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Forty Years of Research at Casablanca (Morocco): New Insights in the Early/Middle Pleistocene Archaeology and Geology[1]

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1. Early and Middle Pleistocene Archaeology and Geology of Casablanca: An Historical Perspective

Research on the first settlement of North Africa began at the end of the nineteenth century. The first African handaxes were found near Temassinine, in Algeria, a few years after the introduction of the "Époque de St Acheul.[2] Rivière made formal reference to a lower Paleolithic industry from the site of Boul Baba, in Tunisia.[3] Several "Chellean biface sites" were then discovered in

1. The Franco-Moroccan Casablanca program is conducted and financed by the *Institut National des Sciences de l'Archéologie et du Patrimoine* (INSAP) of the *Ministry of Culture of the Kingdom of Morocco, the Ministère de l'Europe et des Affaires Étrangères* of France, and the Paul Valéry Montpellier 3 University (France). It is also financially supported by the Department of Human Evolution of the Max Planck Institute for Evolutionary Anthropology in Leipzig (Germany) and the *LabEx Archimede* (ANR-11-LABX-0032-01) within the framework of the *Origines* project. It has received funding from the Aquitaine Region through the Origines projects, the Collège de France, the National Museum of Natural History in Paris, and the University of Bordeaux (France).

2. Gabriel de Mortillet, *Le Préhistorique, Antiquité de l'homme* (Paris: Reinwald, 1883).

3. Jacques Rivière, "L'industrie préhistorique du silex en Tunisie," in *Compte rendu de la 25e Session de l'Association française pour l'Avancement des Sciences, Première partie* (Paris: Association française pour l'Avancement des Sciences, 1896), 199-200.

North Africa at the beginning of the twentieth century.[4] Research expeditions have multiplied over the years, but, although North Africa is rich in lower Palaeolithic evidences, most of the sites lack a stratigraphic context.[5]

In Atlantic Morocco, the construction works which started at the dawn of twentieth century in the city of Casablanca demanded the opening of large quarries allowing the discovery of an exceptional geological, paleontological, and archaeological heritage. The coast between Moroccan Meseta and Kenitra in the north and Safi in the south shows a vast system of longitudinal dune ridges parallel to modern coast. These morpho-sedimentary units are composed of marine and aeolian calcarenites that have left a record of a succession of palaeoshorelines since the end of the Miocene.[6] These palaeoshorelines and morpho-sedimentary units present an exceptional development in the Casablanca region. Since 1917, this sequence captured the interest of many geologists and played a central role in the establishment of a Quaternary stratigraphic framework in North-west Africa.

Lecointre first recognized the Quaternary age of the consolidated littoral deposits of Morocco, previously ascribed to the Pliocene. In 1926, he published his work on the Moroccan Meseta, where he identified five palaeoshorelines and distinguished two faunal complexes on the basis of malacological data: one marked by a "chilo-senegalese" fauna (*Acanthina crassilabrum* and *Trochita trochiformis*) and another, the most recent one, with "submodern" fauna (*Purpura haemastoma* and *Patella safiana*).[7]

In the same year, Antoine published the lithic industries discovered at Martin quarry and the Moroccan Society of Prehistory was created. Antoine, who was the secretary, made an important inventory of prehistoric surface artefacts at Casablanca and reported three stations of the lower Palaeolithic:

4. Maurice Antoine, "Aperçu sommaire sur les industries lithiques du Maroc central," *Bulletin de la Société de Préhistoire du Maroc* 4e année, 1 (1930): 29-49; Pierre Biberson, "Le Paléolithique inférieur du Maroc atlantique," *Publications du Service des Antiquités du Maroc,* 17 (1961); Henri Breuil, "L'Afrique préhistorique," *Cahiers d'Art* 8-9 (1930): 449-500; Ernest Chantre, "L'âge de la pierre dans la Berbérie orientale, Tripolitaine et Tunisie," in *Compte rendu de la 37e Session de l'Association française pour l'Avancement des Sciences, Clermont Ferrand, 1908, 2e partie* (Paris: Association française pour l'Avancement des Sciences, 1909), 686-8; Paul Pallary, "Les collections préhistoriques du Musée des Antiquités algériennes," *Revue africaine* 55 (1911)*:* 306-26.

5. Jean-Paul Raynal et al., "The Earliest Occupation of North-Africa: the Moroccan Perspective," *Quaternary International* 75 (2001): 65-75.

6. David Lefèvre, "Du continent à l'océan. Morphostratigraphie et paléogéographie du Quaternaire du Maroc atlantique. Le modèle casablancais" (Habilitation à diriger des recherches, vol. 3, Université de Montpellier III, 2000); David Lefèvre and Jean-Paul Raynal, "Les formations plio-pléistocènes de Casablanca et la chronostratigraphie du Quaternaire marin du Maroc revisitées," *Quaternaire* 13/1 (2002): 9-21; Pierre Biberson, "Le cadre paléogéographique de la Préhistoire du Maroc atlantique," *Publications du Service des Antiquités du Maroc* 16 (1961); Biberson, "Le Paléolithique."

7. Georges Lecointre, *Recherches géologiques dans la Meseta Marocaine* (Paris: Larose, 1926).

a Chellean industry at the Martin quarry and Acheulean industries at Halioua and Beaulieu (*réservoirs à mazout*) in Aïn Seba. In 1941, Breuil visited the quarries of Casablanca. After examining the artefact series collected by Antoine, he stated that there was undoubtedly a mix of different assemblages in different states of preservation.[8]

In the same year, Neuville and Ruhlmann published the results of their investigation in Casablanca quarries and mainly within Sidi Abderrahmane area. Following Lecointre, they carried out detailed stratigraphic research on the littoral formation of Casablanca, integrating the lithic industries they discovered at Sidi Abderrahmane. On the basis of this work, they identified four palaeoshorelines which they interpreted as the Atlantic equivalents of the Mediterranean ones in southern Italy and Algeria. Based on the excavation at Sidi Abderrahmane, Neuville and Ruhlmann defined also the cultural sequence of the lower Palaeolithic of the Casablanca region (Clacto-Abbevillian, Abbevillian, Acheulean, Tayacian, Levalloisian, and Mousterian).[9] At this time, the Clacto-Abbevillian was the oldest lithic industry recognized in a well identified context in North Africa.

This model was immediately criticized both from a geological and cultural perspectives. Bourcart assessed that Quaternary marine deposits consisted of a unique assemblage formed exclusively by transgressional foreshore deposits followed by complete remodelling during the retreat of the sea.[10] A few years later, Bourcart revised his position and admitted that the Quaternary comprises three distinct complexes separated by erosion.[11] From a cultural perspective, Antoine objected the separation operated by Neuville and Ruhlmann of the archaic Tayacian from the Clacto-Abevillian and the definition of classic Tayacian "based on only 17 artefacts."[12]

Following these criticisms, eminent learned societies urged the protection of the Sidi Abderrahmane site. The "Service des Monuments Historiques" of Morocco accepted these requests and classed two important sites (A and B)[13] of the Sidi Abderrahmane Quarry in the Moroccan cultural heritage list.[14] At this time, Biberson assumed the surveillance of the Casablanca

8. Biberson, "Le Paléolithique," 13-7.

9. René Neuville and Armand Ruhlmann, *La place du Paléolithique ancien dans le Quaternaire marocain*, Collection Hespéris VIII (Rabat: Institut des Hautes Etudes Marocaines, 1941).

10. Jacques Bourcart, "La géologie du Quaternaire au Maroc," *La Revue Scientifique* 3224 (1943): 311-36.

11. Jacques Bourcart et al., "Sur la stratigraphie du Quaternaire côtier à Rabat," *Comptes Rendus des Séances de l'Académie des Sciences* 228 (1949): 108-9.

12. Maurice Antoine, "La préhistoire du Maroc atlantique et ses incertitudes," *Vol. jubilaire de la Société des Sciences naturelles du Maroc (1945).*

13. Site B of Sidi Abderrahmane was destroyed in this period due to the upsurge of the works at Schneider quarry.

14. Biberson, "Le Paléolithique," 17.

hinterland quarries. He revised the Sidi Abderrahmane Site, a context where he discovered prehistoric artefacts and fossil bones.[15]

At the beginning of the 1950s, an increasing research activity determined new advances about the Quaternary geology and prehistory at Casablanca. Several geological works were published, where the existence of a series of raised beaches all along the Moroccan coast was assessed. And soon after, researches began to take tectonic influences into account. They recognized that the age of beaches decreased according with altitude, but the latter could vary from one region to the other.[16]

In 1952, two important congresses were held in Algiers: the XIXth International Geological Congress and the IIth Pan-African Congress of Prehistory. During the congress excursions, participants were able to visit Casablanca quarries and to have a look of the prehistoric and paleontological collections from Schneider Quarry and *Sidi Abderrahmane-Extension.*[17] Antoine published his communication at the IIth Pan-African Congress of Prehistory, which represents the first synthesis of the Moroccan prehistory.[18]

In 1953, Biberson examined with Balout the assemblage of Sidi Abderrahmane unit M deposited at the Archaeological Museum of Rabat and recognized a mixture of old rolled tools belonging to the Pebble Culture and less or not rolled Acheulean tools. In 1953 he discovered in the *Grotte des Littorines* at Sidi Abderrahmane an Acheulean industry and a human mandible attributed by Arambourg to a *Pithecanthropus* very close to *Atlanthropus mauritanicus*.[19] During the 4th Congress of the International Union for Quaternary Research (INQUA) held in Rome in 1953, Biberson presented the results of a first study of the material collected in the *Grotte des Ours* at Sidi Abderrahmane. A year later, he collected rolled artefacts in the basal conglomerate of the Schneider-Airport Quarry and a Pebble-Culture assemblage in the continental deposits lying above. Based on the discoveries in this quarry, Biberson defined the ancient and middle phases of the Moroccan Pebble Culture. In the same year, he collected cobble tools at Tarit Quarries.[20]

15. Pierre Biberson, "Nouvelles observations sur le Quaternaire côtier de la région de Casablanca (Maroc)," *Quaternaria* 2 (1955): 109-49.

16. Marcel Gigout, *Etude géologique de la Méséta marocaine occidentale (arrière pays de Casablanca, Mazagan et Safi)*. Travaux de l'Institut Scientifique Chérifien, Série géologie et géographie physique, 3 (Rabat: Imprimerie Maroc-Matin, 1951), vol. I; Georges Lecointre, *Recherches sur le Néogène et le Quaternaire marins de la côte atlantique du Maroc*. Notes et Mémoires du Service Géologique du Maroc, 174 (Rabat: Éditions du Service géologique du Maroc, 1952), vol. I, Stratigraphie.

17. Biberson, "Le Paléolithique," 18.

18. Maurice Antoine, *Les grandes lignes de la Préhistoire marocaine*. Publications du 11ème Congrès panafricain de Préhistoire, Alger 1952 (Casablanca: Edita, 1952).

19. Camille Arambourg et Pierre Biberson, "Découverte de vestiges humains acheuléens dans la carrière de Sidi Abderrahman, près de Casablanca," *Comptes Rendus de l'Académie des Sciences Paris* 240 (1955): 1661-3.

20. Abderrahim Mohib, "L'Acheuléen de la grotte des Ours à Sidi Abderrahmane (Casablanca, Maroc) dans son contexte régional (fouilles anciennes et récentes)," (PhD diss. Institut National des Sciences de l'Archéologie et du Patrimoine, 2001), 6.

In 1955, Biberson refined his definition of the ancient Pebble Culture thanks to the discovery of lithic material at Déprez Quarry (at present Ahl Al Oughlam Quarry) and Haj Salah ben Tahar Quarry. During a visit together with Alimen to the deposits of Casablanca, he collected lithics in the basal conglomerate. In the same year, Balout, Vaufrey, and Alimen published their volumes on the North African Prehistory.[21] In 1956, Biberson reported the results of his investigations to the French Academy of Sciences and proposed a periodization of the Pebble Culture distinguishing four successive stages: archaic, ancient, middle and evolved. Between 1956 and 1958, he carried out excavations at *Sidi Abderrahmane-Extension* and *S.T.I.C*. Quarries, at *Grotte des Ours*, and at *Cap Chatelier.*[22]

In the second half of 1950s, an intense debate developed on the Quaternary geology of Casablanca and a few attempts to construct a coherent regional chronostratigraphic framework were made.[23] In 1958, Biberson established the basis of the geological scheme which came into widespread use for the Maghreb, successively refined and finally published in 1961 in a volume devoted to the paleogeographical framework of the Palaeolithic in Atlantic Morocco.[24] He defined several palaeoshorelines between 100 and 5-8 m above sea level (asl) and their relative age from the Early to the Late Pleistocene. Biberson interpreted each shoreline as a distinct Quaternary "stage" designated with local names (Messaoudian, Maarifian, Anfatian, Ouljian). Dune and various terrestrial formations occurring between the marine stages were attributed to continental stages defined in other regions of Morocco.

Also in 1958 Biberson published the results of the excavations carried out since 1950 in several quarries of Casablanca in the monumental volume "Le Paléolithique inférieur du Maroc Atlantique." Following the methodological approach performed in Europe by Bordes,[25] he established the fundamental characters of the ancient Palaeolithic industries and proposed an adequate terminology to their definition and the associated descriptive criteria. He defined also the guide-lines of the typological evolution of these industries to

21. Henriette Alimen, *Préhistoire de l'Afrique* (Paris: Boubée et Cie, 1955); Lionel Balout, *Préhistoire de l'Afrique du Nord, essai de chronologie* (Paris: Arts et métiers graphiques, 1955); Raymond Vaufrey, *Préhistoire de l'Afrique*, *I, Maghreb* (Paris: Librairie Masson et Cie, 1955).

22. *Ibidem*, 6-7.

23. Marcel Gigout, "Réflexions sur les bases du Quaternaire marin," *Bulletin de la Société Géologique de France*, 6ème série, VIII (1958): 349-62; Marcel Gigout and René Raynal, "Retouche à la corrélation des phénomènes marins et continentaux dans le Quaternaire marocain," *Comptes Rendus de l'Académie des Sciences Paris*, 248 (1959): 2223-5.

24. Pierre Biberson, "Essai de classification du Quaternaire marin du Maroc atlantique," *Compte rendu sommaire des séances de la Société Géologique de France*, 4 (1958): 67-9; Biberson, "*Le cadre paléogéographique*."

25. François Bordes, *Typologie du Paléolithique inférieur et moyen* (Bordeaux: Delmas, 1961).

propose a synthesis that represented the reference for more than 20 years for the ancient prehistory in Atlantic Morocco.[26]

In this volume, Biberson identified two main civilizations in the lower Palaeolithic: 1) the Pebble Culture, which was divided in two stages (ancient and evolved), successively defined as "Pre-Acheulean"[27] and 2) the Acheulean divided into ancient, middle and evolved.

In 1969 and 1972, human remains were discovered at Thomas Quarry I and Thomas Quarry III (at present Oulad Hamida 1 Quarry) respectively, attributed to *Atlanthropus mauritanicus.*[28] More recently these fossils were considered as a representative of *Homo rhodesiensis*.[29] These fossils were associated with fauna and lithic artefacts.[30]

The Quaternary framework established by Biberson was revised by Stearns in 1978.[31] He developed in his study a mainly morphological and altimetric approach and found three, possibly four, unidentified coastlines between the Maarifian and the Anfatian. Moreover, he tried to correlate all these stages with the marine isotopic stages after an estimate of the uplift rate of the Moroccan Meseta.

In the same year (1978), a joint Morocco-France research programme began in Casablanca area. This programme allowed the stratigraphic reappraisal of the classical localities and the discovery of new and important palaeontological sites in the older part of the sequence, dated to 2.4 and 5.5 Ma (Ahl Al Oughlam and Lissasfa). Several excavations were carried out in classical and newly discovered prehistoric sites: *Grotte des Rhinicéros* at Oulad Hamida 1 Quarry, *Grotte des Ours* and *Cap Chatelier* at Sidi Abderrahmane Quarry, *Sidi Abderrahmane-Extension*, *Grotte des Félins* and *Grotte des Gazelles* at Dar Bou Azza (Fig. 1).[32] First investigated by

26. Biberson, "Le Paléolithique."

27. Pierre Biberson, "Some aspects of lower Palaeolithic of Northwest Africa," in *Background to evolution in Africa.* Walter W. Bishop and J. Desmond Clark (ed.) (Chicago: University of Chicago Press, 1967), 447-76.

28. Emile Ennouchi, "Découverte d'un Pithécanthropien au Maroc," *Comptes Rendus de l'Académie des Sciences Paris* 269 (1969): 763-5; Emile Ennouchi, "Nouvelle découverte d'un Archanthropien au Maroc," *Comptes Rendus de l'Académie des Sciences Paris* 274 (1972): 3088-90.

29. Jean-Jacques Hublin, "Northwestern African Middle Pleistocene hominids and their bearing on the emergence of *Homo sapiens*," in *Human roots; Africa and Asia in the Middle Pleistocene.* Lawrence Barham and Kate Robson-Brown (ed.) (Bristol: CHERUB, 2001), 99-121.

30. Denis Geraads, "La faune des sites à *Homo erectus* des carrières Thomas (Casablanca, Maroc)," *Quaternaria* 22 (1980): 65-94.

31. Charles Stearns, "Pliocene-Pleistocene emergence of the Moroccan Meseta," *Geological society of American bulletin* 89 (1978): 1630-44.

32. Raynal et al., "The Earliest Occupation."; Jean-Paul Raynal et al., "The western quest, First and Second Regional Acheuleans at Thomas-Oulad Hamida Quarries (Casablanca, Morocco)," in *Vocation préhistoire. Hommage à Jean-Marie Le Tensorer*. Études et Recherches Archéologiques de l'Université de Liège, 148. Dorota Wojtczak, Mustafa Al Najjar, Reto Jagher, Hani Elsuede, Fabio Wegmüller et Marcel Otte (eds.) (Liège: Édition ERAUL, Université de Liège, 2017), 309-22.

Biberson, Thomas Quarry I was re-examined in 1985 revealing the presence of an early Acheulean assemblage in unit L.[33] Between 1994 and 2008, new hominid fossils have been discovered at *Grotte à Hominidés* (Thomas Quarry I) associated with a lithic assemblage and a rich fauna and microfauna.[34]

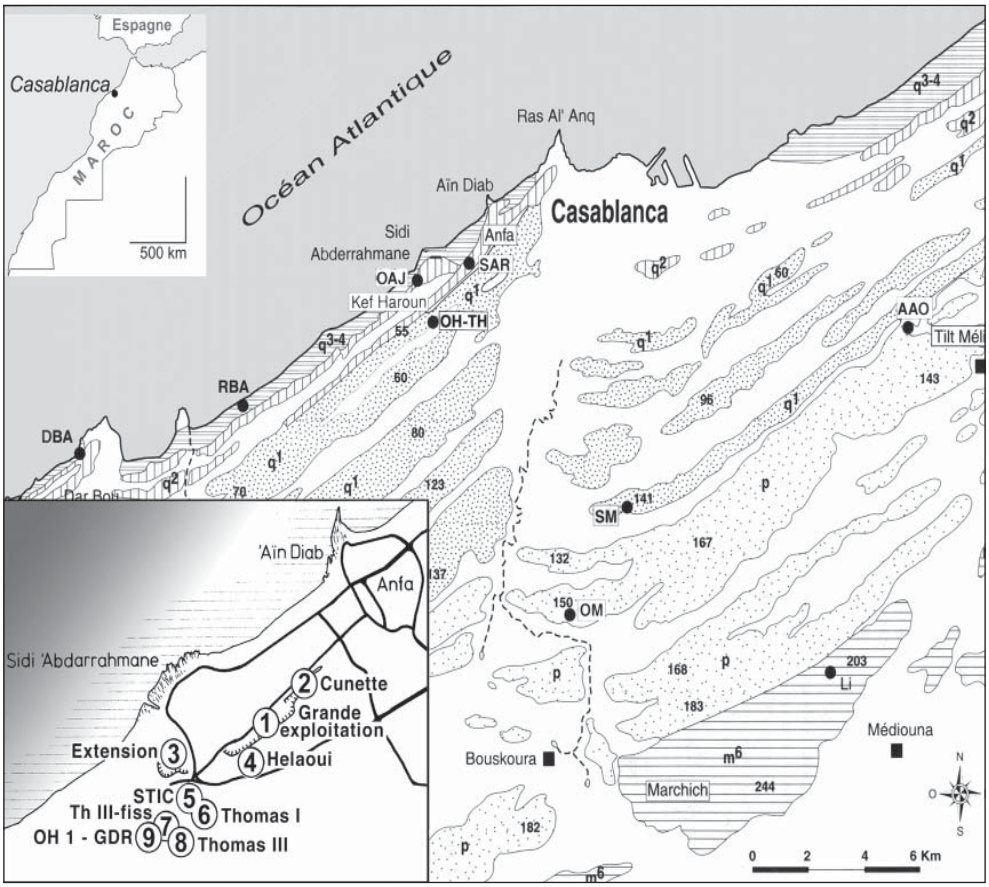

Fig. 1: General map of the Mio-Plio-Pleistocene formations preserved at Casablanca showing location of the main archaeological and geological localities cited in the text. AAO: Ahl al Oughlam; DBA: Dar Bou Azza; Li: Lissasfa; OAJ: Oulad Aj J'Mel; OH-TH: Oulad Hamida-Thomas Quarries; OM: Oulad Malik; RDA: Reddad Ben Ali; SAR: Sidi Abderrahmane Quarries; SM: Sidi Messaoud. Bottom left: the sites of the Sidi-Abderrahman-Thomas-Oulad Hamida area.[35]

33. Jean-Paul Raynal and Jean-Pierre Texier, "Découverte d'Acheuléen ancien dans la carrière Thomas 1 à Casablanca et problème d'ancienneté de la présence humaine au Maroc," *Comptes Rendus de l'Académie des Sciences Paris* 308, série II (1989): 1743-9.

34. Jean-Paul Raynal et al., "Hominid Cave at Thomas Quarry I (Casablanca, Morocco): recent findings and their context," *Quaternary International* 223-224 (2010): 369-82; Jean-Paul Raynal et al., "Contextes et âge des nouveaux restes dentaires humains du Pléistocène moyen de la carrière Thomas I à Casablanca (Maroc)," *Bulletin de la Société préhistorique française* 108/4 (2011): 645-69.

35. Modified after Raynal et al., "The western quest."

2. Casablanca Quaternary Geology Revisited

Based on previous geological researches and on new fieldworks carried out since 1985, D. Lefèvre, J.-P. Raynal, and J.-P. Texier revised the chronostratigraphical framework of the Quaternary littoral deposits of the Casablanca region and proposed a *New Casablanca Stratigrafic Scale*.[36] Moreover, in this new proposal, a more important emphasis was put on morpho-lithostratigraphic criteria and sequence stratigraphy to define the formations and new absolute dates were taken into account.[37]

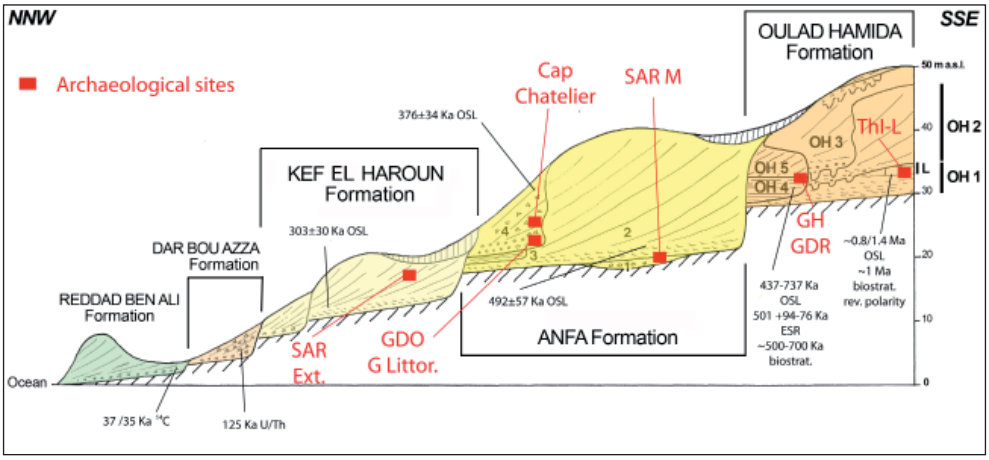

Fig. 2: Synthetic stratigraphic section of the Quaternary formations of the SW area of Casablanca and location of the Sidi Abderrahmane, Oulad-Hamida, and Thomas Quarry archaeological sites (Lefèvre et Raynal, 2018).[38] GDO: *Grotte des Ours*; GDR: *Grotte des Rhinocéros*; GH: *Grotte à Hominidés*; G Littor.: *Grotte des Littorines*; SDA Ext.: *Sidi Abderrahmane-Extension*; SDA M: Sidi Abderrahmane unit M; ThI-L: Thomas Quarry I unit L.

Four formations ranging from the late Early[39] to the Late Pleistocene have been defined: the Oulad Hamida, the Anfa, the Kef Haroun, and the Dar Bou Azza Formations (Figs- 2, 3). The Oulad Hamida, Anfa and Kef El Haroun Formations include several Members. Each member is defined by a unitary sequence characterised by a succession and association of facies of

36. Lefèvre, "Du continent à l'océan."; Lefèvre and Raynal, "Les formations."; Jean-Pierre Texier et al., "Contribution pour un nouveau cadre stratigraphique des formations littorales Quaternaires de la région de Casablanca (Maroc)," *Comptes Rendus de l'Académie des Sciences Paris* 318, séries II (1994): 1247-53; Jean-Pierre Texier et al., "Lithostratigraphy of the littoral deposits of the last one million years in the Casablanca region (Maroc)," *Quaternaire* 13/1 (2002): 23-41.

37. Edward J. Rhodes et al., "New age estimations for the Palaeolithic assemblages and Pleistocene succession of Casablanca, Morocco," *Quaternary Science Review* 25 (2006): 2569-85.

38. Document présenté dans la communication *Cadre chronostratigraphique de la séquence acheuléenne de Casablanca*, David Lefèvre, Mohssine El Graoui, Denis Geraads, Abderrahim Mohib, Jean-Paul Raynal à l'occasion du XV^{ème} Congrès Panafricain de Préhistoire qui s'est tenu à Rabat du 10 au 14 septembre 2018.

39. We use in this paper the revised timescale approved by IUGS (2018), in which the base of the Pleistocene is defined by the GSSP of the Gelasian Stage at 2.588 (2.6) Ma.

depositional environments, including intertidal sediments, associated with a palaeoshoreline, followed by supratidal and aeolian or continental sediments. This sedimentary sequence, which records a high sea level followed by the regression of the ocean and the continentalisation of the coast, is correlative of the sea level variations in relation to global glacio-eustatic changes.

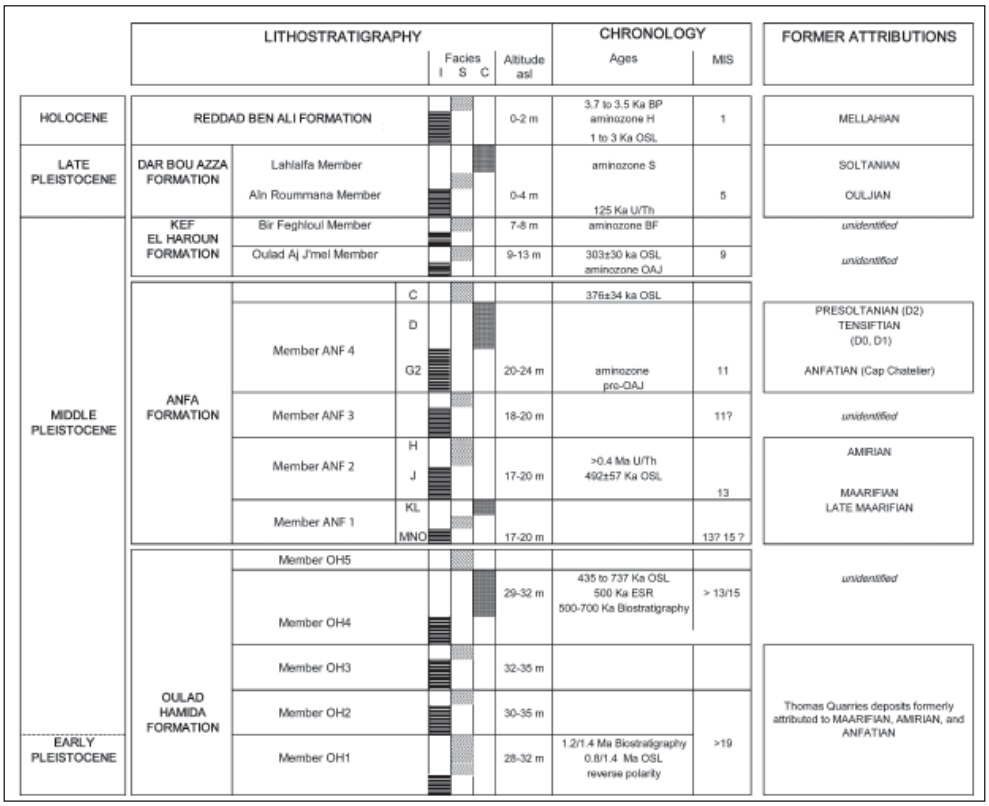

Fig. 3: New Casablanca Stratigraphic Scale from the late Early Pleistocene to the Holocene: lithostratigraphy, chronology, biochronology, correlation with marine isotopic stages, and former chronostratigraphic attributions of Biberson (Lefèvre et Raynal, 2018 updated).[40] I: Intertidal; S: Supratidal; C: Continental.

40. Lefèvre and Raynal, "Les formations."; David Lefèvre et al., "Enregistrements-réponses des variations climatiques du Pléistocène supérieur et de l'Holocène sur le littoral de Casablanca (Maroc)," *Quaternaire* 5, 3-4 (1994): 173-80; Rhodes et al., "New age estimations,"; Raynal et al., "Hominid Cave."; Raynal et al., "Contextes et âge."; Serge Occhietti et al., "Aminostratigraphie du dernier cycle climatique au Maroc atlantique, de Casablanca à Tanger," *Comptes Rendus de l'Académie des Sciences Paris* 317, série II (1993): 1625-32; Serge Occhietti et al., "Aminostratigraphie des formations littorales pléistocènes et holocènes de la région de Casablanca, Maroc," *Quaternaire* 13/1 (2002): 55-64; Denis Geraads, "Plio-Pleistocene mammalian biostratigraphy of Atlantic Morocco," *Quaternaire* 13/1 (2002): 43-53.

2.1 The Oulad Hamida Formation

The Oulad Hamida Formation (OHF) takes its name from the Oulad Hamida area and it has been defined at Thomas Quarry I. It includes five members (OH1 to OH5) sitting on an erosional platform, which formed at an altitude of around 28 m asl at the expense of the Cretaceous or Palaeozoic substratum. The Oulad Hamida Formation predates the Anfa Formation, the members of which correlate to MIS 11, 13 and 15.[41] Thus, the OHF records glacio-eustatic variations, which represent at least five cycles, from the end of the Early Pleistocene to the beginning of the Middle Pleistocene, before at least MIS 15.

Their lithostratigraphy from base to top is as follows:

OH1 Member: Bed 1 is composed of coarse calcirudite at the base and coarse, stratified biocalcarenite; intertidal depositional environments. Bed 2 is a 2 to 3 m succession of yellow lenticular limestone banks (Unit L) with cross-bedding structures, composed of micro-sequences of mudstones, intraclast sands separated by emergent surfaces formed in a continental fluvio-lacustrine hydrosystem with shifting channels and a temporary water table, followed by pedogenised aeolian sands (Unit S). The unit L limestone deposits have a reversed magnetic polarity and must belong to the Matuyama chronozone, an attribution consistent with the OSL dates between 0.8 and 1.2 Ma.[42] Thus, an age of c. 1 Ma is the best estimate for Bed 2, either before or immediately after the Jaramillo sub-chronozone.

OH2 Member: Overlying an erosion surface above the OH1 Member deposits, there are coarse biocalcarenites with curved cross-bedding followed by finer inclined planar-bedding biocalcarenites formed within intertidal depositional environments; vertically there follows massive banks of aeolianites about ten metres thick, their upper part affected by fersialsol pedogenesis. The OH2 deposits register a highstand sea level followed by the regression of the ocean.

OH3 Member: This unit is composed of coarse and/or coquinoid biocalcarenites (with inclined planar bedding), overlying an abrasion platform with associated calcarenite and lacustrine limestone blocks and pebbles that truncate the deposits of OH1 and OH2 Members and cut a cliff into the OH2 Member deposits, the base of which sits at an altitude of 37 m asl. The OH3 deposits register a highstand sea level associated with the formation of a palaeoshoreline.

41. Lefèvre, “Du continent à l’océan.”; Lefèvre and Raynal, “Les formations.”
42. S. Sen, personal communication; Rhodes et al., “New age estimations.”

Several formations are associated with a complex of palaeoshorelines cut into the earlier OH1, OH2 and OH3 Members:

OH4 Member: Composed of fine, grey, planar bedded calcarenites with, at the bottom inside the cavities, calcirudite mixed with blocks from earlier formations; these intertidal facies, which can be seen at an altitude of up to 34 m asl, are associated with the formation of a palaeoshoreline with deep cavities.

OH5 Member: Composed of bedded, fine, grey sands (with millimetric to centimetric planar-bedding) that pass down vertically to an aeolianite made up of layers of weakly cemented grey sands, with pronounced cross-bedding. These deposits are associated with a palaeoshoreline cliff, which partly follows the same path as the one associated with OH4 Member.

The *Grotte à Hominidés* of Thomas Quarry I and the *Grotte des Rhinocéros* of Oulad Hamida 1 Quarry belong to this complex of palaeoshorelines. The ESR dates obtained on faunal remains range from 435±85 to 737±129 Ka, according with the Uranium uptake model.[43] If we consider the biostratigraphic data, the ESR dates and the stratigraphic position of the OH4-OH5 Members in the Casablanca sequence, an early Middle Pleistocene age closer to 0.6/0.7 Ma could be considered for the formation of this coastline and the associated deposits containing the archaeological, paleontological and hominin remains.

2.2 The Anfa Formation

The Anfa Formation has been described from the deposits exposed in the Sidi-Abderrahmane Quarries. It has also been partly recorded at S.T.I.C. Quarry. It includes four members named ANF1 to ANF4 from the oldest to the youngest.

ANF1 Member: In the SW part of Sidi Abderrahman-*Grande Exploitation*, Neuville and Ruhlman (N&R in the following discussion) observed several sedimentary deposits and archaeological layers (K, L, M, N, O Unit of N&R), sitting on an unconformity at the expense of the Palaeozoic substratum at an altitude of 18 m asl.[44] Considering its stratigrafic position at the base of the Anfa Formation, ANF1 Member could be correlated with MIS 13 or MIS15.

ANF2 Member: It rests on Cretaceous limestone or Cambrian quartzites of the substratum on an abrasion platform associated with a marine

43. Rhodes et al., "New age estimations."
44. Neuville and Ruhlmann, *La place du Paléolithique*.

conglomerate. At its base there are 1 to 3 metres of strongly consolidated coarse bioclastic deposits locally including cobbles (Unit J of N&R, Maarifian of Biberson, Late Maarifian of Stearns). Fifteen metres thick biocalcarenic aeolian deposits with large-scale cross bedding overlie the preceding layer (Unit H of N&R). A speleothem from a karst cavity situated at the base of the aeolianite has been dated to 409+/-88 Ka by the U/Th method, the aeolian deposits have an OSL age of 492±57 Ka.[45] The ANF2 Member register a highstand sea level and could be correlated with MIS 13.

Several formations are associated with an abrasion platform and a notched cliff in the ANF2 deposits:

ANF3 Member: This member cuts a shoreline into ANF2. Its base is marked by an abrasion platform between 18 and 20 m asl. It consists of medium to coarse sands from several decimetres to 3 m. A sequence of subtidal, intertidal deposits may be recognized and register a highstand sea level.

ANF4 Member: It cuts the former cliff shaped in ANF2 deposits by the ANF3 Member. This member includes two beds. The Lower Bed (Unit G of N&R, Anfatian of Biberson). It is mainly composed of siliceous gravels and coarse cemented bioclastic sands between 20 and 22 m asl. The Upper Bed (Unit D of N&R) consists of continental bioclastic sands with large-scale cross bedding with a variable component of coarse elements. These rock-debris and gravels are either dispersed throughout the deposits or occur as distinct layers. Rockfall as well as run-off processes have likely interfered with aeolian processes. This bed incorporates upper and final Acheulean industries as well as fossil bones. An aeolian deposit (Unit C of N&R) situated at the top of this continental series has an OSL age of 376±34 Ka.[46] The marine Lower Bed (Unit G-Anfatian) of the ANF4 Member registers a highstand sea level and could be correlated with the MIS 11.

2.3 The Kef El Haroun Formation

This formation has been described from sections located in the Kef El Haroun area. It rests on an erosion surface at the expense of the Cambrian quartzites at an altitude of 10/13 m asl.

It comprises two members named Oulad Aj J'mel Member and Bir Feghloul Member.

Oulad Aj J'mel Member: It is made up of a basal marine conglomerate overlain by 1 to 2 m of coarse evenly laminated bioclastic sands deposited in

45. Rhodes et al., "New age estimations."
46. Ibid.

a foreshore environment and, at the top, ten metres of calcarenite with large-scale cross bedding of dune type. The tidal deposits have been OSL dated at 303±30 Ka.[47] The OAJ marine deposit could be correlated with the MIS 9.

The Bir Feghloul Member: It is fitted into the former member and includes a succession of foreshore bioclastic sands including pebbles and passing upward into a sandy aeolianite.

2.4 The Dar Bou Azza Formation

The Dar Bou Azza Formation fits into a shoreline cut into the Kef El Haroun Formation. Often partially obscured by continental deposits, the cliff can be followed along the entire study area. It is attributed to the Ouljian Stage.[48]

The Lower Unit – Aïn Roummana Member – is situated between 2 and 6 m asl. It includes consolidated deposits 1.5 m thick showing significant facies variability as follows: evenly laminated coarse bioclastic sands dipping seaward, similarly bedded sorted gravels, large flattened blocks lying in a coarse bioclastic matrix with some complete shells. With an age U/Th of 125 Ka, the marine deposits could be correlated with the MIS 5e.[49]

The Upper Unit – Lahlalfa Member – consists of red clayey-sand slope deposits containing heterometric calcarenite and calcrete fragments floating in the matrix. It is subdivided into three sub-units by laminar calcareous crusts. The intermediate sub-unit has yielded an Aterian archaeological assemblage.[50]

Apart from the sedimentary units described above, red clayey sands (known as *Limons rouges*) are mainly found on slopes and in depressions and are widespread in North-west Morocco. Their genesis is complex involving various types of pedogenesis and erosion processes and they often incorporate reworked lithic industries of different ages (Acheulean, Aterian and Iberomaurusian).[51]

3. The Pebble Culture of Atlantic Morocco Revisited and the Absence of a Pre-Acheulean Substratum

If East Africa is rich in Early Pleistocene well-dated sites, North Africa has very few localities documenting the human presence at this age and their

47. Ibid.

48. Biberson, "Le cadre paléogéographique."

49. Lefèvre, "Du continent à l'océan."; Lefèvre and Raynal, "Les formations."

50. Lefèvre et al., "Enregistrements-réponses."

51. Jean-Paul Raynal et al., "Les limons rouges de la Meseta côtière marocaine: limites et chronologie, données récentes," in *9ème Réunion annuelle des Sciences de la Terre* (Paris: Société Géologique de France, 1982), 535; Jean-Paul Raynal and Jean-Pierre Texier, "Les 'limons rouges' du Maroc atlantique: production, transport, transformations, chronologie," in *10ème Réunion annuelle des Sciences de la Terre* (Paris: Société Géologique de France, 1984), 472.

dating remains conjectural. Despite ongoing discussions, the tempo(s) and mode(s) of the first human settlement(s) in the Early Pleistocene and its subsequent development in the Middle Pleistocene are poorly understood in this part of Africa and many aspects remain open questions.

Until now, despite almost a century of archaeological excavations, no Oldowan sites have been identified in Morocco. Indeed, the revision of lithic assemblages classified by Biberson as Moroccan Pebble Culture has shown that they are actually geofacts (Ahl Oughlam Unit 2, Arbaoua, Tardiguet er Rhala,) or younger reworked assemblages (Salé plateau, Allal Ben Abdallah street, Chellah and Douar Doum at Rabat, Sidi-Abderrahmane – *Grande Exploitation* Quarry unit 4 and Schneider Quarry in the Maarif at Casablanca, Souk-el-Arba du Rharb, Tangier's Peninsula, R'mel Pass…) and new research have also provided geofacts in Oulad Malik quarry and Ahl Oughlam Unit 2 at Casablanca.[52] In this problematic context, many questions concerning the Acheulean, its origin and its development also remain unanswered.

The Pebble Culture artefacts found at the famous site of Ahl Al Oughlam (former Déprez Quarry) near Tit Mellil (Fig. 1) are actually geofacts which formed in a high energy marine context. Ahl Al Oughlam site, discovered in 1985 and regularly excavated since 1989, is one of the richest Early Pleistocene paleontological sites and one of the richest in the whole Africa. It has yielded more than fifty species of mammals, including for the first time in North Africa a direct association of rich micro- and macro-fauna. Although comparisons are difficult because all North African sites of this period are much poorer, the fauna allows a rather precise chronological placement of these fissure fillings, posterior in age to the marine unit where Biberson had found his so-called Pebble Culture. Thus, on the whole, the fauna indicates a very open vegetation setting, related to the global climatic crisis of 2.4 Ma.[53] Moreover, considering that no artefacts have been found in the very Early Pleistocene formations, but only geofacts (Fig. 4), there is for now no clear evidence for hominids presence in this part of Maghreb. Unhappily, the Early Pleistocene formations at Casablanca never yielded any archaeological layer but only a few mammals remains. The first clear evidence for human activity is found in the late Early Pleistocene, at Thomas-Oulad Hamida Quarries.

52. Raynal and Texier, "Découverte d'Acheuléen."; Raynal et al. "Préhistoire ancienne au Maroc atlantique: bilan et perspectives régionales," *Bulletin d'Archéologie Marocaine* XXI (2009): 9-54.

53. Denis Geraads et al., "La faune de mammifères du Pliocène terminal d'Ahl Al Oughlam, Casablanca, Maroc," *Comptes Rendus de l'Académie des Sciences Paris* 326 (1998): 671-6.

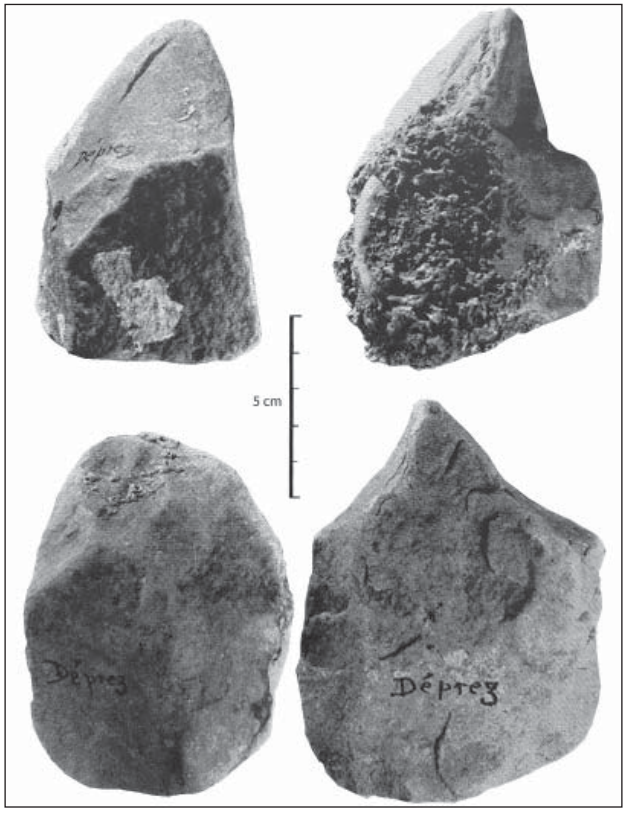

Fig. 4: Geofacts from Ahl al Oughlam (former Déprez Quarry) interpreted by Biberson as Pebble-Culture artefacts.[54]

4. The Emergence of the Acheulean in Atlantic Morocco

As mentioned above, Neuville and Ruhlmann discovered at the base of the Sidi Abderrahmane Quarry, in layer M, an assemblage largely shaped on feldspathic sandstones that they qualified as "Clacto-Abbevillian" (Fig. 5).[55] It contained Acheulean forms (trihedrons, handaxes, cleavers, spheroïds), large flakes (the "Clactonian" component) and various forms of cobble tools, associated with a very fragmentary fauna dominated by *Hippopotamus*. At this time, the Clacto-Abbevillian was the oldest lithic industry known in North Africa. Biberson revisited this interpretation and ascribed this industry to the early Acheulean (stages I and II).[56] Nevertheless, this assemblage belongs probably to the bottom part of the Anfa Formation with an age certainly older than 0.5 Ma (Figs. 2, 3).[57] This is confirmed by an age of 492 ± 57 Ka obtained from the bottom of Member 2 of the Anfa Formation on

54. Modified after Biberson, "Le Paléolithique." 63.
55. Neuville and Ruhlmann, *La place du Paléolithique*.
56. Biberson, "Le Paléolithique," 132-7.
57. Texier et al., "Lithostratigraphy."

backshore sands.[58] It is an Acheulean facies which wrongly "archaic" aspect is, undoubtedly the expression of a simplified technology massively oriented to large flakes production.[59] Stratigraphically speaking, it marks the end of the early Acheulean and not its emergence.

Stage III of the early Acheulean was identified by Biberson in layer D of the S.T.I.C. Quarry, located beyond the south extremity of Sidi Abderrahmane-*Grande Exploitation* Quarry (Fig. 1). This layer yielded a rich quartzite assemblage composed by various types of handaxes, cleavers, trihedrons, bifacial and multifacial cores, and a few bolas (Fig. 5). Some of these pieces are typologically similar to those of the unit L of Thomas Quarry I overhanging the S.T.I.C Quarry. We could suspect erosion processes of layer L and a natural mixing of series, sustained by the existence of a karstic system, but this hypothesis is now impossible to prove since the S.T.I.C. Quarry has been recently completely filled up.[60]

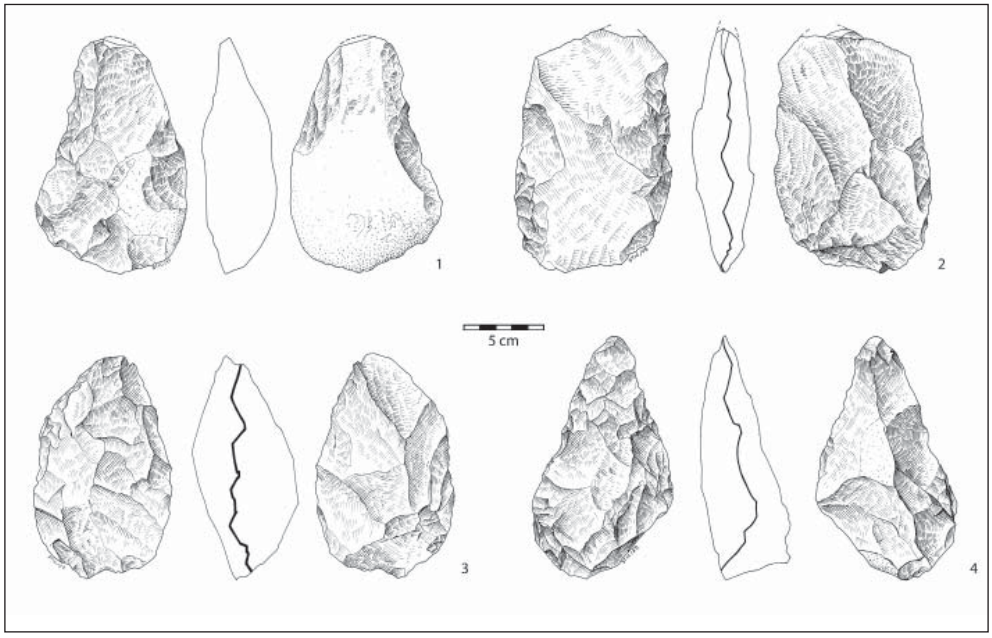

Fig. 5: Large Cutting Tools of quartzite from S.T.I.C. Quarry. Drawings by M. Hirbec-Raynal.

At present, only Thomas-Oulad Hamida Quarries offer a complex of archaeological sites in an indisputable stratigraphic context, spanning from the late Early Pleistocene to the Late Pleistocene and documenting the emergence of the Acheulean and its development.[61]

58. Rhodes et al., "New age estimations."

59. Abderrahim Mohib, "Contribution à l'étude du Paléolithique ancien de Casablanca, l'outillage du niveau M de Sidi Abderrahmane (fouilles Neuville et Ruhlmann 1941)," (Mémoire de fin d'études, Institut National des Sciences de l'Archéologie et du Patrimoine, 1991).

60. Raynal et al., "The western quest."

61. Raynal et al., "The western quest."; Jean-Paul Raynal et al., "Casablanca and the earliest occupation of North Atlantic Morocco," *Quaternaire* 13/1 (2002): 65-77.

The oldest Acheulean of Casablanca has been discovered in Unit L at Thomas Quarry I that corresponds to Bed 2 of the OH1 Member (Figs. 1-3). It is a 2-3 m succession of yellow lenticular limestone banks with a cross-bedded architecture, deposited in a continental fluvio-lacustrine hydrosystem with shifting channels and a temporary water table, followed by pedogenised aeolian sands. Preliminary data suggest that the unit L limestone deposits have a reversed magnetic polarity and must belong to the Matuyama chronozone.[62] Besides, Unit L was dated using the OSL signal of quartz grains, but the resulting date of 989±208 ka is based on a single sample. Although the date is in broad agreement with the magnetically reversed status of these deposits, the large uncertainty does not allow assignment to a particular MIS.[63]

In Unit L, the archaeology is present in two archaeo-stratigraphic sub-units: L1 at the base and L5 at the top. Discovered in 1985, L1 has been systematically excavated (1988-1996 and 2006-2008) at Thomas Quarry I and yielded a rich lithic assemblage together with unmodified cobbles and faunal remains.[64] The same sub-unit was recorded at Oulad-Hamida 1 Quarry at the very base of the stratigraphic sequence and excavated by a small test-trench. Faunal remains are rare and consist mostly of hippos, with some *Elephas* and *Equus*. A *Kolpochoerus* tooth probably belongs to *K. maroccanus*, in agreement with an Early Pleistocene age. Only a few rodent teeth have been recovered. *Ellobius*, a genus that appears at Tighenif, is absent; this might merely be absence of evidence, but both the *Paraethomys* and *Gerbillus* differ from those found in later units of the quarry, suggesting a significant age difference.[65] Bone surfaces are usually unreadable, preventing a detailed taphonomic analysis.

The industry of L1 is mainly focused to Large Cutting Tool production (mainly trihedral and bifacial tools), made on large cobbles and boulders of quartzite collected near the site. It also contains spheroids and sub-spheroids, a large variety of polyhedrons, centripetal and discoid cores and hammerstones of quartzite, as well as flint pebbles flaked using bipolar reduction techniques (Fig. 6). In contrast, L5 yielded a large number of flaked medium-sized pieces, detached following flaking methods already performed in L1, rare biface-like cores and no cleavers.[66]

62. S. Sen, personal communication.
63. Rhodes et al., "New age estimations."
64. Raynal and Texier, "Découverte d'Acheuléen."
65. Geraads, "Plio-Pleistocene."; Denis Geraads, "Biochronologie mammalienne du Quaternaire du Maroc atlantique, dans son cadre régional," *L'Anthropologie* 114 (2010): 324-40.
66. Raynal et al., "The western quest."

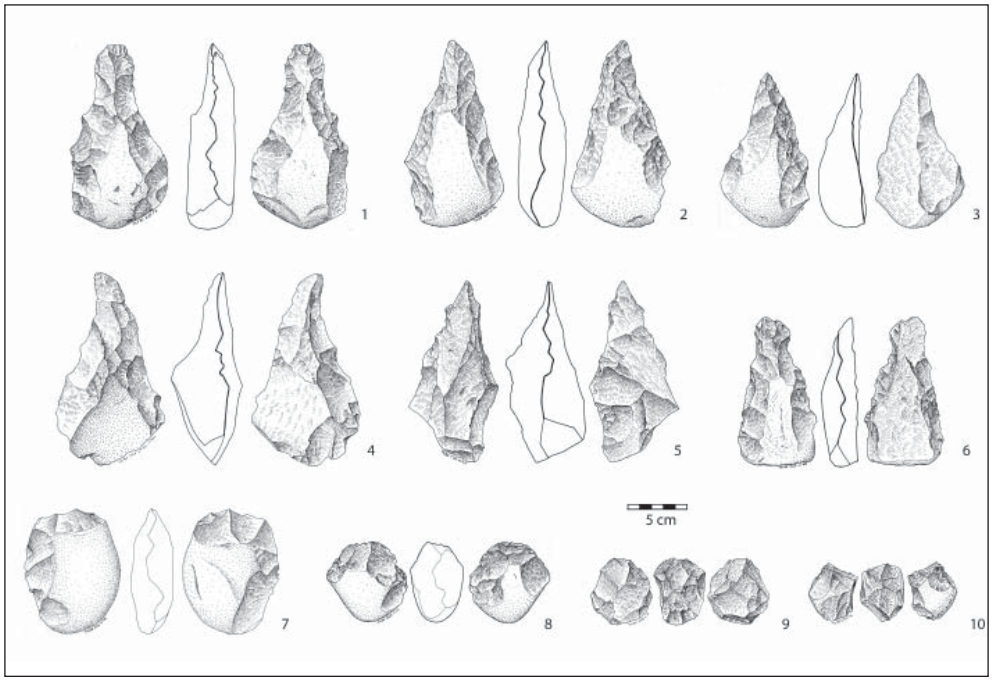

Fig. 6: Thomas Quarry I-unit L1. 1-6: Large Cutting Tools of quartzite; 7-10: Cores for small-medium size flake production of quartzite. Drawings by M. Hirbec-Raynal.

5. The Middle Pleistocene Acheulean at Casablanca

We saw previously that lithics from the S.T.I.C. Quarry and Sidi Abderrahmane Unit M have not been dated yet and may belong to the very beginning of the Middle Pleistocene or be older. However, the main core of the Acheulean sites clearly date to the Middle Pleistocene and were discovered in caves and a few open-air sites. Lithic assemblages, fauna and hominin fossils were discovered in Thomas Quarry I (*Grotte à Hominidés*), Oulad Hamida 1 Quarry (Grotte des Rhinocéros), Sidi Abderrahmane Quarry (*Grotte des Ours*, *Grotte des Littorines* and *Cap Chatelier*), *Sidi Abderrahmane-Extension* Quarry, Sidi Al Khaddir (former Hélaoui Quarry) and some localities uncovered by road and construction works.

5.1. Thomas I-Oulad Hamida 1 Quarries

At Thomas Quarry I a large cavity opens on the north side. The upper part is of Late Pleistocene age and is separated from the underlying deposits by speleothems. The lower half belongs to OH4 Member of the Oulad Hamida Formation and to its associated palaeoshoreline (Figs. 2, 3). It has a complex history of sedimentary and postdepositional processes driven by semi-arid conditions. Unit 4, whose thickness ranges from 0.2 to 1.0 m over an area

of fifty square metres in the central and eastern parts of the cave, contains lithic artefacts, a rich mammalian macrofauna that is supplemented by the addition of a few reptiles and birds, and hominin fossils.[67] OSL measurements provided an age estimate ca 0.4 Ma.[68] Moreover, a direct dating at 0.5 Ma was obtained on one hominid premolar.[69]

The lithic assemblage recovered by recent excavations is mainly manufactured from various quartzites as well as on a few flint pebbles. It is similar to the series collected at the time of the discovery of the first hominin fossil in 1969.[70] Apart from a bifacial *chaîne opératoire*, which was processed outside the excavated area to obtain Large Cutting Tools and heavy pointed tools, the other components indicate a small-medium size flake production (Fig. 7).

The fauna is very well preserved and is dominated by carnivores. A small jackal *Lupulella mohibi*, endemic to North-western Africa, is the most common carnivore, being far better represented than larger ones, such as hyenids, large felids and ursids. Among bovids, Antilopini (*Gazella atlantica*) and Alcelaphini (cf. *Damaliscus*) are dominant. Fossils are in a very good state of preservation despite heavy fragmentation, mostly due to green bone breakage. Carnivore marks (tooth marks and digestion) are widespread among the series, while no evidence of anthropic activity has been observed.[71]

Despite the presence of lithic artefacts within the stratigraphic units, the assemblage, including hominin remains, was mostly accumulated and modified by various carnivores. The predation upon small –and medium– sized bovids and the scavenging of larger taxa are two possible causes of the accumulations.[72] However, within the archaeostratigraphic Unit 4, the absence of horizontal or vertical sorting of artefacts by weight and the presence of refittings of lithic objects seem to attest to at least a partial lithic production in situ.

67. Raynal et al., "Hominid Cave."
68. Rhodes et al., "New age estimations."
69. Raynal et al., "Contextes et âge."
70. Geraads, "La faune des sites."
71. Raynal et al., "Hominid Cave."
72. Camille Daujeard et al., "Pleistocene Hominins as a Resource for Carnivores: A c. 500,000-Year-Old Human Femur Bearing Tooth-Marks in North Africa (Thomas Quarry I, Morocco)," *PlosOne*, 11/4 (2016): e0152284. https://doi.org/10.1371/journal.pone.0152284

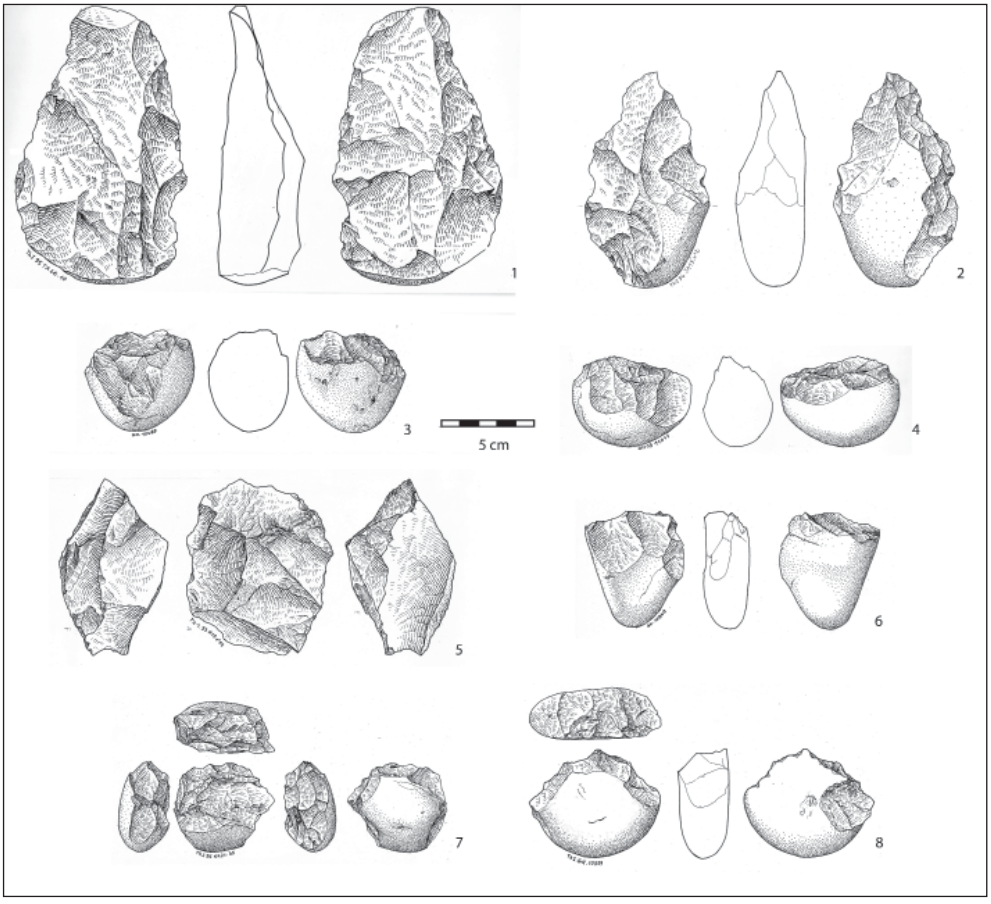

Fig. 7: Thomas Quarry I - *Grotte à Hominidés*. 1, 2: Large Cutting Tools of quartzite; 3-8: Cores for small-medium size flake production of quartzite. Drawings by M. Hirbec-Raynal.

The site of *Grotte des Rhinocéros* was discovered in 1991 at Oulad Hamida Quarry 1 which is an extension of the former Thomas Quarry III.[73] This marine cavity first developed within a complex of palaeoshorelines of the Middle Pleistocene Oulad Hamida Formation (OH4 and OH5 members). The continental infilling sequence is of at least seven metres thick. The lithostratigraphy, biostratigraphy and absolute dating lead to place this assemblage close to that of the *Grotte à Hominidés*. ESR dates however indicate an age estimate within the range of 435-737 Ka, limits provided by early and linear uptake model ages, respectively (Figs. 2, 3).[74]

73. Jean-Paul Raynal et al., "La grotte des Rhinocéros (Carrière Oulad Hamida 1, anciennement Thomas III, Casablanca), nouveau site acheuléen du Maroc atlantique," *Comptes Rendus de l'Académie des Sciences Paris* 316, série II (1993): 1477-83.

74. Jean-Paul Raynal et al., "La Grotte des Rhinocéros (Casablanca, Maroc): le remplissage et son âge," in *Préhistoire de Casablanca, vol. 1: La Grotte des Rhinocéros*. Jean-Paul Raynal and Abderrahim Mohib (ed.) (Rabat: Institut National des Sciences de l'Archéologie et du Patrimoine, 2016), 79-86.

This site is famous for its Rhinocerotid (*Ceratotherium mauritanicum*) remains associated with Acheulean lithic assemblages. These Middle Pleistocene deposits also provided a very rich spectrum of other large mammals. Among ungulates, Bovids largely dominate; they consist mostly of Antilopini (*Gazella atlantica*) and Alcelaphini (*Damaliscus sp.*). Some scarce Equids (*Equus cf. mauritanicus*), Suids (*Kolpochoerus maroccanus* and *Phacochoerus* cf. *africanus*) and Camelids (*Camelus* cf. *thomasi*) are also present. The most common carnivore is the endemic Canid *Lupulella mohibi*, which is much more abundant than larger carnivores, such as Hyenids (*Hyaena* and *Crocuta*), Ursids (*Ursus bibersoni*) or Felids (*Panthera pardus*). Large rodents are represented by *Hystrix* cf. *cristata* and primates by *Theropithecus.*[75]

The lithic assemblage was manufactured mainly on different varieties of quartzite and a few flint pebbles. The macro-industry comprises handaxes of various morphologies and dimensions, as well as rare cleavers and cobble tools. The micro-industry is mainly made of raw flakes that, apart from those coming from the shaping of bifacial pieces, were produced by discoid (unifacial and bifacial) and multifacial flaking, while Levallois method has not now been identified yet within the excavated part of the deposits. Retouched flakes are rare, notches and denticulates are a majority and little diversified (Fig. 8).[76]

75. Denis Geraads, "La faune des vertébrés du Pléistocène moyen de la Grotte des Rhinocéros, Casablanca, Maroc: 4 - Rongeurs et Lagomorphes," in *Préhistoire de Casablanca,* vol. 1, 95-104;

Denis Geraads and Fehti Amani, "La faune des vertébrés du Pléistocène moyen de la Grotte des Rhinocéros, Casablanca, Maroc: 10-Bovidae," in *Préhistoire de Casablanca,* vol. 1, 135-9; Denis Geraads and Rochdie Bernoussi, "La faune des vertébrés du Pléistocène moyen de la Grotte des Rhinocéros, Casablanca, Maroc: 6 -Carnivora," in *Préhistoire de Casablanca,* vol. 1, 111-9; Denis Geraads and Rochdie Bernoussi, "La faune des vertébrés du Pléistocène moyen de la Grotte des Rhinocéros, Casablanca, Maroc: 7 -Rhinoncerontidae," in *Préhistoire de Casablanca,* vol. 1, 121-7;

Denis Geraads and Rochdie Bernoussi, "La faune des vertébrés du Pléistocène moyen de la Grotte des Rhinocéros, Casablanca, Maroc: 8 -Equidae," in *Préhistoire de Casablanca,* vol. 1, 129-31; Denis Geraads and Rochdie Bernoussi, "La faune des vertébrés du Pléistocène moyen de la Grotte des Rhinocéros, Casablanca, Maroc: 9 -Hippopotamidae, Suidae et Camelidae," in *Préhistoire de Casablanca,* vol. 1, 133-4; Denis Geraads and Zeresenay Alemseged, "La faune des vertébrés du Pléistocène moyen de la Grotte des Rhinocéros, Casablanca, Maroc: 3 - Cercopithecidae," in *Préhistoire de Casablanca,* vol. 1, 91-3.

76. Jean-Paul Raynal et al., "La production lithique dans le second Acheuléen régional de la Grotte des Rhinocéros (Casablanca, Maroc) 1: les éclats et micro-outillage sur éclats," in *Préhistoire de Casablanca,* vol. 1, 183-93; Jean-Paul Raynal et al., "La production lithique dans le second Acheuléen régional de la Grotte des Rhinocéros (Casablanca, Maroc). 2: Le macro-outillage," in *Préhistoire de Casablanca,* vol. 1, 195-210.

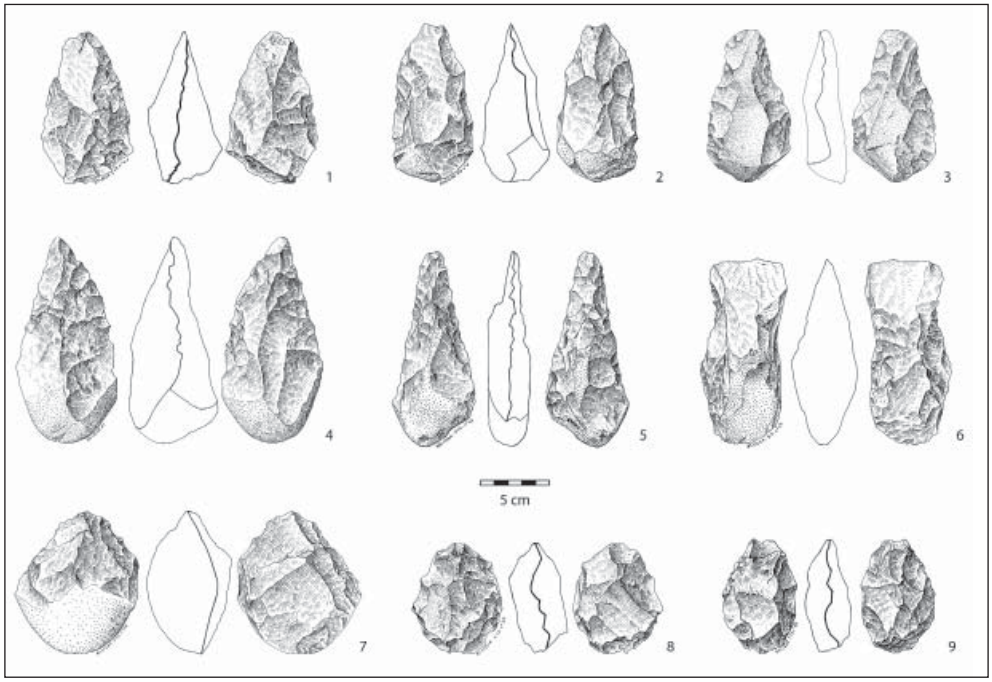

Fig. 8: Oulad Hamida 1 Quarry - *Grotte des Rhinocéros*. 1-6: Large Cutting Tools of quartzite; 7-9: Cores for small-medium size flake production of quartzite. Drawings by M. Hirbec-Raynal.

6.2 Sidi Abderrahmane Quarry

Middle Pleistocene industries were discovered in several caves of Sidi Abderrahmane Quarry (*Grotte des Ours*, *Grotte des Littorines*, and *Cap Chatelier*) and in open-air deposits at *Sidi Abderrahmane-Extension* Quarry (Fig. 1). Two marine highstands and their deposits (Members 3 and 4 of the Anfa Formation) have been recorded using the same polyphase palaeoshoreline (Figs. 2, 3).[77]

The main part of the filling of *Grotte des Ours* is a marine deposit forming the lower part of Member 4 of the *Anfa Formation*. Prior to its setting, the back of the cave was inhabited in alternance by carnivores and humans. Tidal process has mixed former beach and cave deposits and pushed them several times inside the cavity. The archaeological material shows different degrees of wear. It was considered as Middle Acheulean (stage V) by Biberson. *Grotte des Ours* assemblages show the use of very large discoid cores for the production of large flakes (blanks for handaxes and cleavers) and some smaller and of bifacial type, the absence of Levallois cores and the production

77. Texier et al., "Lithostratigraphy."

of complete or partial bifacial pieces, often symmetrical. This Acheulean is probably contemporaneous with the base of Member 4 of the *Anfa Formation* referred to MIS 11 (Figs. 2, 3,).[78]

In the northern part of Sidi Abderrahmane Quarry, the *Grotte des Littorines* was discovered and yielded in 1955 in unit F the fragmentary remains of the Sidi Abderrahmane *Atlanthropus.*[79] The lithic assemblage was attributed to the Middle Acheulean (stage VI) by Biberson.[80]

Along the north-western wall of the *Cunette* (a narrow extension of the main quarry to the north-east) the site named *Cap Chatelier* yielded a lithic assemblage comprising bifaces of various dimensions and morphologies, sometimes very thin, some cleavers and a flake production from Victoria-West, discoid and Levallois with preferential removal methods. It was considered as Developed Acheulean (stage VIII) by Biberson.[81] *Cap Chatelier* deposits are capped by an uppermost dune visible in the north-western *Cunette* wall, which provided an OSL age estimate of 376 ± 34 Ka[82] (Figs. 2, 3).

Beyond the south-western extremity of Sidi Abderrahmane-*Grande Exploitation* was *Sidi Abderrahmane-Extension* Quarry, the type locality of Biberson's Developed Acheulean. Excavations have shown the existence of two archaeological layers. The upper layer yielded some abundant material rich in handaxes of various types, often with a distal bevel. Along with discoid unifacial and bifacial cores there are a few predetermined-cores with preferential removal (Fig. 9).[83]

Lithostratigraphic studies demonstrated that *Sidi Abderrahmane-Extension* deposits lie at the top of the Oulad Aj J'mel Member of the Kef El Haroun Formation which gives an OSL age estimate of 303 ± 30 Ka (Figs. 2, 3).[84] At the moment, the assemblage of layer 4 base at *Sidi Abderrahmane-Extension* is the youngest Acheulean in the Casablanca sequence. The age of 315 ± 34 Ka provided for Djebel Ihroud hominid bearing site 200 km south of Casablanca suggests at least a proximity in time - if not a contemporaneity- with this mousterian-like Middle Stone Age manufactured by modern humans.[85]

78. Mohib, "*L'Acheuléen*."; Raynal et al., "The western quest."

79. Pierre Biberson, "Le gisement de l'"Atlanthrope de Sidi Abderrahmane (Casablanca)"," *Bulletin d'Archéologie Marocaine* 1 (1956): 39-92.

80. Raynal et al., "The western quest."

81. Ibid.

82. Rhodes et al., "New age estimations."

83. Raynal et al., "The western quest."

84. Rhodes et al., "New age estimations."

85. Jean-Jacques Hublin et al., "New fossils from Jebel Irhoud, Morocco and the pan-African origin of *Homo sapiens*," *Nature* 546 (2017): 289-92; Daniel Richter et al., "The age of the hominin fossils from Jebel Irhoud, Morocco, and the origins of the Middle Stone Age," *Nature* 546 (2017): 293-6.

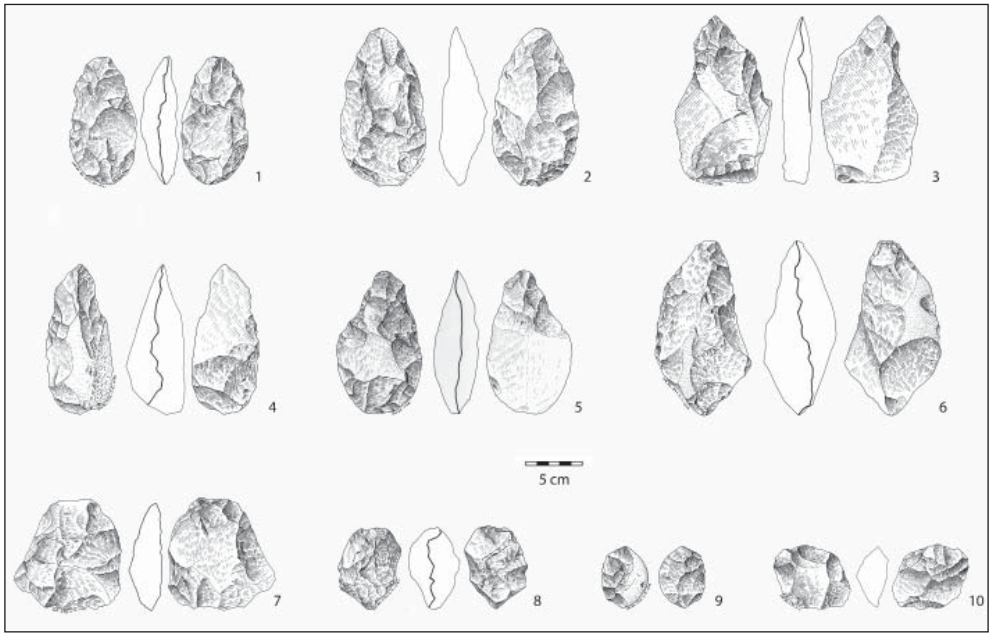

Fig. 9: *Sidi Abderrahmane-Extension* Quarry. 1-6: Large Cutting Tools of quartzite; 7-10: Cores for small-medium size flake production of quartzite. Drawings by M. Hirbec-Raynal.

Conclusions

Early and Middle Pleistocene stratified deposits with archaeological evidences as well as surface collections were described in Morocco, Algeria, Tunisia, and Nile Valley. Unfortunately, most of them lack a precise chrono-stratigraphy.

Currently, the Casablanca Quaternary sequence is the most complete stratified succession of raised beaches and associated continental deposits and pedo-units preserved in North-West Africa. The New Casablanca Stratigrafic Scale allowed 1) to construct a well established chrono-stratigrafic framework for the late Early/Middle Pleistocene of the Casablanca region, 2) to reappraise the stratigrafic and cultural attributions of the Lower Palaeolithic lithic assemblages discovered and studied by Biberson, and 3) to bring new data from modern controlled excavations and to discuss the classical cultural model proposed by Biberson in 1961 (Fig. 10).

Although many archaeological investigations have been carried out in Morocco since the beginning of the twentieth century, no pre-Acheulean sites have been identified. The revision of the lithic collections referred to the Moroccan Pebble Culture showed that all the materials are actually geofacts or younger reworked artefacts. This absence of a pre-Acheulean settlement in Atlantic Morocco is confirmed by the paleontological site of Ahl Al Oughlam dated to 2.4 Ma, that did not yield any lithic artefacts

but only geofacts (Fig. 10). Accordingly, despite ongoing discussions, the timing and mode(s) of the first settlement(s) in the Early Pleistocene are poorly understood in this part of Africa and many aspects related to the "Out of Africa" models remain open questions.

Only Thomas-Oulad Hamida Quarries in the western suburbs of Casablanca include a complex of archaeological sites in an indisputable stratigraphic context, spanning from the late Early Pleistocene to the Upper Pleistocene and documenting several stages in the local emergence and evolution of the Acheulean. The lowermost archaeostratigraphic unit (L) at Thomas Quarry I yielded the oldest Acheulean of North Africa, dated to ~1.0 Ma, probably close to the Tighenif assemblage in Algeria. This early Acheulean has a techno-economic structure distinct from what is claimed to be the preceding regional so-called Oldowan culture in Algeria and from the East African early Acheulean (Fig. 10). We consider it as the "First Regional Acheulean" (FRA).[86] Within this First Regional Acheulean, the technical behaviours identified in the small-medium sized flake productions constitute a common background irrespective of the presence (Thomas Quarry I-L1) or absence (Thomas Quarry I- L5) of Large Cutting Tools, which could present a high typo-technical variation.

A stratigraphic gap of approximately 0.3/0.5 Ma separates the FRA from the Middle Pleistocene Acheulean at Thomas-Oulad Hamida Quarries. This is a crucial period for human cultural and biological evolution when Acheulean technology develops, classically *Homo erectus* evolves and disappears while *Homo rhodesiensis* emerges. This gap is probably partly filled by Unit M of Sidi Abderrhamane-*Grande Exploitation* and from Unit D at S.T.I.C. Quarry, both older than 0.5 Ma. These industries could represent the last terms of the FRA (Fig. 10).

We consider the Middle Pleistocene Acheulean of Casablanca as the "Second Regional Acheulean" (SRA), which presents varied situations. The SRA is very polymorph in a technological perspective, most probably influenced by site formation processes, designated use of the sites, subsistence strategies, functionality of the different knapping outcomes. It is represented as soon as 0.5-0.6 Ma at *Grotte à Hominidés* and *Grotte des Rhinocéros*. It develops during MIS 11, represented at Sidi Abderrahmane Quarry by the *Grotte des Ours* and *Grotte des Littorines* assemblages. The more recent terms show a common use of Levallois flaking, prior to 0.35 Ma at *Cap Chatelier* (D2) and ~0.3 Ma at *Sidi Abderrahmane-Extension* upper layer (Fig. 10).

86. Jean-Paul Raynal et al., "Casablanca des origines," in *Préhistoire de Casablanca,* vol. 1, 11-33; Raynal et al., "The western quest."

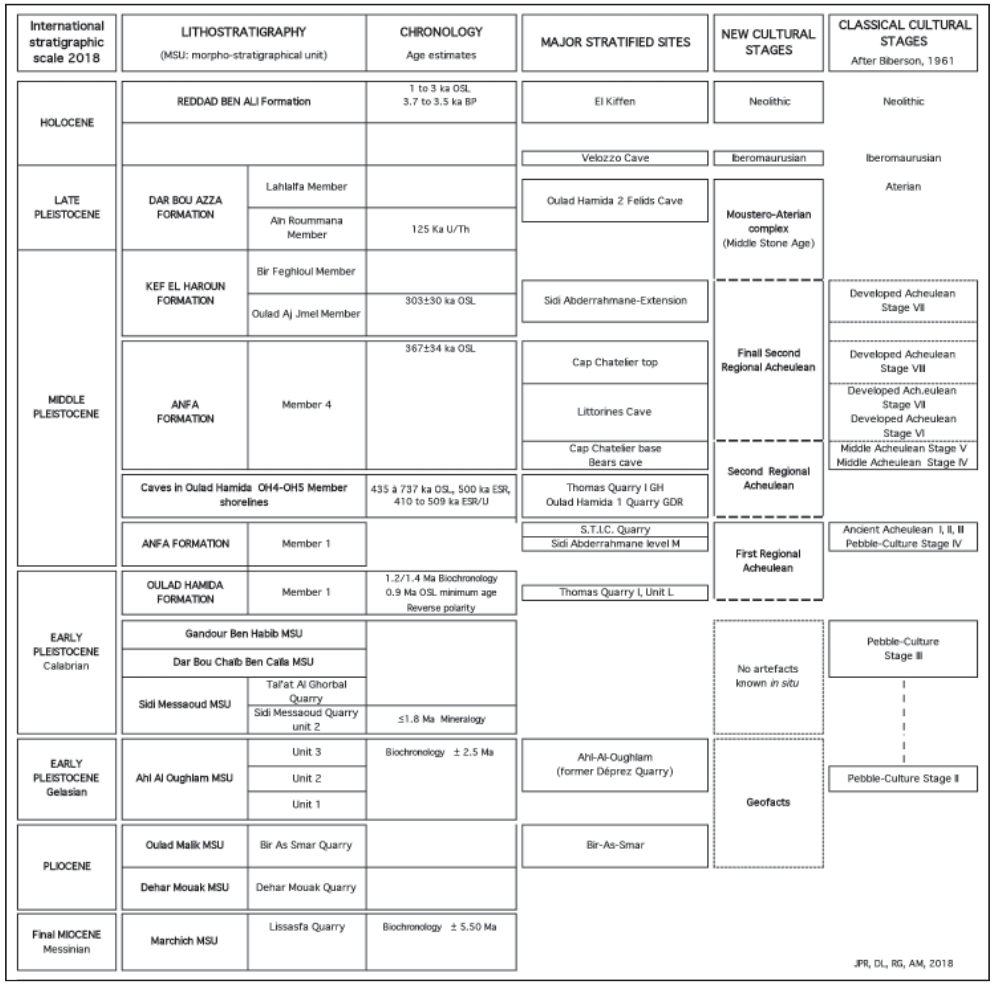

Fig. 10: The Casablanca archaeostratigraphic sequence in its chrostratigraphical framework (2018 update).

This exceptional sequence must from now on, considering its richness, be taken into account at the same rank than those from Eastern and Southern Africa, Europe, Middle East or Asia. The chronological framework necessary for correlations with other African zones for now on not only rests on a reliable biostratigraphic scale, that an intensification of researches will make more detailed, but has been recently strengthened by a series of absolute dates by different methods. Hominins fossils are still rare but new findings have recently occurred in Thomas-Oulad Hamida Quarries in an undisputable stratigraphic context and document the beginning of this story. Future researches will have to establish the nature of the relations with East Africa, Middle East and more widely Eurasia.

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ملخص: أربعون سنة من الأبحاث بالدار البيضاء (المغرب): معطيات جديدة حول الأركيولوجيا والجيولوجيا خلال البلايستوسين الأدنى والمتوسط

يعد تطور الترسبات الساحلية المنتمية للرباعي بمنطقة الدار البيضاء استثنائيا، حيث يبتدئ منذ ما يقرب من 6 ملايين سنة أي خلال الميوسين الأعلى ويستمر طوال فترات البليو-رباعي مسجلا بشكل دقيق مراحل التغيرات المناخية الكونية. احتفظت هذه الوحدات المورفو-رسوبية على تراث أركيولوجي وباليونثولوجي له قيمة علمية بالغة الأهمية. وفي سنة 1961 وبعد قرابة خمسين سنة من الأبحاث، حدد بيير بيبرسون إطارا استراتيغرافيا شاملا للرباعي، كما وضع نموذجا لأهم المحطات الثقافية ظل يشكل منذ تلك الفترة المرجع الأساسي لفترات ما قبل التاريخ القديمة بشمال إفريقيا. لكنه ابتداء من سنة 1978، أشرف برنامج البحث الأثري المغربي/الفرنسي على إنجاز أبحاث ميدانية حديثة بمنطقة الدار البيضاء، مكنت من المراجعة الإستراتيغرافية والأركيولوجية للمواقع الكلاسيكية فضلا عن اكتشاف مواقع ومستويات أثرية جديدة. ونقدم في هذا المقال، عرضا يتناول أركيولوجيا ما قبل التاريخ القديم والجيولوجيا بالدار البيضاء، وذلك من حيث تاريخ الأبحاث أولا، قبل الانتقال في المستوى الثاني إلى معالجة الحالة الراهنة للمعطيات.

الكلمات المفتاحية: المغرب، الدار البيضاء، البلايستوسين الأدنى والمتوسط، الأركيولوجيا، الجيولوجيا.

Résumé: **Quarante années de recherches à Casablanca (Maroc)**: **nouveaux regards sur l'Archéologie et la géologie du Pléistocène inférieur et moyen**

Dans la région de Casablanca, le développement des dépôts littoraux de la séquence quaternaire est exceptionnel, il commence aux environs de 6 millions d'années (Miocène supérieur) et s'étend tout le long des périodes plio-quaternaires avec un enregistrement détaillé des variations des niveaux des océans témoins de l'évolution du climat planétaire. Ces unités morpho-sédimentaires ont conservé un patrimoine paléontologique et archéologique extraordinaire. En 1961, après à peu près 50 ans de recherches, Pierre Biberson établit un

cadre stratigraphique du Quaternaire du Maroc atlantique et définit un schéma culturel qui représenta dès lors la référence pour la Préhistoire ancienne nord-africaine. Cependant, depuis 1978, un programme de recherches archéologiques maroco-français a conduit des travaux de terrain dans la région de Casablanca ayant permis la révision stratigraphique et culturelle des sites classiques et la découverte de nouveaux sites. Dans le présent article, nous présentons la Préhistoire ancienne et la géologie de Casablanca selon deux perspectives: l'historique des recherches et l'état de l'art.

Mots-clés: Maroc, Casablanca, Pléistocène inférieur/moyen, archéologie, géologie.

Abstract: **Forty Years of Research at Casablanca (Morocco)**: **New Insights in the Early/Middle Pleistocene Archaeology and Geology**

In the region of Casablanca the development of Quaternary littoral deposits is exceptional, beginning nearly 6 million years ago (Ma) in the Upper Miocene and spreading over the Plio-Quaternary times with an extremely detailed registration of the global climatic cycles. These morpho-sedimentary units yielded an equally extraordinary paleontological and archaeological heritage. In 1961, after approximately 50 years of researches, Pierre Biberson defined a synthetic framework of the Quaternary of Atlantic Morocco and a cultural model that represented the reference for the ancient prehistory of North Africa. Since 1978 however, a joint Morocco-French research program conducted new fieldworks in the Casablanca region, which allowed the stratigraphic and cultural reappraisal of the classical localities and the discovery of new sites. In this paper we review the Early/Middle archaeology and geology of Casablanca from two perspectives: the history of research and the state of the art.

Key-words: Morocco, Casablanca, Early/Middle Pleistocene, geology, archaeology.

Resumen: **Cuarenta años de investigación en Casablanca (Marruecos)**: **Nuevas perspectivas sobre la arqueología y geología del Pleistoceno inferior y medio**

En la región de Casablanca, la evolución de los depósitos litorales de la secuencia cuaternaria es exceptional, empezo alrededor de 6 millones de años (Mioceno superior) y se extiende a lo largo de los períodos plio-cuaternarios con un registro detallado de las variaciones de niveles de los océanos testigos de la evolución del clima global. Estas unidades morfo-sedimentarias han conservado un patrimonio paleontólogico y arqueológico extraordinario. En 1961, después de 50 años de investigacións, Pierre Biberson estableció un cuadro estratigráfico del Cuaternario del Marruecos atlantico y definió un esquema cultural que representaba desde entonces la referencia para la prehistória antigua del norte de África. Sin embargo, desde 1978, un programa de investigación arqueológica marroquí-francesa ha llevado a cabo un trabajo de campo en la región de Casablanca que ha permitido la revisión estratigráfica y cultural de los sitios clásicos y el descubrimiento de nuevos sitios. En el presente articulo, presentamos la Prehistoria antigua y la geologia de Casablanca segun dos perspectivas: la historia de las investigaciónes y el estado de arte.

Palabras claves: Marruecos, Casablanca, Pleistoceno inferior/medio, arqueología, geología.