
Sedimentary record in french karstic infillings during the last climatic cycle [Enregistrement sédimentaire dans les remplissages karstiques français au cours du dernier cycle climatique.]

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Abstract

Comparison of the sedimentary records in karstic infillings (cave entrances and rock-shelters) from three French regions (northern Alps, Franche-Comté, Périgord) is proposed for the last climatic cycle. There are displays large regional discrepancies, both in the periods recorded periods and in the extent and timing of the sedimentary gaps. These discrepancies are related to the respective geographical position of these three areas relatively to the glacial fronts during the last climatic cycle.

Résumé

Une comparaison de l'enregistrement sédimentaire dans les remplissages karstiques (porches de grottes et abris sous roche) de trois régions de France (Nord des Alpes, Franche-Comté, Périgord) est proposée pour la période du dernier cycle climatique. Elle fait apparaître de grandes disparités régionales en ce qui concerne les périodes enregistrées, l'importance et la place des lacunes sédimentaires. Ces différences sont interprétées en fonction de la position respective de ces trois régions par rapport aux fronts d'avancée glaciaire au cours du dernier cycle climatique.

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SEDIMENTARY RECORD IN FRENCH KARSTIC INFILLINGS DURING THE LAST CLIMATIC CYCLE

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ABSTRACT

Comparison of the sedimentary records in karstic infillings (cave entrances and rock-shelters) from three French regions (northern Alps, Franche-Comté, Périgord) is proposed for the last climatic cycle. There are displays large regional discrepancies, both in the periods recorded periods and in the extent and timing of the sedimentary gaps. These discrepancies are related to the respective geographical position of these three areas relatively to the glacial fronts during the last climatic cycle.

Key-words: Karstic infillings, last climatic cycle, sedimentary gaps, France.

RESUME

ENREGISTREMENT SEDIMENTAIRE DANS LES REMPLISSAGES KARSTIQUES FRANÇAIS AU COURS DU DERNIER CYCLE CLIMATIQUE

Une comparaison de l'enregistrement sédimentaire dans les remplissages karstiques (porches de grottes et abris sous roche) de trois régions de France (Nord des Alpes, Franche-Comté, Périgord) est proposée pour la période du dernier cycle climatique. Elle fait apparaître de grandes disparités régionales en ce qui concerne les périodes enregistrées, l'importance et la place des lacunes sédimentaires. Ces différences sont interprétées en fonction de la position respective de ces trois régions par rapport aux fronts d'avancée glaciaire au cours du dernier cycle climatique.

Mots-clés: Remplissages karstiques, dernier cycle climatique, lacunes sédimentaires, France.

I - INTRODUCTION

This paper provides a synthesis of sedimentary records in cave-entrance and rockshelter infillings from three regions of France where these deposits are both plentiful and well-studied. The regions studied are the northern Alps, Franche-Comté and the Périgord (fig. 1) and each forms a relatively homogeneous whole in terms of geography, geomorphology and climate. During the last glaciation, the position of these three regions were different in relation to the maximum expanse of ice: northern Alps lies within the intraglacial zone or at the limit of glacier extension, Franche-Comté in a zone 20-80 km beyond and Périgord lies far from the maximum expanse (250 km for the Pyrénées, 150 km for

the Massif central). Each site was studied with classical (lithostratigraphy and sedimentology, chrono- and biostratigraphical datas) methods (Campy, 1982, 1990; Campy & Chaline, 1993). The sites we discuss contain evidence of Middle Paleolithic (Mousterian) and/or Upper Paleolithic and/or Mesolithic industries. Findings from these three French regions with extensive karstic infillings indicate that the record of the last interglacial-glacial cycle is high variable and enable us to identify regional features or regional types.

II - NORTHERN ALPS

Some twelve sites in this region have been excavated and studied recently (Bintz & Loebell, 1976; Bintz *et al.*,

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1989). Six sites selected from the most complete and most significant studies are presented in fig. 2. The most frequently occurring sedimentary types and their chronological position are illustrated. The infillings nowhere predate the Tardiglacial (late-glacial time). A number of inter-site differences in the sedimentary record are noted: 1) The thickness of sediments may vary (Charmate, 2 m; Balme Rousse, 4.5 m; Coufin, 5 m; La Fru, 2m; Saint-Thibaud, 7 m; Abri Gay, 7 m); 2) A given climatic phase is not always represented by the same sedimentary facies at each site; 3) Sedimentation on the cave bedrock floor does not always start at the same period. All the infillings do not end at the same time; 4) A number of hiatuses in sedimentation have been identified in the infilling. They represent short periods (around 1000 yr or less) and are diachronous from one site to another.

These differences show that regional climate alone

does not provide a complete picture, and that local features (orientation, limestone type and structure, hill-slope location, etc.) strongly influence the sedimentary pattern. In spite of these differences, regional types can be defined on the basis of inter-site similarities: 1) The infillings nowhere pre-date the Tardiglacial. Where rare instances of older infillings have been reported, as evidenced by *Ursus spelaeus* and Mousterian industry (Lequatre, 1966), they are a hundred meters or so back from the cave entrance; 2) Cryoclastic type sedimentation typically occurs at the base of Tardiglacial infillings (Charmate, Balme Rousse, La Fru, Abri Gay), whereas the top of the Holocene, in particular in the Atlantic, is commonly characterized by carbonate precipitation type sedimentation (calcrete or travertine). In the northern Alps, these features apply both to cave-entrance (Abri Gay, Coufin, Balme Rousse) and to rockshelter (La Fru, Charmate, Saint-Thibaud) infillings. A «northern Alps»

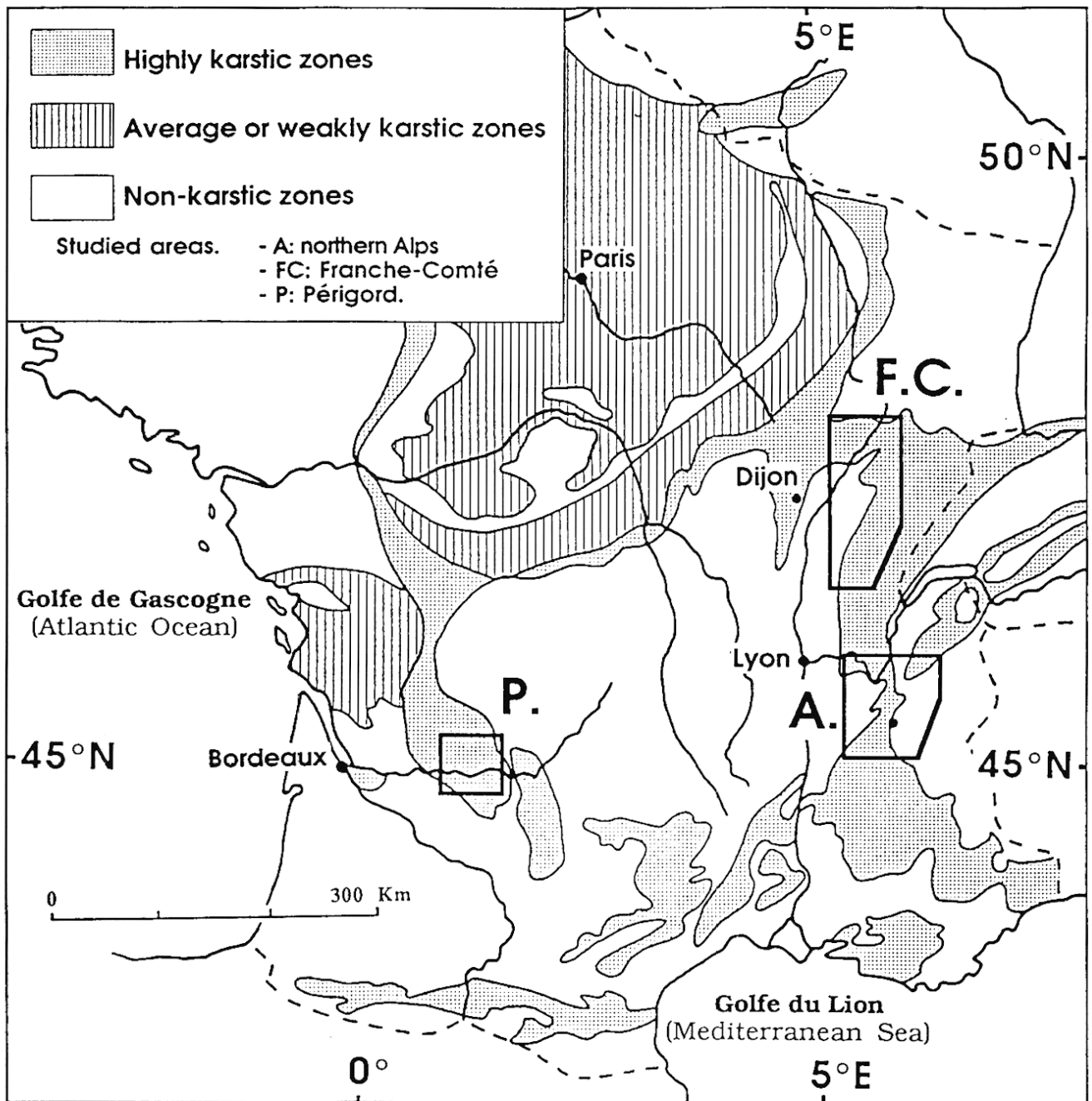


Fig. 1: Location of karstic zones in France and the study regions.
Fig. 1: Localisation des zones karstiques de France et situation des zones étudiées.

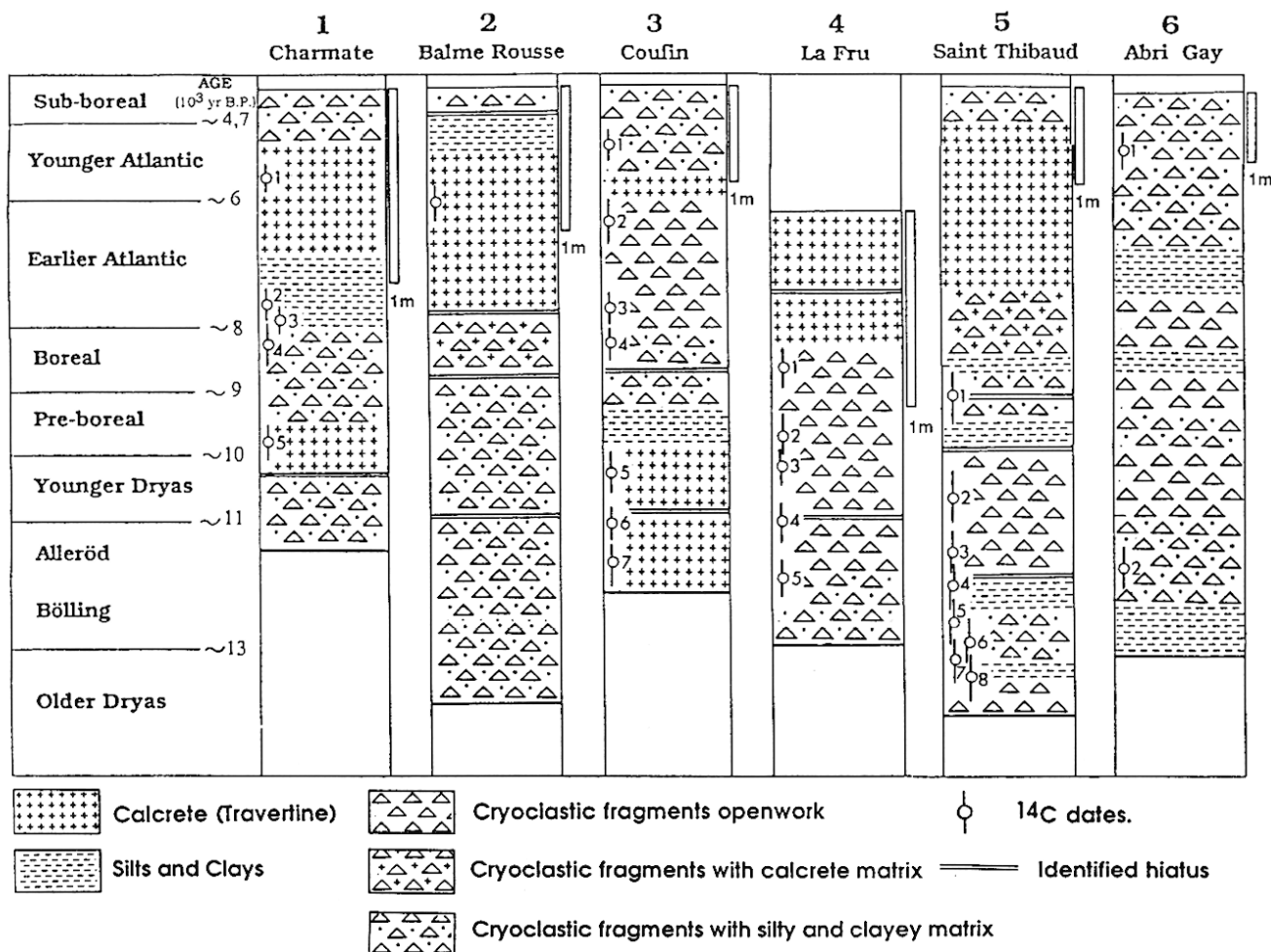


Fig. 2: Sedimentary record during the Tardiglacial and Holocene in the karstic infillings in the northern Alps. The major part of the last climatic cycle was not recorded and no deposits prior to the Older Dryas are known.

Fig. 2: Enregistrement sédimentaire au cours du Tardiglaciaire et de l'Holocène dans les remplissages karstiques des Alpes du Nord. La majeure partie du dernier cycle climatique n'a pas été enregistrée et aucun dépôt antérieur au Dryas ancien n'est connu.

regional type of sedimentary record can thus be defined.

III - FRANCHE-COMTE

Some ten sites have been excavated and studied recently (Campy, 1990; Campy *et al.*, 1989; Campy and Chaline, 1993) in this region, and four of the most thoroughly studied cases are presented here (fig. 3). They show the most frequently occurring sedimentary types and their chronological position in the last interglacial-glacial cycle. A number of inter-site differences in the sedimentary record are noted: 1) The thickness of sediments varies from site to site (Echenoz, 8 m; Gigny, 12 m; Casamène, 5 m; Rurey, 4 m); 2) Sediments from the last interglacial-glacial cycle overlie either clays of deep karst (Echenoz) or interglacial speleothem (Gigny, Casamène, Rurey); 3) All the infillings do not end at the same time, but in every instance there is a lack of sediment in the upper part.

A regional type can be defined in spite of these differences: 1) Most of the sediments of the last interglacial-glacial cycle contain evidence of Mousterian industry and were therefore laid down more than 35,000 years ago; 2) Hiatus indicators show that the whole of the lower Würm part is missing (Lower Glacial and Lower Pleniglacial). Middle Glacial sedimentation is extensive but patchy, and there is a marked hiatus at all the sites

around the middle of the period. The Upper Pleniglacial period is missing at all the sites. In Franche-Comté, it seems that this period was contemporaneous with erosional processes. The upper part of the sedimentary record is comparable to that found in northern Alpine infillings. The base is characterized by cryoclastic deposits (Tardiglacial period) and the top by carbonate precipitation (Holocene period); 3) Well-rounded coarse fractions typically occur in the first half of the Middle Glacial period, and very angular coarse fractions in the second half. These features apply especially to cave-entrance as opposed to rockshelter infillings, which are the only ones to contain sediments older than the Tardiglacial. In Franche-Comté there are rockshelter infillings where sedimentation starts only in the Tardiglacial and, minor details apart, is comparable to that occurring in northern Alpine rockshelters. A «Franche-Comté» regional type of sedimentary record is thus defined.

IV - PERIGORD

This region has a wealth of prehistoric dwellings, and well-studied sites of the type and the period under discussion are numerous. The most representative ones as presented in the latest syntheses (Bordes *et al.*, 1980; Laville *et al.*, 1980, 1983, 1986) are used here. The sites

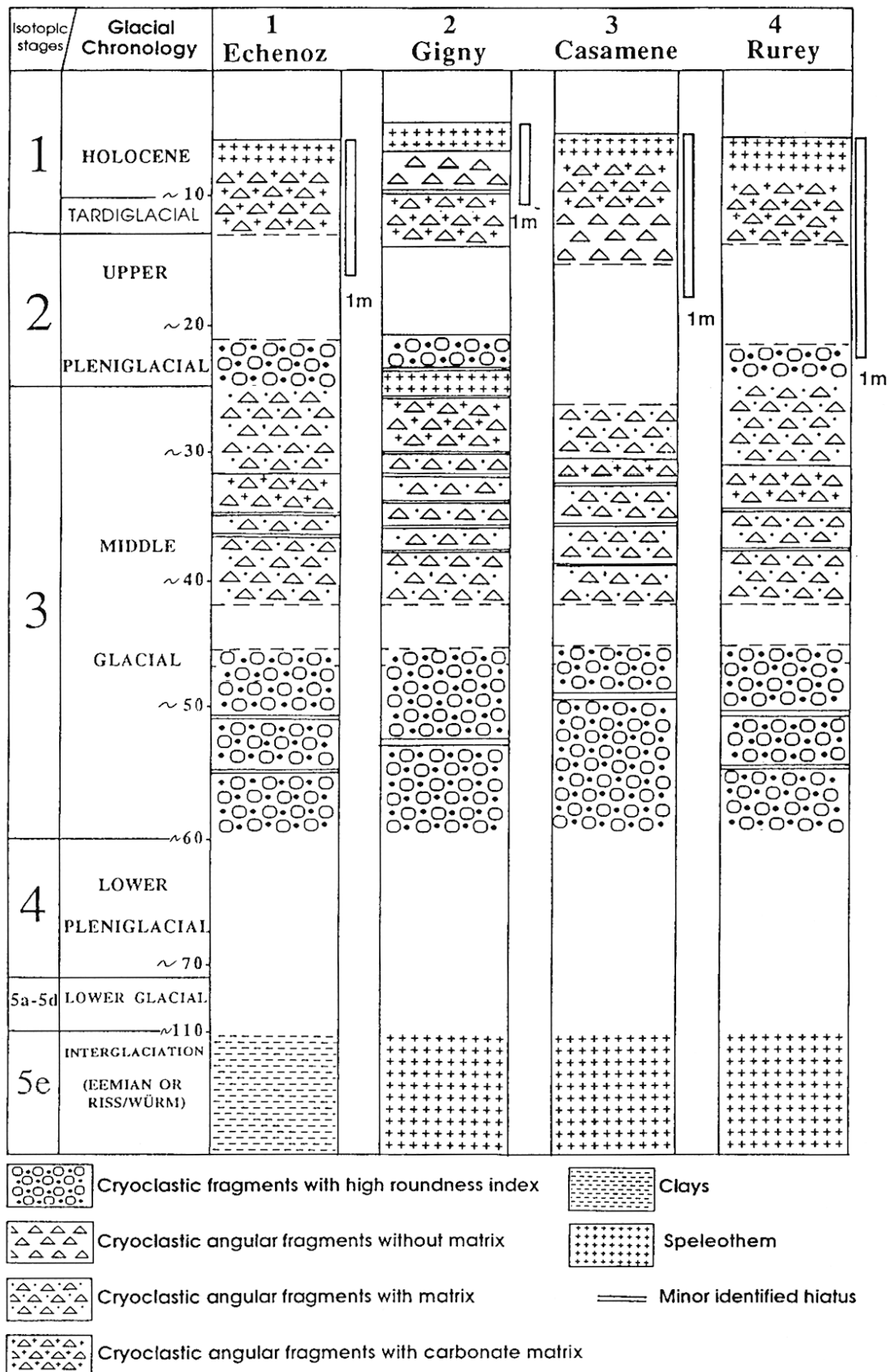


Fig. 3: Sedimentary record during the last climatic cycle in karstic infillings in Franche-Comté. The major identified gaps are shown as blanks.
Fig. 3: Enregistrement sédimentaire au cours du dernier cycle climatique dans les remplissages karstiques de Franche-Comté. Les zones laissées en blanc représentent les lacunes majeures repérées.

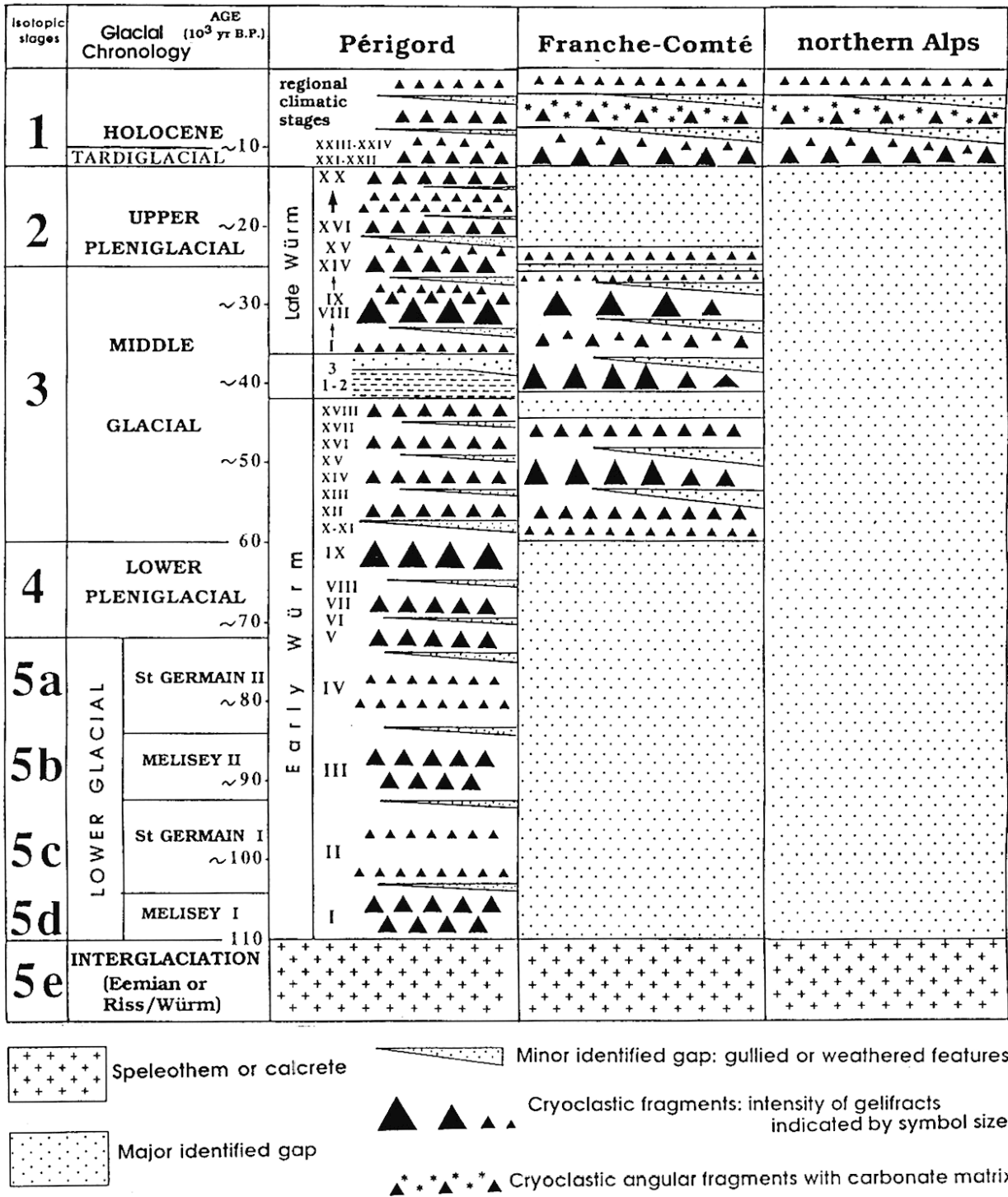


Fig. 4: Comparative sedimentary record during the last climatic cycle in Périgord, Franche-Comté and the northern Alps.
 Fig. 4: Enregistrement sédimentaire comparé au cours du dernier cycle climatique dans le Périgord, la Franche-Comté et les Alpes du Nord.

include cave-entrances (Vaufrey, Pech de l'Aze, Combe Grenal, Caminade, Roc de Combe) and typical rockshelters (Le Moustier, Pataud, Laugerie, La Madeleine, La Ferrassie, La Faurélie). Not all the sites present a complete sedimentary sequence spanning the whole of the last interglacial-glacial cycle because each site has been influenced in part by its individual geomorphological setting. Some sites (Pech de l'Aze, Combe Grenal, Caminade, Le Moustier) have only early Würm-age deposits with a Mousterian industry as they were completely filled at the end of this period, while others (Roc

de Combe, Abri Pataud, Laugerie, La Madeleine, La Ferrassie, La Faurélie) contain only late Würm-age deposits with Upper Paleolithic industries as they became active sediment traps only at this period. Despite these differences, a regional type of sedimentary record for the last interglacial-glacial cycle can be defined (fig. 4): 1) Calcite precipitation (speleothem or cement of breccia formation) or weathering of older sediments characterize the interglacial period (Riss-Würm or Eemian); 2) Cryoclastic sedimentation begins early in the Lower Glacial and the deposits are preser-

ved in numerous Périgord sites, which indicates that the erosion processes were only weak; 3) Sedimentation seems to have been more or less continuous at all the sites over the period with no major breaks, although gaps of 3000-4000 yr are reported at the Abri Pataud-site (Farrand, 1975); 4) This continuity in sedimentation has led to the recognition of a number of regional climatic stades which have been correlated with the global climatic chronology from lacustrine sequences and marine isotopic stages (Laville *et al.*, 1983, 1986).

Two sedimentary groups have been identified within the Würmian glacial period. The «Early Würm» group contains Mousterian industries and is subdivided into 23 cryoclastic levels separated by minor gaps identified by erosional and weathering features. This group corresponds to the Lower Glacial, Lower Pleniglacial and first part of the Middle Glacial periods. The «Late Würm» group contains Upper Palaeolithic industries and is subdivided into 20 diversely cryoclastic levels separated, as with the preceding group, by minor gaps. It corresponds to the second part of the Middle Glacial period and the entire Upper Pleniglacial period. Level XX corresponds to the Older Dryas. Between these two groups dominated by cryoclastic sediments, a further clayey sedimentary unit that is typically gullied and weathered is thought to represent a warmer phase (Cottés interstadial of palynologists). The top of the infillings present sedimentary features similar to those found in other French regions. The Tardiglacial period is commonly identified by 4 levels: XXI (Bölling), XXII (Middle Dryas), XXIII (Alleröd) and XXIV (Younger Dryas).

V - DISCUSSION AND CONCLUSIONS

In the main, karstic infillings of cave-entrances and rockshelters cannot be considered as good climate records of the past. Destructive processes result in numerous sedimentary hiatuses during the infilling. The frequency and chronological position of the largest hiatuses vary from one region to another (fig. 4). In the northern Alps all the pre-Tardiglacial sediments have been destroyed. It may be that they were never laid down, but this is unlikely since the climatic conditions of the Würmian period were highly amenable to cryoclastic processes. In Franche-Comté the absence of deposits of Lower Glacial and Lower Pleniglacial age indicates a sizeable phase of erosion at the end of the period resulting in a hiatus of some 50,000 yr. Two smaller breaks coincide with the central part of the Middle Pleniglacial and the entire Upper Pleniglacial. In the Périgord, no large hiatuses occur as in the other two regions and sedimentation is more continuous throughout the last interglacial-glacial cycle.

In regions where deposits span the entire climatic cycle (Périgord and Franche-Comté), it can be seen that long periods (e.g. Lower Pleniglacial, Middle Glacial, Upper Pleniglacial) have led to comparable sedimentary or erosive responses at each site in the same region. In contrast, for shorter term variations of the order of 1000 yr (e.g., Bölling, Younger Dryas, Boreal), the sedimentary record is not uniform among sites of the same region. A case in point is the Tardiglacial and Holocene infillings in the northern Alps (fig. 2) where site-dependent features (orientation, limestone type, hillslope position, etc.) influence sedimentation and mask the climate-induced effect.

It now remains to try to explain the variations in the

inter-regional sedimentary record. Paleogeographic evidence suggests that the climate has been relatively homogeneous across the three study regions since the Tardiglacial, for which period inter-site differences are greater than inter-regional ones. This was not the case during the earlier periods of the last interglacial-glacial cycle when contrasts were more marked. The study sites in the northern Alps lie in the intra-glacial zone or at the limit of glacier extension during the last maximum (Monjuvent and Nicoud, 1988). Even if the glacier was not directly responsible for the erosion of more ancient deposits, the proximity of the glacial front caused intense destructive processes during melting both by activating karstic networks and so eroding cave-entrance sediments and by activating solifluction and so destroying rockshelter sediments. In Franche-Comté, all the study deposits lie in a zone some 20-80 km beyond the Jura glacier front (Campy, 1982). This paleogeographic zone was thus much influenced by glacial melt phenomena. The Jura glacier advanced twice during the last interglacial-glacial cycle (Campy, 1982), during the Lower Pleniglacial and the Upper Pleniglacial. The two main hiatuses revealed in the karstic infillings in Franche-Comté appear to result from reactivation of karstic networks during the glacial advances. In the Périgord, the greater degree of sedimentary continuity stems from the different regional environment where the reduced impact of periglacial erosion (periodic frost and thaw, episodic reactivation of karstic activity, solifluction) led to better preservation of deposits. The atlantic climate (attenuated temperature amplitude, equability of precipitation) and remoteness from glacial fronts (250 km from the Pyrénées, 150 km from the Massif central) resulted in what can be considered an attenuated periglacial environment.

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