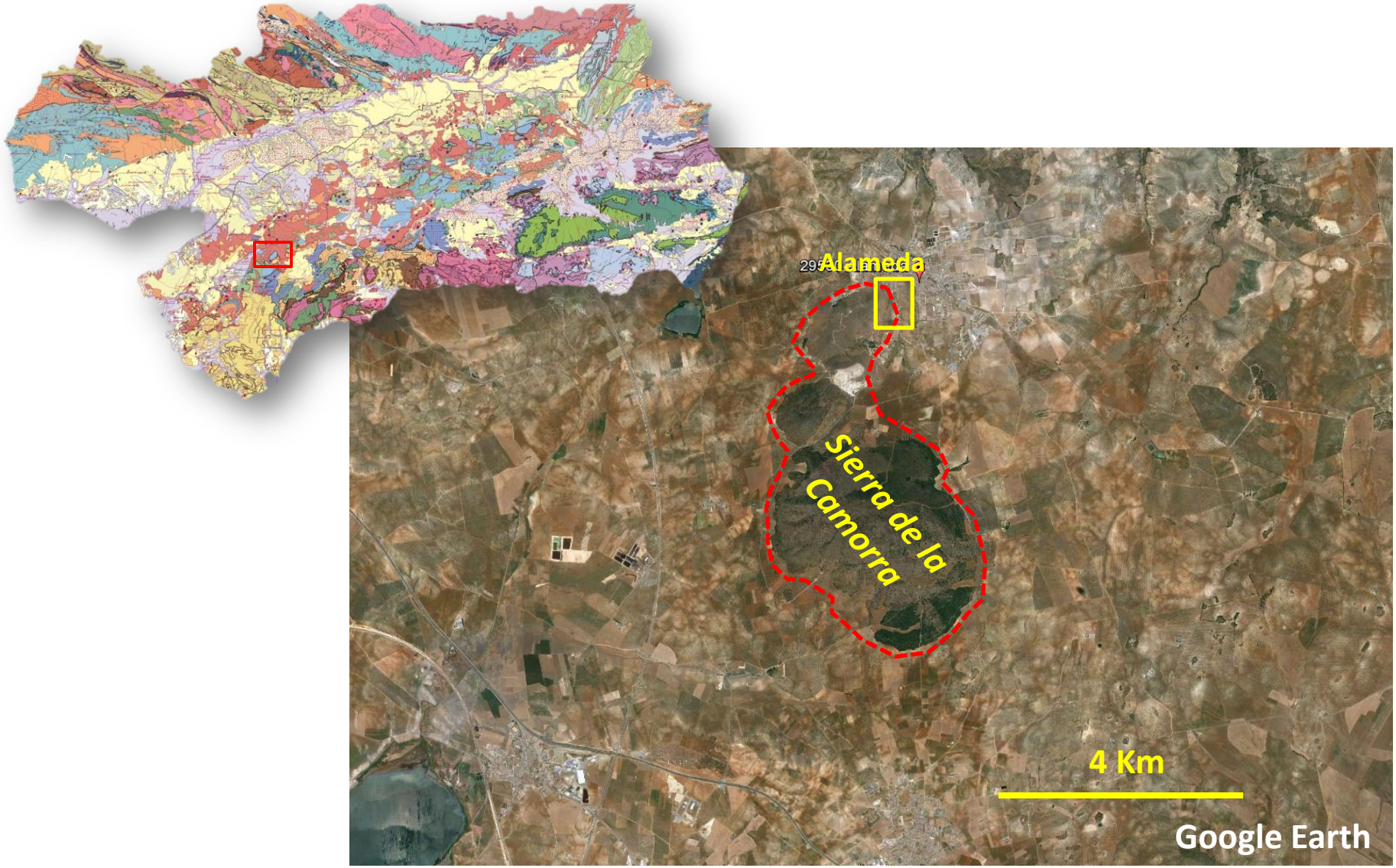


1100 m of Allochthonous Triassic

Western Betic Surface Exposures



Sierra de la Camorra Tectonic Window

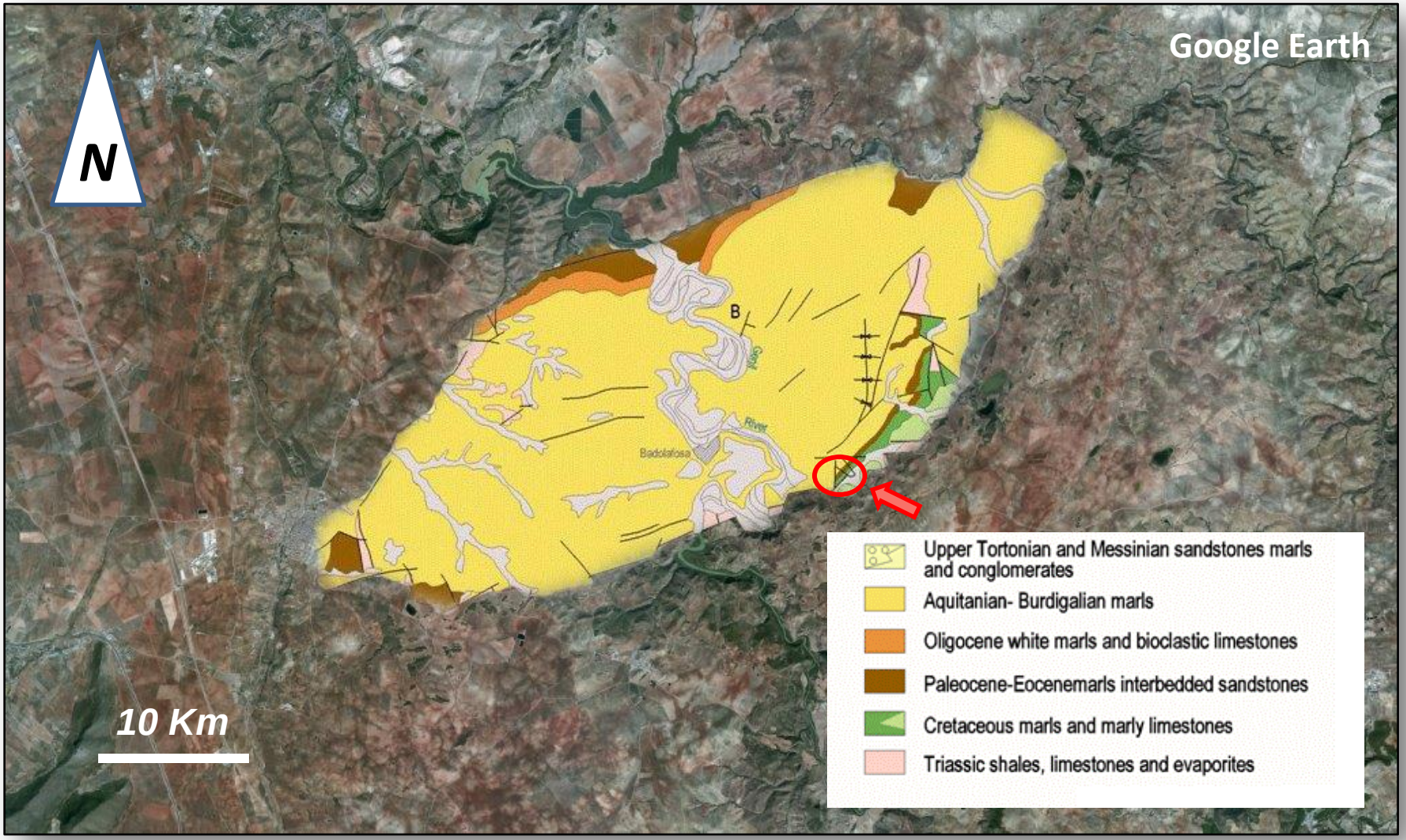


Allochthonous Triassic Basal Detachment of Sierra de la Camorra, Alameda , Malaga

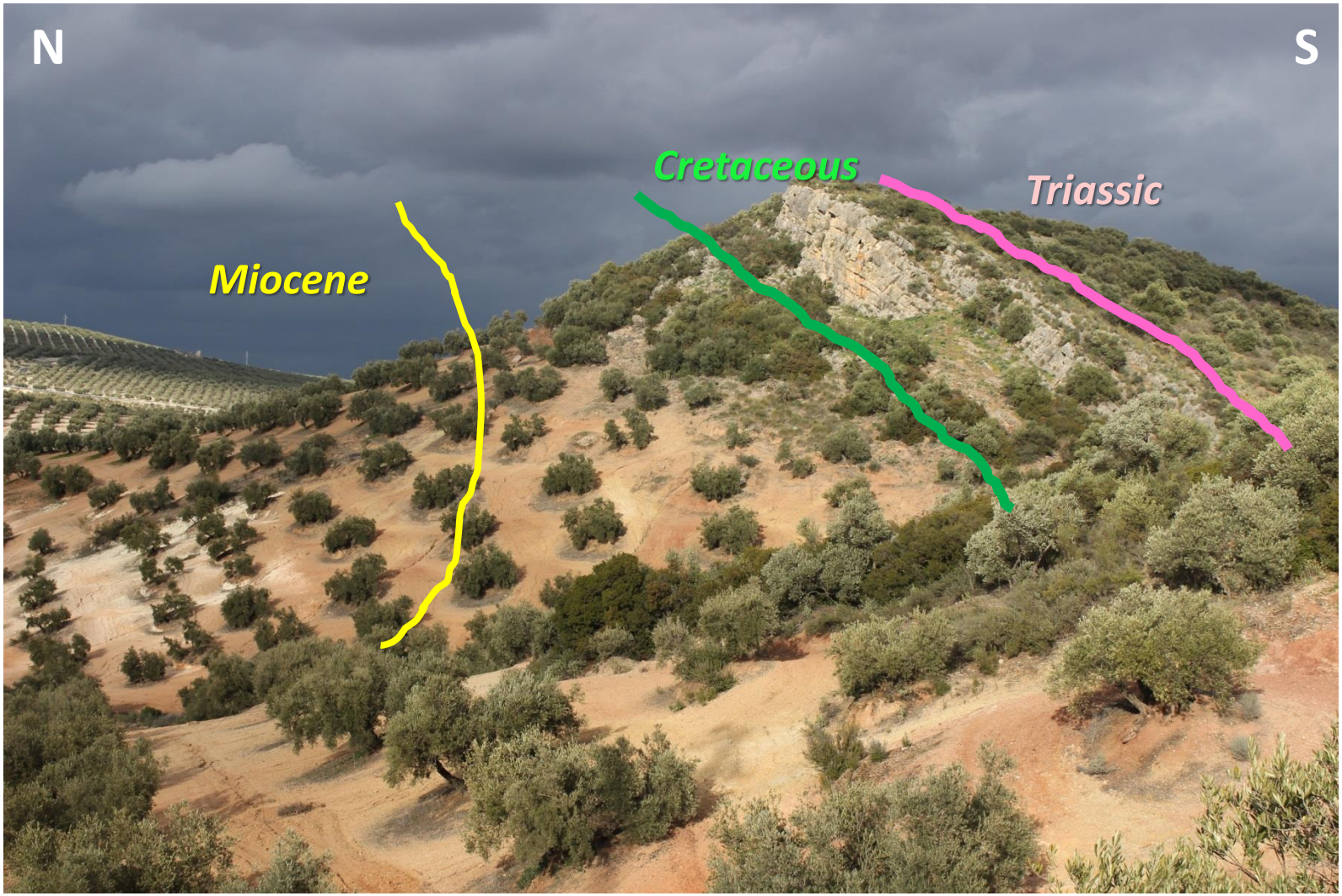
Sense of Displacement

Badolatosa-Malpasillo Minibasin

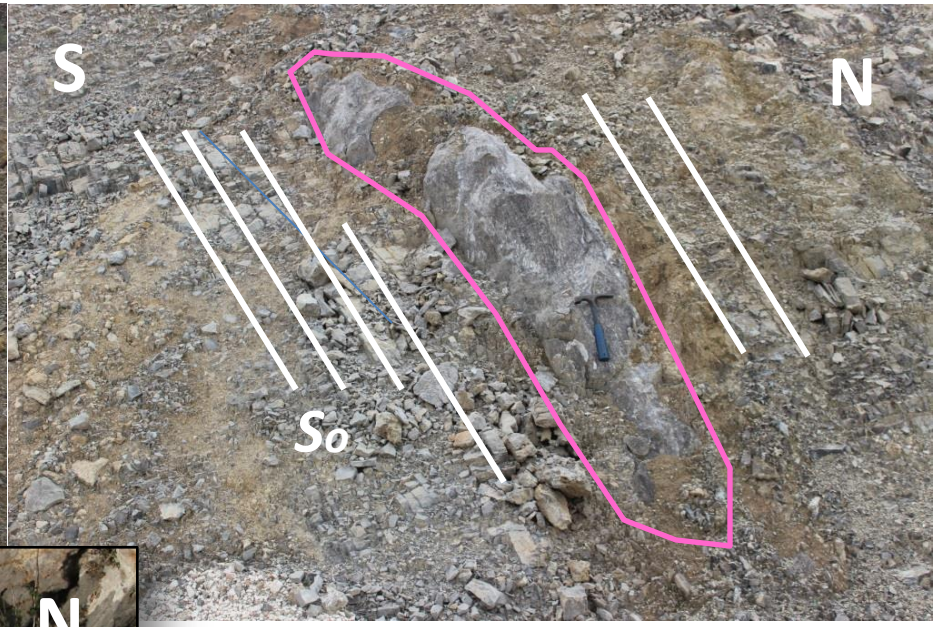
Badolatosa-Malpasillo Minibasin

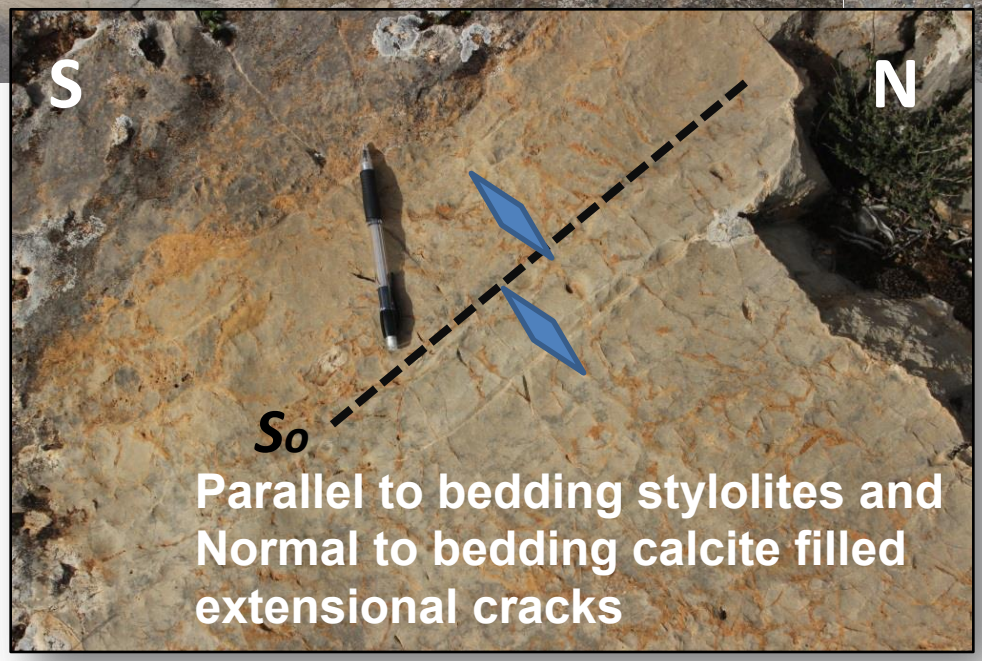


Southern Edge Malpasillo Minibasin



Southern Edge Malpasillo Minibasin





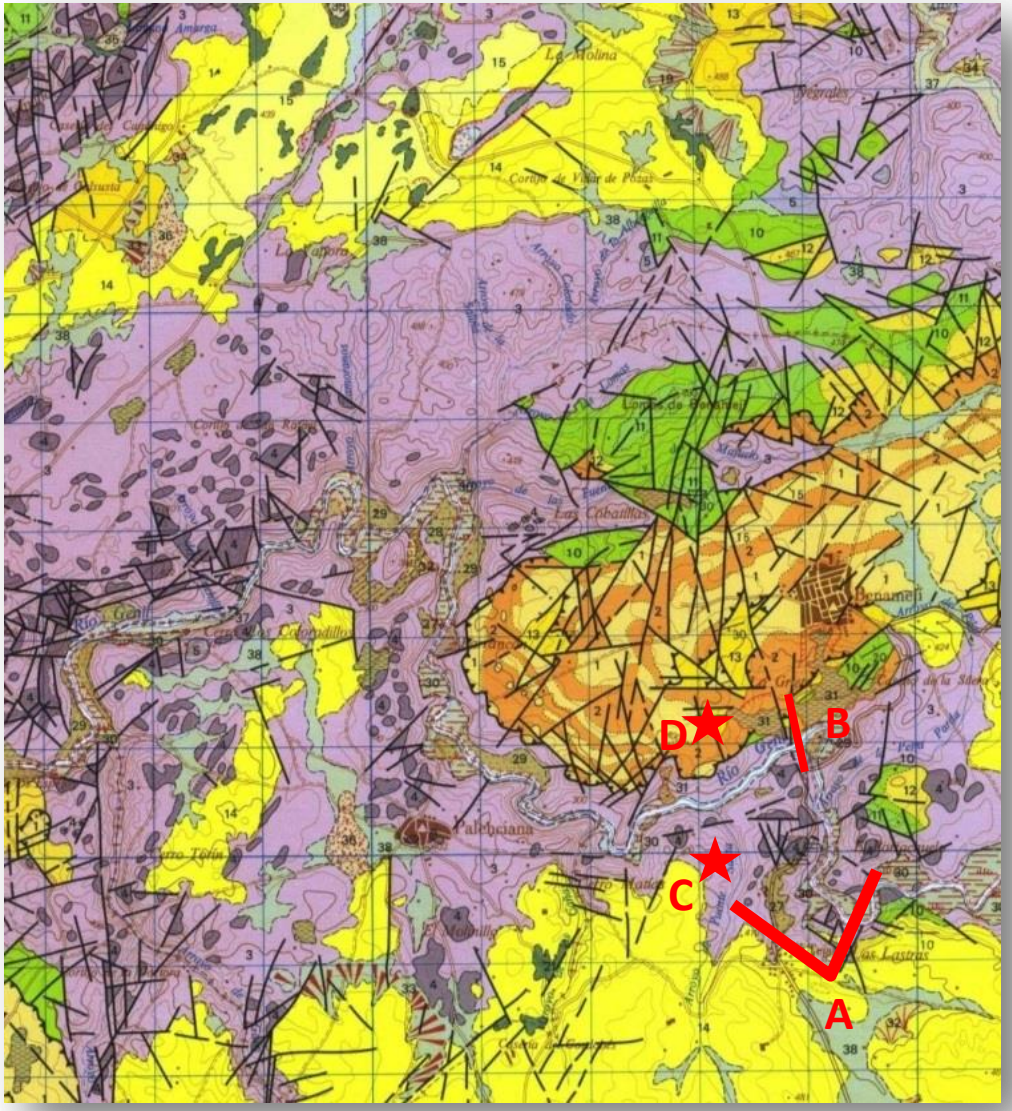
Re-sedimented Triassic Gypsum Blocks within Upper Cretaceous Deep-water Carbonates.

Benameji Paleocene Minibasin

LEGEND

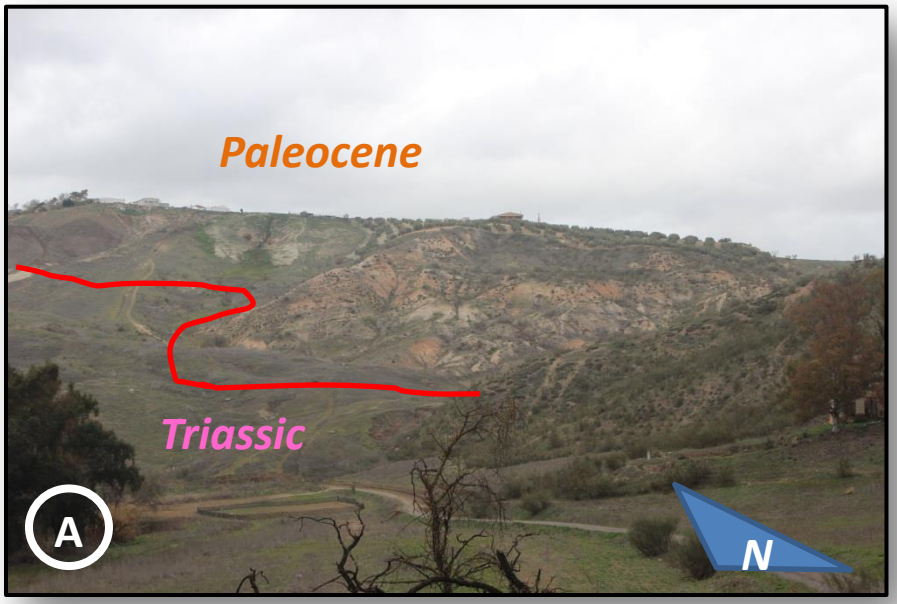
- Miocene
- Paleocene
- Cretaceous
- Triassic

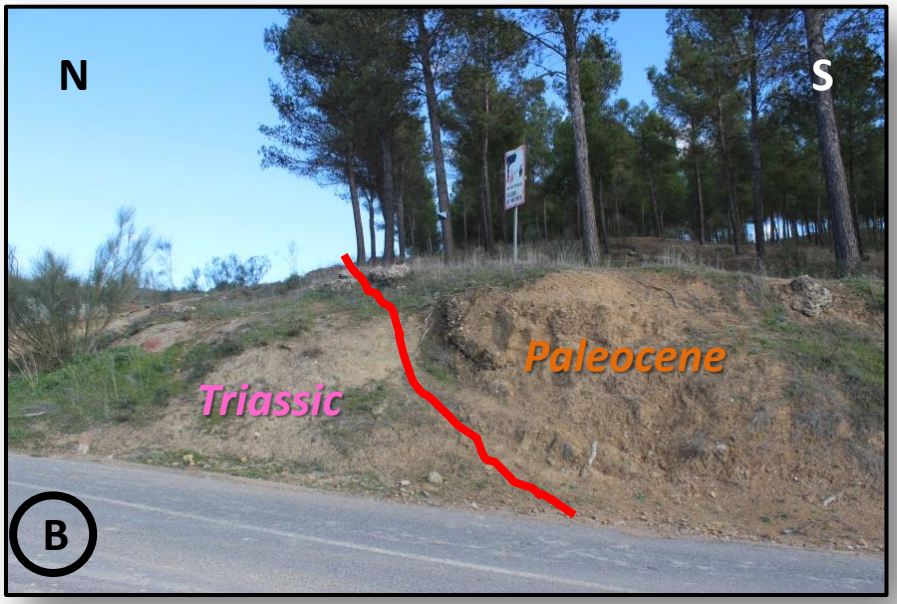
★ Location of next slide pictures.



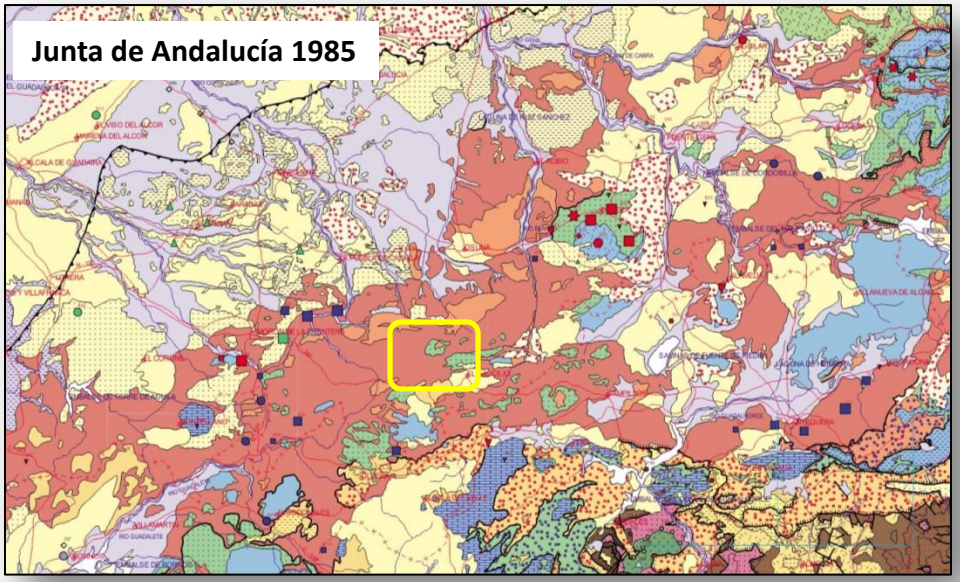
Map from IGME 1986

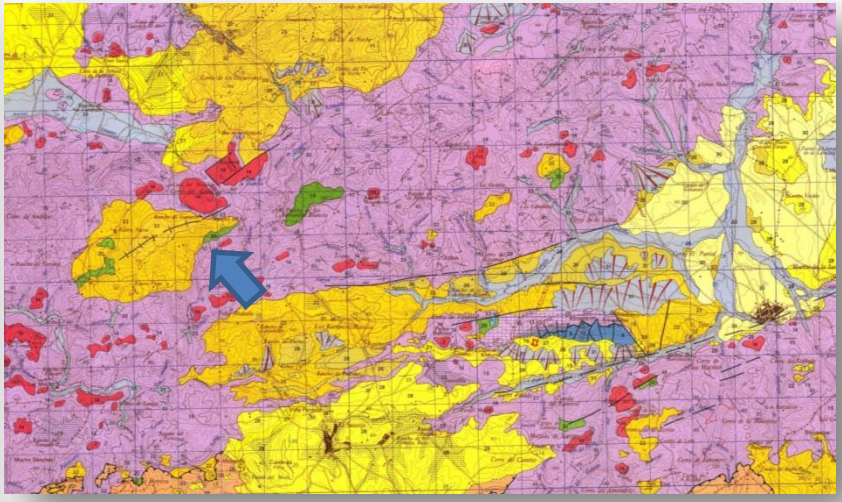
Benameji Paleocene Minibasin



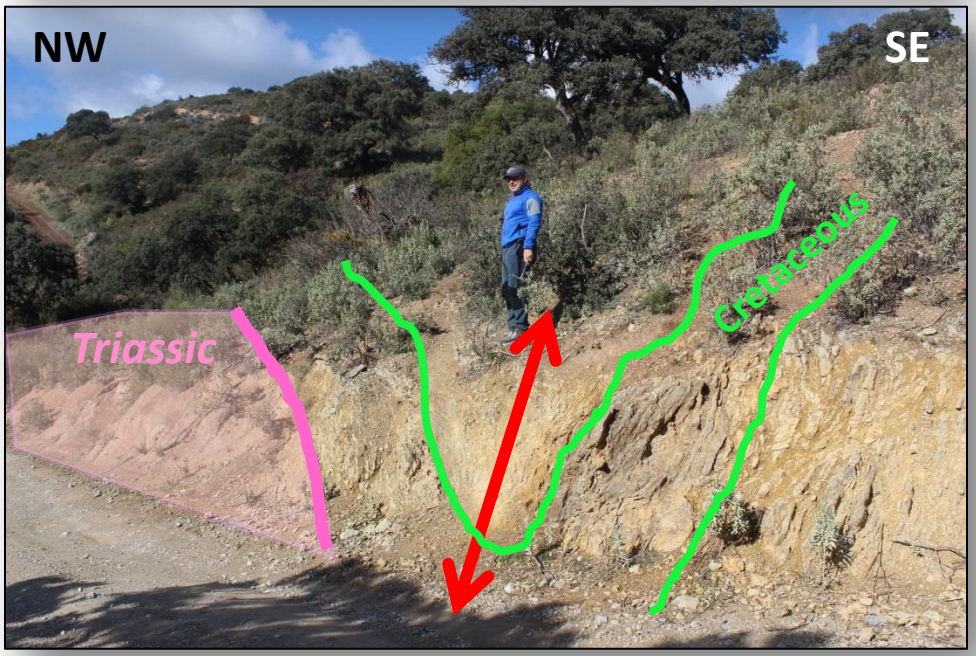


Cerro de Gomeron Minibasin

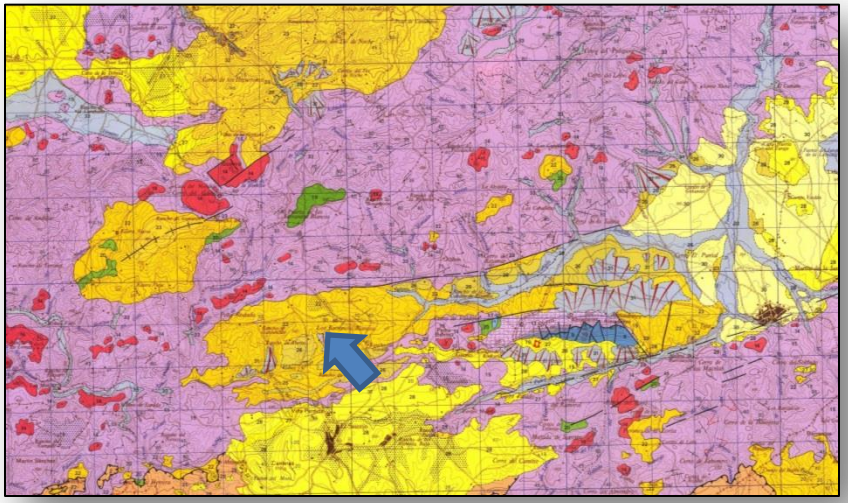




IGME 1986

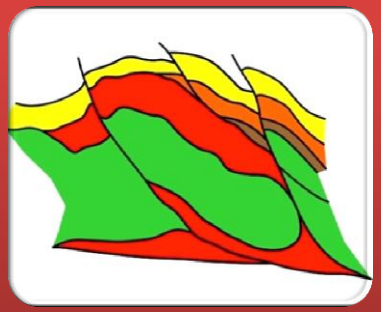


El Saucejo Minibasin



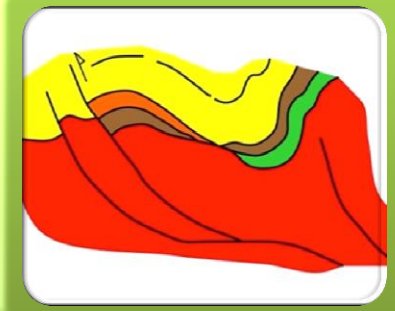
IGME 1986

Types of Compressionally Modified Minibasins



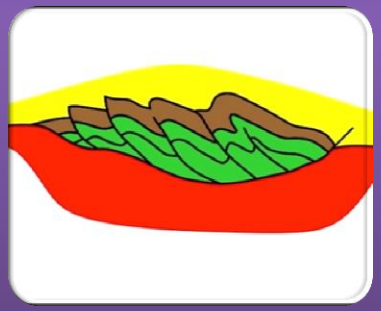
Subsalt Detachment

- Common along frontal & reduced canopies
- Common Allosuture features.
- Folded Salt Canopies



Intra-Salt Detachment

- Evaporitic section involved in the deformation
- Minibasins are refolded as wedge-top basins
- Similar to Inversion structures.



Top Salt Detachment

- The main detachment is the base of the Minibasin
- Small scale folding and imbricated thrusting
- Located in frontal or inner canopies.

Conclusions

- Allochthonous Salt Canopies and related Minibasins have been extensively studied based on seismic data, but few field examples have been analyzed up to now.
- Seismic and well-log data confirms the presence of thick Allochthnous Salt units in the foothills of the Betic Cordillera.
- Surface geological data suggest several salt mobilization episodes since Jurassic and particularly Cretaceous to Paleogene time.
- Upper Cretaceous to Paleogene Canopies are very widespread in the area. These canopies were emplaced during passive margin stage but were later deformed by Neogene Alpine shortening.
- Neogene, mostly Miocene Canopies are present in the so-called Guadalquivir Allochthon, also referred to as Olistostrome. This unit represents an Alpine Accretionary Wedge that involves passive-margin allochthonous evaporites.
- The example presented here of the Betic Cordillera constitutes a complex allochthonous salt nappe (probably composed by different, sutured sheets), which was intensively deformed by later compression during the Alpine orogeny (mainly during the Miocene).
- This structure could therefore represent a more mature allochthonous salt nappe than the field examples described in regions like the Canadian Arctic, the Sivas Basin in Turkey or the Flinders Range in South Australia.

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Thank You for your Attention