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Human paleontology and prehistory

### Stratigraphy and paleoenvironment during the Late Pliocene at Masol paleonto-archeological site (Siwalik Range, NW India): Preliminary results

*Stratigraphie et paléoenvironnement du site paléonto-archéologique de Masol (chaîne des Siwaliks, Inde du Nord-Ouest) durant le Pliocène tardif : résultats préliminaires*

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#### ABSTRACT

The Quranwala zone (Siwalik Range, NW India) is known for its Late Pliocene vertebrates. Since 2008, cut marks and stone tools have been collected from Masol. The sedimentary series belongs to the Subathu sub-basin. These sub-Himalayan deposits contain repetitive sequences (~170 m thick) of silt/clays and sandstones corresponding to the cyclical influx of detrital material in a fluvial environment. Particular features of lithological units allow identification of the stratigraphic position of different paleonto-archeological localities. A first pale environmental reconstruction was enabled by analysis of clay and magnetic minerals. Iron minerals such as haematite and goethite indicate dominant oxic conditions during and after deposition. Clay minerals are of detrital origin, and were supplied from Himalaya by rivers. Illite, the result of physical weathering, is dominant. Smectite present in the lower part of the sequence, was probably supplied from Lesser Himalaya (Suresh et al., 2004). Its presence suggests that the studied area was still a paleo-drainage area for major river(s) during the time considered here.

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## R É S U M É

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Paléoenvironnement  
Ligne de partage des eaux

La zone de Quranwala (Pliocène final, chaîne frontale des Siwaliks, Inde) est connue pour ses Vertébrés fossiles. Depuis 2008, des traces de boucherie et des outils lithiques ont été récoltés à Masol. La série sédimentaire s'inscrit dans le sous-bassin de Subathu. Ces dépôts sous-himalayens renferment une série de séquences répétitives (~170 m d'épaisseur) de silt/argile et de sable/grès. Des caractéristiques lithologiques identifient les localités paléonto-archéologiques et leur position stratigraphique. Une reconstitution paléoenvironnementale préliminaire a été faite grâce à des analyses d'argiles et de minéraux magnétiques. Les minéraux de fer – hématite et goethite – indiquent des conditions oxiques dominantes pendant et après le dépôt. Les argiles sont d'origine détritique, elles ont été transportées par les rivières depuis l'Himalaya. L'illite, résultat d'une altération physique, est dominante. La smectite présente dans la partie inférieure de la séquence provient du bas Himalaya (Suresh et al., 2004). Sa présence correspondrait alors à un paléodrainage de rivière(s) majeure(s) avant l'instauration d'une ligne de partage des eaux entre deux bassins (Indus et Gange actuels).

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## 1. Introduction

The Siwalik Range, also known as the Siwalik Hills, or Siwalik Frontal Range (SFR) in Asian prehistory studies, is the southernmost and geologically youngest WNW-ESE range of the Himalayan chain. This sub-Himalayan zone was extensively studied for sedimentology, tectonics, paleoenvironment, fauna, paleoclimate, stratigraphy, etc. (e.g. Barnes et al., 2011; Burbank et al., 2012; Delcaillau et al., 2006; Kumar et al., 2003, 2007; Nanda, 2002; Pilgrim, 1913; Ranga Rao, 1993; Sanyal et al., 2010; Singh and Tandon, 2010; Thomas et al., 2002; Tripathi, 1986). The Siwalik Frontal Range is a result of the folding and uplift of the Siwalik Group, which is a sequence of continental sediments deposited in the Himalayan Siwalik-Ganga-Indus foreland basin from Middle Miocene to Middle Pleistocene (Fig. 1a). The Indian plate's northward push resulted in the Himalayan foreland basin uplift, which started in Middle/Late Pleistocene (Barnes et al., 2011). The combined action of tectonics and monsoons resulted in intense erosion and exhumation of sediment rich in fossils of aquatic and terrestrial vertebrata from the Masol anticline, NW of India (Fig. 1b, Fig. 2a). Sediments of this anticline, which is also known as the Chandigarh anticline (Barnes et al., 2011), are well known from the literature (e.g. Barnes et al., 2011; Nanda, 2002; Ranga Rao, 1993). Its older part outcrops in the core of the anticline and contains a faunal assemblage belonging to the Tatrot, and more precisely to the so-called Quranwala Zone (or Quarawala Zone), which represents the Late Pliocene, whereas younger sediments belong to the Pleistocene and represent Pinjor (or Pinjaur) faunal assemblage (Ranga Rao, 1993).

Since 2008, the Siwaliks Indo-French Programme of Research has been conducted in the Masol anticline area by the Indian Society for Archaeological and Anthropological Research of Chandigarh and the French Prehistorical Mission in India from the National Museum of Natural History, Paris (Dambricourt Malassé, 2015). Numerous fossils, including bovid bones with intentional cut marks and stone tools, have been collected in the core of this anticline (Abdessadok et al., 2015; Chapon Sao et al., 2015a;

Dambricourt Malassé et al., 2015a, 2015b; Gaillard et al., 2015; Moigne et al., 2015) (Fig. 1). The discovery of bones with intentional cut marks in such a stratigraphic context is compatible with the recent dating of the Early Pleistocene human settlement in China (Longgupo cave, 2,48 Ma) (Han et al., 2015) and with predictions concerning human settlements in the Upper Indus Basin since Late Pliocene (Dennell, 2010), giving support to the 'Out of Africa 1' scenario before 1.8 Ma (Coppens, 2015).

Fossils were collected in several separated, so-called Masol paleonto-archeological localities numbered from Masol 1 to Masol 13 (Fig. 2b). These localities form slopes and platforms in actual landscape eroded by the Patiali Rao stream and its tributaries, such as the Pichhli choe. Fossils have been found either in situ or as redeposited. Masol 1, 2 and 3 are located to the north of the Masol village, Masol 4, 5 and 6 extend to the northwest, and localities from Masol 7 to Masol 13 extend to the southeast of the village. The Late Pliocene age of the fossiliferous sediments has been confirmed by a magnetostratigraphic study realized at the Masol 1 locality (Chapon Sao et al., 2015b). These Late Pliocene sediments are composed of silts/clays and sandstones cyclically deposited in the fluvial environment and different layers are very similar in profile. Moreover, the Middle and Late Quaternary post-depositional processes related to active tectonics (folding and faulting), erosion, redeposition (colluviums, fluvial terraces) resulted in an important modification of the initial position of the sediment (see also Gargani et al., 2015). This situation complicates the correlation between different Masol paleonto-archeological localities and the identification of their exact stratigraphic position.

In this paper, we present the results of investigations conducted during fieldworks in spring 2014 and 2015 and the results of laboratory analyses of samples collected in 2014. The aim of this work was (1) the establishment of the complete lithological log for Late Pliocene sediments available in the Masol anticline, (2) the identification of the sediment sequences with particular features to allow their recognition in different Masol paleonto-archeological localities (Masol 1, Masol 2 to Masol 13), and (3) the

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