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Preliminary dating of the Mansu-Ri and Wondang-Jangnamgyo Early Paleolithic sites

Datations préliminaires des sites du Paléolithique ancien de Mansu-Ri et Wondang-Jangnamgyo

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ABSTRACT

The lack of carbonates and fossils in Early Paleolithic open air river terrace sites in Korea makes chronological assessment difficult. Nevertheless, a paleomagnetic study of the thickest section (about 9 m) at Mansu-Ri (Locality IV) revealed only normal polarity, indicating an age younger than 0.78 Ma all along the section. In Mansu-Ri (Loc. IV), measurements of the in situ-produced ^{10}Be and ^{26}Al concentrations in two pebbles yield similar ^{26}Al/^{10}Be burial durations ranging from a minimum duration of 225 ka to a maximum duration of 621 ka. In Wondang-Jangnamgyo, two pebbles yield different ^{26}Al/^{10}Be burial durations with a minimum duration of 235 ka and a maximum duration of 495 ka for one and ranging from 975 ka to 3.2 Ma for the other. This last unrealistically old burial duration range most likely results from a complex history of successive burials and expositions. Interestingly, by analogy with the Chinese loess section, the obtained minimum burial durations are coherent with the paleomagnetism result interpretation associating to glacial cycles the 3 paleosoils covering the samples dated at Mansu-Ri.

Mots clés :
Paléolithique ancien
Corée du Sud
Nucléides cosmogéniques
Durées d'enfouissement

RÉSUMÉ

La médiocre préservation des carbonates et des fossiles dans les terrasses alluviales aériennes des sites coréens du Paléolithique ancien complique leur cadrage chronologique. Une étude paléomagnétique de la section la plus épaisse (environ 9 m) du site de Mansu-Ri (localité IV) a néanmoins mis en évidence une polarité normale, suggérant pour l'ensemble de la section un âge inférieur à 0,78 Ma. Pour ce site, la mesure des concentrations en ^{10}Be et ^{26}Al produits in situ dans deux galets de quartz conduisent à des durées ^{26}Al/^{10}Be

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d'enfouissement similaires, comprises entre une durée minimum de 225 ka et une durée maximum de 621 ka. Pour Wondang-Jangnamgyo, les deux galets sélectionnés conduisent à des durées $^{26}Al/^{10}Be$ d'enfouissement différentes, comprises entre une durée minimum de 235 ka et une durée maximum de 495 ka pour l'un, et entre 975 ka et 3,2 Ma pour l'autre. Ces dernières durées d'enfouissement minimales et maximales résultent fort probablement d'une histoire complexe d'enfouissements et d'expositions successifs du galet étudié. Les durées minimales d'enfouissement obtenues sont cohérentes avec l'interprétation des résultats issus de l'étude du paléomagnétisme qui, par analogie avec la section de lœss chinois, associe à des cycles glaciaires les 3 paléosols recouvrant les échantillons datés à Mansu-Ri.

1. Introduction

The advent of the Accelerator Mass Spectrometry (AMS) technique has offered opportunities to develop several dating methods linked to the detection and measurements of cosmogenic nuclide concentrations such as carbon 14, beryllium 10 and aluminum 26 (^{14}C, ^{10}Be, ^{26}Al; e.g., Bourlès, 1992; Granger, 2006). One of these new dating methods, developed less than fifteen years ago, is based on the temporal exponential decrease of the $^{26}Al/^{10}Be$ ratio in substrates containing siliceous minerals that have been exposed to the cosmic ray before being buried under deposits that protect them from secondary cosmic ray radiation (e.g., Granger and Muzikar, 2001).

This burial duration dating method initially used to date quartz gravels in caves in order to establish river incision rates (Granger and Muzikar, 2001) was then applied successfully to several sites of paleontological and archaeological interest. Indeed, this method made it possible to date the Hominin sites from the cave of Sterkfontein in South Africa, recently re-evaluated at ~ 3.7 Ma (Granger et al., 2015), then that of Sima del Elefante in Atapuerca (Spain) at ~1.1 Ma (Carbonell et al., 2008). More recently, it was applied to an Early Acheulean site, near the town of Windsorton in South Africa, to determine the age of the Rietputs Formation, estimated between 1.2 and 1.7 Ma (Gibbon et al., 2009), and to the site of Zhoukoudian in China. In this last case, it involved a question of the age of *Homo erectus*, named "man of Beijing", which now is estimated at ~0.8 Ma (Guanjun Shen et al., 2009). Also in Asia, the $^{26}Al/^{10}Be$ dating method applied to 6 quartz artefacts collected in the Paleolithic site of Attirampakkam postponed the arrival of the first hominins on the Indian peninsula at 1.51 Ma ± 0.09 Ma (Pappu et al., 2011). Lastly, the age of the *Homo erectus* of Kocabaş was re-evaluated as between 1.2 and 1.6 Ma (Lebatard et al., 2014a, 2014b).

Recent discoveries of more than a hundred ancient Paleolithic sites in South Korea with which a rich lithic industry is associated (de Lumley et al., 2011) updated hominin dispersion in the Asiatic East and the settlement history of the Korean peninsula. In these sites, mainly in open-air fluviatile context, rich industries were unearthed in siliceous detrital sediments where no fauna was conserved. Only a few cave sites have yielded large mammal faunas in association with Early Paleolithic industries, reflecting the great antiquity of the hominin presence in the Korean peninsula. In the absence of faunas, their chronological frameworks are less certain. To obtain radiometric dates, several dating methods (OSL, ESR, IRSL...) were employed at some sites, but the first attempts were inconclusive or inconsistent (de Lumley et al., 2011 and references therein) and the ancient Paleolithic sites remain poorly dated in Korea.

Among these open-air Early Paleolithic sites, the Mansu-Ri (Figs. 1 and 2) and Wondang-Jangnamgyo (Figs. 1 and 3) areas appear suitable to attempt absolute dating. Here, we present the preliminary results obtained using the burial dating method to determine the burial duration of quartz pebbles from these two South Korean Early Paleolithic sites. At Mansu-Ri (Locality IV) site, the thickness of the section allows to perform a paleomagnetic study whose data are compared to the determined burial durations obtained from the same site.

2. General Context

The two selected Paleolithic sites are open-air sites close to rivers. On both sites, lithic industries were mainly unearthed from soil horizons interbedded with sandy-clayey silt levels corresponding to flood, Aeolian and colluvium deposits (de Lumley et al., 2011).

The Mansu-Ri (Loc. IV) site, located in Cheongwon, Chungcheongbuk-do province, 108 km SSE from Seoul (36°37' N, 127°19' E; altitude: 27–45 m; Fig. 1), was excavated in 2006. Along the ~9 m deep excavated clay-sand sequence (Fig. 2), 5 archaeological levels contained nearly 400 lithic artifacts. Within the first meter, 3 tephras were identified whose oldest age is 90–95 ka (de Lumley et al., 2011, and references therein). The 5-c cultural layer at 6 m depth, from which 46 lithic tools typical from the ancient Paleolithic were unearthed, is the second richest layer. Two quartz pebbles from it were selected for burial dating (Fig. 4). The amplitude of the Mansu-Ri (Loc. IV) sedimentary sequence (up to 9 m) allows us to study the paleomagnetism along the longest section.

The Wondang-Jangnamgyo site, located in the Yeoncheon commune in the Gyeonggi-do province, 50 km north from Seoul (37°97'N, 126°89'E; altitude: 19–25 m, Fig. 1), was discovered in 2008. The longest 5 m section is composed by a succession of brownish clay levels covering pebbled sand with basalt blocs and basalt. However, dated between 130 and 500 ka, the basalt has not yet allowed accurate absolute dating (de Lumley et al., 2011). Three

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