ABIOTIC RAW MATERIAL SUPPLY IN THE NEOLITHIC OF THE EASTERN RIF, MOROCCO. A PRELIMINARY REPORT

Jörg Linstädter, Hiltrud Müller-Sigmund***

Abstract: Since 1995 archaeological research has been undertaken in the Eastern Rif (Morocco) by a Moroccan-German research team with participation of the "Institut National des Sciences de l'Archéologie et du Patrimoine du Maroc" (INSAP), the "Kommission für die Archäologie Außereuropäischer Kulturen des Deutschen Archäologischen Instituts" (KAAK), and the Institute of Prehistoric Archaeology of the University of Cologne. In the course of these studies, several hundred sites have been discovered and a number of these excavated. Sites investigated in more detail cover the time span from the Lower Palaeolithic up to Islamic times. From the onset of the project a particular focus has been on Neolithisation processes in the area. In the last years the raw material supply for pottery and stone tool production has also come into focus. In cooperation with mineralogists and sedimentologists a number of raw material sources could be identified. This paper summarises all known Neolithic sites and potential raw material sources of the area and reconstructs their spatial relations.

Keywords: Morocco, Neolithic, pottery analysis, lithic industry, raw material support.

Resumen: *Desde 1995, la investigación arqueológica en el Rif Oriental (Marruecos) ha sido realizado por un equipo germano-marroquí con la colaboración del "Institut National des Sciences de l'Archéologie et du Patrimoine du Maroc" (INSAP), la "Kommission für die Archäologie Außereuropäischer Kulturen des Deutschen Archäologischen Instituts" (KAAK), y el Instituto de Arqueología Prehistórica de la Universidad de Colonia. Durante los estudios se han descubierto varios centenares de yacimientos y varios de ellos han sido excavados. Los yacimientos investigados con más detalle abarcan desde el Paleolítico Inferior hasta época islámica. Desde el comienzo del proyecto, se ha prestado especial atención a los procesos de neolitización en la zona. En los últimos años el suministro de materia prima para la cerámica y la producción de herramientas de piedra también ha sido objeto de atención. En cooperación con los mineralogistas y sedimentólogos, se ha podido identificar el origen de algunas de las materias primas. Este artículo resume todos los yacimientos neolíticos conocidos y las potenciales fuentes de materia prima de la zona y reconstruye sus relaciones espaciales.*

Palabras claves: *Marruecos, Neolítico, análisis d cerámica, industria lítica, abastecimiento de materia prima.*

Introduction

The analysis of raw materials used in prehistoric times, the localisation of their deposits, as well as modes of transport and exchange are central topics in archaeological research (Zimmermann 1995, Martineau *et al.* 2007, Binder *et al.* 2010). These topics have implications for both on-site and off-site investigations. On-site issues are concerned with the selection and processing of different raw materials for distinct technological or functional purposes, as well as their change through time. Off-site topics deal with mobility patterns between resources and living sites, including operating chains and modes of transport and exchange. In addition to adequate analytical methods the study requires comprehensive and detailed knowledge of the natural resources of a certain working area. As these preconditions are rather disparate from area to area the progress of this archaeological branch shows ample regional differences. In north-eastern Morocco this study is still in its infancy and therefore we present here some preliminary results.

In the last 15 years, the area of the Eastern Rif and the Lower Moulouya valley has seen a number of surveys and excavations carried out by a Moroccan-German research team with participation of the "Institut National des Sci-

* Institute of Prehistoric Archaeology, University of Cologne
** Institute for Geosciences, University of Freiburg
Correspondence: e-mail: joerg.linstaedter@uni-koeln.de

ences de l'Archéologie et du Patrimoine du Maroc" (INSAP), the "Kommission für die Archäologie Außereuropäischer Kulturen des Deutschen Archäologischen Instituts" (KAAK), and the University of Cologne (Mikdad *et al.* 2000, Moser 2003, Nami 2007, Linstädter 2011). More recent fieldwork has been undertaken within the frame of the CRC 806 "Our way to Europe", associated since 2009 at the Universities of Cologne, Bonn and Aachen. Several hundred sites have been documented and some of them excavated. Among sites to have been investigated in more detail are those covering a time span from the Middle Palaeolithic (Nami & Moser 2010) to the Islamic period (Jebb 2008). From the beginning of our studies, particular focus has been upon the transitional process from Epipalaeolithic hunter-gatherers to Neolithic food producing communities (Linstädter 2008). Therefore, preliminary results presented here are based on analyses of Epipalaeolithic and Early Neolithic inventories investigated within the last decade.

Detailed results come from the coastal sites of Ifri Oudadane and Ifri Armas (Linstädter 2010), the open air sites of Mtlili 1, 5 and 6 at the Lower Moulouya (Linstädter *et al.* in press. 2012), and the shelter of Hassi Ouenzga north of Saka (Linstädter 2004) (fig. 1).

Siliceous raw materials utilised for knapped stone artefacts

To classify the siliceous raw materials, so far only macroscopic methods have been applied. Characteristics described within all raw material varieties are: type of the raw part (pebbles, nodules, and plaques), weathering (cortex, bark), structure (grain size and distribution, layering), texture (fissures, inclusions), optical features (surface, colour, transparency, and brilliance) and physical features (fractures).

Up to present, six siliceous varieties can be distinguished in our working area. The so-called "Ain Zora" flint, a black to greyish fine grained material with limestone cortex, is the only variety of which the primary source is known. The outcrops are located in the surroundings of the Ain Zora village, 20 km west of Saka (fig. 1). Two further varieties are found in the pebble beds of the Moulouya valley: a coloured and a white flint. Primary deposits are probably located in the Middle Atlas region, and material from the Moulouya itself must be regarded as a secondary source. A yellow to reddish flint comes from the Oued Oumassine, a tributary of the Oued

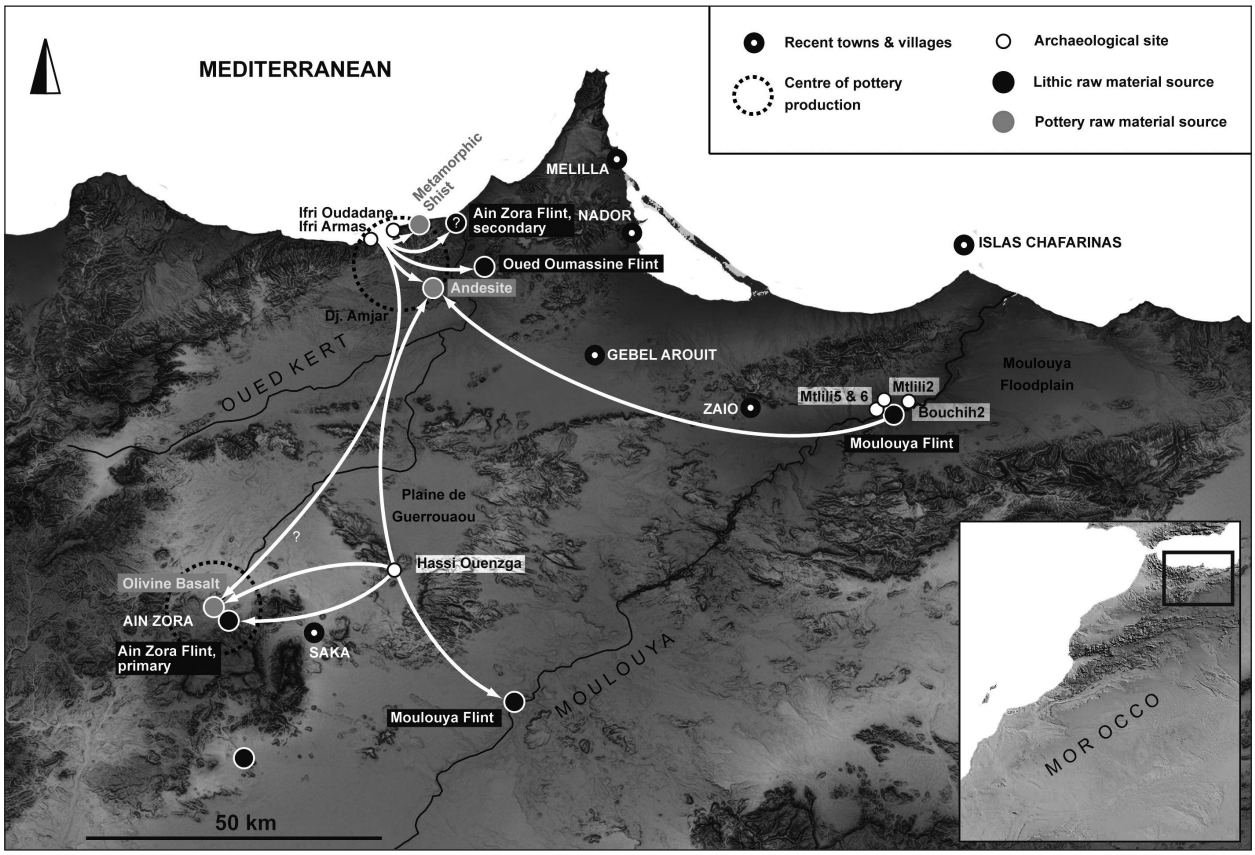

FIGURE 1. Research area between Eastern Rif Mountains and Lower Moulouya valley. The map shows archaeological sites in the inventories of which raw material analyses of pottery and knapped stone artefacts were undertaken. Further sources of siliceous stones, clay and temper are marked by black and grey dots. Arrows show connections between archaeological sites and resource deposits from whence raw material or artefacts arrived at the site. Dashed circles mark the "resource area" (after Arnold 2005) around a clay deposit within pottery was made.

Kert, south of the Melilla Peninsula. For the last two types neither a primary nor a secondary deposit is so far known: An opaque and multi-coloured chalcedony and a brownish chert with thin white cortex. The latter is characterised by flat raw parts with parallel cortexes on upper and lower side so that a platy occurrence is likely. This chert appears first of all in the Epipalaeolithic with pottery deposits from Hassi Ouenzga Abri.

The three Epipalaeolithic, respectively Neolithic, sites or site clusters show distinctive patterns of raw material procurement. The inventories of the costal sites Ifri Oudadane and Ifri Armas are dominated by the black Ain Zora flint. The raw parts fail to show any cortex but instead pronounced gravel barks. Therefore pebbles do not stem from the primary source but rather from the nearby Oued Kert or its tributaries which drain the Ain Zora area. At the sites of Mtlili at the Lower Moulouya the two Moulouya flint varieties were used exclusively. Additionally, at Hassi Ouenzga the Ain Zora flint, the coloured Moulouya flint and the not yet located platy chert are represented.

Preliminary results show that the necessary effort for raw material supply is varies considerably from site to site. To categorise the distances covered, we apply a modified model proposed by Arnold (2005) originally developed for pottery studies and also used for the West Mediterranean Neolithic (Binder *et al.* 2010: 116). Accordingly the distances between living site and raw material source are divided into three categories: up to 1 km, here referred to as "local", which is the preferred distance where up to ca. 50% of clay and temper stem from a given site; the 1-7 km zone, here termed "regional", where further 25% of all materials were obtained; and the surroundings of more than 7 km ("area-wide") from the settlement from where only very few quantities enter the production process (Arnold 2005: 16). If we assume that prehistoric people are interested in a minimal effort, this works only at the Moulouya, where local material is available and represents nearly 100 % of the inventories (Linstädter *et al.* in press.). A slightly different situation prevails at the costal sites of Ifri Oudadane and Ifri Armas which obtain material from a regional periphery. Here a high percentage of raw materials come from the nearby Oued Kert (Ain Zora flint) and Oued Oumassine, whose deltas are located in a distance of 6 to 7 km. The by far greatest effort was made by the inhabitants of Hassi Ouenzga. The nearest raw material outcrop, Ain Zora, is located more than 20 km to the west, resulting therefore in an allochthonous material supply.

Pottery resources

Pottery analysis and the identification of raw material sources were carried out in seven steps (fig. 2).

Step one (pre-selection): In general an analysis of every pottery vessel unit is desirable to have hard data of their mineralogical composition. However, this procedure is not practicable from the technical and financial point of view. Therefore single units from macroscopically distinguishable groups were selected to reduce the sample number. Finally 62 samples from 5 sites with inventories from Epipalaeolithic with pottery, Early and Late Neolithic were analysed which are distributed over the whole area: Hassi Ouenzga (41), Ifri Oudadane (10), Ifri Armas (9), Mtlili 5 (1) and Mtlili 6 (1).

Step two (thin section microscopy): Here micro slides were prepared and microscopically analysed. As a result we obtain mostly quantitative information regarding texture, temper material, proportions of paste, and temper and grain size.

Step three (Electron Microprobe): In a third step the sample will be analyzed by Electron Microprobe. This method allows an analysis of single minerals within the sample and therefore provides the particular mineral composition of the sherd. Preliminary results suggest that an origin of the raw material is close to deposits of either basalt (fig. 3a), andesite (fig. 3b), granite (fig. 3c) or metamorphic schist (fig. 3d). In general, monogenetic tempers prevail. Mixtures indicating an origin from catchments with variable lithologies occur more rarely. Nearly all temper groups are observed at each site (Linstädter and Müller-Sigmund in prep.).

Step four (geological maps and potential raw material deposits): With the minerals occurring in the pottery samples now known, in a next step the geological formations where these minerals occur have to be identified. Geological maps were studied to locate these formations in the working area.

Step five (surveys and sample collection): All accessible spots were surveyed and samples taken. It is assumed that prehistoric potters were more interested in the weathered products than in the rocky source material. If such weathering products were available from erosional channels or small Oueds, samples were taken as well. Of particular interest are accumulations which possess of initial soil formation and the development of clay minerals. These deposits are most applicable for pottery production. Up to now, three outcrops could be located: an olivine basalt in the Ain Zora area (fig. 2), andesite deposits at the Djebel Amjar, including weathering products within a tributary to Oued Kert, and metamorphic schists occurring at the littoral directly beside the Ifri Oudadane site.

Step six (analysis of rock and soil samples): Rock and soil samples are going to be examined using the same procedure as applied for the original archaeological material, including thin section microscopy and Electron Microprobe analysis.

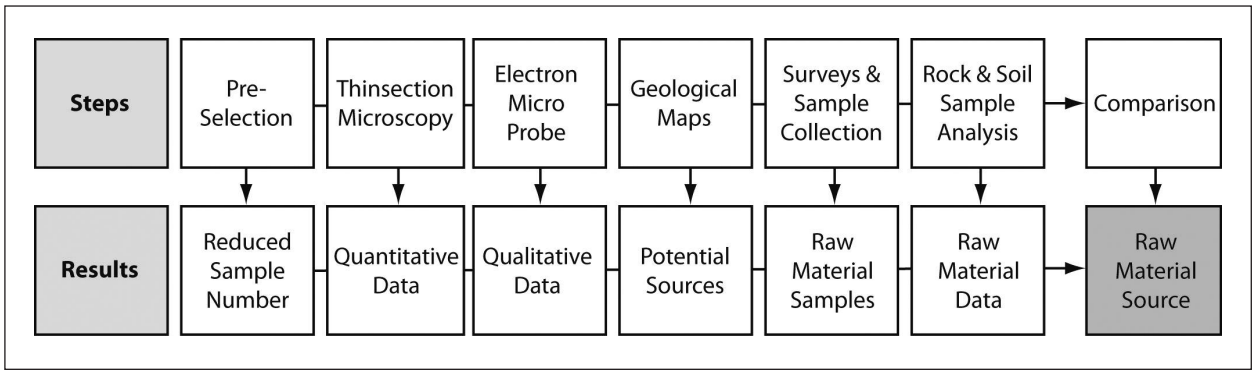

FIGURE 2. "Work-flow" of raw material source locating. The graph shows seven steps from "Pre-selection" of sherd samples to the "Comparison" of pottery-mineralogy and rock & soil sample-mineralogy by which raw material sources can be re-traced.

Step seven (comparison): Finally the results of pottery and rock or soil sample analysis will be compared with the help of statistical methods. In doing so the chemistry of minerals such as amphibole, biotite or olivine from the sherds are correlated with the chemistry of the same minerals from the field sample. As a result, particularly high consistency is shown between the amphiboles and biotites from Djebel Amjar with those from pottery in Hassi Ouenzga, Ifri Oudadane, and Mtlili 6. Pottery made of clay from the Djebel Amjar area therefore can be found within the whole working area of the project.

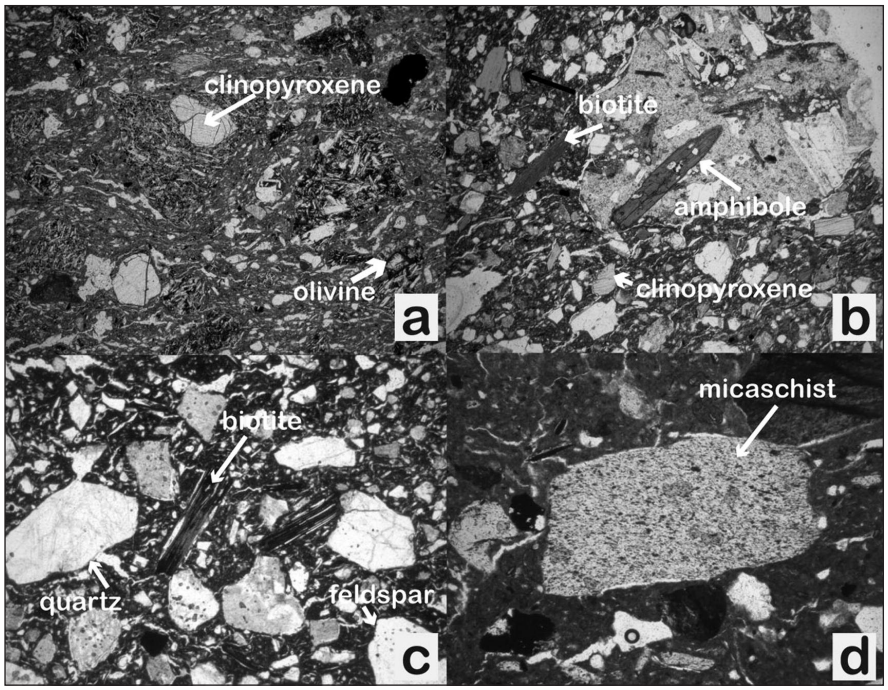

FIGURE 3. Thin section micrographs displaying different temper materials, long edge 5 mm.
(a) olivine-clinopyroxene bearing basalt, (b) biotite-amphibole-clinopyroxene bearing andesite, (c) quartz and feldspar fragments from granitic rock, (d) metamorphic schist.

Discussion

Combining all available information about use and provenance of lithic raw materials and resources of pottery production, the following maintenance routes arise for every site. The sites of Mtlili cover their whole requirements on lithic raw material by local Moulouya flint. Pottery analysis of a Mtlili 6 sherd yielded the typical biotite signature from Djebel Amjar andesite. However, this deposit is more than 60 km away (fig. 1), and after Arnold (2005: 17) this distance is far beyond the limits within which pottery resources were obtained. Therefore the Mtlili 6 vessel was probably produced elsewhere and later transported into the area as part of the equipment of a mobile group.

The coastal sites of Ifri Armas and Ifri Oudadane do not possess local raw material that can be utilised for knapped stone artefacts. Nevertheless two potential sources are located in the regional sector of the sites: the gravel beds of Oued Kert and Oued Oumassine (fig. 1). Further research is needed to confirm whether the black flint, frequently used at the sites of Ifri Armas and Ifri Oudadane, really originates from the lower reaches of the Oued Kert. A part of the pottery inventory of Ifri Oudadane

shows the signature of metamorphic schists cropping out directly beside the shelter. Therefore a local resource for pottery production seems to be available. However, the amount of this coarse pottery is very limited, leading us to the assumption that the quality of this raw material source was not satisfying. The by far largest part of the Ifri Oudadane pottery shows the signature of the Djebel Amjar andesite. This deposit is located within the regional sector and after Arnold (2005) within the range of resource procurement. A sherd sample which shows the signature from the olivine basalt of Ain Zora, which is more than 60 km away, most likely comes from a pot imported from this area (fig. 1).

The last site discussed here is the shelter of Hassi Ouenzga. According to the present state of research this site disposes over neither local nor regional raw material sources. Pottery seems to be made from Ain Zora and Djebel Amjar materials and therefore imported to the site as finished product. Lithic resources come from the Moulouya valley as well as the Ain Zora region (fig. 1).

In conclusion, raw material from local, regional and area wide sources were used. In addition, the import of artefacts from distances in excess of 60 km is confirmed. According to present knowledge two independent centres for pottery production existed in the area of Ain Zora and the Djebel Amjar area which includes the coastal sites of Ifri Oudadane and Ifri Armas. The appearance of Djebel Amjar pottery at the Lower Moulouya and in Hassi Ouenzga, as well as that of Ain Zora pottery in Hassi Ouenzga and at the littoral, indeed documents contacts via mobility or exchange between all three areas.

Bibliography

ARNOLD, D. 2005: Linking Society with the Compositional Analyses of Pottery. *Acts of the XIVth UISPP Congress* (University of Liège 2001): 15-21.

BINDER, D., CLOP, X., CONVERTINI F., MANEN, C., & I. SENEPART 2010: Les productions céramiques du Néolithique ancien. In: MANEN, C., CONVERTINI, F., BINDER, D. & I. SENEPART: *Premières sociétés paysannes de Méditerranée occidentale: structure des productions céramiques*. Paris, Société Préhistorique Française (Mémoire 51): 115-129.

JEBB, M.D. 2008: *The Lower Paleolithic of northern Morocco: bifaces and other stone tools from the open air sites of Ammorene I and Ammorene II*. Magisterarbeit. Eberhard-Karls Universität Tübingen, Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters.

LINSTÄDTER, J. 2004: Zum Frühneolithikum des westlichen Mittelmeerraumes. Die Keramik der Fundstelle Hassi Ouenzga. *AVA-Forschungen* 9. Philipp von Zabern, Mainz.

LINSTÄDTER, J. 2008: The Epipalaeolithic-Neolithic Transition in the Mediterranean region of Northwest Africa. *Quartär* 55: 41–62.

LINSTÄDTER, J. 2010: Recherches récentes sur les sites en grotte du Néolithique ancien dans l'Ouest marocain. In: MANEN, C., CONVERTINI, F., BINDER, D., SÉNÉPART, I. (Eds.): Organisation et fonctionnement des premières sociétés paysannes – structure de production céramique. Séance de la Société Préhistorique Française (Toulouse 2007). *Mémoires LI de la SPF*: 227–235.

LINSTÄDTER, J. 2011: The Epipalaeolithic-Neolithic Transition in the Eastern Rif Mountains and the Lower Moulouya valley, Morocco. In: GIBAJA BAO, J.F., CARVALHO, A.F., BICHO, N.F. (Eds.): The last hunter-gatherers and the first farming communities in the south of the Iberian Peninsula and north of Morocco. Proceedings of the work shop (Faro 2009). *Promotoria Monográfica*, 15: 89-98.

LINSTÄDTER, J., ASCHRAFI, M., IBOUHOUTEN, H., ZIELHOFER, C., BUSSMANN, J., DECKERS, K., MÜLLER-SIGMUND, H., HUTTERER, R. (in press): Flussarchäologie der Moulouya-Hochflutebene, NO-Marokko. *Madrider Mitteilungen* 53.

MARTINEAU, R., WALTER-SIMONNET, A.-V., GROBÉTY, B. & BUATIER, M. 2007: Clay resources and technical choices for neolithic pottery (Chalain, Jura, France): chemical, mineralogical and grain-size analyses. *Archaeometry* 49, 1: 23-52.

MIKDAD, A., EIWANGER, J., ATKI, H., BEN-NCER, A., BOKBOT, Y., HUTTERER, R., LINSTÄDTER, J., MOUHSINE,T. 2000: Recherches préhistoriques et protohistoriques dans le Rif oriental (Maroc). Rapport préliminaire. *Beiträge zur Allgemeinen und Vergleichenden Archäologie* 20: 109-167.

MOSER, J. 2003: *La Grotte d'Ifri N'Ammar. Tome 1: L'Ibéromaurusien*. Lindensoft, Köln.

NAMI, M. 2007: Les techno-complexes ibéromaurusiens d'Ifri El Baroud (Rif Oriental, Maroc). *Zeitschrift für Archäologie Außereuropäischer Kulturen* 2: 183–239.

NAMI, M. & J. MOSER 2010: La Grotte D'Ifri N'Ammar. Le Paléolithique Moyen. *Forschungen Zur Archäologie Außereuropäischer Kulturen* 9. Reichert Verlag, Wiesbaden.

ZIMMERMANN, A. 1995: Austauschsysteme von Silexartefakten in der Bandkeramik Mitteleuropas. *Univ.forsch. zur prähist. Arch. Frankfurt* 26. Köln, Bonn, 1995.