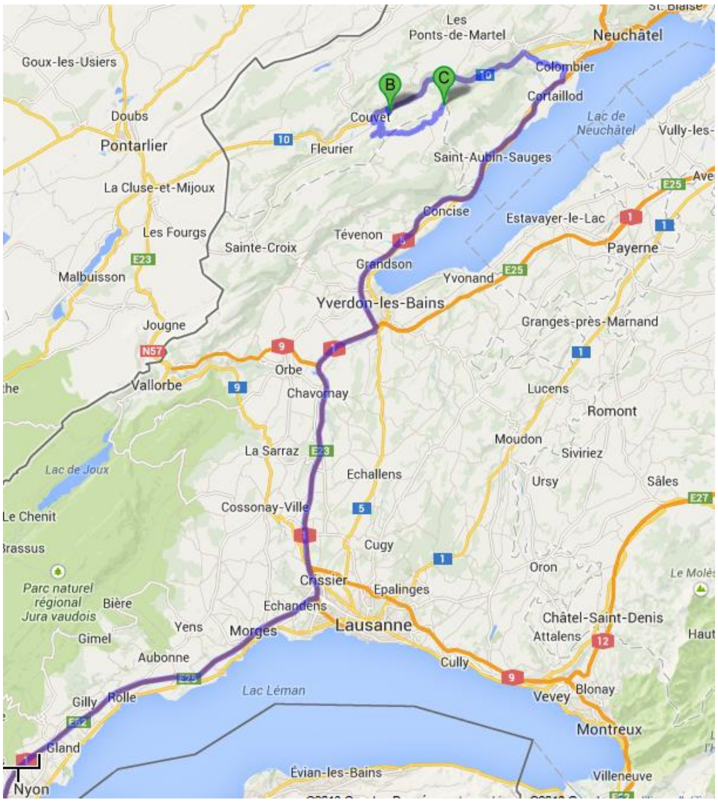
SPE Swiss section
Thursday, 10 October 2013

FIELD TRIP PROGRAMME

08.15	Departure by bus from Pont du Mont-Blanc / Horloge Fleurie bus stop
10.00	Arrival at La Presta (point B on map), Val-de-Travers, coffee/croissant
10.30-12.00	Guided tour of the asphalt mines
12.00-13.45	Lunch at the asphalt mines SPE overview by Serge Rueff
14.00-14.30	Departure to Creux-du-Van (ferme du Soliat,point C on map)
14.30-16:00	Geological stop and presentation at Creux-du-Van and walk, depending on weather
16.30-18.00	Travel back to Geneva by bus



Field trip brochure prepared by Alex Muller, SPE Swiss section

Introduction

Located in the centre of Western Europe, Switzerland is a small country covering 41'288 km^2. About 60% of its surface lies in the Alps, 30% in the Molasse Basin (Plateau) and 10% in the Jura. The Swiss population of approximately 7.8 million, concentrates mostly on the Plateau, where the largest cities are to be found. Amongst them are the two global cities and economic centres of Zürich and Geneva. Switzerland is a federal republic consisting of 26 cantons, with Bern as the seat of the federal authorities. Switzerland comprises three main linguistic and cultural regions: German, French, and Italian, to which the Romansh-speaking valleys are added. The Swiss therefore do not form a nation in the sense of a common ethnic or linguistic identity. The strong sense of belonging to the country is founded on the common historical background, shared values (federalism, direct democracy, neutrality) and Alpine symbolism. The establishment of the Swiss Confederation is traditionally dated to 1 August 1291.

Although the Swiss have the reputation of living from chocolate, cows, tourists and bank accounts, the country is strongly industrialized. Machines, chemicals, pharmaceuticals, watches and textiles being amongst the main products. Currently, there is no major mining industry, and exploration for oil and gas has not yet led to commercially interesting discoveries, but is being continued with an upsurge in recent years.

Today’s field trip will cross the SW part of the Molasse Basin and the central most SE part of the fold and thrust belt Jura chain. We will only have panoramic views on the Alps, weather conditions permitting, from our stop at Creux-du-Van.

Aerial South view from the Jura (Creux du Van) over the Molasse Basin (Plateau) and the Alps (Mont-Blanc on the left).

Asphalt mines of La Presta, Val de Travers

1. Location

The mine is located in the commune of Travers in the Val de Travers, which is part of the canton of Neuchâtel in the Swiss Jura mountains. The Val de Travers is located in a SW-NE trough stretching from the French border to the Areuse gorges. The Areuse drains the said valley and flows into the Lake of Neuchâtel.

Fig. 1 Aerial view of the Presta asphalt mine area and Couvet town.

2. Terminology

The terminology of asphalt is indicating a type of rock composed of carbonated matrix impregnated by asphalts constituted of resins, asphaltenes and of oily constituency.

3. History

The asphalt mines of the Val de Travers are one of the rare Swiss examples of profitable and durable exploitation of natural underground resources. Some explorations for iron ore, copper and gold have been made in the canton of Graubünden, Valais and Ticino, but these mines have never shown any conclusive results. For the asphalt mines however, after a few tentatives during the XVIIIth century and a more intensive extraction during the XIXth century, a systematic industrial exploitation starts in 1873 under an English company, and terminates in 1986.

The asphalt discovered and exploited in the Val de Travers is a heavy hydrocarbon which permeates a limestone layer outcropping on the communes of Travers and Couvet, situated north and south of the valley. Asphalt is known since the antiquity in Egypt and Mesopotamia for its medical properties as well as for the caulking of hulls. Later on, this procedure equipped the European boats conquering the world during the time of the great discoveries. Asphalt was also used to seal reservoirs and water pipes, as much during the Antiquity than later in Europe, as for example in the Versailles fountains.

The history of asphalt started in the Val de Travers in 1710; a Greek scientist found by chance some bituminous rock. He experimented various applications for the asphalt (e.g.

for the watertightness of the regional fountains) and worked out a construction mastic based on heated powder, a bit like the actual procedure. But these first experiments were not followed up any further.

The local industrial entrepreneur Philippe Suchard gave a real boost to the asphalt mines in 1841. Then in 1849, a visionary Basle engineer called Andreas Merian set up the modern procedure of asphalting the roads by heating and compressing the powdered asphalt. He imagined big roads on which vapour worked vehicles would transport merchandises, thus competing with the rail roads!

In 1872, the English company called Neuchâtel Asphalt Company Ltd. (NACO) purchases the mines and starts, the following year, an intensive exploitation of the geological deposit, and exporting the asphalt all over the world. At the end of the XIXth century, not only all the streets of most big European towns, but also New York and Sydney, amongst others, are tarred thanks to the Val de Travers!

The new owners had the working techniques improved by rationalizing the removal as follows: first they drilled large gangways across the asphalt layer, they were immediately fitted out with wooden planks, which allowed the horse driven carts to access on rails. Then, by starting with the galleries located the furthest from the entrance, the veins were exploited to the extremities. Drilled that way, the galleries finally collapsed, but miners had already backtracked to sectors closer to the entry. This method allowed the maximal extraction of asphalt, needing very precise instruments such as the theodolite. Over a hundred kilometres of galleries were traced that way in a dense network.
During the XXth century, changes in the techniques facilitated and rendered more secure the work of the miners: pneumatic tools replaced the rock drills and the pickaxes; the long work to apply the wooden planks in the galleries was replaced by the direct appliance of metallic supports into the vaults; the explosions were triggered by electronic detonators and not anymore by matches of low combustion. As of 1905, when the underground network was extended, the necessity for an electrical ventilator system for the galleries came up. Whereas for the fight against water infiltrations, pumps were installed in order to evacuate up to 2000 litres of water per minute.

Fig. 2 La Presta asphalt mine view.

In 1969 electrical locomotives based on batteries were introduced, and hence replaced definitely the horse driven carts by 1973. A large gallery was drilled in order to collect the asphalt and allowing a low truck, combined with an excavator, to enter the said passage. That gallery is linked to various lateral wells, which allowed the small carts from lower galleries to be pulled up by electrical winches.
Over a time of 5 generations of miners, more than 2,000,000 tonnes of asphalt have been extracted. But, despite all the technical progress allowing an increase on productivity, the Val de Travers mine suffered from the competition of the bitumen extracted from the oil refineries. The said product being less expensive but of lower quality, replaced the asphalt for the road construction. The progressive decline of the vein, lead to the definite shut down of the mine in 1986.

4. <u>Geological setting</u>

The Val de Travers syncline is bordered to the NW by the Trémalmont anticline and to the SE by the Chasseron – Creux du Van anticline and is limited to the SE as well as to the NW by two major thrust faults having thus protected the middle Cretaceous series (Albian argillaceous limestone) from the erosion, as well as important Tertiary Molasse deposits.
In the area of la Presta mines, asphalt is mainly linked to the mid-Cretaceous series (Urgonian white limestone) and up to the top Aptian. The mid-Cretaceous series of the syncline structure are affected by numerous secondary folding.

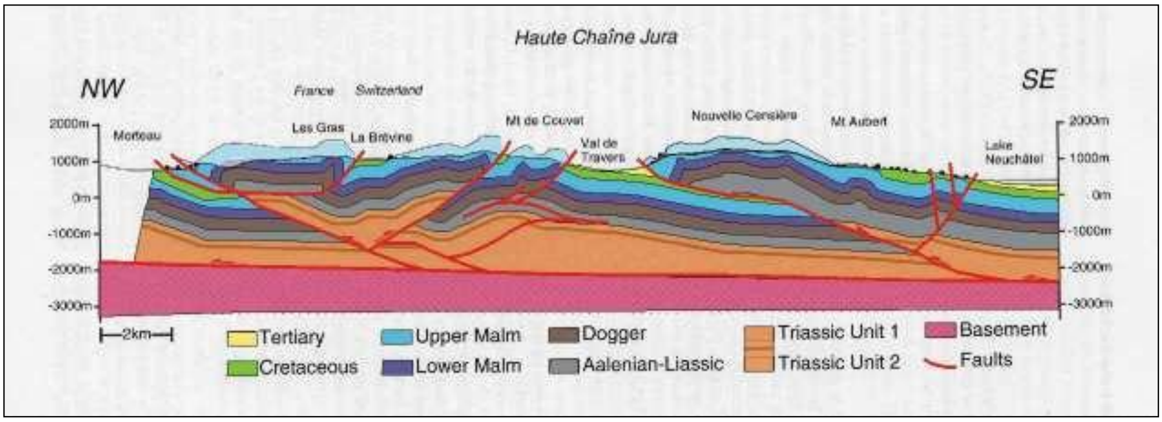


Fig. 3 General geological cross section showing Val de Travers tectonic position.

6. <u>Lithostratigraphy</u>

The study of four wells made during the summer of 1972 by the Neuchâtel Asphalt Company Ltd for a planned SW extension of the exploitation showed the following series in the Presta area:

Tertiary

Molasse (sandstones), grey- light blue shales

Mesozoic

Albian multi-coloured shales with blue-grey layers, rare limestone layers. Albian facies is of low energy environment (anaerobic) with sedimentation gap horizons (phosphatic nodules).

Aptian limestones (calcarenite) impregnated with asphalt over 3 to 10m (1-5% weight) and argillaceous sandstone with glauconite. The aptian facies is of low energy at the base (micrite and shales) grading to high energy at top.

Urgonian limestone, porous, chalky, highly stained with asphalt towards top. None of the studied wells drilled entirely through the Urgonian Formation.
Two deposits have been encountered in the mine, the main one of a thickness of 5 meters with an asphalt weight grade of 8 – 10% and a secondary less important deposit of up to 4m stain thickness and a weight grade of 4 – 5%.

The sedimentary depositional environment of the Urgonian limestone is of carbonate platform with strong biological activity in low to medium water depth.

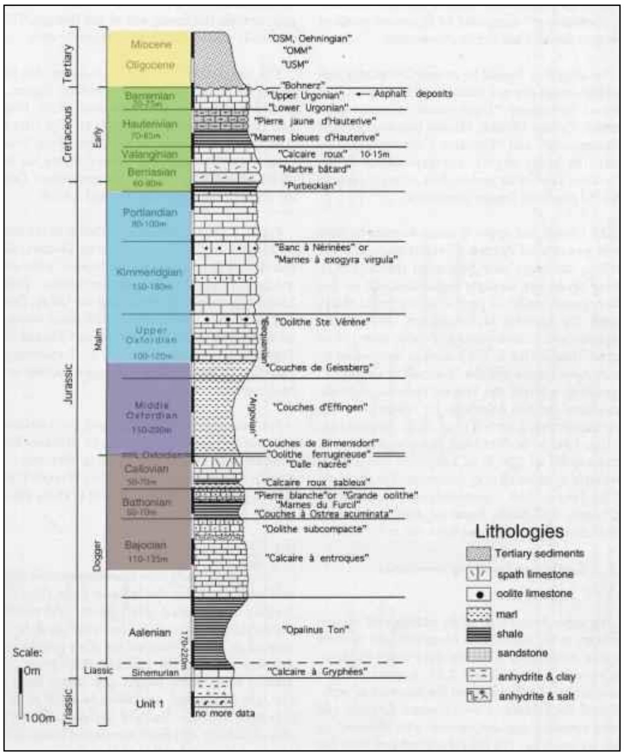


Fig. 4 Lithostratigraphy

7. <u>Asphalts origin and migration</u>

Two theories on the origin of the Presta asphalt where opposed at the end of the XIXth century.
On one hand the in situ theory defended in 1890 by A. Jaccard, who linked the asphalt origin to the in situ decomposition of marine organisms on the Urgonian and Aptian platform and argued that the lagoon paleogeography was an additional proof to the in situ origin of the bitumen.

On the other hand, H. Schardt defended in 1911 the theory of secondary origin by migration of the hydrocarbons (naphtha) into the porous layers of the Urgonian limestone that were later on oxidized and formed the asphalts.

Later theories in geology and further studies from the Presta mine (D. Zweidler, 1985) showed a more conventional genetic model for the asphalt origin.
The Upper Barremian dated Urgonian platform facies acted as stratigraphical traps within the reservoir rock composed of pelletoidal grainstone with good micro inter-crystalline porosity. The Urgonian non reservoir facies is composed of low energy transgressional platform limestone (packstone, wackestone) and shales. The main seal is made of Albian marls.

Migration of hydrocarbons occurred mainly during the pre-Late Pontian stage (upper Miocene). The source rocks are not determined but are documented in the Carboniferous, Lower Permian, Triassic and Jurassic in the Jura Mountains. The Jura chain was folded during the Late Pontian stage. A secondary migration occurred post Late Pontian stage by depletion of the reservoirs by hydrostatic readjustments of the traps.

Fig. 5 Lunch time: Presta mines Café!

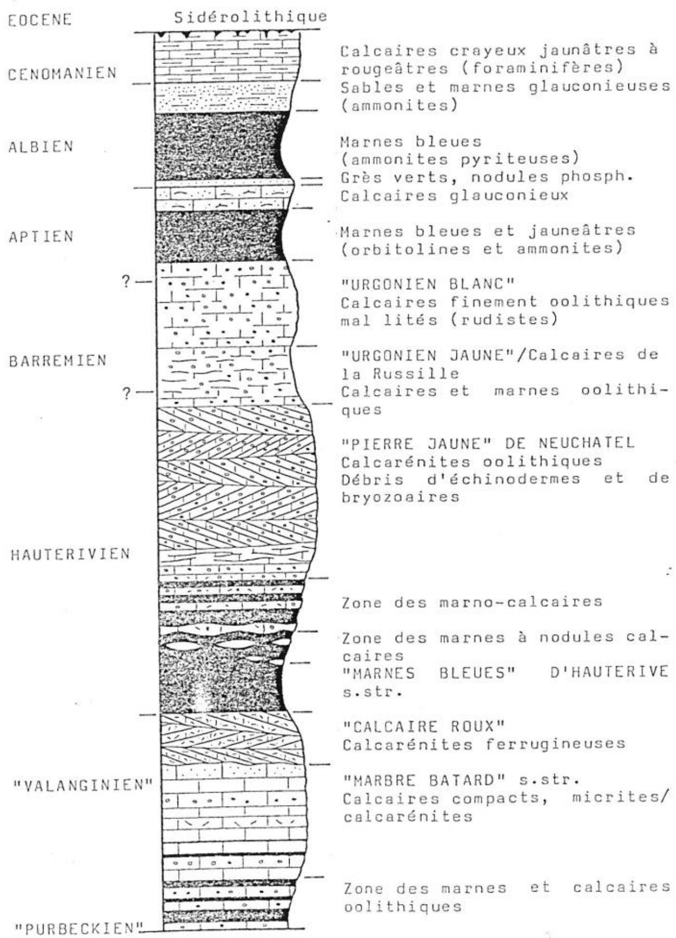
Next page plate:

Annex 1: Lithostratigraphy of the Neuchâtel Jura after J. Remane, unpublished

Annex 2: La Presta mine deposit lithostratigraphy

Annexe I

PROFIL LITHOLOGIQUE SCHEMATIQUE DU CRETACE DU JURA NEUCHATELOIS
(d'après J. Remane, non publié)



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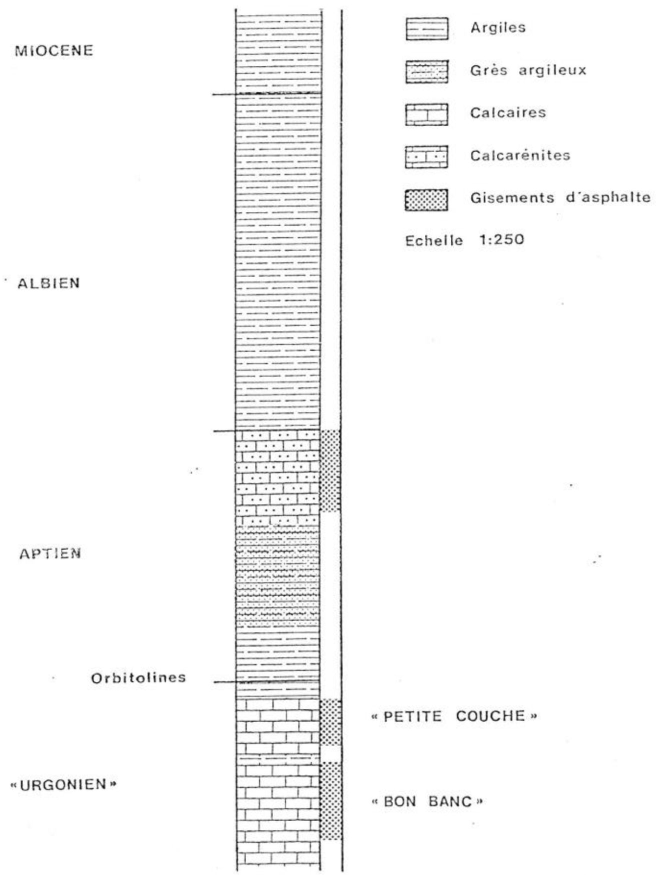
Annexe II

GISEMENTS D'ASPHALTE DU CHAMP DE LA PRESTA

Situation lithostratigraphique



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Creux-du-Van

Photo www.ch.ch

The natural semi circular cliff of Creux-du-Van is cut by erosion in the Chasseron – Creux-du-Van anticline and is composed of Jurassic limestone (Malm). The cliff is 250 m wide and 150 m high in average and lies south of the Val de Travers in the canton of Neuchâtel.
The area is a natural reserve of over 15 km^2 where fauna and flora are protected.
For the wildlife, you may see marmots, badgers, deer, ibex, chamois, foxes, wild boar and even lynx and wild cats have been observed. Various birds of pray, such as the famous peregrine falcon and lots of other bird species are present in the area. The flora in this region of the Jura mountains is very rich and varied. Rock climbing is popular on the cliff but is only permitted from August to December.
The name Creux-du-Van, despite its French sound meaning wind, has a Celtic origin, “vanno”, meaning rock/slope.

The erosion of the Chasseron – Creux-du-Van anticline started during the end of the last glacial period, some 10’000 years ago, when a local glacier flowed towards the greater Plateau glaciers to the SE. The complex erosion mechanism continued during the late quaternary period by water accumulation and percolation forming the present shape of the cliff and its large alive screes.

Access to the point of view above the Ferme du Soliat (1382m) will be by foot along a dirt road approximately 2 km long. Another short walk will lead us to the high point Le Soliat at 1463m.

Panorama views towards the Alps over the Molasse basin and large scale geology will be discussed from the Soliat view point with the help of the plates and figures following this page.

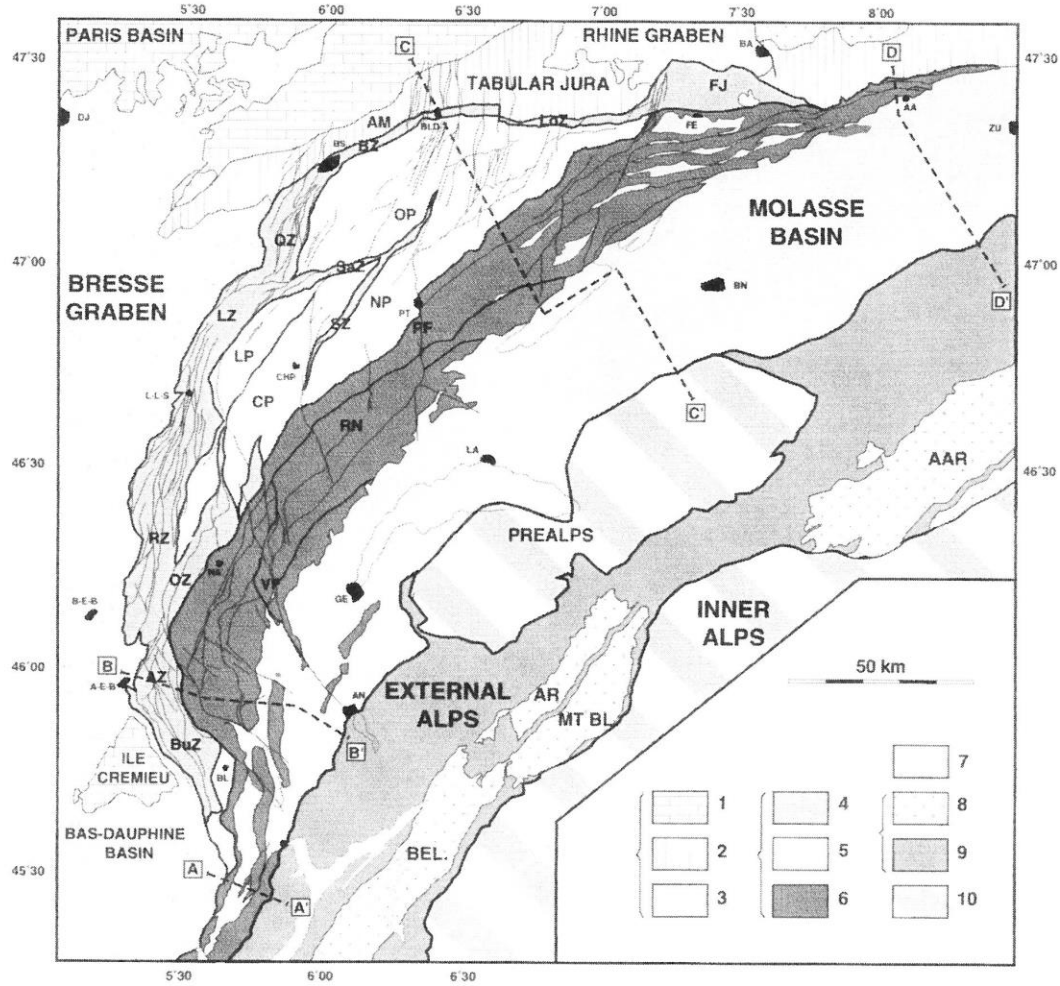

Figure 2: General structural map and thrust belt (Chauve et al., 1980, modified by Philippe, 1995).

1-3: Stable domain (1: Autochthonous Mesozoic cover of the Burgundy platform, 2: Para-autochthonous Mesozoic cover of the Avant-Monts zone and Tabular Jura; 3: Tertiary fill of the Bresse and Rhine grabens); 4-6: Jura fold-and-thrust belt (4: Imbricate zones ("Faisceaux"), 5: Plateaus, 6: Internal Jura); 7: Neogene deposits of the Swiss Molasse Basin; 8-9: Subalpine domain (8: Paleozoic basement, 9: Mesozoic cover); 10: Inner Alps and Swiss Prealps.

Internal Jura: BJ: Basel Jura; RN: Risoux Nappe; VF: Vuache Fault; PF: Pontarlier-Vallorbe Fault.

Imbricate zones ("faisceaux"): AZ: Ambérieu Zone; BZ: Besançon Zone; BuZ: Bugey Zone; FJ: Ferrette Jura; LZ: Lons Zone; LoZ: Lomont Zone; OZ: Orgelet Zone; QZ: Quingey Zone; SaZ: Salins Zone; SZ: Syam Zone.

Plateaux and Tabular Jura: AM: Avant-Monts zone; AP: Ajoie Plateau; CP: Champagnole Plateau; LP: Lons Plateau; NP: Nozeroy Plateau; OP: Ornans Plateau.

External Crystalline massifs: AA: Aar; AR: Aiguilles-Rouges; BEL: Belledonne; MT BL: Mont Blanc.

Cities: AA: Aarau; A-E-B: Ambérieu-en-Bugey; AN: Annecy; BA: Basel; B-E-B: Bourg-en-Bresse; BLD: Baumes-les-Dames; BL: Belley; BN: Bern; BS: Besan on; CHB: Chambéry; CHP: Champagnole; DJ: Dijon; FE: Ferrette; GE: Geneva; LA: Lausanne; L-L-S: Lons-le-Saunier; NA: Nantua; PT: Pontarlier; ZU: Zürich.

B.Colletta, IFP 2002

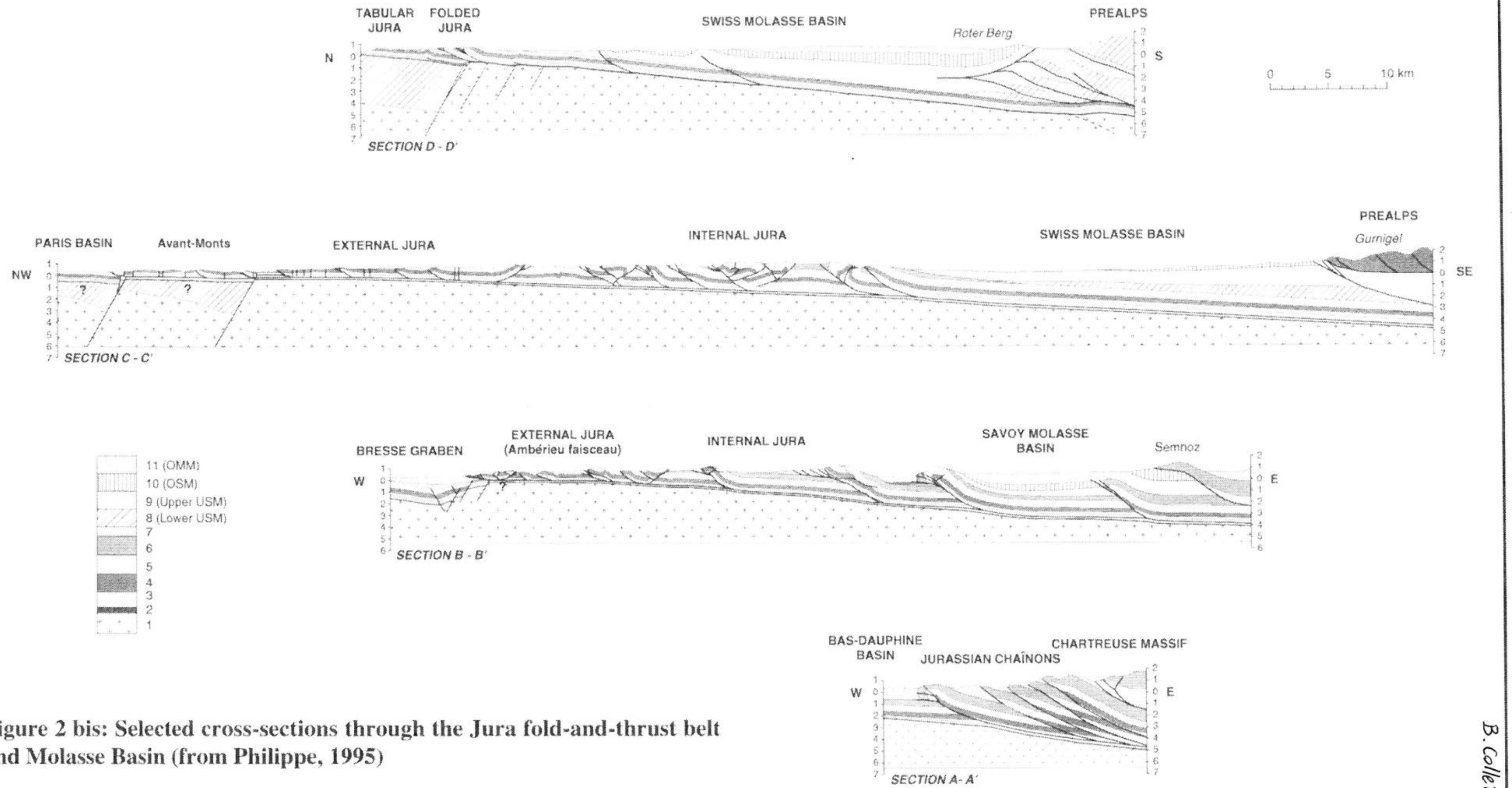

Figure 2 bis: Selected cross-sections through the Jura fold-and-thrust belt and Molasse Basin (from Philippe, 1995)

The eastern parts of the sections cross-cutting the Molasse Basin are from Burkhard, 1990 (sections C-C' and D-D') and Deville et al., 1994 (section B-B').

Stratigraphic fills:
1: Paleozoic basement; 2: Lower Triassic; 3: Middle - Upper Triassic & Lower Jurassic; 4: Middle Jurassic; 5: Upper Jurassic; 6: Neocomian; 7: Aptian; 8 & 9: Rupelian - Chattian; 10: Aquitanian; 11: Burdigalian to Serravalian

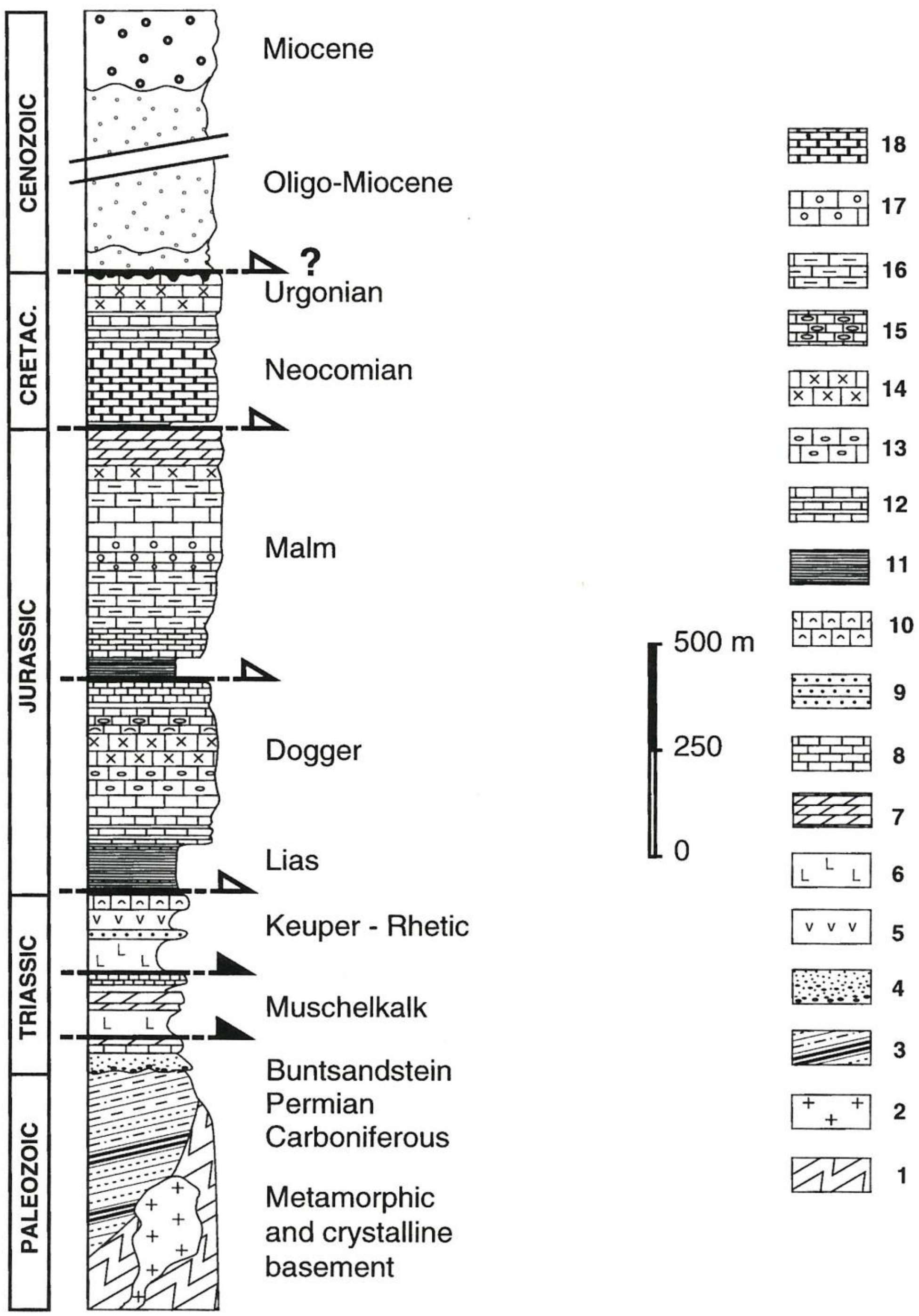

Figure 3: Simplified stratigraphic column of the jura fold and thrust belt (from Philippe, 1995).

Arrows indicate the potential décollement horizons (black arrows show the location of the two main regional sole thrusts. Eastern Jura: Middle Muschlelkalk salt; Central and Southern Jura: Early Keuper salt).

1: Metamorphic basement; 2: Granites; 3: Coal-measures and black shales; 4: Conglomerates, pebbles and sandstones; 5: Evaporites; 6: Massive salt layers; 7: Dolomites; 8: Limestones; 9: Sandstones; 10: Bioclastic limestones; 11: Marls; 12: Alternating marls and limestones; 13: Oncolitic limestones; 14: Reef limestones; 15: Cherty limestones; 16: Argilaceous limestones; 17: Nodular limestones; 18 : Limestones.

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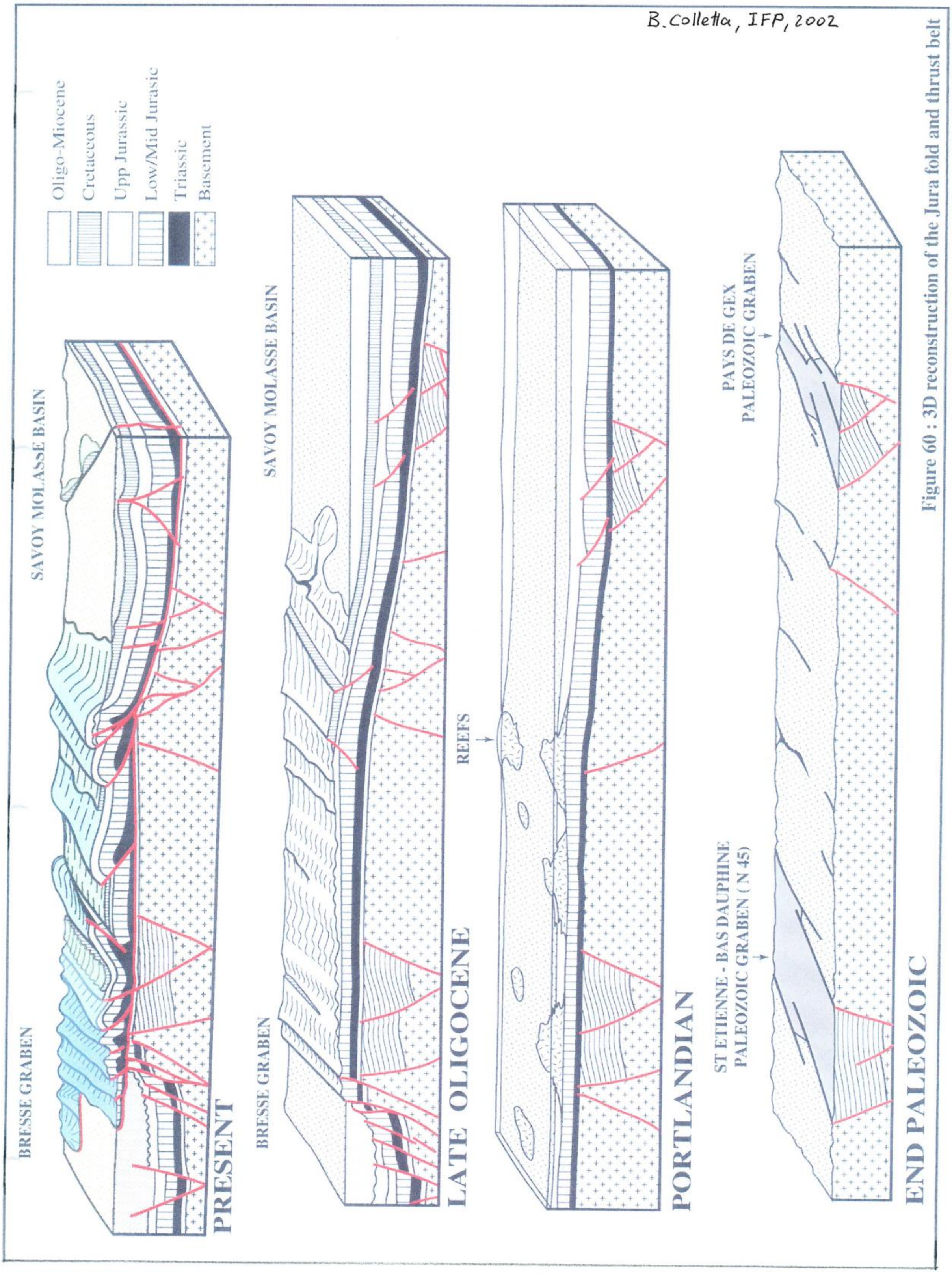

Figure 60 : 3D reconstruction of the Jura fold and thrust belt

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References:

- Geology of Switzerland, a guide book, R. Trümpy, 1980
- Jura Méridional, rapport d'évaluation pétrolière, B. Coletta, IFP, 2002
- Géologie et botanique au Creux-du-Van, T. Basset, www.thierrybasset.ch

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