EARLY BRONZE AGE STRATA AT TELL GHANEM AL-ALI ALONG THE MIDDLE EUPHRATES IN SYRIA: A PRELIMINARY REPORT OF ^{14}C DATING RESULTS

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ABSTRACT. We collected charcoal fragments during an archaeological excavation at the Tell Ghanem al-Ali site, located on the lowest terrace of the middle Euphrates River, and measured their radiocarbon ages with accelerator mass spectrometry (AMS). Two trenches, Square-1 and Square-2, were dug on the slope of the tell; 8 building levels were detected in the Square-2 trench. In total, 31 charcoal samples were collected from the 2 trenches, and their calibrated ages ranged from 3100–2900 cal BC at the lowest building level to 2400–2050 cal BC at the uppermost layers of the mound, and concentrated in the period 2650–2450 cal BC. The pottery fragments collected on the surface of the mound before the excavation survey was started, as well as those collected from the sediment layers during the excavation, were assigned on the basis of typological sequences to the Early Bronze Age (EB)-III and EB-IV periods. Thus, the concentrated dates (2650–2450 cal BC) obtained by ^{14}C dating are consistent with the age estimated by archaeological contexts. However, the oldest dates of the lowest level (level-7) go back to 3100–2900 cal BC, and these dates may suggest the existence of the human residence prior to the EB period at the site, and may therefore lead to a revision of the oldest age limit of the EB period currently accepted in the region.

INTRODUCTION

Relative chronology of the Early Bronze Age (EBA) based on archaeological studies such as a typological analysis of pottery or stone tools is not well established in the areas of the middle Euphrates. Whenever chronological results in this area are reported, they are compared generally with the chronology formed in Palestine, Turkey, or Mesopotamia (Anastasio et al. 2004), because the chronological framework in any area is strongly connected with and influenced by those in nearby areas as the result of material and cultural exchanges, and in particular, human interchange among the areas. In addition, formation of the absolute chronology in the EBA has been tried on the basis of fixed dates of historical events, such as the recorded battles of Sargon, king of the Akkadian Empire, but this historical chronology is not yet completed even in Mesopotamia. Therefore, it is quite important for researchers who study historical events in the 3rd millennium BC in the middle Euphrates to choose a method of estimating reliable dates of archaeological remains, and accelerator mass spectrometry (AMS) ^{14}C dating is one of the practical and useful methods available. However, there is an intrinsic problem in the application of ^{14}C dating to establish an absolute chronology, which arises in calibrating ^{14}C ages to calendar dates. In fact, one of the calibration curves presently available, IntCal04, for example, is not monotonous in the period of 3rd millennium BC, but fluctuates so that a certain ^{14}C age could correspond to multiple possible calendar dates. Thus, ^{14}C dating is not necessarily a perfect tool for establishing the absolute chronology of the EB period, as will be demonstrated in this study. However, Bayesian sequential analysis can be applied to overcome this problem for a well-defined stratigraphic sequence of archaeological layers.

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As described above, both the relative and absolute chronology frameworks of the EBA are not well established in the middle Euphrates region at present. To contribute to the archaeological studies at the Tell Ghanem al-Ali site, we focused on the temporal strata of the site in the EBA by applying AMS ^{14}C dating to carbonaceous samples collected from archaeological layers at the site. We present here a preliminary report concerning mainly the ^{14}C ages obtained. When the sedimentary sequence of the excavated layers will be established at the Tell Ghanem al-Ali site, we will then apply Bayesian sequence analysis to our ^{14}C data.

TRENCH EXCAVATION AND SAMPLE COLLECTION AT TELL GHANEM AL-ALI

The Tell Ghanem al-Ali archaeological site is located on the right flood plain along the middle Euphrates, about 60 km southeast of Raqqa (Figure 1), one of old cities in the Republic of Syria. The site is ~250 m wide from east to west, 300 m wide from south to north. The top of the mound is ~10 m from its ground level at an altitude of ~229 m (Figure 2). The mound is covered with modern graves of local inhabitants.

Figure 1 Locations of the Tell Ghanem al-Ali site and the city of Raqqa, Republic of Syria

For archaeological excavations, 2 trenches were placed on the eastern and northern slopes of the mound (Ohnuma and Al-Khabour 2008). A trench named Square-1 (10 m east-west, 10 m south-north) was set on the eastern slope of the mound where some structures such as white mud or stones and several remains forming a square in shape were clearly observed on the surface. We excavated the Square-1 trench down to only the shallowest building level, and we concentrated on the Square-2 trench. The Square-2 trench, stepped in structure, was set along the northern slope of the mound, covering an area of 4 m east to west and 27 m south-north (Figure 3). Excavations and collection of samples for ^{14}C dating at each trench are briefly described below.

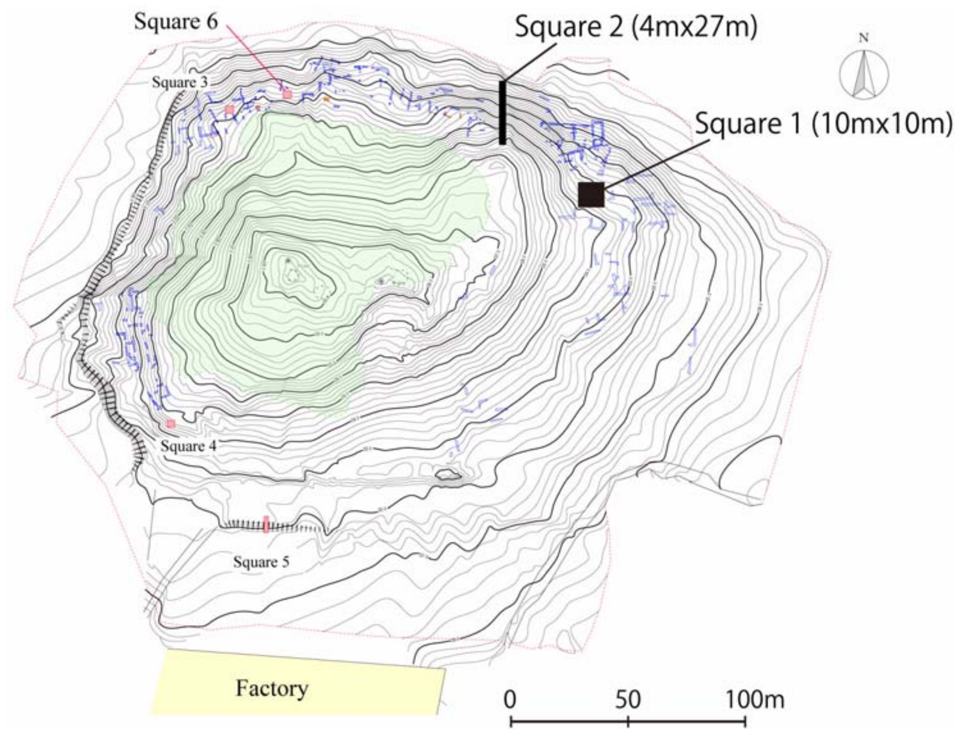

Figure 2 Locations of Square-1 and Square-2 trenches excavated at the Tell Ghanem al-Ali site

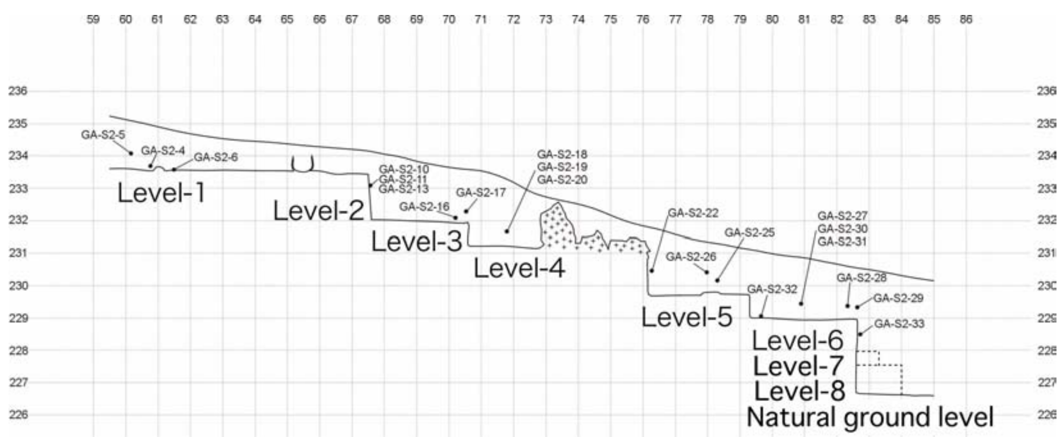

Figure 3 Simplified view of the west cross-sectional outcrop of Square-2 trench. Locations of sampling charcoal fragments are shown with their labels.

Excavations in Square-1 Trench

At the Square-1 trench, surface soils were removed to access the building level containing the archaeological remains consisting of stone and mud-brick wall structures (Hasegawa 2008). At the base floor on which stone and mud-brick walls exist, many structural remnants and archaeological remains such as pottery fragments, cooking pot ware, a hearth, etc., typically found in this region, were recognized. We collected 7 samples of charcoal fragments for ^{14}C dating, from the floor surface (nr 1 in Table 1a) and from different depths of the west (nr 2, 5, 6) and south (nr 3, 4, 7) cross-sectional outcrops of the trench. The sample from the floor surface was selected among the small-scale charcoal aggregations. Other samples were picked from the trench walls as small fragments of charcoal. All charcoal fragments collected for ^{14}C dating should have produced presumably by fire during human activities.

Table 1a ^{14}C age and calibrated dates for charcoal samples collected from the Square-1 trench, at the Tell Ghanem al-Ali site, Raqqa, Syria. Calibration was done with IntCal04 (Reimer et al. 2004)

Nr	Sample code	Sampling location, depth (d) from surface (cm)	$\delta^{13}C^a$ (‰)	^{14}C age (BP ±1 σ)	Calibrated age (2-σ range with probability in %)	Lab # (NUTA2-)
1	GHA07-2 (MH-070823-06)	on the floor surface, d = 60	–25.9	4019 ± 28	2619–2608 cal BC (2.1%) 2598–2594 cal BC (0.7%) 2583–2471 cal BC (92.6%)	13542
2	GHA07-3 (MH-070827-03)	west cross-sectional outcrop, d = 50	–26.8	4001 ± 30	2578–2468 cal BC (95.4%)	13099
3	GHA07-7	south cross-sectional outcrop, d = 10	–30.3	4221 ± 30	2906–2852 cal BC (43.2%) 2813–2743 cal BC (42.5%) 2726–2696 cal BC (9.7%)	13538
4	GHA07-1234	south cross-sectional outcrop, d = 10	–27.4	4055 ± 31	2837–2815 cal BC (6.5%) 2672–2479 cal BC (88.9%)	13103
5	TGAA-1	west cross-sectional outcrop, d = 70	–25.5	4095 ± 29	2861–2808 cal BC (20.7%) 2756–2719 cal BC (8.1%) 2704–2569 cal BC (64.7%) 2515–2501 cal BC (2.0%)	13080
6	TGAA-2	west cross-sectional outcrop, d = 60	–23.1	4107 ± 29	2865–2806 cal BC (23.4%) 2760–2573 cal BC (72.0%)	13083
7	TGAA-3	south cross-sectional outcrop, d = 60	–26.8	4048 ± 32	2836–2816 cal BC (4.8%) 2667–2474 cal BC (90.6%)	13084

[a] $\delta^{13}C$ values shown are measured with the Nagoya AMS system (1-σ uncertainty of about ±1‰).

Excavations in Square-2 Trench

At the Square-2 trench, we could have identified at least 8 building levels, from level-1 to -8 in descending order (Kiuchi 2008; Hasegawa 2009), with stepped structures (Figure 3). The elevation changes from 234.5 m asl at the level-1 floor to 227.6 m asl at the level-8 floor. The altitude of the top horizon of the base sediment (natural ground) at the northern end of the mound is 226.9 m asl. The excavated area at the deepest layer of Square-2 almost reaches the northern rim of the Tell Ghanem al-Ali site.

We collected several charcoal fragments for AMS ^{14}C dating, from 24 horizons belonging to 7 building levels (Table 1b). Figure 3 shows the west cross-sectional outcrop of the Square-2 trench, from which most of the charcoal samples were collected. The samples obtained from other places except this wall are not included in Figure 3. Five charcoal samples (nr 17–21) were collected from the same horizontal layers, consisting of charcoal aggregates ~3 cm thick or less. The ^{14}C ages obtained for these charcoal samples were unusually younger than those for other samples belonging to the same building levels, as will be discussed later in detail. All other samples were picked from cross-sectional outcrops as small charcoal fragments. Samples from level-8 and below are now under ^{14}C analysis, and are not listed in Table 1b.

Table 1b ^{14}C age and calibrated dates for charcoal samples collected from the Square-2 trench, Tell Ghanem al-Ali site, Raqqa, Syria.

Nr	Sample nr	Building level #	Altitude of sampling point (m)	$\delta^{13}C^a$ (‰)	^{14}C age (BP)	Calibrated age BC (calibrated with IntCal04, 2-σ range with probability in %)	Lab # (NUTA2-)
1	GA-S2-1	1st	233.96	−26.1	3970 ± 28	2574–2454 cal BC (91.5%) 2419–2407 cal BC (1.5%) 2376–2351 cal BC (2.4%)	14132
2	GA-S2-2	1st	234.08	−25.1	3914 ± 30	2475–2298 cal BC (95.4%)	14133
3	GA-S2-4	1st	233.70	−27.0	4007 ± 29	2579–2469 cal BC (95.4%)	14134
4	GA-S2-5	1st	234.08	−12.3	4053 ± 29	2836–2816 cal BC (5.5%) 2667–2479 cal BC (89.9%)	14135
5	GA-S2-6	1st	233.55	−17.4	4031 ± 30	2827–2825 cal BC (0.4%) 2625–2473 cal BC (95.0%)	14136
6	GA-S2-10	2nd	233.20	−26.7	3963 ± 32	2573–2511 cal BC (37.4%) 2506–2400 cal BC (50.6%) 2382–2347 cal BC (7.3%)	14139
7	GA-S2-11	2nd	233.10	−28.0	4007 ± 35	2620–2466 cal BC (95.4%)	14140
8	GA-S2-13	2nd	233.15	−24.3	3946 ± 28	2566–2524 cal BC (15.0%) 2497–2344 cal BC (80.4%)	14086
9	GA-S2-16	3rd	232.08	−26.5	4058 ± 27	2836–2815 cal BC (6.6%) 2671–2487 cal BC (88.8%)	14087
10	GA-S2-17	3rd	232.28	−26.8	4076 ± 31	2858–2811 cal BC (14.8%) 2749–2723 cal BC (3.7%) 2700–2562 cal BC (65.7%) 2535–2492 cal BC (11.2%)	14169
11	GA-S2-18	4th	231.66	−23.7	4071 ± 31	2854–2812 cal BC (12.9%) 2746–2726 cal BC (2.5%) 2697–2561 cal BC (65.2%) 2537–2491cal BC (14.8%)	14171
12	GA-S2-19	4th		−25.2	4010 ± 31	2618–2610 cal BC (1.2%) 2581–2464 cal BC (94.2%)	14172
13	GA-S2-20	4th		−25.2	4117 ± 31	2867–2804 cal BC (24.6%) 2777–2577 cal BC (70.8%)	14173
14	GA-S2-22	5th	230.46	−24.1	3808 ± 31	2398–2384 cal BC (1.3%) 2346–2140 cal BC (94.1%)	14174
15	GA-S2-25	5th	230.15	−26.0	4215 ± 31	2903–2850 cal BC (36.7%) 2814–2741 cal BC (45.7%) 2729–2694 cal BC (12.2%) 2686–2680 cal BC (0.7%)	14175
16	GA-S2-26	5th	230.41	−24.4	3838 ± 31	2459–2417 cal BC (8.7%) 2410–2201 cal BC (86.7%)	14176
17	GA-S2-27	6th	229.44	−25.4	3703 ± 27	2198–2167 cal BC (8.8%) 2150–2023 cal BC (85.8%) 1991–1985 cal BC (0.8%)	14088
18	GA-S2-28	6th	229.37	−27.3	3695 ± 28	2196–2170 cal BC (5.6%) 2146–2016 cal BC (86.7%) 1996–1980 cal BC (3.0%)	14089
19	GA-S2-29	6th	229.32	−26.5	3760 ± 27	2286–2247 cal BC (12.7%) 2235–2127 cal BC (71.8%) 2090–2045 cal BC (10.9%)	14092
20	GA-S2-30	6th		−26.1	3753 ± 28	2281–2249 cal BC (8.8%) 2231–2120 cal BC (69.4%) 2095–2041 cal BC (17.3%)	14093
21	GA-S2-31	6th		−25.9	3744 ± 27	2276–2254 cal BC (4.1%) 2228–2224 cal BC (0.5%) 2210–2114 cal BC (65.2%) 2101–2037 cal BC (25.6%)	14094
22	GA-S2-32	6th		−24.8	4339 ± 28	3022–2897 cal BC (95.4%)	14095
23	GA-S2-33	7th	228.48	−26.0	4410 ± 28	3265–3242 cal BC (3.8%) 3104–2918 cal BC (91.6%)	14096
24	GA-S2-36	7th		−25.1	4351 ± 28	3081–3069 cal BC (2.5%) 3026–2902 cal BC (92.9%)	14097

[a] $\delta^{13}C$ values shown are measured with the Nagoya AMS system (1-σ uncertainty of about ±1‰).

EXPERIMENTAL PROCEDURE

AMS ^{14}C dating was performed at the Center for Chronological Research, Nagoya University, including removal of carbonaceous contaminants from the charcoal samples by acid-alkali-acid (AAA) treatments, CO_2 extraction and purification by combusting the pretreated carbonaceous materials in vacuum, production of graphite from the CO_2 by H_2 reduction on Fe powder, and AMS ^{14}C measurements on the graphite targets (Nakamura et al. 2000, 2004). In our routine ^{14}C measurements, CO_2 of 1.5 mg in carbon is normally used to produce graphite targets.

We used the HOx-II standard (NIST oxalic acid, SRM-4990C) as a ^{14}C-concentration reference. The sample $\delta^{13}C$ values were measured by the AMS system with errors less than ±1‰, including the effects from both machine instability and graphite production (Nakamura et al. 2004), and were used for correction of carbon-isotopic mass fractionation in calculating sample ^{14}C concentrations (Mook and van der Plicht 1999). Finally, conventional ^{14}C ages were calculated (Table 1a,b; Figure 4) for samples from the Square-1 and -2 trenches, respectively. The obtained ^{14}C ages were calibrated to calendar dates by using the calibration program OxCal 4.1 (Bronk Ramsey 1995, 2001) and IntCal04 calibration data set (Reimer et al. 2004), and are given in Table 1a,b and Figure 5.

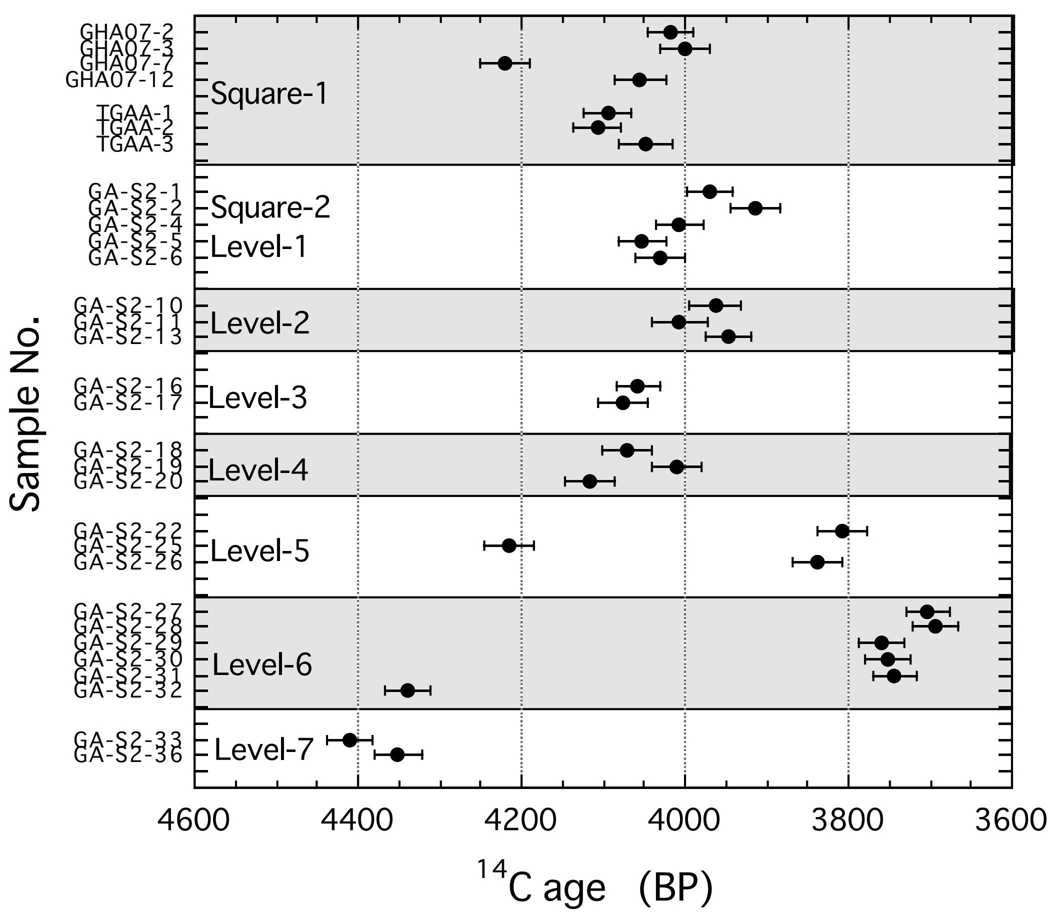

Figure 4 Comparison of ^{14}C ages of charcoal samples divided into subgroups: Square-1 trench; building levels 1 to 7 in the Square-2 trench.

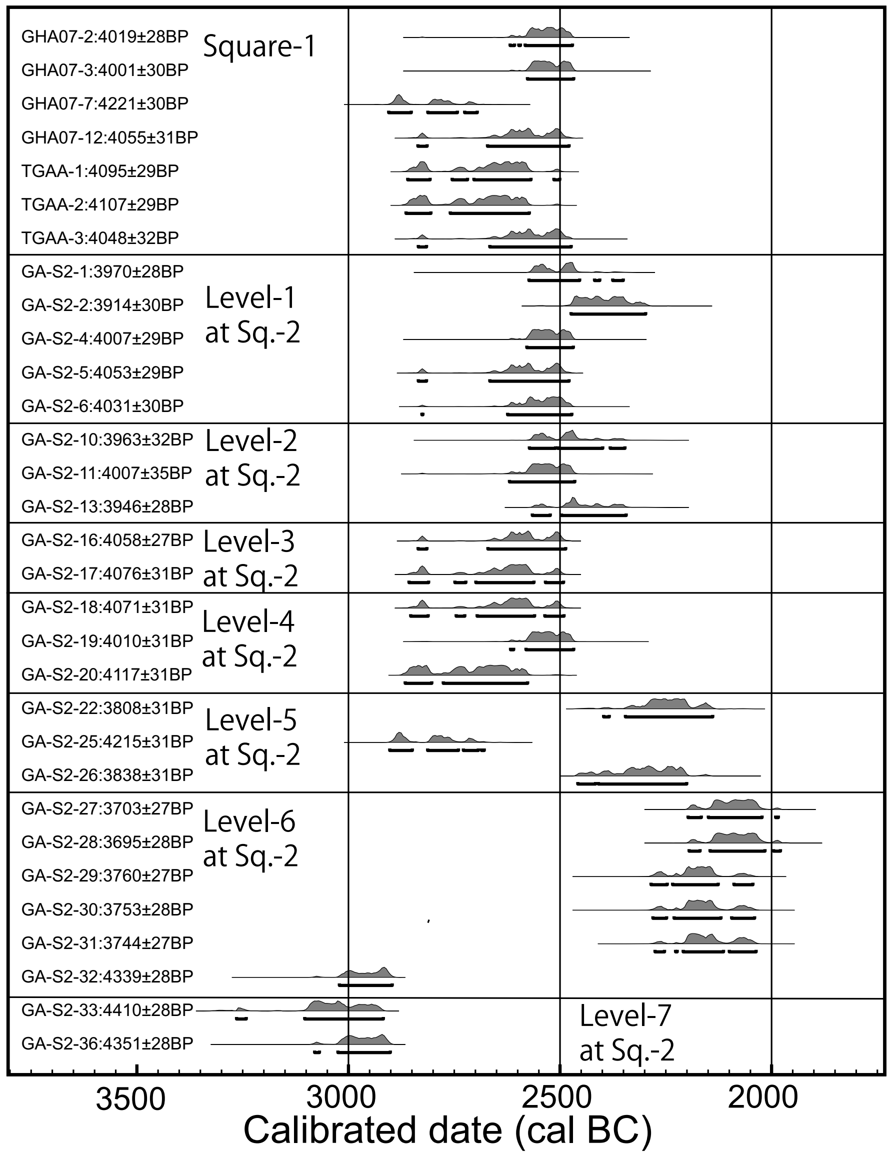

Figure 5 Probability distribution of ^{14}C ages measured for charcoal fragments from Square-1 and Square-2 trenches. Bars under the probability curve for each sample indicate the possible age range with 2-σ uncertainty.

RESULTS AND DISCUSSION

The charcoal samples collected from the Square-1 trench, of which only the upper layers of sediments were excavated (up to ~70 cm), showed ^{14}C ages of 4001 ± 30 to 4221 ± 30 BP (Table 1a, Figure 4). The non-linearity of the IntCal04 calibration curve (Reimer et al. 2004), in particular, a V-shaped fluctuation of ^{14}C age at around 2850–2800 cal BC, results in calibrated age ranges separated into multiple possible regions for Square-1 trench samples. The possible calibrated age ranges are estimated to be 2850–2500 cal BC (2-σ uncertainty range) for most of the samples (Figure 5).

As shown in Figure 4, for charcoal samples collected from the Square-2 trench, ^{14}C ages get older as samples go deeper from the uppermost building level (level-1) to the lowermost level (level-7), except for some disagreements: ages distinctly younger than expected were obtained for 2 samples (GA-S2-22, -26) and 5 samples (GA-S2-27 to -31) from level-5 and level-6, respectively. ^{14}C ages for a part of the samples from the 2 levels are distinctly younger than those from level-1. Since the 5 samples (GA-S2-27 to -31) were all collected from a clear, dark, horizontal layer that extended to wide areas and possessed abundant charcoal fragments, we consider that this layer had been formed by human activities at that time (Figure 3). Though the area of the sondage in the present research is quite limited, and we have not yet detected any building structures connected to this young age period, we can at least speculate that human activities at this site had lasted until around 3700–3850 BP (2400-–2050 cal BC).

On the other hand, sample GA-S2-25 from level-5 and sample GA-S2-32 from level-6 were collected in deeper horizons than other respective samples (Figure 3). They show ^{14}C ages that are far older than those of the samples from respective levels, but consistent with those of the samples from upper and lower building levels, as suggested above. Thus, we consider that these 2 samples were collected from the layers accumulated originally and belong to the respective building levels. In particular, sample GA-S2-32 was collected in association with a cooking pot excavated from the floor of level-6. The ^{14}C age (3022–2897 cal BC) should thus give the age of the pot. Typological analysis of the pot is now in progress.

Detailed analyses of the sedimentary layers excavated at the Square-2 trench and archaeological remains are ongoing. After these critical archaeological examinations, the ^{14}C age results will become useful for refining the chronology of the EBA. At this stage, the age sequences of the 7 building levels at the Square-2 trench are summarized as follows: level-1 to level-2: 2650–2350 cal BC; level-3: 2700–2500 cal BC; level-4: 2850–2500 cal BC; level-5: 2900–2650 cal BC; level-6: 3000–2900 cal BC; level-7: 3100–2900 cal BC; the uppermost layers: 2400–2050 cal BC.

The summary given above suggests that the ^{14}C ages of the samples collected at the Square-1 trench are consistent with the ages of samples from level-1 to level-4 of the Square-2 trench. The calibrated ^{14}C dates of samples from Square-1 range from 2850 to 2500 cal BC (2 σ). In addition, the age of the oldest level possibly dates back to 3100–2900 cal BC, and these figures are older than the oldest limit of the EBA (the EBA normally ranges from 3000 to 2000 BC in Syria, as shown in Figure 6; Anastasio et al. 2004). We need to determine the age of the lowest artificial level as well as that of natural ground level (base sediment) on which the Tell Ghanem al-Ali site was formed.

The $\delta^{13}C$ values for charcoal samples from the Tell Ghanem al-Ali site range from –24 to –28‰, except for 2 values of –12.3 and –17.4‰ (GA-S2-5, -6; see Table 1). These results suggest that most of the charcoal fragments originate from C_3 plants (with typical $\delta^{13}C$ values of about –26.5‰) growing in moderate weather, but the 2 samples with high $\delta^{13}C$ values likely originated from C_4 plants (typical values of about –12.5‰), which normally grow in hot, arid areas. For a more detailed discussion, it is required to identify the species of the source plants that formed the charcoal materials used for $\delta^{13}C$ value and ^{14}C age analyses.

Finally, it should be noted that the charcoal samples dated in this study did not show serious problems of old-wood effects, known to cause ^{14}C age differences between the innermost rings and outermost rings in wood. The apparent shift of ^{14}C ages for 7 charcoal samples from the building levels 5 and 6 is already discussed, and has no relation with this effect. One possible candidate that may show this effect is sample GHA07-7 whose ^{14}C age is older by 150 yr than those for the samples at the relevant level. Other ^{14}C ages were quite consistent with each other and we can speculate that the

Dates (BC)		Historical Terminology (south)	Bronze Age			Early Zazirah		N.-W Syria	
Mid. Chron.	Short Chron.		Palestine	Syria	Turkey	Lebeau 2000	Pfälzner 2001	Amuq	Hama
3000~2900	2900~2800	Jamdat Nasr	EB II	EB I	EB I	0	0	G	K
2900~2700	2800~2600	ED I		EB II	EB II	I	I		
2700~2600	2600~2500	ED II		EB III		II	II	H	
2600~2500	2500~2375	ED IIIa				IIIa	IIIa		
2500~2350	2375~2050	ED IIIb			EB IIIA	IIIb	IIIb	I	J
2350~2170	2230~2050	Akkadian post-Akkad	EB IV	EB IVa	EB IIIB	IV	IV		
2170~2000	2050~1940	Ur-III	(EB-MB) MBI	EB IVb	EB IIIC	V	V	J	

Figure 6 Simplified chronology of the Early Bronze (EB) Age (modified from Anastasio et al. 2004)

main sources of charcoal analyzed here were conceivably small trees, shrubs, or annual plants. Two charcoal samples (GA-S2-5, -6) likely come from C_4 plants and may originate from short-lived shrubs or annual plants based on their $\delta^{13}C$ values. Further ^{14}C dates to be obtained for more charcoal samples from the site will provide useful insight about this problem.

SUMMARY

We conducted ^{14}C dating on 7 and 24 charcoal fragment samples collected from the Square-1 and Square-2 trenches, respectively, during archaeological excavations at the Tell Ghamen al-Ali site. The ^{14}C age sequence obtained by the present study suggests that the site existed from 3100–2900 cal BC at the oldest level to 2250–2050 cal BC at the youngest level. Since the pottery fragments collected on the surface of the mound before excavation survey as well as those collected from the sediments during the excavation were assigned typologically to the periods of EB-III and EB-IV, the archaeological estimates are consistent with the ^{14}C dates. However, the age of the oldest level (level-7) in the present study dates back to 3100–2900 cal BC, which is older than the accepted limit of the EBA (3000–2000 BC) in Syria (Anastasio et al. 2004).

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