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Supplementary Notes

Contents

Supplementary Note 1. Additional fossil hominin materials from Burtele (BRT) localities

There are a few isolated teeth and one frontal fragment recovered from BRT-VP-1 and BRT-VP-2 in addition to the partial foot (BRT-VP-2/73) previously reported by Haile-Selassie et al.[1] (see Table 1 in the main text). The craniodental specimens cannot be assigned to *Au. deyiremeda* with certainty because of their isolated and/or fragmentary nature. The taxonomic assignment of isolated postcranial remains is a persistent problem in paleoanthropology, especially when multiple species overlap in time and space. The morphology of BRT-VP-2/73 is inconsistent with what is currently known about the *Au. afarensis* foot[2-5], thus the null hypothesis would suggest that BRT-VP-2/73 belongs to *Au. deyiremeda*. We currently cannot reject this null hypothesis. However, if *Au. deyiremeda* is a descendant of *Au. afarensis* (see Supplementary Note 6), the presence of a grasping hallux in *Au. deyiremeda* would imply a reversal to arboreal adaptation in this species. A reversal would not be required if *Au. deyiremeda* were descended from a species with foot morphology similar to *Ar. ramidus*, but such a scenario would require many dentognathic homoplasies.

There are a number of other alternatives to this null hypothesis including BRT-VP-2/73 representing a late surviving species of *Ardipithecus*. Foot morphology is unknown for many Pliocene hominins (e.g. *Au. anamensis* and *K. platyops*) and variable where it is known[6-9]. Only the recovery of clearly associated craniodental and pedal remains can test these hypotheses.

Supplementary Note 2. Morphological descriptions of the holotype and paratypes of *Au. deyiremeda*

The detailed anatomical description of specimens assigned to *Australopithecus deyiremeda* are presented below. The descriptive format and terminology used here follows refs. 10-12.

Abbreviations:

C^1 – upper canine; C_1 – lower canine; Dmr – distal marginal ridge; Fa – anterior fovea; Fc – central fovea; Fp – posterior fovea; IPF – interproximal facet; Mlg – median longitudinal groove; Mmr – mesial marginal ridge; Tc – transverse crest.

a. BRT-VP-3/1 (Extended Data Fig. 1)

Preservation*:* This specimen consists of a left maxilla of a young adult individual broken medially near the midline and posteriorly right behind the M^2. The root of left I^1, and crowns of left I^2-M^2 are preserved intact except for an oblique premortem chippage of the distal two-thirds of the I^2 incisal surface. There is no sign of abrasion on the specimen indicating that it was not transported far from its area of discovery. The preserved bony parts include most of the palate, nasoalveolar clivus, root of the frontal process, the nasal floor, the anterior maxillary sinus chamber, and root of the zygomatic process. The midline point on the nasal sill and parts of the intermaxillary suture at P^4/M^1 are preserved, allowing an accurate mirror-imaging to analyze palate shape.

Anterior aspect: The I^1 jugum is present but not as strong as A.L. 200-1 and A.L. 199-1 and the I^2 does not show any sign of jugum. The area between the I^2 and C^1 is flat. The nasoalveolar

clivus is transversely convex but appears to be superioinferiorly flat at the preserved superior half below the nasal sill. The clivus passes smoothly into the nasal cavity for ca. 4.2 mm past the inferior point of the lateral nasal margin and drops down steeply into the nasal floor. The preserved inferior part of the lateral nasal margin is sharp but does not curve medially and merge with a nasal sill as in *Au. afarensis*[12]. It descends inferiorly, curving slightly laterally towards its end, and disappears abruptly into the nasoalveolar clivus above I^2. The lack of crested nasal sill, the smooth transition of the nasoalveolar clivus into the nasal cavity, and the overall morphology of the lateral nasal margin in BRT-VP-3/1, resembles *Au. africanus* specimens such as Sts 52.

Lateral aspect: The preserved superior portion of the nasoalveolar clivus is flat superoinferiorly and CT scan data shows that the incisor roots were also straight indicating that the entire clivus had a straight lateral profile. The postcanine external alveolar margin shows slight convexity inferiorly. The mesiobuccal root of the P^3 is planted vertically although the slightly exposed apical half appears to be angled posterosuperiorly. A shallow depression is present at the anterior base of the zygomatic bone, bounded anteriorly by the canine jugum. The inferior root of the zygomatic process is positioned low, 10 mm above the alveolar margin at the P^4/M^1 level but with no visible zygomaticoalveolar crest. The zygomatic root blends smoothly with the lateral alveolar wall at the same level. However, the anterior margin of the zygoma appears to be at mesial P^4 level, similar to *K. platyop*[13,14].

Medial aspect: The preserved part of the nasolalveolar clivus has a consistent thickness of ca. 11.6 mm. The anteroinferior portion of the clivus is broken and alveolare cannot be placed with certainty. However, based of the preserved superior part of the clivus, the angle of the clivus to the alveolar margin is estimated to ca. 39º. As in early *Homo* specimens such as A.L. 666-1, the angle between the clivus and anterior floor of the nasal cavity is acute[11]. The clivus enters the

nasal cavity ca. 4.6 mm past the inferior edge of the sharp lateral nasal margin and steeply drops (6 mm) down to the nasal floor at the level of the incisive fossa. The overlap between the nasoalveolar clivus and the palatine process is relatively small (3.5 mm). The thickness of the palatine process is consistent (5.9 – 6.1 mm) from the P^3 level to the preserved M^2 level and it runs parallel to the medial alveolar margin across its entire length, indicating that the palate does not deepen posteriorly. The palatine process tapers anterior to the incisive canal's nasal orifice where it also starts curving anteroinferiorly (see Extended Data Fig. 1i, k).

Occlusal aspect: The postcanine internal and external alveolar margins gently diverge from the midline all the way to the preserved M^2. The lateral alveolar margin is straight except for a slight undulation at the C^1-P^3 level due to the combined C^1-P^3 jugum. Mirror-imaging the preserved half shows that the dental arcade is a wide parabola with the canine and incisors forming a prominent arch anteriorly, comparable to *Au. afarensis* specimens such as A.L. 200-1a. The breadth of the alveolar process from the P^3 to the M^2 far exceeds the maximum buccolingual dimension of each tooth at its position. The anterior edge of the greater palatine fossa is visible at the level of distal M^2 ca. 11 mm below the alveolar margin.

Superior aspect: The preserved maxillary sinus is 24.1 mm anteroposteriorly and extends from the P^3 to mid-M^2 level. It is 18.2 mm mediolaterally at the widest point above the P^4/M^1 level and the width of the maxilla at the same point is 35 mm from the midline. Its overall size is short and broad compared to *Au. afarensis* specimens such as A.L. 200-1 and A.L. 199-1. The floor of the maxillary sinus is at the level of, and in some areas slightly below, the nasal floor. The sinus is partitioned into three small chambers separated from each other by slightly elevated septa, the distalmost being the most prominent. The septa are lined up almost perpendicular to the midsagittal plane and at a comparable distance from each other. The anteriormost sinus is small

and rounded. The sinus posterior to it is the widest mediolaterally and longest anteroposteriorly. The major septum defining its posterior boundary rises high along the posterior face of the root of the zygomatic process. The nasoalveolar clivus is transversely convex anteriorly.

Dentition: The I^2 is complete although its distal occlusal half was chipped during life, as indicated by the wear on the broken occlusal surface. In labial and lingual views, the crown tapers root-ward. The lingual face has less relief with only a weak vertical ridge apparent on the distolingual part. A small groove is also present on the distolabial face close to the occlusal surface and the distal margin is slightly convex.

The canine crown is fully formed and its root apex closed. The whole crown is nearly above the alveolar margin although the cervicoenamel line is not visible on the lingual side. The crown apex does not show any sign of wear, further indicating the individual's young age. A thin transverse crack runs centrally from the apex to its base across the entire crown. Its basal outline is a mesiodistally compressed oval. The buccal face of the crown is smooth and convex laterally. The crown has little lingual relief, with only a shallow vertical groove running distal to the mesial crown shoulder. The distal two-thirds of the lingual crown face is flat and featureless although the exposed basal part indicates possible basal bulging. Compared to most *Au. afarensis* upper canines, the mesial crest is long (5.4 mm) relative to the length of the distal crest (7 mm) indicating that it is less incisiform. However, it is comparable to some early *Au. afarensis* upper canines such as LH 3 and LH 6 from Laetoli[10].

The P^3 is unworn and set obliquely, buccolingually long, particularly at its base, and the buccal face tapers occlusally. A thin longitudinal crack runs across the center of the paracone. However, it does not disrupt any of its visible morphology. The crown tapers rootward in lingual and buccal views. The paracone is much higher and larger than the protocone and it has a pointy

apex unlike premolars of most post-*Au. anamensis* hominins, which have more rounded apices. These cusps are separated by a deep Mlg extending from the Fa to the Fp. The Fa and Fp are about the same size. The Mmr is set slightly higher than the Dmr. The distal IPF is set more lingually.

The P^4 is mesiodistally compressed with the longest mesiodistal dimension being at the center. The crown tapers rootward only in buccal view. The lingual Mmr, tip of the protocone, and the Dmr are slightly polished by wear. The Fa is set more buccally, whereas the Fp is set lingually. A deep Mlg runs from the Fa to the Fp. The mesial and distal IPFs are centrally positioned at crown midline.

The M^1 occlusal outline is a rounded square that is slightly longer buccolingually. The buccal face is more bilobate than the lingual face. The protocone is the largest cusp followed by the subequal paracone and metacone. A hairline transverse crack runs across the paracone. The hypocone is slightly smaller. The protocone is flattened by wear together with the obscured Fa and Mmr. The lingual faces of the paracone and metacone are also polished by wear although the cusp tips are prominent and much higher than the flattened and rounded lingual cusps. A small pit is seen on the protocone although no dentine seems to be exposed. A small groove on the mesiolingual corner of the protocone might be a remnant of Carabelli's trait. The hypocone is rounded but less worn than the protocone. A short segment of the Mlg is visible around the Fc area and does not distally extend to the Fp. The Fp is well defined but shallow and positioned lower than the Fc. There is one centrally positioned small distoconule along the Dmr which is better defined buccally than lingually.

The M^2 is unworn and has a rounded square occlusal outline slightly longer buccolingually. The paracone and metacone have pointed cusp tips, more so than the protocone

and hypocone, and none of the cusps show any sign of dentine exposure. The area between the M^1 and M^2 is filled with thin matrix and the presence or absence of mesial IPF cannot be ascertained. However, there is no sign of distal IPF probably indicating that the M^3 did not erupt or was not in occlusion. The protocone is the largest followed by the paracone, metacone, and hypocone, respectively. A Tc runs from the distal part of the protocone to the metacone only truncated by the medial segment of the Mlg which irregularly courses from the Fc to the Fp. Both lingual and buccal faces are bilobate as a result of the vertical grooves between the mesial and distal cusps on both lingual and buccal faces of the crown. The lingual vertical groove is much deeper than the one on the buccal side. The buccal face is more vertical than the lingual face, which slopes occlusally and positions the protocone and hypocone cusp tips closer to the center of the crown. The Fa is a small slit-like groove positioned mesial to the paracone. The buccal half of the Mmr is thin and its lingual half is undefined and merges with the protocone. The Fc is deep and distally bound by the Tc. The Fp is also deep and transversely long. Two small distoconules are centrally positioned on the Dmr.

b. BRT-VP-3/14 (Extended Data Fig. 2a-h)

Preservation*:* This adult mandible was found in three pieces: the left and right halves of the corpus and a fragment of the left ascending ramus. These pieces joined to yield a more or less complete mandible with the apical halves of LI_2 – RI_2 and RP_3-M_3. The teeth on the left side (C_1-M_3) are broken and only their roots are visible. The R_C is also broken at its base immediately above the cervicoenamel junction. Part of the left ascending ramus is preserved with a superoinferior dimension of 27 mm above the alveolar margin of the M_3 and a maximum breadth of 24 mm at the same level. The corpus is well preserved except for some vertical and horizontal

hairline cracks on the lateral surfaces of both sides. Numerous cracks and surface abrasion also obscure the occlusal morphology of the dentition.

Lateral aspect: A number of vertical and horizontal cracks traverse the lateral faces on both sides. However, they don't seem to have substantially altered morphology of the lateral face of the corpus. The symphysis slopes posteroinferiorly and angles ca. 51° measured from a straight line from infradentale to gnathion relative to the alveolar margin. However, it is rounded at its base. The alveolar margin on the right side is almost parallel to the occlusal margin from P_3 to M_2 and curves superiorly at the M_3 level. This creates a noticeable Curve of Spee. Corpus height tapers posteriorly to a marked degree, being tallest at P_3 (37.4 mm) and shortest at M_3 (30 mm). The occlusal wear plane is helicoidal largely due to the lingual tilt of the M_3 occlusal surface. The alveolar margin is damaged at the C_1-P_4 level but the better-preserved margin at $M_{1\text{-}2}$ shows is rounded and becomes sharp at the M_3 level. The oblique line is short and runs from the base of the ascending ramus almost parallel to the alveolar margin on both sides and disappears at distal P_4. The lateral prominence is massive on both sides but slightly more massive on the right side. The anterior edge of the prominence on the right side is at the P_4/M_1 level, 12.5 mm below the alveolar margin, and attains its maximum buttressing at mesial M_2 level. The combined lateral prominence and root of the ascending ramus curves superiorly at mesial M_2 10 mm below the alveolar margin. The M_3 is entirely hidden by the ascending ramus. The anteroinferiorly sweeping extramolar sulcus is anteroposteriorly long and transversely wide. It decreases its breadth posteriorly.

On the right side, the anterosuperiorly opening circular mental foramen is positioned slightly above midcorpus at distal P_3 level. The foramen is 2.4 mm superoinferiorly and 2.2 mm anteroposteriorly. Its inferior margin is 19.5 mm above the base. On the left side however, the

foramen is positioned slightly below mid-corpus at P_3/P_4 level (its inferior margin is 17 mm above the corpus base) and a small accessory foramen is also present 7 mm anterosuperior to the main foramen at the base of the P_3 root jugum. The canine and P_3 juga are weakly developed and separated on the left side by a narrow vertical depression, whereas on the right side there is no separation between the two juga. A small semi-circular depression (8 mm x 10 mm) is present on the right side posterosuperior to the mental foramen. This depression is bound anteriorly by the elevated posterior edge of the foramen and posteriorly by the anterior edge of the lateral prominence. On the left side, the depression is vertically long (21 mm), wide superiorly (13 mm) and narrower inferiorly (7 mm). It extends from the alveolar margin between distal P_3 and mesial M_1 superiorly to the level of the mental foramen inferiorly. The P_3 jugum demarcates its anterior border. The anterior end of the lateral prominence and a mild mesial M_1 jugum demarcate its posterior border.

There is no superior lateral torus on either side. The inferior marginal torus runs for a short distance as an extension of the massive lateral prominence and fades anteriorly at the mental foramen level. Posteriorly, it disappears into the depression at the base of the ascending ramus. When viewed laterally, the preserved posteroinferior corner of the corpus at the M_3 level is concave inferiorly. The preserved posterior part of the corpus shows that the masseteric fossa was very deep.

Medial aspect: The alveolar margin on both sides shows no sign of resorption although split line cracks hinder its detailed description. The alveolar contour is smooth across its length, except for a pronounced swelling at the right P_3 level. In midsagittal section, the postincisive planum is slightly concave superiorly and runs inferiorly, almost vertically, to the level of the superior margin of the shallow geniglossal fossa. The superior transverse torus is poorly defined, only

reaching to distal P_3 level in occlusal view. The inferior transverse torus is also limited to the area immediately below the genioglossal fossa and slightly above the basal contour, posteriorly extending to the distal P_3 level. The genioglossal fossa is very shallow and has no visible spines. The mylohyoid lines sweep anteroinferiorly and demarcate the inferior extent of the alveolar prominence. These lines extend to the mesial M_1 level and mark the superior border of the posterior subalveolar fossa. The anterior subalveolar fossa is very small in size and located very close to the genioglossal fossa. A small foramen is present within the posterior subalveolar fossa at distal M_2 level 7 mm above the base and 16.5 mm below the mylohyoid line on the right side. A similar foramen is also present on the left side at about the same position. A number of microforamina are also visible across the inferior half of the medial face.

Anterior aspect: The labial halves of the incisors are missing and the alveolar margin is abraded. However, the preserved incisor juga indicate that the incisors were implanted vertically and show no sign of procumbency. The juga create shallow mandibular incurvatios between the central incisors and the LI_2 and C_1 although there is no sign of basal incisura. A prominent midline crest runs inferiorly for about half the length of the symphysis.

Occlusal aspect: Anteriorly, the canines and incisors form a shallow arc and the postcanine teeth slightly diverge posteriorly creating a tightly curved parabola. The P_3-M_3 row is almost straight with a slight lateral concavity at the M_{2-3} level. The corpus starts broadening immediately posterior to the P_4 and reaches its maximum breadth at the M_2 level creating a 12.7 mm wide extramolar sulcus at the same level. The lateral prominences are large and anteriorly extend to the distal P_4 level. The wide extramolar sulci are also visible extending for almost the entire anteroposterior length of the lateral prominence.

Basal aspect: The basal contour of the corpus is strongly everted. The left part of the prominent basal trigon is missing. The anterior edge of the base is broad and has a bony septum between the two well-developed digastric fossae that are transversely long and deep. The left and right digastric fossae have dimensions of 9.5 mm (mediolateral) by 3.5 mm (anteroposterior) and 8.0 mm (mediolateral) by 3.0 mm (anteroposterior), respectively. A slit-like transverse groove dominates the center of the fossae. There are also small fossae posterior to the digastric fossae separated by a bony ridge from the latter. The corpus base is sharp where it demarcates the anterior margin of the digastric fossae extending posteriorly as far back as the P_4/M_1 level. It then becomes gently rounded until it reaches at the M_3 level where it gets sharper again. The base is wide across its length but becomes thinner distally posterior to the M_2 level. Orientation of the digastric fossae is similar to A.L. 400-1a.

Dentition: The labial and occlusal halves of all four incisors are missing. However, they show multiple and strong hypolplasia. These lines start close to the cervicoenamel junction and are found across the preserved lengths of the crowns. The preserved lingual faces indicate that the lateral incisors were larger than the centrals and all of the incisors have little relief on their lingual face, with no prominent basal bulging. The canine crowns are missing on both sides. Only parts of the roots are preserved. Based on data acquired from Computed Tomography (CT) scanning, the canine roots are long with the crowns having an obliquely oriented long axis with oval-shaped outline at their base.

Premolars: The right P_3 is complete but has suffered some abrasion on its occlusal and buccal faces. CT-scan images show that both P_3s had three roots (two buccal and one lingual; see extended Data Fig. 2c, d, f). The occlusal crown outline is a mesiobuccal to distolingually elongated oval. It is nearly unicuspid, with the metaconid being minimally developed. The large

protoconid occupies most of the occlusal surface. Lingually, the protoconid ridge descends to the metaconid along the lingual occlusal rim. This rim runs posteriorly to merge with the Dmr which bounds a buccolingually long Fp distally. The protoconid apex shows a buccolingually1.2 mm long shallow dentine exposure, which extends across the length of the distal crest of the cusp and ends at the Dmr. Mesially, a tiny pit represents the Fa with steep buccal and distal walls but opens mesially toward a thin and poorly defined Mmr. The buccal face slopes toward the crown apex when viewed mesially or distally and is mesiodistally convex. The mesial buccal groove is bound by a well-developed mesial buccal ridge that ends superiorly on the buccal edge of the Mmr. The distal buccal groove is not well defined and visible only close to the occlusal rim at the distobuccal corner of the crown. The lingual face is vertical, extremely narrow, and convex. The crown of the right P_4 is extremely damaged and crown morphology is mostly obliterated. CT-scan images show that both P_4s had three roots (two buccal and one lingual; see extended Data Fig. 2c, d, f). The lingual and distobuccal roots fuse toward the base of the crown. It appears that dentine was exposed on the protoconid and the crown had a large Fp. Based on the preserved crown, it also appears that like the P_3, the P_4 crown was also set obliquely relative to the vertical axis of the dental row.

Molars: Most of the $M_{1\text{-}3}$ crowns are preserved on the right side although postmortem abrasion and cracks have altered their occlusal relief. Only the roots are preserved on the left side. The enamel surfaces of the right M_1 metaconid and entoconid are missing on the lingual side. On the occlusal surface, abrasion and few longitudinal cracks have also obscured the occlusal morphology. However, cupped dentine exposures are visible on the buccal cusps and the hypoconulid. The dentine exposure on the latter is circular and 1.5 mm in diameter. It coalesces with the cupped dentine exposure on the hypoconid by an oblique 1.9 mm long and 0.5

mm wide groove, which perforates deep into the dentine. The cupped dentine exposure on the hypoconid is much larger than the one on the hypoconulid, but a crack passing through it inhibits accurate measurement. The dentine exposure on the protoconid is the largest and it is mesiodistally elongated. It seems that there were no dentine exposures on the lingual cusps and they appear to have been worn flat. The M_2 crown is complete but equally damaged by a number of longitudinal and transverse cracks. Only the roots are preserved on the left side. However, none of the cusps show clear dentine exposure except for some occlusal enamel loss possibly due to taphonomic factors. The Mmr is well-defined. The size of individual cusps cannot be determined accurately. The mesiolingual cusp appears to be taller than the other cusps, which are worn flat. The crown is mesiodistally long relative to its breadth. The right M_3 crown is preserved although some cracks on its occlusal surface obliterate the occlusal morphology. The buccal cusps and the hypoconulid are worn flat but no dentine is exposed on any of them. The crown is mesiodistally long relative to its breadth. The metaconid apex is hardly worn. The buccal face of the crown slopes occlusally whereas the lingual face is almost vertical. The mesial marginal ridge is obliterated by wear.

c. BRT-VP-3/37

This specimen is fragment of a right maxilla with a complete P^4 crown and roots of the P^3. The preserved bony part does not allow detailed description of the maxillary morphology. However, the visible buccal root of the P^4 indicates that it formed a jugum with a shallow vertical depression mesially separating it from the buccal root of the P^3. The crown of the P^4 is complete although a thin longitudinal crack runs across its central axis. The crown is mesiodistally compressed giving it a buccolingually long oval occlusal outline. In mesial and distal views, the crown is much wider at its base than at its occlusal surface because the buccal

face tapers occlusally. The protocone is smaller than the paracone and these two cusps are separated from each other by a deep longitudinal groove. The apices of both cusps are slightly polished by wear (protocone more polished than the paracone) although no dentine is exposed. The entire occlusal surface of the protocone is more or less flat. A buccolingually long slit-like anterior fovea is bounded mesially by a well-defined Mmr. The posterior fovea is much larger and the Dmr is also thicker than the Mmr. The mesial IPF is buccolingually wide, concave, and close to the occlusal rim, whereas there is no sign of distal IPF.

d. WYT-VP-2/10 (Extended Data Fig. 2i-o)

Preservation: This specimen is an adult edentulous mandible recovered in two pieces. The right corpus is well preserved from the posterior M_1 level to the symphysis. Only a hairline longitudinal crack runs close to the corpus base, extending from the broken distal edge to the level of the canine anteriorly. The second piece is the corpus under the right M_3 and joins with the larger piece. The base of this smaller piece is missing and its lateral face is abraded. The left corpus is missing entirely, except for the basal part at the C/P_3 level. The symphyseal region is preserved intact. However, the alveolar margin along the incisors is abraded.

***Lateral aspect*:** The alveolar margin on the preserved right side is abraded. However, it appears that it runs parallel to the corpus base, at least in the preserved area. A short canine jugum is present close to the broken alveolar margin. This jugum distally bounds a small but deep depression between the canine and I_2. The surface below the premolars is smooth and there is no sign of a P_3 jugum. There is a small, localized depression immediately behind the mental foramen. The right mental foramen opens superolaterally and it is positioned at the center of the P_3 and near mid-corpus, with its inferior edge 17.4 mm from the corpus base. The foramen is 3.6 mm superoinferiorly and 3.4 mm anteroposteriorly. The left foramen is also preserved at about

the same position as the right side although it is slightly smaller. There are no accessory foramina on the preserved right side. The posterior part of the corpus is largely missing behind the point where the lateral prominence would have been and the preserved area immediately below the M_3 is obliterated by abrasion.

***Anterior aspect*:** The symphyseal region is anteriorly convex in the coronal and transverse planes. The alveolar margin of the incisors is abraded although there are no signs of incisal juga. In lateral view, it gently slopes inferiorly for the superior two-thirds of its course and drastically sweeps posteroinferiorly beginning at the base of the strong basal insicura. The depression anterior to the right canine jugum appears to have also been present on the left side even though it was much smaller and shallower.

***Medial aspect*:** The alveolar margin cannot be determined due to abrasion. However, the internal contour in the preserved region between the canine and M_1 is smooth with no interruptions due to root bulging. The prominent superior transverse torus posteriorly continues all the way to the M_2 level and superiorly bounds a shallow subalveolar fossa that extends anteriorly to the P_4 level. A deep mylohyoid groove runs anteroinferiorly into this sulcus and this groove forms the superior boarder of the inferior transverse torus. In mid-sagittal cross-section, the postincisive planum is short relative to the overall vertical height of the symphysis. It is slightly concave both vertically and transversely and gently slopes posteroinferiorly. The superior transverse torus is prominent, set above mid-corpus level and slightly overhangs the anterior wall of the genioglossal fossa. Posteriorly, it extends to the level of the posterior P_3 when viewed occlusally. The less prominent inferior transverse torus, however, extends posteriorly to the level of the P_4/M_1. The genioglossal fossa is deep, superoinferiorly long, and divided into two halves by a strong vertical genioglossal spine that continues all the way to the center of the inferior

transverse torus. The superior transverse torus appears to have been more tightly curved than the inferior transverse torus.

***Basal aspect*:** The anterior part of the base is preserved intact and it is thick and rounded below the P_3-M_1 level. It is also thick and rounded at the base of the symphysis with a shallow digastric fossa visible on the right side.

***Occlusal aspect*:** It is difficult to determine the orientation of the premolar-molar row due to the absence of teeth on this specimen. However, it is apparent that the canines and incisors were arranged in a straight line. The dental arcade also appears to have been a wide parabola. The anterior end of the superior transverse torus was much narrower than that of the inferior torus. The premolars appear to have three roots with separate root canals. The buccal root is the largest and the smaller mesiolingual and slightly larger distolingual roots merge with the buccal root close to the base of the crowns (see Extended Data Fig. 2o).

Supplementary Note 3. Geology, geochronology, and magnetostratigraphy

Geological context and age

BRT-VP-3 is located 3.5 km south of the Mille River, on the north side of the Mille-Chifra Road, 2 km west of the Waytaleyta River crossing (see Fig. 2a in the main text). The BRT-VP-3 fossils are surface finds, weathered out of planar laminated fine sandstone, locally overlying cobble conglomerate, at the bottom of a 6 m thick section of scree-covered siltstone and fine sandstone. This detrital section is overlain by a basalt flow (2-6 meters thick) that is traceable eastward and northeastward, where it underlies a younger sedimentary section at BRT-VP-1 and BRT-VP-2 (Fig. 2b in the main text), the geology of which was described previously[1]. The younger section, above the Burtele basalt, consists of siltstone and sandstone with locally well developed vertisols[1]. Approximately 1 m above the basalt lies the Burtele tuff (an altered vitric tuff) with a single-crystal K-feldspar $^{40}Ar/^{39}Ar$ age of 3.469 ± 0.008 Ma[1]. Normal paleomagnetic polarities were found in the sandstone below the basalt, the basalt itself, and the section above the basalt. This places the entire composite section, including the fossils from BRT-VP-3, BRT-VP-2 and WYT-VP-2, in chron C2An.3n (3.596-3.330 Ma) of the Astronomically Tuned Neogene Time Scale (ATNTS2004)[15] (Fig. 3 in the main text). These measurements bracket the age of the BRT-VP-3 fossil horizon between 3.596 Ma (maximum from ATNTS2004) and 3.469 Ma (minimum from $^{40}Ar/^{39}Ar$ on the Burtele tuff). The age of the Burtele foot horizon is bracketed between 3.469 Ma (maximum from the age of the Burtele tuff) and 3.330 Ma (minimum from ATNTS2004). WYT-VP-1 is located ~2 km east of BRT-VP-3 and ~1 km south of the measured section in Figure 3 (see main text). Strata at this site are laterally equivalent to those at BRT-VP-2 and are subject to the same age brackets.

Magnetostratigraphy of the Burtele area

The Burtele area exposes siltstones, claystones and sandstones, modified by pedogenic carbonate deposition and growth of diagenetic celestine nodules. These strata are predominantly fluvial in origin, as indicated periods of pedogenic modification and the occurrence of vertebrate fossils. Aquatic vertebrate fossils (fish, turtle, crocodile) and two gastropod beds are, however, found in the lower part of the section. Also, a carbonate bed <20 cm thick is found toward the middle of the section, suggesting the ephemeral development of a fresh water environment. The sandstones beds are up to 1 m thick and exhibit parting lineation and trough cross bedding indicating a dominant eastward paleoflow direction.

Composite section: The topography of the Burtele area exhibits low relief, with small hills and mesas that provide limited exposure. A composite stratigraphic section was constructed by correlating four subsections along a E-W transect. Key units for correlation include: the basal basalt flow, the Burtele tuff near the base of the section, a carbonate bed toward the middle of the section, palaeosols, and continuous sandstone beds. The composite thickness above the basalt is 30 m, between the lowest strata, (basalt flow UTM: 668228/1268779) and the highest stratigraphic outcrop located 1.2 km to 118º direction (669270/1268218). The basalt flow can be followed continuously to the vertebrate locality BRT-VP-3, 1.5 km to the northwest (UTM: 667600/1267351), where 6 m of sedimentary strata are exposed beneath the basalt. In total a composite section of 36 m was measured, including the fossil localities BRT-VP-3, (base), BRT-VP-1, (middle section) and BRT-VP-2 and WYT-VP-2 (top) (Extended Data Fig. 3a).

Paleomagnetic measurements: Paleomagnetic polarity determinations were made for each of the four stratigraphic subsections. A total of 16 samples were collected, from the sedimentary section, consisting of oriented blocks ~500 cm^3 in size, from unaltered fine-grained siltstones

and claystons. In addition two oriented samples were collected from the basalt horizon. The stratigraphic interval between samples varied between <1 m and a maximum of 6 m. Samples were oriented with a Brunton compass, removed from the outcrop, and wrapped plastic film for protection during transport, and ultimately stored in a magnetically shielded room at Berkeley Geochronology Center until paleomagnetic measurements were completed. The blocks were sawn in the laboratory into specimen cubes of (12 cm^3) and the natural remanent magnetization (NRM) was measured in a cryogenic magnetometer. To eliminate secondary magnetizations, alternating field demagnetization was applied to the specimens to remove shorter viscous remanence. Thermal demagnetization at ~50ºC steps up to 400ºC, was applied to remove remanence from the weathering mineral goethite and to isolate the characteristic (primary) magnetic polarity.

Results: The quality of the samples varies between AA, A and B. Nine samples have an AA grade and represent the best and most secure directions, 6 samples are A and one sample is B showing scattered directions between the three different specimens. All these samples show normal remanence directions. The two samples collected from a single basalt flow show transitional directions although samples collected below and above this basalt show normal polarity suggesting that in the basalts the secondary magnetization was not completely removed during the demagnetization procedure. We conclude that all sedimentary rocks and basalt in the Burtele area were deposited during a period of normal polarity (Extended Data Fig. 3b).

Age assignment for BRT-VP-3 locality: The Burtele tuff in the lower part of the section was dated using single-crystal $^{40}Ar/^{39}Ar$ method on K-feldspar phenocrysts to 3.469 ± 0.008 Myr[1]. The stratigraphic interval encompassing the tuff and extending to the top of the local exposures has only normal polarity, and falls within chron C2An3n (3.330-3.596 Myr) of the

'Astronomically Tuned Neogene Time Scale' ('ATNTS2004')[15]. The fossiliferous horizon at BRT-VP-3 is stratigraphically 8 meters below the tuff and lies within the same polarity chron, thus is constrained to the interval 3.469–3.596 Ma. Using local sediment accumulation rates, we can further constrain the age of the BRT-VP-3 level. A minimum of 26 meters of sedimentary strata accumulated in the 140 ka between the tuff (3.47 Myr) and the highest exposed strata (<3.33 Ma), giving a minimum sediment accumulation rate of 18.6 cm/ka for the upper part of the section. This rate can be used to calculate the stratigraphic interval between the Burtele tuff and the fossil site BRT-VP-3. However, 2 m within the 9 m section corresponds to the basalt flow, which represents an instantaneous event that should be omitted for the purposes of rate calculations. The remaining 7 m of silts and sands (6 m below the basalt and 1 m above it) represent a period of <37.6ka (700 cm/18.6cm/ka = 37.63 ka), and yield a maximum age of 3.506 Ma, (3.469 ± 0.0376 Myr) for the fossil site.

Supplementary Note 4. MicroCT Scanning

The BRT-VP-3/1, BRT-VP-3/14, and WYT-VP-2/10 specimens were scanned on the OMNI-X HD600 high-resolution computed tomography scanner at the Pennsylvania State University Center for Quantitative Imaging. Each sample was mounted in a plastic tube and embedded in ~100 micron spherical glass beads. Scan settings are provided in Extended Data Table 3. The highest possible resolution was obtained for each specimen based on size and preservation. Images were reconstructed as 16 bit TIFFs with 1024x1024 pixel grid.

Quantification of Enamel Thickness

Enamel thickness was measured on the preserved first and second upper molars of BRT-VP-3/1 using the microCT data. Each tooth was cropped from the full dataset in Avizo 8.0 (FEI Visualization Sciences Group). The enamel was segmented from the underlying dentine using the hysteresis thresholding in Avizo 8.0.

Both 2D and 3D enamel thickness metrics were computed to facilitate comparison with values reported in other studies. The 2D linear enamel thickness methods followed those outlined in refs. 16 and 17. Each molar was resliced in Avizo along the plane of the mesial enamel dentine junction (EDJ) cusp tips. This mesial cusp section (MCS) as defined elsewhere[16,17] was then used to measure radial thickness in six locations: lingual and buccal cusp tip thickness, lingual and buccal maximum occlusal thickness, and lingual and buccal maximum lateral thickness. Two-dimensional distance maps were used to aid in determining the optimal location to measure thickness at each of these positions on the molar cross-section. The buccal and lingual cusp tips were too worn to measure on the BRT-VP-3/1 M^1, but the other linear distances could be effectively measured. All six values were measured on the M^2.

The 2D and 3D average enamel thickness values were also measured on the unworn M^2 following published methods[17-19]. Variables collected included the 3D average enamel thickness (3D AET) and 3D relative enamel thickness (3D RET). AET is defined as enamel volume divided by EDJ surface area. 3D RET is defined as 3D AET divided by the cube root of the crown dentine volume[18,19]. Two-dimensional AET was calculated by measuring the enamel and dentine areas on the MCS. The 2D RET was calculated by dividing the 2D AET by the square root of EDJ length. These variables were calculated using the separately segmented enamel and dentine datasets in Avizo 8.0.

The 2D and 3D enamel thickness values for the BRT-VP-3/1 M^1 and M^2 are listed in Extended Data Table 3. The BRT-VP-3/1 molars have relatively thick enamel compared to other fossil hominins. The 2D linear enamel thickness for M^1 is similar to that of other early hominins.

Supplementary Note 5. Metric comparison of mandibular dental size and corpus dimensions

In the comparison section of the main text we mention that the postcanine teeth of BRT-VP-3/1, particularly the P^4 and M^1, are very small and the dentition of BRT-VP-3/14, particularly the premolars and the M_1, are also small relative to *Au. afarensis*. Details of the maxillary teeth are given in the main text. Here we describe the mandibular postcanine dental dimensions of BRT-VP-3/14. Comparative measurements of mandibular teeth are provided in Extended Data Table 5. We compiled the measurements for *Au. anamensis, Au. afarensis, Au. africanus, P. robustus* and *P. boisei* from ref. 20 and those for early *Homo* from ref. 21.

The BRT-VP-3/14 premolars are notably small, particularly in their mesiodistal (MD) dimensions. The P_3 MD is smaller than all hominins included in Extended Data Table 5, whereas the buccolungual (BL) dimension is close to the mean value of *Au. afarensis* and falls within the range of all other hominins. Similarly, the P_4 MD of BRT-VP-3/14 falls at the lower end of the *Au. afarensis* range while the BL is close to the mean. The dimensions of the BRT-VP-3/14 M_1 are within the range of *Au. afarensis* although its MD is slightly below the mean for the species. However, most of the M_2 and M_3 dimensions of BRT-VP-3/14 are above the mean values of *Au. afarensis*. The premolar/molar MD length ratio of BRT-VP-3/14 is 0.37. This ratio is 0.54 for *Au. afarensis* when calculated using the mean values of premolar and molar MD for the species. The same method of calculation provides values of 0.50 (early *Homo*), 0.45 (*P. robustus*), and 0.48 (*P. boisei*). This indicates that BRT-VP-3/14 has premolars with relatively small MD dimensions compared to the molars. The phylogenetic and/or taxonomic significance of the

combination of small premolars and M_1 with large M_{2-3} in BRT-VP-3/14 is currently unclear but needs further investigation with additional fossil discoveries.

Given the small size of the premolars and M_1, the *Au. deyiremeda* mandibular corpus is surprisingly robust. Figure 5 in the main text depicts the bivariate scatter of mandibular corpus dimensions (height and breadth) at the M_1 and M_2 levels among Plio-Pleistocene hominins. Confidence ellipses (95%) enclose the *Au. afarensis*, *P. boisei* and early *Homo* samples. Ellipses are not depicted for the other comparative taxa because sample sizes are too small for ellipses to be informative (i.e. they encompass all of the bivariate space). Analyses were carried out in the PAST statistical platform[22].

The dimensions of the mandibular corpus tend to be absolutely larger and relatively broader in *Paranthropus* than in other Plio-Pleistocene hominins[23]. The bivariate plot of mandibular corpus height and breadth at the M_1 level (Fig. 5a in main text) shows that WYT-VP-2/10 is relatively broad, most comparable to specimens assigned to *Paranthropus boisei*. It falls outside the *Au. afarensis* and early *Homo* confidence ellipses. BRT-VP-3/14 falls within the overlapping confidence ellipses of all hominin taxa with regard to the corpus dimensions at M_1, but is relatively broader than *Au. afarensis* and early *Homo* at the M_2 level (Fig. 5b in main text).

Supplementary Note 6. Phylogenetic Analysis

Methods

A parsimony analysis was performed to assess the phylogenetic position of *Au. deyiremeda*. Characters and character state assignments (see Supplementary Notes 7 and 8) were assembled from the literature[12,13,24,25], with the addition of information provided by more recent morphological descriptions[14,26-29] and with slight adjustments in accordance with anatomy preserved in the *Au. deyiremeda* hypodigm. State assignments for *Au. deyiremeda* were calibrated relative to those reported for known hominin species in previous studies[12,14,24,25]. *Pan* served as the outgroup. The analysis was conducted using the Pars program in PHYLIP (version 3.695)[30], which employs a heuristic search algorithm to identify most parsimonious trees. Character states are treated as unordered and unweighted.

Results

The limited number of characters preserved in the *Au. deyiremeda* hypodigm fails to produce a single most-parsimonious tree. Node instability is produced primarily by alternative topologies among *Au. garhi*, *K. platyops*, *Paranthropus* and *Homo* species, but the position of *Au. deyiremeda* is fairly consistent. The majority of the most-parsimonious trees (11/17) position *Au. deyiremeda* as the sister taxon of a clade that includes *Au. africanus*, *K. platyops* and all *Paranthropus* and *Homo* species. The remaining most-parsimonious trees differ only in either including *Au. garhi* in the latter clade (29%) or in placing *K. platyops* and *Au. deyiremeda* together in a sister clade of the *Au. africanus* + *Paranthropus* + *Homo* clade (6%).

Discussion

Australopithecus deyiremeda shares a number of features with *Au. afarensis* that are derived relative to *Au. anamensis* and *Ar. ramidus*, including a less receding mandibular symphysis, the presence (although weakly expressed) of a P_3 metaconid, and thicker enamel. Concurrently, *Au. deyiremeda* is more derived than *Au. afarensis* in terms of the smaller dentition and anterior position of the zygomatic and ascending ramus roots. Furthermore, the relatively broad mandibular corpus and thickly enameled molars fall at or beyond the known limits of *Au. afarensis* variation. In conjunction with spatiotemporal evidence, this morphology suggests that *Au. deyiremeda* is most likely a descendant of *Au. afarensis*.

A number of morphological features, including thick enamel, a relatively wide mandibular corpus, and anteriorly positioned zygomatic and ascending ramus roots, are associated with the genus *Paranthropus*. However, *Au. deyiremeda* does not appear to be closely related to *Paranthropus* because it lacks the dental adaptations that characterize this genus (i.e. molarized premolars, enlarged molars and reduced incisors). *Kenyanthropus platyops* likewise exhibits similarities to *Paranthropus* but lacks the postcanine expansion and many other facial morphological features seen in the latter genus[13]. One study[25] suggested that if *K. platyops* is a valid species, it forms a clade with *Paranthropus* and *Homo.* Others have proposed that *K. platyops* could be the potential ancestor of *Homo rudolfensis*[13], even prompting the transfer of the latter species into the genus *Kenyanthropus* largely based on the flatness of the face[31]. Some aspects of *Au. deyiremeda* morphology, including the parasagittally aligned mandibular premolars and molars, poorly developed P_3 metaconid and primitive maxillary canine, suggest that it is too primitive to belong within the *Parathropus/Homo* clade. In conclusion, our phylogenetic analysis places *Au. deyiremeda* outside the *Paranthropus/Homo* clade and could be a potential ancestor of this clade.

Supplementary Note 7. Characters used in the phylogenetic analysis and descriptions of character states. Definitions and state designations follow refs. 24 and 25), except where indicated.

Character	Character states
Maxilla	
Protrusion of incisor alveoli beyond (anterior to) bi-canine line	0: yes, 1: no
Nasal cavity entrance	0: stepped , 1: variable , 2: smooth with overlap , 3: smooth without overlap
Palate Thickness	0: thin, 1: thick
Anterior palatal depth	0: shallow , 1: variable , 2: deep
Subnasal angle[a]	0: low (≤40°), 1: high (> 40°)
Anterior zygomatic root position[a]	0: posterior, 1: anterior (hypodigm includes specimens with root positioned at P3/P4 level or more anteriorly)
Mandible	
Mandibular corpus area	0: small , 1: variable, 2: large
Orientation of the mandibular symphysis	0: receding, 1: intermediate, 2: vertical
Hollowing of the lateral mandibular corpus	0: present inferiorly, 1: variably reduced or absent, 2: absent
Orientation of mandibular Premolar row	0: P_3-P_4 MD axis is parasagittal, and thus in line with the straight molar rows, 1: P_3-P_4 MD axis is obliquely inclined to the sagittal plane
Mental foramen SI position[b]	0: very low, 1: low, 2: intermediate, 3: high
Anterior limit of root of mandibular ramus[b]	0: posterior to M_1, 1: intermediate, 2: anterior to M_1
Dentition	
Incisors reduced	0: no, 1: moderate, 2: yes
Canines reduced	0: no, 1: somewhat, 2: very
Premolar crown area	0: smallest to 5: largest
Molar crown area[c]	0: smallest to 3: largest
P_3 metaconid development	0: metaconid absent, 1: metaconid very small/infrequently present, 2: metaconid large/frequently present
Enamel thickness[d]	0: very thin, 1: thin, 2: thick, 3: hyperthick
Postcanine cusp position[b]	0: marginal, 1: intermediate, 2: convergent

[a] Character definition and comparative data taken from ref. 14.
[b] Character definition and comparative data taken from ref. 12.
[c] Due to preservation, only M^1 and M^2 area was considered for BRT-VP-3/1 and only M^2 for KNM-WT 40000.
[d] The "thin" category of ref. 25 was split, to accommodate the descriptions of *Ar. ramidus* and *S. tchadensis* as intermediate between *Pan* and *Australopithecus*.

Supplementary Note 8. Characters and their state assignments in *Pan* and hominin species, including *Au. deyiremeda*.

Character	*Pan*	*S. tchadensis*	*Ar. ramidus*	*Au. anamensis*	*Au. afarensis*	*Au. garhi*	*Au. deyiremeda*	*Au. africanus*	*P. aethiopicus*	*P. boisei*	*P. robustus*	*K. platyops*	*H. rudolfensis*	*H. habilis*	*H. erectus*	*H. sapiens*
Incisor alveoli	0	?	0	?	0	0	0	0	1	1	1	1	1	0	0	0
Nasal cavity	0	?	?	?	0	0	0	0	2	2	2	0	0	1	0	3
Palate thickness	0	?	?	0	0	0	0	0	1	1	1	0	0	0	0	0
Ant. palate depth	0	0	?	0	0	0	2	2	0	2	0	2	2	1	2	2
Subnasal angle	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1
Zygomatic root position	0	0	0	0	0	0	1	0	1	1	1	1	1	0	0	0
Man. corpus area	0	0	0	0	0	?	1	0	2	2	2	?	1	0	0	0
Orientation of symphysis	0	2	0	0	1	?	1	1	2	2	2	?	2	2	2	2
Lateral corpus hollow	0	?	0	0	0	?	2	1	2	2	2	?	1	2	2	2
Orientation premolar row	0	0	0	0	0	?	0	1	1	1	1	?	1	1	1	1
Mental foramen SI position	0	1	1	1	1	?	1	2	?	3	2	?	2	2	2	?
Ramus root ant. limit	0	?	0	0	1	?	2	1	?	2	1	?	1	1	1	?
I reduced	0	0	1	1	1	1	1	1	1	2	2	?	1	1	1	2
C reduced	0	1	1	1	1	1	2	1	2	2	2	1	2	2	2	2
Premolar crown area	0	1	1	1	1	4	1	2	4	5	3	?	2	1	1	0
Molar crown area	0	0	0	1	1	2	0	2	3	3	2	0	2	1	0	0
P_3 metaconid	0	?	0	0	1	?	1	2	2	2	2	?	2	2	2	2
Enamel thickness	0	1	1	2	2	2	3	2	3	3	3	2	2	2	2	2
Postcanine cusp position	0	1	1	1	0	?	1	1	?	2	2	?	0	0	0	?

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