Subsurface structures in the Chablais Préalpes : new tectonic interpretations of the Préalpes Médianes nappe based on palinspastic lengths

Autor(en): **Borel, Gilles D. / Mosar, Jon**

Objekttyp: **Article**

Zeitschrift: **Eclogae Geologicae Helvetiae**

Band (Jahr): **93 (2000)**

Heft 3

PDF erstellt am: **21.09.2024**

Persistenter Link: https://doi.org/10.5169/seals-168824

0012-9402/00/030307-8 $1.50 + 0.20/0
Birkhäuser Verlag, Basel, 2000

Eclogae geol. Helv. 93 (2000) 307–314

Subsurface structures in the Chablais Préalpes: New tectonic interpretations of the Préalpes Médianes nappe based on palinspastic lengths

GILLES D. BOREL[1] & JON MOSAR[2]

Key words: Préalpes Médianes, Chablais, palinspastic width, tectonics, thrusting, structure, imbricates

ABSTRACT

In an intergrated approach based on palinspastic reconstruction of basin width at the latest Liassic, on present-day surface structure, and on knowledge of the depth of the basal décollement, we propose a new solution for the structural geology of the Chablais Préalpes south of Lake Geneva. Applied to the whole nappe, this combined approach allows to construct qualitative balanced cross sections and to overcome the inconsistencies between cross-sections proposed in the past. Our approach results from sedimentological investigation and basin analysis of the Préalpes Médianes realm. Comparing the ideal basin width with the observed bed length, the importance (length) of hidden imbricates at depth can be deduced. In the Cornettes de Bise area of the Swiss Chablais, we propose to introduce two important, so far unknown, imbricates which are necessary to fill the space between the basal décollement and the subsurface structures. This new solution is consistent with palinspastic basin width and structural geology, and proposes a mechanism explaining the high structural/topographic relief.

RESUME

Nous proposons ici une nouvelle interprétation de la géologie structurale des Préalpes médianes du Chablais au Sud du lac Léman, au travers d'une analyse qui intègre tout à la fois des données sur la largeur palinspastique du bassin au Toarcien, sur la structure tectonique actuelle et sur la connaissance de la profondeur de décollement basal de la nappe. Cette approche combinée, appliquée à l'ensemble de la nappe, nous permet de construire des coupes qualitativement balancées et ainsi de résoudre l'incohérence subsistant entre les coupes proposées par le passé et les résultats des investigations sédimentologiques et d'analyse de bassin du domaine considéré. Ces derniers paramètres permettent encore de déduire l'importance des structures imbriquées en profondeur en comparant la largeur idéale du bassin à la longeur observée des bancs. Pour la région des Cornettes de Bise dans le Chablais suisse, nous proposons ainsi d'introduire deux écailles, jusqu'ici inconnues, pour remplir l'espace entre le plan de décollement basal de la nappe et les structures de subsurface. Cette nouvelle solution, en accord avec la largeur palinspatique du bassin et avec la géologie structurale de la nappe, explique le mécanisme à l'origine de ce haut structural et topographique.

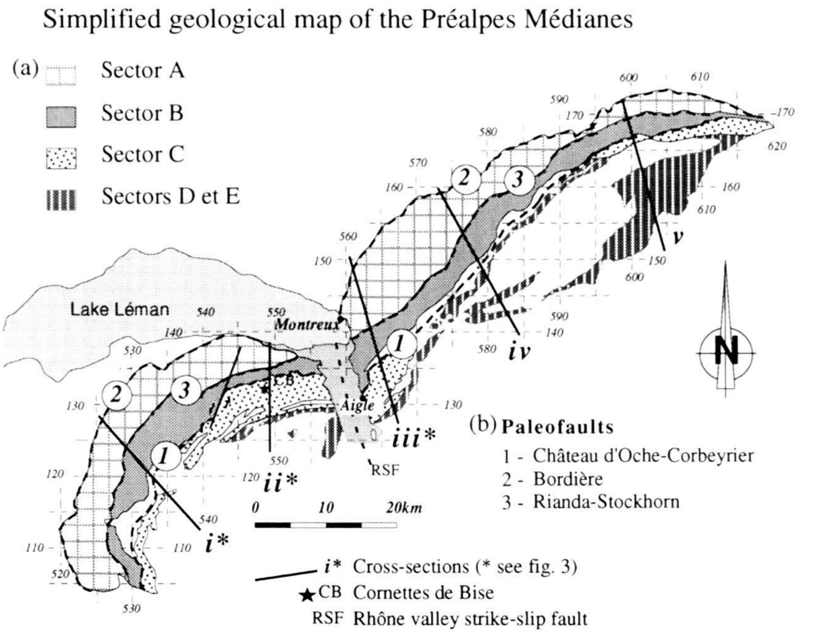
Introduction

The Préalpes are formed by tectonic klippen along the outer arc of the French and Swiss Alps. They are made up of a series of nappes of which the most important one is the Préalpes Médianes nappe (Briançonnais in origin). This nappe detached from its homeland during its incorporation into the orogenic wedge, and was subsequently emplaced towards the N-NW onto the foreland during and after the Early Oligocene (Mosar 1997; Mosar et al. 1996; Stampfli et al. 1998 and references therein). Most of its tectonic and all of its very low-grade metamorphic features were acquired during the incorporation of the Briançonnais terrane into the Alpine accretionary wedge between 45 and 27 Ma (Jaboyedoff & Cosca 1999; Mosar 1988). The tectonic development, however, continued after the emplacement on the foreland and is still active today (Mosar 1999; Stampfli et al. 1998).

Since the pioneering work of Schardt, at the turn of the 20th century, the understanding of the structure and paleogeography of the depositional realm of the Préalpes Médianes has tremendously evolved. The most recent progress has been obtained by approaches combining and integrating research results from structure, sedimentology, stratigraphy and plate tectonic reconstruction (Mosar et al. 1996; Septfontaine 1995; Stampfli et al. 1998).

Most studies have concentrated on the near surface geology and only few studies have adressed the problem of the detailed geometry of the Préalpes Médianes at depth. Recent research results from the study of the deep structure of the Alps (PNR20, Pfiffner et al. 1997b) and data from seismic studies (Burkhard & Sommaruga 1998; Erard 1999; Pfiffner et al. 1997b; Sommaruga 1997, 1999; Vollmayr 1992) have led to a new understanding of the global structure of the Préalpes

[1] Institut de Géologie et Paléontologie, Université de Lausanne – BFSH2, CH–1015 Lausanne, Switzerland. E-mail: Gilles.Borel@igp.unil.ch
[2] Geological Survey of Norway - NGU, Leiv Eirikssons vei 39, 7491 Trondheim, Norway. E-mail: Jon.Mosar@ngu.no



(c) *Restored sectors length along the different sections for latest Liassic*

Profiles	Sector A (km)	Sector B (km)	Sector C (km)	Sector D (km)
i* - Monts d'Hermone-Roc d'Enfer	*15*	8.5	9	non-existent
ii*- Locum-Cornettes de Bise	*10*	2.5	10	6
iii* - Caux-Tours d'Aï	**15**	**10**	**10**	-
iv - Moléson-Gummfluh	*15*	6	-	**7**
v - Hohmad-Turnen	*12*	5	2	-

bold = maximum sector length in reference section; * cross-sections shown in Figure 3
italic = estimated sector length, plain = measured sector length

Fig. 1. Simplified geological map of the Préalpes Médianes (Chablais Préalpes and Préalpes Romandes) and distribution of main sedimentary realms. (a) Sedimantary realms as defined by the latest Liassic paleogeography and location of major profiles discussed. Profiles i, ii, iii see Fig. 3. (b) Location of major Mesozoic paleofaults (1, 2, 3) active during sediment deposition and separating the different depositional realms. The strongest tectonic imbrication during the Alpine deformation occurred in the Chablais Préalpes east of the Bonnevaux strike-slip fault. (c) Measured length of the sectors based on surface geological nformation, see explanation in text for the lengths of sector A.

substratum especially in the western and eastern parts of the Préalpes romandes. A detailed investigation in many parts of the Préalpes remains, however, to be done.

Herein we propose a new structural model for the subsurface geology of the Chablais Préalpes, South of Lake Léman. The tectonic and palinspastic reconstructions discussed hereafter are based on the latest Liassic paleogeography, since the main basin structures were formed during the Liassic synrift basin development of the Briançonnais passive margin (the maximal extension or basin width was reached during this period).

Our goal is to discuss and resolve some major issues in the structural cross sections proposed for the Chablais Préalpes. The very high structural relief in the area S of Lake Léman is not explained satisfactorily by recent models (see Mosar et al. 1996; Septfontaine 1995), especially with respect to the structure at depth. Present-day uplift rates and earthquake activity as well as post-emplacement tectonics (post-Oligocene) were explained by basement tectonics involving the formation of new basement nappes at depth (Mosar 1999). However, these models account only for a small part of the excess structural relief, therefore we propose here a new approach to reconstruct the structure at depth of the Préalpes Médianes nappe in the Chablais area. In the western Préalpes Médianes where almost complete sections of the whole depositional realm are available (Borel 1997; Mosar 1991), when information about the depth of the detachment is taken into account, new constraints on the subsurface structure appear.

1) Geological setting

Based on their large scale tectonic style, the Préalpes Médianes nappe is subdivided into two main portions: the frontal Médianes Plastiques, formed by large fault-related folds and imbricates, and the trailing Médianes Rigides, mainly developed as large imbricates (Lugeon & Gagnebin 1941; Mosar 1991; Mosar et al. 1996; Plancherel 1979). The age of the sediments forming the Préalpes Médianes ranges from Triassic to Eocene. Sedimentary rocks are mainly dolomites, limestones and shales. The main décollement surface over which the Préalpes Médianes have been thrusted and folded is located in the Triassic evaporites (Baud 1972). The geodynamic evolution of the Préalpes Médianes nappe is associated with the geo-history of the Briançonnais microcontinent (Mosar et al.

1996; Stampfli 1992). The Préalpes Médianes developed in a rim basin setting along the northern margin of the Alpine Tethys (Mosar et al. 1996; Stampfli 1992). The main rifting phase corresponds to the opening of the Alpine Tethys during Liassic times. From sedimentological studies of that period (Borel 1997) a simple picture arises, showing similar facies over large areas. Following the Upper Triassic Dolomies Blondes which were uniformly deposited, the subsequent Liassic paleogeography was mostly controlled by three paleofaults induced by the rifting of the Alpine Tethys. The maximum extension of the Préalpes Médianes depositional realm was reached at the end of this main rifting event, and our reconstructions are based on the basin paleogeography at this time (Fig. 1 and 2).

A detailed discussion of the regional geology and tectonics is beyond the scope of this paper and the reader is refered to Badoux & Mercanton (1962), Baud & Septfontaine (1980), Borel (1997), Mosar (1997), Mosar et al. (1996), Septfontaine (1995) and references therein.

2) New constraints from surface geology and subsurface structure

In order to unravel the subsurface geology of the E-NE Chablais Préalpes Médianes and understand the high structural relief in this area, we combined information from:

- new basin analysis and sedimentology
- new Liassic paleogeography and palinspastic reconstruction
- structural geology of folds and thrusts as deduced from surface data
- new information on the present-day depth to the basal detachment of the Préalpes Médianes.

2.1) Palinspastic reconstruction:

Based on extensive fieldwork, informal Liassic formations were defined using sedimentological criteria (Borel 1997). Good control on depositional environments was established by the study of microfacies. The general picture, from external to internal regions (present-day NW to SE) at Domerian time, is a central crinoids grassland bounded by two slightly deeper zones caracteristed by the deposition of spongolites. Notably no slumps or turbidites are recorded within the Liassic formations. Few crinoidal resediments in the spongolites, with local extension only, are known, suggesting very low slope angles (estimated <3°). These slopes correspond to transition zones between formations. The same succession of transition zones can be recognized throughout all of the Préalpes Médianes nappe, and paleofaults are identified below these zones. No lateral (SW-NE) transitions between formations exist along strike of the 160 km long nappe. Consequently, the Liassic paleotopography was almost flat and formations thickness controlled by the passive growth of the faults (Fig. 2). Given the regularity of the distribution of the Liassic sediments throughout the Préalpes médianes, we postulate that the Liassic palinspastic width is constant along the strike of the nappe.

Major paleofaults named Château d'Oche-Corbeyrier, Bordière and Rianda-Stockhorn and repectively and chronologically labelled 1, 2, 3, define five sectors – A to E – from West to East (Fig. 1, 2 and 3). Sector A corresponds to the external portion of the thrust belt. The frontal thrust surfaces break to the surface and portions of unknown extent have been eroded away. Therefore Bordière fault does not exactly correspond to the thrust/basin front, but rather to the present day most external outrcrop of the Préalpes médianes. For exemple, West of Locum an imbricate of sector A, «écaille A» of Badoux (1965), is overridden by the rest of the nappe adding extra length to sector A along this profile. This imbricate is eroded on the Locum-Bise section presented below. Erosion combined with intricate imbrication (see also Mosar 1994) make it therefore difficult to evaluate the exact dimensions of the external sector A.

Sector width was determined by restoring bed length. Restorations were done by measuring layer length parallel to bedding in folded/thrusted profiles (Fig. 1c). This simple procedure (restored bed length before deformation equals present-day bed length after deformation) is justified since internal deformation in the Préalpes Médianes is very small (Mosar 1989). The longest sectors are taken as reference width for a given sector and the cumulative lengths of the widest sectors yield the maximum palinspastic reference basin width. The length of missing portions in a given profile can thus be determined by substracting the observed/measured length from the ideal maximum reference length (Fig. 2 c). The largest cumulative basin width is thus about 42 km. The stratigraphic thickness of the Préalpes Médianes plastiques averages 1500 m from Liassic to Tertiary and 1000 m thick on sector B (Borel 1995).

In order to determine the width of the palinspastically different sectors we have investigated five sections in the Préalpes Médianes nappe (Fig. 1). Three sections are discussed in greater detail: The *Caux-Tour d'Aï section* (reference section, Fig. 1 and 3 c) modified from (Badoux 1965; Mettraux & Mosar 1989). This section shows the best and longest outcrop exposure of sectors A, B and C in the whole nappe, due to the incision of the Rhône Valley. The *Locum-Cornettes de Bise section* (Fig. 1 and 3 b) is modified and completed from Septfontaine (1995) and Girod (1995). This section presents a topographic high and the shortest present-day horizontal width of sector B (see Fig. 1) and a well exposed sector C. The subsurface cross-section shows a retrodeformed 2.5 km long sector B. Considering the conservation of the palinspastic length, 7.5 km are missing in sector B, compared to the reference section. The *Monts d'Hermone-Roc d'Enfer section* (Fig. 1 and 3 a) is modified from Plancherel et al. (1998). Map information and field studies allow us to constrain a restored 8.5 km long sector B. In that case only 1.5 km are missing. Two sections in the Eastern Préalpes Romandes were used for comparing sector widths.

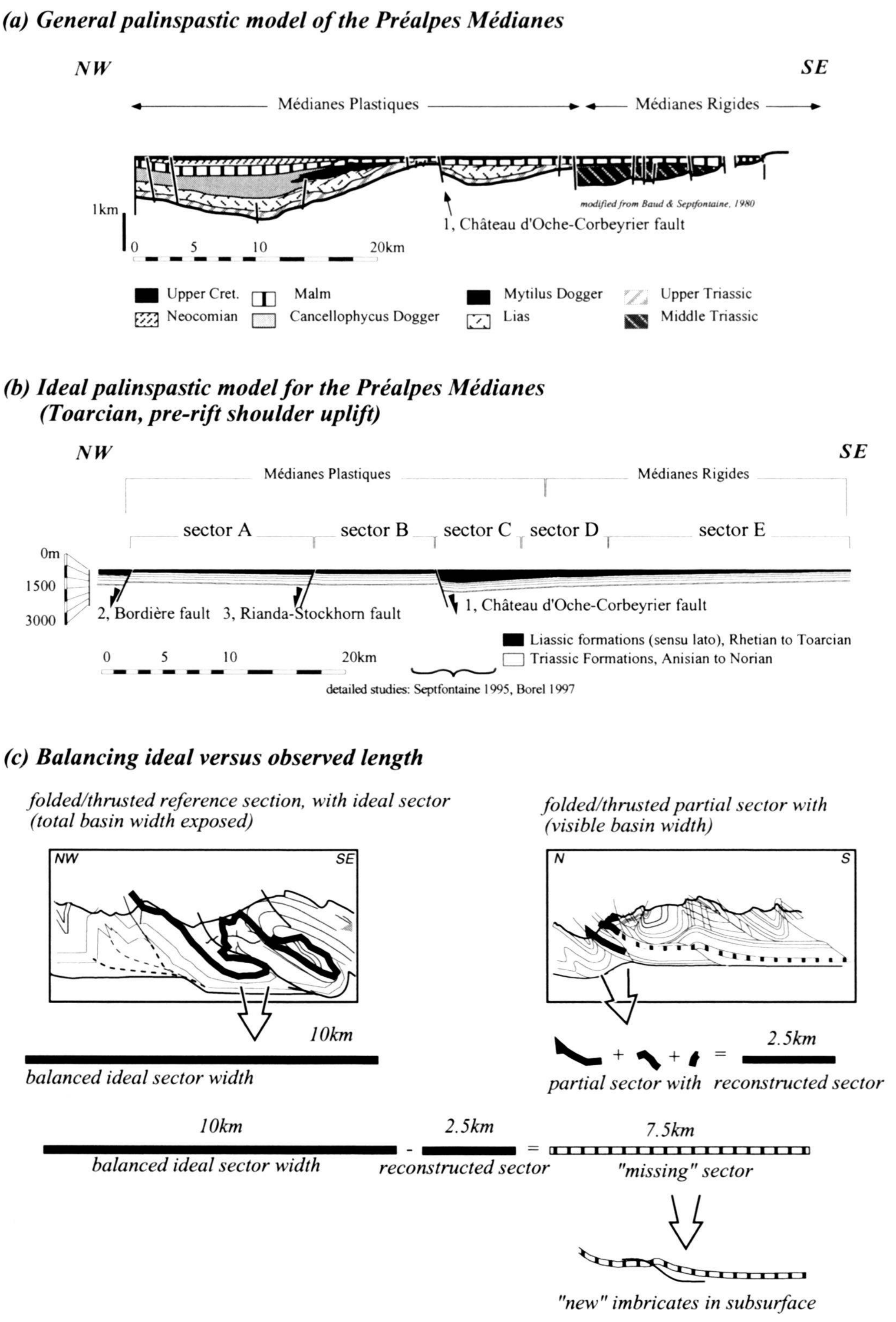


Fig. 2. Palinspastic and tectonic reconstruction models for the Préalpes Médianes. (a) general palinspastic section of the Médianes Plastiques and Rigides depositional domains; (b) Ideal palinspastic reconstruction for the Médianes Plastiques and Rigides domains at the end of the major rifting event (latest Liassic). The three major paleotectonic (synsedimentary) normal faults are shown; (c) Conceptual model for balancing and reconstructing the "unknown" subsurface structure based on information from paleogeography and surface geology by adding known lenghts and comparing them with the ideal length.

2.2) *Tectonic structure:*

The structural geology of the Préalpes in general (Mosar 1997; Mosar et al. 1996; Plancherel 1979 and references therein) and of the Chablais Préalpes Médianes (Badoux & Mercanton 1962) in particular has been discussed extensively since the advent of thrust tectonics (Masson 1976). In order to construct balanced cross sections that are tectonically viable, information about fold and thrust geometry is necessary. New detailed subsurface profiles in the Cornettes de Bise area have been discussed by Septfontaine (1995) and Girod (1995). A new section based on the new geological map in the Chablais Préalpes (Plancherel et al. 1998) and detailed maps (Rappaz et al. 1996) have also been included in our discussion.

The structural style in the Préalpes Médianes is dominated by large scale folds developed in association with thrust-faults and tectonic imbricates of variable importance. All faults and thrusts are rooted in the main décollement surface. The whole of the Préalpes Médianes (Plastiques and Rigides) are detached above this basal décollement in the Triassic evaporites (Baud 1972). The present-day depth to this basal décollement and its topography is a key element for reconstructing balanced/viable sections of the Préalpes Médianes.

From recent studies this basal detachment is known to be located near sealevel, and to exhibit a rather flat geometry in the eastern part of the Préalpes romandes near Thun (Erard 1999; Pfiffner et al. 1997a; Vollmayr 1992). This corroborates results from Mosar (Mosar 1991) based on a balanced cross section.

Interpretation of seismic data from the Lake Geneva – Rhône valley area of the Préalpes also suggest a rather shallow (sea level) present-day basal décollement surface in the frontal sector of the Préalpes (Sommaruga 1999; Steck et al. 1997).

Unpublished data from seismic studies in the Cornettes de Bise in the Swiss Chablais (survey PSBR 8801–8805, recorded 1983 Prakla-Seismos, operator BEB Erdgas & Erdöl) and borehole data (from the E end of Lake Geneva – BEB Erdgas & Erdöl) indicate the same depth to the main detachment (seismic lines and borehole data are deposited at the Musée géologique de Lausanne). This depth of the basal décollement is in agreement with reconstructions in the Préalpes Romandes North of the Rhône river valley (Mosar 1994, 1997).

In the Swiss Chablais, the top of the Triassic sequence (~ 100 m thick) outcrops at an altitude of 1800m in the anticline N of the Cornettes de Bise (Fig. 3 b), while beneath the Mont Gardy and the Col de Verne the same Triassic is probably at an average altitude of 1000 m. This rather high elevation of the basis of the Préalpine series causes the high structural relief in this area. Thus there is a difference in altitude of some 1000 meters to be "filled" with Préalpine rocks, unknown from surface geology in the area (below C Fig. 3 b).

The transition from the Préalpes Médianes Plastiques to the trailing Préalpes Médianes Rigides is in most places obscured by the overlying Nappe Supérieure. It is further complicated by out-of-sequence thrusts cutting through the whole nappe pile (Mosar et al. 1996) as well as the underlying Ultrahelvetics (Jeanbourquin et al. 1992). Similar out-of-sequence thrusts are also cutting through the Préalpes Médianes Plastiques (N of Tours d'Aï – Fig. 3 c; Rianda-Stockhorn fault and N of Mt. Lenla – Fig. 3 b; and possibly at Rocher de la Motte, Château d'Oche-Corbeyrier fault, Roc de la Savine and Roc de l'Enfer – Fig. 3 a). These faults have been linked to the development of imbricates in the authochtonous basement (Mosar 1999). The basal detachment must therefore be affected by these thrusts and show important changes in its topography. Though this can be very important such as under the Sarine valley East of Montreux where the basal décollement varies by as much as 1km (Mosar 1997), the variations in topography in the section from the eastern Chablais are less important (Fig. 3). Integrating the new sections into a larger framework of the frontal geometry of the Alps is beyond the scope of this paper.

3) A new structural solution for the N Chablais Préalpes

Combining the data from different disciplines we can propose a new solution for the deep structure of the Chablais Préalpes Médianes, which is most spectacular beneath the Cornettes de Bises – Gramont area of the N Chablais.

Locum-Cornettes de Bise section (Fig. 3 b): Our model proceeds by filling the subsurface volume of rocks between the base of the surface of sector C and the basal detachment. At least three partly hidden imbricates (B1, B2, B3) with a total length of 7.5 km are required to explain the subsurface structure in a viable way. This allows us to solve the following features: the unusually high altitude of the Cornettes de Bise massif, the steep to overturned orientation of the axial surface of the Mont Gardy syncline and its reverse fault (resulting from imbrication) shown here for the first time. Our model implies an intranappe thrust of the sector C on top of sector B over a distance of more than 7 km. The development of the duplex structure involves the reactivation of the Château d'Oche-Corbeyrier paleofault. To the west the duplex structure is bounded by the sinistral Bonnevaux strike-slip fault. To the east the whole nappe pile is separated from the Préalpes Médianes Romandes by a major intranappe strike slip fault parallel to the Rhône river (Mosar & Borel 1992).

A similar solution with duplexes at depth has been proposed, based solely on structural constraints, in the Médianes Rigides domain in the easternmost Préalpes Romandes along a SSE-NNW profile from Twierihorn-Hohmad (Mosar 1991). The 8 km of missing section of sector C form the eastward extension of sectors known further westward, and therefore are expected to be found S of the Simme valley, beneath the present-day position of the Médianes Rigides.

Monts d'Hermone-Roc d'Enfer section (Fig. 3 a): NW of Terramont towards Mont Forchat and the nappe front, stratigraphic logs (Borel 1997; Peterhans 1926) show a westward

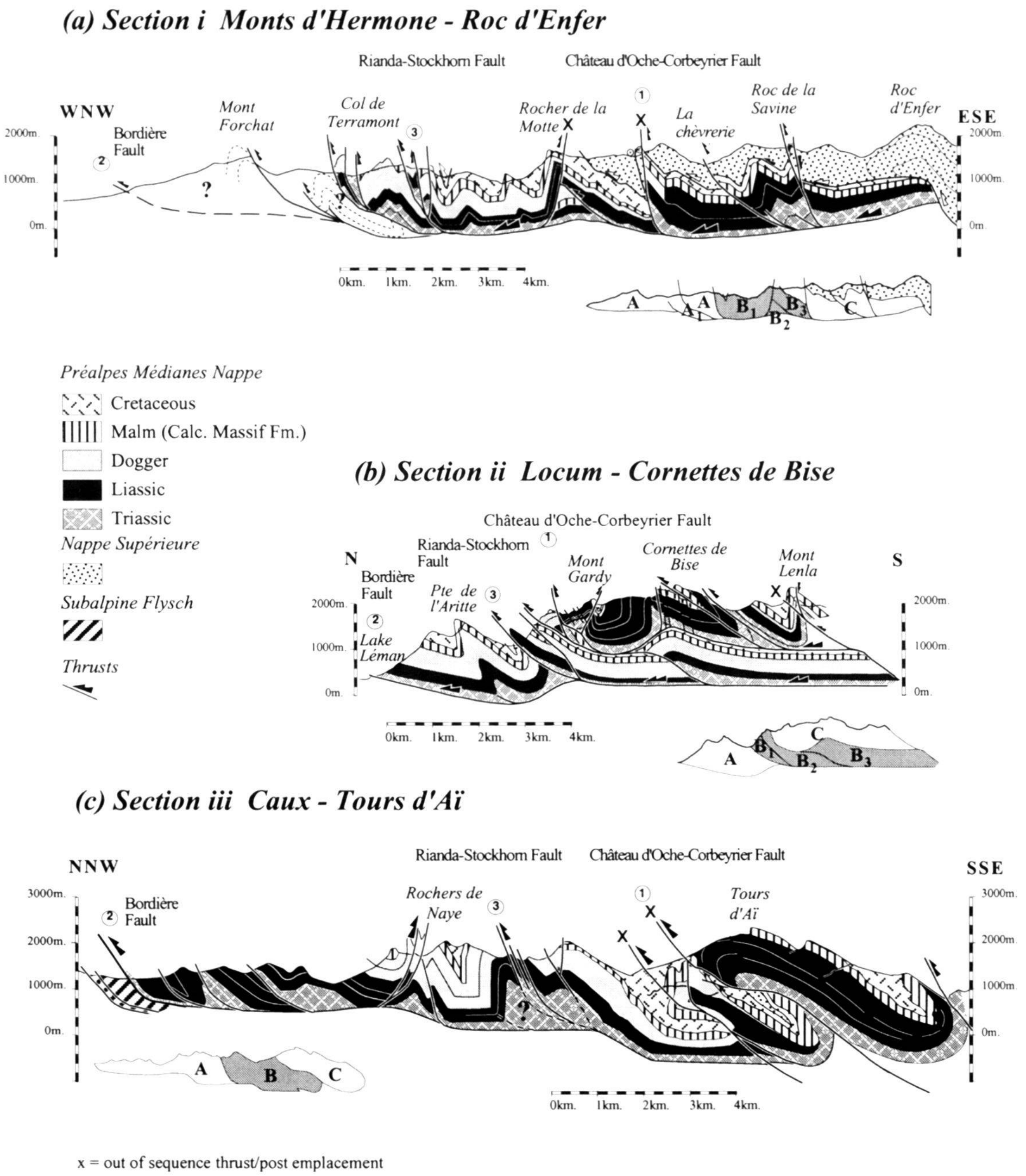


Fig. 3. Cross sections through the Préalpes Médianes Plastiques. (a) Section i: SW Chablais Préalpes. (b) Section ii: area of highest structural relief in E Chablais Préalpes. (c) Section iii: major reference section along the Rhône river valley in the Préalpes Romandes; New proposed structure at depth (imbricates B1, B2 and B3). Location of sections see Figure 1.

thinning of the pre-Pliensbachian formations. A similar evolution is recorded along the reference section Caux-Tour d'Aï. No detailed geological and structural maps exist to date for that region where vegetation is dense and outcrops are sparse. Due to the lack of data we cannot propose a viable subsurface structure model for this area of sector A. However, the size of sector A, in a first approximation, is equivalent to the sector A of the reference section. The available information does not contradict the constant basin length hypothesis.

The sector B constructed on surface geology is 8.5km long. To obtain the reference palinspastic width, 1.5km need to be added to the sector B. The Rocher de la Motte anticline with its reverse fault is the most likely location to add that missing length of beds. Adding a new, 1.5 km long imbricate (B2) in this triangular shaped position will result in a flattening of the basal detachment at depth, underneath the Rocher de la Motte. Triangular zones of this kind typically develop in foreland fold-and-thrust belts in areas where forward and backward thrustings interfer. Similar geometries have been described in the Jura mountains (Sommaruga 1999). Sector C is not well exposed along this profile and its total width remains difficult to evaluate. We cannot exclude that a trailing portion of this imbricate may have been cut off by the overriding Breccia nappe.

4) Conclusions

In our interpretation of the structure of the Préalpes Médianes nappe we draw on independent data from different fields of geology to reconstruct imbricates at depth.

From information on the palinspastic width and thickness of sedimentary realms we propose ideal maximum basin widths for the latest Liassic. Several different sectors are delimited mainly by large syn-sedimentary normal faults. We use the information on a maximum basin width to compare with observed restored lengths along different cross sections, and determine the completeness of the sectors (what bed-length is missing?).

The present-day tectonic surface structure and information from the depth to the basal detachment, as well as the average sediment thickness, determine the total volume (surface on a cross section) of rock above the main décollement. Qualitatively balancing the section (in order not to leave void space) thus requires introducing new imbricates at depth. Their position is also deduced from the palinspastic reconstructions and missing "basin portions".

We combine these two types of information to infer the position and length of hitherto unknown imbricates at depth. Our new interpretation of the geological structure at depth in the W Chablais Préalpes, shows the existence of one or two important tectonic imbricates in the Médianes Plastiques domain. The new solution satisfies criteria from sedimentology and paleogeography, as well as structural geology, and by proposing a doubling of the sedimentary series by imbrication, provides an explanation for the high structural relief observed in the Chablais, especially in the Cornettes de Bise – Gramont area.

Acknowledgements

We would also like to thank A.O. Pfiffner and S. Schmid for reviewing this paper. This research was partially funded by the FNRS (projects 20-33450.92, 2-40352.94).

REFERENCES

BADOUX, H. 1965: Montreux, Feuille n° 47, notice, Atlas Géologique de la Suisse 1:25'000. Comm. géol. Suisse, Basel.

BADOUX, H. & MERCANTON, C.H. 1962: Essai sur l'évolution tectonique des Préalpes médianes du Chablais. Eclogae geol. Helv. 55/1, 135–188.

BAUD, A. 1972: Observations et hypothèses sur la géologie de la partie radicale des Préalpes médianes. Eclogae geol. Helv. 65/1, 43–55.

BAUD, A. & SEPTFONTAINE, M. 1980: Présentation d'un profil palinspastique de la nappe des Préalpes médianes en Suisse occidentale. Eclogae geol. Helv. 73/2, 651–660.

BOREL, G.D. 1995: Préalpes médianes: courbes de subsidence et implications géodynamiques. Bull. Soc. vaud. Sci. nat. 83/4, 293–315.

– 1997: Evolution dynamique du domaine briançonnais: les Préalpes médianes au Lias. Thèse de doctorat, Lausanne, Lausanne, 178 pp.

BURKHARD, M. & SOMMARUGA, A. 1998: Evolution of the Swiss Molasse basin: structural relations with the Alps and the Jura belt. Geol. Soc. London, Spec. Publ. 134, 279–298.

ERARD, P.-F. 1999: Traitement et interprétation de cinq lignes sismique réflexion à travers la Plateau molassique et les Préalpes suisses, de Bienne à Lenk. Thèse de doctorat Thesis, Université de Lausanne, Inst. de Géophysique, 107 pp.

GIROD, F. 1995: Géologie de la région des Cornettes de Bise (Préalpes du Chablais franco-suisse). Bull. Soc. vaud. Sci. nat. 83/4, 317–334.

JABOYEDOFF, M. & COSCA, M.A. 1999: Dating incipient metamorphism using 40Ar/39Ar geochronology and XRD modeling: a case study from the Swiss Alps. Contrib. Mineral. Petrol. 135/2, 93–113.

JEANBOURQUIN, P., KINDLER, P. & DALL'AGNOLO, S. 1992: Les mélanges des Préalpes internes entre Arve et Rhône (Alpes occidentales francosuisses). Eclogae geol. Helv. 85/1, 59–83.

LUGEON, M. & GAGNEBIN, E. 1941: Observations et vues nouvelles sur la géologie des Préalpes romandes. Bull. Lab.Géol.Univ. Lausanne 72, 1–90.

MASSON, H. 1976: Un siècle de géologie dans des Préalpes: de la découverte des nappes à la recherche de leur dynamique. Eclogae geol. Helv. 69/2, 527–575.

METTRAUX, M. & MOSAR, J. 1989: Tectonique alpine et paléotectonique liasique dans les Préalpes Médianes en rive gauche du Rhône. Eclogae geol. Helv. 82/2, 517–540.

MOSAR, J. 1988: Métamorphisme transporté dans les Préalpes. Schweiz. mineral. petrogr. Mitt. 68/1, 77–94.

– 1989: Déformation interne dans les Préalpes Médianes (Suisse). Eclogae geol. Helv. 82/3, 765–793.

– 1991: Géologie structurale dans les Préalpes médianes (Suisse). Eclogae geol. Helv. 84/3, 689–725.

– 1994: Géologie structurale à l'est de Montreux (Préalpes médianes plastiques, Suisse). Eclogae geol. Helv. 87/1, 11–32.

– 1997: Folds and thrust in the Préalpes Médianes plastiques romandes. Bull. Soc. vaud. Sci. nat. 84/4, 347–384.

– 1999: Present-day and future tectonic underplating in the Western SwissAlps: reconciliation of basement/wrench-faulting and décollement folding of the Jura and Molasse Basin in the Alpine foreland. Earth planet. Sci. Lett. 173/3, 143–145.

MOSAR, J. & BOREL, G.D. 1992: Paleostress from the Préalpes médianes (Switzerland). Ann. Tect. 6/2, 115–133.

MOSAR, J., STAMPFLI, G.M. & GIROD, F. 1996: Western Préalpes Médianes Romandes: timing and structure. A Review. Eclogae geol. Helv. 89/1, 389–425.

PETERHANS, E. 1926: Etude du Lias et des géanticlinaux des Préalpes médianes entre la vallée du Rhône et le lac d'Annecy. Mém. Soc. Helv. Sci. Nat. 69/2, 191–344.

PFIFFNER, O.A., ERARD, P.-F. & STÄUBLE, M. 1997a: Two cross sections through the Swiss Molasse basin (lines E4-E6, W1, W7-W10). In: Deep structure of the Swiss Alps – Results from NRP 20 (Ed. by O.A. PFIFFNER, P. LEHNER, P.Z. HEITZMAN, S. MUELLER & A. STECK). Birkhäuser AG., Basel, pp. 64–72.

PFIFFNER, O.A., LEHNER, P., HEITZMAN, P.Z., MUELLER, S. & STECK, A. (Editors) 1997b: Deep structure of the Swiss Alps – Results from NRP 20. Birkhäuser AG, Basel, 380 pp.

Plancherel, R. 1979: Aspects de la déformation en grand dans les Préalpes médianes plastiques entre Rhône et Aar. Eclogae geol. Helv. 72/1, 145–214.

Plancherel, R., Broquet, P., Caron, C. et al. 1998: Samoëns, Pas-de-Morgins (655), Carte géologique détaillée de la France,1:50'000. BRGM, Orléans.

Rappaz, F., Hager, M. & Pahud, P.-F. 1996: Thollon – Dent d'Oche. mémoire de licence, Lausanne, Lausanne, 40 pp.

Septfontaine, M. 1995: Large scale progressive unconformities in Jurassic strata of the Préalpes S of lake Geneva: interpretation as synsedimentary inversion structures, Paleotectonic implications. Eclogae geol. Helv. 88/3, 553–576.

Sommaruga, A. 1997: Geology of the Central Jura and the Molasse Basin: new insight into an evaporite-based foreland fold and thrust belt. Mém. Soc. neuchât. Sci. nat. 12, 176.

– 1999: Décollement tectonics in the Jura foreland fold-and-thrust belt. Marine Petrol. Geol. 16, 111–134.

Stampfli, G.M. 1992: Exotic terrane in the Alps, the Briançonnais domain as an example, 29th Int. Geol. Cong. Abstr. vol., Kyoto, pp. 123.

Stampfli, G.M., Mosar, J., Marquer, D., Marchant, R., Baudin, T. & Borel, G.D. 1998: Subduction and obduction processes in the Swiss Alps. Tectonophysics 296, 159–204.

Steck, A., Epard, J.L., Escher, A., Lehner, P., Marchant, R.H. & Masson, H. 1997: Geological interpretation of the seismic profiles through Western Switzerland: Rawil (W1), Val d'Anniviers (W2), Mattertal (W3), Zmutt-Zermatt-Findelen (W4) and Val de Bagnes (W5). In: O.A. Pfiffner, P. Lehner, P.Z. Heitzman, S. Mueller & A. Steck (Editors), Deep structure of the Swiss Alps – Results from NRP 20. Birkhäuser AG., Basel, pp. 123–138.

Vollmayr, T. 1992: Strukturelle Ergebnisse der Kohlenwasserstoff-exploration im Gebiet von Thun, Schweiz. Eclogae geol. Helv. 85/3, 531–539.

Manuscript received February 4, 2000
Revision accepted May 24, 2000