Geophysical Research Abstracts, Vol. 7, 06631, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06631

Paleomagnetic datings on "Siderolithic" paleoweathering profiles along French Massif Central.

C. Ricordel (1), M. Thiry (1,2), M.-G. Moreau (3), H. Théveniaut (4).

(1) Géosciences, Ecole des Mines de Paris, 35 rue St Honoré, 77305 Fontainebleau, France, (2) CNRS-UMR 7619 Sisyphe "Structure et fonctionnement des systèmes hydriques continentaux", France, (3) IPGP Laboratoire de Paléomagnétisme et de Géomagnétisme, 4 Place Jussieu 75252 Paris Cedex 05, France, (4) BRGM – Guyane, Domaine de Suzini, route de Montabo, B.P. 552, 97333 Cayenne Cedex 2, France (caroline.ricordel@ensmp.fr)

1 Introduction

Geodynamical evolution of a region is actually mainly constrained by the sedimentary record in the basins. Generally, little is known about geodynamics of the peripheral areas and even less of the evolution of the basement areas. However extending isochroneous lines, from basin to basement, could be of great mean to constrain geodynamical model of basin considering not only subsidence in the basin but also uplift and erosion on its edge.

Remnant kaolinitic paleoweathering profils are scattered around the Massif Central. These"Siderolithic" formations have classically been ascribed to the Tertiary, namely the Late Eocene and Oligocene periods. Such paleoweathering occurrences have been studied by mean of paleomagnetic dating in three areas along a north-south section through the Massif Central.

2 Sampling and paleomagnetic methods

The study is based on oriented samples collected on ferrugineous duricrust horizons. The weathering profiles were sampled at vertical intervals of 40-50 cm. All remanence measurements were obtained at the Paleomagnetic Laboratory of the Institut Physique du Globe de Paris and final results were carried out using PaleoMac 5 software (Cogné, 2003).

The remanence measurements were made using a three-axis cryogenic magnetometer (2G). The samples were subjected to stepwise (50˚C to 10˚C) thermal demagnetization up to 650-700˚C. Results of progressive demagnetization experiments were displayed using Zijderveld diagrams (Zijderveld, 1967). Characteristic components were determined by a least-square straight line analysis constrained (or no) to pass through the origin (Kirschvink, 1980). Statistical procedures have been used to calculate site-mean directions (Fisher,1953).

Relative dating of the azoic hardpans have been acquired by comparing the recorded paleomagnetic poles from the samples with the apparent polar wandering path of the Eurasian plate (Besse and Courtillot, 2002).

3 The “Siderolithic” paleoweathering profiles

3.1 In northern Massif Central

In the Saint Désiré area (edge of the Cher Graben), contrasting paleolandscapes, formed from deep paleodrainages and pediments surrounding bedrock paleoreliefs, are buried by Siderolithic deposits. Two sedimentary units have been distinguished: fluviatile deposits with feldspar, kaolinite and smectite fill up paleovalleys; debris flow and sheet flow deposits with quartz ans micaschist gravels, kaolinite and illite form the pediment and are capped by red silica dusricrusts (Simon-Coinçon *et al.*, 2000). The red duricrust develops within the micaschist fragments bearing clayey formations and shows variable facies: coarse with numerous quartz gravels and cross stratifications, or on the contrary finer, better sorted, without clear layering. The red duricrusts form contrasting catena with upstream nodular facies organized in rough columnar structure and downstream development of braided subhorizontal layering (Thiry, 1999). They locally reach over 20 m thickness.

The nodular facies gave no exploitable paleomagnetic signals contrary to the coarse and massive ones. Two sections gives interpretable results and all the samples were used to calculate the mean paleomagnetic directions. The upper part of the profiles suggests an age around 140 Ma while the lower part gives ages centered around 50 Ma (Théveniaut, 2003; Quesnel *et al.*, 2003). This points out a deepening of the paleoprofile in two steps. Remains the question if this deeping was progressive during a long time interval or performed in two steps by renewal of the weathering after burial and exhumation.

3.2 In the centre of Massif Central

In the Saint-Germain-de-Lembron area, on the edge of the Limagne graben, along the fault scarp outcrop thick red kaolinitic formations. These Siderolithic deposits are also arranged in clear paleolandscape features: around basement paleoreliefs, leaned against fault scarps, infilling paleovalleys, etc. The “Les Mottes” section at Boudes shows a 20 m thick succession of iron mottle and bleached horizons. Micromorphological studies allows to relate these horizons to the superimposition of three paleoweathering profile (Thiry *et al*., 2004). At the base, resting on the basement, there is a mature red kaolinitic soil with numerous pedological features (nodules, illuviations, ...). This first paleosol has been buried by about 15 m of clayey and sandy deposits. A weathering profil developed in these deposits and displays successive horizons: an upper leached sandy horizon, with ferrugineous rhyzolite-like pipes; a middle clayey, hydromorphic horizon, with numerous clay illuviations and iron oxide pisolithes; a lower mottled horizon that penetrates and bleaches the former basal paleosoil. A younger paleosoil containing a pedogenetic silcrete horizon tops the section.

In the whole, we sampled 6 sub-sites in the “Les Mottes” section and 7 others sites in the Lembron area. Analyses of two sites are still in progress. 64% of samples yielded a well defined component between 500 and 700˚C. The paleoweathering profiles in the Lembron area date back to 140 Ma with a confidence ellipsis encompassing all ages between 140 and 110 Ma.

3.3 In southern Massif Central

In Naussac, red kaolinitic paleosoils developped on a coarse alluvial fan leaned on a fault scarp. The paleosoils show well preserved pedogenic features (termites burrows, illuviation and hydromorphic features, nodules...) but regarding the heterogeneity of the deposits they do not dispay clear pedogenic horizons. Thus it is not possible to state if they tally with one or several superimposed paleosoils.

Paleomagneting datings have been performed for 2 sites. More than 60% of samples give high temperature consistent signals with well clustered caracteristic component (α_{95}= 6˚). The age proposed is around 160 Ma.

4 Conclusion

Paleomagnetic datings collected from paleoprofiles have deeply renewed our knowledge of the Lower Cretaceous continent. Paleomagnetic data on the *in situ* paleosoils give late Jurassic to early Cretaceous ages on formations that were previously ascribed to the lower Tertiary. Several points have to be highlighted.

1. Ages become older from the North to the South of the Massif Central.
2. The development of paleoweathering corresponds probably to a long lasting continental evolution and landscape stability. Unfortunatly it is difficult to make reconstructions of the paleolandscapes because only scattered patchworks of the weathering blancket are preserved.
3. No evidence of detritic elements proceeding from a Mesozoic cover (inherited sandstones or cherts) has been recognised and weathering reaches the basement. This points out that no Mesozoic cover was present on the basement of Massif Central during development of the red kaolinitic paleosoils.
4. These datings have major incidences on the geodynamic evolution of the Massif Central and subsident basins around. Previous studies of apatite fission tracks thermochronology pointed to deposition of a thick (2000 m) sedimentary cover during the Early Cretaceous (Neocomian) (Barbarand *et al*., 2001; Séranne *et al.*, 2002).

In the futur, making substantial progress in paleoweathering profiles dating, especially in the scope of improving time resolution, will allow to attempt efficient correlation between the continental records, i.e. the paleoweatherings, and the diverse processes involved in their development (eustatism, climate, global and regional tectonics). Moreover, progress in dating paleoweathering features and continental azoic deposits, will allow to build up a "continental stratigraphy" of the ancient climatic and geomorphological events and to establish a mass balances between weathering/erosion/basin deposits.

4.1 References

Barbarand J., Lucazeau F., Pagel M., Séranne M., 2001, Burial and exhumation history of the south-eastern Massif Central (France) constrained by apatite fission track thermochronology. Tectonophysics, 335/3-4, 275290.

Besse J., Courtillot V., 2002. Apparent true polar wander and the geometry of the geomagnetic field over the last 200 Ma. J. Geophys. Res, 107, 2300, doi:10.1029/2000JB000050

Cogné J.P., 2003. PaleoMac : a Macintosh TM application fir treating paleomagnetic data and making plate reconstructions. Geochem. Geophys. Geosyst, 4(1), 1007, doi: 10.1029/2001GC000227.

Fisher, R. A., 1953. Dispersion on a sphere. Phil. Trans. Roy. Soc. London, Ser. A, 217, 295.

Kirschvink J.L., 1980. The least-squares line and plane and the analysis of paleomagnetic data. Geophys. J. Roy. Astron. Soc., 62, 699-718.

Quesnel F., Thiry M., Simon-Coinçon R., Théveniaut H., Wyns R., 2003, Paléopaysages siderolithiques au nord du massif central. 9ème Congrès Français de Sédimentologie, Bordeaux, 14 au 16 oct., Livre des résumés, Publ. ASF, Paris, 38, 416-417.

Séranne M., Camus H., Lucazeau F., Barbarand J., Quinif Y., 2002, Surrection polyphasée de la bordure cévenole. Un exemple de morphogenèse lente. Bull. Soc. géol. France, 173/2, 97112.

Simon-Coinçon R., Thiry M., Quesnel F., 2000. Paléopaysages et paléoenvironnements sidérolithiques du Nord du Massif central (France). C.R. Acad. Sci. Paris, Sciences de la terre et des planètes, 330/10, 693700.

Théveniaut H., 2003. Paleomagnetism as an indirect dating tool of lateritic weathering profiles (saprolite, bauxite and ferricrete): theoretical bases, method, results in French Guiana, Africa and Europe, In: Paleoweathering and paleosurfaces in the Ardennes-Eifel region –Preizerdaul, Luxmbourg, 14-17 mai 2003, Geologie de la France, 1, 89-90.

Thiry M., 1999.Diversity of continental silicification features: Examples from the Cenozoic deposits in the Paris Basin and neighbouring basement. In : Palaeoweathering, palaeosurfaces and related continental deposits (eds. Thiry M. & Simon-Coinçon R.), Spec. Publ. Intern. Ass. Sediment., 27, 87-128.

Thiry M., Moreau M.-G., Simon-Coinçon R., Ruellan P.-Y., 2004. Datation des paléoaltérations et des évenements geodynamiques continentaux-II- paléoaltérations, paléoreliefs et datation des formations « sidérolithiques » du Lembron. Rapport Armines/Ecole des Mines, LHM/RD/2004/03, 76 p.

Zijderveld J.D.A, 1967. A.C. demagnetization of rocks: Analysis of results, In: Methods in Paleomagnetism, ed D.W. Collinson, K.M. Creer and S.K. Runcorn, Elsevier, Amsterdam, 254-286.