Paleomagnetism as an indirect dating tool of lateritic weathering profiles (saprolite, bauxite and ferricrete): theoretical bases, method, results in French Guiana, Africa and Europe

Hervé THÉVENIAUT (1)

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Paleomagnetism can be used as a relative dating tool when classical radiometric dating technics can not be achieved. However, two conditions have to be met for a successful use of such an approach. It is first necessary that the studied rocks have magnetic minerals which could carry a stable remanent magnetization. Secondly, the studied rocks have to belong to a continent which has a well defined Apparent Polar Wander Path (APWP) which will be the reference used for relative dating.

Lateritic weathering profiles nearly always meet the first condition as they were formed under conditions which transformed any primary mineralogy to a secondary one which usually concentrates oxi-hydroxides minerals. Goethite and hematite are quite often such secondary minerals which acquire a chemical remanent magnetization during their crystal growth and therefore the profile formation.

The secondary condition is met for stable continents up to 200 Ma ago for which well calibrated APWP have been established by the use of well calibrated paleomagnetic data transferred on any continent with accepted oceanic opening parameters (Besse and Courtillot, 2002). Lateritic weathering profiles are essentially estimated to be formed after Triassic time, therefore meeting this secondary condition.

Initially discovered in Australia as a secondary magnetization (Schmidt and Embleton, 1976), the « weathered » paleomagnetic signal was applied as a dating tool mainly in Australia and India (Idnurm and Schmidt, 1986). A few studies followed but apart from these Australian and Indian studies, only attempts were undertaken on the other continents.

Recently this approach regain some interest by the study of a complete lateritic profile in French Guiana (Théveniaut and Freyssinet, 1999) and the study of different duricrust paleosurfaces of the Guyana Shield in French Guiana and Suriname (Théveniaut and Freyssinet, 2002). Other studies were undertaken in West Africa (Théveniaut and Freyssinet, in prep.) and more recently in western Europe.

We here present all results obtained in South America, West Africa and France which show a a strong imput of the paleomagnetic approach for the understanding of lateritic weathered profile formation. The other studies in the French Massif Central border (Théveniaut *et al*., in prep.) and on the Borne de Fer ferricrete in northeastern France (Théveniaut *et al*., in prep.) will also be detailed.

This approach on these continents and their varying bedrock and weathering origin allowed an important relative dating within and between profiles. The vertical approach of a complete profile (Théveniaut and Freyssinet, 1999) in French Guiana brought to the calculation of a saprolitization rate concordant by this physical approach to those estimated by geochemical analyses (*e.g.* : Silica mass balance). The study of duricrust formation exhibited characteristic signals acquired at different periods and corresponding to each elevated duricrust remnants. On the West African saprolitic profile, a clear diachronic signal shows for the first time the different stages which shape the present day landscape.

Following these results, tentative use of paleomagnetism was undertaken in western Europe in the French Massif Central border and in the French Ardenne border. In the French Massif Central border, the « siderolithique » red sandstones formation was sampled with different results. The most interesting results came from the Loze profile which recorded two paleomagnetic signals due to two weathering phases. Initially considered

(1) Brgm-Guyane, domaine de Suzini, route de Montabo, 97333 Cayenne cedex, France. h.theveniaut@brgm.fr

as Tertiary formations, our paleomagnetic relative ages show the profiles were initially affected by weathering processes during Cretaceous time before the effect of a second Tertiary episode.

The results of the paleomagnetic study of the « Borne de Fer » profile differ from the others as the main magnetic carrier appears to be goethite rather than hematite. The Cretaceous age obtained appears then as one of the oldest paleomagnetic signal recorded by a secondary goethite. Moreover, this « old » age strenghtens the idea of the Ardenne evolution with weathering episodes which left some remnants of greater interest for the understanding of western Europe geomorphological evolution.

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