Recent deformation in the frontal Jura fold-and-thrust belt from a deep-seated thrust fault: evidence from Late Quaternary fluvial terraces

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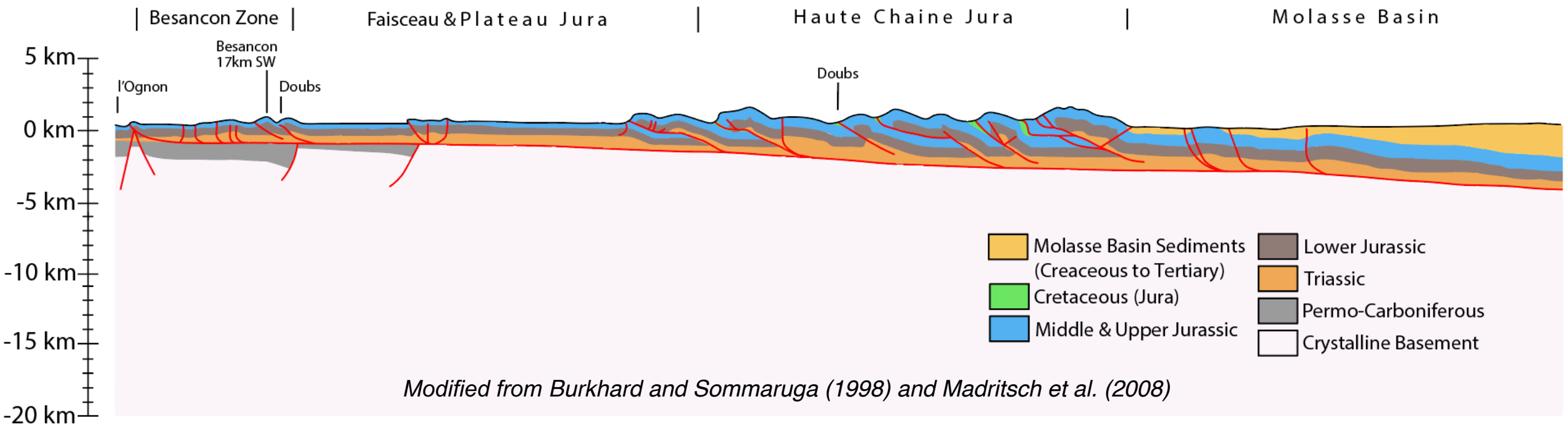
An Overview of the Jura Mountains

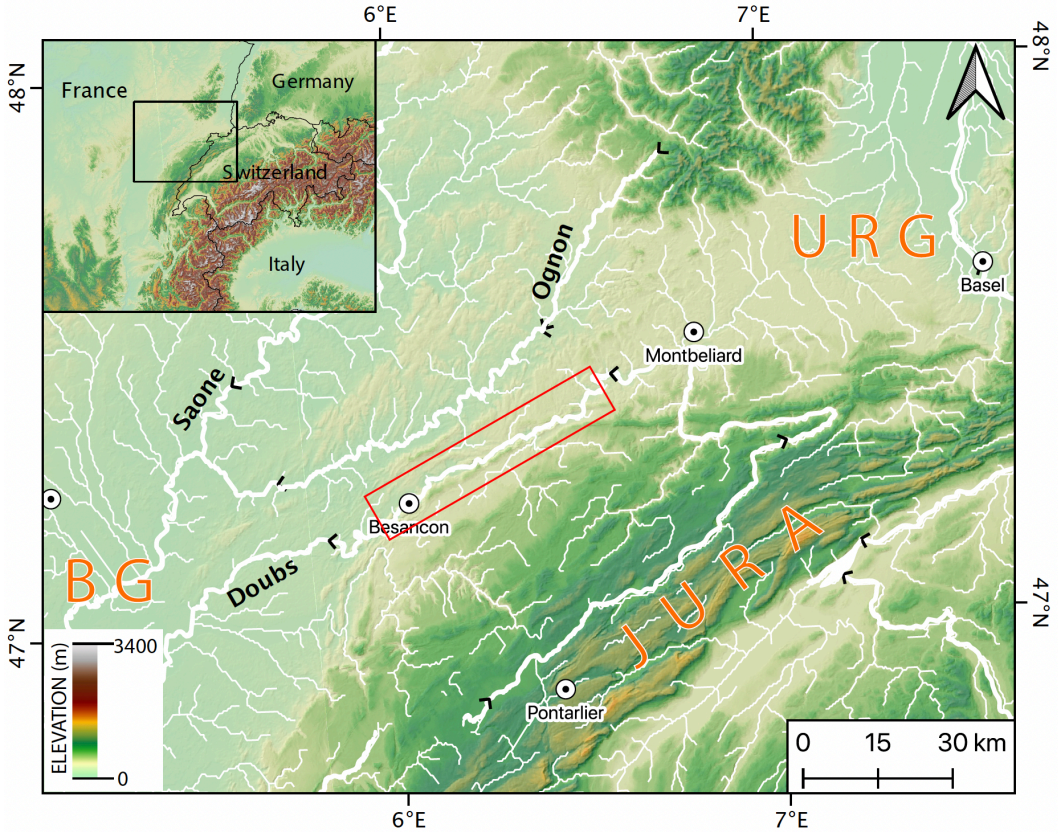


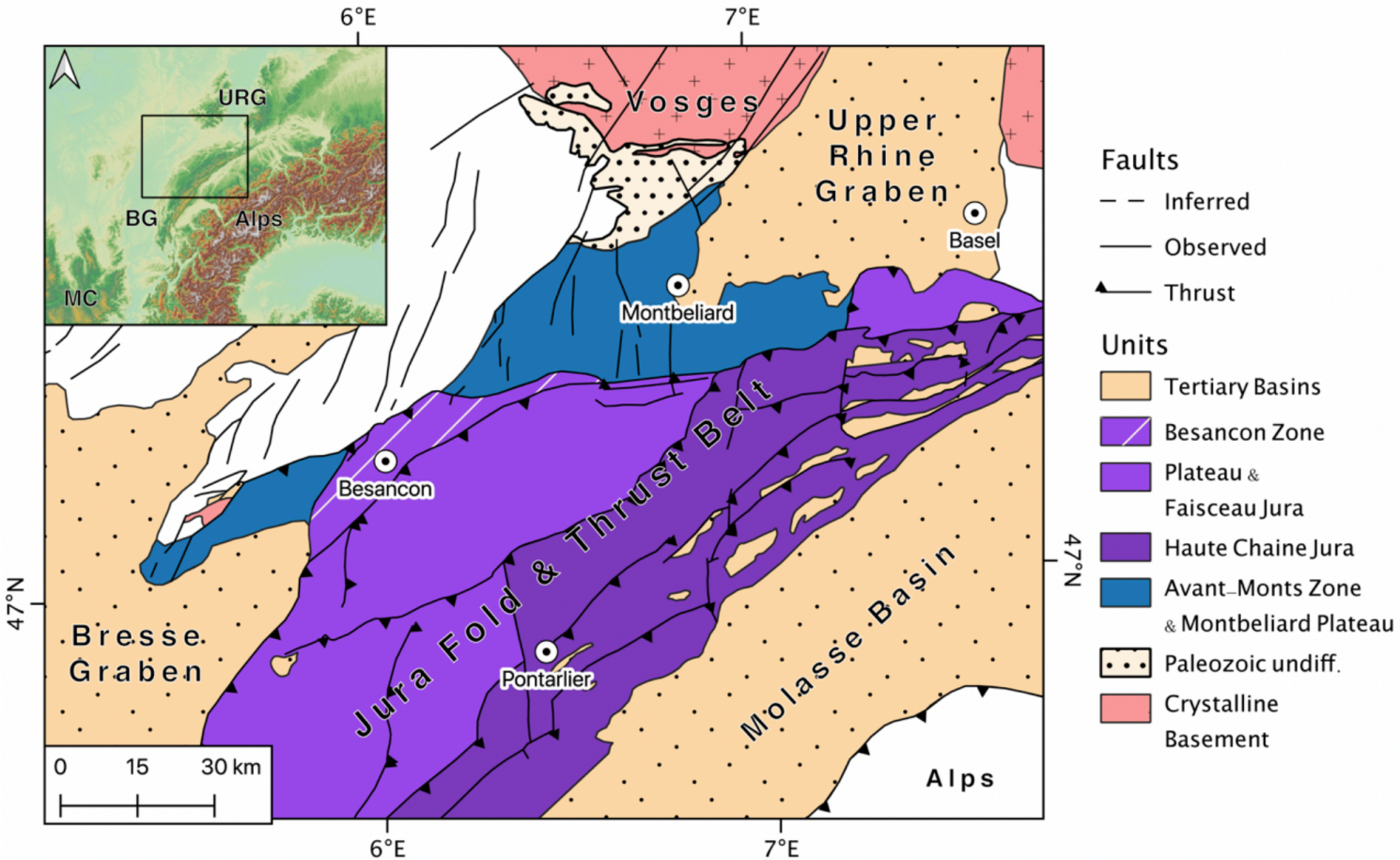
Modified from Burkhard and Sommaruga (1998) and Madritsch et al. (2008)

How is the northwestern edge of the Jura fold-and-thrust belt currently deforming?

- Inactive?
- Continuing thin-skinned deformation?
  - Nivière and Marquis (2000): abandonment of terrace risers (Upper Rhine Graben)
- Change to a thick-skinned regime?
  - Becker (2000): borehole in situ stress measurements (Haute Chaine Jura)
  - Ustaszewski and Schmid (2006): Paleostress reconstruction (Upper Rhine Graben)

The Doubs River and the Besançon Zone





Previous Literature

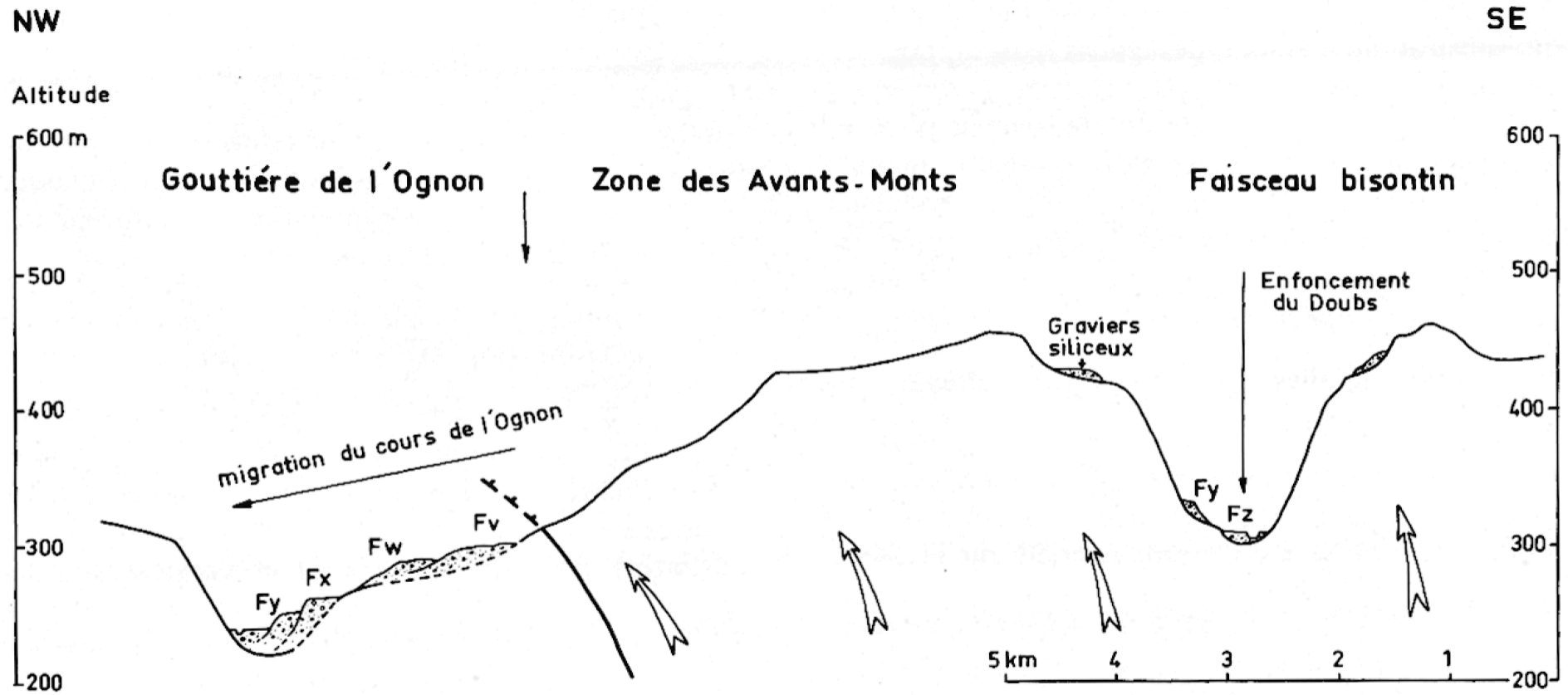
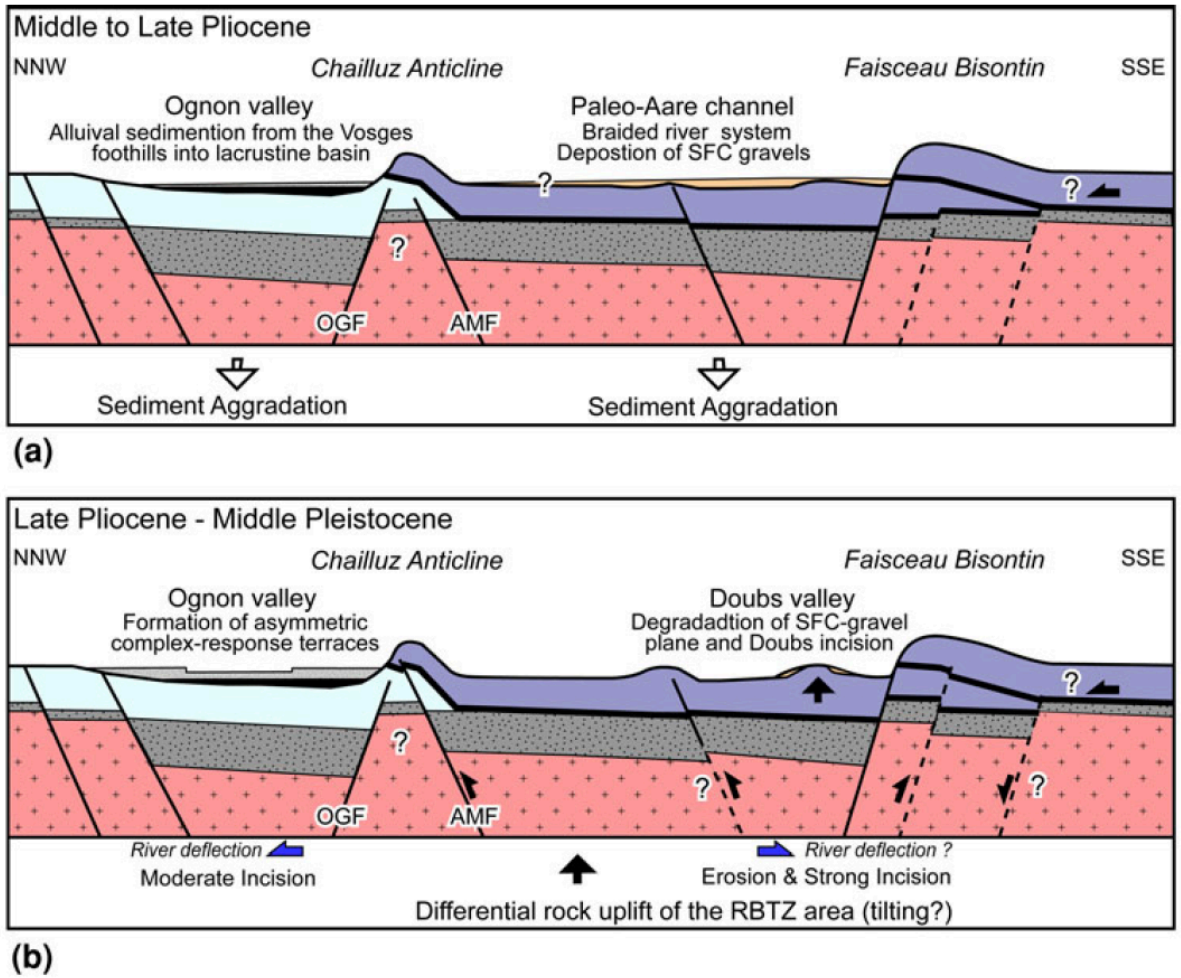
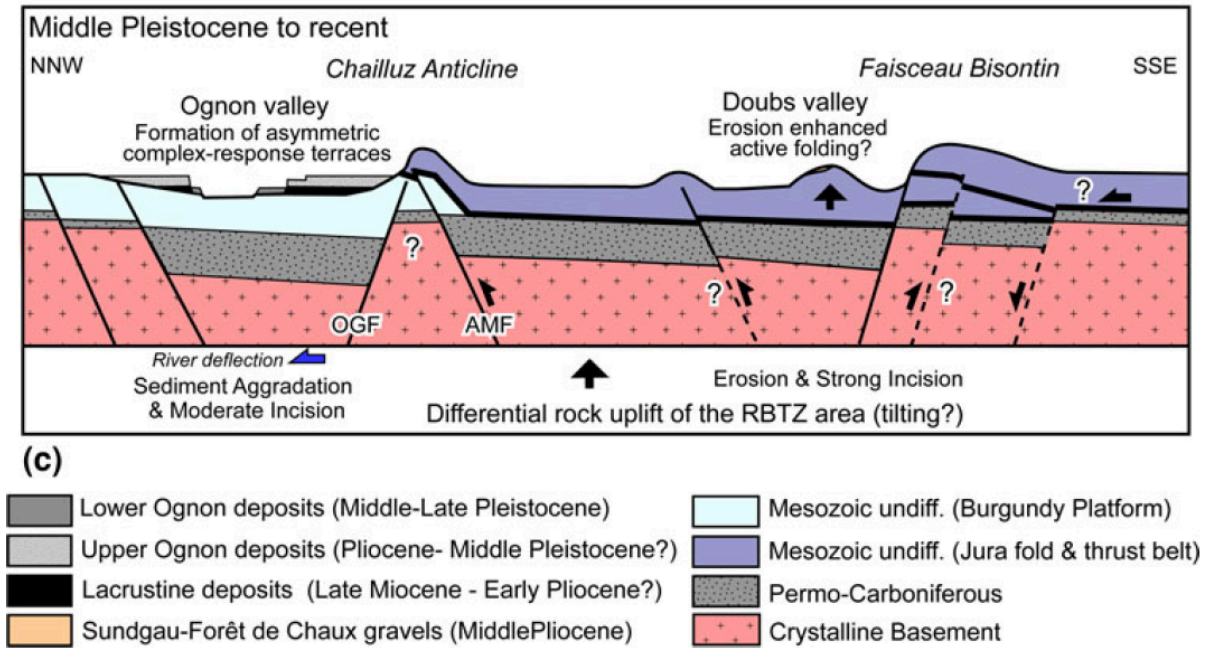


Fig. 3. — Coupe transversale comparée des vallées du Doubs et de l'Ognon et position respective des dépôts alluviaux.
Fig. 3. — Comparaison in transversal outcrop of Doubs valley and Ognon valley. Respective position of alluvial deposits.

Campy, 1984

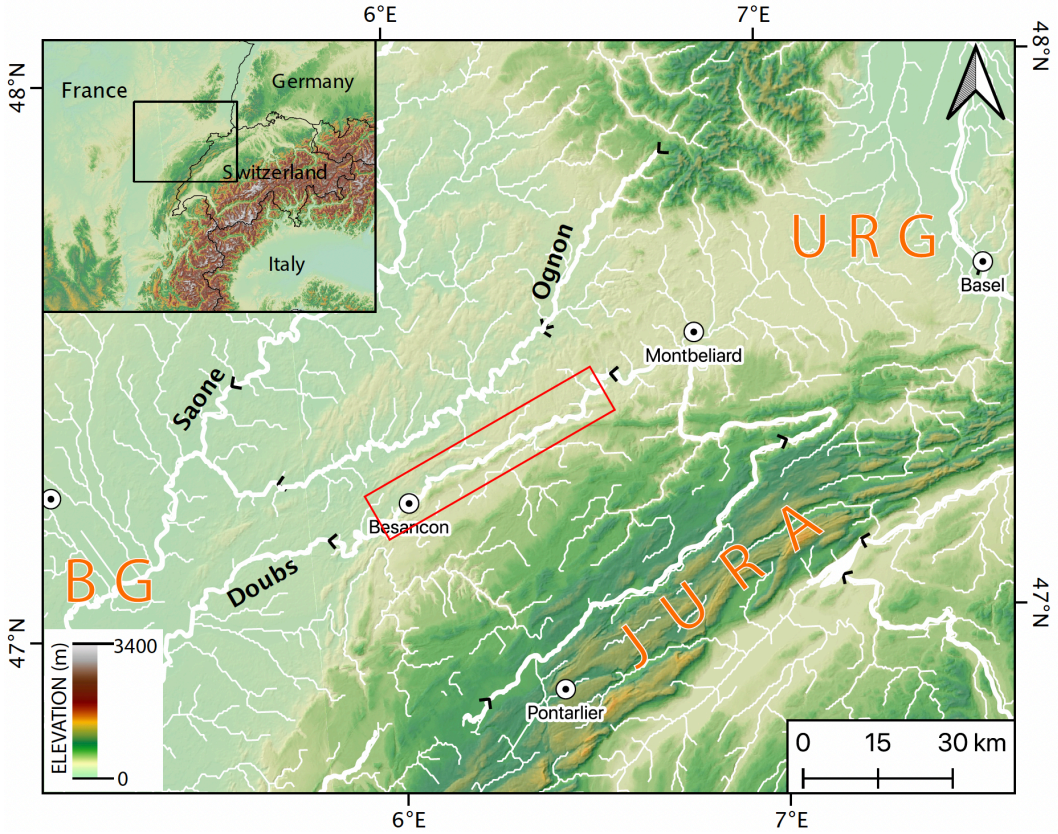
Previous Literature

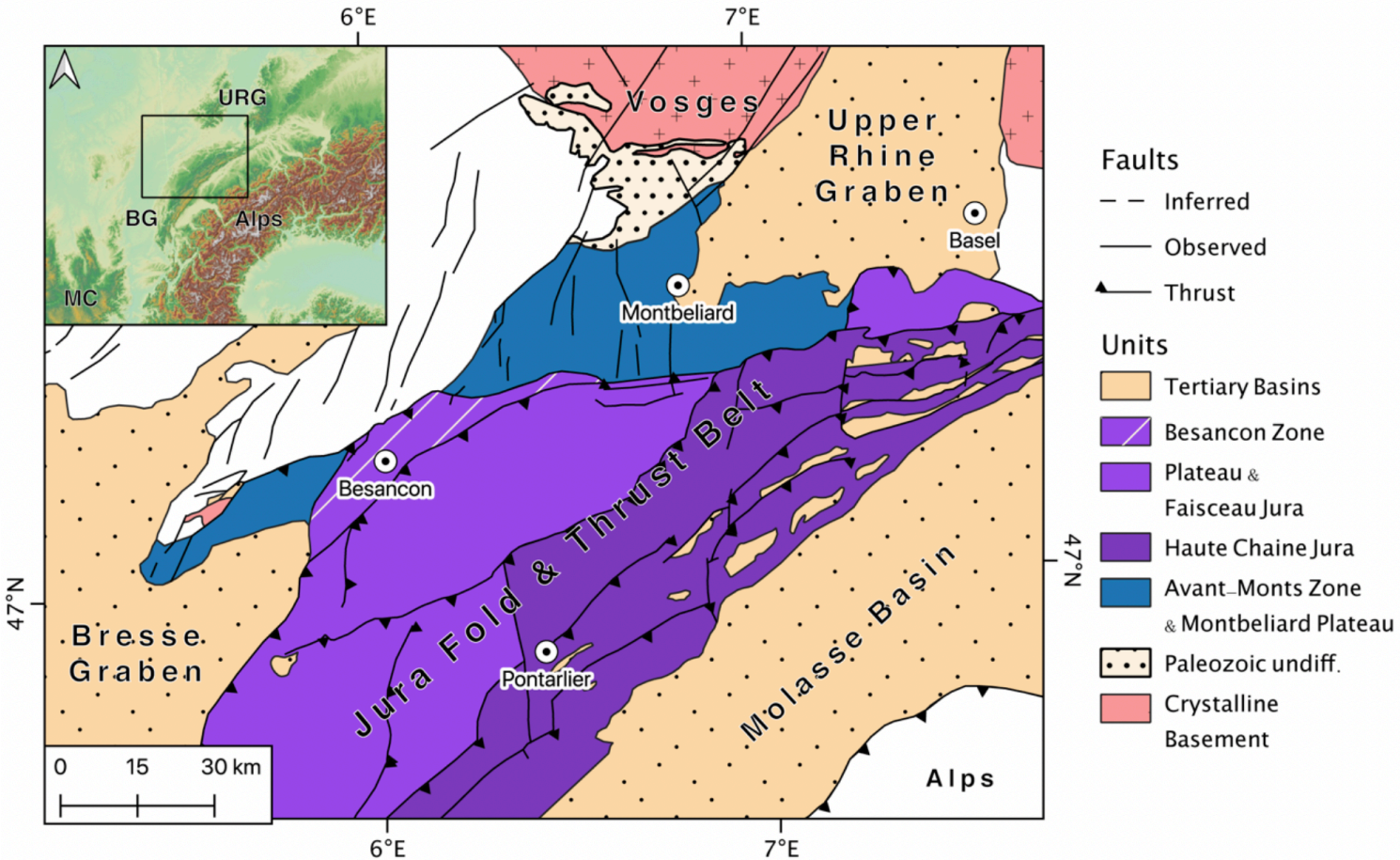




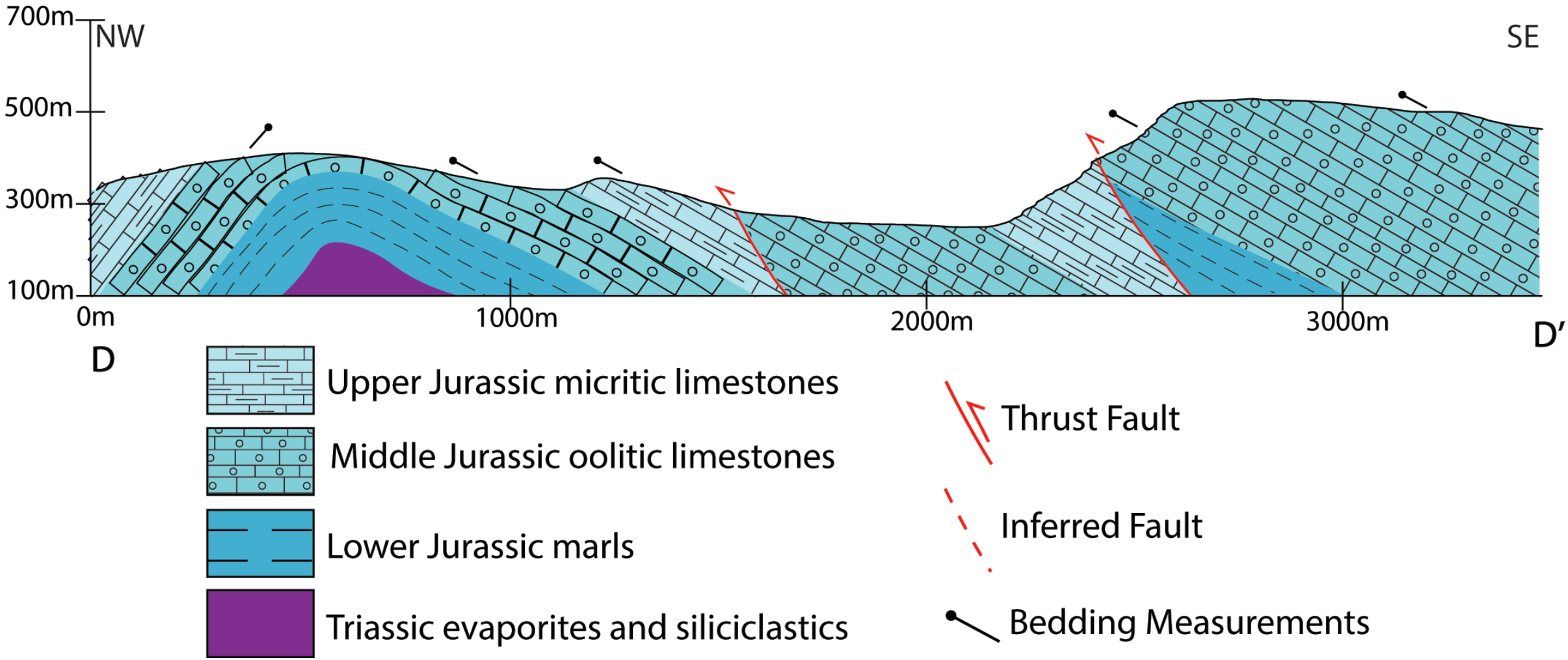
Madritsch et al., 2010b

The Doubs River and the Besançon Zone





Geology along the Doubs River



Fluvial Terraces along the Doubs River: T0

Tread Elevation = 1.5m
Strath Elevation = 1m

Fluvial Terraces along the Doubs River: T1

Tread Elevation = ≤25m
Strath Elevation = ~5m

Fluvial Terraces along the Doubs River: T2 (Clerval)

Tread Elevation = ?
Strath Elevation = ~20m

OSL Dating Results (T1)

Sample	n	Water (%)	D (Gy/ka)	De (Gy)	Age (ka)
DEL-01-Q	24	10 ± 5	1.223 ± 0.06	79.92 ± 10.19	65.4 ± 8.9
		15 ± 5	1.168 ± 0.056		68.4 ± 9.3
		20 ± 5	1.119 ± 0.052		71.4 ± 9.7
DEL-02-Q	16	10 ± 5	1.378 ± 0.063	58.87 ± 12.08	42.7 ± 9.0
		15 ± 5	1.315 ± 0.058		44.8 ± 9.4
		20 ± 5	1.259 ± 0.054		46.8 ± 9.6

Sample	n	Water (%)	D (Gy/ka)	De (Gy)	Age (ka)	g (%)	Unfaded Age (ka)
DEL-01-F	15	10 ± 5	2.067 ± 0.152	277.79 ± 23.9	134.3 ± 15.2	0.62 ± 0.58	142.1 ± 18.1
		15 ± 5	2.008 ± 0.15		138.3 ± 15.8		146.3 ± 18.6
		20 ± 5	1.955 ± 0.148		142.1 ± 16.3		150.3 ± 19.1
DEL-02-F	15	10 ± 5	2.166 ± 0.095	95.16 ± 17.59	43.9 ± 8.4	0.62 ± 0.61	46.3 ± 9.2
		15 ± 5	2.098 ± 0.092		45.4 ± 8.6		47.8 ± 9.6
		20 ± 5	2.037 ± 0.089		46.7 ± 8.9		49.3 ± 9.8
DEL-02-F-SG	55	10 ± 5	2.166 ± 0.095	69.42 ± 8.87	32.1 ± 4.3	0.62 ± 0.61	33.8 ± 5.0
		15 ± 5	2.098 ± 0.092		33.1 ± 4.5		34.9 ± 5.1
		20 ± 5	2.037 ± 0.089		34.1 ± 4.6		35.9 ± 5.3

OSL Dating Results

- T1 (5m) dated at 35 ± 5 ka gives an uplift rate of **0.14mm/yr**

  **0.17 mm/yr from Madritsch et al. 2010a*

  **onset of Last Glacial Maximum = ~33 – 26.5 ka*

- Assuming that the uplift rate is stable through time:

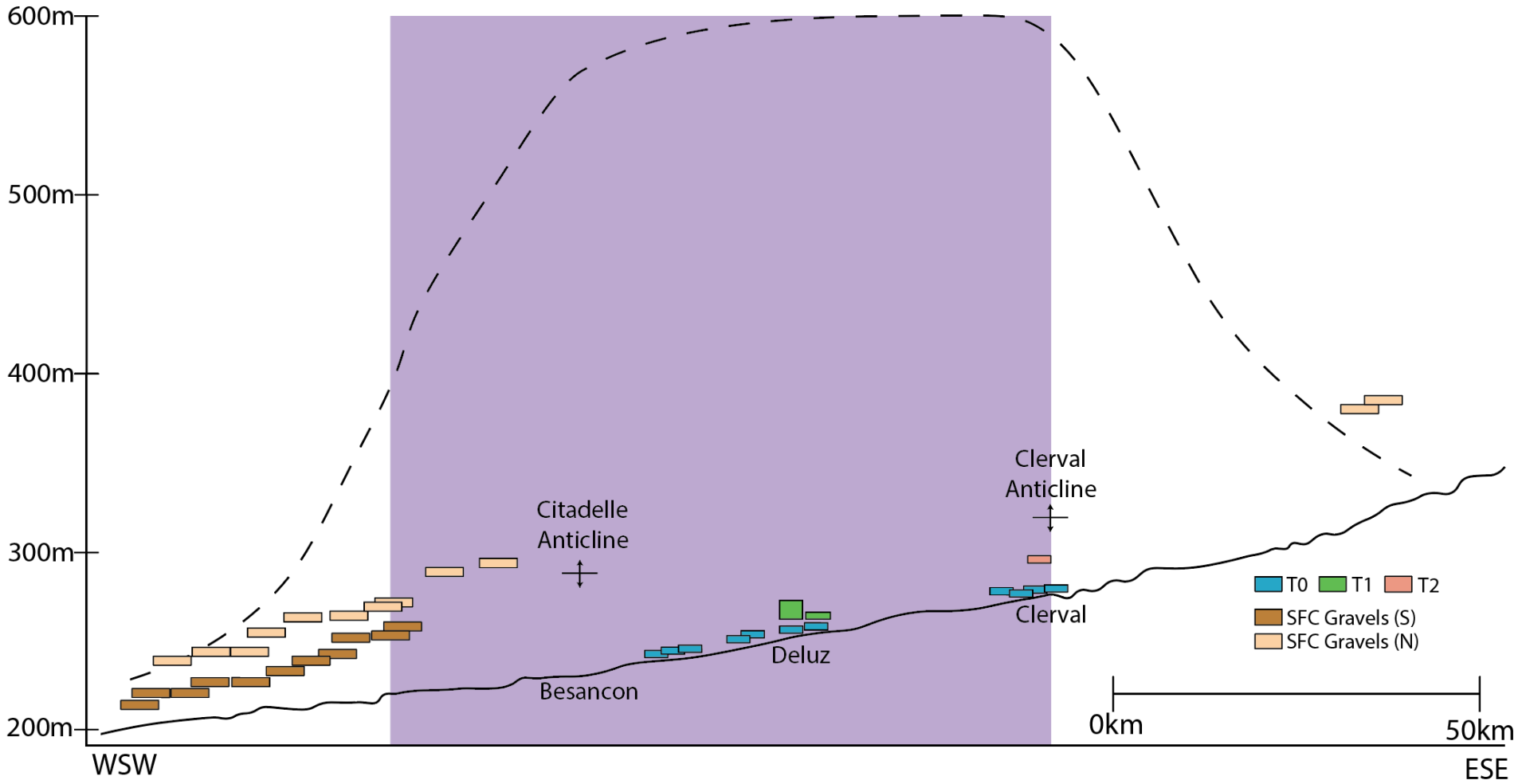
  T0 (1m) = ~ 7 ka (same age as in Madritsch et al. 2010a)

  T2 (20m) = ~140 ka

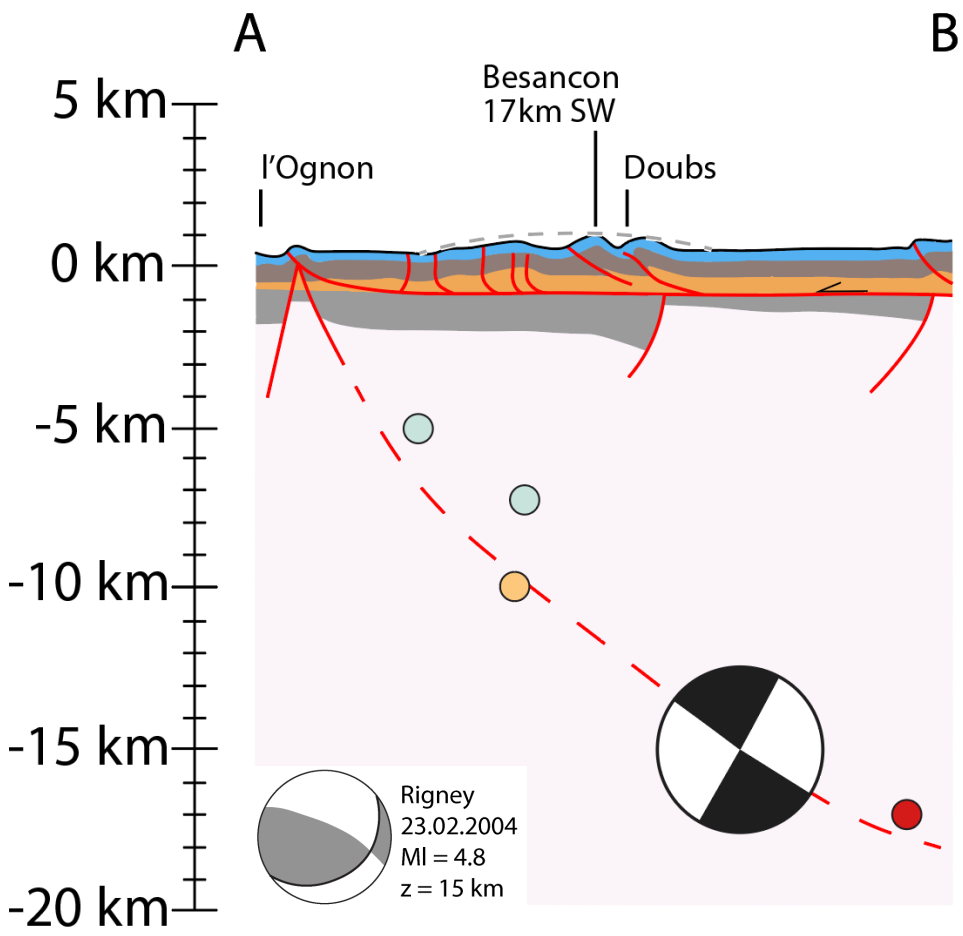
- T2 gives an interesting computed age, as the “oldest” ages from T1 are ~145 ka

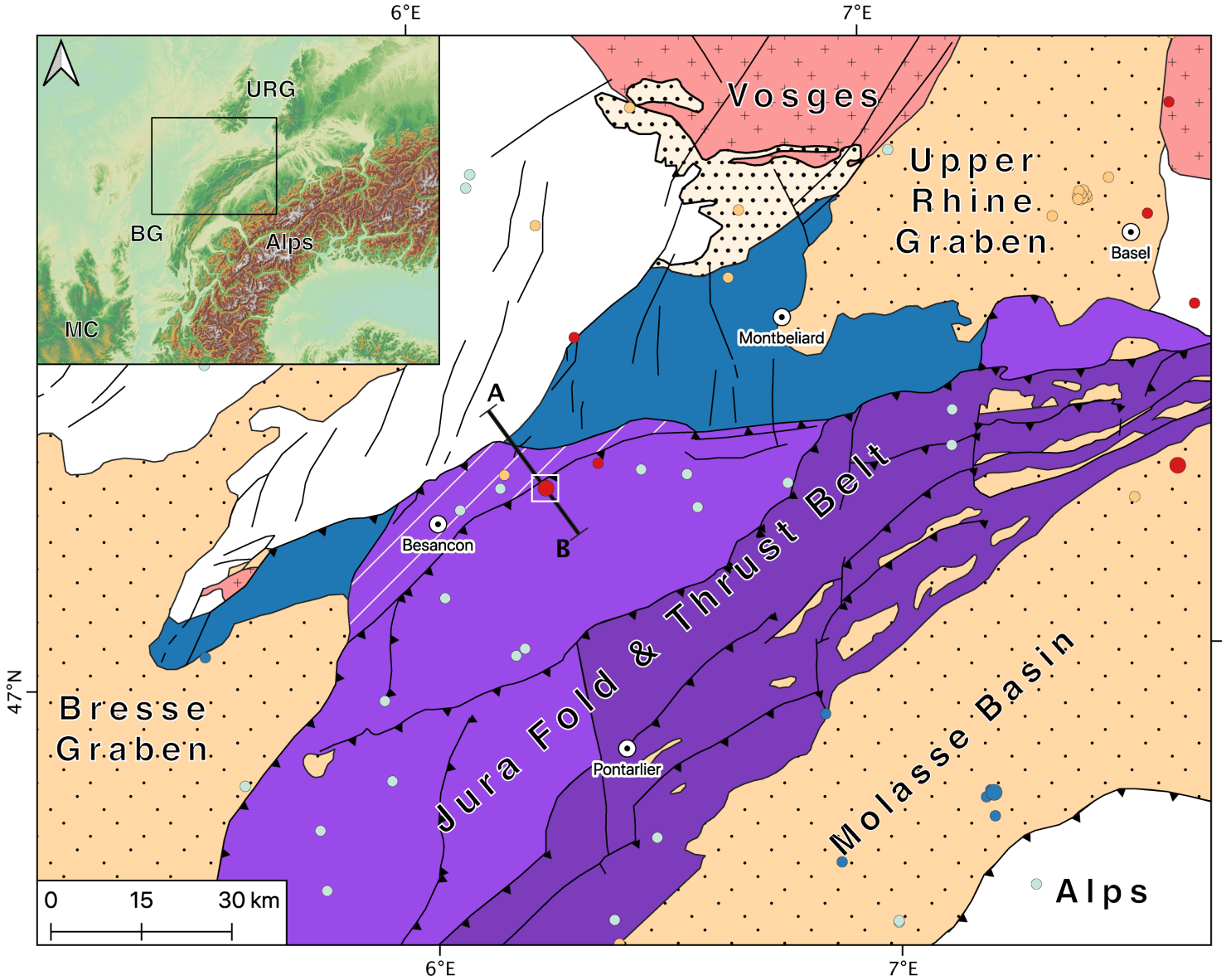
  **Penultimate Glacial Maximum = ~140 ka*

Fluvial Terraces along the Doubs River



Regional Setting of the Besançon Zone





References

- Becker, A. (2000). The Jura Mountains – an active foreland fold-and-thrust belt? Tectonophysics. 321. 381-406. 10.1016/S0040-1951(00)00089-5.
- Burkhard, M. & Sommaruga, A. (1998) Evolution of the western Swiss Molasse basin: structural relations with the Alps and the Jura belt. In: Mascle A, Puidgef bregas C, Luterbacher HP et al (eds) Cenozoic foreland basins of western Europe, Geological Society, London, Special Publications 134: 279–298.
- Campy, M. (1984) Signification dynamique et climatique des formations et terrasses fluviatiles dans un environnement de moyenne montagne. Bulletin de l'Association francaise pour l'Etude du Quaternaire 1, 87–92.
- Madritsch, H., Schmid, S. & Fabbri, O. (2008). Interactions between thin- and thick-skinned tectonics at the northwestern front of the Jura fold-and-thrust belt (Eastern France). Tectonics 27. 10.1029/2008TC002282.
- Madritsch, H., Preusser, F., Fabbri, O., Bichet, V., Schlunegger, F., & Schmid, S. (2010a). Late Quaternary folding in the Jura Mountains: Evidence from syn-erosional deformation of fluvial meanders. Terra Nova 22, 147-154. 10.1111/j.1365-3121.2010.00928.x.
- Madritsch, H., Fabbri, O., Hagedorn, EM. et al. (2010b). Feedback between erosion and active deformation: geomorphic constraints from the frontal Jura fold-and-thrust belt (eastern France). Int J Earth Sci (Geol Rundsch) 99, 103–122. https://doi.org/10.1007/s00531-009-0468-7
- Niviére, B. & Marquis, G. (2000). Evolution of terrace risers along the Upper Rhine Graben inferred from morphologic dating methods: evidence of climatic and tectonic forcing. Geophys J Int 141(3):577–594. doi:10.1046/j.1365-246x.2000.00123.x
- Ustaszewski, K. & Schmid, S.M. (2006). Control of preexisting faults on geometry and kinematics in the northernmost part of the Jura fold-and-thrust belt. Tectonics 25:TC5003. doi:10.1029/2005TC001915