THE WĀDĪ AR-RUWAYSHID MINING COMPLEX: CHALCOLITHIC / EARLY BRONZE AGE CORTICAL TOOL PRODUCTION IN NORTH-EAST JORDAN

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Introduction

The cortical tool or cortical scraper, also known as 'fan scraper', 'tabular scraper' or 'Jafr tool', is an important *leitfossil* of Chalcolithic and Early Bronze Age cultures across south-west Asia, including Egypt[1].

The first clear evidence for the production of cortical tools was discovered by Gary Rollefson in 1979 on the northern rim of the Jafr basin (Rollefson 1980: 14, figs. 1-2), who therefore named these items "Jafr cores" or "Jafr flakes". However, the importance of this discovery was not recognized until the late 1990s, when Leslie Quintero, Phil Wilke and Gary Rollefson revisited this region and carried out two surveys on the northern rim of the Jafr basin in 1997 and 1999. They discovered large opencast mines, where cortical scrapers were produced on a near-industrial scale comfortably exceeding one million objects (Quintero *et al*. 2002: 45). Additional evidence for flint-mining and on-site cortical tool production was discovered by Sumio Fuji to the west of the Jafr basin at Qā' Abū Ṭulayḥa West at around the same time (Fuji 2000, 2003).

All of these sites are characterised by evidence for opencast mining of flint nodules in more or less shallow pits and trenches, accompanied by core preparation and subsequent cortical flake removal. Production of these cortical flakes was the aim of these activities.

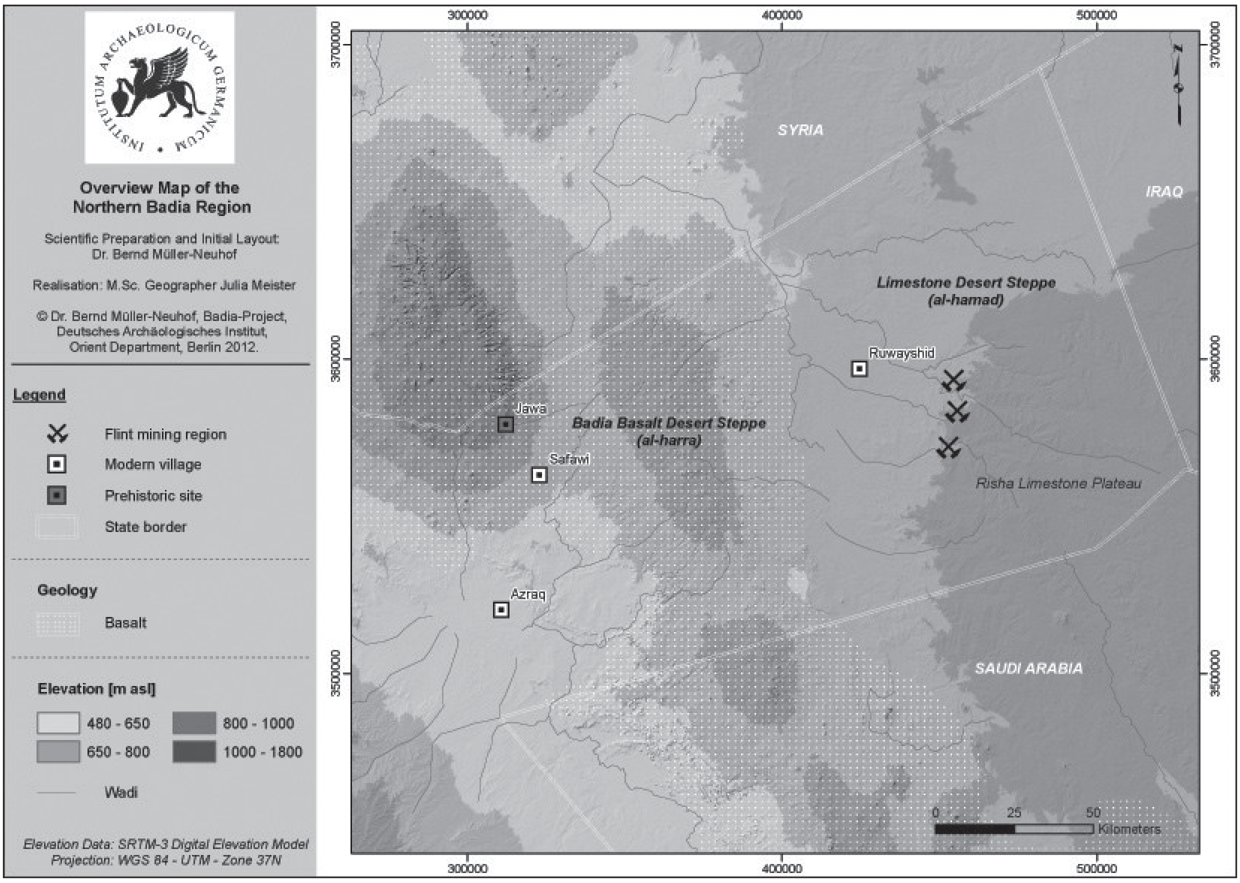
In 2000, Ricardo Eichmann and the author discovered a similar mine in north-east Jordan on the western fringe of the ar-Rīshah limestone plateau in the Wādī ar-Ruwayshid region. This mine was subsequently revisited and documented by the author in 2006, when it was realised that several additional mines are present on the same 'promontory' as the first mine (Müller-Neuhof 2006). However this region was not visited again for more detailed survey for another four years.

In 2010, a two-week survey was carried out[2] as part of the 'Arid Habitats in the 5th to Early 3rd Millennia BC: Mobile Subsistence, Communication and Key Resource Use in the Northern *Bādiyah* (North-East Jordan)' archaeological survey project, which has been funded by the German Research Foundation (*Deutsche Forschungsgemeinschaft*) since 2010[3]. A second

1. The author prefers the term cortical scraper instead of 'fan scraper', 'tabular scraper' or 'Jafr tool', as these terms do not give a clear description of these objects. The term 'fan scraper' refers to the fan-shaped design of these tools, but elongated shapes are also documented. The term 'tabular scraper' points to the utilisation of tabular flint for these tools; however, this implies that these tools have bifacial cortical faces, which is observed more in Late Neolithic lithic assemblages and almost never in Chalcolithic / EBA assemblages. The denomination 'Jafr tool' refers to just one place of origin where these items have been found, but there are more, as demonstrated by this contribution. Therefore, the term 'cortical scraper' (or 'cortical flake'/ 'cortical tool') seems to be a better term for these objects, as it describes their principal common characteristic: the cortical face of the blanks.

2. Participants in the 2010 survey season, in addition to the author, were Wesam es-Said (archaeologist, DoA Azraq) and Jan Krause (geographer, Institute of Geographical Sciences, *Freie Universität Berlin*).

3. When the first mining area was discovered in 2000 it was named RU 27. The numbering of this mining area and three further mining areas in 2006 (RU 28-30) was based on the co-ordinates of archaeological sites and specific topographical features identified during the short reconnaissance trip in 2000; the designation was kept during the 2006 survey (see Müller-Neuhof 2006). However, owing to the discovery of further mining areas in 2010 it was decided to rename these sites. Now RU 27 is equivalent to RUW 1, RU 28 to RUW 2, RU 29 to RUW 3 and RU 30 to RUW A (a Late Neolithic burin site).



1. Map of the northern bādiyah with the location of the Wādī ar-Ruwayshid mining complex (©DAI Orient-Abteilung, J. Meister and B. Müller-Neuhof).

and final survey season in the mining region was carried out in March 2012[4].

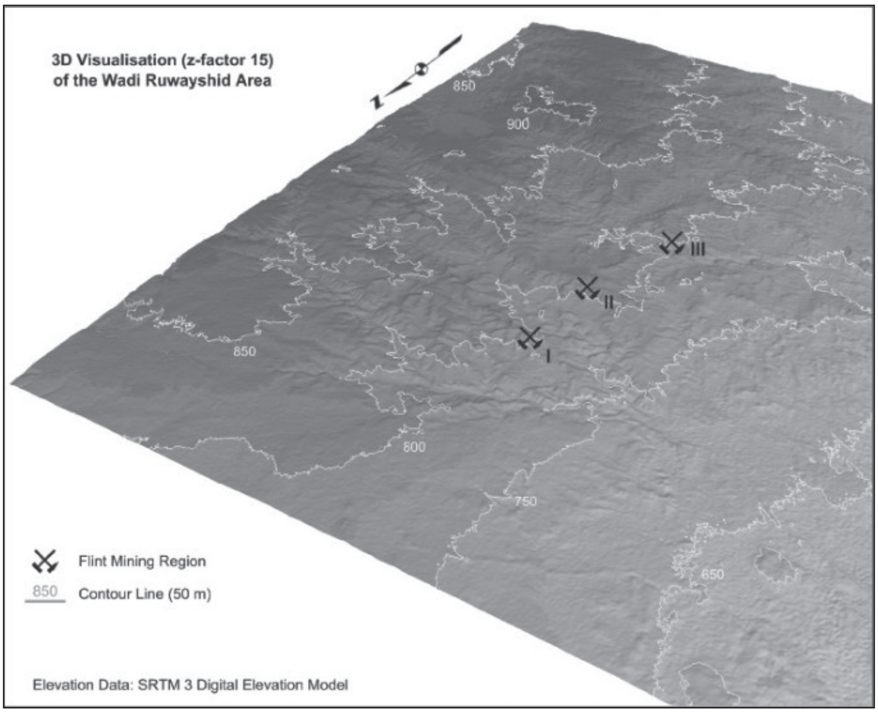
Location and Extent of the Mining Region

The Wādī ar-Ruwayshid flint-mining region is located east of the basalt steppe-desert (*al-Ḥarrah*), in the limestone steppe-desert (*al-Ḥamād*) on the western escarpment of the ar-Rīshah limestone plateau (**Fig. 1**). This rises towards the south-east, with its highest elevation at Jabal ‘Unayzah - located where the borders of Jordan, Iraq and Saudi Arabia converge. This plateau comprises the watershed between Wādī Ḥawrān to the east and the Wādī ar-Ruwayshid system to the west. As a result, the western margins of the plateau in particular are characterised by several *wadi*s, cutting into the flanks of the plateau and creating individual plateau-like ‘promontories’. The surface, especially of the raised ground, is covered with typical *Ḥamād*-type flint pavement (**Fig. 2**).

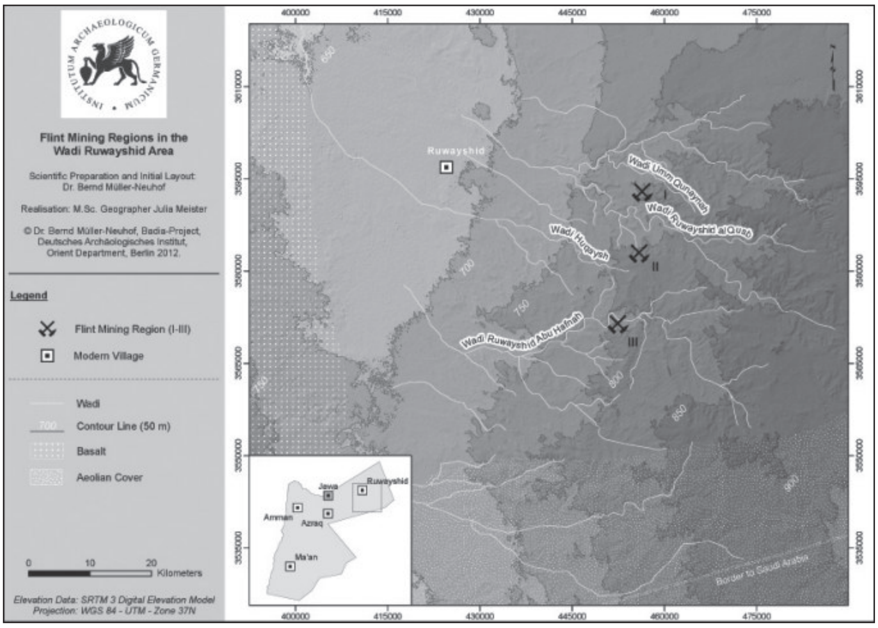
Several Eocene flint layers, characterised by fine texture and dark brown colour, outcrop at different levels on the slopes leading up to the raised ground. However, survey data indicate that large-scale mining and cortical flake production activities were restricted to flint sources occurring at elevations between 780 and 830m asl, mostly between 810 and 815m asl. It is assumed that these flint sources belong to a single flint layer, even though this layer occurs at slightly different elevations on different areas of raised ground. This may be the result of post-depositional events, such as subsidence and uplift associated with tectonic processes.

Following our observation that flint-mining activities were concentrated at elevations be-

4. Participants in the 2012 survey season at the mines, in addition to the author, were Jenny Bradbury (archaeologist, CBRL ‘Ammān), Wesam es-Said (archaeologist, DoA Azraq) and Johannes Köhler (archaeology student, Institute of Near Eastern Archaeology, *Freie Universität Berlin*).



2. 3D visualisation of the western escarpment of the ar-Rīshah limestone plateau with location of the three mining areas (Areas I - III) (©DAI Orient-Abteilung, J. Meister and B. Müller-Neuhof).



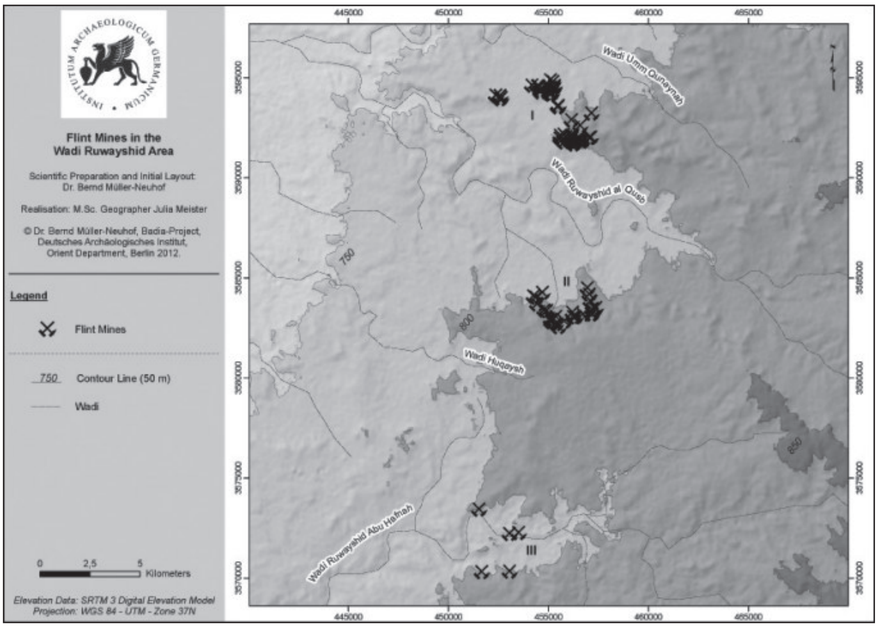
3. Map with location of the three mining areas (Areas I - III) in the Wādī ar-Ruwayshid mining region (©DAI Orient-Abteilung, J. Meister and B. Müller-Neuhof).

tween 780 and 830m asl, the eastern and western limits of the flint-mining region could be defined, as the rising elevation (to the east) means that the desired flint layer is covered by later flint and limestone layers, and the falling elevation (to the west) means that the desired layer does not exist.

Another observation was that mining of the flint layer only occurs where it outcrops from the steeper slopes of the 'promontories'. This enabled us to define the northern limit of the mining region, beyond which there is a shift towards more gentle slopes on which the flint layer is covered by ancient colluvium.

Beyond the southern limit of the mining region, the slope conditions are steeper and should theoretically have outcropping flint layers. However, in practice these areas are covered with a thick layer of reddish aeolian sediment which obscures all potential flint outcrops (**Fig. 3**).

The full extent of the mining region is there-



4. *Detailed map of the three mining areas with the location of individual mines (©DAI Orient-Abteilung, J. Meister and B. Müller-Neuhof).*

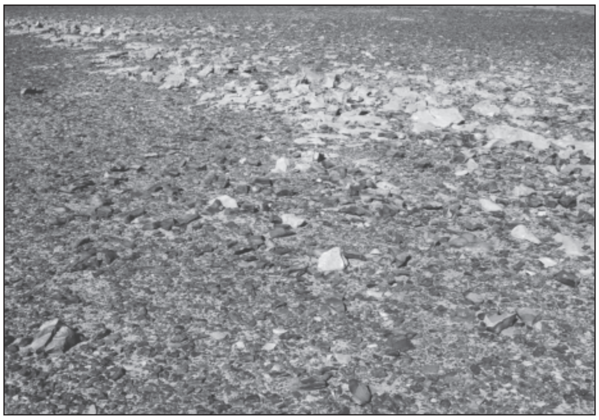
fore located between Wādī Umm al-Qunayyah in the north and Wādī ar-Ruwayshid Abū Ḥafanah in the south. Within this region, three concentrations of mines could be defined, *viz*. Area I in the north (surveyed in 2010), Area II in the centre and Area III in the south (both surveyed in 2012). These areas are divided by Wādī ar-Ruwayshid al-Quṣb (between Areas I and II) and Wādī al-Ḥuqaysh (between Areas II and III). As already mentioned, the southern limit of the region is defined by Wādī ar-Ruwayshid Abū Ḥafnah, although it should be noted that mining activities were recorded on bth the northern and southern banks of the *wadi* (**Fig. 4**).

The entire mining region, including the *wadi*s between the three mining areas, extends over an area of *ca.* 324km^2. This is probably the only mining region on the ar-Rīshah plateau, because it is only in this area that the slopes are steep enough to ensure that the outcropping flint layers are not buried under aeolian sediments[5].

Mines, Workshops and Prospecting Sites

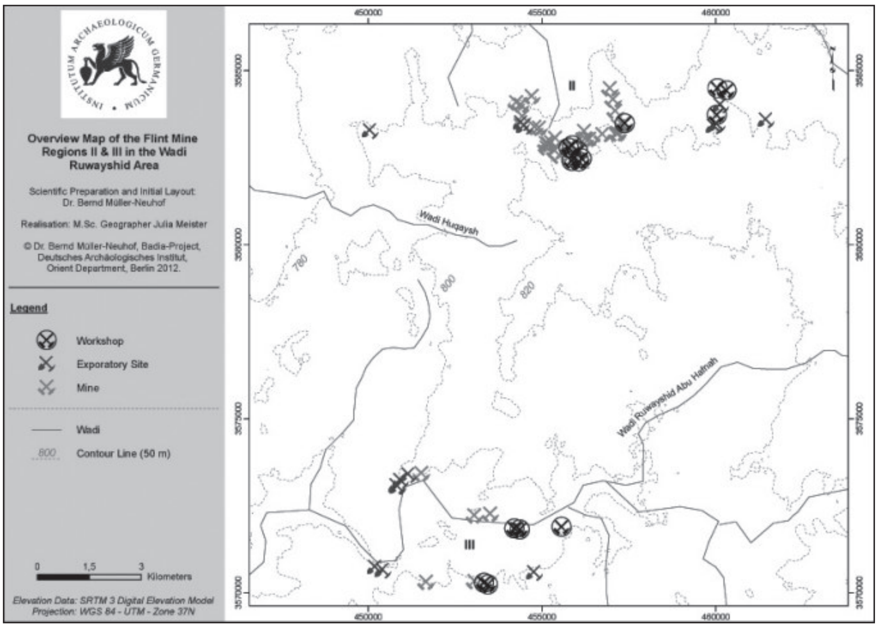
In addition to the mines, we were able – especially in 2012 – to identify so-called workshops and prospecting sites; these are discussed below.

Workshops are here defined as relatively small, discrete areas in which small-scale mining activities – typically simple, horizontal mining of the outcropping flint layer and on-site production of cortical tool blanks – took place (**Fig. 5**). The scale of cortical flake production at such workshop sites is much lower compared to that of the 'true' mines. It can be assumed that, on such sites, production of cortical flakes was primarily to meet the personal requirements of the groups or individuals frequenting them[6]. Especially in Area II but to some extent also in Area III, such workshops are located east of the mines at slightly



5. *Cortical flake production workshop in Area I (RUW5.22) (©DAI Orient-Abteilung, B. Müller-Neuhof).*

5. Following identification of the trench mines on the ground, it proved possible to identify the mines on Google Earth satellite images. No evidence for additional mines was detected on the ar-Rīsha plateau, not even on its Iraq side.
6. Concerning the output and possible organisation of the mining activities and their socio-economic context see below.



6. *Map of Areas II and III with location of mines, workshops and prospecting sites (©DAI Orient-Abteilung, J. Meister and B. Müller-Neuhof).*

7. *Cortical flake production workshop (RUW40) with remains of animal pen structure in the foreground (©DAI Orient-Abteilung, B. Müller-Neuhof).*

higher elevations (**Fig. 6**), quite often in association with a single animal pen (**Fig. 7**).

In Area I, such workshop sites are more frequent, being located in between the 'true' mines on the same 'promontories'.

Additionally, several sites were discovered where mining but no cortical tool production took place. These sites reach considerable size, but are all defined by the lack of any proper cortical flake production. Only a few negative scars of very small, thick cortical flakes indicate some trial production. These sites are all located on the eastern or western margins of mining Areas II and III (**Fig. 6**). It can therefore be assumed that these were prospecting sites, where the raw material was tested for its suitability for cortical flake production (**Fig. 8**) but was found wanting.

8. *Prospecting site (RUW26) with flint outcrop in the foreground and mined flint nodules in the background (©DAI Orient-Abteilung, B. Müller-Neuhof).*

Quarries, Pit Mines and Trench Mines:

Different Techniques of Raw Material Extraction

Four different techniques of flint raw material extraction have been observed during our two survey seasons in the three areas of the Wādī ar-Ruwayshid flint-mining region. In part, these vary according to geographical location.

The northern mining region, Area I, is characterised by horizontal mines and pit mines. Horizontal mining took place on the ridges of the escarpments, where the desired outcropping flint layer lay under a layer of limestone *ca.* 0.2m thick. The raw material was obtained, first by quarrying the upper limestone layer from the side of the slope and then by extracting the exposed flint nodules and flint nodule fragments (**Fig. 9**). Evidence for this mining technique was observed on all 'promontories' with mining activity in Area I. However, with the exception of a few workshops, it was not observed in the other two areas.

Identified pit mines are always associated with horizontal mines on the 'promontory' ridges. They are therefore extensions of horizontal mining activities, starting on the edges of the ridges and extending towards the top of the 'promontories', where mining pits were excavated.

These pits can be identified today by concentrations of quarried limestone, which formerly covered the flint layer, lying in their immediate vicinity. The typical *Ḥamād*-type surface is absent from the shallow, formerly open pits, which are now filled with aeolian sediments and are characterised by relatively minor concentrations of flint-mining debris (**Fig. 10**).

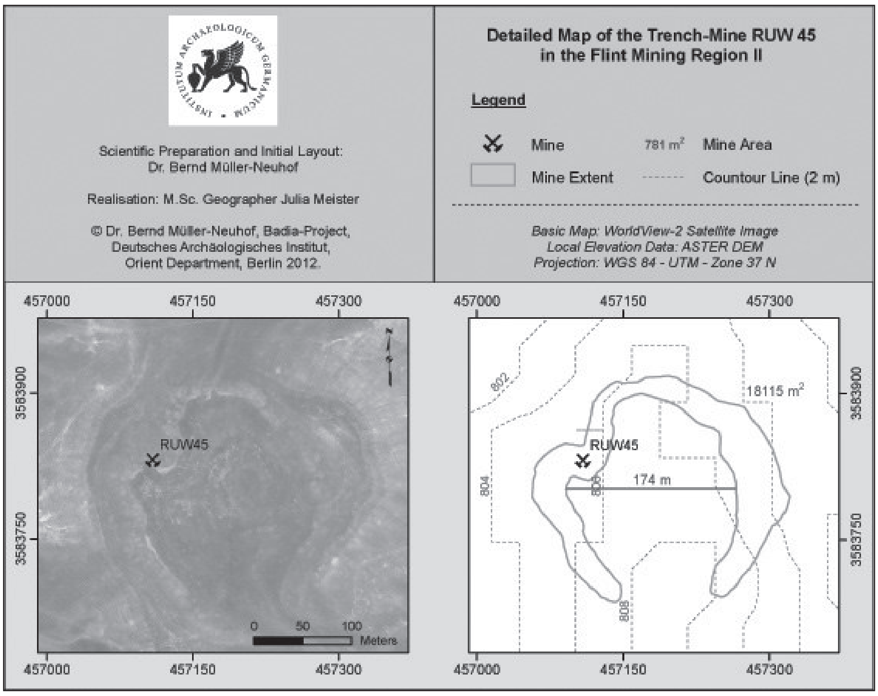
Owing to the fact that the flint layer was located close to the ground surface, immediately under the *ca.* 0.2m thick limestone layer, the entire depth of these mining pits was probably never more than 0.4 to 0.6m. Pit-mining is also confined to Area I.

Area II is characterised by abundant trench mines. These are all located on the tops of the 'promontories', typically close to the escarpments, parallel to and following the escarpment edges (**Figs. 11, 12**). Some of these trench mines reach lengths of almost 1,000m. In some cases, the entire top of the 'promontory' is traversed by several trenches. The width of the trenches varies between 10 and 20m. The combined extent of all identified trench mines, including a large combined trench / horizontal mine (see below), is 24 ha or 0.24km^2. Mining debris is usually concentrated on one side of the trench, typically that closest to the escarpment. Cores, core production debris and remains of cortical flake production are abundant within the mining debris, both on the trench floor and trench sides. Additionally, basalt tools for mining and blank removal were discovered in these trenches. These were mostly hammerstones of different sizes (**Fig. 13**), but a fragment of a large pestle-shaped hammerstone was also found (**Fig. 14**).

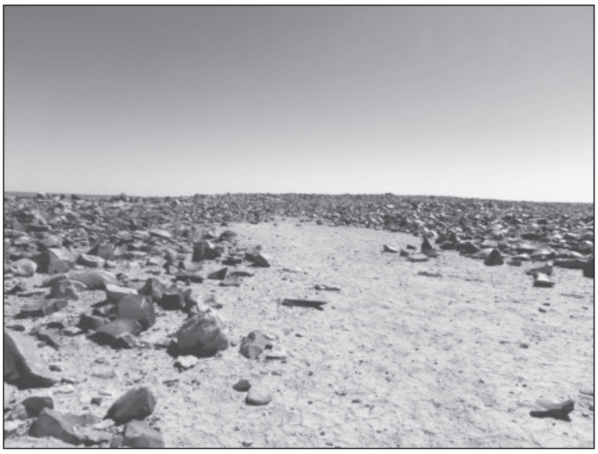
The largest mine, a combined horizontal / trench mine with a length of almost 1,500m, was identified in Area III. The western part of

9. Flint mine (RUW3.5) with evidence for horizontal mining activities. Note the quarried limestone which originally covered the flint layer (©DAI Orient-Abteilung, B. Müller-Neuhof).

10. Pit mine (RUW3.20). Note whitish concentrations of limestone and mining debris, and minor concentration of flint-mining debris in the foreground (©DAI Orient-Abteilung, B. Müller-Neuhof).



11. *Satellite image and map of a trench mine (RUW45) (©DAI Orient-Abteilung, J. Meister and B. Müller-Neuhof).*



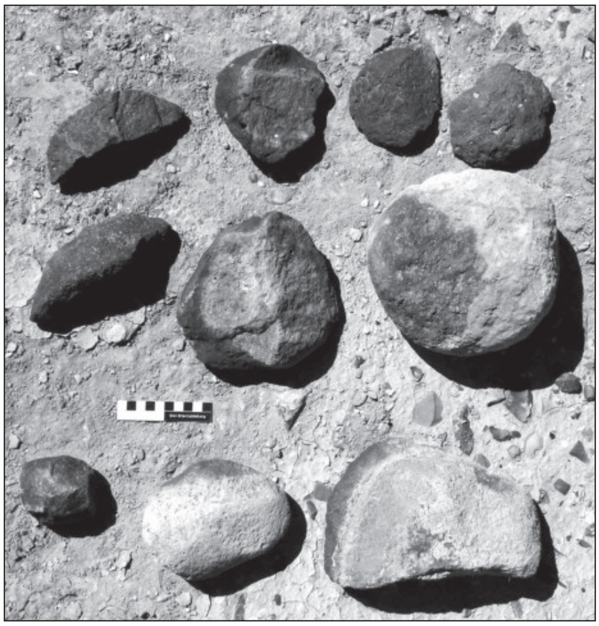
12. *'Floor' of a trench mine (RUW45) (©DAI Orient-Abteilung, B. Müller-Neuhof).*

the mine is characterised by a long quarry-like exposure all along the cliff, far below the escarpment, following a flint outcrop (**Fig. 15**). To the east, the mine changes into a trench mine because the topography changes from a cliff to a gentler slope.

Cortical Flake Types

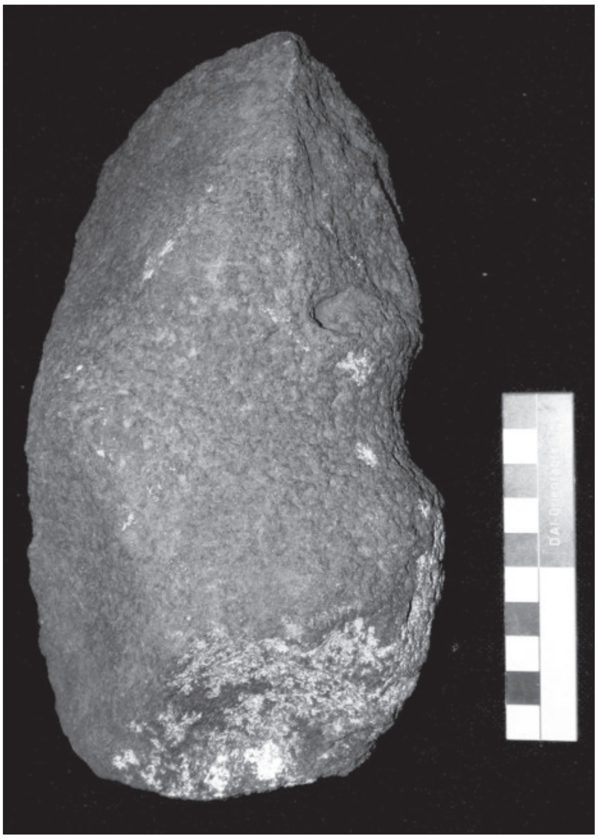
Three different types of cortical flake were identified on the basis of their negatives on the cores, *viz*. the fan-shaped flake, the elongated fan-shaped flake and the elongated flake.

In Area I, where pit and horizontal mining was carried out, most of the cortical flake negatives are fan-shaped (**Fig. 16**). In contrast, in Areas II and III, elongated flakes are clearly in the majority (**Fig. 17**), with smaller quantities of elongated fan-shaped cortical flakes (**Fig. 18**).



13. *Mining and cortical flake production tools: basalt hammerstones and hammerstone fragment from a trench mine (RUW45) (©DAI Orient-Abteilung, B. Müller-Neuhof).*

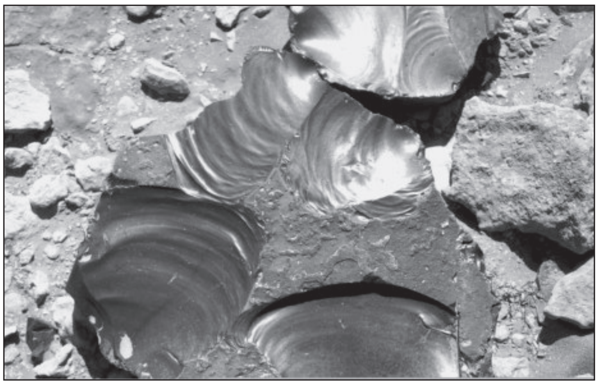
Since it was not possible to see any differ-



14. *Mining and cortical flake production tools: basalt pestle from a trench mine (RUW19) (©DAI Orient-Abteilung, B. Müller-Neuhof).*

15. *Horizontal mine showing exposed flint layer (RUW27) with cortical flake cores and mining debris above and below the exposed flint layer (©DAI Orient-Abteilung, B. Müller-Neuhof).*

ences in the platform preparation of fan-shaped and elongated cortical flake negatives, the reason for their different appearance might be explained by the fact that some cortical faces are plain while others are slightly convex.



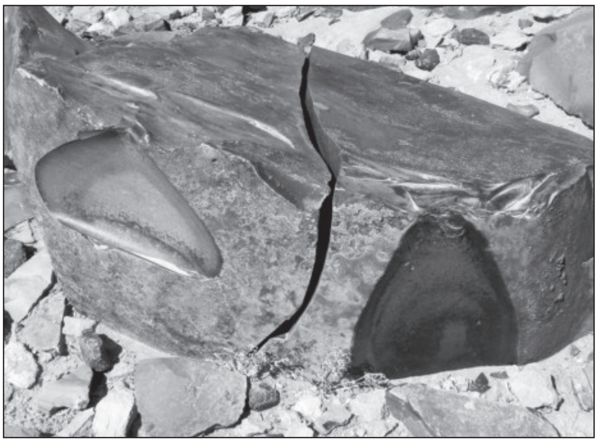
16. *Cortical flake core (from RUW3.28) with fan-shaped flake negatives (©DAI Orient-Abteilung, B. Müller-Neuhof).*

17. *Cortical flake core (from RUW19.2) with elongated flake negatives (©DAI Orient-Abteilung, B. Müller-Neuhof).*

It was observed that cores with slightly convex surfaces have elongated cortical flake negatives (cf. **Fig. 17**), while cores with plain surfaces are characterised by fan-shaped negatives (cf. **Fig. 16**). Elongated fan-shaped negatives were produced on cores where the surfaces lie in somewhere in between the plain and slightly convex types (cf. **Fig. 18**; see also **Fig. 19**).

It is not yet clear whether or not the flint nodules in Area I tend to have plain surfaces, while those of Areas II and III are more convex in their surface shape. The reason may also lie in the size of the flint nodules and therefore the cores, which can be correlated with the mining technique. Large nodules may have been extracted

18. Fragment of a cortical flake core (from RUW45) with negative of an elongated fan-shaped flake (©DAI Orient-Abteilung, B. Müller-Neuhof).



19. Cortical flake core (from RUW45) with one negative of a fan-shaped flake on a plain surface and another negative of an elongated fan-shaped flake on a slightly convex surface (©DAI Orient-Abteilung, B. Müller-Neuhof).

from trench mines because such mines exposed large areas. Thus, (almost) complete flint nodules could be extracted from the exposed flint layer. Extracting nodules from flint layers by horizontal mining broke up the nodules, which resulted in smaller chunks and therefore smaller cores.

In addition, the area of the flint layer exposed in pit mines was much more restricted than in the trench mines. Therefore, the extraction of flint nodules in these mines typically resulted in their breakage within the flint layer, which likewise produced smaller cores.

Economic Output, Dating and the Socio-Economic Context of Production

The overall surface area of all identified mines and workshops amounts to *ca.* 380,000m^2 (38 ha). In both survey seasons, several counts of cortical flake negatives on cores lying on the surface were carried out at different mines and workshops; cores embedded in mine sediments and mining debris were not considered.

The average number of negatives per m^2 was five. In pit mines and trench mines, the average increased to 11 negatives per m^2. Workshop sites, which extend over *ca.* 10,000m^2, have an average of 1.5 negatives per m^2.

Working on the basis of the above-mentioned average of 5 negatives per m^2, which is a conservative estimate overall, cortical flake production in the entire Wādī ar-Ruwayshid mining region amounted to at least 1.9 million blanks.

Mining activities in the ar-Ruwayshid region were highly organised, implying preliminary prospection for raw material (represented by prospecting sites on the edges of the actual mining areas), the manufacture and use of special mining and blank production tools (made on raw material originating in the basalt desert [e.g. hammerstones of different sizes; large extraction pestles]) and, finally, the planned and organised excavation of the mines themselves, especially in the case of trench mines. It seems clear that, at least in trench-mining Areas II and III, specialist groups were involved in these activities, which may hint at the date of these sites.

The period during which cortical scrapers were a common component of pre- and protohistoric toolkits in south-west Asia covers almost 3,000 years, from the beginning of the Late Chalcolithic until Early Bronze Age (EBA) III, possibly even EBA IV. However, it seems unlikely that mining activities in the Wādī ar-Ruwayshid region were carried out over such an extended period, as these mines are in a remote location lacking water resources without even natural facilities for water storage.

This suggests that specialist groups were involved, who were experts in living for at least part of the year in such arid environments, far away from settlements, and who possessed appropriate logistical support for carrying out tasks such as prospection and mining.

It therefore seems likely that the entire economic *chaîne opératoire*, consisting of prospection, mining, blank production, transport and even distribution of the cortical tool blanks, was carried out by specialised transhumant pastoralists. These groups may have possessed domestic donkeys as beasts of burden (see also Quintero *et al*. 2002: 45). They would also have been familiar with the region, because of their frequent visits to the *wadi*s on the ar-Rīshah plateau between late autumn and early spring, when water and pastures were available, as part of their annual pastoral cycles (cf. Müller-Neuhof 2010, in press a). The suggestion that the primary function of cortical scrapers was for processing animal products (*viz*. shearing, slaughtering, skinning etc.) (cf. Henry 1995: 372) supports the proposal that pastoral groups were likely involved in these mining activities.

The beginnings of specialised (semi-) nomadic pastoralism, defined primarily on the basis of the emergence of surplus production of secondary animal products (cf. Sherrat 1983: 99) and which includes the specialised exploitation of geological resources in remote and mostly arid environments (cf. Müller-Neuhof in press b; Rosen 2002: 30ff.), is thought to date to the end of the Late Chalcolithic or beginning of the EBA (Rosen 2002: 30ff.), *viz*. towards the end of the first half of the 4th millennium BC.

The extent to which the Late Chalcolithic / EBA settlement of Jāwā, located almost 140km west of these mines as the crow flies, was directly or indirectly involved in the mining activities (e.g. as a place for exchange) remains an unsolved question. If the mining activities were entirely linked to the existence of the Late Chalcolithic / EBA settlement at Jāwā, the period of their exploitation would contract to a few centuries during EBA I, in the second half of the 4th millennium BC. However, the dating of the ar-Ruwayshid mines and, potentially, the interpretation of the socio-economic background of the groups involved may need to be reconsidered in the near future. Just 50km from these mines to the west as the crow flies, a new Late Chalcolithic / EBA site has been recently discovered[7]. The fortified settlement of Khirbat Abu al-Ḥūṣayn is located on top of a small volcano on the eastern edge of the basalt desert.

The presumed Chalcolithic / EBA date of this site relies on the few surface finds and architectural features found so far. Evaluating the possible rôle of Khirbat Abu al-Ḥuṣayn in the mining activities in the Wādī ar-Ruwayshid region is a task for future research.

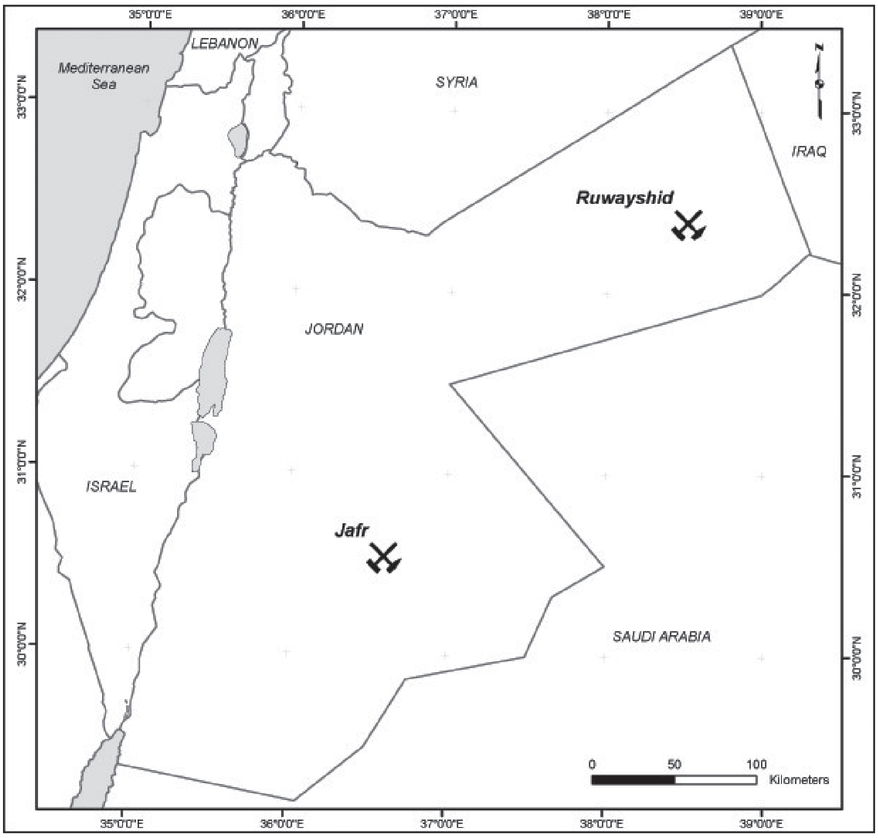
Conclusion

The Wādī ar-Ruwayshid flint-mining region on the western escarpment of the ar-Rīshah plateau is the second known mining region (after Jafr) where cortical scraper blanks were produced on an 'industrial' scale during the Late Chalcolithic / EBA period (**Fig. 20**). In both regions, which are characterised by remote location and arid environments, specialised transhumant pastoralists are highly likely to have been involved in organised prospection, mining, blank production and transport (distribution) of the blanks. The existence of just two mining and tool production regions seems unlikely in view of the long period of cortical scraper use and their wide distribution all over south-west Asia.

It is currently unclear where further mining and tool production regions might be expected. The existence of such large mines west of the Jordan valley and on its eastern bank can in all probability be excluded, because extensive surveys in these regions have not identified any evidence for their presence.

The location of the Ruwayshid and Jafr mines in the eastern part of Jordan relates to the specific qualities of the flint raw material, which is probably only to be found in environments with similar Eocene deposits. However, the

7. This site was discovered in autumn 2010 during one of the two transect surveys across the basalt desert, conducted as part of the wider research project. However, as the 2010 visit was too short for proper examination of the site, another visit was undertaken in March 2012. Evidence was found for a genuine Late Chalcolithic / EBA fortified settlement, with double-faced walls and a gate structure. A detailed survey of this site, including documentation of the architecture, is planned for the 2013 spring season.



20. Map showing the two main Chalcolithic / EBA flint-mining and cortical scraper production regions: Jafr and ar-Ruwayshid (©DAI Orient-Abteilung, N. Marquardt and B. Müller-Neuhof).

Ruwayshid region shows that, even within areas with these deposits, mining activities were very much restricted to specific topographic conditions, *viz*. outcrops of the desired raw material, with no colluvial or aeolian cover on slopes of the raised ground. These observations reduce the number of possible locations where further mines might be discovered, whether in Jordan or in adjacent regions to the north or east.

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