The Transition from Hunting–Gathering to Food Production in the Gamo Highlands of Southern Ethiopia

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Abstract Over three field seasons between 2007 and 2012, we excavated three caves—Mota, Tuwatey, and Gulo—situated at an average elevation of 2,084 m above sea level in the cool and moist Boreda Gamo Highlands of southwestern Ethiopia. Anthropogenic deposits in these caves date from the Middle to Late Holocene (ca. 6000 to 100 BP) and provide excellent preservation of material culture, fauna, flora, and human skeletal remains from which to investigate changes in technologies and habitat use over the last several thousand years. Here, we present results and interpretations, suggesting ways in which Holocene communities of the Boreda Gamo Highlands...
constructed new landscapes and technologies in their transition from hunting and gathering to an agropastoral way of life.

Résumé Entre 2007 et 2012, au cours de trois missions de terrain, nous avons fouillé trois grottes—Mota, Tuwatey et Gulo—situées à une altitude moyenne de 2154 mètres au dessus du niveau de la mer. Sur le haut plateau au climat froid et humide de Boreda Gamo, dans le sud-ouest de l’Éthiopie. Les gisements anthropiques dans ces grottes datent de l’Holocène moyen à tardif (environ 6000 à 100 BP) et présentent une excellente conservation de la culture matérielle, de la faune, de la flore et des restes humains, à partir desquels ont pu être étudiés les changements technologiques et dans les modes d’occupation au cours des derniers millénaires. Nous présentons ici les résultats et les interprétations, proposant les modalités par lesquelles les communautés holocènes des hauts plateau du Boreda Gamo ont construit de nouveaux paysages et technologies pour passer de la chasse et de la cueillette à un mode de vie agropastoral.

Keywords Ethiopia · Gamo · Later Stone Age · Cave archaeology · Hunter and gatherer · Food production

Archaeological Identification of Food Production in the Horn of Africa

The Horn of Africa has long been recognized as a major center of plant domestication and an important region for the advent and development of pastoralism in Africa (Brandt 1984; Clark 1980; Curtis 2013; D’Andrea et al. 1999; Fuller and Hildebrand 2013; Fuller et al. 2014; Harlan 1969, 1971, 1992; Lesur et al. 2014a; Phillipson 1993; Portères 1976; Purugganan and Fuller 2009; Vavilov 1950; Westphal 1975). However, one of the unique aspects of the Horn and specifically Ethiopia is the relatively late domestication of animals and plants compared to the adjacent regions of South Arabia and the Nile Valley (Harrower et al. 2010). Current archaeological evidence for farming in the Horn, in the form of agropastoralism, dates to the third millennium BP (Bard et al. 1997; Boardman 1999; Brandt 1984; Brandt and Carder 1987; Clark 1988; Clark and Prince 1978; Clark and Williams 1978; Curtis 2013; D’Andrea 2008; D’Andrea et al. 1999, 2008a; Guthertz et al. 2015; Harrower et al. 2010; Lesur et al. 2007, 2014b; Marshall and Hildebrand 2002; Negash 2001; Phillipson et al. 2000; Schmidt and Curtis 2001).

Within the Horn of Africa, northern Ethiopia and Eritrea have yielded the most comprehensive evidence for ancient African plant domestication, with domesticated teff (Eragrostis tef) and finger millet (Eleusine coracana) dating to the third and second millennium BP, respectively (D’Andrea 2008; D’Andrea et al. 2008a, b; Marshall and Weissbrod 2011). However, the ancient Ethiopian communities may have originally relied on Western Asian cultivars such as emmer (Triticum dicoccum) and bread wheat (Triticum aestivum), barley (Hordeum vulgare), lentils (Lens esculentus), and linseed/flax (Linum usitatissimum) (Beldados et al. 2015; D’Andrea et al. 1999; Curtis 2013; Fuller et al. 2014). Macrobotanical evidence for these domesticates is found in northern Ethiopia at Pre-Aksumite sites and in Eritrea at Ancient Ona culture sites dating to the early third millennium BP (Bard et al. 1997; Boardman 1999; Curtis 2013; D’Andrea 2008; D’Andrea et al. 2008a). The highlands of the Horn of Africa are unique on the continent for the ancient cultivation of African and Near Eastern crops, but the relative contribution of each to the overall regional diet and economic system varied (D’Andrea et al. 2011; Phillipson et al. 2000). For example, the stable isotope analysis of a human burial dated to 1600 BP from the Tigray region of northern Ethiopia indicates that the individual depended on a plant-based diet centered on Near Eastern C3 plants with a lesser reliance on African C4 plant material (D’Andrea et al. 2011). However, one cannot generalize based on this single individual.

Today, the food production systems of southwestern Ethiopia are significantly different from that of northern Ethiopia. Populations in the southern highlands tend to domesticate animals and grow a mixture of Near Eastern and African grain crops, and they rely upon root crops and enset (Ensete ventricosum) more than northern populations. Enset is an endemic domesticate that provides a nutritious starchy food. It is grown in small areas with terracing, is both drought- and pest-resistant, and has a widespread and probably very ancient presence in food production traditions (Brandt et al. 1997; Curtis 2013; Hildebrand 2007). Pastoralism and farming occurred much later in southern Ethiopia than in northern Ethiopia and other regions of eastern Africa as suggested by preliminary excavations at rockshelter and caves in Wolayta (Asmare 2015; Barnett 1999; Guthertz et al. 2002; Lesur et al. 2007), Kafa (Hildebrand et al. 2010), and the Gamo region (Arthur...
et al. 2009, 2010). At Kumali rockshelter in Kafa, Hildebrand et al. (2010) found extensive quantities of desiccated plant material that date after 1740 BP, which may be wild enset, domesticated enset (*Ensete ventricosum*), or possibly domesticated banana (*Musa* spp.), suggesting early reliance on vegeculture. Enset cultivation is often associated with Omotic-speaking populations, and some linguists suggest that Omotic speakers may have originated in southwestern Ethiopia and may have begun collecting enset ca. 10,000 years ago (Bender 1988, p. 152; Blench 2006, p. 150–152, 159–160; Blench and Dendo 2008; Blench and MacDonald 2006, p. 346, 359, 457–459).

As with the advent of domesticated plants, our knowledge of when pastoralism was adopted in southern Ethiopia is dependent on a small number of investigated sites (see Hildebrand et al. 2010; Lesur et al. 2007). At Mochena Borago, the most thoroughly excavated rockshelter in southern Ethiopia, located just 50 km to the north of Boreda Gamo, there is no evidence of domesticated animals in the Holocene strata dating from 7000 to 1000 cal BP (Lesur et al. 2007). The majority of the faunal remains at Mochena Borago consist of African buffalo (*Syncerus caffer*) and a wide range of other wild fauna, many of which no longer inhabit the region. Rockshelter sites from the Kafa region, located northwest of the Gamo region, indicate that cattle and caprines date no earlier than ~2000 BP. This was contemporaneous with the first pottery production in the area (Hildebrand et al. 2010). These dates are much later than the evidence for animal domestication in the areas further south, especially in the Lake Turkana region, where faunal evidence reveals that cattle and goats were added to an already established broad spectrum hunter–gatherer economy when the climate was transitioning from a humid to a dry period ca. 4200 BP (Ashley et al. 2011; Barthelme 1984; Marshall et al. 1984; Robbins 1984, 2006). Various factors are proposed to explain the late adoption of pastoralism in southwest Ethiopia, including heavy rainfall, dramatic topography, dense forests, and a reliance on perennial plants, such as enset and yams (Hildebrand and Grillo 2012; Lesur et al. 2014a).

In this article, we add to the nascent understanding of food production in southwestern Ethiopia based on the research findings at three cave sites—Mota, Tuwatey, and Gulo, in the Gamo region. The archaeological evidence from these caves, dating from the Middle to Late Holocene (ca. 6000 to 100 BP), reveal a classic Later Stone Age lithic assemblage, the inception of pottery, the transition from wild to domesticated fauna and flora, and a burial with a complete ancient African human genome. The cultural changes demonstrated in the archaeological record offer new perspectives concerning human use of highland landscapes in southwestern Ethiopia over the last 6,000 years.

The Gamo region of southern Ethiopia is diverse with elevations ranging from 1,200 m along the Rift Valley lakes of Abaya and Chamo to 4,000 m in the highlands. The contemporary Gamo human population numbers over one million and the region’s agricultural production is dependent on a bimodal rainfall pattern (Wana and Woldu 2006). The populations live at a variety of altitudinal zones and consume different types of grains, domesticated animals, dairy products, and tubers, in part, based on access to resources stratified across the different ecozones of the region. Indigenous cultivars of Ethiopia are grown alongside crops of western Asian origin, as well as those of wider tropical Africa, the Americas, and greater Eurasia (see Samberg et al. 2010). The relatively high rainfall and steep gradients affect the integrity of open-air archaeological site deposits in this region. However, caves are protected from significant alluvial disturbance, providing excellent locales for the preservation of ecofacts and material culture in anthropogenic deposits. Between 2005 and 2012, we began our study of the Gamo landscape by working with the Boreda community to identify, locate, map, and test sites, including cave sites in the northern Gamo Highlands, ~2,154 m above sea level (Arthur et al. 2017). In our collaboration with the Boreda community, particularly elders, they revealed to us the presence of Mota Cave, Tuwatey Cave, and Gulo Cave, each possessing substantial anthropogenic deposits (Fig. 1). Favorable taphonomic conditions in these caves have permitted a good preservation of material culture, fauna, and flora that allow us to investigate the long-term development of hunter–gatherer and food production adaptations, as well as changes in technologies and habitat use.

Mota, Tuwatey, and Gulo caves are situated in columnar basalt formations behind waterfalls, which drain over and in front of each cave. The splash erosion at the foot of the waterfall over each cave affects the softer layers of sediments, generating an overhanging wall that is prone to collapse. The debris cone caused by the collapse often diverted water to the inner part of the cave thereby enlarging it (Fig. 2). In Tuwatey Cave, for example, there is a thick layer of mud created from the diversion of the water back into the cave that allowed a small pond to form for a time during the early part of the
Historic period, ca. 300–200 BP. In Mota Cave, there was once an underground stream that ran below the current cave deposits as evidenced by the presence of rounded and subrounded gravels resting directly on the basalt bedrock. During the early formation of the caves, prior to human occupation, rounded and subrounded gravels were deposited, upon which both natural and anthropogenic deposits accumulated during the Middle and Later Holocene, forming a complex stratigraphy that spans more than 6,000 years.

Mota Cave (Site GB20)

The Mota Cave deposits indicate human activity since the fifth millennium BP (Table 1). The cave is situated 1,963 m above sea level on the western escarpment of the northern Boreda Gamo Highlands (Fig. 3). The cave was documented in 2011 in collaboration with local Boreda elders and was partially excavated in 2012. Our local guides identified the site as Mota Gongola (Mota Cave), but later an elderly woman revealed a second name for the site, Sorsha Gongola or the Snake Spirit Cave. According to her, the site played an important role in the local religious practices. It was in this cave that her husband would make barley powder and sheep’s blood offerings to the snake spirit, Sorsha, a practice meant for the spiritual and physical wellness of the community.

The cave measures 14 m in width and 9 m in depth and has a large area of rock fall in the center of the floor. Rounded gravels are at the bottom of the cave deposit indicating intensive fluvial erosion when the cave was formed. Excavations, including one shovel test unit and

Fig. 1 Map showing the location of the Gamo region and the caves within Ethiopia
four excavated units toward the mouth of the cave (1, 3, 5, 6, and 7) and a second test unit and one excavated unit (2 and 4) in the back of the cave, reveal multiple anthropogenic layers (Fig. 4). The east wall (Table 2 and Fig. 5) and west wall (Table 3 and Fig. 6) of units 3 and 5 have nine different sediment layers with one hearth and revealed one human burial with a cairn. The hearth present in unit 5 extends into adjacent unit 1, level 4. The burial in unit 3 extends into units 5, 6, and 7. Unit 4 consists of 16 sediment layers (Table 4 and Fig. 7) and includes a second hearth feature (L3–6, stratigraphic layers 3 to 11). Unit 2 adjacent to unit 4 consists of a separate third hearth feature (L3–4). The radiocarbon dates obtained from 11 organic samples from these units date from 4520 to 300 cal BP (Table 1). Three broad time ranges are represented: Pre-Pottery period: 4520–3340 cal BP (a burial and a hearth), Early Pottery period: 2370–1620 cal BP (two hearths), and Historic period: 330 cal BP to 300 BP (possible hearth).

Pre-Pottery Period and Earliest Occupation (4520 to 3340 Cal BP)

The first inhabitants to occupy Mota Cave were Pre-Pottery hunters, gatherers, and fisher people who were utilizing the lowland lakes but living in the highlands, where they prepared their obsidian tools, cooked their food, and buried their dead. No botanical remains have been recovered during this time span. Evidence of their earliest subsistence is a tilapia fishbone with an associated date of 4520 cal BP. This is a clear indication that people were fishing in, or acquiring fish through some forms of exchange from, Lake Abaya or Lake Chamo in...
the adjacent Rift Valley lowlands. Connection with the lowlands is also confirmed based on the predominance of obsidian and chert/chalcedony tools. The analysis by portable X-ray fluorescence spectrometry of 65 obsidian pieces from the Pre-Pottery levels of unit 4 indicates procurement mainly from three chemically distinct sources, but their geological locations have not been identified (Fig. 8). A small bit of ochre (unit 5, L6) adjacent to the burial was perhaps used for body ornamentation, and geodes (unit 4, L6) associated with a hearth and another placed under the leg of the interred person indicate mortuary ritual/symbolic activities at the site.

**Diet and Technology** The faunal remains and the lithics suggest a hunting–gathering way of life and in situ animal processing and microlithic obsidian tool production. The fauna are few for the earliest occupation but indicate people were hunting small to large, wild animals including bovid, klipspringer, suid, monkey, and hare (Table 5). The presence of one tilapia bone also

| Lab no.       | Site          | Unit:level:cm bs | 14C BP  | d13C (%) | Cal BP  | 95% range BP | Recovery method | Dating type |
|---------------|---------------|------------------|---------|----------|---------|--------------|-----------------|-------------|
| Beta-405537   | Mota Cave     | 5:6:40–50        | 4480 ± 30 | −27.2    | 4520 ± 30 | 5295–4975    | Sieve            | AMS         |
| OxA-29631     | Mota Cave     | 5:7:50           | 3997 ± 29 | −14.5    | –       | 4524–4418    | In situ          | AMS         |
| Beta-331419   | Mota Cave     | 4:5:40–50        | 4030 ± 30 | −24.0    | 4050 ± 30 | 4780–4440    | Sieve            | AMS         |
| Beta-331422   | Mota Cave     | 5:7:50           | 3620 ± 30 | −14.8    | 3790 ± 30 | 4240–4090    | In situ          | AMS         |
| Beta-331420   | Mota Cave     | 4:6:50–60        | 3780 ± 30 | −24.8    | 3780 ± 30 | 4240–4080    | Sieve            | AMS         |
| Beta-331418   | Mota Cave     | 4:4:31–40        | 3300 ± 30 | −22.4    | 3340 ± 30 | 3680–3480    | Sieve            | AMS         |
| Beta-405096   | Mota Cave     | 2:3:20–30        | 2380 ± 30 | −24.5    | 2370 ± 30 | 2485–2345    | Sieve            | AMS         |
| Beta-405095   | Mota Cave     | 2:2:10–20        | 1700 ± 30 | −25.1    | 1700 ± 30 | 1695–1545    | Sieve            | AMS         |
| Beta-331421   | Mota Cave     | 5:4:24–30        | 1610 ± 40 | −24.5    | 1620 ± 30 | 350–540      | In situ          | AMS         |
| Beta-405094   | Mota Cave     | 3:2:10–20        | 330 ± 30  | −24.9    | 330 ± 30  | 485–305      | Sieve            | AMS         |
| Beta-331417   | Mota Cave     | 4:3:20–31        | 310 ± 30  | −25.8    | 300 ± 30  | 460–300      | Sieve            | AMS         |
| Beta-237451   | Tuwatey Cave  | 1:8:91–101       | 5500 ± 40 | −23.9    | 5520 ± 40 | 6400–6280    | Sieve            | AMS         |
| Beta-405091   | Tuwatey Cave  | C7:7:60–63       | 5280 ± 30 | −25.1    | 5280 ± 30 | 6180–5945    | In situ          | AMS         |
| Beta-405097   | Tuwatey Cave  | J5:7:60–73       | 5020 ± 30 | −24.8    | 5030 ± 30 | 5895–5660    | In situ          | AMS         |
| Beta-237453   | Tuwatey Cave  | 2:9:99–110       | 4380 ± 40 | −22.2    | 4430 ± 40 | 5280–4870    | Sieve            | AMS         |
| Beta-237454   | Tuwatey Cave  | 2:10:110–120     | 4310 ± 40 | −24.0    | 4330 ± 40 | 4970–4840    | Sieve            | AMS         |
| Beta-237450   | Tuwatey Cave  | 1:7:79–91        | 4420 ± 40 | −24.5    | 4420 ± 40 | 5280–4870    | Sieve            | AMS         |
| Beta-237452   | Tuwatey Cave  | 2:5:42–54        | 3230 ± 50 | −25.3    | 3230 ± 50 | 3570–3360    | Sieve            | AMS         |
| Beta-405090   | Tuwatey Cave  | M3:6:50–60       | 1900 ± 30 | −24.0    | 1920 ± 30 | 1925–1820    | In situ          | AMS         |
| Beta-405092   | Tuwatey Cave  | O2:8:71–80       | 1810 ± 30 | −24.1    | 1820 ± 30 | 1825–1635    | In situ          | AMS         |
| SUERC-61527   | Tuwatey Cave  | C7:7:60–70       | 492 ± 29  | −23.6    | 492 ± 29  | 534–500      | Sieve            | AMS         |
| Beta-405093   | Tuwatey Cave  | 1:3:30–40        | 290 ± 30  | −24.1    | 300 ± 30  | 460–295      | In situ          | AMS         |
| SUERC-61528   | Tuwatey Cave  | 1:2L:10–20       | 172 ± 29  | −22.3    | 172 ± 29  | 282–34       | Sieve            | AMS         |
| SUERC-61529   | Tuwatey Cave  | 1:2:10–20        | 122 ± 29  | −21.5    | 122 ± 29  | 265–10       | Sieve            | AMS         |
| Beta-249262   | Gulo Cave     | 1:5:80–100       | 5380 ± 40 | −25.7    | 5390 ± 40 | 6280–6010    | Sieve            | AMS         |
| Beta-405084   | Gulo Cave     | 1:1:20           | 2260 ± 30 | −25.8    | 2250 ± 30 | 2345–2155    | Sieve            | AMS         |
| Beta-249261   | Gulo Cave     | 1:2:20–40        | 2050 ± 40 | −26.2    | 2070 ± 40 | 2120–1920    | Sieve            | AMS         |
| Beta-405086   | Gulo Cave     | 1:4:60–80        | 2020 ± 30 | −24.3    | 2030 ± 30 | 2055–1900    | Sieve            | AMS         |
| Beta-405085   | Gulo Cave     | 1:3:40–60        | 1680 ± 30 | −24.6    | 1690 ± 30 | 1695–1535    | Sieve            | AMS         |
| Beta-405087   | Gulo Cave     | 1:6:100–115      | 1690 ± 30 | −28.6    | 1630 ± 30 | 1570–1415    | Sieve            | AMS         |

1 From carbonized *Hordeum vulgare* seed
2 From carbonized *Gossypium* sp.
3 From carbonized *Hordeum vulgare* seed
Fig. 3  Mota Cave

Fig. 4  Plan map of Mota Cave and location of excavation areas
suggests that the occupants of Mota had access to the aquatic resources in the lowlands. The Pre-Pottery period at Mota has a rich lithic assemblage, 20% of which consists of a wide range of Late Stone Age tools. Lithic materials reinforce the presence of a hunting and gathering technology with unifacial points and likely hafted microlithic tools used for cutting, engraving, sewing, and scraping (Barham 2013).

The cave’s occupants produced small tools (Table 6), typical of the microlithic tradition, from primarily obsidian, but there is a small representation of other rock types, such as chert, quartz, and basalt, in the lithic assemblage. The greatest concentration of lithics was associated with the human burial, discussed below, and in unit 4 (Table 6). These hunters and gatherers engaged in hide processing activities with chert and obsidian scrapers (double, side, end, end–side, end double side, circular, convergent, and backed) with edge angles ranging from 47° to 85° in various stages of use. Almost one-third of the scrapers exhibited multiple-use edges. This suggests that they likely hafted these tools in open hafts secured with rope rather than mastic so that they could easily remove the scraper and rehaft using another edge. The assemblage also indicated that people sewed hides with awls and engraved with burins. They cut meat and/or cut wild grasses with possibly hafted backed blades made of microlithic geometric tools such as crescents, trapezoids, and triangles with cutting edge angles ranging from 20° to 48°. Furthermore, they hunted with obsidian triangular, oval, and polygon unifacial points. These are primarily associated with hearths at the site (Fig. 9). Cores, debitage, a hammerstone, and scraper and point preforms indicate that the inhabitants were actively making the tools present in the cave. The early peoples of Mota knapped a range of core sequences including obsidian single platform cores, and pyramidal, radial, and bipolar cores, which resulted in blade (14%) and flake (86%) debitage production (Fig. 10). The consistent presence of debitage at Mota Cave throughout the deposit (Tables 7 and 8) demonstrates that individuals were engaged in core reduction and tool production.

Ethnographically, stone tool making is a technology that is transferred through scaffolding from elders to youth beginning when the latter reach puberty (Arthur 2018, p. 227–228). Among all historic and ethnographically documented lithic practitioners, both men and women knapped. Bipolar cores are particularly associated with women in almost all known stone-knapping traditions (Arthur 2010, 2018, p. 208). Therefore, women may have been active toolmakers at Mota. The presence
| Layer | Soil structure | Texture fines | Gravels | Pebbles | Color | Ash | Charcoal | Note | Facies interpretation |
|-------|----------------|--------------|---------|---------|-------|-----|----------|------|------------------------|
| 1     | Weak fine prismatic | Loamy sands (L) | ***AN |         |       |     |          |      | Present-day soil |
| 2     | Sandy loam (L) | ****AN SA SR F | *AN F |       | 10YR 4/4 |     |          |      | Debris accumulation by weathering |
| 3     | Sandy loam (L) | ****AN SA SR | **AN |       | 10YR 5/3 | *   |          |      | Mixing of anthropogenic fire-derived materials and natural sediments |
| 4     | Sandy loam (L) | *****AN SA | ***AN SA |       | 10YR 3/1 | *** |          |      | Mixing of anthropogenic fire-derived materials and natural sediments |
| 5     | Sandy loam (L) | ****AN SA | ***AN |       | 10YR 5/2 | *   |          |      | Charred fine material |
| 6     | Ash (C) | | White | | | |          |      | Fire ash |
| 7     | Sandy loam (FC) | | | | | |          |      | Fire ash and charcoals |
| 8     | Sandy loam (FC) | ***AN SA | | | 10YR 6/2 | | |        |      | Debris accumulation by weathering |
| 9     | Sandy loam (FC) | ****AN SA | ****AN SA | | 10YR 3/2 | | |        |      | Debris accumulation by weathering and mixing with guano-derived organics |

Gravels: up to 5 cm. Pebbles > 5 cm

Roundness and shape: AN = angular, SA = subangular, SR = subrounded, F = flat. Compaction: L = loose, FC = fairly compact, VC = very compact

* = rare, ** = scarce, *** = common, **** = abundant, ***** = very abundant
of a broken core dating to the Pre-Pottery period also may suggest the presence of novice toolmakers. Novices are more likely to break tools during use and to create spurs on scrapers when resharpening during use (Weedman 2002; Arthur 2018, p. 163–169). Fourteen percent of the geometric tools were broken, which suggests novices may have been engaged in cutting meat and/or wild grasses. Nearly 30% of the Mota scrapers exhibited spurs which, in ethnographic examples of hide processing, would render the tools useless. This would explain why most of the spurred scrapers were discarded in a hearth.
### Table 4 Description of Mota Cave sediments from section 4

| Layer | Soil structure | Texture fines | Gravels | Pebbles | Color   | Ash      | Charcoal | Note                                | Facies interpretation                                      |
|-------|----------------|---------------|---------|---------|---------|----------|----------|-------------------------------------|------------------------------------------------------------|
| 1     | Weak fine prismatic Loamy sands (L) | ***AN |         |         | 10YR 5/4 |          |          | Present-day soil                    |                                                            |
| 2     | Sandy loam (L) | ****AN SA SR F | ***AN F |         | 10YR 5/3 |          |          | Debris accumulation by weathering   |                                                            |
| 3     | Sandy loam (L) | ****AN SA SR | *AN     |         | 10YR 5/2 | *** **   |          | Mixing of anthropogenic fire-derived materials and natural sediments |                                                            |
| 4     | Ash (L)        |               | White   | *****   |         |          |          | Fire ash                            |                                                            |
| 5     | Sandy loam (L) |               | 7.5YR 5/6 | ** **  |         |          |          | Burning                             |                                                            |
| 6     | Loamy sands (L) | ****AN SA |         |         | 10YR 5/3 | ** **   |          | Charred fine material               | Mixing of anthropogenic fire-derived materials and natural sediments |
| 7     | Loam (L)       | ***AN SA      |         |         | 10YR 5/2 | *** **   |          | Charred fine material               | Mixing of anthropogenic fire-derived materials and natural sediments |
| 8     | Sandy (L)      |               | 10YR 4/3 | ***     |         |          |          | Burning                             |                                                            |
| 9     | Loamy sands (L) | ***AN SA SR |         |         | 10YR 3/3 | **** *** |          | Charred fine material               | Mixing of anthropogenic fire-derived materials and natural sediments |
| 10    | Ash (L)        |               | 10YR 3/1 | *****   | **     |          |          | Fire ash                            |                                                            |
| 11    | Sandy loam (L) | *AN           | 10YR 3/2 | *****   | *** ** |          |          | Charred fine material               | Mixing of anthropogenic fire-derived materials and natural sediments |
| 12    | Ash (L)        |               | White   | *****   |         |          |          | Fire ash                            |                                                            |
| 13    | Sandy loam (L) |               | 10YR 3/3 | * **   |         |          |          | Reworking of burnt materials       |                                                            |
| 14    | Ash (L)        |               | White   | *****   |         |          |          | Fire ash                            |                                                            |
| 15    | Sandy loam (FC) | ***AN SA SR | ***AN |         | 10YR 3/2 | *** ** |          | Thin ash lenses within              | Mixing of anthropogenic fire-derived materials and natural sediments |
| 16    | Sandy loam (FC) | ***SR | ***SA |         | 10YR 3/1 |          |          | Charred fine material               | Mixing of anthropogenic fire-derived materials and natural sediments |

Gravels: up to 5 cm. Pebbles > 5 cm

Roundness and shape: \( AN = \) angular, \( SA = \) subangular, \( SR = \) subrounded, \( F = \) flat. Compaction: \( L = \) loose, \( FC = \) fairly compact, \( VC = \) very compact

\* = rare, \** = scarce, \*** = common, \**** = abundant, \***** = very abundant
A majority of fauna and lithics were recovered near and around the hearth in unit 4, well dated to between 3340 and 4050 BP, indicating that the back portion of the cave was an area of tool making, as well as hide and food processing soon after the internment of the individual in the cairn. A geode was also found near the hearth feature. The presence of four points, including two triangular, an oval, and a tanged point, and geometrics, suggests that animals were likely processed near the hearth. Nearly half of the fauna bones were burned, indicating cooking of the meat on the bone. The presence of end and side scrapers near the hearth also indicates that people either hafted their tools and/or processed hides in this location. The presence of four obsidian and one dark gray chert cores and one hammerstone suggests lithic production near the hearth, though most of the debitage seems to have been removed perhaps to the front of the cave where a large amount of lithic debitage is scattered throughout the burial cairn. We should note that we have not yet conducted refitting studies to determine if debitage and the cores are from the same pieces of raw materials.

Bayira (By-ra), Diet, and Population Dynamics

Beginning around 4500 cal BP, people began to use the Mota Cave to bury their dead. Excavations revealed a basalt stone cairn burial with an adult male skeleton from which the first ancient human genome
Table 5 Faunal results from Mota Cave during the Pre-Pottery period

| Mota Cave GB20 unit | St 1 | Tu 3 | Tu 3 | Tu 3 | Tu 3 Burial | Tu 4 | Tu 4 | Tu 4 | Tu 5 | Tu 5 | Tu 5 | Tu 5 | Tu 6 | Tu 6 | Tu 6 Rock cairn | ST 2 | ST 2 |
|---------------------|------|------|------|------|-------------|------|------|------|------|------|------|------|------|------|-----------------|------|------|
| Level               | Lv 4 | Lv 5 | Lv 6 | Lv 7 | Lv 5 | Lv 6 | Lv 7 | Lv 5 | Lv 6 | Lv 7 | Lv 5 | Lv 6 | Lv 7 | Lv 4 | Lv 5 | 50–60 cm bs | ST 2 | ST 2 |
| Human (*Homo sapiens*) | 9 | 1 | | | | | | | | | | | | | | 1 | 1 |
| Large bovid         | 2 | | | | | | | | | | | | | | | |
| Middle-sized bovid  | 4 | | | | | | | | | | | | | | | 1 |
| Klipspringer (*Oreotragus oreotragus*) | 3 | | | | | | | | | | | | | | | |
| Small-sized bovid   | 9 | 1 | 1 | | | | | | | | | | | | | | |
| Suid                | 2 | 5 | | | | | | | | | | | | | | 1 |
| Middle-sized mammal | 10 | | | | | | | | | | | | | | | 1 |
| Cercopithecidae     | 5 | 1 | 2 | | | | | | | | | | | | | 2 | 1 | 1 |
| Hynax (*Procavia capensis*) | 1 | | | | | | | | | | | | | | | 3 | 1 |
| Porcupine (*Hystrix cristata*) | 1 | | | | | | | | | | | | | | | |
| Hare (*Lepus capensis*) | 3 | | | | | | | | | | | | | | | |
| Cane rat (*Thryonomys swinderianus*) | 2 | 1 | 11 | 14 | 1 | 7 | | | | | | | | | | 6 |
| Rodent              | 2 | 4 | 1 | | | | | | | | | | | | | | 1 |
| Amphibian           | 1 | | | | | | | | | | | | | | | |
| Tilapia (*Tilapinii*) | 1 | | | | | | | | | | | | | | | |
| Crab                | 1 | | | | | | | | | | | | | | | 2 |
Table 6  Lithic tools ($n = 259$) recovered from Mota Cave Pre-Pottery period

| Cal BP | Utilized/modified flakes and blades whole | Broken utilized/modified flakes and blades | Total informal tools | Scraper | Broken scraper | Burin | Awl | Geometrics | Backed flakes |
|--------|------------------------------------------|-------------------------------------------|----------------------|---------|---------------|-------|-----|------------|---------------|
| Unit 2, L5 | 1 | 2 | 3 | 0 | 0 | 1 | 1 | 2 | 1 |
| Unit 2, L6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Unit 3, L4 | 2 | 3 | 5 | 3 | 1 | 0 | 0 | 3 | 0 |
| Unit 3, L5 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 3 | 0 |
| Unit 3 feature 1 rock cairn human burial | 4524–4418 | 2 | 0 | 2 | 0 | 0 | 1 | 8 | 0 |
| Unit 3, L6 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Unit 3, L7 | 3 | 0 | 3 | 0 | 0 | 0 | 1 | 2 | 0 |
| Unit 4, L4 hearth 3 | 3340 ± 30 | 5 | 6 | 11 | 5 | 0 | 0 | 1 | 4 | 0 |
| Unit 4, L5 hearth 3 | 4050 ± 30 | 5 | 1 | 6 | 13 | 0 | 1 | 2 | 10 | 0 |
| Unit 4, L6 hearth 3 | 3780 ± 30 | 4 | 1 | 5 | 5 | 0 | 0 | 4 | 5 | 0 |
| Unit 4, L7 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 3 | 0 |
| Unit 5, L6 | 4520 ± 30 | 2 | 0 | 2 | 3 | 0 | 0 | 1 | 3 | 0 |
| Unit 5, L7 | 3790 ± 30 | 1 | 4 | 5 | 1 | 0 | 1 | 6 | 0 |
| Unit 5, L8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Units 3, 4, 5 interface (30–50) | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Total | 27 | 18 | 45 | 41 | 1 | 3 | 14 | 53 | 1 |

Percent of total formal and informal tools

| Backed blades | Broken geometric and backed blades/ flakes | Core chopper | Unifacial point | Unifacial point preform | Biface preform | Hammerstone | Total formal tools |
|---------------|-------------------------------------------|--------------|-----------------|-------------------------|----------------|-------------|-------------------|
| Unit 2, L5 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Unit 2, L6 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| Unit 3, L4 | 3 | 5 | 0 | 0 | 0 | 1 | 16 |
| Unit 3, L5 | 2 | 0 | 0 | 1 | 0 | 0 | 7 |
| Unit 3 feature 1 rock cairn human burial | 10 | 0 | 0 | 1 | 0 | 0 | 20 |
| Unit 3, L6 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| Unit 3, L7 | 5 | 0 | 0 | 0 | 0 | 0 | 8 |
| Unit 4, L4 hearth 3 | 9 | 4 | 0 | 1 | 0 | 0 | 24 |
| Unit 4, L5 hearth 3 | 9 | 1 | 1 | 1 | 1 | 0 | 39 |
| Unit 4, L6 hearth 3 | 8 | 2 | 0 | 1 | 1 | 0 | 27 |
| Unit 4, L7 | 3 | 0 | 0 | 1 | 0 | 0 | 13 |
| Unit 5, L6 | 5 | 3 | 0 | 0 | 0 | 0 | 15 |
from the African continent was sequenced (Gallego Llorente et al. 2015). We have named the skeleton Bayira, meaning “firstborn” in the Gamo language. Bayira’s burial orientation is distinct and strongly suggests an emphasis on a purposeful arrangement of his body that must have been symbolically significant to the people who buried him. Bayira was laid down in a north/south direction with his head facing west on a bedrock pillow stone in a fully flexed position. He was buried in an ashy layer under a small stone cairn of basalt rocks but directly on top of the round basalt gravels (Fig. 11). When we uncovered Bayira, his bones were fragmented and the articulation of the bones was displaced in many areas due to the heavy weight of the stone cairn. The burial was directly dated to cal BP 4524–4418 and 4240–4090 (see Table 1). The morphology of the bones and the DNA indicate Bayira was a male and was 30 to 50 years old at death. This is the only known burial from this time period in southwestern Ethiopia.

Burial goods were placed with Bayira, including a geode, calcite, and heat-treated white-gray pink chert debitage under his leg (Figs. 12 and 13). Chert, basalt, and obsidian tools and debitage (no cores) were scattered throughout the burial cairn including two modified/utilized flakes, one awl, 10 backed blades, eight geometrics, one triangular unifacial point, and 167 pieces of debitage. These were likely the last offering to Bayira as they covered him with the stone cairn. Over 300 pieces of obsidian and other green and red lithic debitage were recovered within the cairn and adjacent to the burial, particularly in basalt gravels in unit 5 (L6–8).

Bayira’s skull and postcranial remains are highly fragmentary and incomplete. Preserved elements of his skull include over 70 bone fragments representing the frontal, right and left parietal, occipital, and temporal bones, as well as the zygomatic, the mandible, and alveolar regions of the maxilla. The adult maxillary dentition is complete, and the mandibular dentition includes the left M3, M2, PM4, PM3, C, I2, and I1 and the right I1, I2, PM2, M1, M2, and M3. Most postcranial skeletal elements preserve cortical bone but are damaged in articular/trabecular regions. The right and left clavicles are present with damage to the medial and lateral ends, and the axillary border of the right scapula is also preserved. Bayira’s left humerus, right ulna, femora, tibiae, and fibulae are virtually complete but fragmentary. However, other elements of his remains are only partially preserved such as his left ulna, right

| Table 6 (continued) |
|---------------------|
| Hammerstone Total formal tools |
| Bayira | 25 |
| Backed blades |
| Broken geometrics and backed blades/flakes |
| Backed blades |
| Unifacial point preform |
| Cone chopper |
| Core chopper |
| Unifacial point preform |
| Percent of total formal and informal tools |

| Unit 5, L7 | Unit 5, L8 | Units 3, 4, 5 interface (30–50) | Total |
|-----------|-----------|-----------------------------|-------|
| Hammerstone | 66 | 19 | 1 | 11 | 2 | 1 | 214 | 82 |
| Broken geometrics and backed blades/flakes | 6 | 1 | 19 | 66 |
| Backed blades | 2 | 0 | 0 | 0 | 0 | 0 | 6 | 4 |
| Unifacial point preform | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| Cone chopper | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 3 |
| Core chopper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Percent of total formal and informal tools |

| Unit 5, L7 | Unit 5, L8 | Units 3, 4, 5 interface (30–50) | Total |
|-----------|-----------|-----------------------------|-------|
| Hammerstone | 66 | 19 | 1 | 11 | 2 | 1 | 214 | 82 |
| Broken geometrics and backed blades/flakes | 6 | 1 | 19 | 66 |
| Backed blades | 2 | 0 | 0 | 0 | 0 | 0 | 6 | 4 |
| Unifacial point preform | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| Cone chopper | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 3 |
| Core chopper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Percent of total formal and informal tools |

| Unit 5, L7 | Unit 5, L8 | Units 3, 4, 5 interface (30–50) | Total |
|-----------|-----------|-----------------------------|-------|
| Hammerstone | 66 | 19 | 1 | 11 | 2 | 1 | 214 | 82 |
| Broken geometrics and backed blades/flakes | 6 | 1 | 19 | 66 |
| Backed blades | 2 | 0 | 0 | 0 | 0 | 0 | 6 | 4 |
| Unifacial point preform | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| Cone chopper | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 3 |
| Core chopper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Percent of total formal and informal tools |
and left radii, and innominate bones, and the other regions of his skeleton, including the vertebrae as well as manual and pedal elements, are either absent or highly fragmented.

In agreement with Bayira’s aDNA analysis (Gallego Llorente et al. 2015), the osteological analysis confirms that the individual was a male. His pelvis features a relatively narrow sciatic notch and a shallow and broad pre-auricular sulcus. The fragmentary and relatively gracile subpubic ramus features minor subpubic concavity but no ventral arc. However, Bayira’s pubic symphysis was not preserved. The sacrum had a narrow S1 body relative to the breadth of the alae. All the observable features of the pelvis are most consistent with male morphology. Bayira’s mandible is well-preserved and he exhibited a prominent mental eminence and trigone, typical of category 4 (Buikstra and Ubelaker 1994) and marked gonial flare, which are more consistent with the male sex. His age estimation is possible based on several characteristics. All of his visible epiphyses were fused, including the vertebral annular epiphyses. The ramal epiphysis of the ischium is fused but with a visible line. Bayira’s lower third molars were fully erupted, in occlusion, with moderate tooth wear. The left auricular surface of the os coxa (hip bone) has no remaining transverse organization and is characterized by coarse granularity, with some microporosity and moderate retroauricular activity. All of these features indicate that Bayira was a mid-aged adult who died between the ages of 30 and 50.

Overall, Bayira’s skeletal morphology and genetic signature indicates that he was small bodied and gracile, and therefore, had a relatively low body mass. These are characteristics of highland adaption which contemporary local population also share, indicating that the latter may have a deep history in the highlands. Bayira has several elements that are preserved well enough to provide direct osteometric data. The length of the right femur is approximately 418 mm (± 5 mm), and the maximum femoral head diameter (41.77 mm) could be measured directly. The length of the right tibia is estimated at 366 mm (± 5 mm). No regression equations for the estimation of stature and body mass are available that are specific to populations of the Horn of Africa. Using Feldesman and Fountain’s (1996) generic equation for populations of African descent and Raxter’s et al. (2008) equation for Egyptian males, Bayira’s stature was estimated as 154.8 cm or 158.2 cm, respectively. In addition, the Bayira’s body mass was estimated as 55.16 kg., based on his femoral head diameter (Ruff et al. 1997). The aDNA of Bayira also offers insights into prehistoric adaptation to life in the Ethiopian highlands (Gallego Llorente et al. 2015). His genotype possessed SNP variants in the LIPE and UBAP2 genes, which are thought to be involved in adaptation to hypoxic environments at high altitudes (Udpa et al. 2014).

Stable isotope data obtained from collagen sampled from the petrous bone ($\delta^{13}C = -14.5\%_e; \delta^{15}N = -8.7\%_e$) suggests that Bayira relied on indigenous foods, particularly C4 pathway foods which may include wild sorghum, finger millet, and/or teff. These African crops, especially their wild spp., have yet to be documented in southern Ethiopia at this early date, and Bayira predates both the origins of agriculture and pastoralism in this area. More rigorous interpretation of these results will
require a detailed analysis of the isotopic signature of local food webs. Bayira’s genome also indicates that he possessed none of the alleles known to be associated with lactase persistence, suggesting that he was not engaged in pastoralism 4,500 years ago.

Besides being the first ancient genome sequenced from Africa, Bayira’s skeleton and the archaeological record associated with him provide an opportunity to examine ancient regional and interregional population dynamics. This individual predates a Eurasian gene flow into parts of northeastern Africa that seems to have occurred after 3,000 years BP (Gallego Llorente et al. 2015). His aDNA data therefore presents relatively nonadmixed African genomic reference for exploring much more recent demographic events in the region. Hence, with Bayira as a reference point, geneticists have demonstrated a significant level of western Eurasian admixture in genomes in East Africa after 3,000 years BP, similar to Neolithic (LBK) genomes in Europe. The mechanisms by which this happened are unclear but may have been due to gene flow related to specific population interactions in the Southern Red Sea area or elsewhere in northeastern Africa followed by gene flow among African populations across the continent. Archaeological and epigraphic evidence does suggest that beginning about 3,000 years BP interaction between polities in the northern Horn of Africa and the Southern Arabian Peninsula intensified and new forms of sociopolitical and economic organization appeared, perhaps as a consequence of this interaction (Curtis

### Table 7  Lithic cores and debitage (n=1058) recovered from Mota Cave Pre-Pottery period

| Cal BP       | Cores Bipolar core | Bipolar core fragment | Broken core fragment | Flakes | Blades | Angular waste | Resharpening | Broken | Total debitage |
|--------------|-------------------|----------------------|---------------------|--------|--------|---------------|--------------|--------|----------------|
| Unit 2, level 5 (40–50) | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 3 |
| Unit 2, level 6 (50–70, 20 cm) | 0 | 0 | 0 | 0 | 43 | 3 | 1 | 0 | 45 | 92 |
| Unit 3, level 4 (23–30) | 1 | 0 | 0 | 0 | 11 | 2 | 2 | 2 | 47 | 64 |
| Unit 3, level 5 (30–40) | 0 | 1 | 0 | 0 | 27 | 7 | 1 | 1 | 21 | 57 |
| Unit 3 feature 1 rock cairn human burial | 4524–4418 | 0 | 0 | 0 | 62 | 5 | 8 | 11 | 81 | 167 |
| Unit 3, level 6 (40–50) | 1 | 0 | 0 | 0 | 5 | 1 | 1 | 12 | 11 | 30 |
| Unit 3, level 7 (50–52) | 2 | 0 | 0 | 0 | 11 | 1 | 1 | 1 | 9 | 23 |
| Unit 4, level 4 (31–40) hearth | 3340±30 | 1 | 0 | 0 | 63 | 13 | 2 | 15 | 35 | 128 |
| Unit 4, level 5 (40–50) hearth | 4050±30 | 1 | 2 | 0 | 0 | 10 | 13 | 5 | 8 | 36 | 72 |
| Unit 4, level 6 (50–60) hearth | 3780±30 | 0 | 0 | 0 | 62 | 6 | 5 | 2 | 7 | 82 |
| Unit 4, level 7 (60–72) | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 6 | 9 |
| Unit 5, level 6 (38–50) | 4520±30 | 0 | 0 | 0 | 30 | 0 | 1 | 0 | 41 | 72 |
| Unit 5, level 7 (50–55) | 3790±30 | 1 | 0 | 0 | 43 | 9 | 7 | 14 | 152 | 225 |
| Unit 5, level 8 (55 to bedrock) | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 8 | 13 |
| Units 3, 4, 5 interface (30–50) | 0 | 0 | 0 | 0 | 5 | 0 | 2 | 1 | 2 | 10 |
| Total | 7 | 3 | 0 | 1 | 381 | 60 | 37 | 67 | 502 | 1,047 |
| Unit 2, L5 | Cal BP | Obsidian | Basalt | Chert/chalcedony | Quartz | Obsidian | Chert/chalcedony | Quartz | Basalt | Obsidian |
|-----------|--------|----------|--------|-----------------|--------|----------|-----------------|--------|--------|----------|
|           |        | debitage | debitage| debitage        | debitage| debitage | debitage        | debitage| debitage | debitage |
| Unit 2, L5 | 3      | 0        | 0      | 0               | 5      | 0        | 0               | 0      | 0      | 3        |
| Unit 2, L6 | 92     | 0        | 0      | 0               | 2      | 0        | 0               | 0      | 0      | 0        |
| Unit 3, L4 | 61     | 1        | 2      | 0               | 12     | 3        | 0               | 1      | 5      |          |
| Unit 3, L5 | 46     | 0        | 10     | 0               | 7      | 0        | 0               | 0      | 1      |          |
| Unit 3 feature 1 rock cairn human burial | 4524–4418 | 130 | 6 | 30 | 0 | 20 | 0 | 0 | 0 | 2 |
| Unit 3, L6 | 29     | 0        | 1      | 0               | 3      | 0        | 0               | 0      | 0      | 0        |
| Unit 3, L7 | 23     | 0        | 0      | 0               | 8      | 0        | 0               | 0      | 2      |          |
| Unit 4, L4 hearth | 3340 ± 30 | 111 | 2 | 15 | 2 | 22 | 2 | 0 | 0 | 11 |
| Unit 4, L5 hearth | 4050 ± 30 | 71 | 1 | 0 | 0 | 36 | 2 | 0 | 1 | 5 |
| Unit 4, L6 hearth | 3780 ± 30 | 83 | 0 | 6 | 0 | 25 | 1 | 0 | 1 | 5 |
| Unit 4, L7 | 9      | 0        | 0      | 0               | 13     | 0        | 0               | 0      | 0      |          |
| Unit 5, L6 | 4520 ± 30 | 69 | 0 | 3 | 0 | 17 | 0 | 0 | 0 | 0 |
| Unit 5, L7 | 3790 ± 30 | 208 | 0 | 17 | 0 | 22 | 2 | 0 | 1 | 5 |
| Unit 5, L8 | 13     | 0        | 0      | 0               | 2      | 0        | 0               | 0      | 0      |          |
| Units 3, 4, 5 interface (30–50) | 7 | 1 | 2 | 0 | 8 | 0 | 0 | 0 | 2 |
| Total | 955 | 11 | 85 | 2 | 202 | 10 | 0 | 4 | 41 |

| Unit 2, L5 | Basalt modified/utilized | Chert/chalcedony modified/utilized | Obsidian core | Chert core | Basalt core | Obsidian nodule | Chert/chalcedony nodule | Quartz nodule |
|-----------|--------------------------|-----------------------------------|--------------|-----------|-------------|-----------------|--------------------------|----------------|
| Unit 2, L5 | 0                        | 0                                 | 0            | 0         | 0           | 0               | 0                        | 0              |
| Unit 2, L6 | 0                        | 0                                 | 0            | 0         | 0           | 0               | 0                        | 0              |
| Unit 3, L4 | 0                        | 0                                 | 1            | 0         | 0           | 0               | 0                        | 0              |
| Unit 3, L5 | 0                        | 0                                 | 1            | 0         | 0           | 0               | 0                        | 0              |
| Unit 3 feature 1 rock cairn human burial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 3, L6 | 0                        | 0                                 | 1            | 0         | 0           | 0               | 0                        | 0              |
| Unit 3, L7 | 1                        | 0                                 | 2            | 0         | 0           | 0               | 0                        | 0              |
| Unit 4, L4 hearth | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| Unit 4, L5 hearth | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| Unit 4, L6 hearth | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 4, L7 | 0                        | 0                                 | 0            | 0         | 0           | 0               | 0                        | 0              |
| Unit 5, L6 | 0                        | 0                                 | 0            | 0         | 0           | 0               | 0                        | 0              |
Bayira also helps us begin to piece together the population history of southwestern Ethiopia. Genetically, this individual is closest to the Ari ethnic group (Gallego Llorente et al. 2015), an Omotic-speaking

|                | Basalt modified/utilized | Chert core | Chert/chalcedony modified/utilized | Chert/chalcedony core | Obsidian core | Obsidian nodule | Quartz nodule | Total |
|----------------|--------------------------|-----------|-----------------------------------|-----------------------|----------------|----------------|---------------|-------|
| Unit 5, L7     | 0                        | 0         | 0                                 | 0                     | 0              | 0              | 0             | 2     |
| Unit 5, L8     | 0                        | 0         | 0                                 | 0                     | 0              | 0              | 0             | 0     |
| Units 3, 4, 5, 6 interface (30–50) | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 |
| Total          | 2                        | 0         | 10                                | 1                     | 0              | 0              | 0             | 10    |

Table 8 (continued)

Fig. 11 Rock cairn in Mota Cave

Bayira also helps us begin to piece together the population history of southwestern Ethiopia. Genetically, this individual is closest to the Ari ethnic group (Gallego Llorente et al. 2015), an Omotic-speaking

Fig. 12 Geode found in association with the burial Bayira in Mota Cave
society living in southwestern Ethiopia today. Currently, no living people from the Gamo Highlands where Bayira lived have been genetically sequenced for comparison, so future research will be required to fully understand the genetic relationships between Bayira and the people living in the Gamo Highlands today. The Omotic languages are linguistically the most divergent of the Afroasiatic language phylum, suggesting that Omotic speakers may have lived in southwestern Ethiopia for a long and sustained period of time (Ehret 2000, p. 290). The 4,500-year-old remains of Bayira may lend support to this view.

**Early Pottery Period and Middle Occupation (~ 2370–1620 Cal BP)**

Two highly fragmented sherds with either a polished or burnished surface were recovered near a hearth feature at Mota and possibly date as early as 3340 BP (unit 4 L4, Table 9). However, the absence of pottery in other contemporaneous units/levels dating to this earlier time suggests that these two sherds may represent a slippage of material from the upper strata. Although the advent of pottery in the archaeological sequence of Mota is unclear, it is certain that potters were using red slip on the exterior and interior surfaces of pottery vessels ca. 2400 BP. Thirty of these sherds have been firmly dated to 2370–1620 BP. The use of red slip was unique to the long tradition of pottery production in southwestern Ethiopia (Fig. 14). Beginning around 2400 BP, the people at Mota were not only utilizing pottery, they were also cultivating domesticated crops. However, domesticated animals did not appear for nearly another 1,000 years. Instead, they obtained their meat protein by hunting small bovids living in the highland montane zones. The Early Pottery people persisted in producing microlithic tools. Although tools represent only 7% of the assemblage, there is a higher density of lithics during this period at 0.00112 per cm$^3$. Nearly all the lithic tools are obsidian and there is only one chert scraper (a bit of debitage and no cores). There may have been an increased access to the lowland obsidian sources. This implies that the highland peoples were also in greater contact with the lowland pastoralists from whom they likely obtained domesticated animals.

The recovery of a single barley grain from unit 2, level 3 may indicate that the consumption of barley began in the Gamo Highlands ca. 2400 BP. Despite extensive flotation of 47 samples (940 liters of sediment), only 10 plant macroremains (excluding wood) were recovered from among 7 samples. The barley grain was submitted for AMS radiocarbon dating to the Scottish Universities Environmental Research Centre (SUERC), University of Glasgow. However, the dating did not succeed due to insufficient carbon after pretreatment. Nevertheless, this level is dated with charcoal to ca. 2400 BP, suggesting that barley and cereal farming may have been established in this region sometime during the third millennium BP (see Table 1). In Mota Cave, the evidence for domesticated sheep (*Ovis aries*)/goat (*Capra hircus*) appears in the archaeological sequence ca. 1700 cal BP and that of cattle (*Bos taurus*) ca. 1620 cal BP. However, hunting, which particularly focused on bush pig, bushbuck, and klipspringer, continued to be an important source for protein, hides, and other materials.

The Early Pottery lithic assemblage comprised of microlithic tool production, and this was characterized by flake (89%) and blade (11%) debitage produced from obsidian pyramidal, double platform, single platform, and bipolar cores (Tables 10, 11, and 12). Obsidian broken cores, a few broken tools, and hundreds of broken pieces of debitage are associated with knapping during this period. Broken cores and an abundance of debitage, of which 43% is cortical, are indicative of inexperienced knappers. Cross-cultural ethnographic studies have shown that novice knappers tend to produce larger amounts of debitage and are more likely to select poorer quality raw materials compared to experienced knappers (Arthur 2018, p. 146–150). Alternatively, this large debitage assemblage may represent the production of tool blanks such that tool refinement occurred in another location.
Table 9  Pottery surface treatment description from Mota, Tuwatey, and Gulo caves from the Early Pottery period

| Site  | Unit, level | Number | Interior treatment | Burnish | Plain | Smudge | Red slip | Exterior treatment | Burnish | Plain | Smudge | Red slip | C14 cal BP |
|-------|-------------|--------|--------------------|---------|-------|--------|----------|--------------------|---------|-------|--------|----------|------------|
| Mota  |             |        |                    |         |       |        |          |                    |         |       |        |          |            |
| ST2-2 | 16          | 5      | 7                  | 1       | 7     | 2      | 6        | 5                  | 1       | 5     | 3      | 1700 ± 30 |            |
| ST2-3 | 11          | 3      | 6                  | 3       | 3     | 9      | 2        | 7                  | 2370 ± 30 |       |        |          |            |
| ST2-4 | 1           | 1      | 1                  | 1       | 1     | 1      |          | 1                  | 1       | 1     | 1      | 1620 ± 30 |            |
| TU5-4 | 1           | 1      |                    | 1       | 1     |        |          |                    |          | 1     | 2      | 3340 ± 30 |            |
| TU3-4 | 1           | 1      |                    | 1       | 1     |        |          |                    |          |       |        |          |            |
| TU4-4 | 2           | 2      |                    | 2       | 2     | 2      |          | 2                  |          |       |        |          |            |
| Tuwatey|             |        |                    |         |       |        |          |                    |         |       |        |          |            |
| 1-4   | 2           | 2      |                    | 2       | 2     |        |          | 2                  |          |       |        |          |            |
| 1-5   | 1           | 1      |                    | 1       | 1     | 1      |          | 1                  |          |       |        |          |            |
| 2-3   | 3           | 2      | 1                  | 1       | 1     | 2      |          | 2                  |          |       |        |          |            |
| C7-5  | 2           | 1      | 1                  | 1       | 1     | 1      |          | 1                  |          |       |        |          |            |
| C7-6  | 1           | 1      |                    | 1       | 1     | 1      |          | 1                  |          |       |        |          |            |
| C7-7  | 1           | 1      |                    | 1       | 1     | 1      |          | 1                  |          |       |        | 5290 ± 30 |            |
| M3-3  | 1           | 1      |                    | 1       | 1     |        |          | 1                  |          |       |        | 1920 ± 30 |            |
| M3-5  | 1           |        |                    | 1       | 1     |        |          | 1                  |          |       |        |          |            |
| M3-6  | 1a          |        |                    | 1       | 1     |        |          | 1                  |          |       |        |          |            |
| N3-4  | 2b          | 1      |                    | 1       | 1     | 1      |          | 1                  |          |       |        |          |            |
| O2-6  | 8           | 8      |                    | 4       | 8     | 5      |          | 2                  |          |       |        | 1820 ± 30 |            |
| O2-8  | 1           | 1      |                    | 1       | 1     | 1      |          | 1                  |          |       |        | 2250 ± 30 |            |
| O3-4  | 1           | 1      |                    | 1       | 1     |        |          | 1                  |          |       |        | 2030 ± 30 |            |
| Gulo  |             |        |                    |         |       |        |          |                    |         |       |        |          |            |
| ST1-1 | 4           | 3      | 1                  | 1       | 1     | 3      |          | 1                  | 4       | 2250 ± 30 |            |
| ST1-4 | 1           | 1      |                    | 1       | 1     |        |          | 1                  |          | 2030 ± 30 |            |

Note: It was common for the interior and exterior surface treatments to have two types of surface treatments.

a Too much food residue on the interior
b Too much food residue on the exterior
We found two circular rock hearth features at the site dating to the Early Pottery period. One was in test unit 2 (L2–4) in the back of the cave in association with a triangular unifacial obsidian point, pottery, burned bone, and shell dating to 1700–2370 BP. The hearth had large amounts of charcoal and ash and was constructed with small stones. There were a few tools in the hearth area, including an end and a side scraper, scraper core, geometric tools, and utilized and modified flakes. These tools are indicative of cutting and hide working and/or hafting activities. Only end and side scrapers with single working edges were present during this period, suggesting that people likely hafted their tools in closed mastic hafts compared to the open hafts of the Pre-Pottery period. The presence of numerous broken cores and abundant debitage at the bottom of the hearth feature may suggest that people were discarding their waste material in this hearth or using it as an insulator. There was an extensive amount of faunal remains associated with this hearth including one sheep/goat element; small, medium, and large bovids; bushbuck (*Tragelaphus scriptus*); hyrax (*Procavia capensis*); suid; middle-sized mammal; cane rat; and rodents (Table 13). The pottery associated with the hearth consisted of 26 body sherds and one unidentifiable small rim sherd with a variety of surface treatments, including burnishing, plain, smudge, and red slip on the interior and exterior. Use-alteration analysis indicates that the vessels were used for cooking and other food processing activities as evident in the interior food residue \( (n = 4) \). They were also possibly used for the fermentation of either dairy products or beer production based on interior wear and pitting \( (n = 6) \) (Table 14) (Arthur 2002, 2003, 2014).

The second hearth, found in test unit 5, extends into unit 1 and dates to ca. 1600 BP. Stones also were arranged to encircle the hearth which was about 50 cm in diameter and containing ashy soil and a large amount of charcoal. Obsidian tools are found in this hearth but not in abundant numbers. These tools included a few modified/utilized flakes and blades, scrapers (end and side scrapers), a burin, an awl, and some geometrics (crescent, backed blade, trapezoid). All of these indicate cutting and scraping/scaper haft replacement activities near the hearth. A bipolar core and two pyramidal cores attest to tool making. The faunal elements found in this hearth include one cattle (*Bos taurus*) element, small-sized bovid, baboon (*Papio anubis*), aardvark (*Orycteropus afer*), rodent, and amphibian elements. The pottery included only one body sherd that has a polished interior and exterior.

**The Historic Period and Last Occupation (330–300 Cal BP)**

By 330 BP, Mota Cave was occupied again. The new occupants also engaged in hunting and gathering and consumed tubers and more domesticates. There were far more ceramics in the Historic period than in the Early Pottery period. In contrast, there were fewer stone tools, though the obsidian and chert microlithic technology continued (Tables 15, 16, and 17). While in the Pre-Pottery period, pXRF analysis indicates the exploitation of three main obsidian sources, only two of these sources continued to be utilized during the Historic period analysis based on the analysis of 39 pieces from unit 4 (Fig. 8). Furthermore, quartz is added as a knapping resource at this time. Only two areas of the cave were the focus of human activity during this time—the very front and the back of the cave.

Boreada elders stated that in the past they and their ancestors prepared and brought barley beer and animal’s blood to the entrance of the cave for offerings to ancestral and nature spirits. This would explain the presence of serving vessels, such as bowls and plates in units at the front of the cave—TU3, 6, and 7. Two of the bowls are large with rim diameters of 30 and 38 cm. They may have served as communal eating bowls and/or storage vessels. One bowl was much smaller with only a 14-cm
Table 10  Lithic tools \((n = 54)\) recovered from Mota Cave Early Pottery period

| Unit          | Cal BP     | Utilized/modified flakes and blades | Broken utilized/modified flakes and blades | Total informal tools | Scraper | Broken scraper | Burin | Awl | Geometrics | Backed flakes | Backed blades | Broken geometrics and backed blades/ flakes | Core chopper | Unifacial point | Unifacial point preform | Total formal tools |
|---------------|------------|------------------------------------|-------------------------------------------|----------------------|---------|---------------|-------|-----|------------|--------------|--------------|--------------------------------------------|--------------|----------------|------------------------|------------------|
| Unit 2, L2    | 1700 ± 30  | 1                                  | 4                                          | 5                    | 1       | 0             | 0     | 0   | 1          | 0             | 1            | 0                          | 0             | 0              | 0                      | 3                |
| Unit 2, L3    | 2370 ± 30  | 0                                  | 2                                          | 2                    | 0       | 1             | 0     | 0   | 2          | 0             | 1            | 0                          | 0             | 0              | 0                      | 4                |
| Unit 2, L4    | 1620 ± 30  | 2                                  | 0                                          | 2                    | 1       | 0             | 0     | 1   | 2          | 1             | 0            | 1                          | 0             | 0              | 0                      | 5                |
| Unit 5, L4    | 1620 ± 30  | 2                                  | 0                                          | 2                    | 2       | 1             | 0     | 4   | 1          | 1             | 0            | 2                          | 0             | 0              | 0                      | 12               |
| Unit 5, L5    | 1620 ± 30  | 2                                  | 0                                          | 2                    | 2       | 1             | 0     | 4   | 1          | 1             | 0            | 2                          | 0             | 0              | 0                      | 12               |
| Total         | 6          | 10                                 | 16                                         | 8                    | 3       | 1             | 1     | 10  | 4          | 6             | 3            | 0                          | 1             | 0              | 0                      | 38               |
diameter. One large plate with a 50-cm diameter could have served as a *bache*, a form that is used in ethno- graphic context to cook *injera*, a sourdough-risen flatbread made out of teff flour (Tables 18 and 19; Arthur 2006). The pottery, based on wear and pitting found on the interior of the vessels, also shows that foods containing dairy products and/or beer were being utilized. In addition, the exteriors of the vessels have a severe wear pattern suggesting that the pottery was intensely used for serving and/or storage of foods and may have been moved around (Table 14). Bovid spp., sheep, and hare and carbonized parenchyma (tuber fragments) were also identified in this part of the cave along with scrapers, burins, geometrics, and utilized and modi- fied flakes (Tables 15 and 20). This occupation level indicates that people were engaging less in lithic tech- nology (394 lithics, density of 0.0002 per cm$^3$) com- pared to earlier periods.

Elders also stated that they used the cave in times of war to hide. While annual ritual hunting is acknowledged prior to the late twentieth century, mostly large bovids were favored in those hunting events. Therefore, the evidence of smaller animals such as small- and medium-sized wild bovids, hare, and cane rats in the cave may indicate need-based consumption while the people were in hiding and in distress. Carbonized parenchyma (tuber) fragments (unit 3, L2) also indicate the consumption of tubers during this time (Table 21). Unit 4 contained the densest amount of artifacts for this time period. These included burned wood, burned rock, human teeth, ce- ramics, and stone tools. An informal hearth feature, comprising of an ashy deposit with burned rocks and gravels but without a formal circle of stones, was found in this portion of the cave. Charcoal recovered from this context dates the hearth to 300 BP. One large jar rim with a 16-cm diameter rim was also found in this location. This could have served as a cooking and/or storage vessel. On the basis of interior food residue ($n = 4$), wear ($n = 6$), exterior carbon deposition ($n = 2$), and pitting ($n = 2$), the use- alteration of the body sherds indicates cooking and/or storage as the predominant functions of the vessels (Table 14). In addition, microlithic backed crescents and other geometrics were found near this hearth feature showing that the occupants also engaged with cutting-related activities (Fig. 15). Scrapers, awls, and a burin were recovered in this area, indicating hide processing and/or replacing of scrapers in hafts. However, most of the scrapers had multiple-use edges suggesting that people were likely using an open haft with rope or string rather than mastic to secure their scrapers, as was the case during the Pre-Pottery occupation. Half of the scrapers in this area are spurred suggesting the presence of novice tool users (Arthur 2018, p. 166–169).

Tuwatey Cave (Site GB15)

Tuwatey Cave was occupied between ca. 5520 and 300 BP (Table 1). However, the archaeological
|                  | Cal BP | Obsidian debitage | Basalt debitage | Chert/chalcedony debitage | Quartz debitage | UID debitage | Obsidian formal tool | Chert/chalcedony formal tool | Quartz formal tool | Basalt formal tool |
|------------------|--------|-------------------|-----------------|---------------------------|-----------------|--------------|---------------------|----------------------------|------------------|------------------|
| Unit 2, L2       | 1700 ± 30 | 34                | 0               | 5                         | 0               | 0            | 3                   | 0                         | 0                | 0                |
| Unit 2, L3 hearth| 2370 ± 30 | 65                | 0               | 11                        | 0               | 0            | 4                   | 0                         | 0                | 0                |
| Unit 2, L4 hearth| 188     | 0                 | 0               | 9                         | 0               | 0            | 8                   | 0                         | 0                | 0                |
| Unit 1, L4 ash   | 0       | 0                 | 0               | 0                         | 0               | 0            | 1                   | 0                         | 0                | 0                |
| Unit 5, L4 hearth| 1620 ± 30 | 53                | 0               | 2                         | 0               | 0            | 7                   | 0                         | 0                | 0                |
| Unit 5, L5 hearth| 245     | 0                 | 0               | 2                         | 0               | 0            | 11                  | 1                         | 0                | 0                |
| Unit 5, L4 feature| 13     | 0                 | 0               | 7                         | 0               | 0            | 0                   | 0                         | 0                | 0                |
| Total            | 598     | 0                 | 36              | 0                         | 0               | 34           | 1                   | 0                         | 0                | 0                |

|                  | Obsidian modified/ utilized | Basalt modified/ utilized | Chert/chalcedony modified/ utilized | Obsidian core | Chert core | Basalt core | Obsidian nodule | Chert/chalcedony nodule | Quartz nodule |
|------------------|----------------------------|---------------------------|-------------------------------|-------------|-----------|-------------|----------------|------------------------|---------------|
| Unit 2, L2       | 4                          | 0                         | 1                             | 0           | 0         | 0           | 0              | 0                      | 0             |
| Unit 2, L3 hearth| 2                          | 0                         | 0                             | 1           | 0         | 0           | 0              | 0                      | 0             |
| Unit 2, L4 hearth| 5                          | 0                         | 0                             | 3           | 0         | 0           | 0              | 0                      | 0             |
| Unit 1, L4 ash   | 0                          | 0                         | 0                             | 0           | 0         | 0           | 0              | 0                      | 0             |
| Unit 5, L4 hearth| 0                          | 0                         | 0                             | 2           | 0         | 0           | 0              | 0                      | 0             |
| Unit 5, L5 hearth| 2                          | 0                         | 0                             | 4           | 0         | 0           | 0              | 0                      | 0             |
| Unit 5, L4 feature| 2                        | 0                         | 0                             | 0           | 0         | 0           | 0              | 0                      | 0             |
| Total            | 13                         | 0                         | 1                             | 10          | 0         | 0           | 0              | 0                      | 0             |
sequence suggests that the activities in Tuwatey were much different than those at Mota. Tuwatey overlooks the Kulano River, a major tributary of the Omo River and is located 2,037 m above sea level on the eastern escarpment of the Boreda Gamo Highlands. This cave was documented in 2007 with the assistance of Gamo elders. Tuwatey literally means "immature child excited to come out."

At Tuwatey, elders made ritual offerings when a new child was born, and in the Historic period, their ancestors hid there during war and insecurity.

We excavated parts of the cave during the 2007, 2011, and 2012 field seasons. The cave possesses a main chamber measuring 15 m in width and 20 m in depth (Figs. 16 and 17). Eleven square meters of excavation in 2007 and 2012 has revealed extensive hearth features in several areas of the central chamber including units TU1 (L3–4), TU2 (L4–5), J5 (L6), and M3 (L5–6). The hearth features were not associated with patterned rock outlines as was found at Mota Cave but contained extensive amounts of ash and charcoal. Geochemical analysis of Tuwatey indicates that people were intensively using fire in the cave. There are laminated clays in the upper levels of the cave, followed by an accumulation and diagenesis of bat guano which overlays abundant areas of dense charcoal and ash indicating a heavy use of the site for making fireplaces. These sediments continue to be interspersed with guano and charcoal lenses down to the bedrock (Tables 22 and 23 and Figs. 18 and 19). Analysis of microliminology reveals that there are fires associated with the cultural facies, all indicating that individuals were modifying the cave by (a) burning materials in situ, (b) reworking and/or trampling on fire remains, (c) cleaning/sweeping or removal of materials, (d) using wood in a limited amount to fuel fires, (e) using an abundant amount of grasses, and (f) depositing organic remnants (bones, etc.) in secondary phosphates.

Ground-penetrating radar (GPR) using a 400-MHz antenna (Fig. 20) indicated a bowl-like bedrock floor in the cave and revealed potential hearth features prior to excavations. A grid of 400-MHz reflection profiles was

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### Table 13 Faunal results from Mota Cave during the Early Pottery period

| Mota Cave GB20 unit | Tu 3 | Tu 4 | Tu 5 | Tu 7 | ST 2 | ST 2 | ST 2 |
|---------------------|------|------|------|------|------|------|------|
| Level               | Lv 4 | Lv 4 | Lv 4 | Lv 2 | Lv 2 | Lv 3 | Lv 4 |
| Large bovid         | 1    | 1    |
| Cattle (Bos taurus) |      |      |
| Sheep (Ovis aries)/goat (Capra hircus) |      |
| Bushbuck (Tragelaphus scriptus) | 2    | 2    |
| Middle-sized bovid  | 2    | 1    | 4    |
| Klipspringer (Oreotragus oreotragus) | 1    | 2    |
| Small-sized bovid   | 8    | 1    | 5    | 1    | 4    |
| Suid                | 1    |      |      |      |      |      | 4    |
| Middle-sized mammal | 4    |      |      |      |      |      |      |
| Baboon (Papio anubis) | 1    |
| Cercopithecidae     |      |      |      |      |      |      |      |
| Aardvarks (Orycteropus afer) | 1    |
| Hyrax (Procavia capensis) |      | 2    |
| Hare (Lepus capensis) | 3    |
| Cane rat (Thryonomys swinderianus) | 2    | 1    | 5    |
| Small mammal        | 3    |      |      |      |      |      |      |
| Rodent              | 1    | 2    | 3    | 4    |
| Bat                 | 2    |      |      |      |      |      |      |
| Amphibian           |      | 2    |      |      |      |      | 4    |
| Crab                |      |      |      |      |      |      |      |
collected on the generally flat floor of the cave with lines spaced at 50 cm, and reflections recorded to 35 nanoseconds (ns), which is about 1.1 m depth in two-way travel time (Conyers 2013). Maximum radar energy penetration was about 25 ns (80 cm), with distinct attenuation of energy within the thicker sediment package at about 20 ns (60 cm) (Fig. 21). The sediment layers in the middle of the cave are generally horizontal (Fig. 22). There are very distinct areas of rock fall in the front and rear of the cave as well as on its sides where the ceiling is low, creating a “bowl” sediment package within the cave. The sediments within this bedrock-bounded bowl

| Site | Unit level | Number | Interior treatment food residue | Wear | Pitting | Exterior treatment carbon | Wear | Pitting | Date (cal BP) |
|------|------------|--------|---------------------------------|------|---------|---------------------------|------|---------|--------------|
| Mota | ST2-2      | 3      | 3                               | 8    | 1700 ± 130 |
|      | ST2-3      | 1      | 2                               | 3    | 2370 ± 30  |
|      | ST2-4      |        | 1                               | 1    |          |
|      | TU3-1      |        | 1                               | 1    | 30 ± 30   |
|      | TU3-2      |        | 1                               | 1    | 30 ± 30   |
|      | TU3-3      |        | 1                               | 1    | 4         |
|      | TU3-4      |        | 1                               |      |           |
|      | TU4-1      |        | 1                               |      |           |
|      | TU4-2      |        | 1                               |      |           |
|      | TU4-3      | 4      | 6                               | 1    | 310 ± 30  |
|      | TU4-4      |        | 1                               | 1    | 3300 ± 30 |
|      | TU5-2      | 1      | 1                               | 1    |           |
|      | TU5-3      | 3      | 1                               | 1    |           |
|      | TU3, 5, 6-1| 1      | 1                               |      |           |
|      | TU7-1      |        | 1                               |      |           |
| Tuwatey | TU1-1      | 1      | 1                               | 1    |           |
|      | TU1-4      | 1      | 1                               | 1    |           |
|      | TU2-1      | 1      | 1                               |      |           |
|      | TU2-2      |        | 1                               |      |           |
|      | TU2-3      |        | 1                               | 1    |           |
|      | C7-1       |        | 1                               | 2    |           |
|      | C7-3       | 1      | 1                               | 1    |           |
|      | C7-5       | 1      | 1                               |      |           |
|      | C8-2       | 2      | 1                               |      |           |
|      | D8-1       | 1      | 1                               |      |           |
|      | M3-3       | 1      | 1                               |      |           |
|      | M3-5       | 1      | 1                               |      |           |
|      | M3-6       | 1      | 1                               | 1900 ± 30 |
|      | N3-4       | 2      | 1 spalling| 1     |           |
|      | O2-6       |        | 1                               | 5    | 1810 ± 30 |
|      | O2-8       |        | 1                               |      |           |
| Gulo | ST1-1      | 2      | 1                               |      |           |
|      | ST1-4      | 1      | 1                               |      |           |
### Table 15  Lithic tools (n = 109) recovered from Mota Cave Historic period

|       | Cal BP | Utilized/modified flakes and blades whole | Utilized/modified flakes and blades broken | Total informal tools | Scraper | Scraper fragment | Burin | Awl | Geometrics | Backed flakes | Backed blade | Geometrics and backed blades/ flakes broken | Core chopper | Unifacial point | Unifacial point preform | Total formal tools |
|-------|--------|------------------------------------------|------------------------------------------|---------------------|---------|-----------------|-------|-----|-------------|---------------|-------------|-------------------------------------------|--------------|----------------|-----------------------|------------------|
|       |        |                                          |                                          |                     |         |                 |       |     |             |               |             |                                           |              |                |                       |                  |
| Unit 1, L1 | 0     | 0                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Unit 1, L2 | 0     | 0                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Unit 1, L3 | 1     | 2                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Unit 2, L1 | 0     | 1                                         | 1                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 2                |
| Unit 3, L1 | 0     | 1                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Unit 3, L2 | 330 ± 30 | 1                                      | 2                                         | 1                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 1                |
| Unit 3, L3 | 0     | 0                                         | 0                                         | 0                   | 0       | 0               | 1     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 1                |
| Unit 4, L1 | 0     | 0                                         | 1                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 1             | 0               | 0                       | 2                |
| Unit 4, L2 | 7     | 3                                         | 5                                         | 0                   | 0       | 0               | 1     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 15               |
| Unit 4, L3 | 300 ± 30 | 6                                      | 4                                         | 5                   | 0       | 0               | 3     | 4   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 26               |
| Unit 5, L1 | 0     | 0                                         | 1                                         | 0                   | 0       | 0               | 9     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 10               |
| Unit 5, L2 | 1     | 1                                         | 1                                         | 0                   | 1       | 0               | 3     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 5                |
| Unit 5, L3 | 2     | 4                                         | 2                                         | 0                   | 0       | 0               | 4     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 9                |
| Unit 6, L1 | 0     | 0                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Unit 6, L2 | 0     | 1                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Unit 6, L3 | 0     | 0                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Unit 6, L4 | 0     | 0                                         | 0                                         | 0                   | 0       | 0               | 0     | 0   | 0           | 0             | 0           | 0                                         | 0             | 0               | 0                       | 0                |
| Total   | 18    | 19                                        | 37                                        | 17                  | 2       | 3               | 28    | 1   | 10          | 8             | 1           | 2                                         | 0             | 0               | 0                       | 72               |
exhibit a number of subtle concave upward reflections that are likely hearths, but could be other depressions of unknown origin (Fig. 21).

The shapes of hearths in GPR reflection profiles have been discovered in cave sediments elsewhere (Conyers 2016). When all GPR reflection profiles are resampled and a three-dimensional volume of reflections is created, the features and sediment package reflections can be sliced into horizontal packages and then visualized (Conyers 2013). The individual depth slices show high areas on the margins of the cave floor caused by rockfall, and there is sediment package within the bedrock “bowl” (Fig. 23). Within this sediment package, low amplitude reflections are interpreted as concentrations of hearths. Excavations and soil micromorphological studies in Tuwatey Cave subsequently revealed that the inhabitants constructed multiple hearth features (i.e., units TU1 L4–5, TU2 L4–5, J5 L6, and M3 L5–6), providing support for extensive controlled use of fire in several areas of the cave. Thirteen radiocarbon AMS dates for Tuwatey range from the Pre-Pottery period (5520–3230 cal BP)—units 1, 2, C7, J5 L4–10, two hearth features; Early Pottery period (1925–1820 cal BP)—M3, N2, N3, O2, and O3 L4–11, one possible hearth; and Historic period (492–122 cal BP)—all units, levels 1–3 (Table 1).

### Table 16 Lithic cores and debitage (n = 281) recovered from Mota Cave Historic period

| Cal BP | Cores | Bipolar core | Bipolar core fragment | Broken core fragment | Flakes | Blades | Angular waste | Resharpening | Broken debitage |
|--------|-------|--------------|-----------------------|----------------------|--------|--------|-------------|--------------|----------------|
| Unit 1, L1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, L2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, L3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Unit 2, L1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 1 |
| Unit 3, L1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 3, L2 | 330 ± 30 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 3 |
| Unit 3, L3 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 1 | 8 |
| Unit 4, L1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Unit 4, L2 | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 4 | 2 |
| Unit 4, L3 | 300 ± 30 | 2 | 0 | 0 | 0 | 11 | 0 | 54 | 2 |
| Unit 5, L1 | 0 | 0 | 0 | 0 | 16 | 1 | 1 | 1 | 22 |
| Unit 5, L2 | 0 | 0 | 0 | 0 | 3 | 0 | 4 | 0 | 1 |
| Unit 5, L3 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 4 | 5 |
| Unit 6, L1 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 8 |
| Unit 6, L2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| Unit 6, L3 | 0 | 0 | 0 | 0 | 5 | 1 | 2 | 0 | 0 |
| Unit 6, L4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Total | 5 | 0 | 0 | 0 | 1 | 61 | 2 | 72 | 16 |

**Pre-Pottery Period and Earliest Occupation (5520 to 3230 Cal BP)**

Hunters and gatherers occupied Tuwatey Cave ca. 5520 cal BP making this the earliest Holocene occupation in the Gamo Highlands. Inhabitants seemed to have used the cave for temporary shelter to sleep and a place to keep warm. Hence, they constructed multiple hearths and left very few material remains behind. The hunters and gatherers did not use the cave as a place to produce materials or to cook a large amount of foods, as the frequency and density of artifacts (0.0000068 lithic per cm³) and ecofacts are not as prevalent as in Mota Cave. Furthermore, artifacts are widely scattered and only occur in units 1, 2, C7, and J5 located in the center of the cave. There is no evidence of domesticated animals or plants during this period. The majority of the faunal materials are unidentified to species, but they are either large or small bovids (Table 24). The deposits from this period consist of a large amount of ash and charcoal with only one definitive hearth (unit J5) associated with one side scraper, one resharpening flake, and one chopper core (see Table 24). In unit 1, level 4–5, a second possible hearth yielded no
| Table 17 | Lithic raw material types recovered from Mota Cave Historic period |
|----------|---------------------------------------------------------------|
|          | Cal BP | Obsidian debitage | Chert/chalcedony debitage | Quartz debitage | UID | Obsidian formal tool | Chert/chalcedony formal tool | Quartz formal tool | Basalt formal tool |
|          |        |                   |                             |                |     |                       |                             |                  |                    |
| Unit 1, L1 | 0     | 0                 | 0                            | 0               | 0   | 0                      | 0                            | 0                 | 0                  |
| Unit 1, L2 | 0     | 0                 | 0                            | 0               | 0   | 0                      | 0                            | 0                 | 0                  |
| Unit 1, L3 | 1     | 1                 | 1                            | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 2, L1 | 1     | 1                 | 1                            | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 3, L1 | 330 ± 30 | 14              | 1                             | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 3, L2 | 300 ± 30 | 13              | 1                             | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 3, L3 | 300 ± 30 | 25              | 1                             | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 4, L1 | 1     | 1                 | 1                            | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 4, L2 | 10    | 1                | 1                            | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 4, L3 | 0     | 0                 | 0                            | 0               | 0   | 0                      | 0                            | 0                 | 0                  |
| Unit 5, L1 | 2     | 2                 | 2                            | 2               | 2   | 2                      | 2                            | 2                 | 2                  |
| Unit 5, L2 | 2     | 2                 | 2                            | 2               | 2   | 2                      | 2                            | 2                 | 2                  |
| Unit 5, L3 | 0     | 0                 | 0                            | 0               | 0   | 0                      | 0                            | 0                 | 0                  |
| Unit 6, L1 | 7     | 7                 | 7                            | 7               | 7   | 7                      | 7                            | 7                 | 7                  |
| Unit 6, L2 | 3     | 3                 | 3                            | 3               | 3   | 3                      | 3                            | 3                 | 3                  |
| Unit 6, L3 | 0     | 0                 | 0                            | 0               | 0   | 0                      | 0                            | 0                 | 0                  |
| Unit 6, L4 | 1     | 1                 | 1                            | 1               | 1   | 1                      | 1                            | 1                 | 1                  |
| Unit 7, L1 | 0     | 0                 | 0                            | 0               | 0   | 0                      | 0                            | 0                 | 0                  |
| Unit 7, L2 | 0     | 0                 | 0                            | 0               | 0   | 0                      | 0                            | 0                 | 0                  |
| Total     | 222   | 13                | 22                           | 17              | 1   | 60                     | 6                            | 1                 | 2                  |
Overall, the earliest people at Tuwatey left few lithic artifacts. These consisted of one obsidian side scraper, four utilized/modified flakes, one obsidian awl, one obsidian geometric, three backed tools (two obsidian and one basalt), and 13 pieces of debitage (Tables 25 and 26). All of these show that limited activities relating to sewing, cutting, and scraping took place in the cave.

**Early Pottery Period and Middle Occupation (1920–1820 Cal BP)**

The earliest pottery at Tuwatey occurs later than at Mota and is associated with a hunting and gathering assemblage in the northeast corner of the cave with no specific feature. Pottery from Tuwatey Cave indicates that by 1925 BP potters were utilizing a range of surface treatments, polishing, burnishing, smudging, and red slip on both the interior and exterior surfaces (Table 9). While there is one sherd that has an associated date of 6000 BP, it seems most likely that this sherd is in this level due to some bioturbation and it is unlikely that people were using pottery at this early date. Most pottery, fauna, and lithics were concentrated in the back of the cave in units N and M, with the heaviest concentrations in units O2 and O3. A possible hearth in unit M L5–6 consists of obsidian, basalt, chert, and quartz debitage and one obsidian scraper, two obsidian geometrics, and three obsidian modified flakes. There are also ceramics, a large bovid element, and two crab pincers (Tables 27, 28, and 29). Unlike the earlier occupation, the presence of chert and obsidian radial and pyramidal cores in the back units of the cave suggests that tools may have been made at the site. However, all of the debitage but four flakes are obsidian. So it seems that if the two chert cores were worked at the site, the knappers were very experienced and left little debitage, or the debitage was cast elsewhere at the site yet unexcavated, or discarded outside the site. All the formal and informal tools were made of obsidian, so chert core reduction at the site seems unlikely.

**The Historic Period and Last Occupation (492–122 Cal BP)**

Interviews with elders suggest a ritual use for the cave as well as use for protection during war during the Historic period. Compact floors were identified in the front and the center of the cave. Compact floors in units C7 and C8 (L1–3) near the front of the cave contained an
Table 18  Pottery surface treatment description from Mota, Tuwatey, and Gulo caves from the Historic period

| Site | Unit level | Number | Interior treatment | Burnish | Plain | Smudge | Red slip | Exterior treatment | Burnish | Plain | Smudge | Red slip | C14 cal BP |
|------|------------|--------|--------------------|---------|-------|--------|----------|-------------------|---------|-------|--------|----------|------------|
| Mota |            |        |                    |         |       |        |          |                   |         |       |        |          |            |
| ST2-1|            | 2      | 1                  | 1       | 1     | 1      | 1        | 1                 | 1       | 1     | 1      | 1         |            |
| TU3-1|            | 2      |                    |         |       |        |          |                   |         |       |        |           |            |
| TU3-2|            | 5      | 2                  | 3       | 2     | 3      | 1        | 1                 | 1       | 1     | 1      | 1         | 330 ± 30   |
| TU3-3|            | 12     | 9                  | 3       | 8     | 1      | 3        | 6                 | 6       | 6     | 2      |           |            |
| TU4-1|            | 3      | 2                  | 2       |       |        |          |                   | 3       | 2     | 2      |           |            |
| TU4-2|            | 9      | 1                  | 7       | 7     | 2      | 3        | 6                 | 7       |       | 3      |           |            |
| TU4-3|            | 38     | 33                 | 3       | 14    | 2      | 10       | 16                | 19      | 13    |        | 300 ± 30  |            |
| TU5-2|            | 4      | 3                  | 1       | 1     | 1      |          |                   | 2       | 1     | 1      |           |            |
| TU5-3|            | 10     | 8                  | 4       | 3     | 4      | 4        | 3                 | 3       | 3     | 1      |           |            |
| TU6-1|            | 1      | 1                  |         |       |        |          |                   |         |       |        |           |            |
| TU7-1|            | 2      | 1                  | 2       | 1     |        |          |                   | 1       | 1     | 1      | 1         |            |
| Tuwatey|           |        |                    |         |       |        |          |                   |         |       |        |           |            |
| 1-1  |            | 2      | 2                  |         | 2     | 2      |          |                   |         |       |        | 2         | 300 ± 30   |
| 1-3  |            | 2      | 2                  | 2       | 2     |        |          |                   |         |       |        | 2         |            |
| 2-1  |            | 1      | 1                  | 1       | 1     |        |          |                   |         |       |        | 1         |            |
| 2-2  |            | 2      | 2                  |         | 2     |        |          |                   |         |       |        | 1         |            |
| C7-1 |            | 3      | 3                  |         | 2     | 3      |          |                   |         |       |        | 2         |            |
| C7-2 |            | 1      | 1                  |         | 1     |        |          |                   |         |       |        | 1         |            |
| C7-3 |            | 1      | 1                  |         | 1     |        |          |                   |         |       |        | 1         |            |
| C8-1 |            | 15     | 12                 | 7       | 2     | 4      |          | 9                 | 12      | 2     |        |            |            |
| C8-2 |            | 2      | 2                  | 1       | 1     | 1      |          | 2                 |         |       |        |            |            |
| D8-1 |            | 5      | 5                  | 1       |       | 1      |          | 4                 |         |       |        |            |            |
| D8-2 |            | 11     | 10                 |         | 1     | 2      |          | 6                 |         |       |        |            |            |
| O3-1 |            | 1      | 1                  |         |       |        |          |                   |         |       |        |            |            |
| O3-2 |            | 1      |                    |         |       |        |          |                   |         |       |        |            |            |
| Gulo |            |        |                    |         |       |        |          |                   |         |       |        |            |            |
| ST1-Sur|          | 2      | 2                  |         | 2     | 2      |          |                   |         |       |        |            |            |
The abundance of ceramics, particularly jars, and half of the stone tools associated with this occupation include obsidian end and end-side scrapers, a modified flake, a geometric, and a backed blade (Tables 30 and 31). The adjacent unit D8 (L2–3) also produced many sherds, as well as a scraper and a backed blade. All four rims found in the upper levels are jar rims that have a polished and smudged surface treatment on both the exterior and interior (Tables 18 and 19). One jar has comb stamping (D8 L2) and the other has rippling (unit C8 L1). The rim sherds have only limited evidence of use-alteration attributes. There is occasional interior pitting and only one sherd has evidence of sooting (unit C8 L1). In this part of the cave, beginning around 492 cal BP, we find the first evidence that people were eating domesticated plants at Tuwatey, as suggested by five barley seeds (Hordeum vulgare). There are also three indeterminate cereal seeds from level 7 in unit C7 associated with the compact floor. While this level has an Early Pre-Pottery date (Table 1), we have directly dated one of the five barley seeds to ca. 1416–1440 AD, an indication that the barley seed was likely moved to this level by bioturbation. Out of 28 flotation samples studied, only ten samples produced some identifiable plant remains, and from these, only 28 identifiable specimens were found. This is extremely sparse in comparative terms and tends to suggest that plant-based activities and/or context for charring of waste were only occasional within this cave. Nevertheless, the identified remains include barley, wheat, sorghum, finger millet, cotton, probably fruits of a Rhamnus shrub, and a few fragments of possible tubers (i.e., charred parenchyma tissue). Two barley grains and one cottonseed were subjected to AMS radiocarbon dating, and the dates fall between the late seventeenth century and early twentieth century AD (Tables 32 and 33).

A second compact surface in the center of the cave was identified at J5, level 2. One backed blade and one flake were found here, but fauna and ceramics were absent. Parts of a wood string instrument were recovered from nearby unit 2 (L1 and 2) along with flakes, angular waste, utilized flakes and blade, and two cores (L1–3) as well as large bovid, suid, rodent, and crab remains (Table 34). In addition, a barley seed and a cottonseed (Gossypium sp.), both found in unit 1, level 2, date to 172 and 122 cal BP, respectively (Fig. 24). At the back of the cave, only a few artifacts were found in all the units and levels. For example, two sherds were present in O3 L1–2, with one sherd having burnished surface and red slip on the interior and a burnished and smudged exterior. The other sherd has only polish on the exterior and interior. There is no evidence of use-alteration on either sherd. Also, a piece of iron slag and a few pieces of debitage (N3 L1) and two small ground stones (with worn surface), as well as rodent and crab remains (M3 L3), were recovered. (Table 35). No domesticated fauna has been recovered from Tuwatey Cave.

| Table 19 Pottery rim descriptions from Mota and Tuwatey caves |
|-----------------------------------------------------------|
| Site unit level | Rim type | Type of rim | Rim thickness (mm) | Radius (cm) | Diameter (cm) | Percent of rim | Temper size (mm) | Temper type | Temper composition (%) | Date (cal BP) |
|----------------|----------|-------------|------------------|-----------|-------------|---------------|----------------|-------------|----------------------|-------------|
| Mota           |          |             |                  |           |             |               |                |             |                      |             |
| Surface        | Jar      | Direct      | 7.2              | 6         | 12          | 16            | 1/16–2.0       | Quartz, basalt| 15                   |             |
| ST2-3          | Unidentified | Direct    | 12.7             | –         | –           | –             | 1/16–1.0       | Quartz, basalt| 5         | 2370 ± 30            |             |
| TU3-1          | Bowl     | Direct      | 12.9             | 15        | 30          | 3             | 1/16–2.0       | Quartz, basalt| 20                   |             |
| TU3-1          | Plate    | Convex      | 15.8             | 25        | 50          | 2             | 1/16–2.0       | Quartz, basalt| 15                   |             |
| TU4-3          | Jar      | Direct      | 7.7              | 8         | 16          | 6             | 1/16–2.0       | Quartz, basalt| 10                   | 300 ± 30    |
| TU6-1          | Bowl     | Convex      | 5.9              | 7         | 14          | 9             | 1/16–1/4       | Quartz, basalt| 40                   |             |
| TU7-1          | Bowl     | Direct      | 12.8             | 19        | 38          | 3             | 1/16–2.0       | Quartz, basalt| 30                   |             |
| Tuwatey        |          |             |                  |           |             |               |                |             |                      |             |
| C7-1           | Jar      | Direct      | 5.9              | 7         | 14          | 9             | 1/16–1/4       | Quartz, basalt| 3         |             |             |
| C8-1           | Jar      | –           | –                | –         | –           | –             | 1/16–2.0       | Quartz, basalt| 10                   |             |
| C8-1           | Jar      | –           | –                | –         | –           | –             | 1/16–2.0       | Quartz, basalt| 40                   |             |
| D8-2           | Jar      | Direct      | 7.3              | 4         | 8           | 12            | 1/16–1/4       | Quartz, basalt| 10                   |             |
Table 20 Faunal results from Mota Cave during the Historic period

| Mota Cave GB20 unit Level | ST 1 Lv 2 | ST 1 Lv 3 | Tu 3 Lv 2 | Tu 3 Lv 3 | Tu 4 Lv 1 | Tu 4 Lv 2 | Tu 4 Lv 3 | Tu 5 Lv 1 | Tu 5 Lv 2 | Tu 6 Lv 1 | Tu 6 Lv 2 | Tu 6 Lv 3 |
|---------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Human \((Homo sapiens)\)   | 2         |           |           |           |           |           |           |           |           |           |           |           |
| Large bovid               | 1 1       | 3 3       |           |           |           |           |           |           |           |           |           |           |
| Cattle \((Bos taurus)\)   | 1         |           |           |           |           |           |           |           |           |           |           |           |
| Sheep \((Ovis aries)/goat\ (\(Capra hircus\)) | 3 1 1 1 1 |           |           |           |           |           |           |           |           |           |           |           |
| Middle-sized bovid        | 1         | 2 1 1 1   |           |           |           |           |           |           |           |           |           |           |
| Small-sized bovid         |           | 1 3 3 2   |           |           |           |           |           |           |           |           |           |           |
| Suid                      |           | 1 2 12    |           |           |           |           |           |           |           |           |           |           |
| Middle-sized mammal       | 1         | 1 5 4 3   |           |           |           |           |           |           |           |           |           |           |
| Baboon \((Papio anubis)\) |           |           |           |           |           |           |           |           |           |           |           |           |
| Hyrax \((Procavia capensis)\) |           |           |           |           |           |           |           |           |           |           |           |           |
| Hare \((Lepus capensis)\) |           |           |           |           |           |           |           |           |           |           |           | 2         |
| Cane rat \((Thryonomys swinderianus)\) | 2 1 |           |           |           |           |           |           |           |           |           |           |           |
| Small mammal              |           | 3         |           |           |           |           |           |           |           |           |           |           |
| Rodent                    | 5 5 1 1 5 |           |           |           |           |           |           |           |           |           |           |           |
| Crab                      | 2 2 1     |           |           |           |           |           |           |           |           |           |           |           |

Gulo Cave (Site GB17)

Gulo Cave, situated at an elevation of 2,254 m above sea level, was occupied from 5380 to 1690 cal BP (Table 1) indicating it is contemporary with the Pre-Pottery and Early Pottery periods at Mota and Tuwatey. The cave is located on the eastern escarpment of the Gamo Highlands facing the Rift Valley lakes. Gulo Cave is approximately 18 m in width and 7.5 m in depth. A preliminary shovel test, 75 cm wide, was placed near the entrance of the cave, just within the drip line (Fig. 25). The stratigraphy revealed a series of guano and phosphatized layers, 20 cm below the surface (Table 36 and Fig. 26). In the deepest deposits of Gulo Cave dating to 5380 BP, we recovered only one piece of chert angular waste. The richest deposit was level 4 dating to ca. 2020 BP, which included 20 pieces of chert angular waste and four ceramic body sherds (Table 9) dating to ca. 2250 BP. In the upper levels, dating to ca. 1600 BP, we recovered two sherds, two obsidian blades, and two pieces of chert angular waste, as well as three fauna elements (one large bovid and two unidentified elements), but no floral material was found. The preliminary testing of Gulo suggests that, with expanded excavations, it has potential for revealing further information about the Pre-Pottery and Early Pottery periods of the Gamo Highlands and the transition to food production.

Table 21 Archaeobotanical results from Mota Cave

| Mota Cave GB20 unit Level | St 2 Lv 6 | St 2 Lv 3 | Tu 3 Lv 2 | Tu 3 Lv 4 | Tu 4 Lv 4 | Tu 4 Lv 5 | Tu 4 Lv 3 | Tu 5 Lv 4 | Tu 5 Lv 3 |
|---------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Sample # (SS)             | 6 3       | 107 109   | 113 115   | 113 117   |           |           |           |           |           |
| \(Hordeum vulgare\)       | 1         |           |           |           |           |           |           |           |           |
| Parenchyma fragments (tubers) | 1 2 2     |           |           |           |           |           |           |           |           |
| Indeterminate seed/fragment | 1 1       |           |           |           |           |           |           |           |           |
| Large indeterminate legume |           |           |           |           |           |           |           |           |           |
| Total plant macroremains  | 1 2 2 1 2 0 1 1 |           |           |           |           |           |           |           |           |
| Terrestrial mollusk       | 1 x       |           |           |           |           |           |           |           |           |
| Dung fragments             | x x       |           |           |           |           |           |           |           |           |

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However, due to the scant information we currently have about the site, it is not included in the comparative discussion below.

Gamo Boreda Intersite Diversity

Mota and Tuwatey caves were occupied during three contemporary time periods, which provide evidence for the local transition to food production: a Pre-Pottery period ca. 5500–3200 BP, an Early Pottery period 2400–1600 BP, and a Historic period 500–120 BP. Although the Boreda cave sites are contemporaneous, in close proximity to one another (2.6 km), and share similar altitudinal and ecological zones, the archaeological assemblages and features of Tuwatey and Mota caves suggest that the caves were utilized very differently. Tuwatey is a much larger cave with burning of the entire cave floor, which may have been a reaction to bat occupation (layers of bat guano). The substantial bat guano deposits in Tuwatey suggest phases of prolonged abandonment of the cave. In addition, there is evidence of flooding during the Historic period in Tuwatey Cave. The density of artifacts at the two sites indicates that Mota was more intensively utilized than Tuwatey. The excavated volume from Tuwatey is three times greater than Mota, yet the number of artifacts recovered from Mota (3009 faunal elements, 120 pottery sherds, and 2431 lithics) is much greater than that found at Tuwatey (189 faunal elements, 72 sherds, and 99 lithics). The human remains from Mota indicate that the people were highland-adapted by 4500 BP, and while there may have been a stable population in the highlands, people could still have been highly mobile, occupying different cave sites seasonally, traveling to lowlands during dry seasons to take advantage of fish and wild game, or perhaps occupying yet unidentified open-air sites in the highlands.

The artifacts and features at the two sites suggest that Mota may have been utilized more for both everyday and ritual activities, and Tuwatey for short overnight stays. During all three periods at Mota, there is clear evidence that people were actively engaged in tool making, leatherworking, cutting and butchering, and cooking at formal hearths. In the Pre-Pottery period, Mota Cave was used as a mortuary site with a carefully constructed rock cairn laid over the Bayira burial. In contrast, the occupants of Tuwatey engaged in only a small amount of tool production and hide working in the early two periods at the site. Only in the later historic periods did people at Tuwatey leave behind compact floor structures. Tuwatey may have served as a place primarily for sleeping and the large amount of ash material may have been the result of possible preparation of the cave with grass fires to clear the cave of bats, porcupines, and/or hyenas so that people could sleep more soundly and safely.

A comparison of Mota and Tuwatey assemblages through time indicates that people produced and utilized primarily obsidian microlithic tools, particularly backed blades, about 5,000 years ago, but these began to dissipate in number ca. 2400 BP when the first pottery appeared. Subsistence in the region changed focus from a variety of small to large bovids and the addition of lake species to smaller montane bovids such as klipspringer and
bushbuck by 2400 BP. Then, ca. 1700 BP, domesticated animals entered the archaeological sequence.

**Pre-Pottery Period (5500–3200 BP)**

During the Pre-Pottery period, hunters, gatherers, and fisher people were utilizing the caves. At Mota, people hunted small to large bovids, klipspringers, suids, monkeys, and hares with obsidian unifacial points. Burnt bone indicates that they cooked their game at the site. In addition, a tilapia bone at Mota suggests connections with the Rift Valley lakes to the east. The skeletal remains of Bayira suggest that this individual and likely the general population of the area were highland adapted, lactose intolerant, and consumed C$_4$ indigenous African grasses (Gallego Llorente et al. 2015). In contrast, there was no direct evidence, in the form of microlithic points, for hunting at Tuwatey. At another site in southern Ethiopia about 60 km to the north, Mochena Borego, deposits dating ca. 4370 BP indicate hunting was concentrated on wild bovids, particularly African buffalo from the lowland plains (Lesur et al. 2007, 2014b) (Fig. 28). The authors hypothesize that these large animals may have been driven into the cul-de-sac at the end of the valley below the cave and then most likely were transported to the site already disarticulated, as carrying a carcass whole up the steep escarpment to the cave seems unlikely. In the far south in the lowland deposits of Yabello-4 dating prior to 4100 BP, people hunted Grevy’s zebra, African buffalo, and oryx (Hundie 2001, p. 193).

Knappers at both Mota and Tuwatey seemed to prefer obsidian for tool production and people utilized stone
Table 22  Description of Tuwatey Cave sediments from unit 1

| Layer | Soil structure | Texture fines | Gravels | Pebbles | Color | Ash | Charcoal | Note | Facies interpretation |
|-------|----------------|---------------|---------|---------|-------|-----|----------|------|-----------------------|
| 1     | Sands (L)      | ***AN         | 10YR    | *       | Finely laminated | Accumulation from past shovel test |
| 2a    | Loamy clays (FC)| *SA SR       | 6/6     | 10YR    | *** **** | Finely laminated with desiccation cracks | Deposition in standing water |
| 2b    | Weak poliedric structure | Loamy clays (FC) | *SA SR | 2/2     |                   | Mixing of anthropogenic fire-derived materials as well as deposition in standing water with some debris input |
| 3     | Sandy loam (FC)| *AN SA SR     | 10YR    | 5/2     | Phosphatic laminae | Phosphatization of guano-rich thin layers |
| 4     | Clayey loam (FC) | ****SA SR | 7.5YR   | *** **** | Abundant phosphatic nodules, fillings and concentrations | Mixing of anthropogenic fire-derived materials as well as debris accumulation by weathering with accumulation of guano |
| 6a    | Clayey loam (FC) | ****AN SA     | 7.5YR   | 5/3     | ** Abundant phosphatic nodules, fillings and concentrations | Debris accumulation by weathering with accumulation of guano |
| 6b    | Sandy loam (FC) | ****AN *****AN | 7.5YR   | 3/3     | ** Debris accumulation by weathering | Debris accumulation by weathering |
| 6c    | Sandy loam (FC) | ****AN *****AN | 7.5YR   | 3/3     | ** Debris accumulation by weathering | Debris accumulation by weathering |
| 5.1   | Sandy loam (L) | *AN           | 7.5YR   | 2.5/1   | ** Abundant phosphatic nodules, fillings and concentrations | Burning |
| 5.2   | Ash (L)        | *AN           | White   | *****   | ** Fire ash | Fire ash |
| 5.3   | Sandy (L)      | 7.5YR         | 5/1     | * **    | ** Burning | Burning |
| 5.4   | Loamy sands (L) | ***AN SA      | White   | *****   | * Mixing of anthropogenic fire-derived materials and natural sediments | Mixing of anthropogenic fire-derived materials and natural sediments |
| 5.5   | Ash (L)        | *AN           | White   | *****   | * Fire ash | Fire ash |
| 5.6   | Sandy loam (L) | **AN          | 7.5YR   | 7/1     | ** *** Mixing of anthropogenic fire-derived materials and natural sediments | Mixing of anthropogenic fire-derived materials and natural sediments |

Gravels: up to 5 cm. Pebbles > 5 cm

Roundness and shape: AN = angular, SA = subangular, SR = subrounded, F = flat. Compaction: L = loose, FC = fairly compact, VC = very compact

* = rare, ** = scarce, *** = common, **** = abundant, ***** = very abundant
| Layer | Soil structure | Texture fines | Gravels | Pebbles | Color | Ash | Charcoal | Note | Facies interpretation |
|-------|----------------|---------------|---------|---------|-------|-----|----------|------|-----------------------|
| 1     | Sands (L)      | ***AN         |         |         |       |     |          |      | Accumulation from past shovel test |
| 2a    | Loamy clays (FC) | 10YR 5/4     | ****    |         |       |     |          |      | Finely laminated         |
| 3     | Sandy loam (FC) | *AN           | 7.5YR 8/2 | **     |       |     |          |      | Phosphatic laminae       |
| 4     | Clayey loam (FC) | ****SA SR    | 7.5YR 3/3 | ***    | ***   |     |          |      | Abundant phosphatic nodules, fillings, and concentrations |
| 6d    | Sandy loam (FC) | ****AN SA     | ****AN SA | 7.5YR 5/3 | * |     |          |      | Anthropogenic material and debris accumulation by weathering with accumulation of guano |
| 6e    | Sandy loam (FC) | ****AN        | ****AN   | 7.5YR 3/3 | * |     |          |      | Abundant phosphatic nodules, fillings, and concentrations |
| 6f    | Sandy loam (FC) | ****AN        |         |         | 7.5YR 3/3 | * |     |          |      | Anthropogenic fired derived material and debris accumulation by weathering |
| 5.1   | Sandy loam (L)  | *AN           | 7.5YR 2.5/1 | * | ***** |     |          |      | Burning |
| 5.2   | Ash (L)         | *AN           | White    | ***** | ***   |     |          |      | Anthropogenic material mixed with fire ash |
| 5.3   | Sandy (L)       |               | 7.5YR 5/1 | * | ***   |     |          |      | Burning |

Gravels: up to 5 cm. Pebbles > 5 cm

Roundness and shape: AN = angular, SA = subangular, SR = subrounded, F = flat. Compaction: L = loose, FC = fairly compact, VC = very compact

* = rare, ** = scarce, *** = common, **** = abundant, ***** = very abundant
Fig. 18 Tuwatey Cave profile of unit 1

Fig. 19 Tuwatey Cave profile of unit 2
microliths for cutting, scraping, and sewing. Backed blades are particularly more prevalent than in the later periods at these sites, representing 18–25% of the formal tool assemblage. At Mota, the tools were likely associated with hide working, sewing, and meat and grass processing, as well as stone tool production. Large numbers of broken tools and flakes as well as scraper spurs suggest that novice toolmakers and users, perhaps youth, occupied Mota Cave with experienced and adult knappers. The absence of cores at Tuwatey indicates that people were not engaged in tool production, but a
few lithics suggest they may have been sewing, cutting, and scraping on a limited basis. The absence of broken tools and spurs at Tuwatey suggests that only experienced tool users worked at the site. At Mota, people preferred to make and use formal tools (83% of tools) fashioned from obsidian (94%). In contrast, 64% of the tools made in Tuwatey were formal and these were made mostly from obsidian (86%). Knappers at Mota and Tuwatey preferred obsidian for their unifacial points (11/11, 0/0), microliths (110/120, 2/4), scrapers (39/40, 1/1), and awls (10/14, 1/1). They also utilized basalt (Mota—four microliths, one awl; and Tuwatey—two microliths) and green and black/brown chert for tool production (Mota—six microliths, two awls, and one scraper). There is little published regional information available for comparison with the lithic assemblages of the Gamo Pre-Pottery Mid-Holocene sites. To the north of the Gamo region in Wolayta, at the site of Harurona, early deposits are dated to ca. 12,000 BP. Bachechi (2005) states that the obsidian geometric blade microlithic assemblage at Harurona resembles the end of the phase A of the Ethiopian Blade Tradition, which potentially dates from ca. 22000 BP to 3500 BP (Brandt 1980, 1982, 1986). At Mochena Borego, also in Wolayta, there is no detailed description of the Holocene lithics beyond the presence of obsidian segment (crescent) microliths dating to ca. 4370 BP (Gutherz et al. 2002). At Kumali in the Kafa region, Hildebrand et al. (2010) do not distinguish between Early and Late Holocene assemblages and instead indicate that the site’s deposits dating from ca. 9426 to 1665 BP exhibit a dominance of chert debitage and cores, though there was a preference by knappers to use obsidian to produce microliths, and basalt and chert for scrapers.

The human burial, ochre, and geodes at Mota and ochre at Tuwatey suggest ritual activity that appears to be unique for this time period in southern Ethiopia. Ochre may have been used to color hides or as part of body ornamentation. The most significant ritual activity was associated with the remains of Bayira. He was carefully buried in a fetus-like position under a cairn facing west, with a geode and calcite underneath his leg. Heat-treated white-gray-pink chalcedony debitage was

| Table 24 Faunal descriptions from Tuwatey during the Pre-Pottery period |
|---------------------------------|-----|-----|
| Tuwatey Cave GB 15 unit         | Unit 2 | Unit 2 |
| Level                          | 5    | 8    |
| Large bovid                    | 1    | 1    |
| Unit, level | Cal BP   | Utilized/modified flakes and blades whole | Scraper | Awl | Geometrics | Backed flake | Backed blade | Core chopper | Total formal tools | Flakes | Angular waste | Resharpening | Broken | Debitage |
|------------|---------|------------------------------------------|---------|-----|------------|--------------|--------------|-------------|------------------|--------|--------------|-------------|--------|----------|
| Unit 1, level 4 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 1, level 5 | 3230 ± 50 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 1, level 6 | 1       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 1                | 0      | 0            | 0           | 0      | 1        |
| Unit 1, level 7 | 4420 ± 40 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 1, level 8 | 5500 ± 40 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 1, level 9 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 1, level 10 | 0        | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 2, level 4 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 2, level 5 | 3230 ± 50 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 1           | 0      | 1        |
| Unit 2, level 6 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 2, level 7 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit 2, level 8 | 0       | 0                                        | 1       | 0   | 0          | 0            | 0            | 0           | 1                | 0      | 0            | 1           | 0      | 0        |
| Unit 2, level 9 | 4430 ± 40 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 1        |
| Unit 2, level 10 | 4330 ± 40 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit C7, level 4 | 1       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 1                | 2      | 0            | 0           | 0      | 0        |
| Unit C7, level 5 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit C7, level 6 | 5280 ± 30 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit C7, level 7 | 5280 ± 30 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit C7, level 8 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit C7, level 9 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit C7, level 10 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit J5, level 4 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit J5, level 5 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit J5, level 6 ash feature 1 | 0 | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Unit J5, level 7 ash feature 1 | 5030 ± 30 | 2                                        | 1       | 0   | 0          | 0            | 1            | 1           | 3                | 0      | 0            | 0           | 0      | 0        |
| Unit J5, level 8 | 0       | 0                                        | 0       | 0   | 0          | 0            | 1            | 0           | 1                | 0      | 0            | 0           | 0      | 0        |
| Unit J5, level 9 | 0       | 0                                        | 0       | 1   | 0          | 0            | 0            | 0           | 1                | 0      | 0            | 0           | 0      | 0        |
| Unit J5, level 10 | 0       | 0                                        | 0       | 0   | 0          | 0            | 0            | 0           | 0                | 0      | 0            | 0           | 0      | 0        |
| Total        | 4       | 1                                        | 1       | 1   | 1          | 2            | 1            | 7           | 6                | 3      | 1            | 3           | 13     | 14       |
Table 26 Lithic raw material types \((n = 24)\) Tuwatey during the Pre-Pottery period

| Unit, level | Cal BP | Obsidian debitage | Basalt debitage | Chert/chalcedony debitage | Quartz debitage | Obsidian formal tool | Basalt formal tool | Obsidian modified/utilized | Basalt modified/utilized | Chert modified/utilized |
|-------------|--------|-------------------|-----------------|---------------------------|----------------|---------------------|-------------------|----------------------------|--------------------------|-------------------------|
| Unit 1, level 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, level 5 | 3230 ± 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, level 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Unit 1, level 7 | 4420 ± 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, level 8 | 5500 ± 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, level 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, level 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 2, level 4 | 3230 ± 50 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 2, level 5 | 3230 ± 50 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 2, level 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 2, level 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 2, level 8 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Unit 2, level 9 | 4430 ± 40 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Unit 2, level 10 | 4330 ± 40 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit C7, level 4 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Unit C7, level 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit C7, level 6 | 5280 ± 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit C7, level 7 | 5280 ± 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit C7, level 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit C7, level 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit C7, level 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit J5, level 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit J5, level 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit J5, level 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit J5, level 7 ash feature 1 | 5030 ± 30 | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 1 | 0 |
| Unit J5, level 8 ash feature 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit J5, level 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit J5, level 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 5 | 1 | 3 | 1 | 6 | 1 | 2 | 1 | 1 | 1 |
Table 27  Lithic tools (n = 31) and debitage at Tuwatey during the Early Pottery period

| Unit, level | Cal BP    | Utilized/modified flakes and blades whole | Utilized/modified flakes and blades broken | Scraper | Awl | Geometrics | Total formal tools | Cores | Flakes | Angular waste | Resharpening | Broken | Total debitage |
|------------|----------|------------------------------------------|-------------------------------------------|---------|-----|------------|-------------------|-------|--------|---------------|--------------|--------|----------------|
| Unit M3, level 4 | 0        | 1                                        |                                           | 0       | 0   | 0          | 0                 | 1     | 1      | 0             | 0            | 2      |
| Unit M3, level 5 | 0        | 1                                        | 1                                          | 2       | 3   |             | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit M3, level 6 | 1920 ± 30| 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit M3, level 7 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit M3, level 8 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit M3, level 9 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit M3, level 10 | 0       | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N2, level 4 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N2, level 5 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N2, level 6 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N2, level 7 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N2, level 8 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N2, level 9 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N2, level 10 | 0      | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N3, level 4 | 1        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 1     | 0      | 0             | 0            | 0      |
| Unit N3, level 5 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N3, level 6 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 1      |
| Unit N3, level 7 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N3, level 8 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N3, level 9 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit N3, level 10 | 0       | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 1     | 0      | 0             | 0            | 0      |
| Unit O2, level 4 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit O2, level 5 | 0        | 0                                        | 0                                          | 1       | 1   |             | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit O2, level 6 | 0        | 0                                        | 0                                          | 0       | 1   | 1          | 1                 | 1     | 0      | 0             | 0            | 0      |
| Unit O2, level 7 | 0        | 0                                        | 0                                          | 1       | 1   | 2          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit O2, level 8 | 1820 ± 30| 0                                        | 0                                          | 1       | 0   | 1          | 1                 | 0     | 0      | 1             | 0            | 2      |
| Unit O2, level 9 | 0        | 2                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 0      |
| Unit O2, level 10 | 0      | 0                                        | 0                                          | 0       | 1   | 1          | 0                 | 0     | 0      | 0             | 0            | 1      |
| Unit O2, level 11 | 0       | 0                                        | 0                                          | 1       | 0   | 1          | 1                 | 2     | 0      | 0             | 0            | 2      |
| Unit O3, level 4 | 0        | 0                                        | 0                                          | 0       | 0   | 0          | 0                 | 0     | 0      | 0             | 0            | 1      |
also deposited in the burial. In addition, there was a large accumulation of debitage near his head and debitage was also scattered within the rock cairn placed above him. This debitage, consisting of obsidian and green and red chert, may have had ritual significance.

*Early Pottery Period (2400–1600 BP)*

Pottery appears later at Tuwatey than at Mota, but at both sites, people continued to hunt wild bovids while incorporating some domesticated crops and animals into their diet. During the Early Pottery period at Mota, most activities focused near two circular rock features that are associated with wild and domesticated animal remains, shells, pottery, and lithics. At Tuwatey, most activities occurred in the back of the cave and were not associated with any particular feature. In the Gamo Highlands, the use of pottery preceded the consumption of domesticated plants and later domesticated animals. The low frequency of domesticated plants and animals at these cave sites and the persistence of hunting suggests that the Gamo highlanders were not fully dependent on domesticates. At this time, people were either involved in low-scale production of pottery and food cultivation, or they traded for these items.

The pottery from the caves is highly fragmented and consists mostly of small sherds with surface treatments characterized by polished, burnished, smudged, and red slip. Red slip does not occur in the present-day Gamo assemblages or from the historic open-air sites that we have excavated. The early pottery from Mota has burnishing on some of the exterior and interior surfaces, but there is no burnishing found on any of the Tuwatey sherds. During the Early Pottery period, the majority of the Mota sherds are found at the front of the cave. In Tuwatey, the highest density of the pottery is found on the side of the cave’s central chamber, suggesting the storage of pottery or discarding of broken sherds along the cave wall. Comparing the Gamo pottery from other nearby regions such as the Nechisar Plains (Lesur et al. 2014b), Kafa (Hildebrand et al. 2010), and Yabello (Hundie 2001) indicates some similarities but also regional variations. The Nechisar Plain is located in the lowlands to the southeast of the Gamo Boreda region (Lesur et al. 2014b). The Nechisar pottery, consisting of only body sherds excavated from

| Unit, level | Cal BP | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|-------------|---------|---|---|---|---|---|---|---|---|---|---|---|
| O3, level 5 |         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O3, level 6 |         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O3, level 7 |         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O3, level 8 |         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O3, level 9 |         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O3, level 10|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total       |         | 1 | 4 | 3 | 1 | 4 | 8 | 3 | 5 | 2 | 1 | 7 | 15 |

**Table 27** (continued)
### Table 28: Lithic raw materials from Tuwatey during the Early Pottery period

| Cal BP       | Obsidian debitage | Basalt debitage | Chert/chalcedony debitage | Quartz debitage | Obsidian formal tool | Obsidian modified/utilized | Obsidian core | Chert core |
|--------------|-------------------|----------------|---------------------------|----------------|----------------------|-----------------------------|---------------|-----------|
| Unit M3, level 4 | 1                 | 1              | 0                         | 0              | 0                    | 1                           | 0             | 0         |
| Unit M3, level 5 | 2                 | 0              | 1                         | 1              | 3                    | 1                           | 0             | 0         |
| Unit M3, level 6 | 0 1920 ± 30       | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit M3, level 7 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit M3, level 8 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit M3, level 9 | 1                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit M3, level 10 | 0                  | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N2, level 4 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N2, level 5 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N2, level 6 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N2, level 7 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N2, level 8 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N2, level 9 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N2, level 10 | 0                  | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N3, level 4 | 0                 | 0              | 0                         | 0              | 1                    | 0                           | 1             | 1         |
| Unit N3, level 5 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N3, level 6 | 1                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N3, level 7 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N3, level 8 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N3, level 9 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit N3, level 10 | 0                  | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O2, level 4 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O2, level 5 | 0                 | 0              | 0                         | 0              | 1                    | 0                           | 0             | 0         |
| Unit O2, level 6 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O2, level 7 | 0                 | 0              | 0                         | 0              | 1                    | 0                           | 0             | 0         |
| Unit O2, level 8 | 1 1820 ± 30       | 1              | 1                         | 0              | 1                    | 0                           | 0             | 0         |
| Unit O2, level 9 | 0                 | 0              | 0                         | 0              | 0                    | 2                           | 0             | 0         |
| Unit O2, level 10 | 1                  | 0              | 0                         | 0              | 0                    | 0                           | 1             | 0         |
| Unit O2, level 11 | 2                  | 0              | 0                         | 1              | 0                    | 0                           | 1             | 0         |
| Unit O3, level 4 | 1                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O3, level 5 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O3, level 6 | 0                 | 0              | 0                         | 0              | 1                    | 0                           | 0             | 0         |
| Unit O3, level 7 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O3, level 8 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O3, level 9 | 0                 | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Unit O3, level 10 | 0                  | 0              | 0                         | 0              | 0                    | 0                           | 0             | 0         |
| Total         | 10                | 2              | 1                         | 1              | 8                    | 5                           | 1             | 2         |
Mome Cave, has stylistic traits including comb stamping with impressed lines or short nail impressions. However, the Nechisar vessels have thick walls and are heavily tempered with large mica suggesting that populations using the Mome Cave were producing locally made pottery. The decorative traits from the Yabello area also have comb stamping, but there is no indication of a red slip on the ceramics (Hundie 2001). The Kafa area to the northwest of the Gamo has pottery consisting of only body sherds with decorative motifs (i.e., herringbone and parallel incisions), and the slip has mica temper (Hildebrand et al. 2010). In the Gamo region, comb stamping and rippling near the rim do not occur on pottery until the Historic period.

As people were utilizing pottery for the first time, they also began to consume barley in this region as evident in Mota where a single barley seed dated to ca. 2400 BP was found. Phytoliths analysis is ongoing but offers a potential method for identifying the presence of enset (*Ensete ventricosum*). The only other region nearby with similar dates for the adoption of domesticated plants is Kafa, where at Kumali rockshelter possible evidence of wild or domesticated enset or a domesticated *Musa* sp. was found in addition to two partial coffee seeds dating to 1740 BP, while wild animals such as Grevy’s zebra, dik-dik, hartebeest, warthog, and eland continue to be hunted (Hundie 2001, p. 100, 113–114, 134–135, 195–197).

At both Mota and Tuwatey, people were engaged in cutting, sewing, and leather scraping activities with microlithic obsidian tools that have an increasingly standardized morphology during the Early Pottery period. A comparison of the breadth/length and thickness/length ratio of the geometric tools through time at Mota suggests that there is increased standardization (Fig. 27). At both sites, there is a slight increase in the portion of scraper tools and a reduction in backed blades. Particularly at Tuwatey, a substantial decrease in the use of utilized and modified flakes and blades is evident (from 37% down to 8%). People at Mota and Tuwatey sites primarily produced almost all their tools with obsidian, as this rock type accounts for 95% and 81% of the entire lithic assemblages, respectively. At Tuwatey, this was a substantial change because only 54% of the assemblage was obsidian during the previous period. In addition, 41% of the lithic assemblage at Tuwatey consists of tools compared to 8% at Mota. There is a larger amount of debitage at Mota (91% of assemblage) compared to Tuwatey (49% of assemblage). This implies that people were making tools at Mota. The large amount of debitage in association with broken tools and cores further suggests novice toolmakers and users at Mota. Under one of the hearths at this site, people placed

| Table 29  | Faunal descriptions from Tuwatey during the Early Pottery period |
|-----------|---------------------------------------------------------------|
| Tuwatey Cave GB 15 unit | M3 | M3 | M3 | N2 | N3 | N3 | O2 | O2 | O2 | O3 | N2 | N2 | N3 | O2 | O2 | O2 | O3 | O3 |
| Level | 5 | 6 | 7 | 4 | 4 | 5 | 4 | 5 | 6 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 3 |
| Human (*Homo sapiens*) | 1 | 1 | | | | | | | | | | | | | | | |
| Large bovid | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Small-sized bovid | 1 | | | | | | | | | | | | | | | | |
| Rodent | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Bat | 9 | 1 | | | | | | | | | | | | | | | |
| Crab | 2 | 1 | | | | | | | | | | | | | | | |

Afr Archaeol Rev (2019) 36:5–65
Table 30 Lithic tools and debitage ($n = 44$) from Tuwatey during the Historic period

| Location          | Cal BP | Utilized/modified flakes and blades whole | Utilized/modified flakes and blades broken | Scraper | Geometrics | Backed flake | Backed blade | Total formal tools | Cores | Bipolar core | Flakes | Angular waste | Broken flakes | Total debitage |
|-------------------|--------|-------------------------------------------|-------------------------------------------|---------|------------|--------------|--------------|-------------------|-------|--------------|--------|----------------|--------------|----------------|
| Unit 1, level 1   | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              | 0            | 0              |
| Unit 1, level 2   | 172 ± 29 (cotton seed) and 122 ± 29 (barley seed) | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              | 0            | 0              |
| Unit 1, level 3   | 300 ± 30 | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              | 0            | 0              |
| Unit 2, level 1   | 0      | 1                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 7            | 1      | 8              |              |                 |
| Unit 2, level 2   | 1      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 4            | 2      | 6              |              |                 |
| Unit 2, level 3   | 1      | 0                                         | 0                                         | 0       | 0          | 0             | 2             | 0                 | 1     | 1            | 1      | 2              |              |                 |
| Unit C7, level 1  | 1      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 1     | 0            | 1      | 1              |              |                 |
| Unit C7, level 2  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit C7, level 3  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit C8, level 1  | 0      | 0                                         | 2                                         | 0       | 0          | 2             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit C8, level 2  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 2             | 0                 | 0     | 2            | 0      | 2              |              |                 |
| Unit D8, level 1  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit D8, level 2  | 0      | 0                                         | 0                                         | 1       | 0          | 1             | 1             | 1                 | 0     | 0            | 0      | 0              |              |                 |
| Unit D8, level 3  | 0      | 0                                         | 1                                         | 0       | 1          | 2             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit J5, level 1  | 0      | 0                                         | 0                                         | 1       | 0          | 1             | 0             | 1                 | 0     | 0            | 1      | 1              |              |                 |
| Unit J5, level 2  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit J5, level 3  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit M3, level 1  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit M3, level 2  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit M3, level 3  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit M2, level 1  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit M2, level 2  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit N2, level 1  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit N2, level 2  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit N2, level 3  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit N3, level 1  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 3            | 0      | 3              |              |                 |
| Unit N3, level 2  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit N3, level 3  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
| Unit D8, level 1  | 0      | 0                                         | 0                                         | 0       | 0          | 0             | 0             | 0                 | 0     | 0            | 0      | 0              |              |                 |
broken tools, cores, and debitage, which may have been used as an insulator or to secure sharp waste away from their feet.

**Historic Period (500–120 BP)**

Elders in the Gamo Highlands identified Mota and Tuwatey caves as locations for ritual offerings to ancestral and nature spirits and as places of refuge during conflicts with the Italian colonists and the Ethiopian state in the Historic period. At Mota, the front of the cave yielded evidence for serving vessels, vessels for beer or dairy products, and domestic fauna all associated with potential ritual activities. At Tuwatey, there are two compact surfaces with indications that people also were engaged in ritual activities. The compact surface at the front of the cave is associated with ceramic jars, barley, and a few obsidian tools. A second compact surface is located in the center of the cave in association with a few lithics, but no fauna or ceramics. Nearby, parts of a wood string instrument, wild fauna, barley, and cotton were recovered. The deposits at the back of Mota and Tuwatey support oral histories that indicate possible use for hiding in the times of conflict and insecurity. At Mota, there are the remains of small and medium bovids, tubers, and cooking pottery, as well as stone tools for hide scraping and cutting activities. While at Tuwatey, the few artifacts include rodent and crab remains, two small ground stones, iron slag, and a small amount of pottery.

At Mota and Tuwatey, people consumed both domesticated and wild fauna and engaged in scraping, sewing, and cutting activities. Stone tool production continued with obsidian as the preference for tool production at Mota (83% of assemblage, two chert scrapers and four chert geometrics) compared to Tuwatey where people utilized more diversified raw materials including obsidian (58%), chert (37%), and quartz (4%). Indeed, across the southern Ethiopian highlands, people persisted in making microliths as is evident at the eighteenth-century Kafa sites (Hildebrand et al. 2010) and the Mome Gongolo sites located in the lowlands between Lakes Abaya and Chamo to the east of the Gamo Highlands (Lesur et al. 2014b).

The stylistic attributes, form, and use-alteration studies of ceramics suggest different ceramic traditions at the two sites. Comb stamping and appliqué
are rare and appear on two sherds from Tuwatey, but none from Mota. The ceramic forms at Tuwatey are limited to jars, while the Mota ceramic assemblage consists of jars, bowls, and plates (Table 19). Furthermore, the use-alteration analysis of the pottery and the faunal analysis suggest that Mota Cave inhabitants had culinary practices that differed from those inhabiting Tuwatey Cave (Table 18). Use-alteration analysis is beginning to be more widely utilized in African archaeology (e.g., Arthur 2002, 2003, 2014; Dunne et al. 2012, 2018; Reid and Young 2000). Ethnoarchaeological studies of ceramic use have confirmed specific use-alteration patterns, such as carbon deposits and surface abrasions.

### Table 31 Lithic raw material from Tuwatey during the Historic period

| Cal BP         | Obsidian debitage | Chert/ chalcedony debitage | Quartz debitage | Obsidian formal tool | Obsidian modified/ utilized | Chert modified/ utilized | Obsidian core | Chert core |
|----------------|-------------------|-----------------------------|-----------------|----------------------|---------------------------|--------------------------|---------------|-----------|
| Unit 1, level 1 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit 1, level 2 | 172 ± 29 (cotton seed) and 122 ± 29 (barley seed) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unit 1, level 3 | 300 ± 30           | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit 2, level 1 | 0                  | 0                           | 1               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit 2, level 2 | 2                  | 3                           | 0               | 0                    | 0                         | 1                        | 0             | 0         |
| Unit 2, level 3 | 0                  | 1                           | 0               | 0                    | 0                         | 1                        | 0             | 2         |
| Unit C7, level 1 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit C7, level 2 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit C7, level 3 | 3                  | 0                           | 1               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit C8, level 1 | 0                  | 0                           | 2               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit C8, level 2 | 2                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit D8, level 1 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit D8, level 2 | 0                  | 0                           | 1               | 0                    | 0                         | 2                        | 0             | 0         |
| Unit D8, level 3 | 0                  | 0                           | 2               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit J5, level 1 | 1                  | 0                           | 0               | 1                    | 0                         | 0                        | 0             | 0         |
| Unit J5, level 2 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit J5, level 3 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit M3, level 1 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit M3, level 2 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit M3, level 3 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit N2, level 1 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit N2, level 2 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit N2, level 3 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit N3, level 1 | 2                  | 0                           | 1               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit N3, level 2 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit N3, level 3 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit O2, level 1 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit O2, level 2 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit O2, level 3 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Unit O3, level 1 | 0                  | 0                           | 0               | 1                    | 0                         | 0                        | 0             | 0         |
| Unit O3, level 2 | 0                  | 0                           | 0               | 2                    | 0                         | 0                        | 0             | 0         |
| Unit O3, level 3 | 0                  | 0                           | 0               | 0                    | 0                         | 0                        | 0             | 0         |
| Total          | 10                 | 11                          | 2               | 6                    | 4                         | 2                        | 2             | 2         |
on ceramic vessels that represent specific types of food processing (e.g., Arthur 2014; Skibo 1992, 2013). The lack of sooting on the sherds at Mota and high frequency of burn marks on fauna remains suggest that roasting rather than boiling may have been a more common cooking practice. This contrasts with Tuwatey where sooting was common, possibly from a wet mode of cooking, such as soups.

The evidence from Tuwatey Cave indicates the adoption of barley into the local economy by 500 BP, providing the earliest directly dated archaeological evidence for domestication of barley (*Hordeum vulgare*) in southern Ethiopia. The cotton seeds, dating to ca. AD 1700, are at present the earliest dated in southwestern Ethiopia, suggesting that the Boreda Gamo communities have been engaged in the weaving craft for at least the last two or three centuries. Subsequently, an expanded agricultural repertoire is evident from ca. 300 BP that included wheat, sorghum, finger millet, and cotton.

### Regional Comparison

The Gamo caves were occupied during three contemporary time periods, which provide evidence for changes in the lithic and food way assemblages through time: a Pre-Pottery period 5500–3200 BP, an Early Pottery period 2400–1600 BP, and a Historic period 500–120 BP. Broadly, the microlithic tool technology recovered at Mota, Tuwatey, and Gulo with a later introduction of pottery and domesticates is characteristic of the Later Stone Age (LSA) between the Later Pleistocene Marine Isotope Stage 3 (MIS 3) and the Late Holocene.

### Table 32 Recovered plant remains from Tuwatey Cave (GB15)

| Taxa               | Plant part          | C7 | C7 | C7 | C7 | D8 | TP1 (2011) |
|--------------------|---------------------|----|----|----|----|----|------------|
| Barley             | *Hordeum sp.*       |    |    |    |    |    |            |
|                    | Grains              | 2  | 3  | 2  | 4  | 2  |            |
|                    | *Hordeum sp.* apical|    |    |    |    |    |            |
|                    | Ends                |    |    |    |    |    |            |
|                    | *Hordeum sp.*       |    |    |    |    |    |            |
|                    | Embryo ends         |    |    |    |    | 1  |            |
|                    | cf. *Hordeum sp.*   |    |    |    |    |    |            |
|                    | Grain fragment      |    |    |    |    | 1  |            |
| Wheat              | cf. *Triticum*      |    |    |    |    |    |            |
| Sorghum            | *Sorghum sp.*       |    |    |    |    | 1  |            |
|                    | Grain               |    |    |    |    |    |            |
|                    | cf. *Sorghum sp.*   |    |    |    |    |    |            |
|                    | Grain               |    |    |    |    | 1  |            |
| Finger millet      | *Eleusine coracana* |    |    |    |    | 1  |            |
| Cotton             | *Gossypium sp.*     |    |    |    |    | 1  |            |
|                    | Whole seed          |    |    |    |    |    |            |
|                    | *Gossypium sp.*     |    |    |    |    | 7  |            |
| Other              | cf. *Rhamnus sp.*   |    |    |    |    | 1  |            |
|                    | Seed fragment       |    |    |    |    |    |            |
| Cereal indeterminate | Fragments         | x  | 3  | 2  |    | 5  |            |
| Parenchyma tissue/tuber | Fragments      | x  | 3  | 2  |    |    |            |
| Total identifiable remains |                | 2  | 5  | 2  | 7  | 3  | 1  |

### Table 33 AMS radiocarbon dates on seeds from Tuwatey

| Context | Dated material | Lab no. | C14 age | Error  | $\delta^{13}$C (‰) | Calibrated (68.2%) |
|---------|----------------|---------|---------|--------|---------------------|--------------------|
| GB15-C7-7 | *Hordeum vulgare* | SUERC-61527 | 492     | 29     | −23.6               | 1416–1440 AD       |
| GB15-1-2L | *Gossypium sp.*   | SUERC-61528 | 172     | 29     | −22.3               | 1668–1683, 1734–1782, 1798–1806, 1929–1949 AD |
| GB15-1-2L | *Hordeum vulgare* | SUERC-61529 | 122     | 29     | −21.5               | 1685–1708, 1718–1732, 1808–1888, 1911–1928 AD |
(ca. 60,000 to < 1,000 years BP). This is typified, in large part, by high frequencies of geometric microliths and small blade production with pottery production as early as 8000 BP, and the introduction of food production ca. 4000 BP (for reviews, see Ambrose 1998, 2002; Barham and Mitchell 2008; Bon and Fauvelle-Aymar 2014; Brandt 1986; Clark 1954; Clark and Williams 1978; Finneran 2000a, b, 2007; Guérin and Faure 1996; Gutherz et al. 1996, 2015; Jones et al. 2017; Leplongeon 2014; Lesur et al. 2014a; Ménard et al. 2014; Negash 1997, 2001; Phillipson 1977; Pleurdeau et al. 2014; Tribolo et al. 2017). The earliest evidence for pastoralism from northern Ethiopia dates to ca. 1741–1540 BCE (Marshall and Negash 2002; Lesur et al. 2014a), and West Asian cereals and indigenous grains appeared in the third millennium BP (Curtis 2013; Table 34 Faunal descriptions from Tuwatey during the Historic period

| Tuwatey Cave GB | Unit | Unit | Unit | Unit | Unit | M3 |
|-----------------|------|------|------|------|------|----|
| Level           | 2    | 2    | 3    | 5    | 8    | 3  |
| Large bovid     | 1    | 1    | 1    | 1    | 1    |    |
| Suid            |      |      |      |      |      | 1  |
| Rodent          |      |      |      |      |      | 2  |
| Crab            |      |      |      |      |      | 1  |

Fig. 24 a Barley grain from Mota Cave, dorsal, lateral, and ventral views. b Barley grains (dorsal view) from Tuwatey (C7-7). c Finger millet grain from Tuwatey (TP1-2L). d Cotton seeds from Tuwatey (TP1-2L).
The earliest evidence for herding and ceramic production in the Horn began by 2000 BP and vegetation sometime after 1740 BP (Hildebrand et al. 2010; Lesur et al. 2014).

In southwestern Ethiopia, there are few Later Stone Age cave assemblages for comparison. Microlithic industries are variously defined as small blades and flakes under 30 mm in length and are generally associated with the LSA (Clark 1985, p. 95; Clark and Kleindienst 1974, p. 99), though microliths also are known in terminal Pleistocene assemblages (Brandt 1982; Brandt et al. 2012; Guthertz et al. 2014; Leplongeon 2014; Ménard et al. 2014). Clearly, resembling the other LSA cave and shelter site assemblages in southwestern Ethiopia, the people at the Gamo highland caves primarily produced small or microlithic retouched blades and flakes, backed flakes and blades, crescents, trapezoids, and triangle-shaped geometrics, as well as awls, scrapers, and points. The lack of interest in studying Mid and Late Holocene sites in comparison to the Pleistocene–Holocene transitions means that studies are near nonexistent or assemblages are sparsely described. Fifty kilometers to the north of the Gamo Highlands are the sites of Harurona (ca. 12,000 BP to present) and Mochena Borago (ca. 4500–100 BP) in the Wolayta region (Bachechi 2005; Brandt et al. 2012; Guthertz et al. 2002) (Fig. 28). At Harurona, the assemblage from the terminal Pleistocene to Holocene is described as part of the Ethiopian Blade Tool Tradition associated with Lake Besaka to the north (Brandt 1980, 1982). Guthertz et al. (2002) mention that at Mochena Borago (ca. 45,000–100 BP), there are segments/crescents in the Mid-Holocene and blades in the Late Holocene but the proportions are unclear. Sixty kilometers to the southeast of the Gamo are the Rift Valley Mome Gongolo sites dating to ca. 1499–293 BP, demonstrating the continued production and use of quartz and obsidian tools particularly microliths, with the addition of chert, chalcedony, and rhyolite in the later occupation (Lesur et al. 2014b). More than 180 km to the south at Yabello, excavated assemblages at rockshelters have limited direct dating, ca. 2900–1300 BP (Clark 1945; Hundie 2001). About 200 km to the northwest of the Boreda Gamo Highlands, the Kafa region shelter sites of Kumali, Duba, Shelui, Koka, Shapa, and Chiri date between ca. 8400 and 130 BP. Here, there was a persistence of microliths primarily made of obsidian with scrapers produced from basalt and chert (Hildebrand and Brandt 2010; Hildebrand et al. 2010). Like the Gamo cave sites, a recent comparison of geometrics by Leplongeon and Ménard (2017) from Goda Buticha, Bulbulu River sites, and Mochena Borago indicates that there is increased symmetry in tool forms in the Late Holocene (4.2 ka–present) compared to earlier periods.

Based on the current evidence from the Gamo Highlands, it appears that adoption of domesticated crops was a slow and intermittent process over a long period of time with local wild resources dominating food assemblages until circa the last 500 years. Pottery appeared ca. 2400 BP, slightly earlier than in the Kafa region. Wild animal remains dominate the assemblages of the Pre-Pottery and Early Pottery periods indicating that although domesticates appear ca. 1700 BP, they were either infrequently culled, herded

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**Table 35 Tuwatey Cave groundstone descriptions**

| Location       | Type   | Shape | Length (mm) | Width (mm) | Thickness (mm) | Weight (g) |
|----------------|--------|-------|-------------|------------|----------------|------------|
| Unit O3 level 2| Handstone | Oval  | 88.6        | 50.9       | 45.4           | > 200      |
| Unit M3 unit 2 | Handstone | Oval  | 93.4        | 59.3       | 36.7           | > 200      |
Table 36  Description of Gulo Cave sediments from shovel test 1

| Layer | Soil structure | Texture fines | Gravels | Pebbles | Color | Ash | Charcoal | Note | Facies interpretation |
|-------|----------------|---------------|---------|---------|-------|-----|----------|------|-----------------------|
| 1     | Loamy sands (L) | *AN           |         |         | 7.5YR 3/2 |     |           |      | Recent trampled surface |
| 2.1   | Loam (L)        | *AN           |         |         | 7.5YR 5/2 |     |           |      | Guano accumulation     |
| 2.2   | Loam (L)        | *AN           |         | White   |        |     |          | Phosphatic laminae     | Guano transformation |
| 3.1   | Sandy (L)       | *AN           |         |         | 7.5YR 3/2 | ***|           |      | Anthropogenic layer    |
| 3.2   | Sandy (L)       | *AN           |         |         | 7.5YR 3/3 | *  |          | Common phosphatic crusts| Anthropogenic material mixed with guano and debris |
| 4.1   | Loam (FC)       | ***AN         |         |         | 10YR 7/3 to white |     | Very abundant phosphatic nodules, fillings, and concentrations | Phosphatization of guano |
| 4.2   | Sandy (FC)      | **AN          |         |         | 10YR 6/4–7/4 |     | Abundant phosphatic nodules and concentrations | Debris accumulation by weathering with accumulation of guano and phosphatization |
| 5.1   | Sandy (FC)      | *****AN *****AN |        |         | 10YR 5/3–6/3 |     | Abundant phosphatic nodules | Debris accumulation by weathering with accumulation of guano and phosphatization |
| 5.2   | Sandy (FC)      | *****AN *****AN |        |         | 10YR 7/3 |     | Rare phosphatic nodules | Debris accumulation by weathering with accumulation of guano |
| 5.3   | Sandy (FC)      | ***AN **AN    |         |         |        |     |          |      |                       |
| 5.4   | Sandy (FC)      | *****AN *****AN |        |         |        |     |          |      |                       |
| 5.5   | Sandy (FC)      | ***AN **AN    |         |         |        |     |          |      |                       |
| 5.6   | Sandy (FC)      | *****AN *****AN |        |         |        |     |          |      |                       |
| 5.7   | Sandy (FC)      | ***AN **AN    |         |         | 10YR 7/2 |     | Abundant phosphatic nodules and concentrations | Debris accumulation by weathering with accumulation of guano and phosphatization |
| 5.8   | Sandy (FC)      | ***AN **AN    |         |         | 7.5YR 4/4 |     | Common phosphatic nodules and concentrations | Debris accumulation by weathering with accumulation of guano |
| 5.9   | Sandy (FC)      | *****AN *****AN |        |         | 10YR 7/3 |     | Rare phosphatic nodules |                       |

Gravels: up to 5 cm. Pebbles > 5 cm

Roundness and shape: AN = angular, SA = subangular, SR = subrounded, F = flat. Compaction: L = loose, FC = fairly compact, VC = very compact.

* = rare, ** = scarce, *** = common, **** = abundant, ***** = very abundant
elsewhere, or acquired through trade, slightly later than documented in the Kafa region. The current archaeological research focusing on the development of food production is just beginning to concentrate on the Holocene record in southwestern Ethiopia (Hildebrand and Brandt 2010; Lesur et al. 2007, 2014b; K. Arthur et al. 2009, 2010). However, historic highland southwestern Ethiopia possessed food-producing traditions that include pastoralism, agropastoralism, horticulture, and more intensive forms of agriculture. Perhaps, most characteristic of southwestern Ethiopia are the horticultural traditions focusing on the propagated tuber crops of enset and yams.

Fig. 26 Gulo Cave profile of shovel test 1

Fig. 27 A comparison of the breadth/length and thickness/length ratio of the geometric tools at Mota Cave indicating increased standardization through time
The understanding of when, how, or why this complex suite of adaptations developed still remains elusive. All of these point to the need for further work in the Gamo Highlands and other environmental zones of southwestern Ethiopia.

Conclusion

Why do domesticated flora and fauna appear so late in the archaeological record of southwestern Ethiopia compared to adjacent regions, such as in northern Kenya (third millennium BP) (Marshall 2000) and other sites in the Horn of Africa including Asa Koma (Lesur 2004), Laga Oda (Clark and Prince 1978; Clark and Williams 1978), and Lake Besaka (Brandt 1980, 1984)? Different reasons may explain this situation. On one hand, paleoenvironmental data show that the strong climatic variations characterizing the Holocene were less pronounced in southwestern Ethiopia where altitude and the well-developed hydrological networks limited the effects of aridity (Mohammed and Bonnefille 1998). A reduction in rainfall might have created drier ecosystems during some phases, but was never sufficiently drastic to completely modify natural formations. Therefore, most communities in the southern highlands continued to rely mainly on wild resources, as is the case at Mochena Borago (Lesur et al. 2007). Unlike the lowlands where the deterioration of climatic and environmental conditions forced populations to find alternative solutions, such as greater mobility or the adoption of domestic resources, the communities in the mountains benefitted from a stable natural environment that ensured continuity in food-sourcing strategies.

In other words, the region’s rich landscapes and abundant wild resources may not have been propitious to early food producers. Climatic conditions with heavy rains and cold temperatures, as well as wet and dense forests, create a difficult environment for agriculture and livestock farming, for migratory producers, as well as for permanent local settlers who wished to keep small herds of cattle or cultivate cereals. Similarly, the steep and rugged topography of this mountainous zone could have acted as a physical barrier for pastoralists coming from the plains and could have slowed down the diffusion of cattle and caprines (Lesur et al. 2014a). Lastly, it is also important to address the difficulty of integrating the production of plants and domestic animals in the...
social and economic hunter–gatherer system (Brooks et al. 1984; Guille-Escuret 1989; Marshall et al. 2004), particularly in specialized societies well adapted to their specific environment, as has already been observed in comparable contexts linked to insularity (Vigne 1997). One clue to this resistance to adoption of food production may be observed in the unique vocabulary of Omotic speakers, such as the Gamo, have for domesticated animals (Blench 2006; Blench and MacDonald 2006). In her ethnographic research with the Gamo, K. Arthur (2018, p. 35) noted that Gamo words for cattle and goat are similar to those used for parallel wild species, especially African buffalo and dik-dik, that were important in historic ritual hunts and in the earlier hunting traditions of the region.

Our research has spurred additional questions focusing on intersite diversity and regional interactions. For example, are there other burials in the Gamo Highlands that could add to our knowledge of highland population adaptation, diet, and ritual practices? Distinctions in features and artifact and ecofact assemblages between Mota and Tuwatey caves suggest important variation in the quality and intensity of occupations. How might future research at the much less investigated Gulo Cave and other untented sites in the area compare and contrast with these better-explored sites? What might future obsidian sourcing studies provide for investigating ancient interaction spheres in southern Ethiopia that may have linked the Gamo Highlands to wider regional networks during the Middle and Late Holocene? Future research by our project and others suggests that southern Ethiopia may provide exciting insights into this critically important period of the Eastern African past.

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Compliance with Ethical Standards
Conflict of Interest The authors declare that they have no conflict of interest.

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