Considering the Arabian Neolithic through a reconstitution of interregional obsidian distribution patterns in the region

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As a result of a programme devoted to obsidian geochemical analyses for the Red Sea region (VAPOR), the register of analysed obsidian artefacts from Arabia has grown considerably in recent years. A percentage of these correspond to surveyed and excavated Neolithic contexts in Yemen, Saudi Arabia and Oman. This growing database of site to source matches has enabled us to consider the Neolithic of Arabia as more than just a period of sedentism and initial domestication, but as a period where we can begin piecing together the formulation of complex social networks and exchange mechanisms that included, and may even have depended to some extent on, mobile groups. Using obsidian source analyses coupled with spatial mapping, site and lithic data, we use obsidian as a guide to gain a better understanding of the early dynamics of interaction between regions in Arabia and beyond, and to assess what role the socio-economic networks identified may have had in the process of Arabian Neolithisation, or in certain cases, the lack thereof.

Keywords: South Arabia, Neolithic, obsidian sourcing, exchange mechanisms, lithic technology

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I. Introduction

I.1. Preface

For decades, Arabia has been regarded as peripheral to discussions of Neolithisation because the processes that occurred there in the early to mid-Holocene do not correspond to those of the classic Near Eastern model. In the Near East it is primarily the domestication of plants, and also that of animals, which is the major marker signalling the adoption of a Neolithic way of life. As archaeological research expands and more data is collected across Arabia and Africa, researchers in Arabia are moving further away from defining the Neolithic of these regions using the classic Near Eastern Neolithic criteria, and certainly in what concerns the quasi-dependence on agriculture. If defining a Neolithic depended on all these criteria being present, most regions would not have witnessed a Neolithic before historic times, if at all.

In the last three decades, it has become increasingly more common for archaeologists working in Arabia and sub-Saharan Africa to treat Neolithisation as a process that could include varied and co-existing social and economic trajectories, depending on the region. The models of Neolithisation that are emerging involve strategies of subsistence suited to specific regions, and ones that lead to complex social structures, food production and eventual domestication without the requirement of an agricultural way of life, per se (Brandt & Carder 1987; Clark & Brandt 1984; Cleuziou & Tosi 1997; Crassard 2009; Fedele 1987:

35–38; 2009; Gutherz 2008; Marshall & Hildebrand 2002; Joussaume 1995; Lesur 2007; Tosi 1986). It has become quite clear now that in those regions of Arabia where the climate and environment were not necessarily favourable for agriculture, it was often adopted belatedly, if at all, by most Neolithic communities.

In those landscapes where mobile and sedentary pastoral groups co-existed and thrived, however, complex exchange networks emerged quite early (see Ndiema, Dillian & Braun 2010: 96). These Neolithic sites were not densely populated and had lower thresholds for settlement and population growth than their Near Eastern and Anatolian neighbours, despite their capacity to manage some surplus (early presence of storage vessels), and have sedentary lifestyles.

The issue we focus on in this paper is that of long-distance exchange as a phenomenon which develops alongside the first Neolithic societies in Arabia and signals the presence of complex social networks, some degree of economic management and technological change and the formalisation of inter-group relationships through developed channels of communication. We specifically look at the circulation of obsidian, a volcanic glass that exists in few regions of the world and was nonetheless used widely in prehistory for the production of sharp tools and elite objects. Its wide use meant that it was often exchanged at long distances from its origin, and that it circulated in far-reaching networks, possibly alongside other products of value (Inizan & Francaviglia 1996; Francaviglia 1996). Using previously published results as a point of departure (Khalidi, Lewis & Gratuze 2012; Khalidi *et al.* 2010; Khalidi 2009; Barca, Lucarini & Fedele 2012), we present new data pertaining to obsidian geochemical analyses carried out as part of the Volcanological and Archaeological Program for Obsidian Research (VAPOR), on obsidian artefacts collected from Neolithic sites in Arabia by numerous projects.

Published obsidian geochemical analyses of artefacts concern obsidian recovered in the Tihamah coastal plain, the western escarpment (Khalidi 2007, 2008, 2011) and the highland plains in Yemen (Khalidi, Lewis & Gratuze 2012; Lewis & Khalidi 2008; Lewis *et al.* 2010), as well as previous results (Neolithic sites in the Hadramawt and in the eastern highlands, Yemen) that have been reassessed through a comparison to our updated geological database (Khalidi, Oppenheimer, Gratuze, Boucetta et al., 2010; Barca, Lucarini & Fedele 2012). Apart from a summary of these results, this paper will concentrate on a discussion of the source of Yafa' in highland Yemen, which emerged as a major source of obsidian in Arabia, and on new obsidian source matches from three additional Neolithic sites in Arabia (Jebel Ghubayr, al-'Abr, and Mundafan) that have the potential to expand our view of the exchange networks in Arabia during the Neolithic (Fig. 1).

I.2. Current state of obsidian research in Arabia and Africa: VAPOR

The last five years have been dedicated to the building of an obsidian database for Arabia and Africa, in the context of a collaborative programme called VAPOR. This programme focuses on the systematic survey and sampling of sources of obsidian in Arabia and the Horn of Africa and their analysis mainly by Laser Ablation High-Resolution Inductively Coupled Plasma Mass-Spectrometry (LA-HR-ICP-MS). Results have allowed us to build an archaeological and analytical reference database that completely renews previous data, as well as bringing new information to light.

In the field in Yemen, we identified two unanalysed flows pertaining to the previously published obsidian sources of Jebel Lisi and Jebel Isbil (Francaviglia 1990a, 1990b) in the eastern highland plains, as well as four unknown sources in the western highland plains. Systematic sampling across flows was carried out to be able to define the widest range of geochemical compositions for each outcrop or volcanic complex. Thus far the Yafa' outcrop has the widest range of compositions, which we can confidently separate from other source compositions. Also distinguished are yet unlocalised Groups 1–4 that are compositionally related to those of Yafa' and are probably located in the vicinity of those Yafa' outcrops we have sampled (Khalidi, Lewis & Gratuze 2012).

VAPOR has also been carrying out analyses on obsidian from hundreds of archaeological sites in Arabia, the Near East and the African Horn, a small percentage of which are certainly Neolithic in date. Our analyses have shown that in Arabia during the Neolithic period, the obsidian source of Yafa', located in the western highland plains of Yemen, provided most of the obsidian across the highlands, but also at long distance, with the material reaching the largest distances towards the eastern interior. Obsidian from the source of Jebel Lisi was also present on some sites in the highlands, although in smaller quantities. Highland Yemen obsidian has yet to appear beyond the western foothills (highlands), and only one example matching the source of Yafa' has been found so far in the Tihamah coastal plain. Thus far the compositions of all analysed Tihamah obsidian (except for the above sample) fall into the family of African

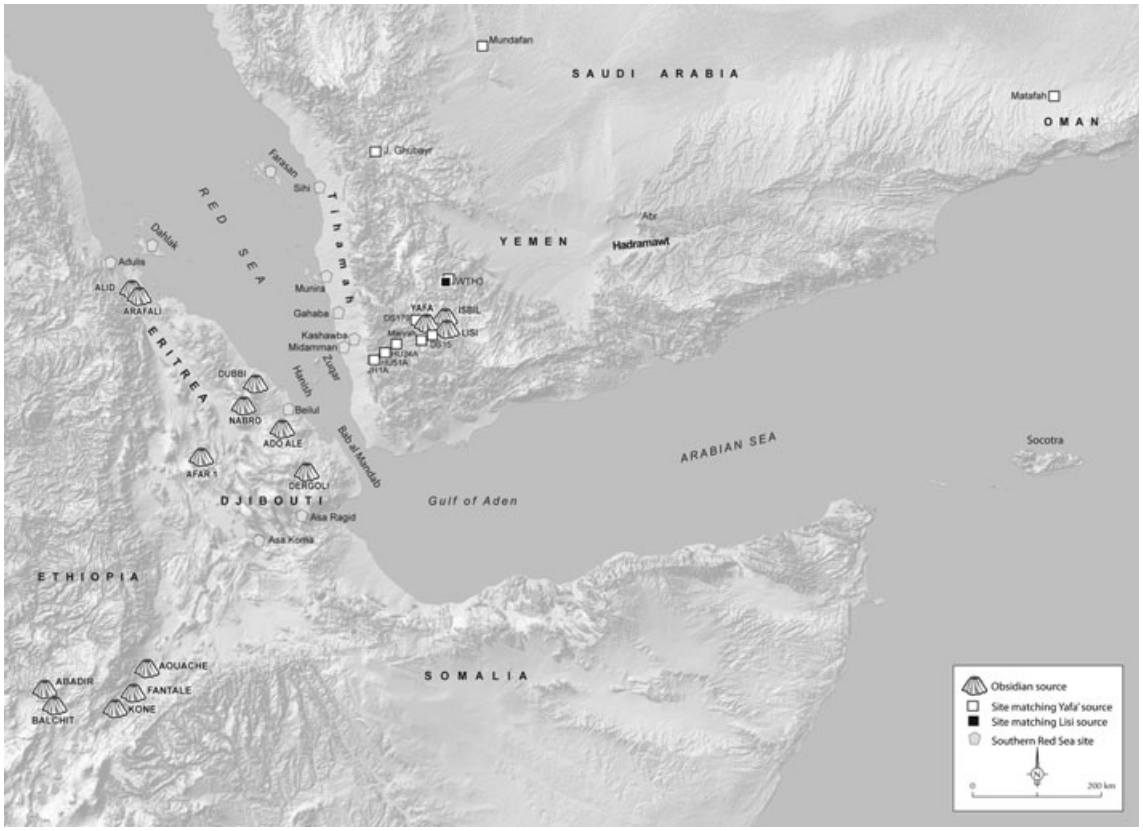


Fig. 1.
Map illustrating the sites and source outcrops mentioned in the text.

obsidian sources although there are yet to be exact matches. This reinforces other cultural evidence for cross-Red Sea contact and exchange between the Yemen and Horn of Africa coasts (Khalidi 2007, 2009; Khalidi, Oppenheimer, Gratuze, Boucetta et al., 2010).

II. The Yafa' source and local highland obsidian distribution

II.1. Yafa'

Geological and archaeological work along the Yafa' source outcrop included investigation of an extensive obsidian workshop area (DS179), previously documented by the Dhamar Survey Project (DSP) (Wilkinson, Edens & Gibson 1997: 122). This workshop is probably one of a series located along the Yafa' obsidian flows, and for the time being remains unexcavated and undated. Upon a first assessment of non-lithic surface collections (ceramics, stone architecture), DS179 appears to be Bronze Age to Himyarite in age, but it is likely that the area of the site, rich in cortical nodules with volumes favourable for the extraction of lamellar products, was in use much earlier. A large number of the lithics recovered are single-platform bladelet cores on cortical nodules of the type found in abundance across the site (Fig. 2). Most of the debitage and waste recovered are cortical or pertain to the bladelet core preparation and reduction sequences suggested by the cores (Fig. 3). Our investigation of surface finds revealed that no cores were exhausted, and that many were abandoned after only a few removals, likely due to the abundance of nodules on the site. Most cores recovered had cortical platforms that needed little to no preparation (Fig. 2/a), and all were exploited using a direct percussion technique.

While this workshop site remains undated, it is likely to have been a knapping area in the Neolithic and to have been eclipsed by later occupations. Planned future surveys and excavations will reveal its date and whether or not more important Neolithic obsidian workshops existed in the vicinity. To date, DS179 is the only extensive bladelet workshop found along an obsidian source in Yemen, and it is no surprise that it was discovered along the Yafa' flows from which highland Neolithic populations were intensively exchanging obsidian across the highlands and at long distance across Arabia, in much smaller quantities.

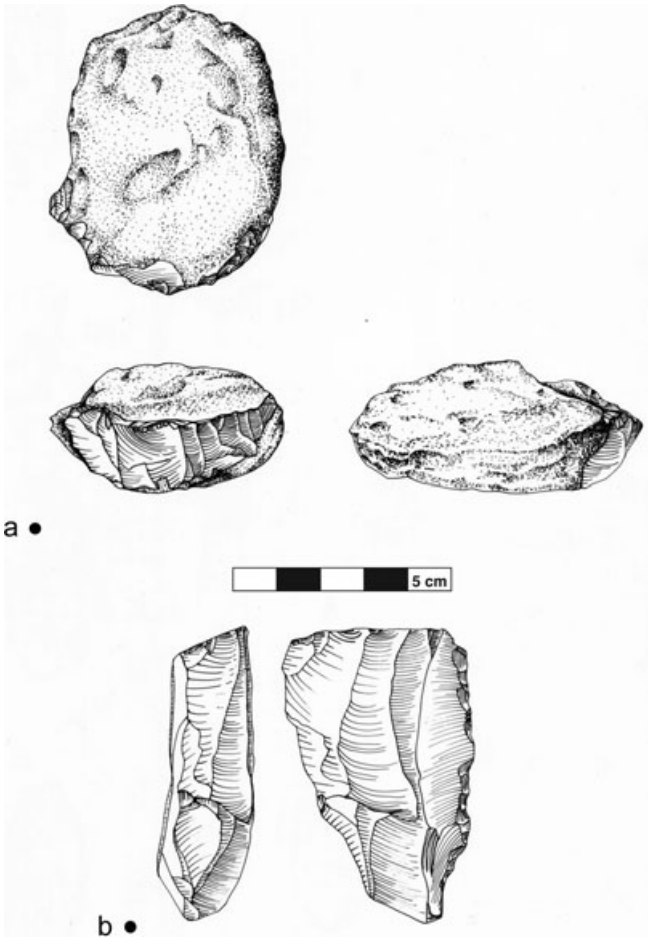


Fig. 2.
Illustration of two obsidian cores collected on the surface of site DS179 on the Yafa' obsidian source.

II.2. Central and western highlands

The results of analyses of thirty-nine obsidian artefacts from nine DSP sites with Neolithic components located in the highland source zone (Dhamar/Rada' highland plains; two stratified) demonstrate that 59% of the archaeological obsidian collected matches the Yafa' source, and 21% matches the Yafa' Region[1] sources. The remaining 23% of archaeological obsidian matches the Group 5 source which has afinities to the Jebel Lisi outcrop (Khalidi, Lewis & Gratuze 2012: 152).

II.3. Eastern highlands

The data provided in Barca, Lucarini and Fedele's recent publication (2012) clearly demonstrate that local Neolithic

[1] Yafa' Region includes the minor sources of Maryah, Jibjibiyyah and Jirab al-Suf, and Groups 1–4 which relate to the Yafa' source.

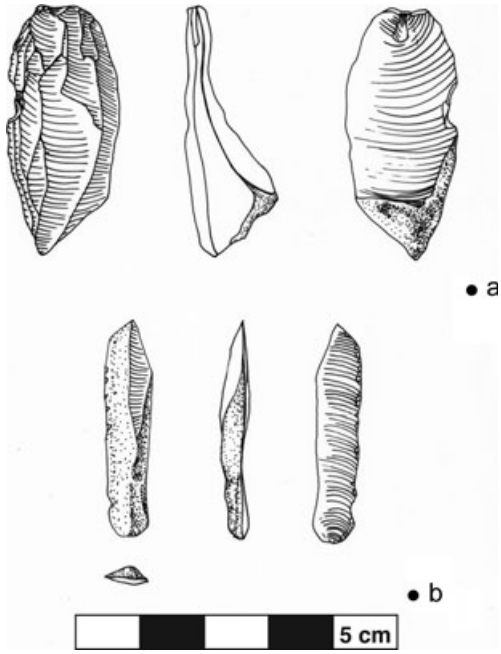


Fig. 3.
Illustration of two obsidian cortical lamellar products collected on the surface of site DS179 on the Yafa' obsidian source.

obsidian networks extended to sites in the Khawlan eastern highlands. The Wadi ath-Thayillah 3 site is an aceramic Neolithic open-air settlement consisting of stone elliptical structures, and a fauna of which 89% are domesticates (2012: 606). The site was occupied between the sixth and fourth millennia BC and is located in the eastern highlands with access to natural passages to the desert interior. Twenty obsidian artefacts from the Wadi ath-Thayyilah 3 excavations were analysed and compared to our geochemical obsidian source database (Khalidi *et al.* 2010). Of these, 70% (n = 14) match the Yafa' source and 30% (n = 6) match the Jebel Lisi source (Barca, Lucarini & Fedele 2012: 618).

II.4. Local highland networks

In a recent article, spatial mapping of site to Yafa' source matches in the highlands revealed an evident north–south corridor that was in use from the Neolithic to the early Islamic period, and along which obsidian appears to have circulated with more intensity than along other avenues (Khalidi, Lewis & Gratuze 2012: 154). A highland eastern corridor is becoming clearer with further analyses of obsidian from the eastern highlands (Barca, Lucarini & Fedele 2012; Khalidi *et al.* 2010: 2339), which show Yafa' as being the major supplier of obsidian during the

Neolithic period followed by Jebel Lisi and its Group 5 relative.

Between the sixth and fourth millennia BC, some Neolithic populations in the central highlands lived in permanent settlements with domesticated herds (Barca, Lucarini & Fedele 2012: 606; Fedele 2009: 223) while others were mobile groups. We have shown that groups taking part in either strategy were engaged in obsidian exchange. Within this context, some degree of resource and territorial management is expected, as is the formalisation of natural corridors of movement from one region to the next, like that of the north–south corridor through the highland plains. Recent analyses of material from excavated Neolithic period contexts in Saada extend this corridor of movement to the northern highlands of Yemen and beyond.

III. North of Yafa': Saada and Najran

Recent geochemical analyses were conducted on obsidian artefacts from the sites of Jebel Ghubayr (n = 6) and Mundafan (n = 3) located in northern Yemen and Najran, Saudi Arabia, respectively. These analyses confirm that the obsidian found on these sites matches the Yafa' outcrop. In this case the distance between source and sites is between 300 and 500 km as the crow flies.

III.1. Northern Yemen highlands (Saada region)

Jebel Ghubayr is located in the northern Saada province of Yemen and is a rock shelter with engraved animal reliefs along its walls. This site was surveyed by M. Garcia and M. Rachad in 1992 (Garcia & Rachad 1997; Inizan & Rachad 2007) and consisted of *in situ* deposits that included the remains of hearth structures, lithic material and faunal remains (Inizan 2007: 67). No soundings were carried out and the material was recovered from the surface of the site. A number of tools and waste, of which forty were obsidian fragments, were collected from the site. The obsidian material included one cortical end scraper, bladelet fragments and flakes (Inizan 2007: fig. 34/4,8,9). The most characteristic tools recovered were bifacially worked points and end scrapers, most from flint material (2007: fig. 33). No obsidian/flint cores or core trimming products were found on the surface, suggesting that knapping took place away from the shelter.

Although the site is not dated, it has been interpreted as a rock shelter occupied during the Neolithic period but associated with hunters. This period designation is by no means certain but is based on the wild animal species (predominantly wild equids) represented on the associated shelter walls and the typo-technological characteristics of the lithic toolkit, specifically the bifacially flaked projectile points of the tanged and winged variety that can be dated to as early as the seventh millennium BC (Crassard 2008) or between 6500 and 4500 BC based on the presence of a single trihedral point (Charpentier 2008; Inizan 2007).

The six obsidian artefacts analysed include cortical flakes and bladelets (Fig. 4). Four of these match the source of Yafa' and two of these belong to Group 5 (Figs 5 & 6) which remains unidentified but is related to the Jebel Lisi source in Yemen.

III.2. Saudi Empty Quarter: southern Saudi Arabia

Slightly further north-east of Saada, along the Holocene margins of the Mundafan palaeolake in the Empty Quarter (Najran province) of Saudi Arabia, three obsidian artefacts (Fig. 4) were collected from the surface of the site of Mundafan-20 (Crassard *et al.*, forthcoming). The site, which has an estimated date of seventh–sixth millennium BC, is interpreted as a temporary or seasonal hunting site by the authors. The three obsidian artefacts analysed, which include one bladelet fragment and two flakes, match the source of Yafa' in highland Yemen (Figs 5 & 6). Crassard *et al.* (forthcoming) interpret the lithic industry at Mundafan as belonging to different cultural facies than those defined for Yemen, Oman and the UAE.

III.3. Discussion of northerly networks

Both the sites of MDF-20 and Jebel Ghubayr are probably seasonal sites with lithic industries that suggest that hunting activities (projectile points) and the treatment of hides (end scrapers) were carried out on or near the site. The environmental (palaeolake margin, rock shelter) and cultural contexts (wild equid reliefs) of both sites further suggest that wild animal resources would have attracted populations during the early to mid-Holocene. Furthermore, they are both supplied with obsidian from the same source (Yafa') at hundreds of kilometres distance to the north-north-east of the source. These data are the first to support the theory that mobile groups were engaged in the circulation of obsidian from the Yafa' outcrop. The implications are that in the Neolithic, obsidian circulated in relatively large amounts (Jebel Ghubayr n = 40) throughout the highlands, even at significant distances, but witnessed a substantial drop-off as they moved away from the highland centre to the lowland desert interior (Mundafan n = 3). Moreover, there is a clear participation of mobile or partially mobile groups in this circulation.

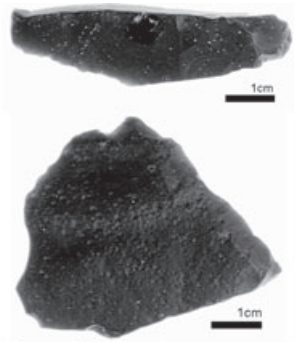
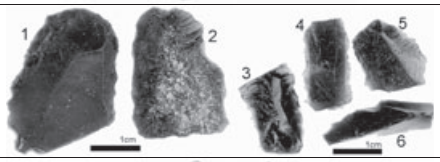
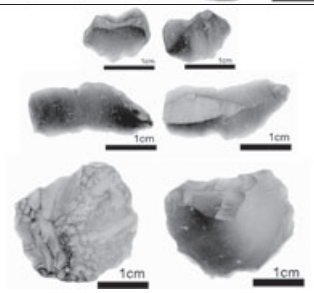
Site	Sample	Region	Relative date		Origin
Al-'Abr	ABR1/1 ABR1/2	Jawf-Hadramawt	Aceramic Neolithic		Yafa'
Jebel Ghubayr	SA92/A/1-6	Northern Yemen, Saada	Aceramic Neolithic		1 and 5: group 5 2, 3, 4 and 6: Yafa'
Mundafan	Mundafan 1 Mundafan 2 Mundafan 3	Southern Saudi-Arabia, Najran	7th – 6th millenium BC		Yafa'

Fig. 4.
Table of descriptions and photographs of the analysed obsidian artefacts from the sites of Jebel Ghubayr, Mundafan and al-'Abr.

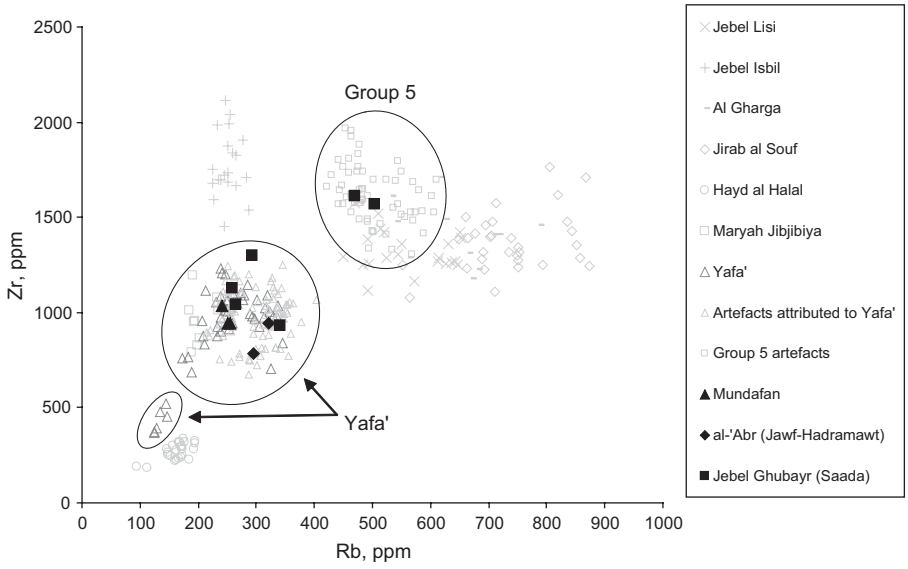


Fig. 5.
Diagram Rb/Zr of the al-'Abr, Jebel Ghubayr and Mundafan obsidian artefact compositions in relation to the Yemen highland obsidian source compositions and to other artefacts related to Yafa' and Group 5 analysed to date.

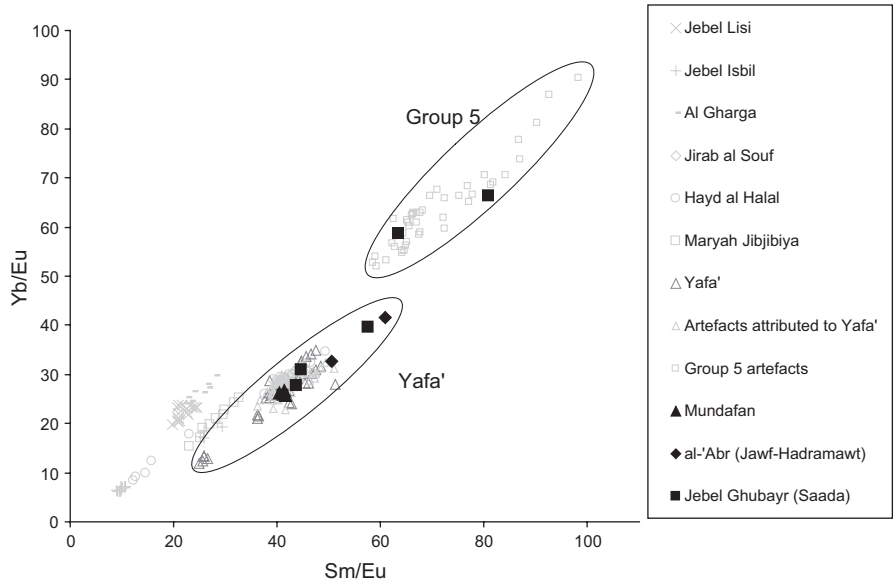


Fig. 6.
Diagram Yb/Eu–Sm/Eu of the al-'Abr, Jebel Ghubayr and Mundafan obsidian artefact compositions in relation to the Yemen highland source compositions and to other artefacts related to Yafa' and Group 5 analysed to date.

IV. East of Yafa': Hadramawt and Dhofar

Published results have shown that obsidian from the Neolithic site of Wadi Matafah, located in Omani Dhofar, matches the source of Yafa' (Khalidi *et al.* 2010: 2339). This site is located at an estimated 1000 km from the source as the crow flies. New geochemical analyses of obsidian (n = 2) collected on the surface of the Neolithic site of al-'Abr 1 in the Jawf-Hadramawt by M-L. Inizan in 1993, were recently carried out and add to our knowledge of Yafa' obsidian circulation towards eastern Arabia. Both obsidian artefacts match the source of Yafa' in the western highland plains. These include two obsidian flakes, one of which is cortical (see Fig. 4). The site of al-'Abr is located at an estimated 350 km east-north-east of the source zone in the lowland desert interior. If we add the site of Mundafan to the picture, we can posit that the desert interior had its own networks through which smaller amounts of materials moved. The sites of Al 'Abr and Matafah are on two ends of the major Hadramawt river valley. The Jawf-Hadramawt palaeoriver certainly acted as a corridor suitable for human mobility as well as settlement in the early to mid-Holocene. Mundafan is located along one of many Holocene palaeolakes that dotted what is now the arid desertscape of the Arabian interior. This palaeolake is likely to have served as a stopping point for mobile or partially mobile groups. The picture we can begin to draw is one of a region that was possible to traverse, dotted with watering holes ideal for seasonal settlement or itinerant stops, and riverine systems that acted as corridors to far-reaching areas like that of Dhofar in Oman. While the archaeological record remains incomplete in terms of what actual settlement patterns may have looked like in the early to mid-Holocene, we can begin to see that the role of mobile groups was a key factor in the movement of obsidian at such long distances.

V. Discussion: Afro-Arabian and inter-Arabian networks

Except in the case of the Tihamah coastal plain (Red Sea coast) where a substantial amount of obsidian arrived from East Africa (Khalidi, Oppenheimer, Gratuze, Boucetta et al., 2010), there is a significant drop-off in the amounts of obsidian found on non-highland Arabian Neolithic sites. The fluidity of the highland obsidian network is interrupted once the geography changes. One could point to differences in subsistence strategies or distance, but both the sites of Jebel Ghubayr in the northern Yemen highlands and Mundafan in the Saudi Arabian desert are thought to pertain to groups of seasonal hunters and are at large distances from the source outcrops supplying them without taking elevation into account. As regards obsidian circulation, it is possible that the importance of the subsistence strategy of a group (specifically of mobile

groups) came into play where the redistribution of this material towards the eastern Arabian interior was concerned, with seasonal mobile groups moving the material with them and trading small amounts for needed goods. A better understanding of the modes of co-existence and co-dependence of settled pastoralists or agriculturalists and seasonal or mobile groups, which occurred in the Holocene in Arabia, is crucial for understanding both the circulation of goods across extreme terrain and over long distances and the process of Neolithisation in Arabia. It is likely that this process was partially affected by groups being exposed to one another and being linked by an intensification of exchange. As for new studies emerging on the Neolithic of East Africa, the Neolithic of Arabia cannot be discussed without an understanding of the life ways of non-sedentary groups and their relationship to sedentary communities. Obsidian research has proved to be an invaluable tool for understanding such relationships in Arabia and the development of such data is certain to reveal the complex nature of exchange networks in the context of a different kind of Neolithic.

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