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Artikel: Sedimentology of the Upper Marine Molasse of the Rhône-Alp region, eastern France : implications for basin evolution

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Kapitel: 3: Structure and tectonic setting

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directly overlies Mesozoic strata with a large chronostratigraphic gap. In general, the biostratigraphical control *within* the OMM is very poor, though the top of the OMM can be dated by the first occurrence of planktic foraminifera such as *Orbulina universa* and *Orbulina suturalis*, demonstrating an age of N8 or younger (Langhian or Serravallian). Previous workers have been forced into making primarily a lithostratigraphical subdivision of the succession (Lamiraux 1977; Mujito 1981), dated where possible by poor microfaunal assemblages (Latreille 1969), or correlated loosely with similar lithological units outside of the region which have more reliable biostratigraphical assignments (Perriaux 1984).

The lithostratigraphical units defined by Lamiraux (1977) have, in places, interfingering relationships along their boundaries, so that parts of some units are age-equivalent to parts of other units. We therefore have built our stratigraphic framework on the basis of the work of Lamiraux (1977), differentiating five *lithosomes* – a term which Wheeler & Mallory (1956) used for "*a rock mass of essentially uniform or uniformly heterogeneous lithologic character, having intertonguing relationships in all directions with adjacent masses of different lithologic character*". The succession is well differentiated into these lithosomes in the southern half of the study area between Chambéry and the Bas-Dauphiné (Fig. 4), but the stratigraphy is less well differentiated towards the north of the area in Haute-Savoie. However, the Montaugier unit acts as a marker that is found throughout the region; it does not exhibit obvious interfingering relationships with other lithosomes.

3. Structure and Tectonic Setting

Closure of the Piemont/Tethyan ocean and collision of Adria and Europe (Tapponnier 1977) resulted in the shortening of the European margin and the downflexing of the European plate (Karner & Watts 1983; Mugnier & Ménard 1986; Homewood et al. 1986). The resulting foreland basin filled firstly with Eocene to lower Oligocene marine sediments typified by the North Helvetic Flysch of Switzerland and Haute Savoie (principally the Taveyannaz and Val d'Illiez Formations) and the Annot and Champsaur Formations of Haute Provence and les Hautes-Alpes. The basin then filled essentially to sea level during the Molasse phase (Oligocene to mid-Miocene). Telescoping of the European margin to the east of the study area in the Oligocene to late Miocene resulted in the deformation of these foreland basin sediments (principally the Eocene-early Oligocene flysch-like sediments and the Chattian-Aquitanian Lower Freshwater Molasse, together with, in the Chartreuse, the Burdigalian OMM).

Continued compression from the Alpine wedge since the end-Miocene caused folding of the Mesozoic substrate of the region together with its Tertiary cover, forming the NNE–SSW trending southern prolongation of the Folded Jura. The shortening accompanying this phase of deformation is, however, slight compared to the large displacements in the orogenic belt proper (Mugnier et al. 1987; Gratier et al. 1989). Section balancing indicates that the shortening across the Jura folds in the southern part of the study area is about 5%, with this value increasing progressively towards the north into the Jura fold-thrust belt (Chauve et al. 1988; Guellec et al. 1990). The western limbs of the Jura folds are commonly cut by steep thrust faults (Fig. 5). These may be older faults dating from the Rhine-Bresse-Rhône extensional phase that have been inverted, creating folds in their hangingwalls. The OMM is preserved in synclines between these Jura folds.

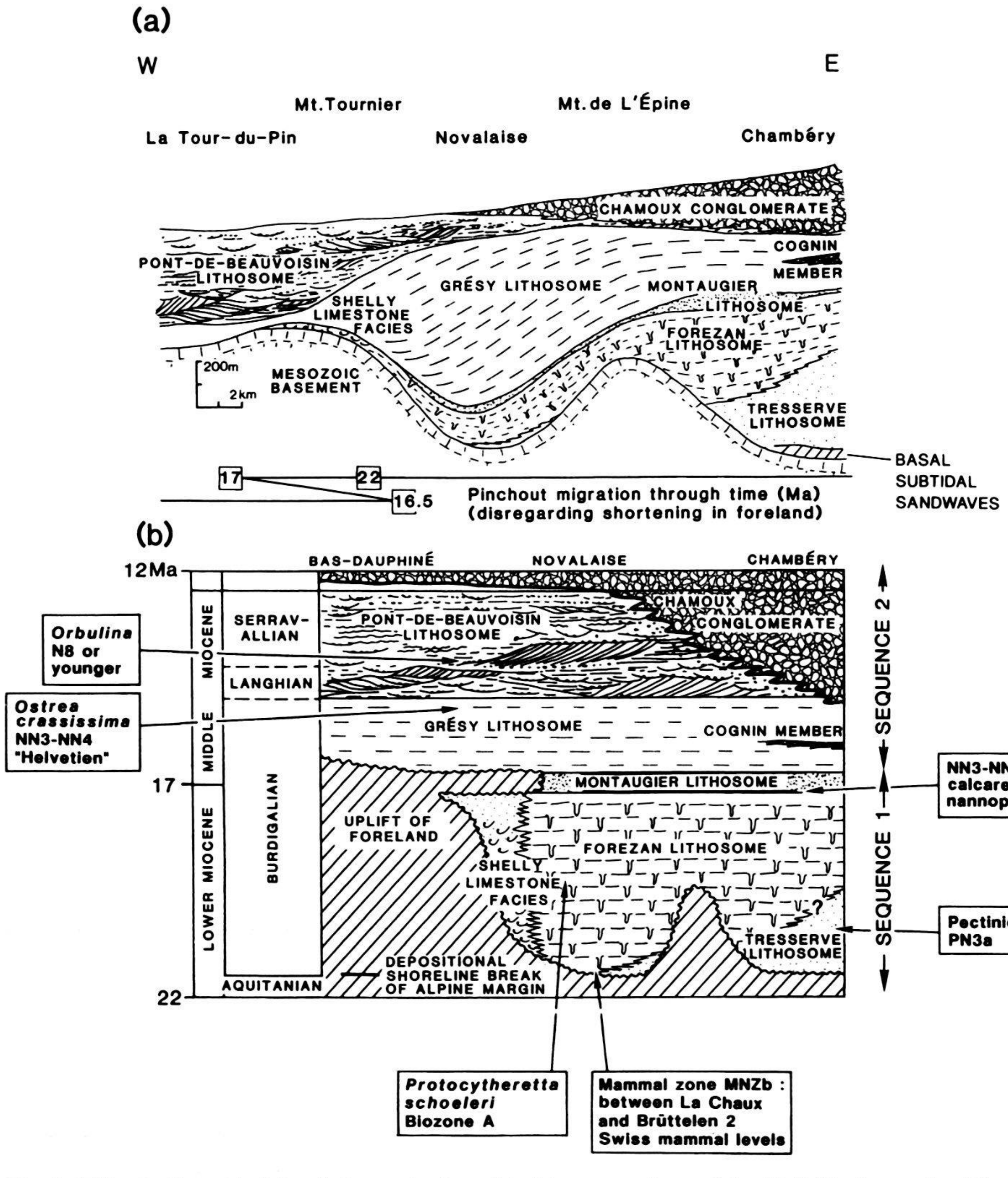

Fig. 4. Lithostratigraphic (a) and chronostratigraphic (b) cross-sections of the OMM in the south of the Rhône-Alp study area. Adapted from Lamiraux (1977), with approximate absolute ages derived largely from the European Oligocene-Miocene correlation chart of Berger (1992). Key faunal elements for chronostratigraphy are annotated. The lithosomes are named from villages nearby representative sections.

Although Eocene E–W folds and faults related to the compressional Pyrenean-provençal phase of deformation are found in the Rhône valley and Basse-Provence, strongly influencing molassic sedimentation (Gigot et al. 1974; Jones 1988), no such structures have been positively identified further to the north in the Rhône-Alp region (Siddans 1983).

During the late Eocene to Oligocene, the western European area underwent E–W extension, forming the linked rift basin system of the Rhine-Bresse-Rhône (Goguel 1948; Rat 1978; Ziegler 1988; Bergerat 1987; Bergerat et al. 1990). NNE–SSW trending

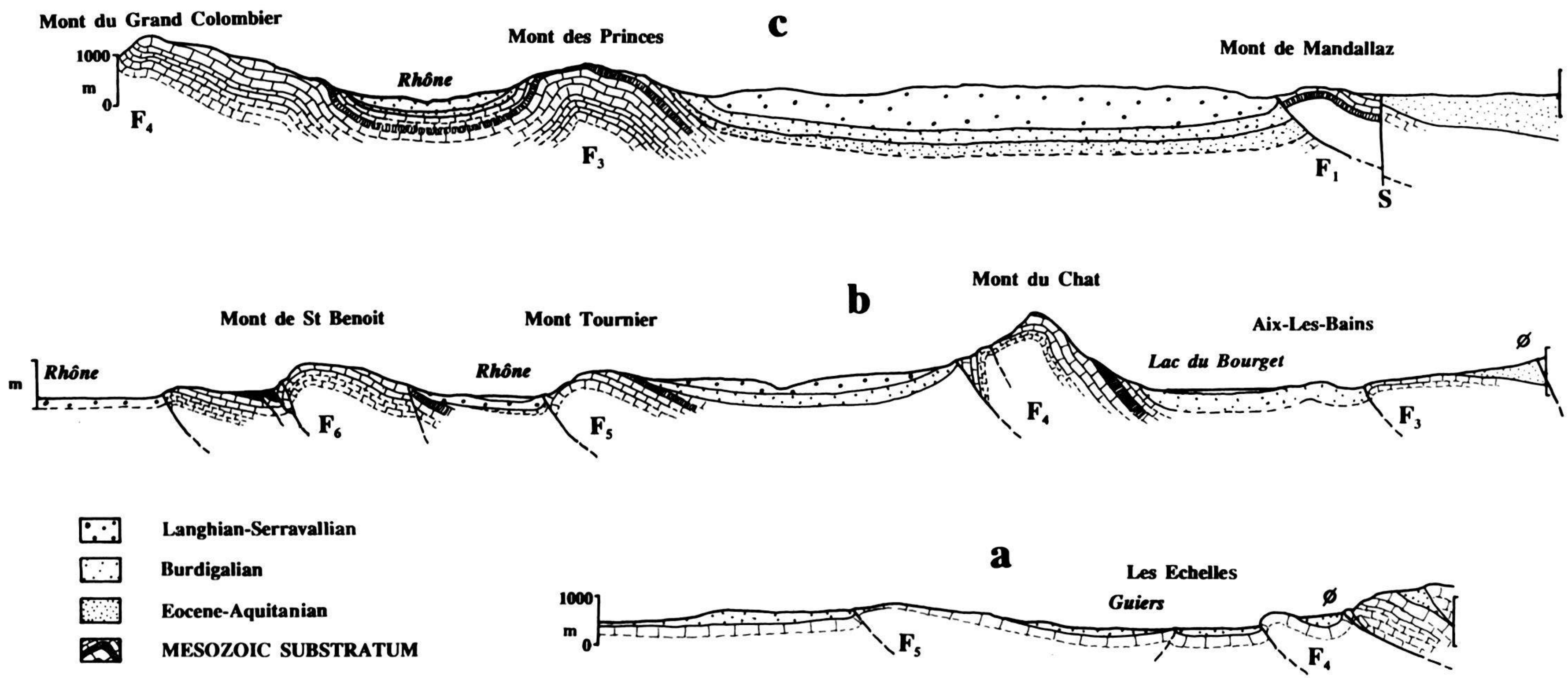

Fig. 5. Structural cross-sections across the Rhône-Alp region derived from geological maps. Sections a to c are located in Figure 2.

extensional faults of the Bresse graben and Jura province (Laubscher 1988; Chauve et al. 1988) extended southwards into the Rhône-Alp region and even into the Vercors and Chartreuse (Gidon 1982; Butler 1991, p 289), compartmentalizing the molasse basin during the Oligocene to early Miocene.

The OMM is found, therefore, in a number of structural positions: (i) within the Alpine orogenic wedge (basal deposits in the Chartreuse), (ii) within synclines between Jura folds (Rumilly, Chambéry and Novalaise synclines) and (iii) in the little deformed Bas-Dauphiné.

4. Sedimentology of the Upper Marine Molasse

4.1 The Initial Flooding

The Rhône-Alp region was flooded during the European micromammal biozone MN2b (Berger 1983, 1985), corresponding to the late Aquitanian-earliest Burdigalian (about 22 Ma). The marine transgression advanced along the peri-Alpine basin both from the SW (the *rhodanienne* origin of Rigassi 1977a; Büchi & Schlanke 1977; Berger 1985) and from the NE (the *viennoise* origin of Vavra 1982, and confirmed by Berger 1985). Working on sections in Haute-Savoie and western Switzerland, Berger (1985) concluded that the transgression was diachronous. In the case of Haute-Savoie, and therefore also the Rhône-Alp region, it originated from the south.

After the marine transgression, the Rhône-Alp region was occupied by a seaway that widened towards the NE into the Swiss Molasse Basin and to the SW into the "Rhodano-provençal Gulf" of Provence and the southern Rhône valley (De Lapparent 1938; Demarcq 1970, 1984) (Fig. 3). The western shore was rocky (Demarcq 1962; Latreille 1969), with Miocene marine sediments pinching out onto Cretaceous limestones (eg. at Gorges de Chailles; 8661 3582). The eastern shore has since been obscured by thrusting in the Subalpine chains and is thought to have extended further to the east to a position close to the base-Burdigalian uplifting thrust front (Demarcq 1962; Latreille 1969). The local presence of irregular unconformity surfaces on Cretaceous limestones (Fig. 6) covered with the traces of rock-boring bivalves, and limestone conglomerates and breccias containing bored pebbles, led Demarcq (1962), Perriaux (1984) and Perriaux et al. (1984) to conclude that the seaway at this time was characterized by numerous shallow shoals and islands.

The subcrop map of the unconformity (Fig. 7) shows that the topography of the surface was far from smooth, with wide variations in the amount of stratal omission below it. Actual amounts of missing stratigraphy are difficult to assess since lateral variations in Mesozoic-Palaeogene stratigraphy undoubtedly existed. However, it is evident that (1) progressively more substratum has been removed by erosion from north to south (north of Rumilly, the unconformity rests on Aquitanian, Chattian and Stampian deposits (Michel & Caillon 1957), whereas in the south the unconformity cuts down to Mesozoic carbonates, so that in the south of the study area (eg. at Les Echelles), in the Chartreuse and the Vercors, Miocene sediments rest directly on Lower Cretaceous Urgonian limestones); (2) there are local rapid changes in the stratigraphic level to which the unconformity cuts down, and positions of postulated palaeohighs are associated with distinctive facies within the Tertiary, such as the continental breccias of the Chattian-