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The peri-Alpine Paleogene Red Molasse of southeastern France - II. Faucon-du-Caire/Turriers area (Alpes-de-Haute-Provence)

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Abstract: The SW-NE-trending Faucon-du-Caire/Turriers tectonic corridor hosts a thick Paleogene Molasse Rouge *s.l.* succession that shows similarities to the same interval found in the nearby Esparron syncline. In each setting, the succession is composed of three superposed sequences designated S1, S2 and S3 from bottom to top respectively (Ferry *et al.*, 2025). Although similar in internal character, they vary in thickness between the two localities with respect to both complete sequences and subunits. Sequence S1 represents the western shore of a continental basin oriented to the Alpine Mountain Belt. Deposits of sequence S2 (Molasse Rouge 1, or MR1) are confined to a valley that forms a westward continuation of the Esparron syncline, terminating against the Grand Vallon fault, which caused a shift of the river to the southwest where its exits the Digne transported basin. Downstream, its course likely followed the front of the Ventoux-Lure thrust. Deposits of sequence S3 (Molasse Rouge 2, or MR2) are up to 500 m thick in the Faucon-du-Caire/Turriers area, comprising a lower pebbly facies, around 200 m thick, that was formed by a braided fluvial system. This is overlain by reddish sandstone-dominated alluvial fan deposits approximately 300 m thick. Sequence S3 appears to be mostly constrained to the Faucon-Turriers corridor. Its materials were transported to the SW, exiting the Digne nappe along the front of the Ventoux-Lure thrust. This path is better documented than that of MR1. A first major point is confirmation that a major change in paleocurrent orientation occurred around the Rupelian-Chattian transition, with the deposits of upper Rupelian sequence S1 being oriented to the Alps, and those of the Chattian sequences S2 and S3 oriented the opposite direction to the west. A second point is that strong tectonic deformation occurred between the deposition of MR1 and MR2.

Keywords:

- molasse;
- Rupelian;
- Chattian;
- Alps;
- France

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Résumé : *Les molasses rouges paleogènes péri-alpines du Sud-Est de la France - II. Secteur de Faucon-du-Caire/Turriers (Alpes-de-Haute-Provence).-* Le couloir tectonique de Faucon-du-Caire/Turriers comporte une épaisse succession Paleogène de Molasse Rouge qui présente des similitudes avec celle réanalysée dans le secteur plus méridional d'Esparron-Esclangon (Ferry *et al.*, 2025). La série est composée des mêmes trois séquences superposées, nommées S1, S2 et S3, de la base au sommet. Elles varient cependant en épaisseurs et faciès de dépôt pour chacune des unités qui les composent. Les dépôts de la séquence S1, d'âge probablement rupélien supérieur, représentent la bande de faciès torrentiel bordant un bassin à polarité orientée vers les Alpes, au contraire de ceux des deux suivantes, d'âge chattien, qui ont l'orientation inverse, vers l'extérieur de la chaine. Les dépôts de la séquence S2 (ou Molasse Rouge 1, MR1) remplissent une paléovallée qui est la continuation vers l'ouest de la paléovallée synclinale d'Esparron. Mais le trajet est dévié contre la faille du Grand Vallon pour sortir du bassin transporté de Digne vers le SW, et suivre vraisemblablement le front du chevauchement Ventoux-Lure. Les dépôts de la séquence 3 (ou Molasse Rouge2, MR2) ont une épaisseur totale d'environ 500 m dans le couloir de Faucon-Turriers. Ils comportent un faciès fluviatile conglomératique en tresses à la base (épaisseur 200 m) surmonté par les dépôts rouges d'un cône alluvial sablo-

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argileux (environ 300 m). Le sens d'écoulement de ces deux unités est vers le SW, suivant exactement l'orientation du couloir tectonique. Il existe pour cette séquence S3 des données sédimentaires robustes supportant l'idée d'un exutoire longeant le front Ventoux-Lure. Les données acquises confirment donc un changement de polarité sédimentaire au passage Rupélien-Chattien, ainsi que des déformations tectoniques intra-chattiennes qui modifient fortement les reliefs et donc les dépôts-centres de la séquence S2 à la séquence S3.

Motsclefs :

- molasse ;
- Rupélien ;
- Chattien ;
- Alpes ;
- France

1. Introduction

This study is the continuation of the revision of Oligocene deposits in front of the southern French Alps, which were grouped for a long time under the catch-all term of "Molasses Rouges" in the French literature. In a previous paper (Ferry *et al.*, 2025), we revised these units in the central external part of the Digne nappe (Fig. 1.A), especially the Esparron and Esclangon synclines (resp. ESP and ESC, Fig. 1.A) due to their spectacular and laterally continuous outcrops. The Molasse Rouge successions (Fig. 2) were subdivided there into three unconformity-bounded continental sedimentary successions, named sequences S1, S2 and S3. Sequence S1 is mostly represented by torrential breccia fans (basal unit BU) whose deposits were often considered as a mere basal facies of the MR. Our revision suggested, instead, that they could represent a fully independent foreland sequence, but, which needed a broader regional survey to be fully recognized as such. Sequences S2 and S3 cover the most part of MR deposits. Our work showed that the depot-centres of sequences S2 and S3 shifted over time, due to intervening tectonic deformation. Also, fluvial depositional facies are different, supporting the need to split the thick MR deposits above the basal breccia (S1) into MR1 (S2) and MR2 (S3). Current direction in S1 deposits are to the east, those of MR1 and MR2 are to the west and contain inner Alpine material, contrarily to those of S1. The discussed age of the three sequences is likely latest Rupelian for S1 (to be confirmed after a broader regional study), and Chattian for S2 (MR1) and S3 (MR2). Both the MR1 and the MR2 bear low-sloped fluvial deposits at base (meandering for MR1 and braided pebbly for MR2). These basal deposits are overlain by large alluvial fan deposits in both sequences, which are, therefore, judged to record relief changes during their deposition.

The present study focusses on an elongated area (FT, Fig. 1.A) that is particularly tectonically complex on the frontal part of the Digne thrust (Arnaud *et al.*, 1977; Gidon, 1997). According to Gidon (1997), what we call here the Faucon-Turriers (FT) corridor based on sedimentologic data discussed further is not included in the Digne Nappe (Fig. 1.B). Its sole is uplifted by the Grand Vallon (or Faucon) fault (Fig. 1.B), therefore, revealing a half window corresponding to the corridor. A succession of thrusts to the SW occur within this half window, from the Faucon tectonic scales (units not represented on Fig. 1.B for clarity) to the units south of the W-E inverse fault of the Bouchouse ravine (Fig. 1.B). These units were formerly included in the Valavoire thrust (Gidon & Pairis, 1992), but considered later (Gidon, 1997) as autochtonous.

As in the Esparron-Esclangon area to the south (Fig. 1.A), three continental depositional sequences are recognized and mapped in orange, pink and violet colours, in stratigraphic order (Fig. 1.B). Unlike in the Esparron-Esclangon area, the Molasse deposits rest to the NE on marine "Nummulitic" successions (Calcaire Nummulitique and Marnes Bleues) (Fig. 1.B). The upper, sandstone-dominated part, of the marine succession, or Grès d'Annot, is lacking here, either being non-deposited or eroded before the deposition of the Molasse sequences.

2. Field data

Due to difficult accessible steep slopes and a more or less dense vegetation cover, most sections were estimated from picture panoramas, and the geometry of deposits imaged through a drone survey.

2.1. Basal breccia unit (BU) of sequence S1

A thick breccia system resting on Upper Jurassic limestone and marlstone (Terres Noires Fm.) crops out along the Defens crest, just NE of Le Caire village, and south of the Valentin thrust fault (Fig. 1.B). The breccia beds are clast-supported, ungraded, angular limestone clasts of local origin, sourced in Mesozoic deposits of the subalpine basin. At the base of the sequence, breccia beds are channelled (Fig. 3.A). Higher up, they are more laterally-continuous and were, therefore, deposited as debris flow lobes. Huge debris flow beds carrying megablocks of Tithonian limestone occur at base (Figs. 3.C, 4). As a whole, the slope of the Defens hill exposes a natural section through a Paleogene torrential fan, oriented roughly perpendicular to the direction of the hill crest (Fig. 3.A-B). The succession is overall fining-up (Figs. 3.D, 4).

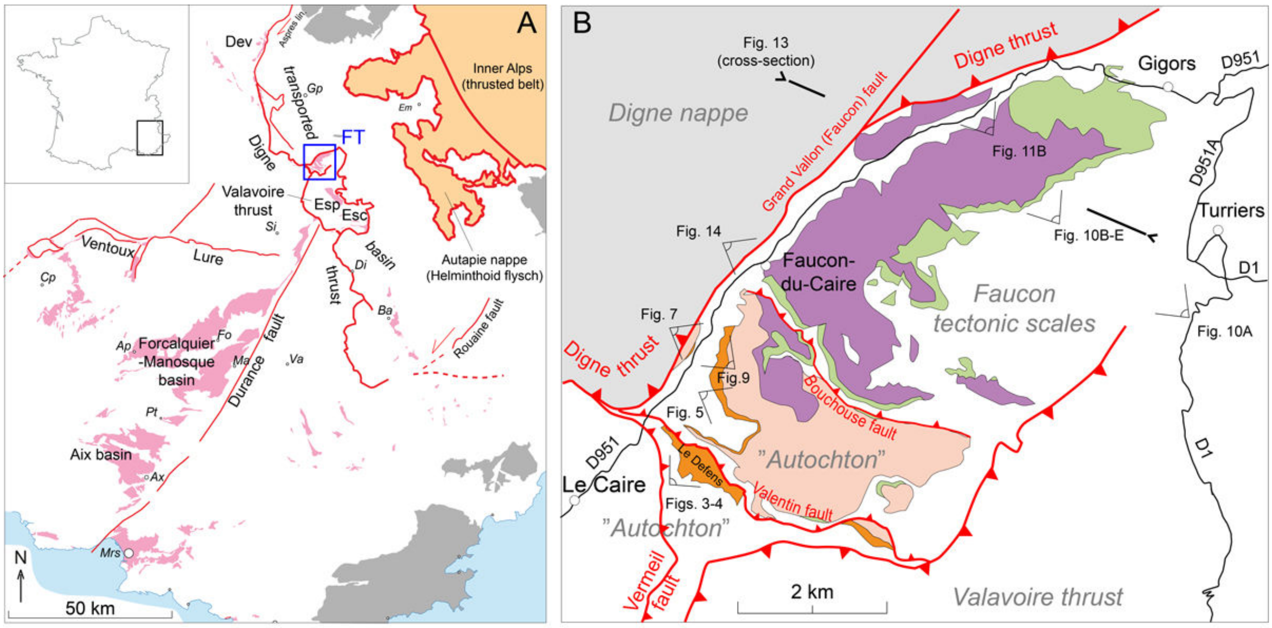

Figure 1: Location maps. A, outcrops of Oligocene peri-Alpine continental deposits in SE France (in pink), dark-grey: Paleozoic basement including Permian sedimentary rocks and volcanics. B, map of the three continental sequences in the Faucon-Turriers corridor bounded by the Grand Vallon fault (orange, sequence 1; pink, sequence 2 or Molasse Rouge 1 [MR1]; violine, sequence 3 or Molasse Rouge 2 [MR2]), green, Calcaire Nummulitique and Marnes Bleues; white, undifferentiated Mesozoic deposits). Tectonic units named in grey italics after GIDON (1997), as well as fault names. Abbreviations: Ap, Apt; Ax, Aix; Ba, Barrême, Cp, Carpentras; Dev, Dévoluy; Di, Digne; ESC, Esclangon; ESP, Esparron; Fo, Forcalquier; FT, Faucon-Turriers; Ga, Gap; Ma, Manosque; Mrs, Marseille; Si, Sisteron; Va, Valensole.

The basal breccia also occur in the next tectonic unit NE of the Valentin thrust fault (Fig. 5.A, location on Fig. 1.B). The outcrop being perpendicular to the previous one, the onlap of sequence 1 deposits is visible on its basal boundary, which truncates the Jurassic Terres Noires Formation. The facies appears overall more distal, as claystone interbeds develop, and average grain-size decreases (Fig. 5.B). The unsorted breccia material (Fig. 5.C) is channelled within overbank fine-grained deposits. The fact that the depositional facies is overall more distal vs. the one observed on the Defens crest, gives the overall orientation of the sedimentary system to the NE. The top of the sequence shows light-grey lacustrine limestone (Figs. 5.A, 7.C). The Valentin thrust fault (Fig. 1.B) clearly shortened the facies transition between a proximal torrential system and a distal fan, which evolved with time to a lacustrine environment (Fig. 6).

Given the similarities with the Esparron syncline to the SE, the observations made in the Faucon-Turriers area suggest that the basal breccia unit (BU) belong to a full tectonostratigraphic flexural sequence, laterally-continuous, beginning with the deposition of a high-sloped torrential fan followed by the progressive flattening of the topography and the deposition of lacustrine limestones.

The basal breccia toplaps the basal boundary of Sequence 2 and disappear to the NE within the Grand Vallon valley (Fig. 7.A), indicating that the bounding surface of the overlying Sequence 2 (MR1) is rapidly truncational towards the inner Alps, exactly the same way it is in the Esparron syncline to the SE (FERRY *et al.*, 2025, Fig. 9).

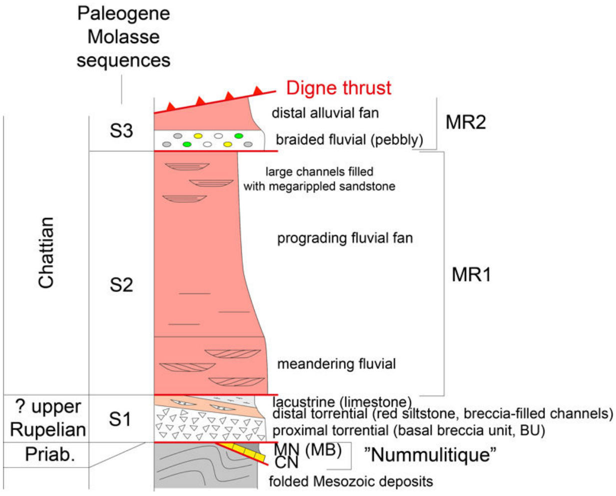

Figure 2: Paleogene depositional sequences recognized in the Esparron-Esclangon area (FERRY *et al.*, 2025). Without scale. CN, Calcaire Nummulitique; BM, Blue Marls or Marnes Nummulitiques, Priab., Priabonian.

2.2. Sequence 2 or MR1

Excellent exposures of Sequence 2 are found along the left bank of the Grand Vallon Creek, south of Faucon-du-Caire village (Fig. 7.A). The succession is comprised of three sandstone intervals separated by red, pink or violet claystone (Figs. 4.A, 5.A). The sandstone intervals consist of multistoried point-bar deposits, with well-defined internal lateral accretion (Fig. 7.B, .D), and sole casts at the base that are roughly perpendicular to the lateral accretion (Fig. 7.C). Within the clay-dominated intervals, scattered point bar deposits may be present amid overbank sandstones. The depositional environment of the MR1 is that of a meandering fluvial system, in

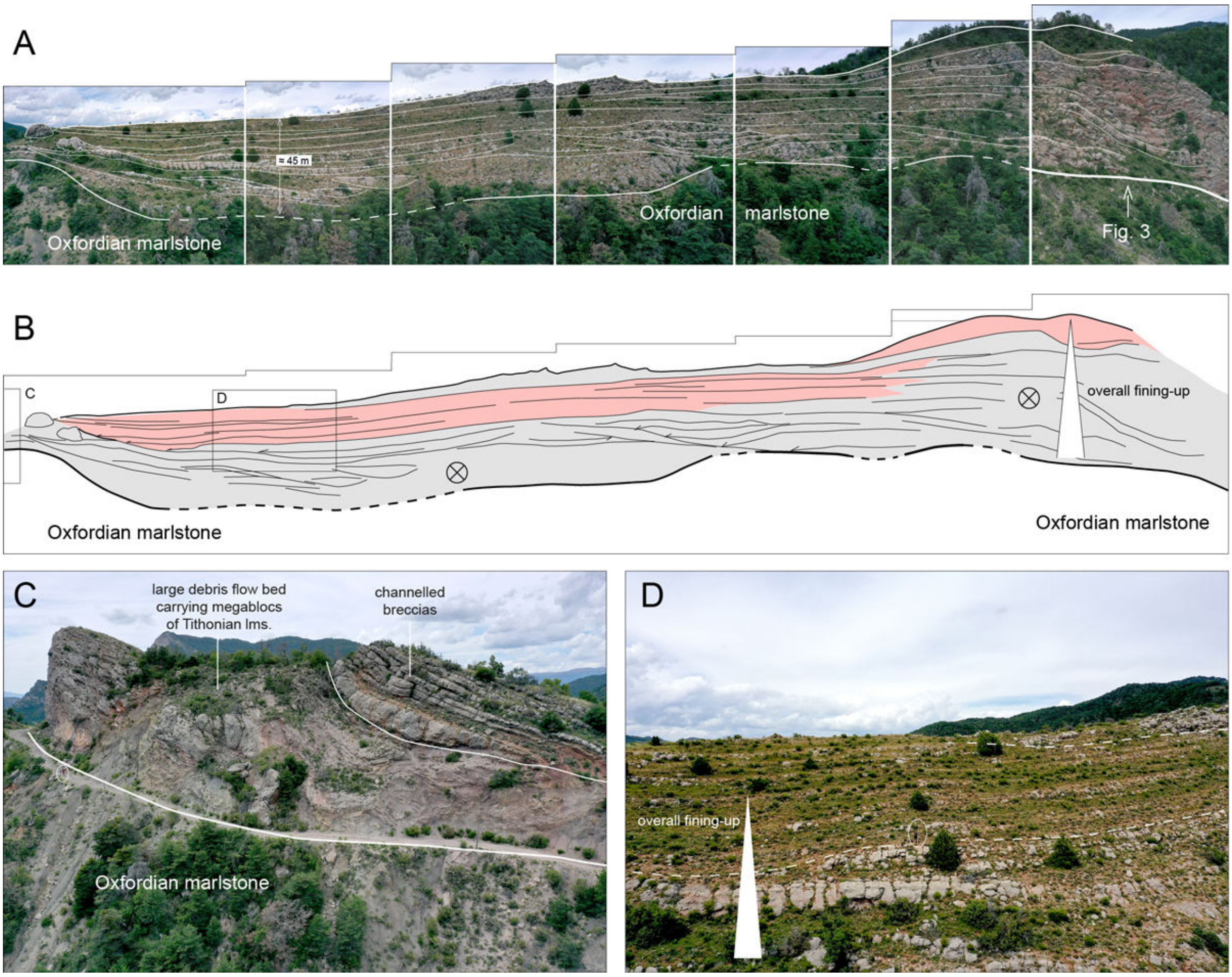

Figure 3: Sequence 1 along the Defens crest (location on Fig. 1.B). A, internal geometry of the torrential fan from a set of pictures taken by a drone. B, interpretation; grey, coarse breccia beds, channelled or not; pink, more clay-prone deposits (breccia beds passing up to reddish claystone). Direction of flow inferred from regional data. C, large debris flow carrying megablocks at base of the sequence (location on picture B). D, closer view showing the differences between facies colored in grey and pink on picture B (circled, Ph. Sorrel with a 3 m-long key staff, for scale).

Figure 4: Lateral view of the Defens torrential fan showing megablocks of Tithonian limestone at base, capped by la stack of laterally-continuous breccia lobes, and passing up to red claystone (fining-up sequence).

which the stacking of point bars were the result of the shifting of the river with time within a large valley. If they are constrained in a narrow valley, possibly they indicate that the amalgamation rate of point bars records changes in the subsidence rate, forming subsequences. Three subsequences (pbs 1 to pbs 3, Fig. 7.A) are observed.

Sequence 2 shows a similar meandering fluvial pattern as seen at the base of MR1 in the Esparron syncline (Ferry *et al.*, 2025). The main difference is that the succession in the Faucon-du-Caire area is much thicker, and was not buried by a prograding fluvial fan.

The thickness of sequence 2 is 300-350 m, up to the top of the mountain (Fig. 7.A). The stratigraphic contact of point=bar stack pbs3 with overlying Sequence 3 deposits is only visible farther up the valley, close to Faucon-du-Caire village.

A minor fault-propagation fold is found at the base of MR1 (Fig. 7.A). The fault and fold were subsequently truncated and are separated by point bar stack pbs 2 by an angular unconformity. This feature is evidence that faulting, folding and subsequent erosion occurred during the deposition of MR1 (Fig. 8).

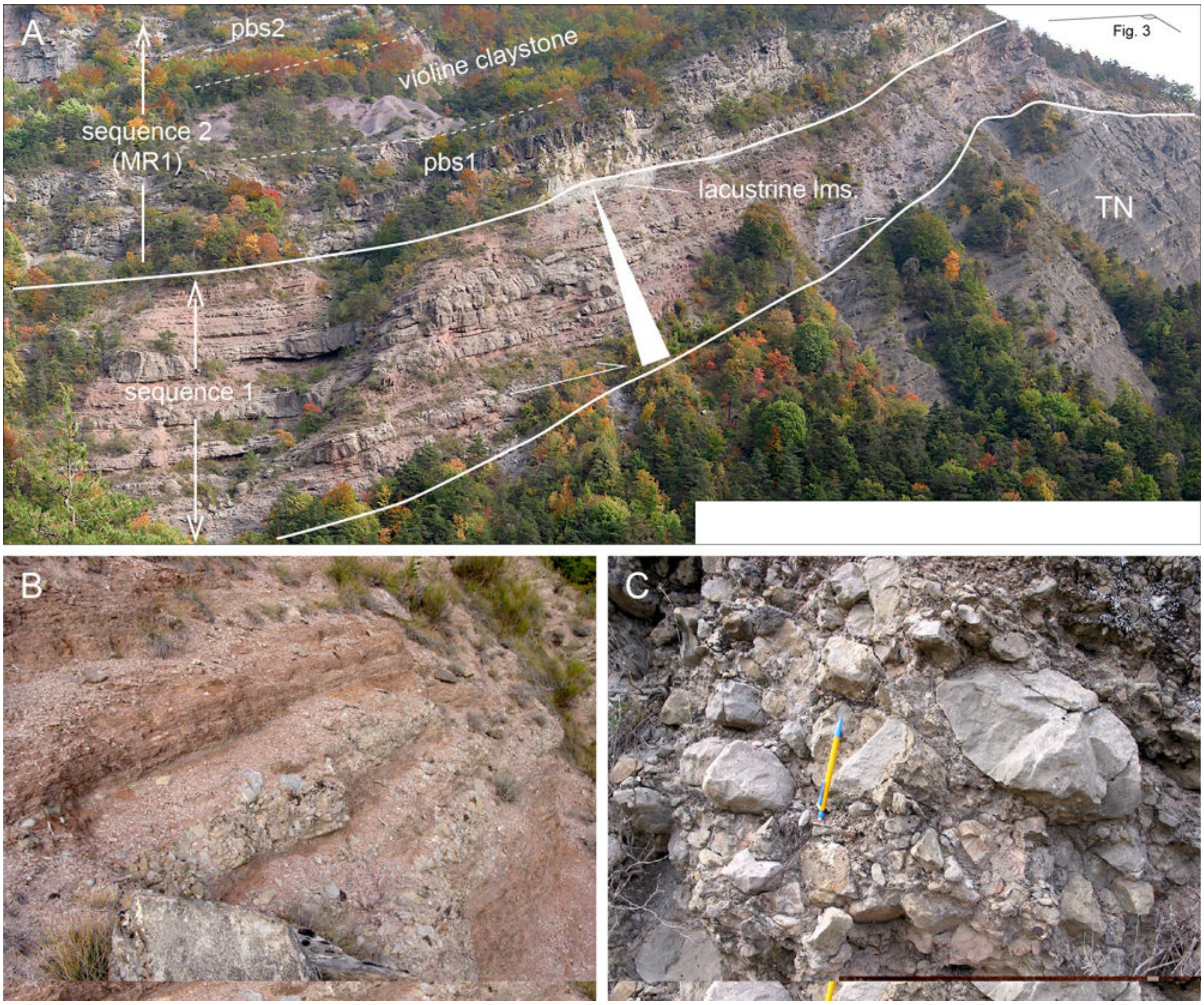

Figure 5: Downdip facies changes within sequence 1 on left bank of the Grand Vallon valley (location on Fig. 1.B). A, general view of sequence 1 resting on Upper Jurassic marlstone (Terres Noires, Tn, Formation). The sequence finishes here by light grey lacustrine limestone. Sequence 2 (or MR1) comprises stacks of sandstone-filled point bars separated by claystone intervals. B, view of the distal facies of the Defens torrential fan (Fig. 3) made of channelled coarse breccia capped by red claystone. C, close up view of the unsorted breccia filling-up the channels.

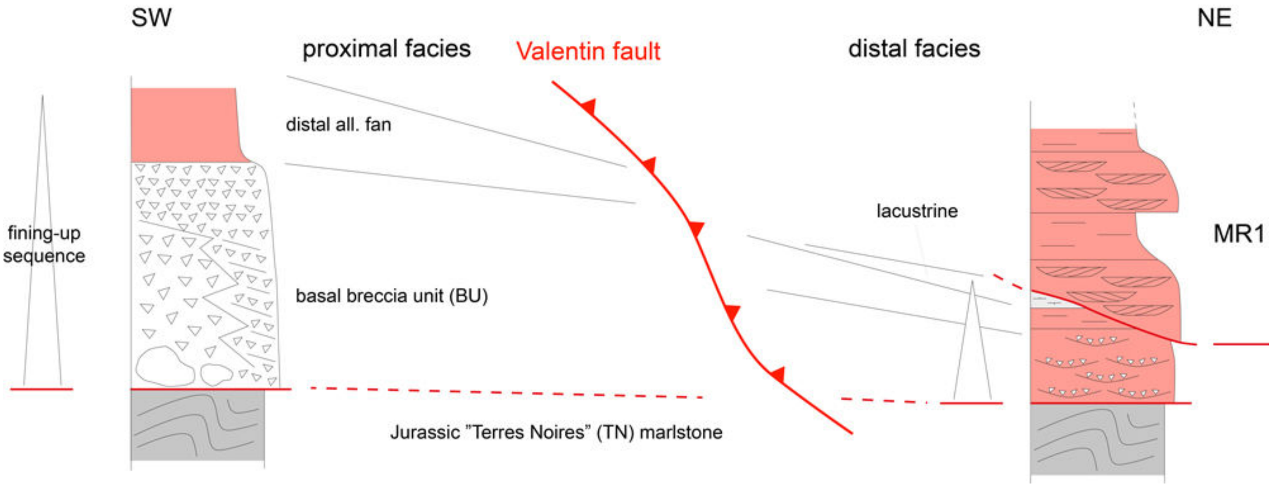

Figure 6: Facies changes of sequence 1 deposits on both sides of the Valentin fault (without scale).

The multistory point-bar deposits found on the left bank of the Grand Vallon valley are less prominent (pbs1) or lacking (pbs2) than along the right bank (Fig. 9.A-B). The upper stack pbs3 is also dominated by overbanks deposits on the right bank (Fig. 9.C) in contrast to the left bank where thick sandstone-filled channels are observed. This abrupt change in the succession over a short distance suggests that the course of the meandering river was likely controlled by the Grand Vallon fault, as deposits pinched against it, likely indicating a change in the river course.

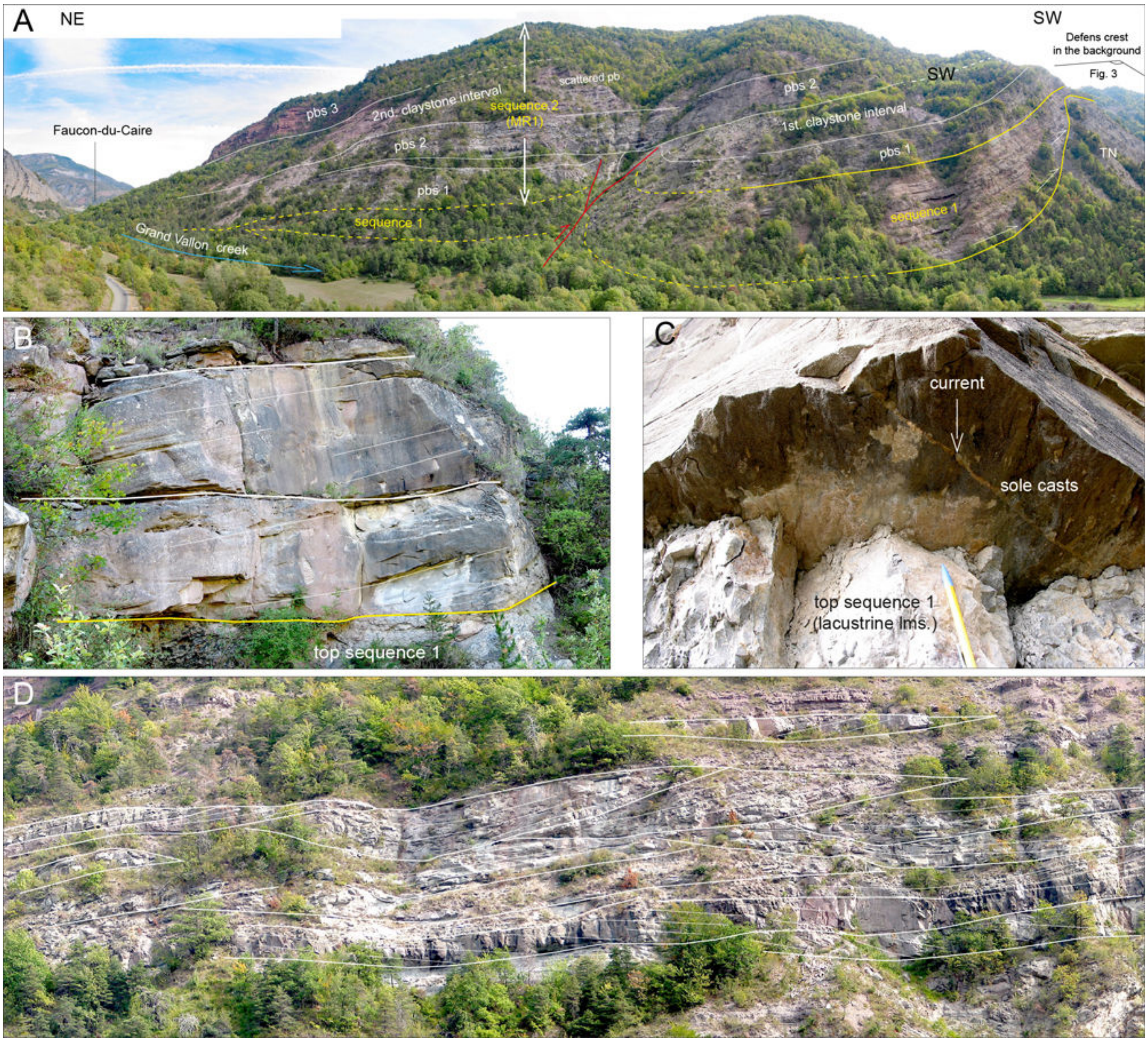

Figure 7: Sequence 2 (MR1) on left bank of the Grand Vallon. A, general view (explanations in the text); pbs, point bars stacks; thickness of sequence 2 is about 250 m. B, Close view of two stacked sandstone-filled channels showing the inclined internal stratification of point bars. C, view of the sole cast at base of the lower sandstone bed of picture B, oriented at high angle vs. the inclined internal stratification, a characteristic of river bends in meandering systems, also note the underlying light-grey limestone (lacustrine) forming the top of sequence 1. D, closer view of the nested point bars forming the point bar stack 2 (pbs 2), center of picture A.

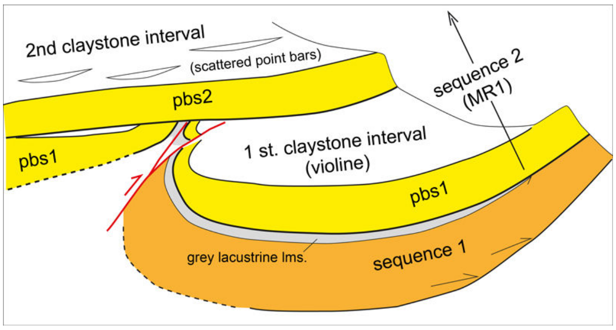

Figure 8: Cartoon depicting the synsedimentary fold sealed by point bars stack pbs2, seen on center of Figure 7.A.

2.3. Sequence 3 or MR2

The Molasse Rouge 2 (MR2) was analyzed through a drone footage of some crests (Sommet des Plauts, Tête de Louberie, Tête de la Plane) facing the Turriers Village to the NW (Fig. 1.B). A section was logged along the Gigors to Faucon road (D 951) by the Sarraut pass of the Grand Vallon valley. MR2 is poorly exposed along the right bank of the Grand Vallon valley between Gigors and Faucon-du-Caire villages. Geological maps (1/50.000 sheets of Laragne-Montéglin, # 893, and of Seynes-les-Alpes, # 894) show the formation is dissected by several thrust slice faults, which further complicates the stratigraphic analysis of a complex fluvial system on a densely forested slope. Just south of Faucon-du-Caire, on the left bank of the Grand Vallon valley, well-exposed outcrops reveal stratigraphic relationships between Sequences 2 and 3 (Fig. 1.B).

The crest NW of Turriers village exposes the stratigraphic relationships between the Jurassic marine marlstone (Terres Noires Fm.), the base of the marine nummulitic succession and MR2 (Fig. 10.A). Molasse sequences 1 and 2 are not

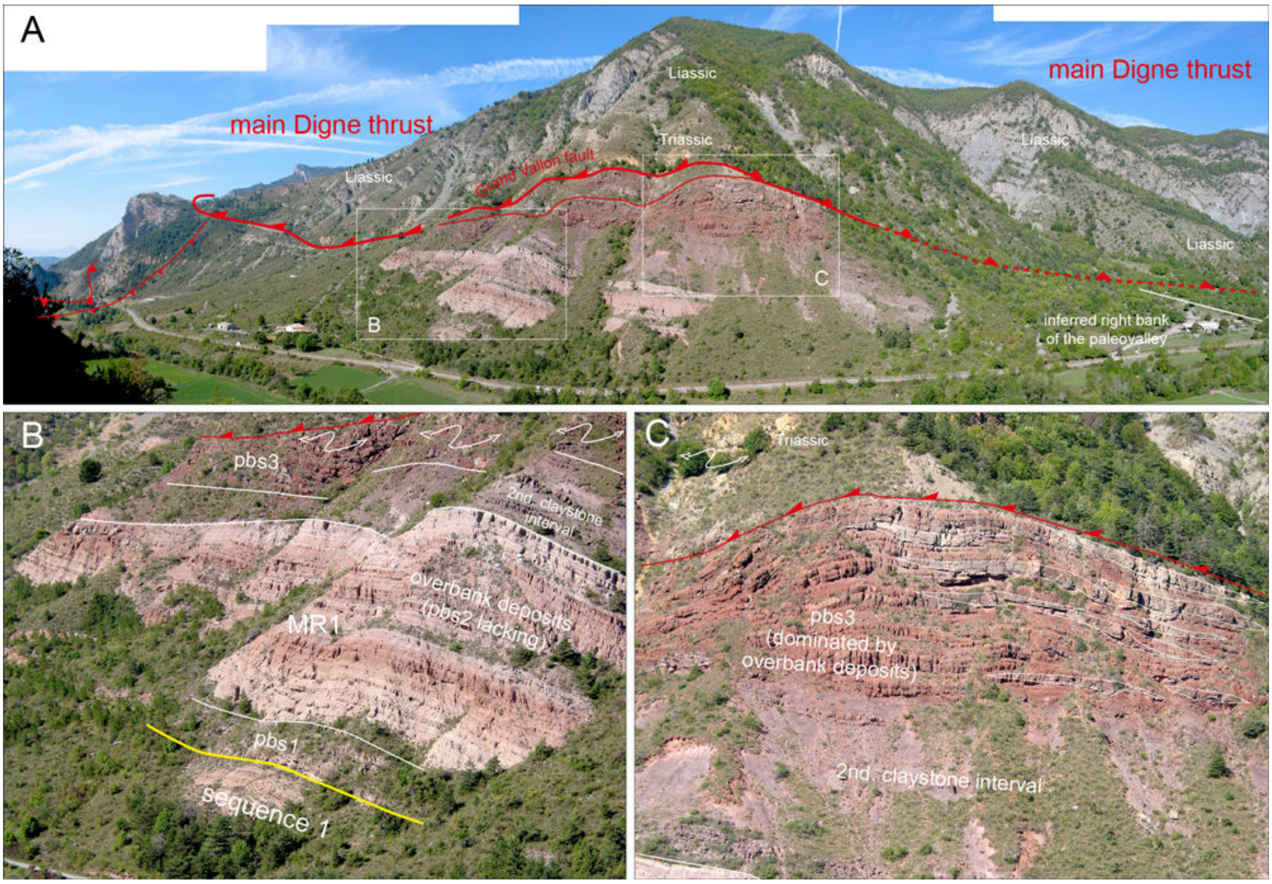

Figure 9: Facies changes within the MR1 on right bank of the Grand Vallon (location on Fig. 1.B). Pbs1 is reduced in thickness, pbs2 is lacking and pbs3 is mostly made of red overbank deposits (few thin channels). Inferred paleogeography, see discussion.

present at this locality. S3 deposits exposed along the crest are comprised of nested channels fills composed of a mixture of well-rounded pebbles and more angular clasts (Fig. 10.B). Quartzite pebbles of probable Alpine origin make up the majority of the well-rounded material. They are associated with metamorphic "green rocks" (serpentinites) and radiolarites from the inner Alps. The depositional environment is interpreted as a braided stream combining angular pebbles from distant (dominent) and local sources. Drone footage along the crest (Fig. 10.C) reveals interbedded conglomerate similar to that cropping out in Figure 10.B, and finer-grained material. There is a lack of lateral continuity between these two facies, suggesting that the depositional environment was a large, braided stream system with shifting channels producing pebble-dominated bars, and cutting into overbank deposits. The underlying nummulitic succession comprises a regularly bedded, fine-grained offshore limestone (Calcaire nummulitique, Fig. 10.D), overlain by a deeper-water, dark-gray marlstone with interspersed fine-grained limestone beds (Marnes nummulitiques or Marnes Bleues, Fig. 10.E).

Within the upper Grand Vallon valley, close to Gigors village (Sarraut pass, Fig. 1.B), MR2 deposits are vertical to overturned against the Digne thrust (Fig. 11.A). MR2 deposits can be subdivided into a lower MR2a unit (Fig. 11.B), showing the same pebbly facies observed on the crest facing the Turriers village (Fig. 10.B), and an upper unit (MR2b) comprised of reddish deposits (Fig. 11.A). The thickness of the three subunits of lower MR2 deposits (a to c, Fig. 11.B) preserved against the Digne thrust is around 200 m. The basal reddish deposits of MR2b consist of silty claystone with sandstone lenses interpreted as filled channels, locally thick with lateral accretion (Fig. 12.A), indicating a sinuous channel path. A several-meters thick interval of dark claystone is intercalated in the basal part (Fig. 12.B-C), likely representing the infilling of a large abandoned channel or a swampy lowland. The claystone includes small, nested channels filled with thin laminated sandstones, representing flood events (Fig. 12.E). Channell-filled sandstone may be gravelly at base, with subrounded clasts (Fig. 12.F), in contrast to that of the well-rounded pebbly materiel of the lower MR2. The thickness of MR2b red deposits can be more than 300 m, as estimated from panoramas (Fig. 12.D). A cross-section (Fig. 13) illustrates stratigraphic and structural relationships.

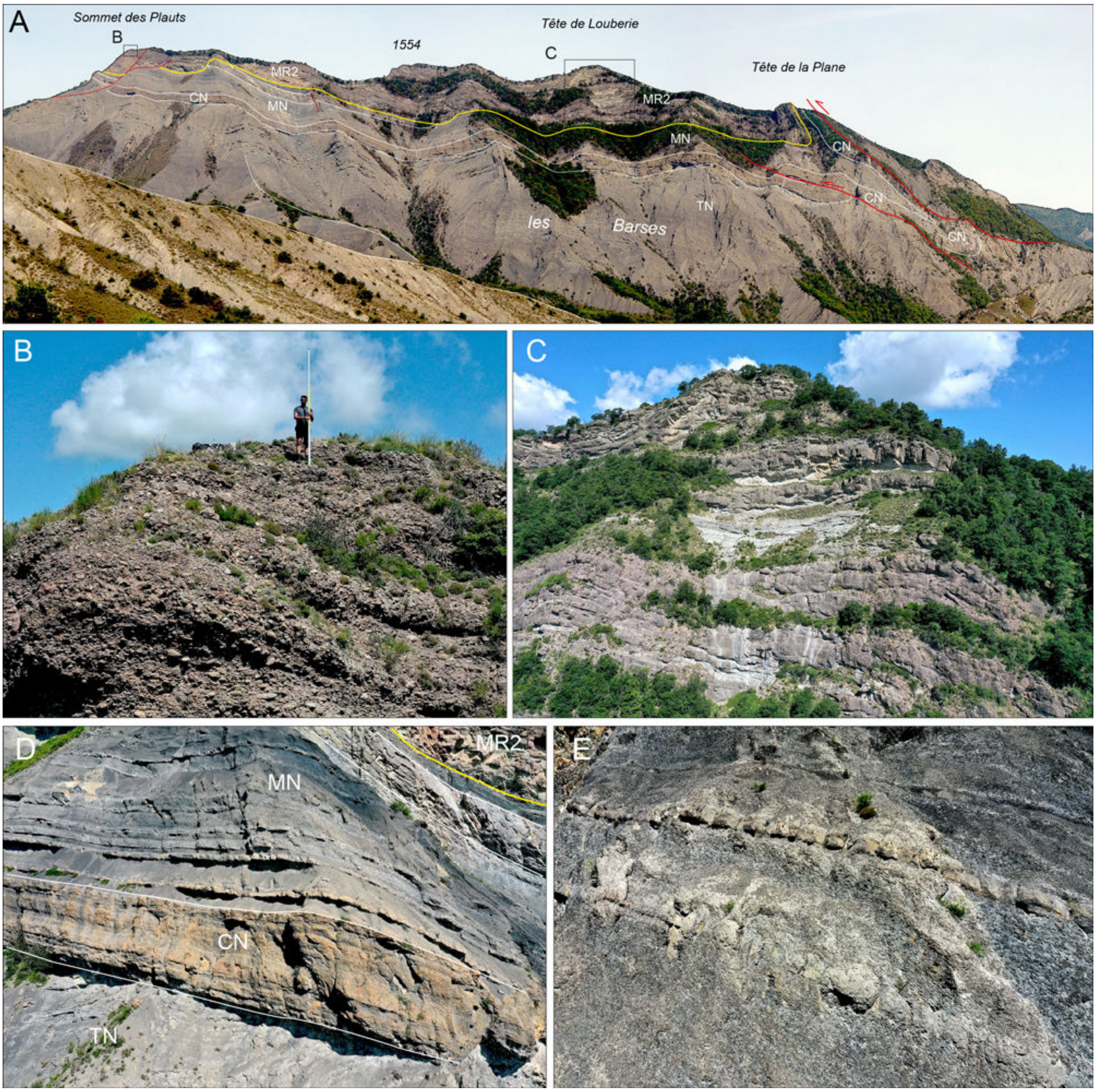

Figure 10: Sequence 3 seen from the Turriers road (location on Fig. 1.B). The MR1 is lacking here, and sequence 3 (MR2) rests directly on marine "Nummulitic" deposits. A, General view. B, close view of the rounded pebbly conglomerate forming the MR2; Ph. Sorrel with a 3 m-long key staff for scale. C, view of the thick (circa 100 m) conglomerate succession forming the base of the MR2. D, Close view of the "Nummulitic" succession sandwiched between the Upper Jurassic marlstone (Terres Noires, TN, Formation) and the MR2 (CN Calcaire Nummulitique, MN, Marnes Mummulitiques or Bleues Marls). E, close view of the Marnes Nummulitiques.

The left bank of the Grand Vallon creek, close to Faucon-du Caire village (Fig. 14), shows the stratigraphic relationships between MR1 and MR2 deposits on both sides of the Bouchouse fault (location, Fig. 1.B). Upstream, MR2 deposits rest directly on either the Jurassic Terres Noires marlstone, or lenses of preserved marine Nummulitic deposits, as in the area of Turriers village (Figs. 1.B, 10). South of the Bouchouse fault, the MR2a pebbly subunit rests unconformably on the multistory pointbar deposits (pbs3) of the MR1 (Fig. 14).

All the stratigraphic data collected in the Faucon-Turriers tectonic corridor are summarized in Figure 15, which shows that strong tectonic deformation occurred between deposition of MR1 and MR2.

3. Age of sequences

No additional data are found vs. what was found in the previous study (Ferry *et al.*, 2025). The age of Sequence 1 is judged to be late Rupelian, mostly because it clearly is an independent flexural sequence predating the deposition of MR1 (Sequence 2). Its basal breccia unit (BU) was often considered once as a marginal deposit of MR1. But, its age and significance remain to be discussed on a larger scale in integrating other data from in front of the Alpine chain (work to come). The two Molasse Rouges sequences (S2 and S3) belong to the Chattian.

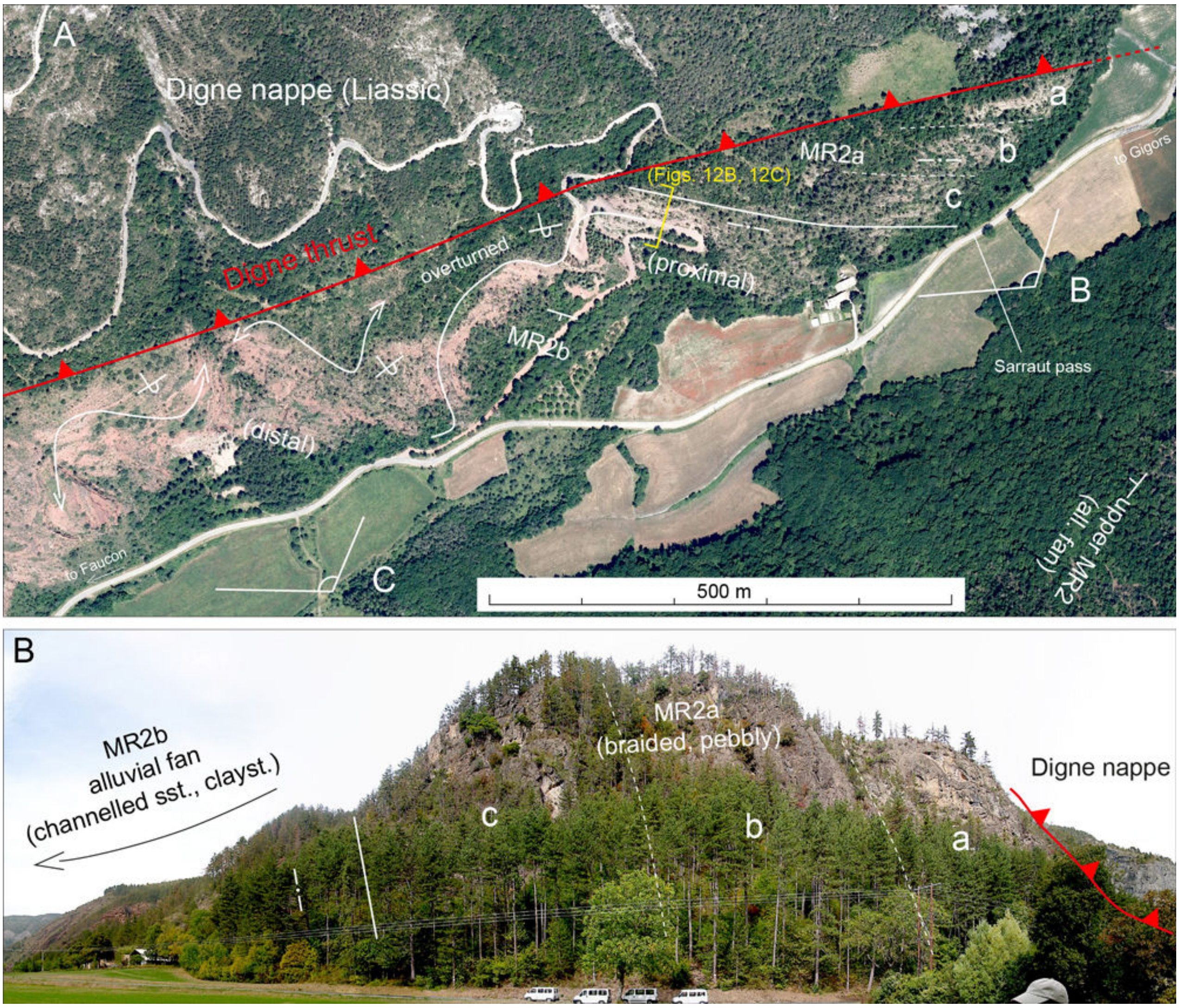

Figure 11: Sequence 3 (MR2) along the Faucon to Gigors road (location on Fig. 1.B). The sequence comprises at base a package (a, b, c) of well-rounded polygenic conglomerate units (lower MR2, or MR2a ≈150 m thick) and, at top a slowly fining-up alluvial fan (upper MR2, or MR2b). A, aerial view; B, view of the basal package of polygenic conglomerate (MR2a). C, view of the distal part of the alluvial fan of the MR2a, here overturned against the Digne thrust (see aerial view A).

4. Stratigraphic comparison with the Esparron-Esclangon area

Changes in facies and successions between the Esparron-Esclangon (Ferry *et al.*, 2025) and the Faucon-Turriers (this study) areas are summarized in Figure 16. The three depositional sequences S1 to S3 are recognized in both localities. Although more or less truncated by the basal boundary of Sequence 2, Sequence 1 appears to be laterallycontinuous along the Alpine belt, as well as having an internally finingup pattern. The most pronounced facies changes are within Sequence 2 (MR1). In the Esparron-Esclangon area, the meandering fluvial facies is found only at the base of MR1 at Esparron, where it is overlain by a prograding fluvial fan bearing large, thick sandstone lenses representing filled channels with an internal braid pattern at top. To the east of Esclangon, the meandering fluvial faciès at the base of MR1 is absent and the alluvial fan has a different pattern. Sequence 3 (MR2) shows in both localities the same pattern of a relatively lowsloped braided fluvial system overlain by an alluvial fan, except for thicknesses.

5. Paleogeographies

The paleogeography for each sequence is shown in Figure 17.

Outcrops of Sequence 1 are limited to the frontal thrusts of the Digne thrust system because it is truncated northward by those of Sequence 2 (Fig. 5.A). The Valentin thrust shortens the updip to downdip areal extension of the depositional system (Fig. 6). The areal organization of deposits is similar to that at the NW termination of the Esparron syncline (Ferry *et al.*, 2025, Fig. 23.A). In each area, a belt of torrential fans is associated with high relief adjacent to a flatlying basin floor that opens towards the inner Alpes. The western boundary of this basin might correspond to the western boundary of the transported Digne basin.

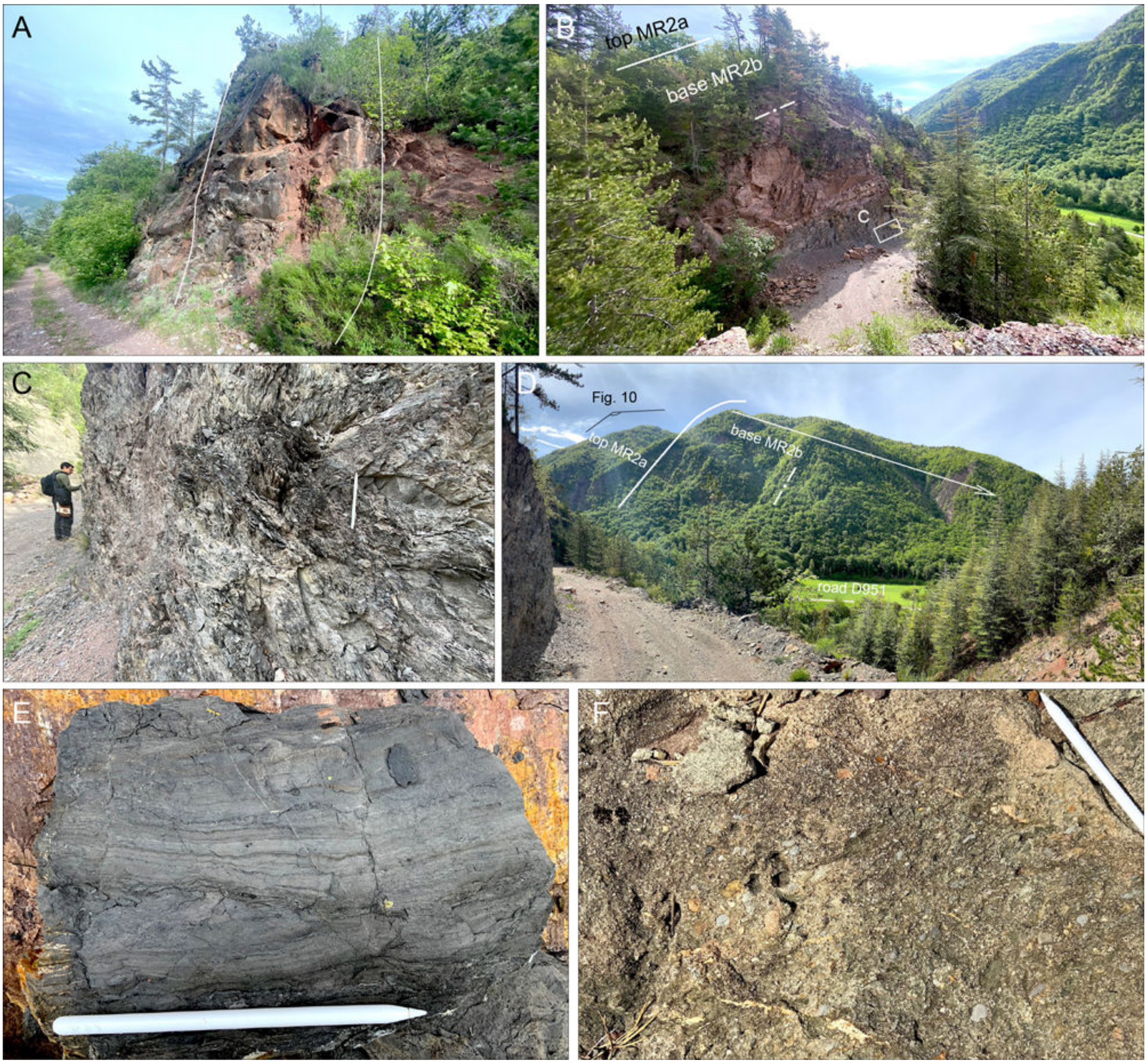

Figure 12: Facies of the MR2 along the Faucon to Gigors road. A, deep, sandstone-filled channel within the basal part of the lower MR2 (MR2a). B, Base of the upper MR2 alluvial fan (MR2b) showing a dark siltstone bed intercalated between the red sandstone and claystone. C and E, closer views of the laminated dark bed. D, view of the strongly dipping succession of the MR2 on the eastern bank of the valley. The crest to the left is the crest shown on Fig. 10.C. The total thickness of the MR2 reaches ≈ 650 m. F, view of the coarse-grained sandstone bearing poorly-rounded gravels filling the large channels in the lower part of the MR2. G and H, view of the overturned succession of lower MR2 (MR2a) alluvial deposits against the Grand Vallon fault.

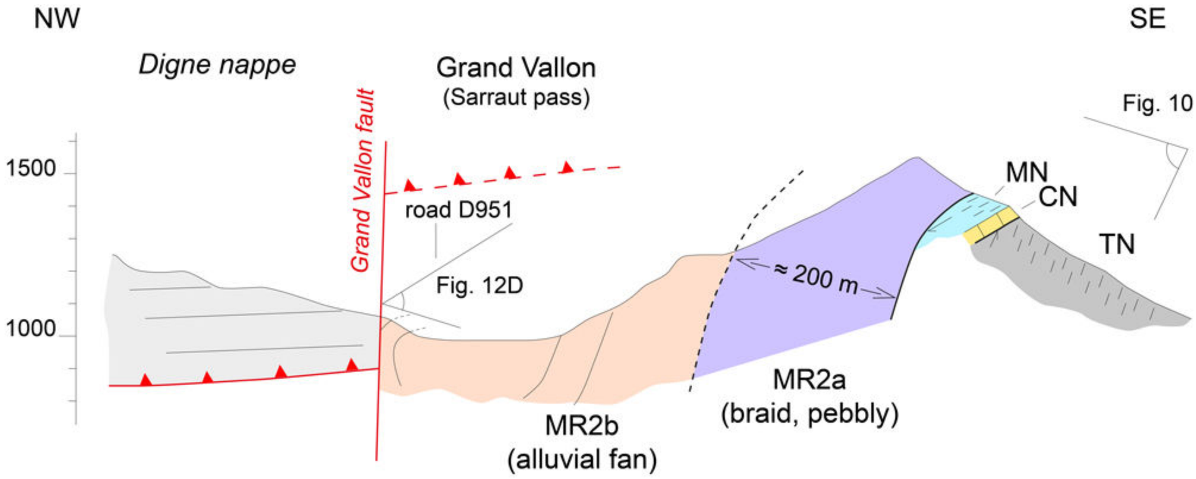

Figure 13: Stratigraphic organization of Sequence 3 (MR2) across the Faucon-Turriers tectonic scale (location on Fig. 1.B).

Figure 14: Stratigraphic relationship between MR1 and MR2 around Faucon-du-Caire on both sides of the Bouchouse fault. Abbreviations: TN, Jurassic Terres Noires Fm.; CN, Nummulitic limestone.

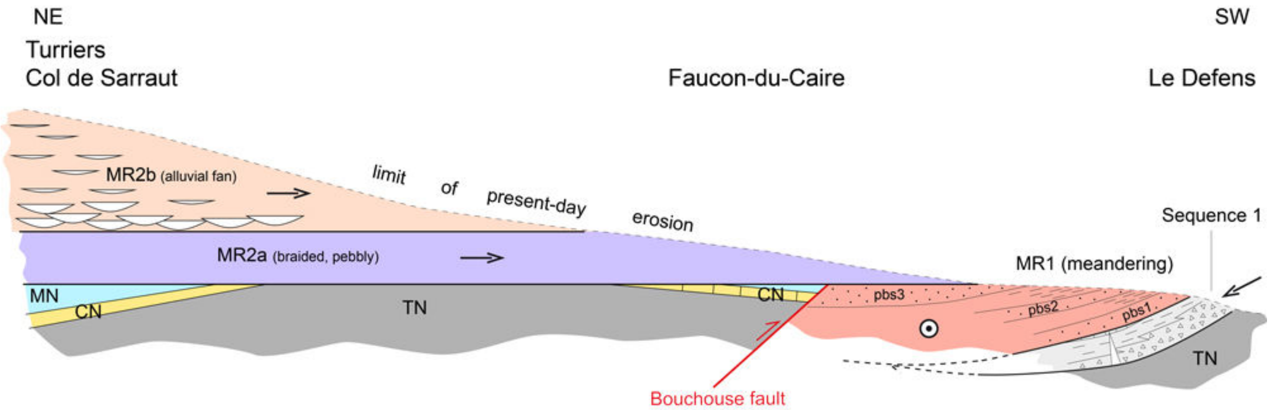

Figure 15: Stratigraphic relationship between Sequence 1, Sequence 2 (MR1) and Sequence 3 (MR2) along the eastern bank of the Grand Vallon. Arrows indicate directions of the stream in each sequence. Tectonic units according to GIDON (1997).

It is difficult to determine the orientation of a meandering fluvial system, due to the dispersion of current directions. As a whole, the deposits of Sequence 2 appear to be a continuation to the NW of those found in the syncline valley of Esparron. Accordingly, Sequence 2 deposits are also lacking to the NE in the next tectonic scale, north of the Bouchouse fault (Figs. 1.B, 15). Termination of the multistory point bar deposits against the Grand Vallon fault (Fig. 9) suggests that the course of the river was diverted to exit the Digne nappe around the SW termination of the Faucon-Turriers corridor (Fig. 17). This implies that topographic relief was controlled by the Grand Vallon fault, which would have been active at that time. The greater thickness for the meandering stream succession of MR1 is likely due to enhanced subsidence on the eastern compartment of the fault. From work in progress, MR1 deposits are lacking NW of the Faucon-Turriers area where MR2 rests on folded Jurassic and Cretaceous deposits, suggesting that the western compartment of the fault was uplifted during the deposition of MR1. The course of the river outside the Digne nappe is unknown, due to the scarcity of Paleogene deposits to the west. It was possibly flowing in front of the Ventoux-Lure thrust (Fig. 1.A), but this needs further investigation.

Pebble imbrication within channelfill deposits along the crest of Les Plauts indicates a paleoflow direction to the SW, following the Faucon-Turriers corridor. The path of the MR2a fluvial system flowing from the Digne nappe along the Ventoux-Lure thrust is supported by a similar succession of channelform polygenic conglomerates that contain Alpine radiolarites and "green rocks" within red claystone close to Montfroc village (Fig. 18). The conglomerate infill of channels is heterogenous and composed of either entirely wellrounded (Fig. 18.B) or mixed poorly and wellrounded clasts (Fig. 18.A). Poorly rounded clasts are local material supplied by tributaries into the main river carrying the wellrounded material coming from the inner Alpes. This succession at Montfroc was assigned a Miocene age (MONTENAT *et al.*, 2000) based on a reappraisal (GARNIER, 1999) of the geological map of Séderon (FLANDRIN *et al.*, 1961) and of a correlation with a section situated 10 km farther west (Montbrun syncline, Fig. 18.C) where a somewhat similar conglomerate rests disconformably on Miocene deposits. According to FLANDRIN *et al.* (1961), the polygenic conglomerate observed at Montfroc unconformably overlies Cenomanian deposits. According to GARNIER (1999), the succession is inverted by faulting, placing the Montfroc conglomerate on Miocene deposits. Our investigation shows that the pebble assemblages of the third Miocene conglomerate bed at Montbrun (MONTENAT *et al.*, 2000), as well as that of the potentially coeval Montfroc conglomerate, are completely different. At Montbrun, the conglomerate comprises only subrounded, finegrained limestone clasts reworked from the local Mesozoic Vocontian basin, in contrast to the mixed lithologies of the Montfroc conglomerate (Fig. 18). The facies of the third Montbrun con-

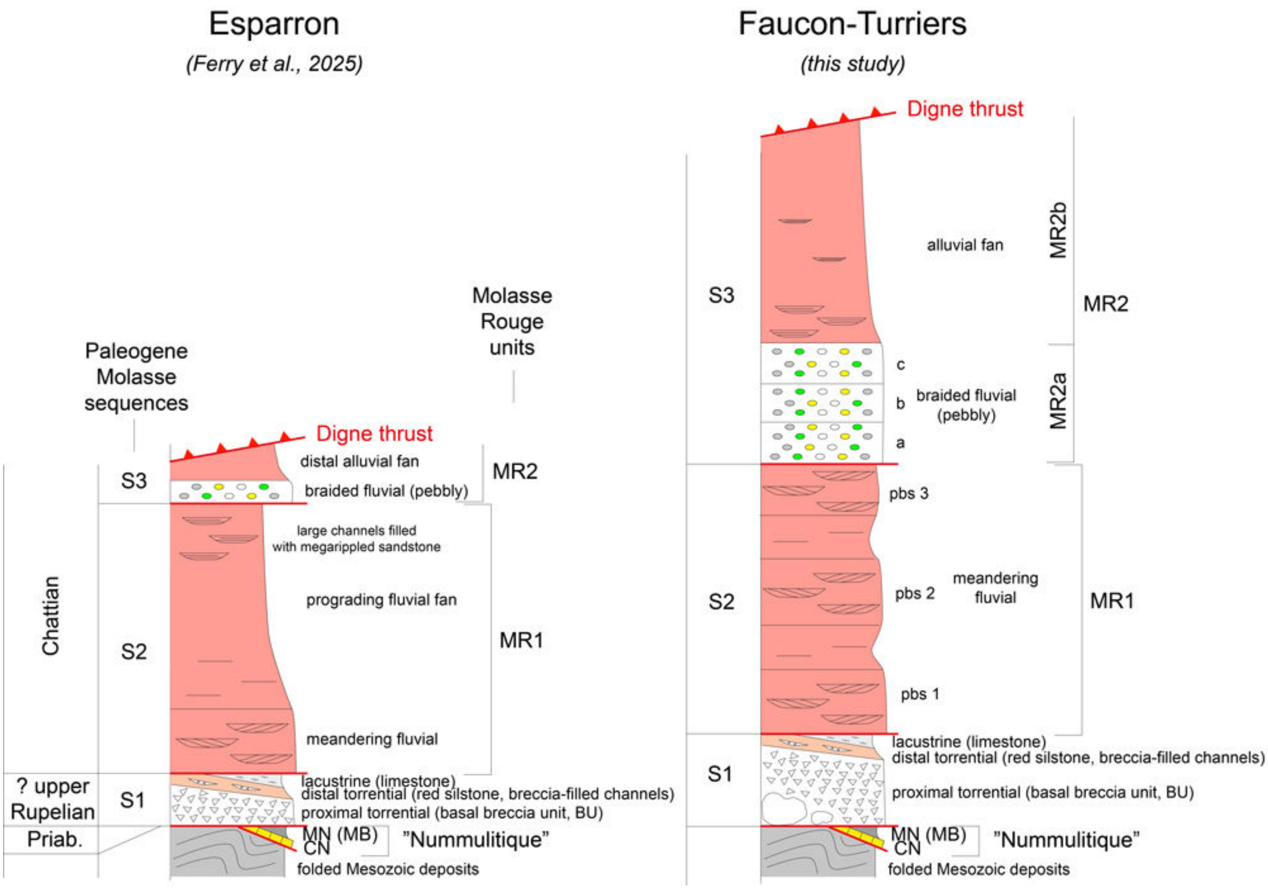

Figure 16: Compared stratigraphic successions (Esparron-Esclangon vs. Faucon-Turriers areas). CN, Calcaire Nummulitique; MN, Marnes Nummulitiques (or MB, Blue Marls, as they are also termed); pbs, point bar stacks within MR2; Priab., Priabonian.

glomerate is, in fact, very similar to the Serravallian Traversiers Conglomerate (Monier & Cavelier, 1991) observed farther west in the Comtat basin. Their age and facies are similar. Poor outcrop conditions today at Montfroc prevent reexamination of the nature (stratigraphic or tectonic) of formation boundaries. On the basis of the nature of conglomerates, we reject the correlation made by Montenat.

If our conclusions are correct, the fluvial system of the lower MR2 (MR2a) would have exited the paleovalley in front of the Ventoux-Lure thrust through the breached Suzette diapir (Montmirail locality, Fig. 18.C). However, this needs further investigation (work in progress), including a revision of the stratigraphic data of Huet *et al.* (2025) for the area around the SW wall of the Suzette diapir (Baumes-de-Venise crest).

Currently, no data support the hypothesis that meandering river deposits of MR1 in the Digne nappe followed the same path as that of MR2 outside the nappe. An exit along the Durance fault is however not possible, as briefly discussed in Ferry *et al.* (2025). This, therefore, remains an open question, until the upper part of the Montmirail succession is revisited in detail.

6. Conclusions

The study of the Faucon-Turriers tectonic corridor confirms the result obtained farther south within the transported basin of the Digne nappe (Ferry *et al.*, 2025).

The basal breccia unit (BU) is a full tectono-stratigraphic sequence (S1) oriented parallel to the Alps and is no longer to be considered as a mere marginal breccia facies at the base of the Molasses Rouges of other authors.

The first unit of the Molasses Rouges, *stricto sensu* (Sequence 2 or MR1), represents the meandering fluvial infilling of a syncline paleo-valley that followed the western boundary of the depositional basin. Its course shifted to the west where striking paleo-relief formed by the SW-NE-oriented Grand Vallon fault bounding the Faucon-Turriers corridor. Its course then likely followed the front of the Ventoux-Lure thrust to the west, but this remains to be better documented through a reappraisal of the Montmirail succession in the Comtat basin (middle Rhône valley).

The second unit of the Molasses Rouges (Sequence 3 or MR2) represents a braided fluvial system flowing straight west from the inner Alps. Its path along the front of the Ventoux-Lure thrust is better documented than that of MR1.

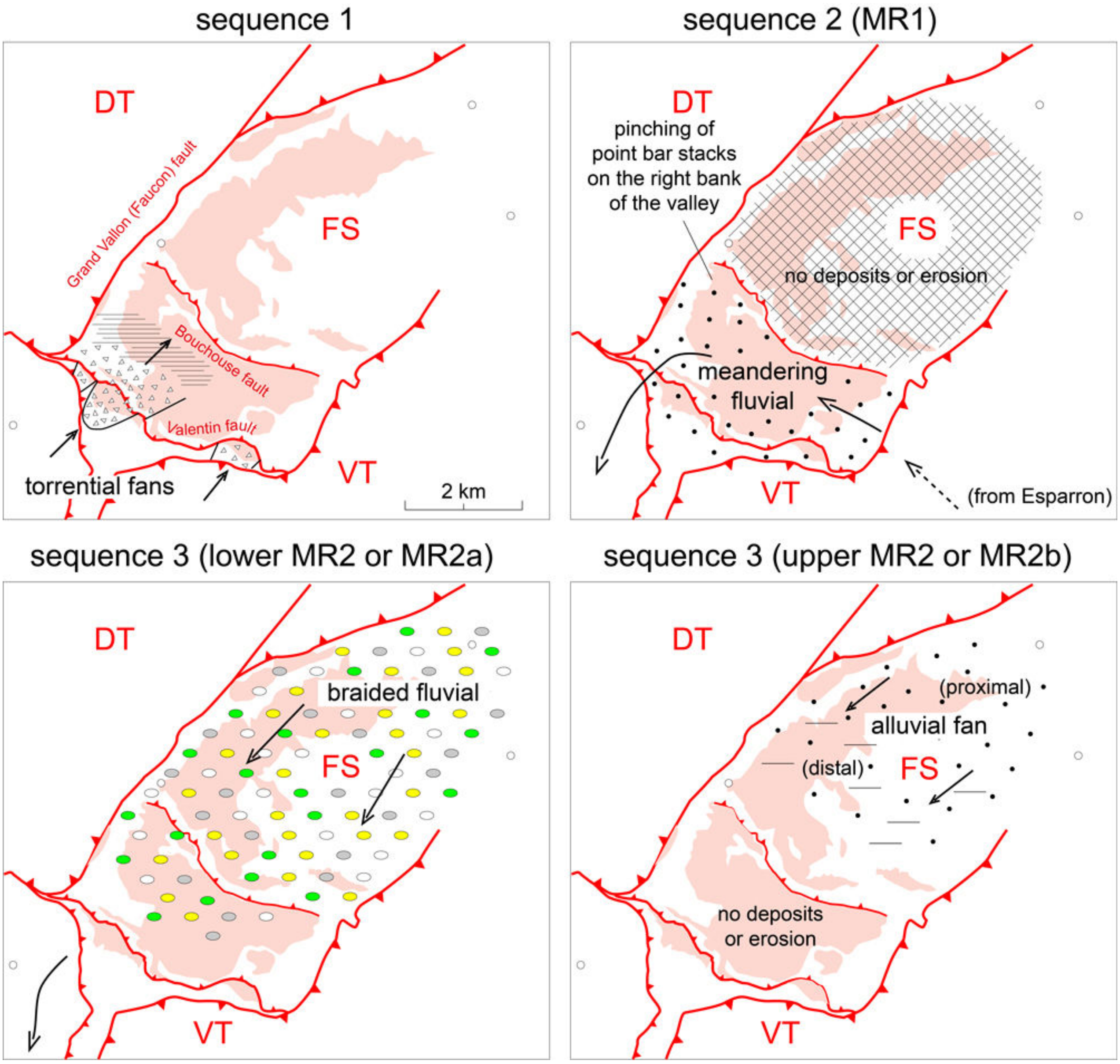

Figure 17: Successive paleogeographies (Sequences 1 to 3).

As in the Esparron syncline (Ferry *et al.*, 2025), the depot-centres of MR1 and MR2 strongly shifted within the Digne nappe, therefore evidencing major tectonic deformation during the Chattian.

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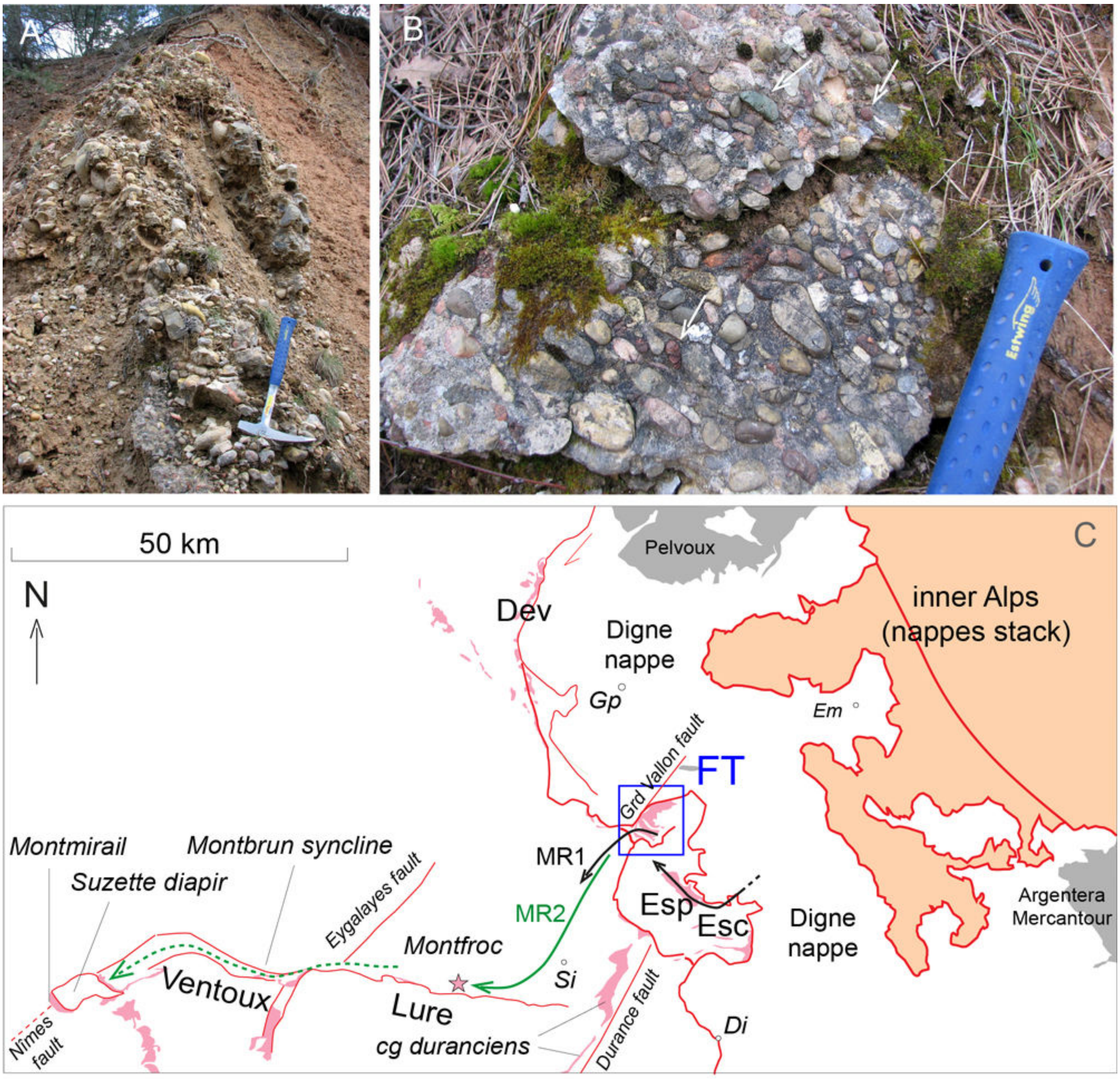

Figure 18: The Montfroc conglomerate in front of the Ventoux-Lure thrust, as a possible outlet route to the west for the lower MR2 fluvial system. A, conglomerate infill of channels within red claystone; B, close view showing pebbles of inner Alpine "green rocks" and red radiolarites (arrows); D, map showing the path of the MR1 and MR2 fluvial systems out of the Digne nappe.

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