The Dorothy Garrod Site: a new Middle Stone Age locality in Olduvai Gorge, Tanzania

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Abstract

Olduvai Gorge (Tanzania) is a key site for the study of human evolution as well as the origin of modern humans and the Middle Stone Age (MSA). In this study, we present a new MSA location named Dorothy Garrod Site (DGS), found in the main branch of Olduvai Gorge. The site has only one archaeological level, located stratigraphically in the Upper Ndutu. Although it has not yet been possible to radiometrically date it, it has yielded numerous archaeological remains with a functional association between the faunal remains and the lithic industry. The fauna identified includes Alcelaphini, Hippotragini, and Equidae, some of which present percussion marks and evidence of burning. The lithic industry involved knapping using discoid methods. The retouched blanks are denticulates and retouched flakes with, up to now, a total absence of points. DGS is therefore a new site that will aid our understanding of modern human occupations in northern Tanzania in a period for which there is a dearth of properly contextualised archaeological evidence.

Keywords Middle Stone Age · Lithic · Fauna · Olduvai · Tanzania
Introduction

Olduvai Gorge, known as the Cradle of Humankind, is a key locality for understanding the origin of the genus Homo. However, the work dedicated to the evolution of modern humans has been until recently less intensive than the studies focused on the primeval moments of our genus.

In Olduvai Gorge, the Middle Stone Age (MSA) levels are in the Ndutu Beds, which primarily consist of tuffaceous, aeolian, fluvial, and colluvial deposits left in the final stage of the gorge formation, which cover the areas eroded by the Olduvai River (Hay 1976). The stratigraphy containing MSA has been divided into the Upper and Lower Ndutu. The Naisiusiu Beds, associated with Later Stone Age (LSA) occupations, overlie the Ndutu Bed.

Several researchers have approached the chronology of the Ndutu Beds. For Hay (1976), using the amino-acid method, the Upper Ndutu would have a chronology of between 32 and 60 ka BP, and the Lower Ndutu between 60 and 400 ka BP (Hay 1976). Manega, who performed most of the work on the chronology in the younger Olduvai deposits, dated the Upper Ndutu using single-crystal laser fusion (SCLF) as having a mean of 230±10 ka BP with a range of 210±20–450±40 ka BP. The beginning of the Naisiusiu Beds has been dated as 42±10 ka BP (Manega 1993). Later, Skinner and colleagues used electron spin resonance (ESR) to date the onset of the Naisiusiu as 62±5 ka BP (Skinner et al. 2003).

Two human remains were found in the Ndutu Beds. OH-11, a palate and maxillary arch of Homo sp., was found on the surface of DK and assigned to the Ndutu Beds (Hay 1976: 159; Leakey 1971: 230). This hominin presents a robust morphology by modern standards (Rightmire 1980: 227). A partial calvaria, OH-83, was recently recovered from the Upper Ndutu, close to the PLK site (Reiner et al. 2017) and identified as Homo sapiens. Unfortunately, there is no direct dating for either of these.

From an archaeological perspective, research projects conducted at the site have not been numerous, but they have been very fruitful. The work of Mary Leakey revealed the existence of ancient MSA remains that could be related to the Ngaloba Beds of Laetoli (Leakey et al. 1972). However, the data presented does not allow for greater precision. Several decades later, Mabulla’s work delved into this possibility (Mabulla 1990). Similarly, in a project led by Eren in 2013, 72 surface-find spots were located, providing 521 flaked pieces from the MSA as well as some faunal remains (Eren et al. 2014). Recently, our project team excavated and published the findings of the Victoria Cabrera Site (VCS), a multi-layer MSA deposit with fauna and lithics dated between 86 and 75 ka BP (Maillo-Fernández et al. 2019a).

These previous projects have demonstrated the enormous potential of Olduvai Gorge in terms of understanding the ways of life of the first modern humans in the region. In this context, this paper presents a new in situ MSA site with a single, rich archaeological level in the Ndutu Beds of Olduvai Gorge.

Dorothy Garrod Site (DGS)

The DGS is located on the northern side of Olduvai Gorge, at the junction between the main and side gorge, 200 m west of the KK fault and over 400 m from VCS (Maillo-Fernández et al. 2019a). It was discovered during a fieldwork survey in 2017. It may be the place Eren referred to as RAC (Eren et al. 2014: Fig. 1). The site has been partially excavated over three consecutive seasons, in February and July 2018, and in February 2019, over an area of slightly more than 28 m² (Figs. 1 and 2).

DGS is embedded within the Ndutu formation. Given its relative position in the gorge, it can be initially assigned to Upper Ndutu. The sedimentological and aeolian facies at the site are coherent with this interpretation. Assuming that DGS is within the Upper Ndutu formation, it would be relatively older than VCS, which is dated to 75–86 ka BP. Nonetheless, the precise stratigraphic location of DGS will be further studied once more data has been gathered on the poorly studied Ndutu formation. An attempt to date this level using optically stimulated luminescence was made, but the poor luminescence signal of both the quartz and feldspar grains made it impossible to draw an accurate age.

Excavations have exposed 3.5 m of Ndutu formation. The DGS assemblage is embedded in a poorly cemented tuffaceous silt level (level 3), underlying two tuffaceous silt to very fine tuffaceous sand levels (levels 1 and 2), and conformably overlying a fine sand level (level 4, Fig. 3). Level 4 is a perfectly sorted, heavily cemented fine sand deposit, likely to be aeolian in origin. All the clasts appear well rounded and very spherical, with some prismatic augite minerals. No archaeological or palaeontological remains were found in level 4. Level 3 is a poorly cemented tuffaceous silt, also probably aeolian. The deposit is well sorted, with some occasional small and medium-sized pebbles. Embedded in this layer are abundant archaeological tools and some faunal remains. Level 2 conformably overlies level 3 and is a tuffaceous silt deposit. It is well sorted and cemented, with no archaeological or palaeontological content. Level 1 is a well sorted, very fine sand deposit, heavily cemented, conformably overlying level 2. No archaeological or palaeontological remains have been found in level 1.
Methods

Fabric analysis

Total stations were used to georeference all > 2 cm remains. The orientation patterns of bone and lithic remains were recorded to reinforce the geological reconstruction of the site and assess the impact of post-depositional events (e.g., wind, water flows, gravity, and sedimentation) on the archaeological arrangement in each of the documented levels. We used compasses and clinometers to measure the horizontal and vertical orientations of each of the remains with a longitudinal axis A at least twice its width, which divides the object symmetrically along its longitudinal axis (Voorhies 1969; Domínguez-Rodrigo and García-Pérez 2013; Cobo-Sánchez et al. 2014).

Spatial information was analysed using ArcGIS 10.4.1 (Desktop, Engine) and Oriana 4.0. The measurements were first transformed from degrees into radians and then into circular objects using R’s “circular” library (http://www.r-proje...
Fig. 2  Distribution of DGS archaeological materials, ground plan, and profile

Fig. 3  Stratigraphic section of DGS

Key

- Silt
- Tuffaceous silt
- Sand
- Tuffaceous sand
- MSA industry
- Faunal remains
Faunal analysis

The faunal remains were classified according to taxa, size category, anatomical element, side, and portion whenever possible. To analyse the representation of anatomical elements, carcasses were divided into anatomical areas: cranial (horn, cranium, mandible, hyoid, and teeth), axial (vertebra, ribs, pelvis bone, and scapula), and appendicular (limb bones). Four indexes were used to estimate taxonomic and anatomical abundance: the number of identified specimens (NISP), the minimum number of elements (MNE), the minimum number of individuals (MNI), and the standardised minimum number of animal units (%MAU) (Binford 1984; Grayson 1984; Lyman 1994). To estimate the MNE, the side, landmarks, and the age of each identifiable specimen were considered. The size of the specimens was established according to the categories described by Bunn (1982): size 5 (over 850 kg); size 4 (400–850 kg); size 3 (150–400 kg); size 2 (20–150 kg); and size 1a (5–20 kg) (Assefa 2006).

Spearman’s rank order was used to test the correlation between %MAU and bone mineral density (Lam et al. 1999). We assessed the visibility of the cortical bone surfaces based on how much surface could be studied: 0 = none, 1 = one-third, 2 = two-thirds, and 3 = whole surface.

The cortical surfaces were evaluated and analysed. As a result, numerous modification types including concretions, weathering, burning, bone breakage marks, and tooth marks were identified (Behrensmeyer 1978; Binford 1981; Capaldo 1998; Caceres 2002; Pickering and Egeland 2006; Domínguez-Rodrigo et al. 2009).

Lithic analysis

Taphonomic analysis

In order to correctly interpret the archaeological assemblage, it is essential to know which possible post-depositional processes affected it. For the DGS lithic assemblage, we paid special attention to the following alterations: rounding and pseudo-retouching. Rounding refers to abrasion on an artefact’s surface caused by contact with other sedimentary particles, giving rise to breakage, wear, and micro-detachments (Pedraza 1996: 210). There can be various causes for this process, though it is always linked to hydric phenomena where water converges with the carried load (Shackley 1978). We have classified rounding into three categories: not very intense (RD1), intense (RD2), and very intense (RD3).

Pseudo-retouching refers to the mechanical alteration of the surface of the lithic material. It causes alternating and denticulated edges, with randomly distributed scars of variable sizes (Stapert 1976) with undefined orientations and irregular sizes (Tringham et al. 1974: 192). This is usually caused by the movement of lithic artefacts in the sediment due to trampling or hydraulic processes (Stapert 1976). We have classified the pseudo-retouching into three categories: marginal, deep, and very deep.

Techno-typological analysis

The study of lithic technology is understood as a conceptual approach to the material culture of various human groups (Inizan et al. 1995: 13). The ultimate goal of studies of this sort is to investigate human conduct by analysing technical, social, and symbolic behaviour (Inizan et al. 1995: 14).

To carry out this analysis, we used the concept of the chaîne opératoire, which is defined as a sequence of acts, gestures, and tools constituting a technical process with a roughly predictable series of steps (Karlin 1992; Karlin et al. 1992; Audouze and Karlin 2017).

In this paper, we present the essential characteristics of the lithic industry implemented at DGS. We pay particular attention to recognising the lithic operational schemes carried out at the site, which have been described according to the different protocols employed, including discoid (Boëda 1993, 1995; Terradas 2003), Levallois (Boëda 1994; Boëda et al. 1990), and single platform (Clark and Kleindienst 2001). The parameters analysed for each piece were raw material type, dimensions, type of blank, fractures, alterations, and technological classification.

There is a lack of consensus in the typological studies of the ensembles from East Africa, which has been considered an obvious handicap in comparing collections, as noted by numerous authors (e.g., Clark and Kleindienst 2001; Douze 2012; Will et al. 2019b; Shea 2020). In this work, we applied a more general approach by assigning the retouched blanks to large typological groups (sidescrapers, endscrapers, burins, backed pieces, etc.).
Results

Fabric results

The null hypothesis of uniform distribution could be rejected for the DGS assemblage. The statistical Rayleigh\( (Z = 22.137; p = 2.43\times 10^{-10})\), Kuiper\( (V = 1.3.497; p \leq 0.01)\), and Watson\( (U^2 = 1.179; p \leq 0.05)\) tests support the fact that there is anisotropy in the orientation, indicating that the assemblage has more than one preferred orientation (Table 1). The stereogram and rose diagram show non-uniform orientation distribution for the archaeological materials, with various preferential horizontal trends (Fig. 4). The Woodcock diagram has a von Mises distribution \( k \) concentration value lower than 0.2, indicating an anisotropic fabric for the assemblage (Fig. 4).

Faunal results

A total of 280 fossils were recovered during the excavation of DGS (Table 2): 247 were bone remains, 27 tooth remains, two fragments of ostrich eggshell, and four fragments of terrestrial molluscs. The site had a low identification rate, with only 2.5% of the remains being taxonomically identified: two Equidae teeth were recovered (0.9% of the total NISP) and two tribes of bovid were evidenced: one Hippotragini mandible (0.5% of the total NISP) and four Alcelaphini teeth (1.9% of the total NISP). The rest of the faunal remains could not be identified taxonomically, but a total of 206 remains were assigned to a weight size category: 44.6% of the ungulate NISP were size 2 (NISP: 95), 30% were size 3 (NISP: 64), 15% were size 1 (NISP: 32), and 7% were size 4 (NISP: 15). A total of 61 remains could not be classified in any way, in terms of anatomy, taxonomy, or weight size category.

Table 1 Statistical tests applied to the DGS assemblage

| One sample tests                      |               |
|---------------------------------------|---------------|
| Rayleigh test \( (Z) \) 22,137        |               |
| Rayleigh test \( (p) \) 2.43E-10       |               |
| Watson’s \( U^2 \) test \( (\text{uniform}, U^2) \) 1.179 |               |
| Watson’s \( U^2 \) test \( (p) \) <0.005       |               |
| Kuiper’s test \( (\text{uniform}, V) \) 3,497 |               |
| Kuiper’s test \( (p) \) <0.01          |               |

Fig. 4 Rose diagrams (a) and stereograms (b) showing non-uniform distributions and horizontal trends. Woodcock (c) diagram showing anisotropic fabrics.
A total of four individuals were counted from the identified taxa: two individuals of Alcelaphini, one individual of Hippotragini, and one individual of Equidae. The calculation of the age at death of these individuals indicated that they were prime adults. For the calculation of the MNI for the different weight categories count a total number of 5 individuals, one individual for each, although their age could not be identified. Three remains of the postcranial skeleton were assigned to a juvenile individual because they involved unfused bones: a coxal bone and a metapodial of weight size 2, and a metacarpal of weight size 1.

The results of the Spearman coefficient between the %MAU and mineral density indicate that there are positive and statistically significant correlations in the faunal assemblage from DGS (Spearman’s $r_s = 0.2005; p = 0.047761$). This indicates that there is a positive relationship between the representation of the anatomical parts and their mineral density, although it is low.

The surface preservation of the bones from the DGS assemblage could be considered poor. In only 14% of the remains were all the surfaces well preserved, while 17.3% were well preserved over two-thirds of their complete surface area. In 35.1% of the assemblage, less than one-third of the complete surface was well preserved, and in 33.6%, all of the surface areas were poorly preserved. This poor visibility of the cortical surfaces is due in part to the presence of sediment concretions (Fig. 5), which affect a total of 99 remains (35.3%).

Anthropogenic modifications were evidenced by burning and bone breakage. A total of 58 remains have burning damage. Considering only the remains where at least one-third of the cortical surface or more was well preserved, remains with burning damages represent 27.4% of the assemblage. By burning degree distribution, the most abundant is degree 2 (NR = 24), followed by degree 3 (NR = 14), degree 4 (NR = 7), and degree 1 (NR = 1), and nine bone remains present a combination of degrees 3 and 4, and three bone remains have a combination of degrees 4 and 2 (Fig. 5). The signs of human bone breakage modifications identified are a complete type a notch on a size 3 bovine tibia ($A = 9.45; C = 4.29; D = 22.77$) and an incomplete type b notch on a size 1 bovid femur ($A = 9.78; C = 5.71; D = 28.16$). Only one remains presented carnivore tooth marks: a fragment of an ungulate vertebra of size 3.

### Table 2 NISP by anatomical elements, taxa, and weight size category of the level 3 of DGS

| NSIP          | Hippotragini | Alcelaphini | Equidae | Weight size categories | Indeterminate | Total |
|---------------|--------------|-------------|---------|------------------------|---------------|-------|
|               |              |             |         | 4  | 3  | 2  | 1  |
| Skull         | 1            | 5           | 4       | 10          |               |       |
| Mandible      | 1            |             |         | 2           |               |       |
| Isolated teeth| 4            | 2           | 2       | 9           | 9             | 1     | 27  |
| Vertebral     | 7            | 4           |         | 11          |               |       |
| Rib           | 2            | 1           |         | 3           |               |       |
| Scapula       | 1            | 1           |         | 2           |               |       |
| Humerus       | 3            | 2           | 2       | 7           |               |       |
| Radius/ulna   | 1            | 2           |         | 3           |               |       |
| Carpals       | 1            | 1           |         | 2           |               |       |
| Metacarpal    | 2            | 1           |         | 3           |               |       |
| Coxal bone    | 2            | 2           |         | 4           |               |       |
| Femur         | 1            | 5           |         | 6           |               |       |
| Patella       | 1            |             |         | 1           |               |       |
| Tibiae        | 1            | 2           | 4       | 8           |               |       |
| Artragalus    | 2            | 2           |         | 4           |               |       |
| Calcaneum     | 1            |             |         | 1           |               |       |
| Metatarsal    |              |             |         |             |               |       |
| Metapodial indet | 1       | 2           | 1       | 4           |               |       |
| Articular bone indet | 1 | 1 | 2 | | | |
| Sesamoid      | 1            |             |         | 1           |               |       |
| Phalax        | 2            |             |         | 2           |               |       |
| Long bone     | 8            | 23          | 41      | 14          | 86            |       |
| Flat bone     | 2            | 7           | 14      | 2           | 25            |       |
| Indeterminate bone |       |             |         | 60          | 60            |       |
| Ostrich eggshell |         |             |         | 2           |               |       |
| Terrestrial mollusc |       |             |         | 4           |               |       |
| Total         | 1            | 4           | 2       | 15          | 64            | 95    | 32  | 61  | 280 |
Lithic analysis

The lithic assemblage from level 3 at the DGS has so far yielded 1,179 lithic pieces, of which 40 have been retouched. A total of 113 pieces of the assemblage (the majority in phonolite) have not yet been studied due to alteration and have been excluded from this analysis (Table 3).

Taphonomic analysis

Rounding was scarce in the lithic assemblage (Table 4), with only six pieces being affected by this type of alteration (0.5% of the lithic assemblage). Five of these were not very intense while one was very intense. We can therefore rule out hydric or erosive phenomena being involved in the formation and alteration of the lithic assemblage.

A total of 615 blanks (52.1% of the total) presented pseudo-retouching. Among these, 85.2% had marginal pseudo-retouching ($n = 524$), 12.5% ($n = 77$) were classified as deep, and 2.3% ($n = 14$) as very deep (Table 4). The most plausible origin for the pseudo-retouching is trampling (McBrearty et al. 1998). However, we cannot rule out the possibility of pseudo-retouch caused by the knapping process itself in Naibor quartzite due to the natural fracture planes of this raw material.

Techno-typological analysis

The raw materials used at the DGS are Naibor quartzite (79.9%), phonolite (8.2%), sandstone (6.1%), and, to a lesser extent, basalt (3.6%), hyaline quartz (1.4%), chert (0.3%), and quartzite or gneiss (0.1% each) (Table 5). All the raw materials had a local origin.

The Naibor quartzite, formed by recrystallisation of the quartz grains contained in the original sandstone when it underwent intense metamorphism (Rubio-Jara et al. 2017), originated from the Naibor Soit hill just 2 km north of Olduvai Gorge, while the phonolite source was the Engelosen volcano, 7 km north of the DGS. This comes in slabs and could be affected by flow banding. Despite this, it is of good quality for knapping (Jones 1994, pp. 257). The basalt came from Lemagrut volcano, 10–12 km south of the site. This raw material may have been acquired in palaeochannels from Lemagrut or the Side Gorge, as in the lower beds of Olduvai Gorge (Jones 1994). The other raw materials can be found relatively easily in the Olduvai riverbed itself.

The presence of cortex was low in the 1,018 pieces analysed. Only 7% of the blanks were totally cortical and around 18% presented a partial cortical surface. More than 75% had no cortical remains on their dorsal surfaces (Table 6).

From a technological perspective, there were 757 exploitation blanks, most of which could not be used to identify the operational scheme ($n = 458, 60.5\%$). Of those blanks that could be identified, the type of operational scheme involved prepared core methods (discoid and Levallois) and others with a single platform. There was no bipolar knapping.

Discoid methods were the most abundant operational scheme, with 26 cores and 222 blanks, representing 29% of the total blanks exploited (Fig. 6 and Fig. 7: 2, 4, 7). Almost all the knapped blanks were Naibor quartzite or, to a lesser extent, basalt or sandstone. The discoid methods used were unifacial and bifacial (15 and 14 cores, respectively). The blanks were typical of this type of method (Boëda 1993; Terradas 2003): chordal flakes, pseudo Levallois points, square flakes, and flakes that are wider than they are long.

Levallois methods were scarce: 24 blanks and one core (5.2% of the exploited blanks). All the cores and more than half of these blanks can be related to the Centripetal Levallois method. The rest of the Levallois flakes have characteristics of preferential, unidirectional, and bidirectional...
methods (Boëda et al. 1990; Fig. 7: 1, 3, 5, 6, 8). There is no evidence of Levallois points.

Single platform knapping (normal type sensu Clark and Kleindienst 2001) was represented by 38 flakes and one core

Table 3 General lithic inventory of DGS. In parentheses, pieces without complete data

|                | Sandstone | Basalt | Quartzite (fine coarse) | Hyaline quartz | Phonolite | Gneiss | Indet | Naibor quartzite | Chert | Total |
|----------------|-----------|--------|-------------------------|----------------|-----------|--------|-------|-------------------|-------|-------|
| **Phase 0: test and raw material preparation** |           |        |                         |                |           |        |       |                   |       |       |
| Cobble         | 2         |        |                         |                |           |        |       |                   |       |       |
| Tested cobble  | 1         | (1)    |                         | 1              |           |        |       |                   |       |       |
| Totally cortical flake | 1 |        |                         |                |           |        |       |                   |       |       |
| Totally cortical blade | 1 |        |                         |                |           |        |       |                   |       |       |
| Cortical flake with no cortical platform | 14 |        |                         |                |           |        |       |                   |       |       |
| **Phase 1: preparation** |           |        |                         |                |           |        |       |                   |       |       |
| Cordal flake   | 3         | 1      |                         | 4              |           |        |       |                   |       |       |
| Kombewa flake  |           |        |                         |                |           |        |       |                   |       |       |
| Lateral cortical flake | 1 |        |                         |                |           |        |       |                   |       |       |
| Core tablet    |           |        |                         |                |           |        |       |                   |       |       |
| Debordant flake | 1 | 2     |                         |                |           |        |       |                   |       |       |
| Striking platform preparation flake | 4 |        |                         | 4              |           |        |       |                   |       |       |
| Pseudo Levallois point | 2 |        |                         |                |           |        |       |                   |       |       |
| **Phase 2: exploitation** |           |        |                         |                |           |        |       |                   |       |       |
| Ordinary flake | 35        | 8      |                         | 6              | 37        |        |       | 341               |       | 428   |
| Indet. flake   | 2         | 2      |                         | 2              |           |        |       | 13                |       | 19    |
| Single platform flake | 1 | 2     |                         | 3              |           |        |       | 32                |       | 38    |
| Bidirectional flake | 1 | 1      |                         | 1              |           |        |       | 6                 |       | 9     |
| Bipolar flake  |           |        |                         |                |           |        |       |                   |       |       |
| Discoid flake  | 6         | 2      |                         | 1              | 12        |        |       | 162               |       | 183   |
| Preferential Levallois | 3 |        |                         |                |           |        |       | 3                 |       | 3     |
| Unipolar recurrent Levallois | 3 |        |                         | 2              |           |        |       | 2                 |       | 7     |
| Bipolar recurrent Levallois |           |        |                         |                |           |        |       |                   |       |       |
| Centripetal recurrent Levallois | 2 | 4     |                         | 2              | 6         |        |       | 8                 |       | 22    |
| Indet. Levallois |           |        |                         |                |           |        |       |                   |       |       |
| Blade          |           |        |                         |                |           |        |       | 1                 |       | 1     |
| **Phase 4: abandon** |           |        |                         |                |           |        |       |                   |       |       |
| Cores          |           |        |                         |                |           |        |       |                   |       |       |
| Discoid (bifacial) | 10       |        |                         |                |           |        |       | 10                |       | 10    |
| Discoid (partial) | 1         |        |                         |                |           |        |       | 1                 |       | 1     |
| Discoid (unifacial) | 14       | 1      |                         |                |           |        |       | 15                |       | 15    |
| Centripetal    | 7         |        |                         |                |           |        |       | 7                 |       | 7     |
| Levallois (centripetal) | 1 |        |                         |                |           |        |       | 1                 |       | 2     |
| Single striking platform | 1 |        |                         |                |           |        |       | 1                 |       | 1     |
| Oportunistic   | 1         |        |                         |                | 1         | 13     |       | 15                |       | 15    |
| Polyhedral     | 7         |        |                         |                |           |        |       | 7                 |       | 7     |
| Kombewa        |           |        |                         |                |           |        |       |                   |       |       |
| Core total     | 2         |        |                         |                |           |        |       | 58                |       | 62    |
| **Divers**     |           |        |                         |                |           |        |       |                   |       |       |
| Chunk          | 2         | 4      |                         | 1              | 3         | 1      | 51    | 1                 | 63    |
| Chips          | 4         | 1      |                         | 5              |           |        |       | 19                |       | 29    |
| Indet          | 1         |        |                         |                |           | 1      | 1     | 3                 |       | 3     |
| Other          | 2         |        |                         |                |           | 1      | 9     | 12                |       | 12    |
| Hammer         |           |        |                         |                |           |        |       | 5                 |       | 5     |
| Anvil          | 1         |        |                         |                |           |        |       | 1                 |       | 1     |
| No modified    | 1         |        |                         |                |           |        |       | 1                 |       | 2     |
| No data        | 6         |        |                         | 41 (112)       | 1         | 2      | 162   |                   |       |       |
| **Total**      | 67        | 37     |                         | 14             | 123       | (113)  | 1      | 5                 | 813   | 4      | 1179 |
The majority of the blanks were Naibor quartzite, while there were also phonolite, basalt, and hyaline quartz blanks to a much lesser extent.

Other operational schemes present on the site and identified through the cores were polyhedric, opportunistic, and Kombewa. The blanks of the first two are currently difficult to distinguish and there was only one Kombewa flake in the entire assemblage.

From a typological point of view, retouched pieces were scarce (Table 7). Only 40 pieces evidenced retouching, representing 3.4% of the assemblage. Most of the pieces were denticulate (35%) and retouched flakes (32%). The next most abundant groups were notches and sidescrapers (12.5% each). There were two heavy-duty pieces: a bifacial piece and a transversal sidescraper. There were no retouched or Levallois points.

Most retouched pieces were made of Naibor quartzite, and the blanks were of undetermined type (45%) and discoid (32.5%). The retouched pieces from single platform methods

| Cortex | N  | %  |
|--------|----|----|
| I      | 75 | 7.4|
| IIA    | 25 | 2.5|
| IIB    | 46 | 4.5|
| IIC    | 115| 11.3|
| III    | 750| 73.6|
| INDET-n/a | 7 | 0.7|
| Total  | 1018| 100|

Table 6 Presence of cortex in DGS lithic assemblage. I: cortical, IIA: > 2/3; IIB: 1/3–2/3; IIC: < 1/3; III: no cortex

Fig. 6 Lithics of DGS. 1 Discoid core; 2–3 discoid flakes. All on Naibor quartzite
were 10%, and 5% correspond to Levallois flakes (Table 8). All other retouched blanks were scarce (Table 8).

**Discussion**

The numerous lithic remains associated with partially anthropically manipulated fauna make DGS one of the most important MSA deposits in Olduvai, with potential implications for the understanding of MSA peoples in northern Tanzania, although we still do not know the exact stratigraphic position of DGS in the Ndutu Beds, nor its chronology, and although the excavated surface is still small (28 m²).

From a taphonomic point of view, the presence of various preferential orientations indicates the influence of post-depositional processes in the orientation of the archaeological remains. Cobo-Sánchez et al. (2014) indicated that anisotropy could be detected in autochthonous assemblages affected by low-energy transport conditions. This is supported here by the dearth of polished or abraded specimens and the unbiased representation of different specimen sizes. In the case of the faunal remains, no abrasions have been observed as in the lithic remains, which is due to the fact that sediment concretions are the most abundant modification and have been able to hide this type of modification.

The identifiable taxa are Alcelaphini, Hippotragini, and Equidae. Most of the remains are size classes 3 and 2. Although the cortical surfaces of the bones are poorly preserved, we were able to identify anthropogenic modification as evidenced by burning, the most abundant, and bone breakage. Although there are burnt bone remains, no combustion focus or charcoal could be identified during
the excavation, but considering the abundance of burning degrees 3, 4, and the combination of 3 + 4, is an indication of direct action of fire over bone remains. Carnivore modifications are almost non-existent, and only one fossil has carnivore tooth marks.

In terms of material culture, the MSA occupation of the DGS is characterised by the use of discoid-type prepared core (bifacial and unifacial methods) and Levallois methods. Single platform or opportunistic methods are secondary. Retouched pieces are not very numerous, only accounting for 3.4% of the total lithics, and these are retouched flakes and denticulates. Currently, there is a complete absence of points and only one bifacial piece. The most widely used raw material was Naibor quartzite (almost 80%), which originated in Naibor Soit hill, just 2 km north of the site.

Without a clear chronological and stratigraphical framework, it is difficult to place DGS within the regional MSA scheme proposed by Mehlman (1989), which is still broadly accepted. This is divided into several industries that, from oldest to most recent, are (Table 9): Njarasan, described at the Eyasi Shore site; Ngaloban at Laetoli (Mabulla 2015; Masao and Kimombo 2022); Sanzako at Mumba VIB; Kisele at Mumba VI; Nasera 12–17 and 18–25; and the Loiyangalanian described at Loiyangalani (Bower and Mabulla 2012). Therefore, there is great variability in the industries, in line with the picture for the whole of East Africa, where this variability is the most prominent characteristic (Clark 1988; Tryon and Faith 2013; Will et al. 2019a), despite attempts to gain deeper insight into this technocomplex in the region (Blinkhorn and Grove 2018).

Considering the provisional data on the stratigraphic position of the site, the DGS lithic set could be contemporary with the Kisele or Loiyangalanian industries.

Making direct comparisons between lithic assemblages is complex due to the lack of unification between the methods used in northern Tanzania and eastern Africa in general (e.g., Will et al. 2019b; Shea 2020), although some general comparisons can still be made. From a techno-typological perspective, the DGS collection has several points in common with almost all the other assemblages: the discoid-type production as the main operational scheme and the use of local raw
materials to make lithic tools. This feature sets these assemblages apart from others in southern Tanzania, such as Kilwa (Betin and Ryan 2020).

If we focus on the Kisele and Loiyangalanian industries, DGS distances itself from Kisele because of the absence of points in this assemblage; unifacial and bifacial points are very common in Kisele (Mehlman 1989; Bushozi et al. 2020). On the other hand, the divergences with Loiyangalanian are evident in the knapping methods, where bipolar knapping is prevalent and is typologically dominated by sidescrapers (Maíllo-Fernández et al. 2019a, b). However, the feature that the DGS has in common with both these industries is that the most widely used operational scheme was discoid.

Retouched blanks were scarce and dominated by denticulates and retouched pieces. The low frequency of retouched material still has no clear explanation. It could be in line with the hypothesis put forward by Tryon and Faith (2013: 242) in which the retouching frequency is linked to the presence of fine-grained raw materials. In this case, chert is extremely scarce and there is no obsidian. Even so, this could also be due to other factors such as the sharp edges of Naibor quartzite or the activities performed with the lithic pieces recovered from DGS.

### Conclusion

The conclusions presented for the DGS are still preliminary, but it is clear that they represent yet further evidence of the potential of Olduvai Gorge for studying the MSA, in conjunction with the previous work of M. Leakey, A. Mabulla, and M. Eren and with the information provided from the excavation of the VCS (Maíllo-Fernández et al. 2019a, b).

DGS evidences a human occupation from which lithic industry and fauna have been found together, and where the latter displays the evidence of human manipulation (percussion and burning). The lithic elements were knapped with local raw materials, especially Naibor quartzite, and the most numerous operational schemes were of the discoid type. The retouched blanks were denticulates and retouched blanks and, at least until now, there is a total absence of points.

The fauna identified taxonomically include Alcelaphini, Hippotragini, and Equidae. Attempts to date DGS have so far been unsuccessful, but preliminary stratigraphic studies place the deposit in a VCS-like timeline at around MIS 5–4. This could also be related to the Kisele and Loiyangalanian industries.

The excavation of the DGS is not yet complete, but it is already clear that this new site will contribute to our
understanding of the patterns of settlement and interaction with the ecosystem of modern humans in northern Tanzania.

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Declarations

Conflict of interest The authors declare no competing interests.

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