ICAANE 2021 Bologna
April 8

Akkadian Accuracy

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Harvey Weiss

Leilan Akkadian abandonment internal urban process revealed through high resolution dating accuracy

1. Leilan ceramic assemblage phase definition

Acropolis NW subperiod IIc

v.

Lower Town South phases 4a-b

2. Leilan ^{14}C dating accuracy

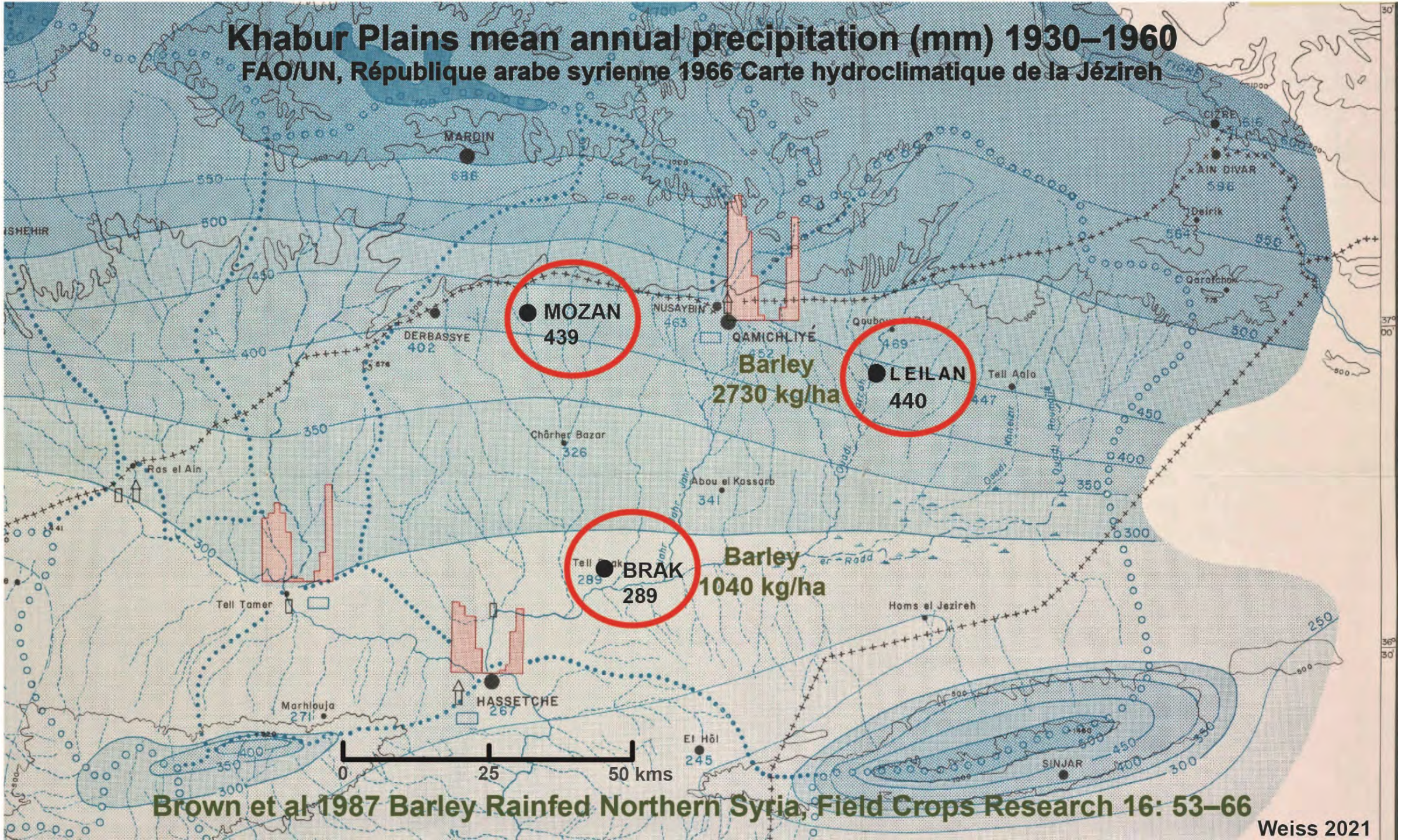
Acrop NW floors' (Akkadian administrators) grain samples period IIc: end ~2200 BC

v.

Lower Town South floors' (indigenous workers) grain samples phase 4a: end ~2150 BC

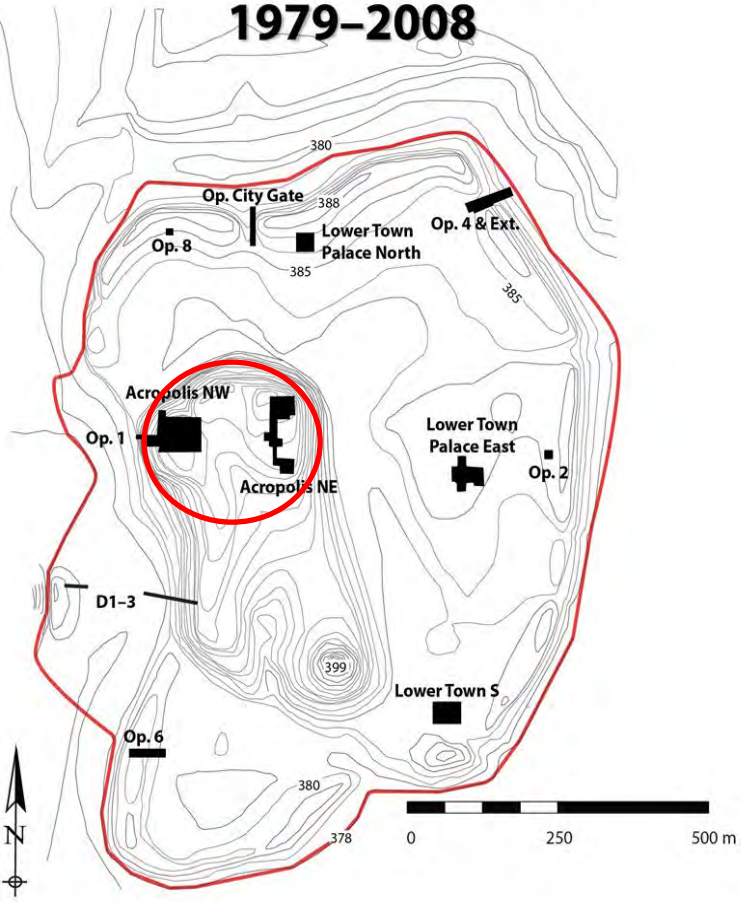
3. Global 4.2 ka BP megadrought synchronous across Mesopotamia, Egypt, Indus

4. Khabur Plains – West Syria – Levant – Nile – Greece – Italy – Spain collapse processes synchronous at 4.2 ka BP megadrought

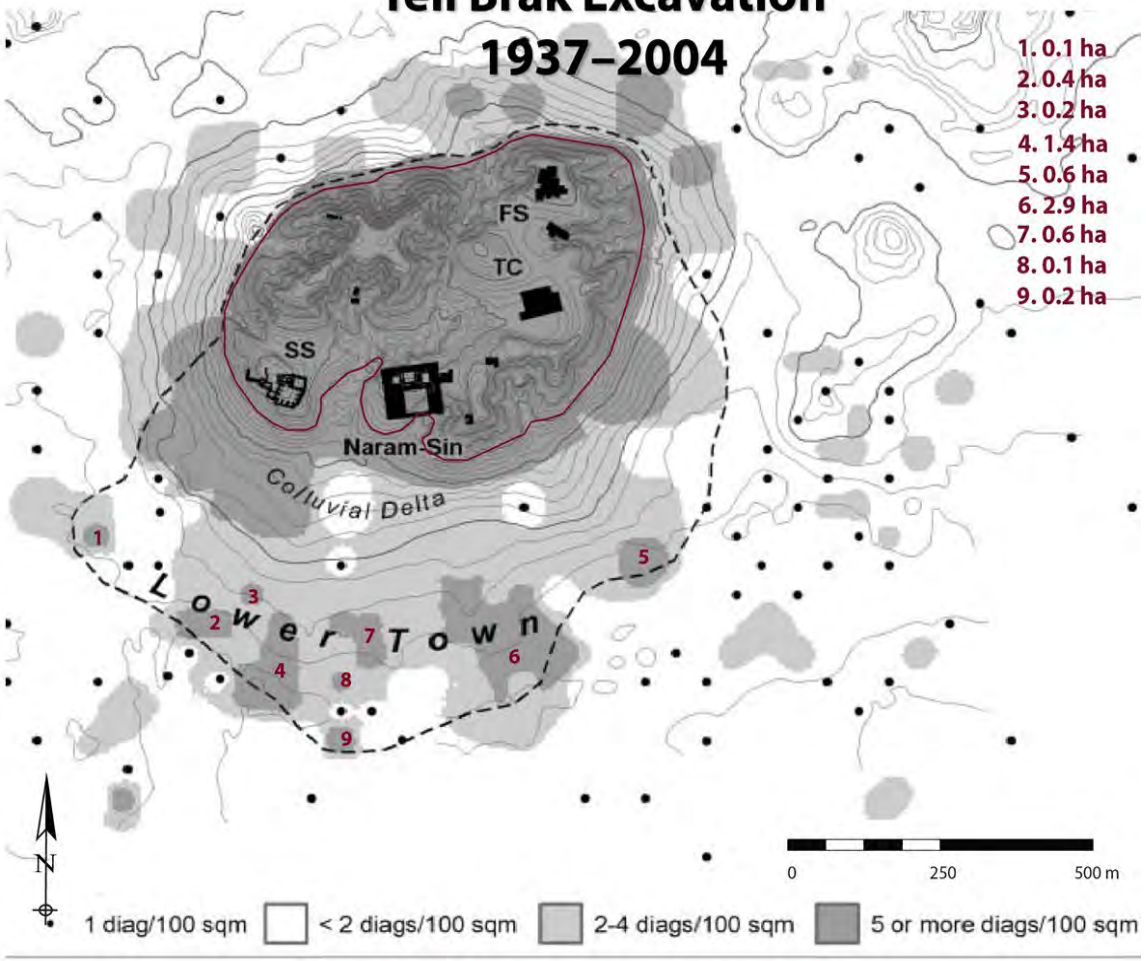

Khabur Plains mean annual precipitation (mm) 1930–1960
FAO/UN, République arabe syrienne 1966 Carte hydroclimatique de la Jézireh
MARDIN
686
MOZAN
439
NUSAYBIN
463
QAMICHLIYÉ
452
Barley
2730 kg/ha
LEILAN
440
DERBASSYE
402
Tell Aala
Chârher Bazar
326
Ras el Ain
Abou el Kassarb
341
BRAK
289
Barley
1040 kg/ha
Tell Tamer
Homs el Jezireh
HASSETCHE
267
Marhlouja
271
El Hôl
245
SINJAR
AIN DIVAR
596
Qarafchok
0
25
50 kms
Brown et al 1987 Barley Rainfed Northern Syria, Field Crops Research 16: 53–66
Weiss 2021

Akkadian imperial control strategies Khabur Plains.

Tell Leilan Excavation 1979–2008



Tell Brak Excavation 1937–2004



Leilan Akkadian Acropolis: 8.5 ha
Leilan Akkadian Lower Town: 75 ha

Brak Akkadian Acropolis: 29 ha
Brak Akkadian Lower Town: 6.5 ha

Leilan high agro-production, 440 mm precip.
Acropolis small population Akkadians.
Lower Town large pop agric workers.

Brak marginal agro-production, 289 mm precip.
Acropolis large population Akkadians.
Lower Town small pop agric workers.

Accurate dating and measurement suggest few Akkadian forces to control Khabur Plains cities.

New data on the post-Akkadian abandonment of Tell Leilan

M. Arrivabeni PhD Thesis FUB 2021

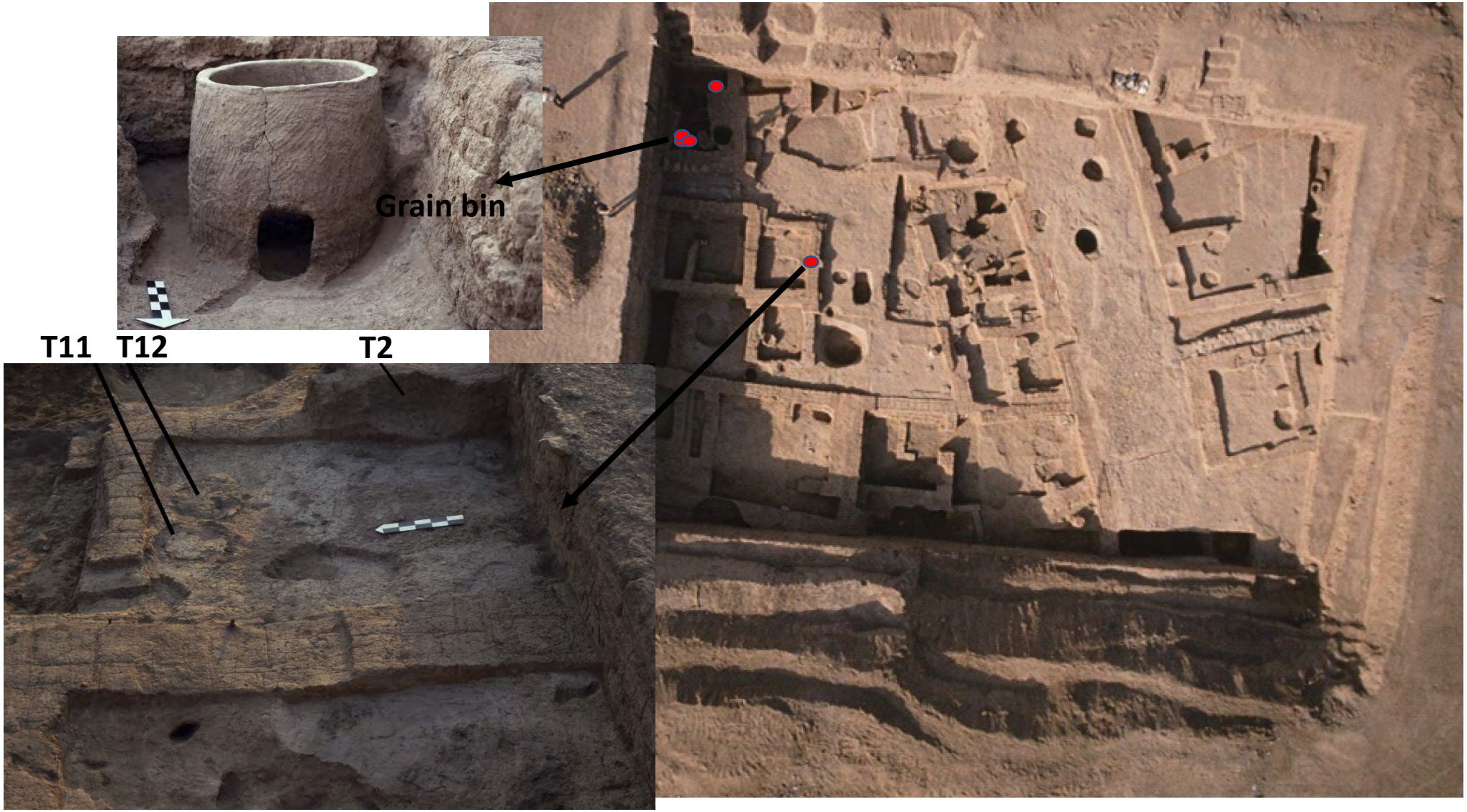
- Analysis of the 1989 excavation at Lower Town S chrono-stratigraphy;
- Correlation with Acropolis NW sequence 2006 excavation;
- Khabur plains other sites sequences.

The Lower Town South terminal occupation: LTS Phases 4a-b

LTS 4b: *abandonment* and *squatters*

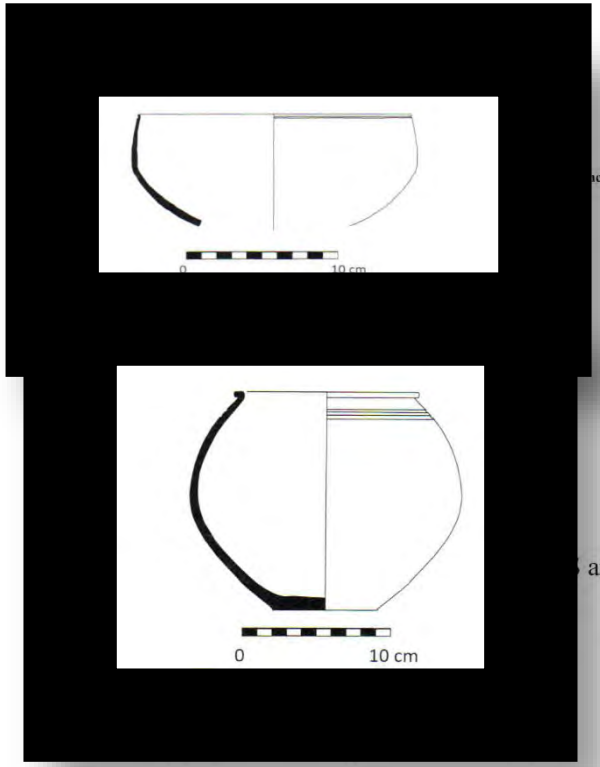
LTS 4a: size *reduction* and *functional change*

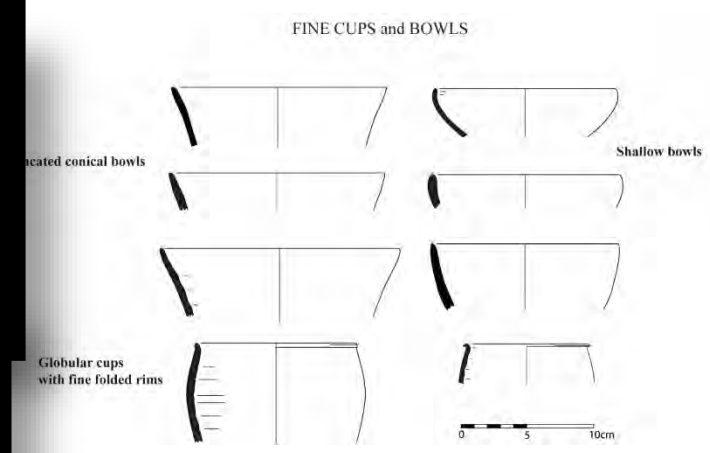
LTS Phase 4a ^{14}C samples contexts

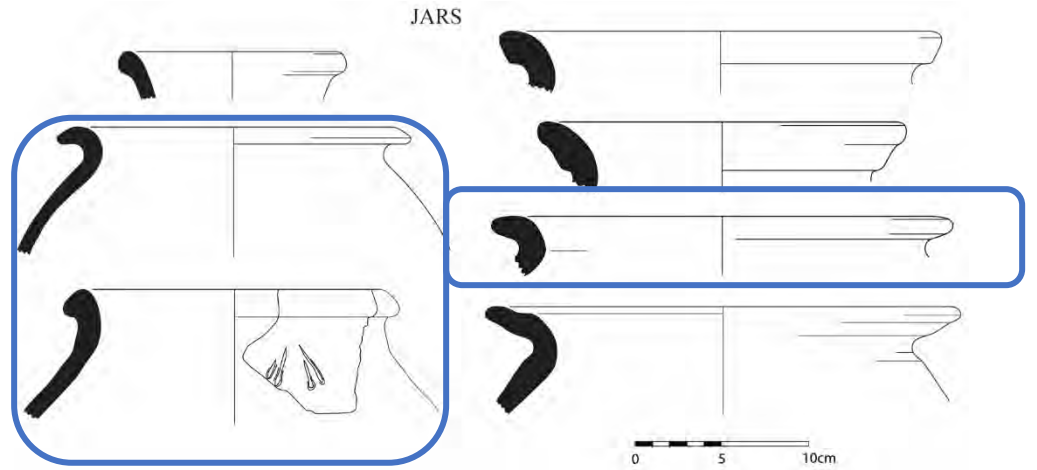


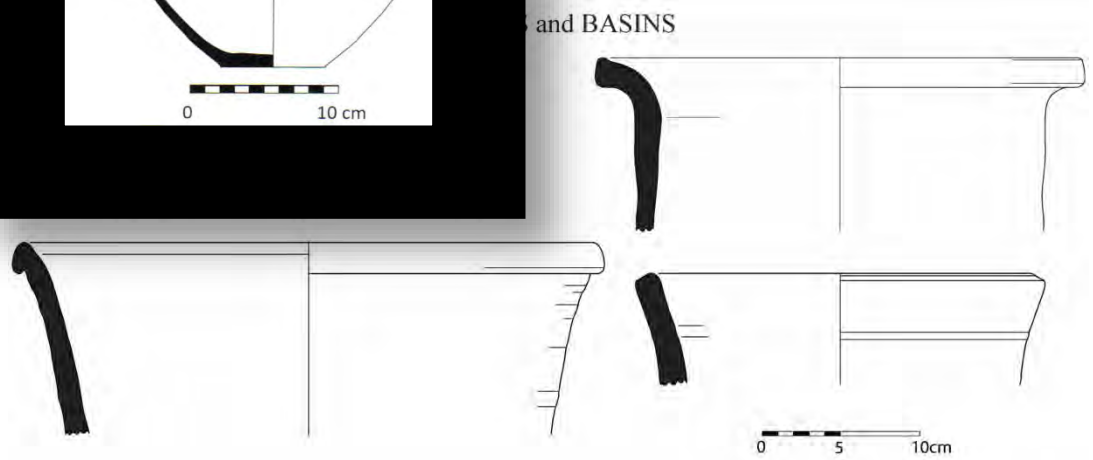
Five ^{14}C dates from carbonized seeds from ovens, a grain bin and associated floors

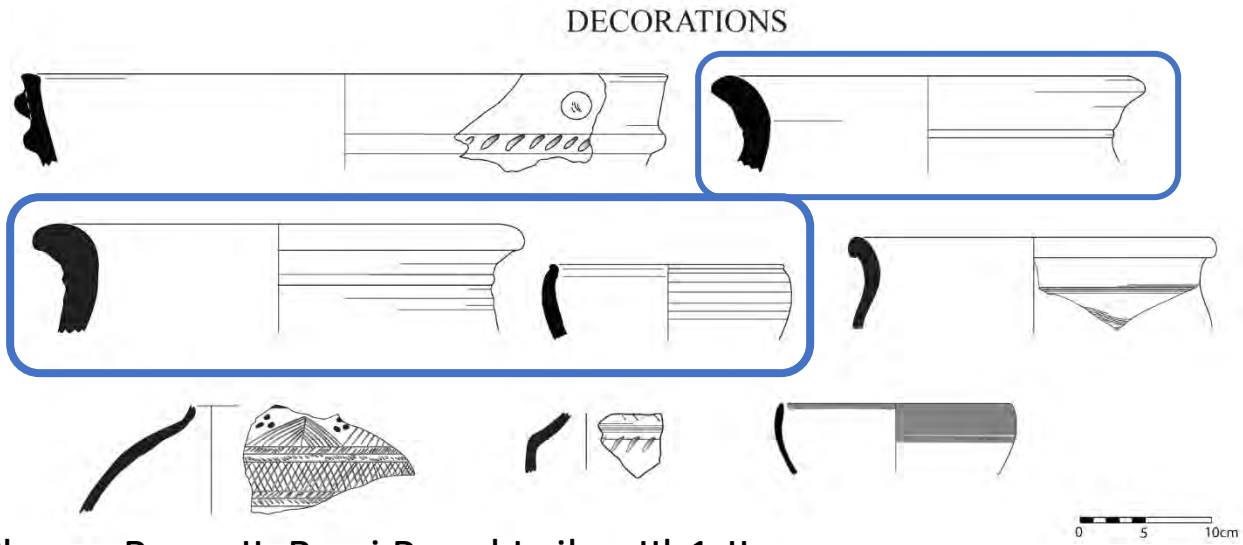
Ceramic diagnostic types from LTS Phase 4





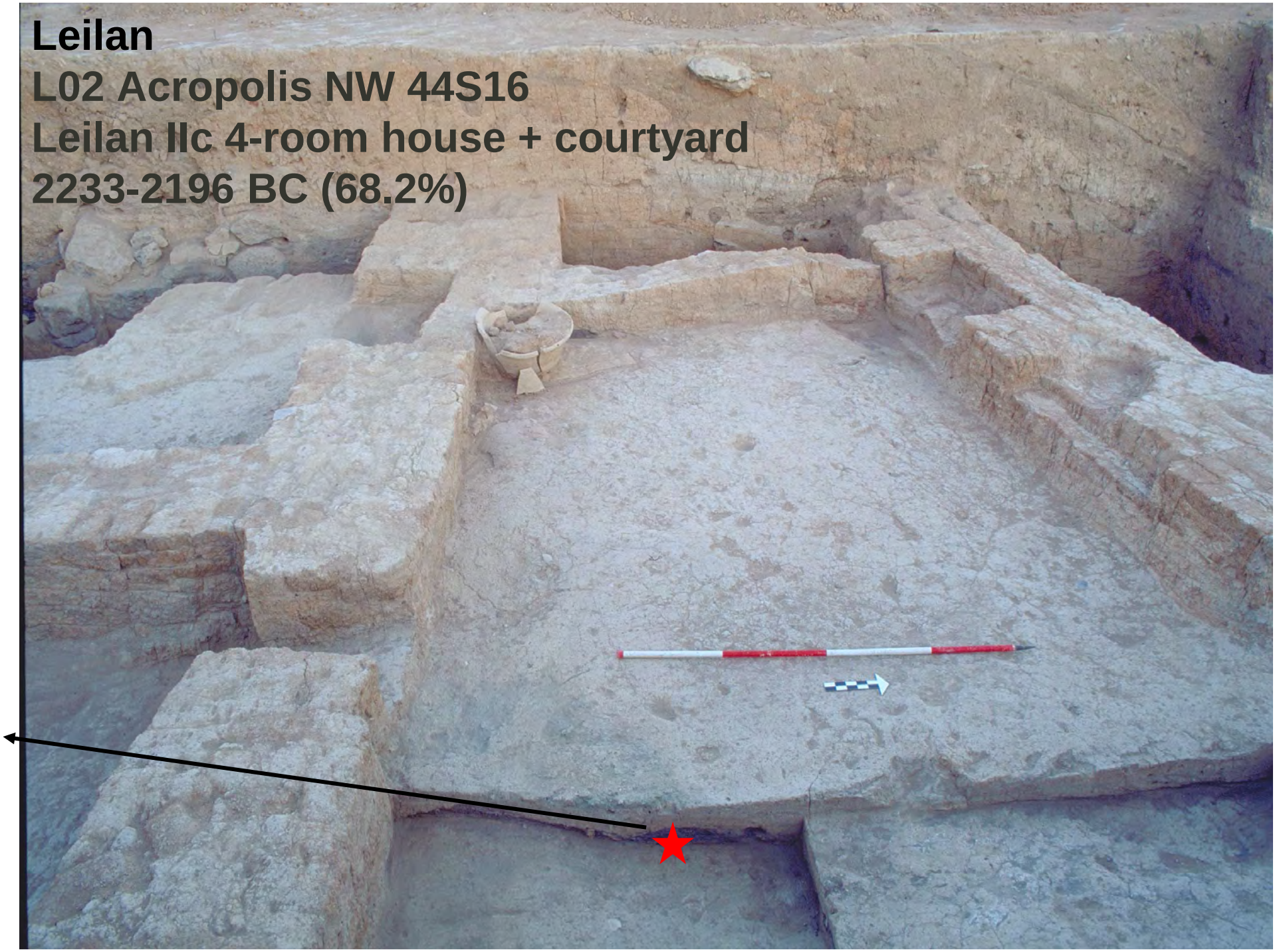






1. LTS Phase 4 types present at Brak N, Chagar Bazar II, Barri P and Leilan IIb1-IIc;
2. LTS Phase 4 types (n= 4) absent at Leilan´s Acropolis (in blue);
3. LTS Phase 4 missing two types present at other post-Akk. assemblages (on black)

LTS post-Akk ceramic assemblage variability is not chronological


Leilan
L02 Acropolis NW 44S16
Leilan IIc 4-room house + courtyard
2233-2196 BC (68.2%)
Carbonized grain deposit on floor

^{14}C dates for Leilan Lower Town South PHASE 4a and END Boundary

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RESEARCH ARTICLE GEOLOGY

Mediterranean radiocarbon offsets and calendar dates for prehistory

Sturt W. Manning[1,*], Bernd Kromer[2], Mauro Cremaschi[3], Michael W. Dee[4], Ronny Friedrich[5], Carol Griggs[1] and Carl...
+ See all authors and affiliations

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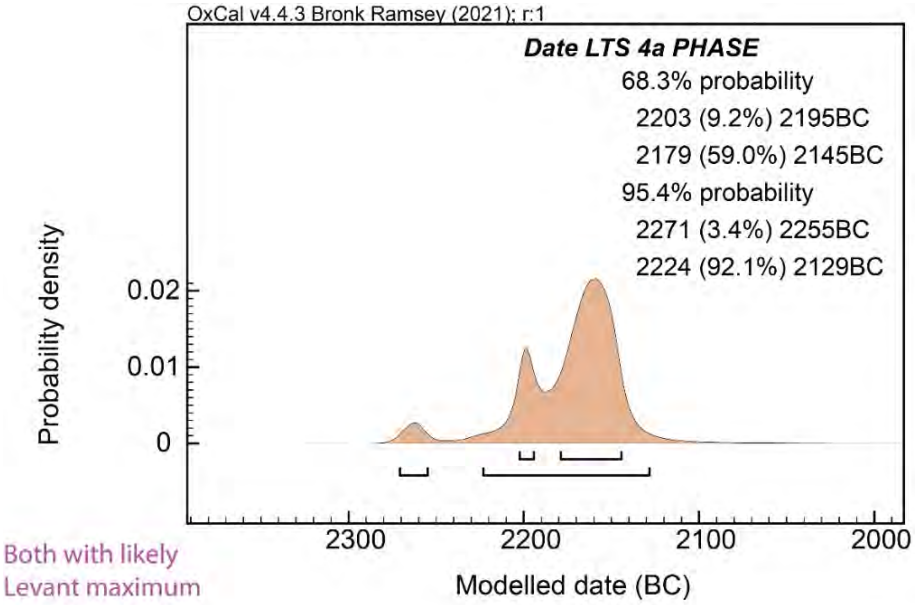
Vol. 6, no. 12, eaaz1096
DOI: 10.1126/sciadv.aaz1096

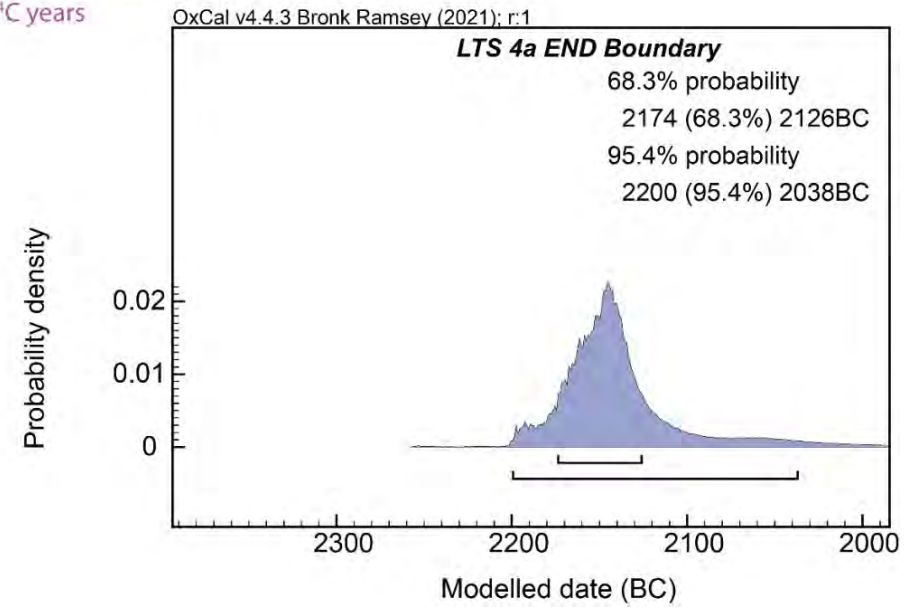
Article Figures & Data Info & Metrics eLetters PDF

Abstract

A single Northern Hemisphere calibration curve has formed the basis of radiocarbon dating in Europe and the Mediterranean for five decades, setting the time frame for prehistory. However, as measurement precision increases, there is mounting evidence for some small but substantive regional (partly growing season) offsets in same-year radiocarbon levels. Controlling for interlaboratory variation, we compare radiocarbon data from Europe and the Mediterranean in the second to earlier first millennia BCE. Consistent with recent findings in the second millennium CE, these data suggest that some small, but critical, periods of variation for Mediterranean radiocarbon levels exist, especially associated with major reversals or plateaus in the atmospheric radiocarbon record. At high precision, these variations potentially affect calendar dates for prehistory by up to a few decades, including, for example, Egyptian history and the much-debated Thera/Santorini volcanic eruption.



Both with likely Levant maximum growing season offset ca. 19±5 ^{14}C years



Which means latest plausible ages shown
(if smaller to zero offset, then *slightly* older ages)

Leilan Acropolis period IIc v. Lower Town South phase 4 end dates

Models aimed at defining END Phase Boundaries using Tau_Boundary paired with a Boundary:

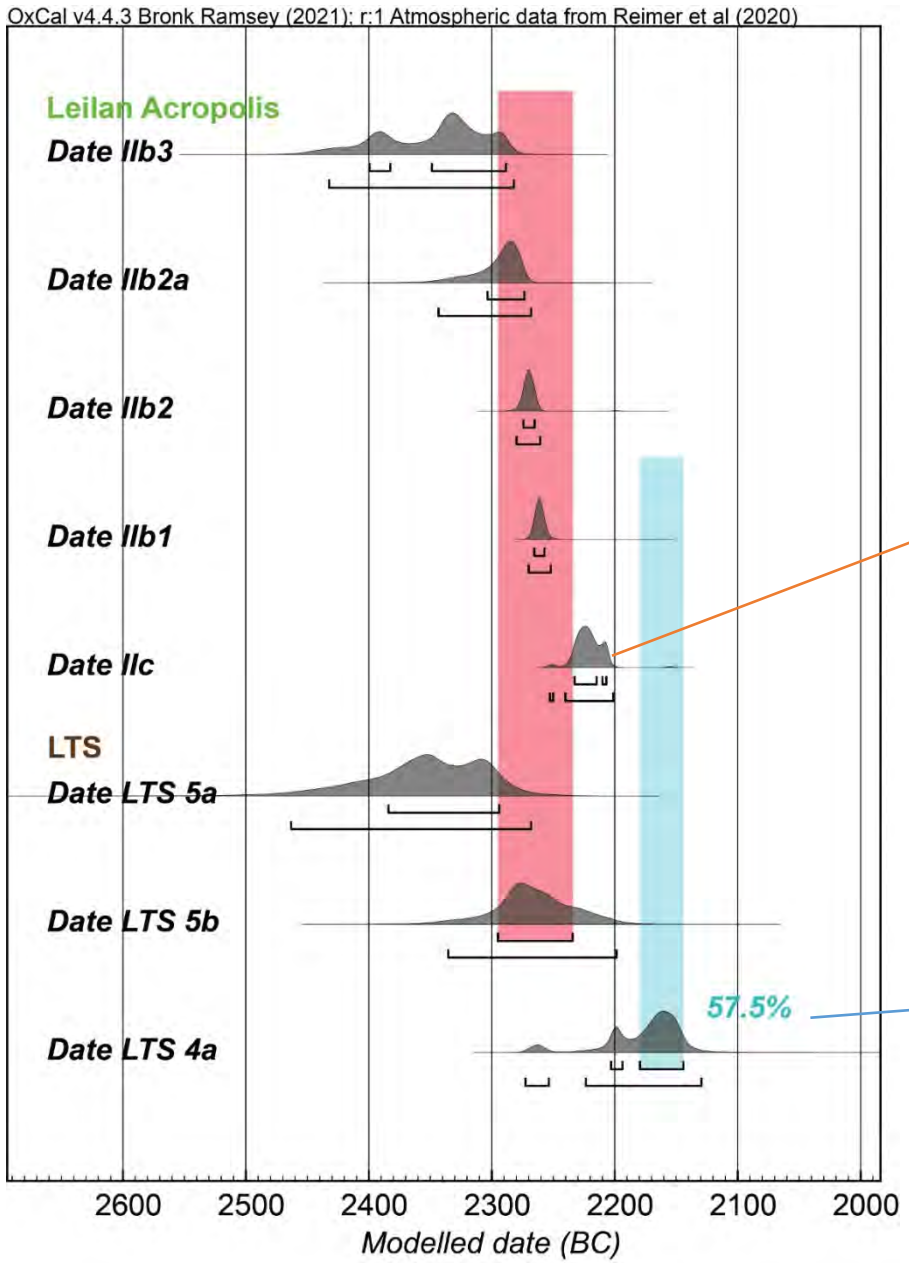
With *approx. max. likely Levant growing season offset*

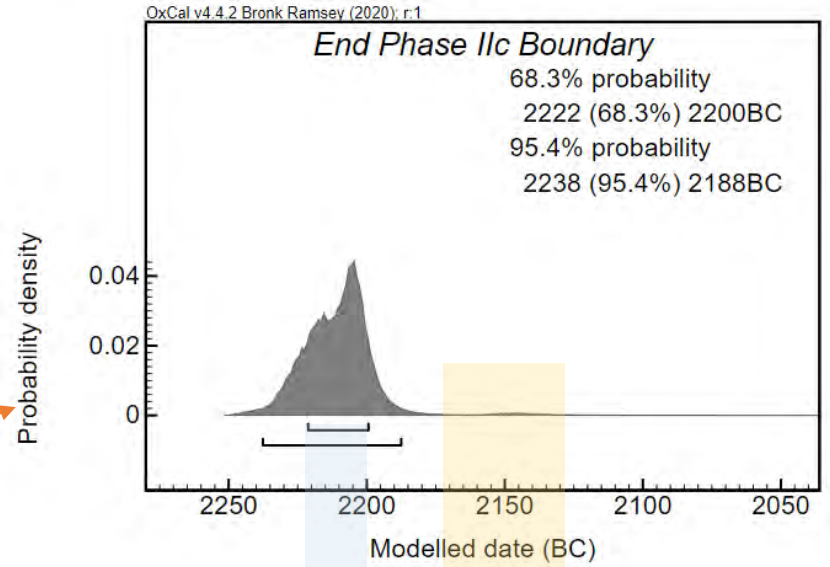
Leilan Acropolis Periods and LTS Phases modelled with data describing the overall Phase in each case (modelled with Uniform prior).

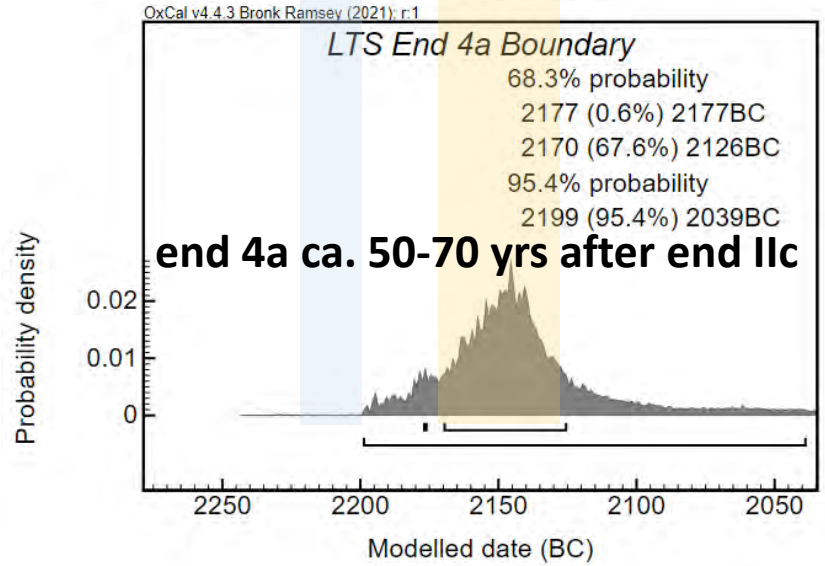
Contrast models aimed at end of Phase to right.

LTS 5b = IIb2a + IIb2 + IIb1

End LTS 4a ca. 50-70 years after end Acropolis IIc .

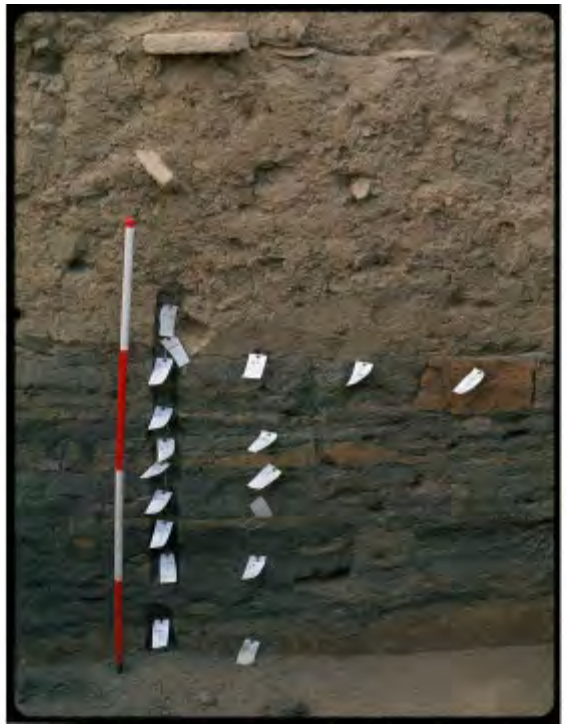






Also with *approx. max. likely Levant growing season offset*

Leilan post-Akkadian abandonment at 2200/2150 BC



1 1950 BC

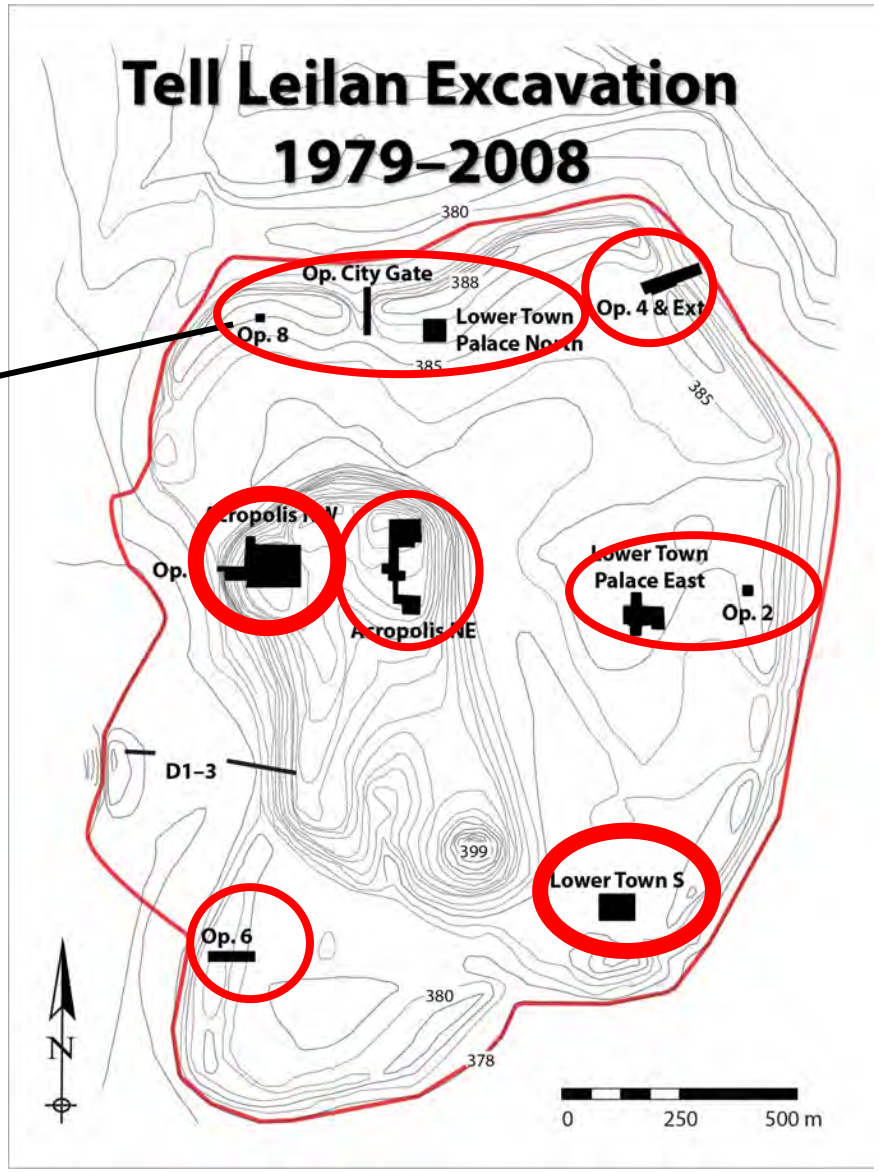
2

3 2200 BC

4

5 2700 BC

6



pAkk – Khabur abandonment

Acrop NW abandonment ^{14}C ~2200 BC

Lower Town South abandonment ^{14}C ~2150 BC

Brak
Post-Akkadian abandonment

Akkadian period
ca. 2300-2200 BC
area occupied 36 has.
[incl 6 has. lower town]

post-Akkadian period:
ca. 2200-2170 BC
85% abandoned.
area occupied 5 has.

post-pA/EJV period:
ca. 2170-1900 BC
100% abandoned
area occupied 0 has.

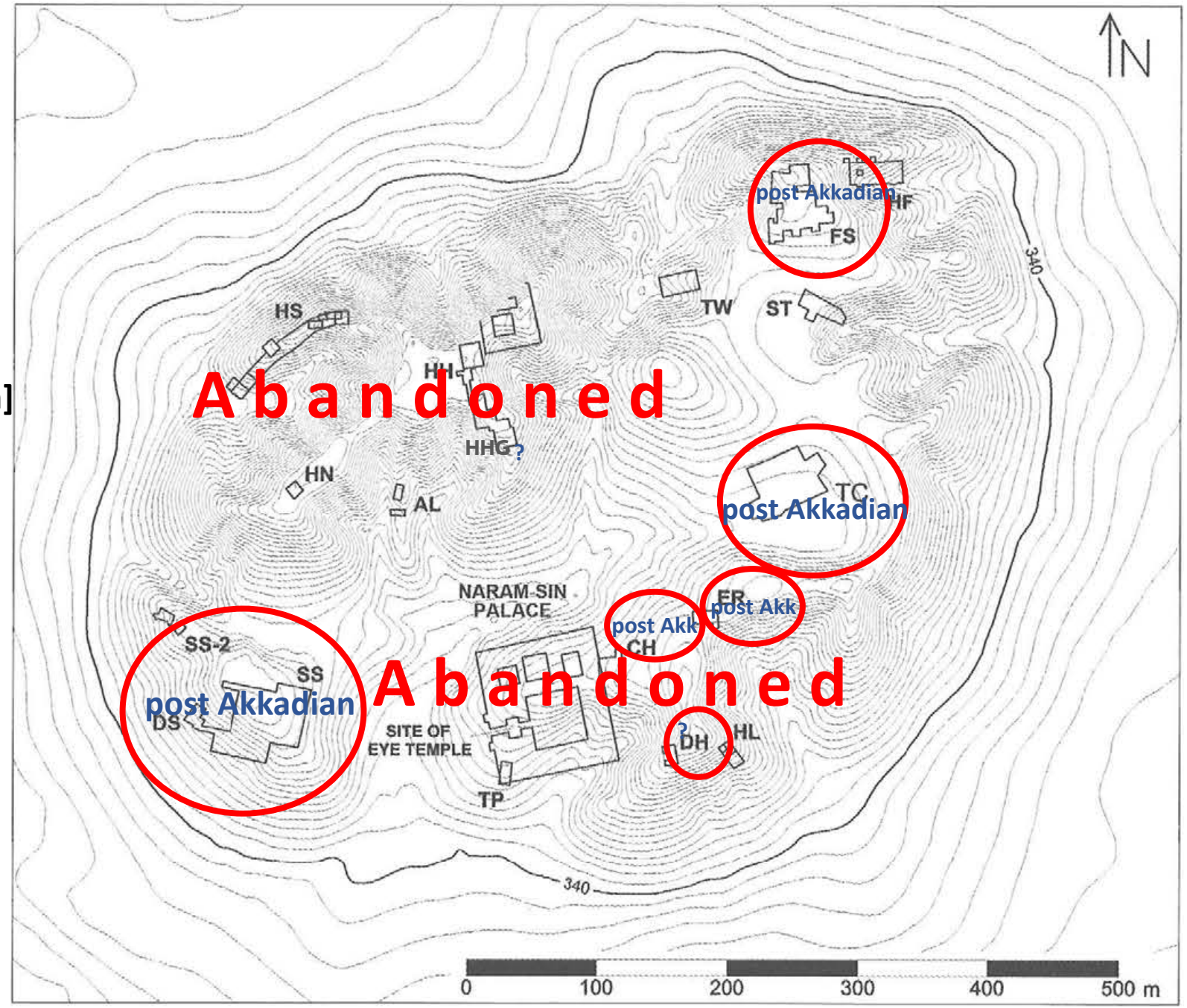
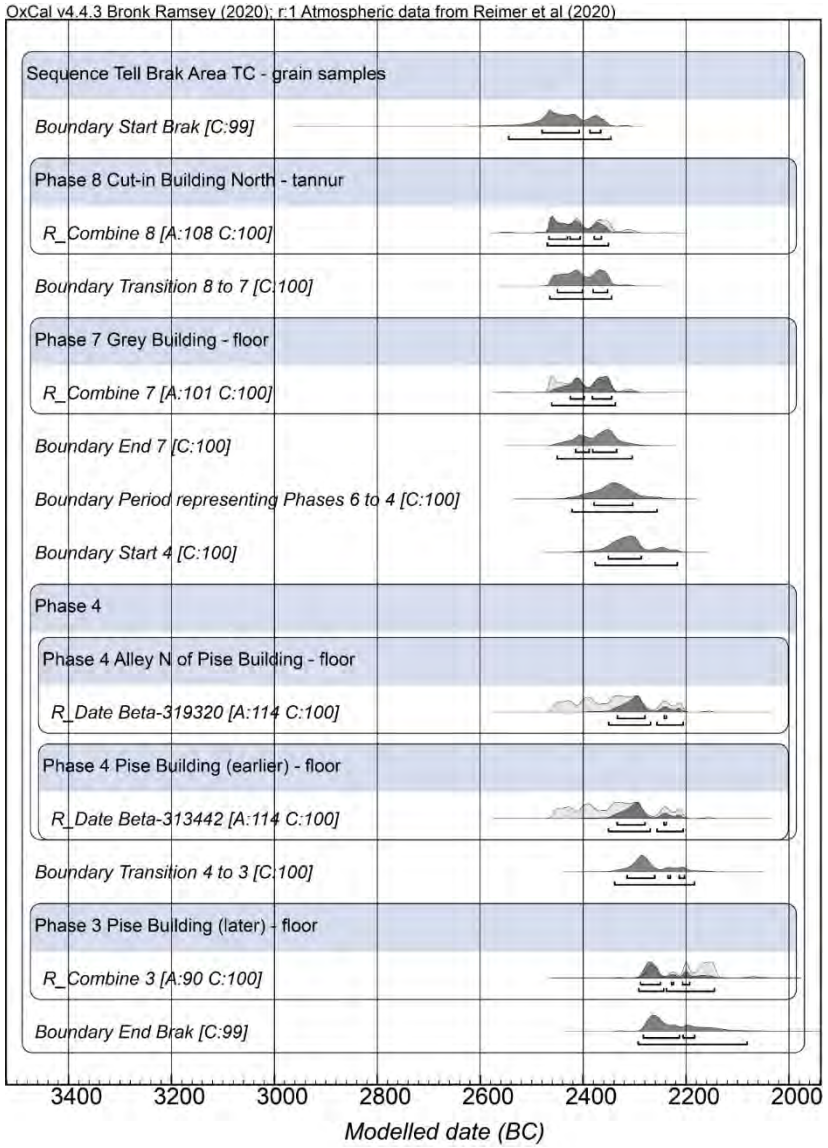


Figure 1: Contour plan of Tell Brak with areas excavated 1937-2004.

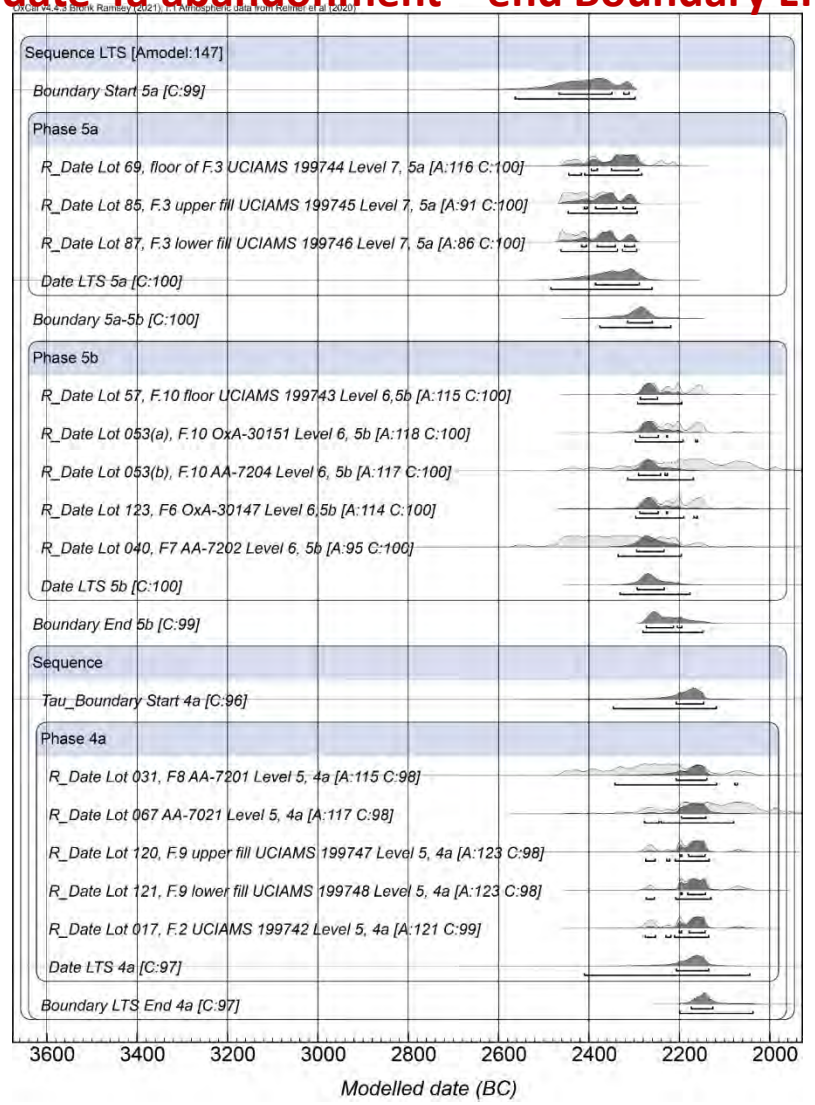
Emberling et al 2012;
Colantoni 2012

Radiocarbon dates Brak and Leilan: Leilan 4a ends ~ 50-70 years after Brak TC

Tell Brak Acropolis n=5 Emberling et al. 2012



Tell Leilan Lower Town South n=13 Model, Tau_Boundary Phase 4a date 4a abandonment = end Boundary LTS 4a



68.3% hpd: **end Boundary Brak Acropolis TC = 2284-2184 BC**

end Boundary Leilan LTS 4a = 2171-2126 BC

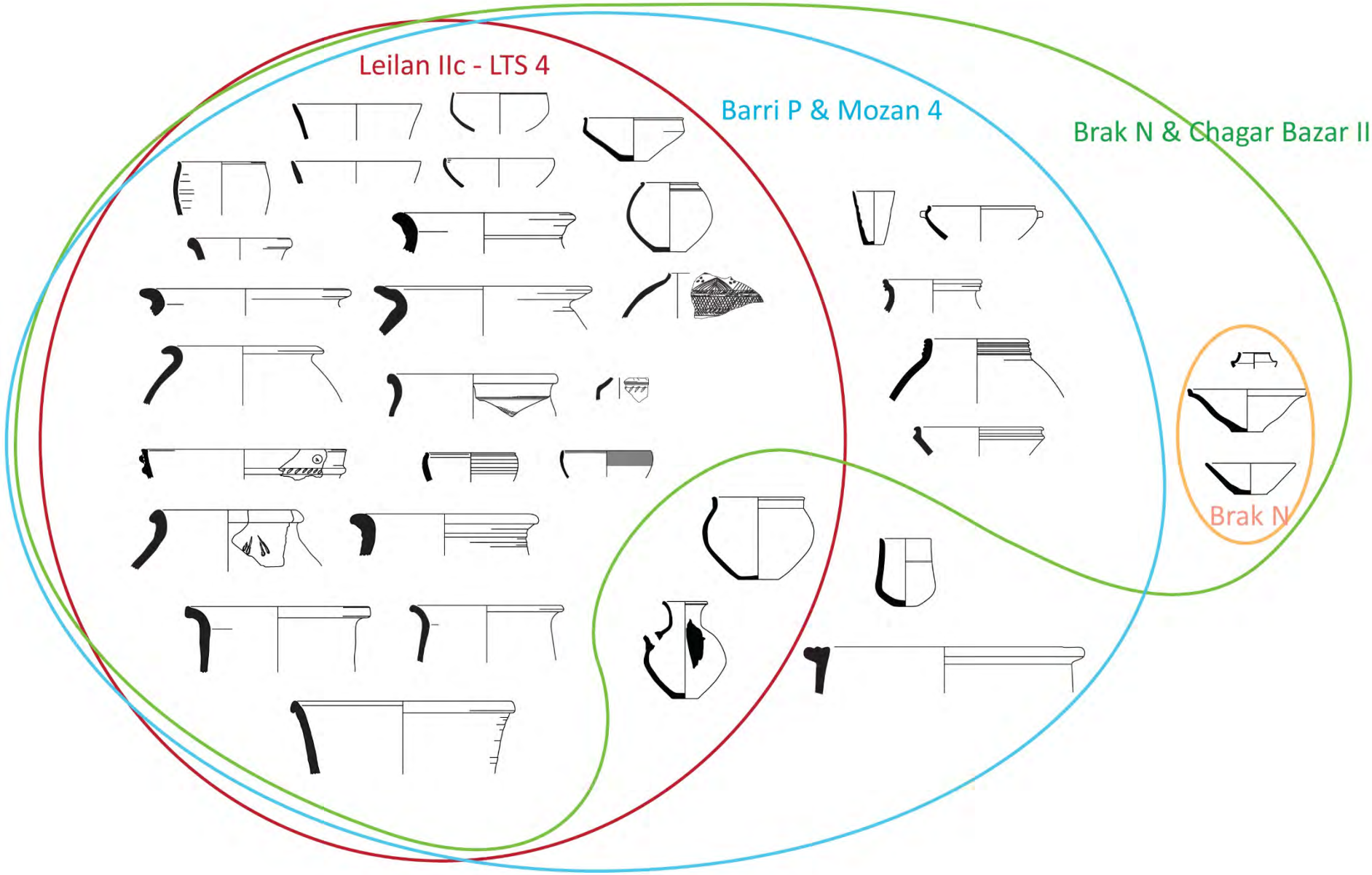
Leilan Lower Town was abandoned ca 50 years after the Leilan Acropolis and the Brak Acropolis

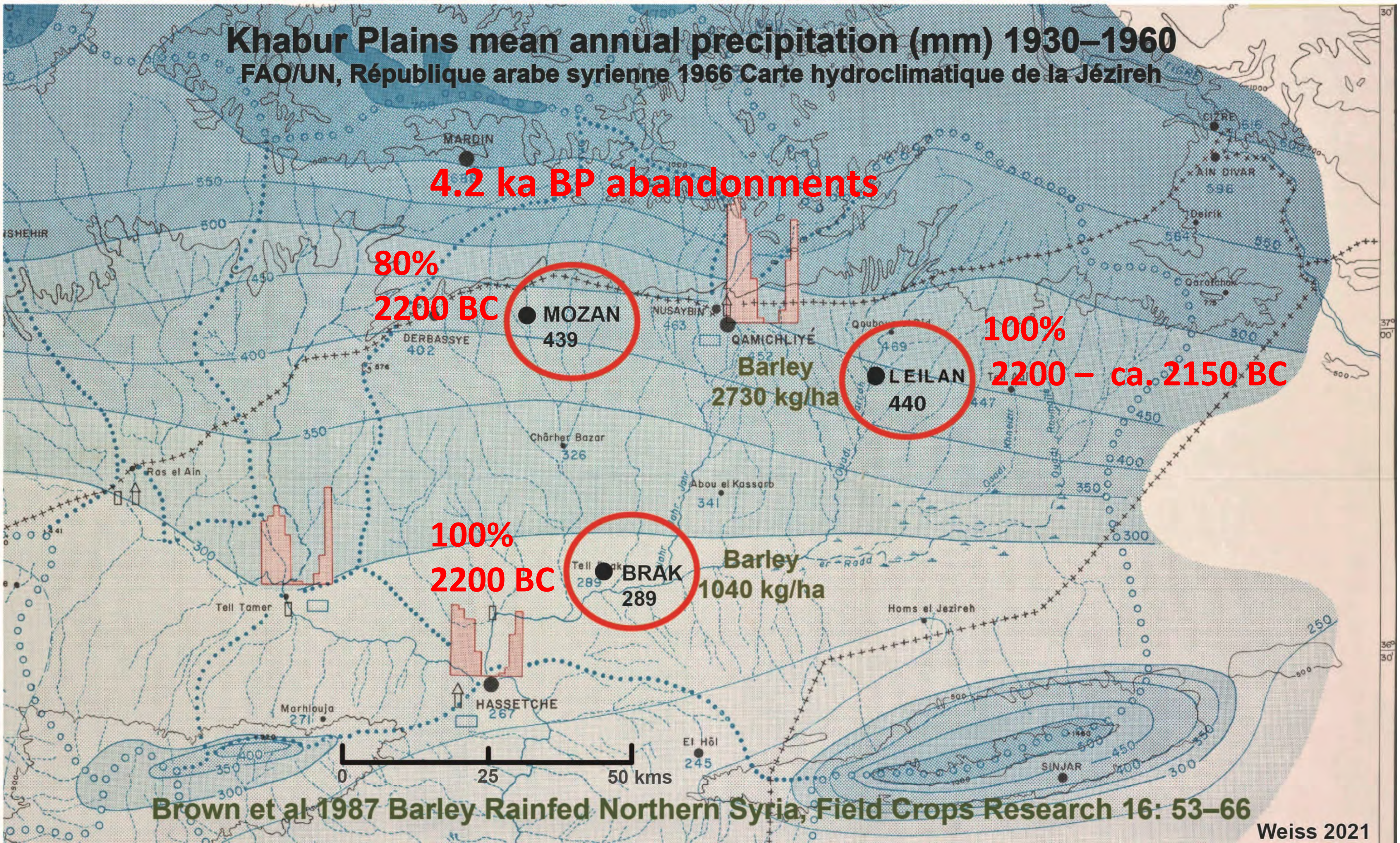
[LTS ceramic period definition and ^{14}C dates]

This suggests that at 2200 BC the Leilan Acropolis Akkadian administrators and military forces retreated [to Akkad / southern Mesopotamia], while the Leilan Lower Town indigenous agricultural workers abandoned the region at a slower rate -- suffering reduced precipitation and agro-production, but without Akkadian imperial levies -- ending ca. 2150 BC.

KHABUR PLAINS POST AKKADIAN CERAMIC ASSEMBLAGE

- **Largely uniform assemblage with increased regionalization and site(s)-wise minor synchronous differences**





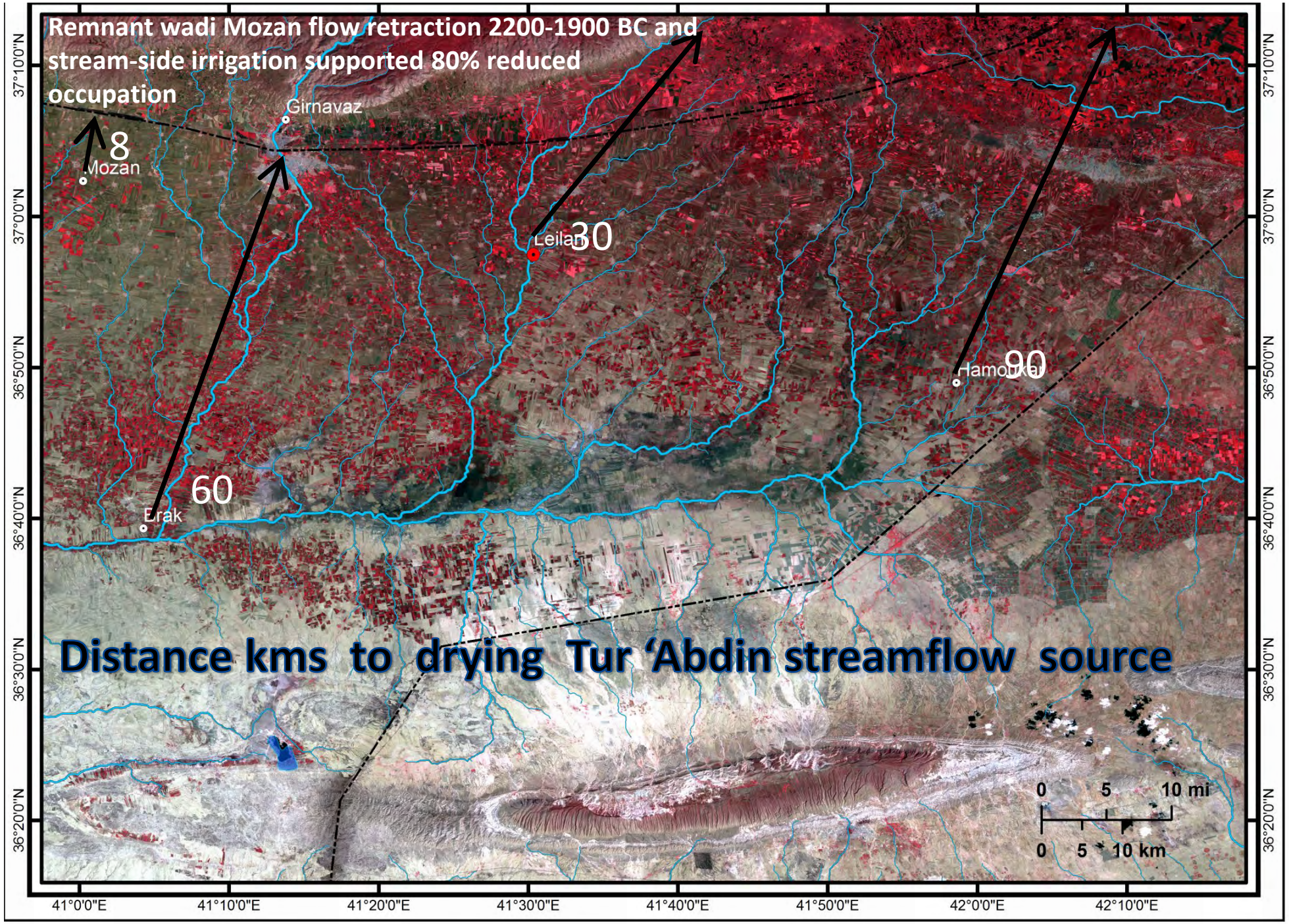
Khabur Plains mean annual precipitation (mm) 1930–1960
FAO/UN, République arabe syrienne 1966 Carte hydroclimatique de la Jézireh
4.2 ka BP abandonments
80%
2200 BC
MOZAN
439
100%
2200 – ca. 2150 BC
LEILAN
440
Barley
2730 kg/ha
100%
2200 BC
BRAK
289
Barley
1040 kg/ha
MARDIN
NUSAYBIN
QAMICHLIYE
DERBASSYE
Châgher Bazar
Ras el Ain
Abou el Kassaïb
Tell Tamer
HASSETCHE
Homs el Jezireh
Marhlouja
El Hôl
SINJAR
CIZRE
AIN DIVAR
Deirik
0
25
50 kms
Brown et al 1987 Barley Rainfed Northern Syria, Field Crops Research 16: 53–66
Weiss 2021

Chronostratigraphy Late Third Millennium BC Khabur Plains

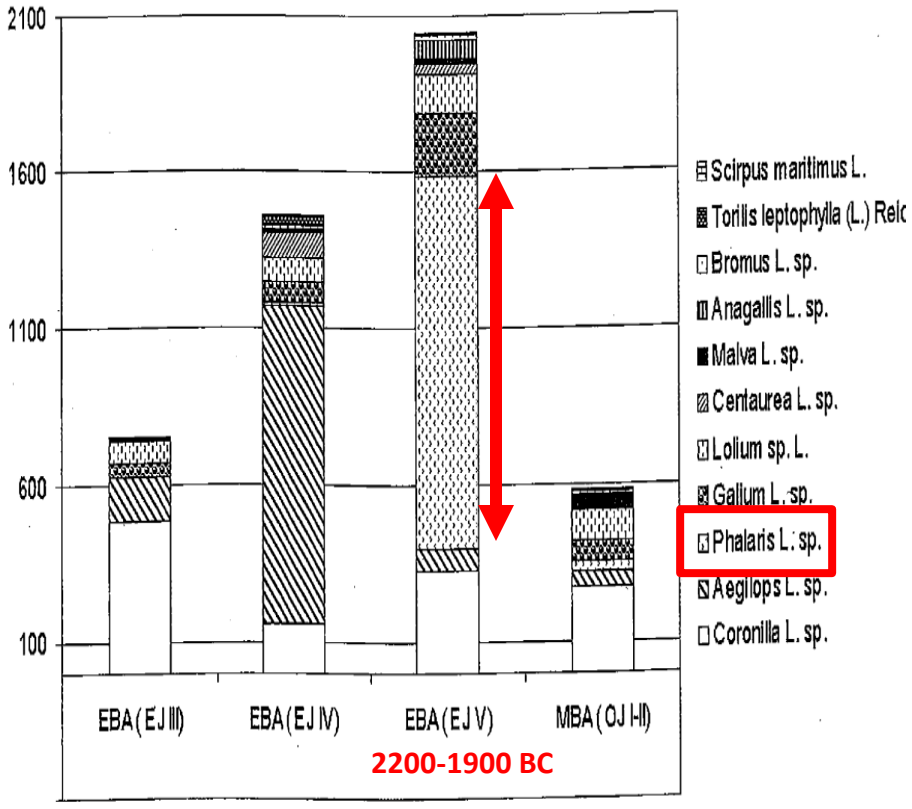
BC	Leilan	Moh Diyab	Brak	Chagar Bazar	Arbid	Barri	Mozan	Hamoukar
	LTE/N Palaces					34A		
	I Acrop NE-				IIa, b	34B		
	Temples	VIII cemetery	P HH, HN	Khabur houses	IIc	O 34C	houses 5	
1950	★ Early Khabur	IX pisé bldgs / fdtns			III kilns, pits	34D cemetery	C4 burials	
2000							C5	
2050								
							C6	
2100								
2150							★C7	
	★ 4a-b *abandoned*					35A *abandoned*	houses 4	
2200	pits			I pits	IV pits			pits
	★ IIc *abandoned*	XIc	FS1_SS1/TC PB		★ Vb-a Main Bldg	P		
		XIb	★N FS2_SS2	II Chant. D, Bât. 1	VI pA houses	35B kiln 1016	erosion 3	?
	abandoned	*abandoned*	*abandoned*	*abandoned*	*abandoned*	*abandoned*	*abandoned*	*abandoned*
2250	★ IIb1 AAB, TUB	TUB (6a-4, 5a-12)	FS3_SS3 NSP			36	C8 Palace 2	
	★ CG, Lower Town		Lower Town				Lower Town	
	Op 4, Op 7, Op 8						C9	
2300	★ IIb2 AAB	XIa	★M FS4_SS4		VII houses	Q 37 small rms	C10	3
							C11	
2350	★ IIb3 Scribal Room		FS5_SS5					
	★ IIa late	XII	L		VIII	R	C12 phase 1	2

BC is Leilan ^{14}C (Weiss et al 2012; Arrivabeni 2021; Manning 2021)
start early Khabur 1995 - 1896 (95.4%), 1969 - 1919(68.2%)
end IIc 2222 - 2200 (68.3%hpd)
end IIb1 2245 - 2218 (68.3%hpd)
★ ^{14}C

Arbid:
30% ^{14}C rejection
^{14}C loci uncertain


Remnant wadi Mozan flow retraction 2200-1900 BC and stream-side irrigation supported 80% reduced occupation
Girnavaz
8
Mozan
Leilan
30
90
Hamoukar
60
Erak
Distance kms to drying Tur 'Abdin streamflow source
0 5 10 mi
0 5 10 km
37°10'0"N
37°0'0"N
36°50'0"N
36°40'0"N
36°30'0"N
36°20'0"N
41°0'0"E
41°10'0"E
41°20'0"E
41°30'0"E
41°40'0"E
41°50'0"E
42°0'0"E
42°10'0"E

Phalaris (canary grass) weeds = stream-side agriculture at 80% reduced size Mozan at 4.2 ka BP



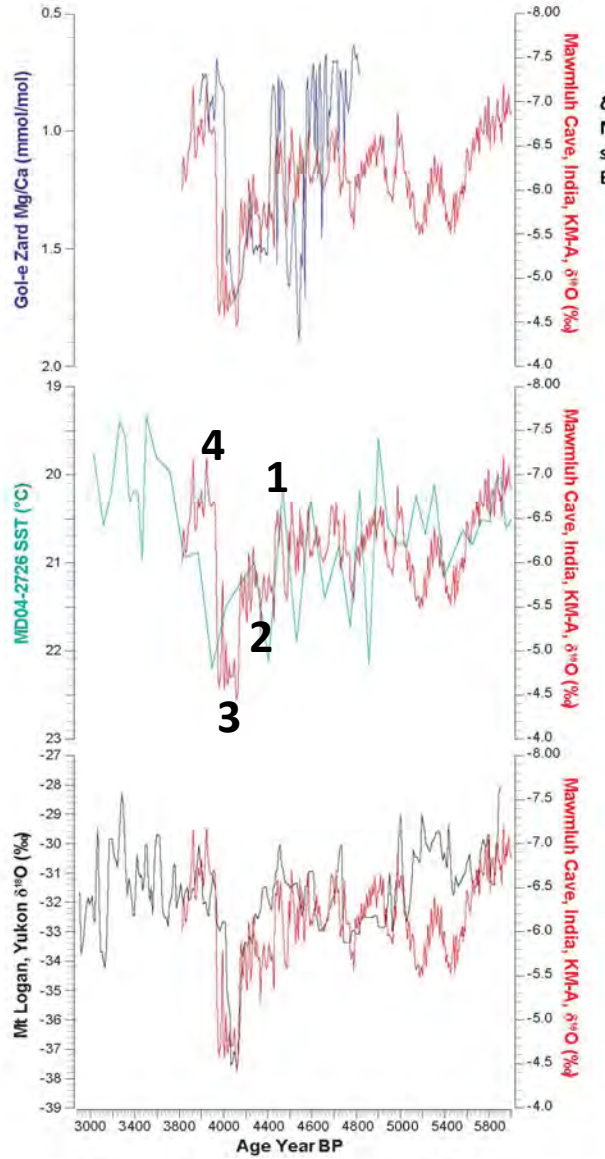
igure 71: Typical and probable weed numbers in the different phases of Early and Middle Bronze Age Tell Mozan.

"Large-scale irrigation in any of the phases at Tell Mozan seems unlikely, as typical indicators occur in only small numbers." Riehl 2010: 67.

Global 4-stage congruence at 4.2 ka BP

synchronous Mesopotamia, Egypt, Indus

Mg/Ca
West Zagros, Iran
speleothem
Carolin et al 2019



δ18O
NE India
speleothem
Berkelhammer et al 2012

SST
Nile delta
deep sea fan
Jalali et al 2017

δ18O
Yukon, Canada
glacier
Fisher et al 2008

KM-A, Mt Logan, MD04-2276, Gol-e Zard

4.2 ka BP proxy site	Onset	Terminus	Resolution	Publication
KM-A Mawmluh India	4303±26	4071±31	5-6	Berkelhammer et al 2012
KM.1, 2 Mawmluh India	4255±16		5	Kathayat et al 2018
63KA ISM Indus delta	4194±30	3933±30	18	Giesche 2020
63KA IWM Indus delta	4266±30	3954±30	18	Giesche 2020
ANJ94-5 Madagascar	4340±30	3990±10	10	Wang et al 2019
Gol-e Zard NW Iran	4260±40	3970±70	2-15	Carolin et al 2019
MD99-2275 N Iceland	4290±12	4060±34	5	Jalali et al 2019
Mt Logan Yukon CA	4300±70	4000±70	2-3	Fisher et al 2008

Across the sub-polar North Atlantic, Europe, Mediterranean, West Asia, the Indus, and East Asia, the 4.2 ka BP megadrought was an abrupt 4-stage process.

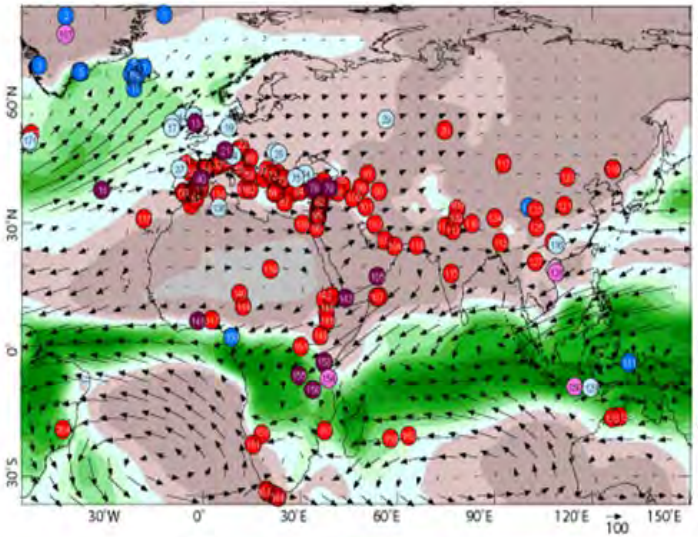
Global proxy congruence, that extends to the western hemisphere, documents reduction/displacement of the westerlies, Indian Summer Monsoon, East Asian Summer Monsoon, El Niño, and the Inter-Tropical Convergence Zone. This suggests an AMOC slowdown originating with sub-polar North Atlantic glacial melt and freshwater hosing that is documented at 4.2 ka BP --but yet unexplained (Weiss 2019; 2021).

Weiss 2021

4.2 – 3.9 ka BP megadrought proxy distributions hemispheric, regional and local

ERA-I moisture vector transport DJF

dry
wet
cold
warm
uncertain



4.2 – 3.9 ka BP megadrought paleoclimate proxy sites Eastern hemisphere

hemi-spheric 1

Weiss 2021

regional 2

The 4.2 ka BP megadrought proxy loci coincident with westerlies moisture vectors for rain-fed northern and southern Anatolia-source irrigation agriculture.

local 3

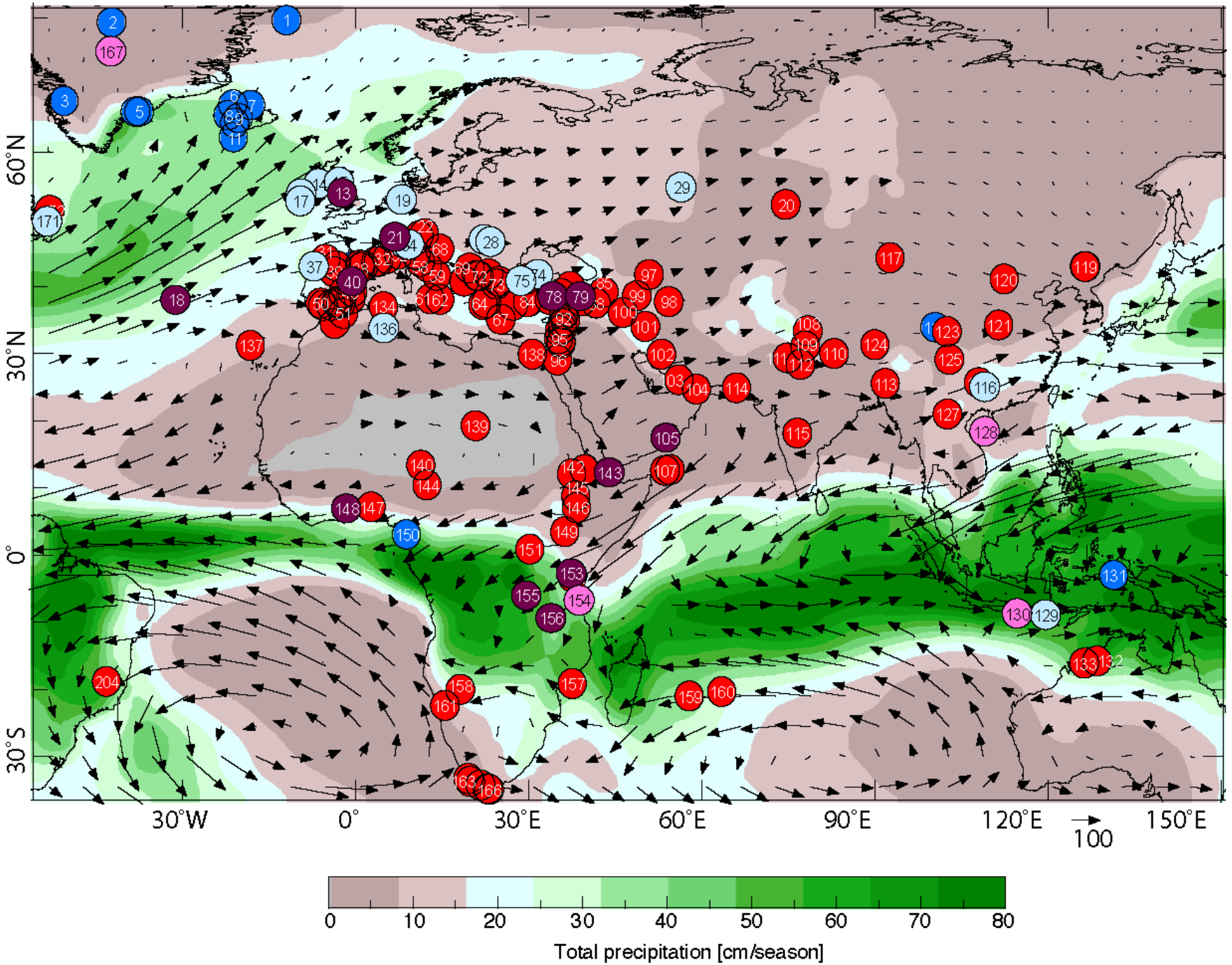
Temporal coincidence:

Gol-e Zard Mg/Ca
4260±40 – 3970±70 BP

Lellan ppA ^{14}C chronology
2150 – 1950 BC

ERA-I moisture vector transport DJF

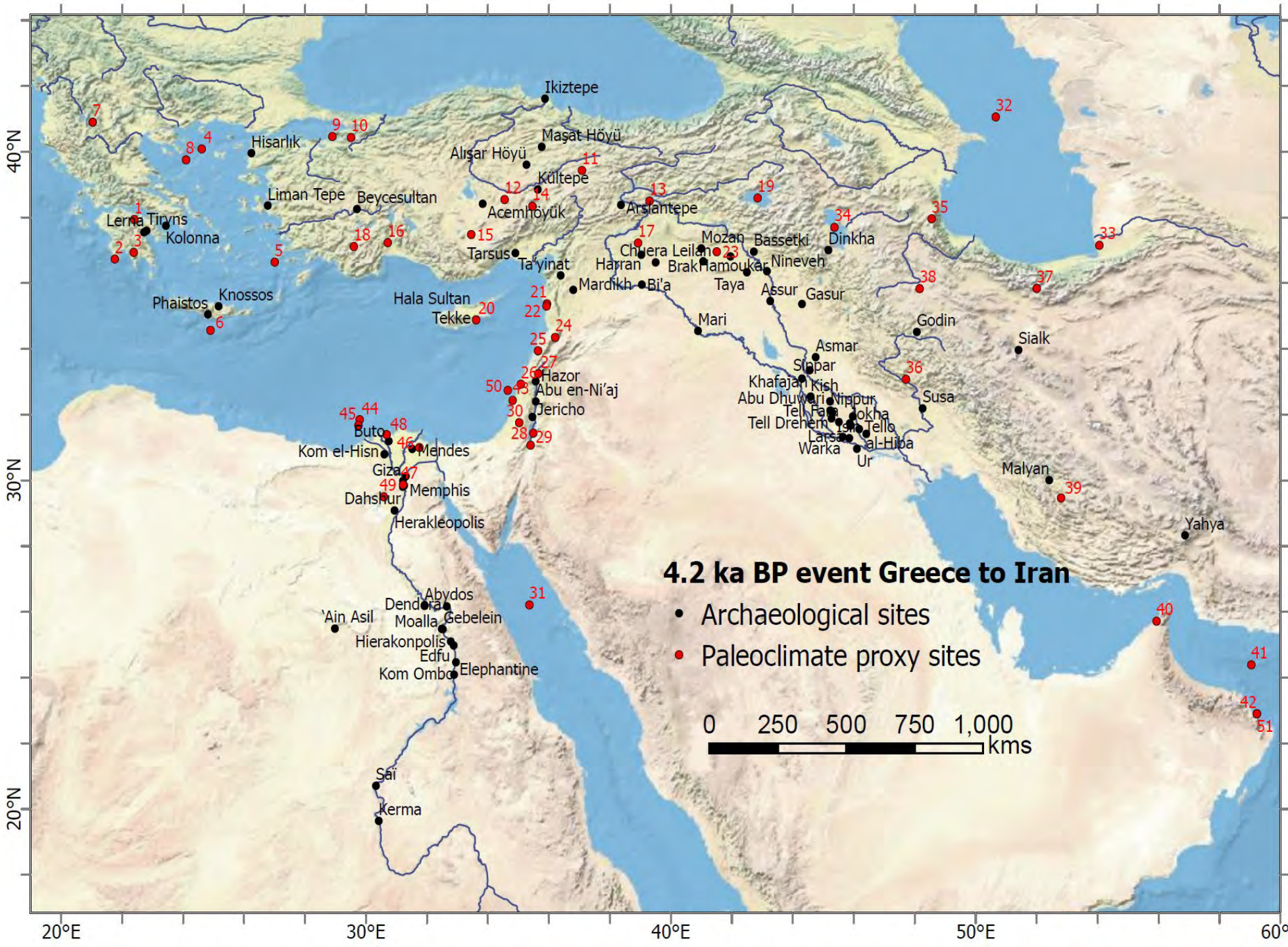
- dry
- wet
- cold
- warm
- uncertain



4.2 – 3.9 ka BP megadrought paleoclimate proxy sites Eastern hemisphere

hemi-spheric 1

Weiss 2021

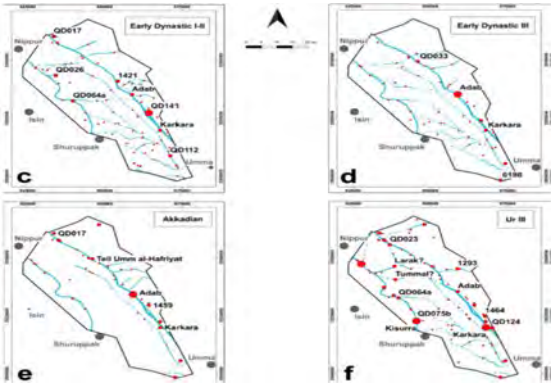


Greece to Iran:

50 marine, lake and speleothem core proxy records document the Med westerlies 4.2 ka BP megadrought.

regional 2

4.2 ka BP megadrought coincident with Akkadian period southern Euphrates flow retraction.



"…the almost complete abandonment of the area between Shuruppak towards Umma."
Marchetti and Zaina 2020: 219.

Spatial coincidence:

4.2 ka BP megadrought proxy loci coincident with westerlies moisture vectors for Mesopotamian rain-fed northern and southern (Anatolia-source) irrigation agriculture.

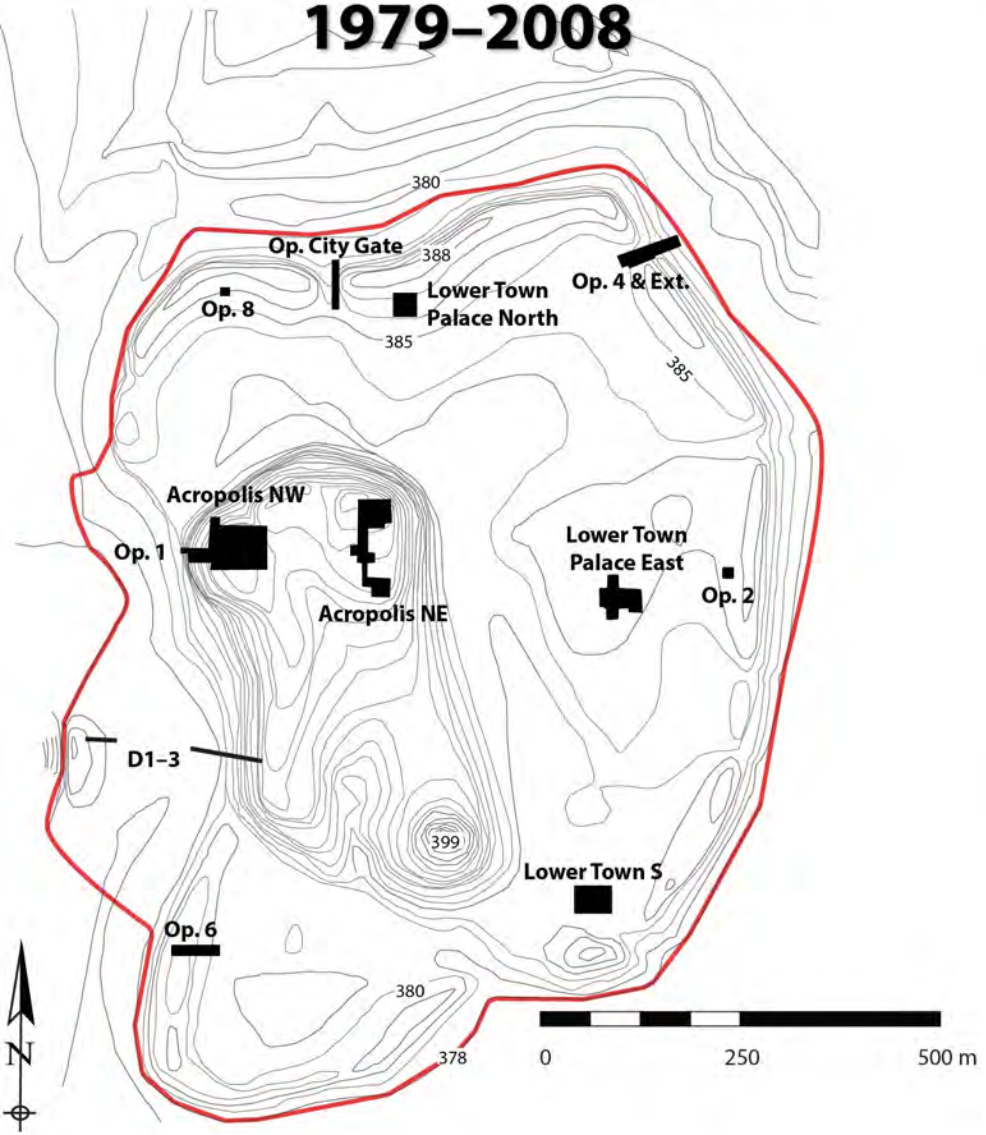
Temporal coincidence:

Gol-e Zard Mg/Ca
4260±40 – 3970±70 BP

Leilan ppA ^{14}C
2150 – 1950 BC

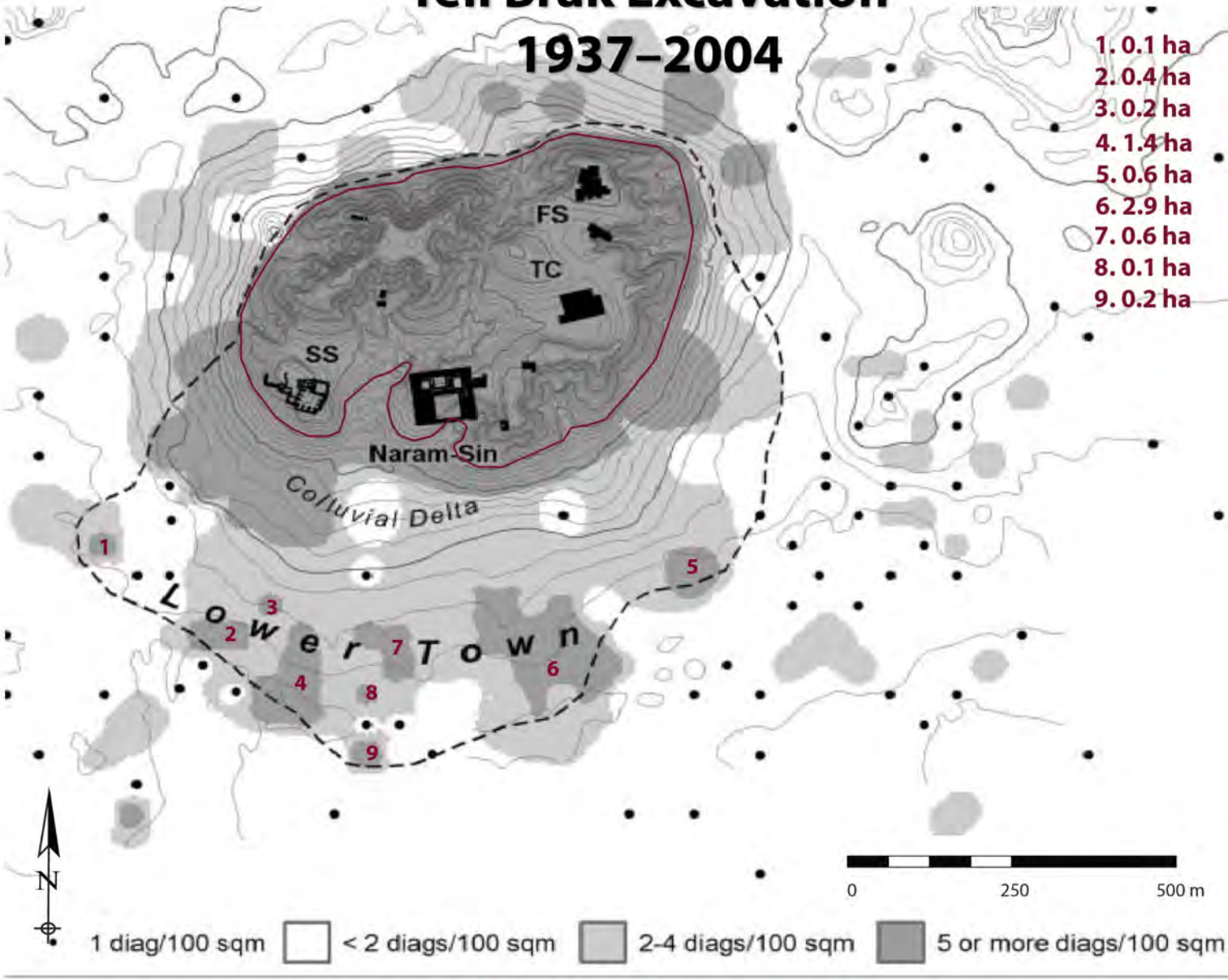
local 3

Tell Leilan Excavation
1979–2008



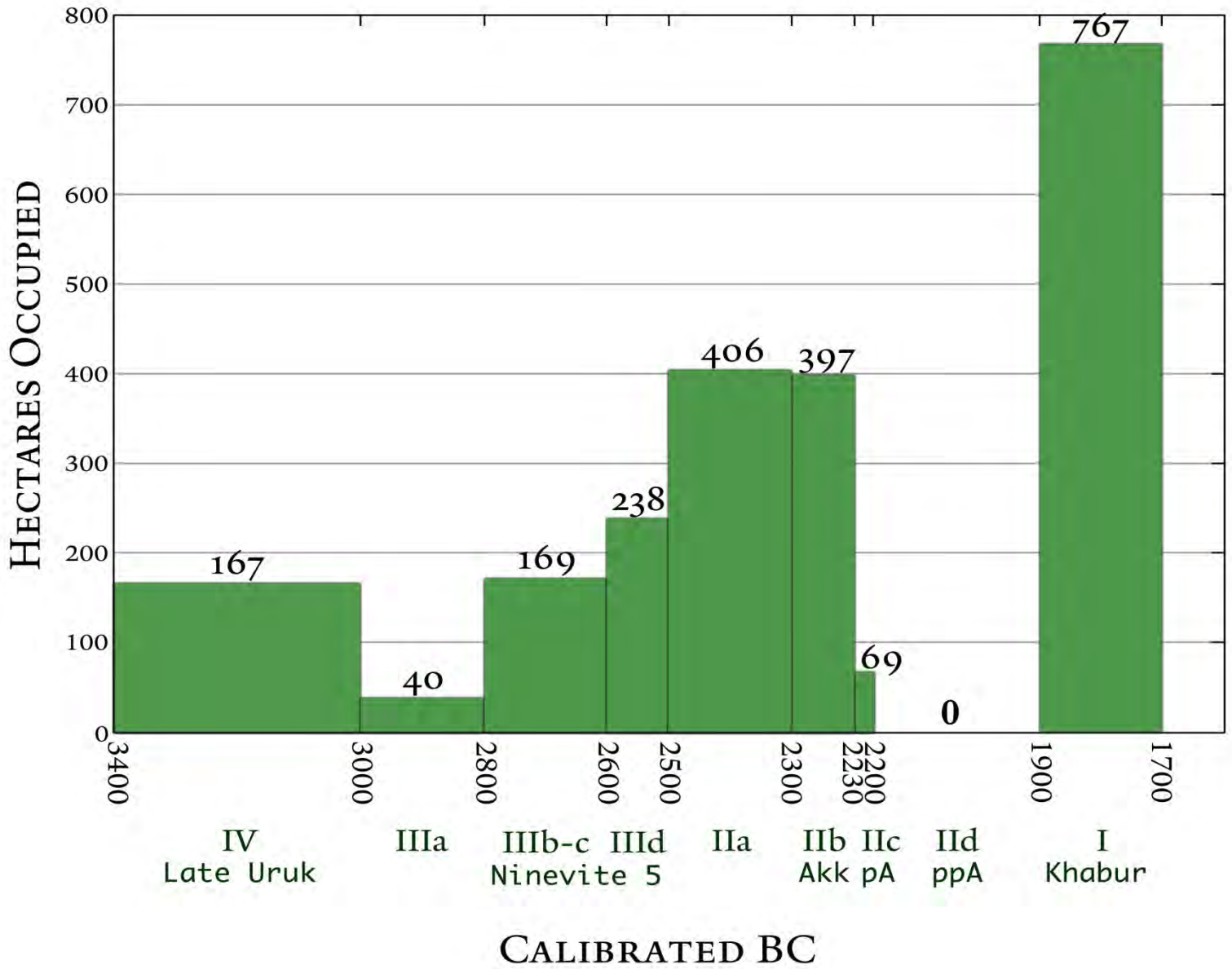
Leilan Akkadian Acropolis: 8.5 ha
Leilan Akkadian Lower Town: 75 ha

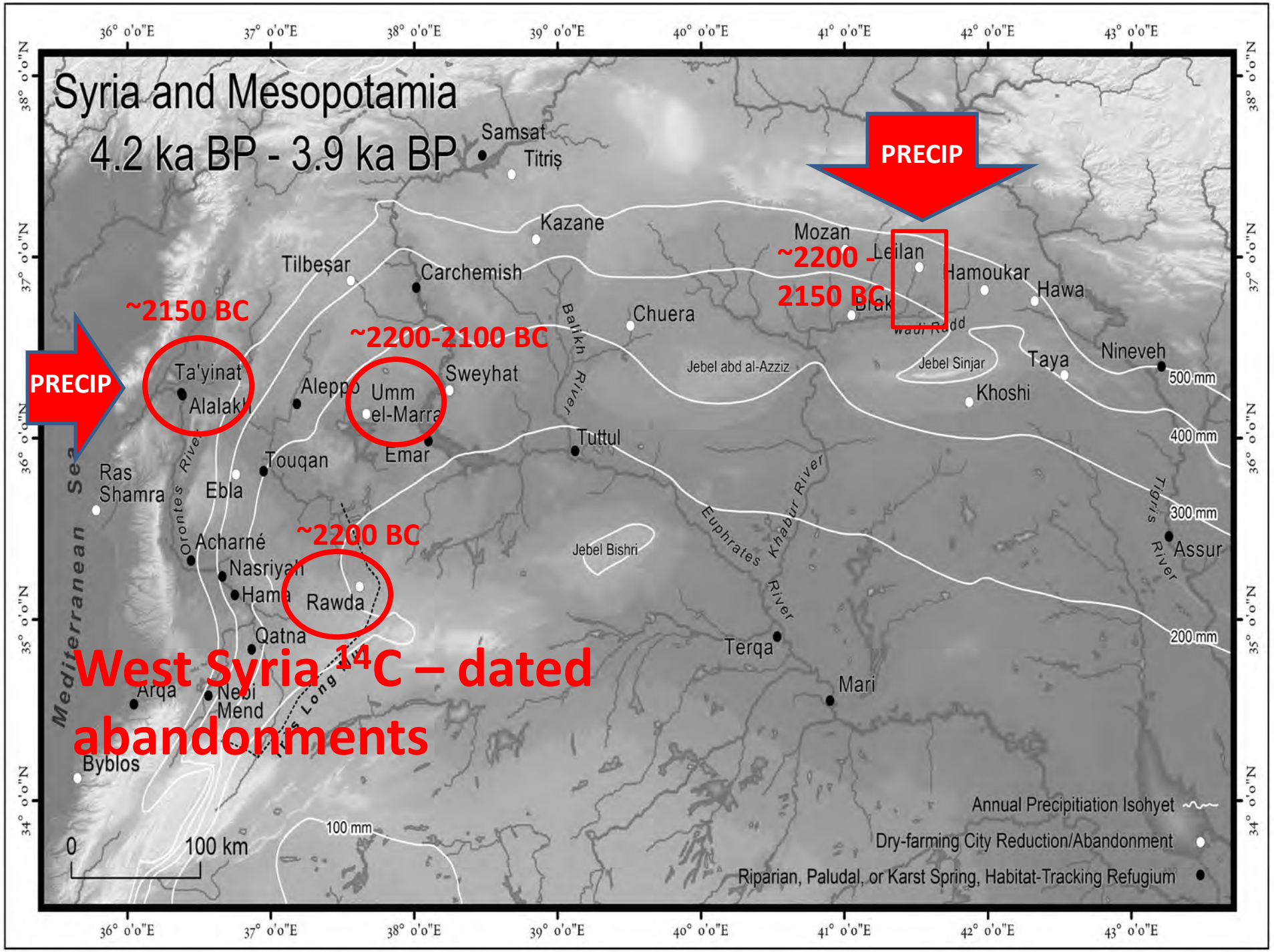
Tell Brak Excavation
1937–2004

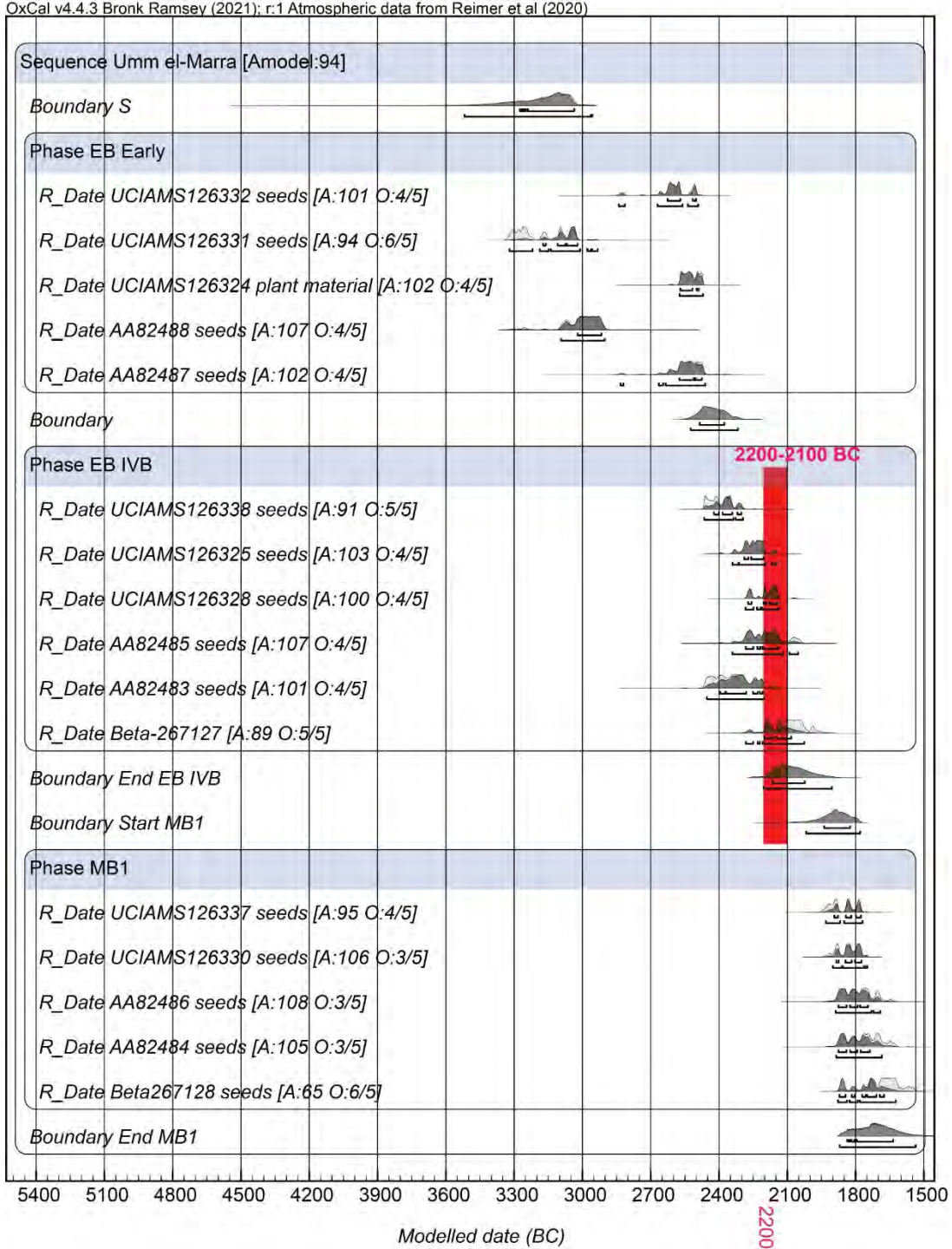


Brak Akkadian Acropolis: 29 ha
Brak Akkadian Lower Town: 6.5 ha

Leilan Region Survey

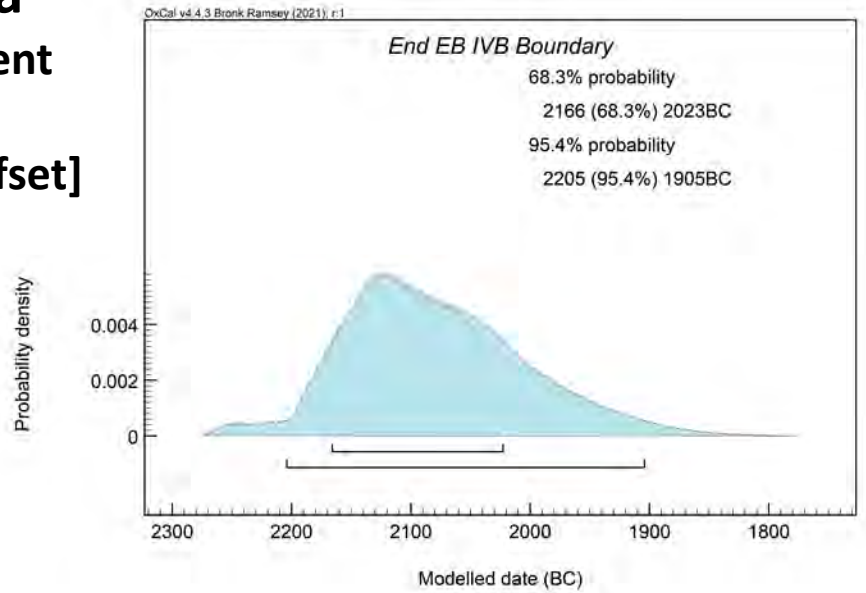


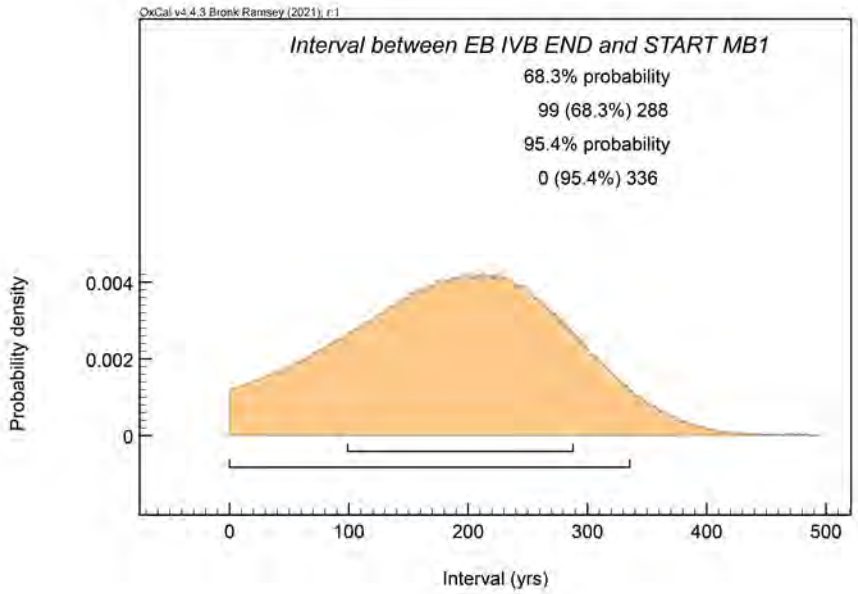

Syria and Mesopotamia
4.2 ka BP - 3.9 ka BP
PRECIP
~2200 - 2150 BC
~2150 BC
PRECIP
~2200-2100 BC
~2200 BC
West Syria ^{14}C – dated abandonments
Samsat
Titriş
Kazane
Tilbeşar
Carchemish
Mozan
Leilan
Hamoukar
Hawa
Chuera
Balikh River
Jebel abd al-Azziz
Jebel Sinjar
Taya
Nineveh
Khoshi
Sweyhat
Umm el-Marra
Aleppo
Ta'yinat
Alalakh
Tuttul
Emar
Touqan
Ebla
Ras Shamra
Mediterranean Sea
Orontes River
Acharné
Nasriyah
Hama
Rawda
Qatna
Arqa
Nebi Mend
Byblos
Jebel Bishri
Euphrates River
Khabur River
Terqa
Mari
Tigris River
Assur
500 mm
400 mm
300 mm
200 mm
100 mm
0
100 km
Annual Precipitiation Isohyet
Dry-farming City Reduction/Abandonment
Riparian, Paludal, or Karst Spring, Habitat-Tracking Refugium

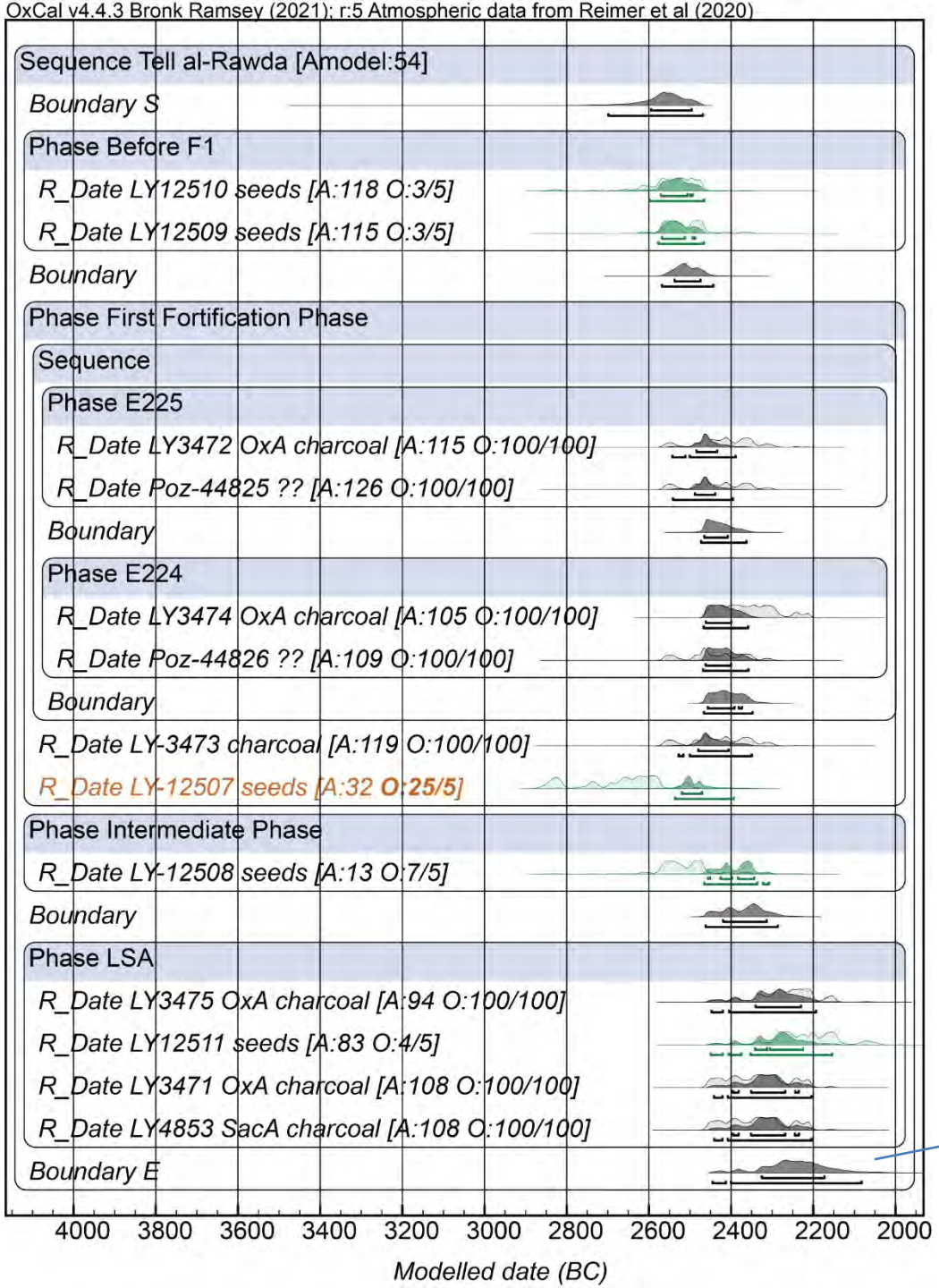


Umm el-Marra

EB IVb abandonment [with likely Levant growing season offset] ca. 2200-2100 BC





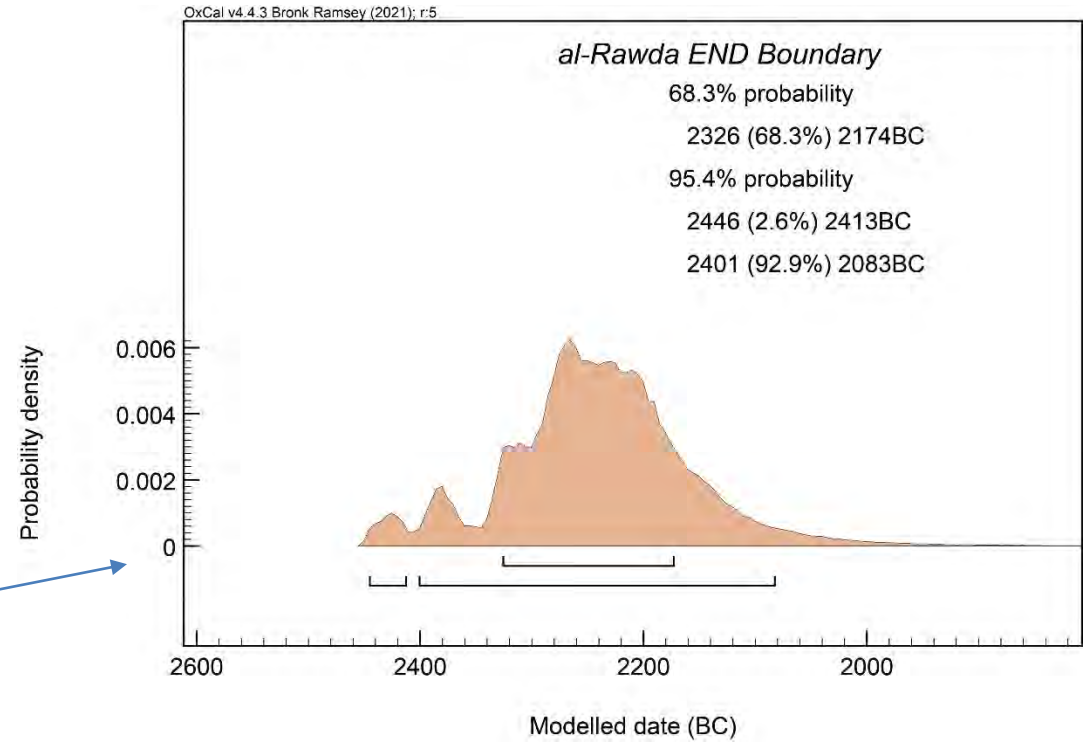


al-Rawda

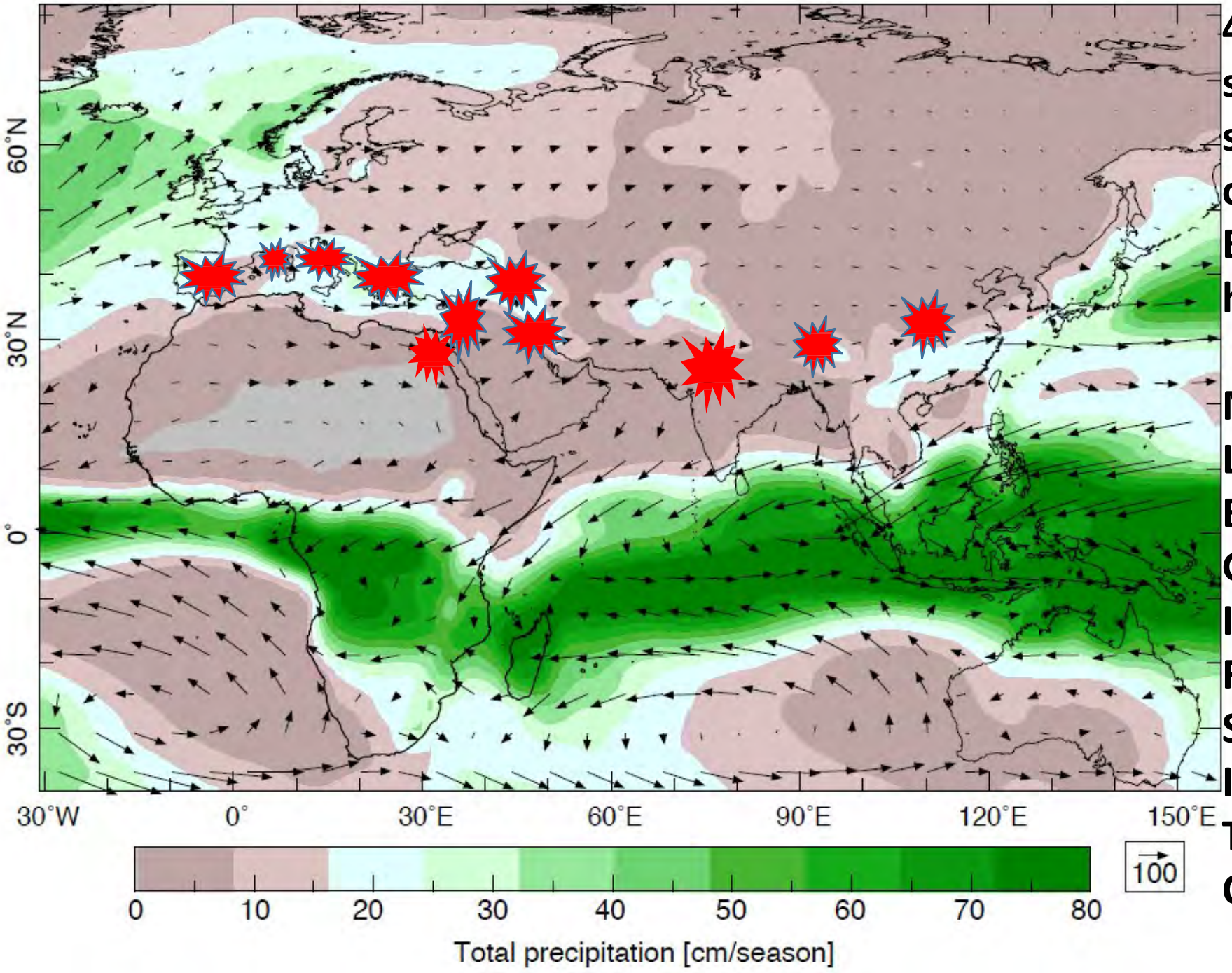
combining (and best interpolation of) data in Schwartz 2017 and Brochier 2020 (data not all the same)

One larger outlier (LY-12507) at 25% probability. One LSA phase date on short-lived material (LY-12511) is a little later than 3 charcoal dates. Need more non-charcoal dates. Current evidence poor temporal definition.

End LSA phase could be 23rd century BC or around 2200 BC.



ERA-I moisture vector transport DJF



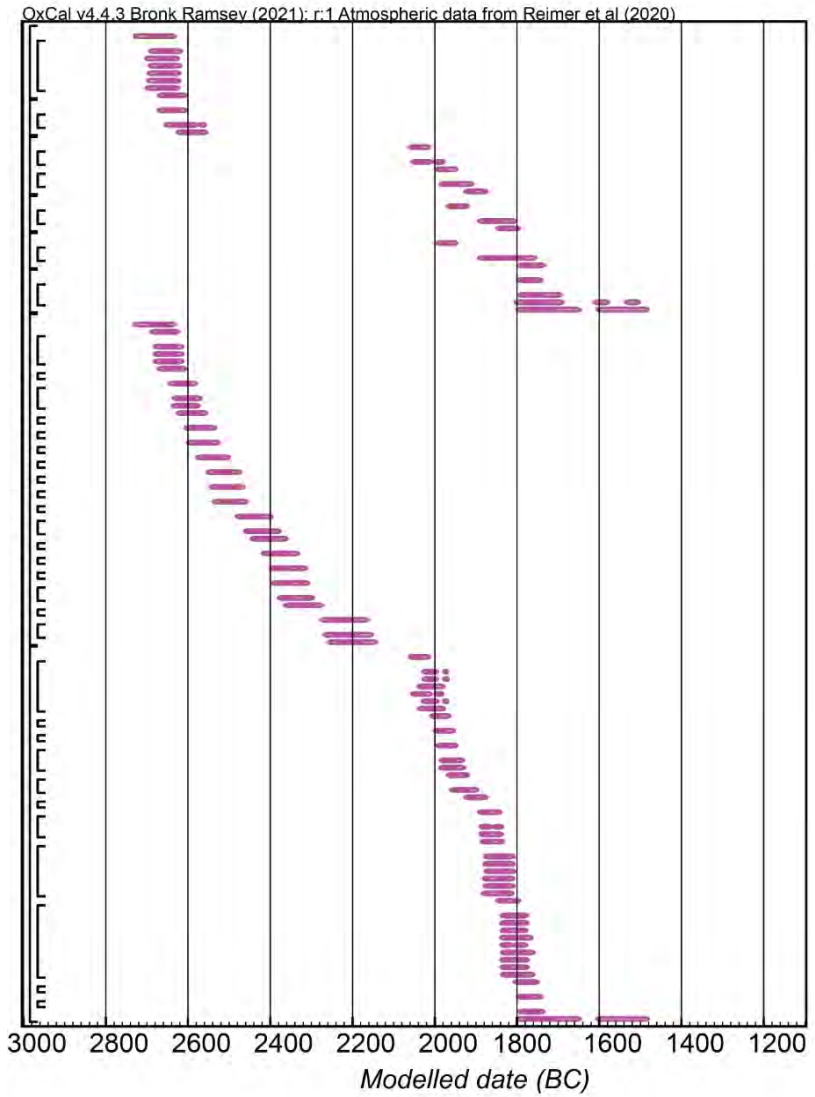
4.2 - 3.9 ka BP synchronous societal collapses Eastern hemisphere:

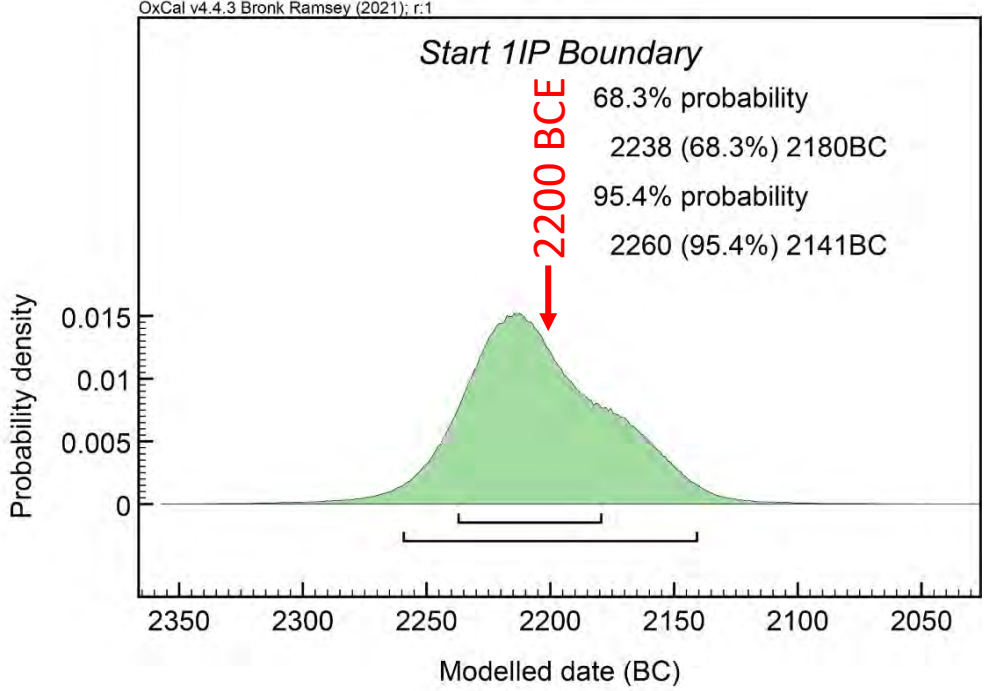
Mesopotamia, Levant, Egypt, Greece, Italy, France, Spain, Indus? Tibet? China?

Weiss 2021

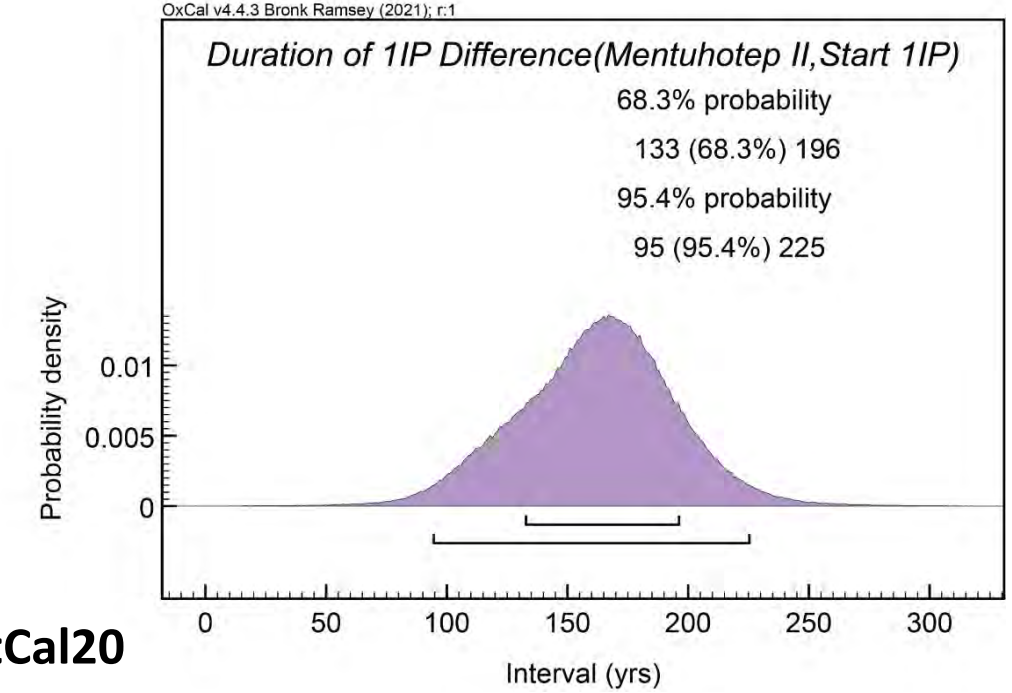
Egypt First Intermediate Period

Summary of elements and structure





Start First Intermediate Period (median = 2208 BC)



Duration of the First Intermediate Period

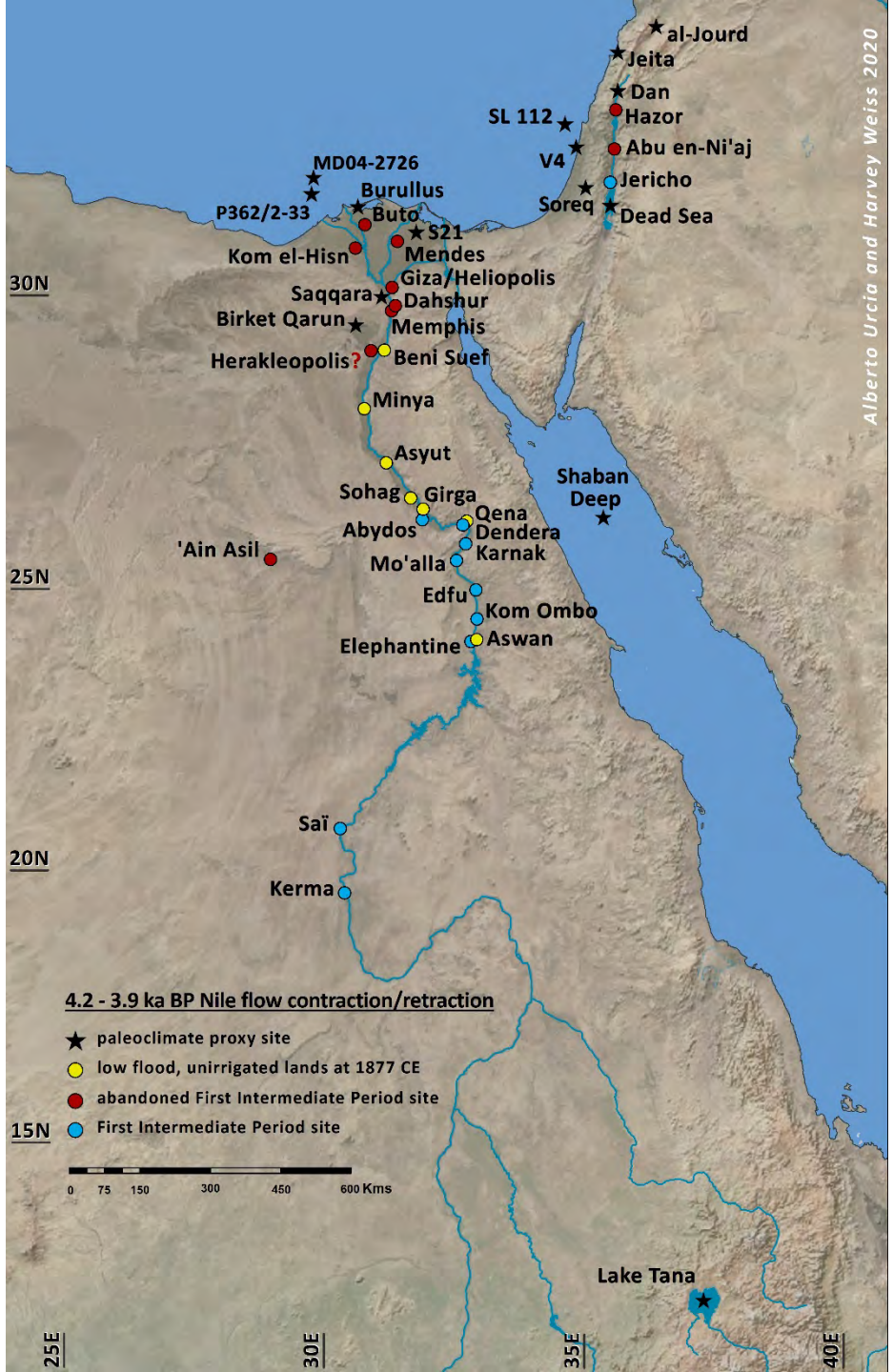
OK and MK Model (Ramsey et al 2010) re-run with IntCal20

Old Kingdom Collapse

4.2 – 3.9 ka BP Nile flow retraction, a function of Indian Summer Monsoon reduction, causes FIP Nile delta abandonment and habitat-tracking to Middle Nile.

"A distinction may be made between flow contraction, meaning narrowing of a channel, and flow retraction, meaning a shortening of the distance to which flowing waters extend. Whether because of avulsive channel relocation or climate-related flow reduction, settlements adjoining watercourses may need to shift unless their economy is to decline. Both flow contraction and retraction may happen simultaneously."

Macklin, Mark and John Lewin 2015 The Rivers of Civilization. QSR 114: 228-244.



Hermes Cave, Peloponnese, Greece 4.2 ka BP

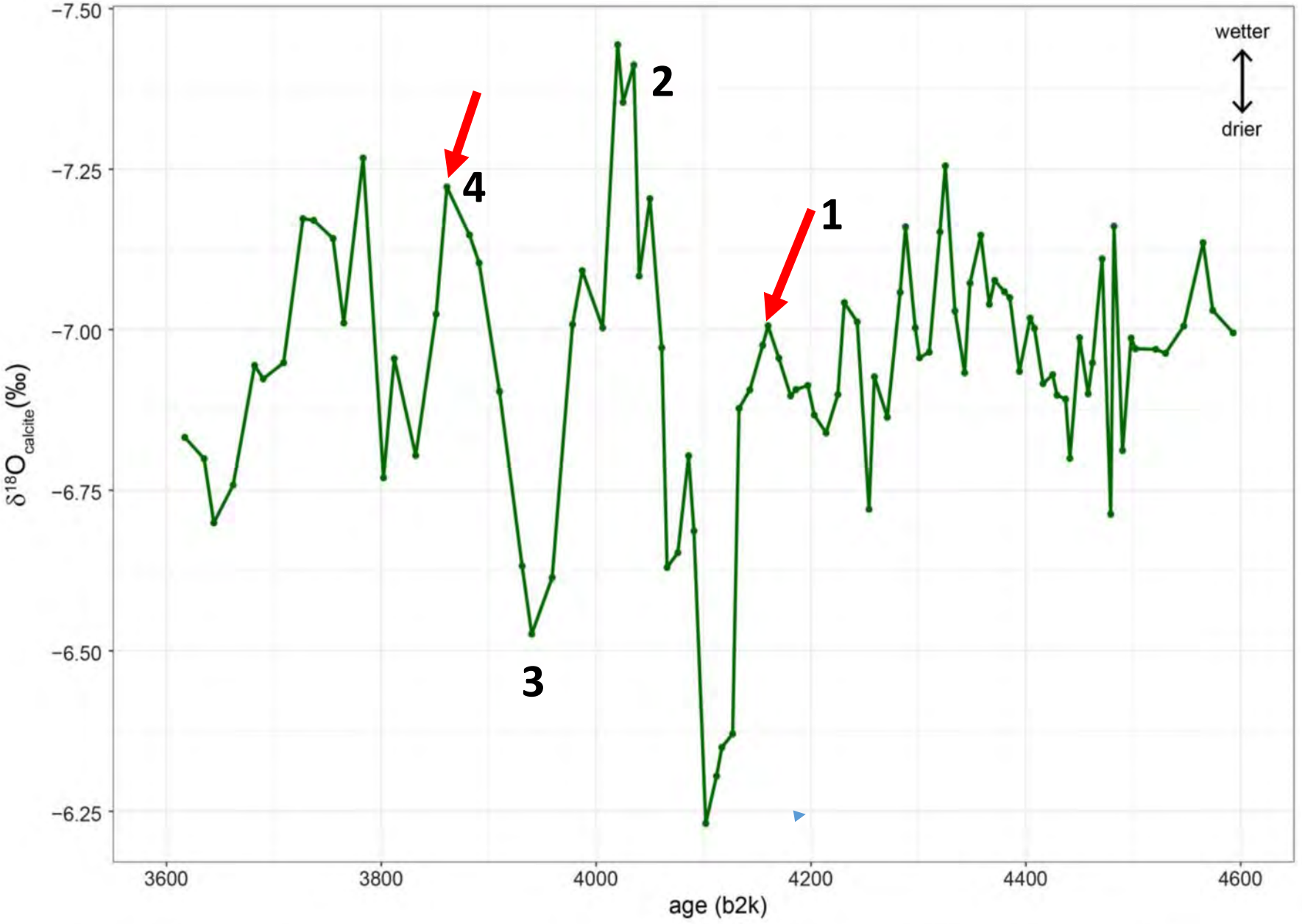


Figure 7: Evolution of the $\delta^{18}O$ values of Hermes Cave stalagmite GH 17-05 between 4600 and 3600 years b2k.

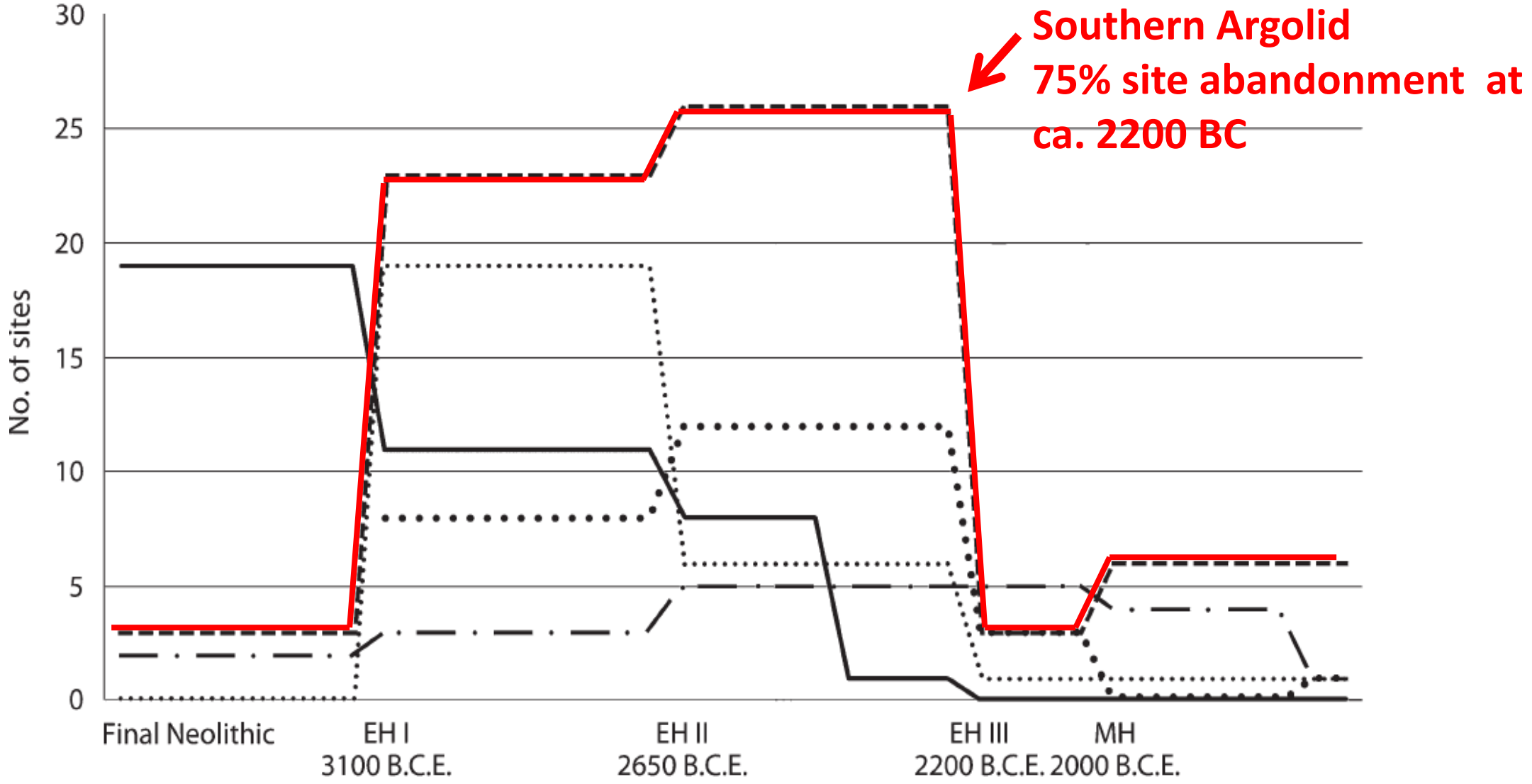
Kluge et al 2020

"Outstanding is one high-amplitude change at 4.2-4.0 ka (Fig. 7) that shows the largest change of the whole record with a 1.2 ‰ shift within about 60-70 years and includes both the least and the most negative calcite δ18O values ….

"…the highest fluctuations in the δ18O values are found between 4.15 and 4.02 ka (±0.2 and ±0.3 ka, respectively) (corresponding to 4100-3970 cal BP in 14C based chronologies), which is consistent with the timing of 10 an aridity event in Northern Mesopotamia within the given uncertainty ranges (Carolin et al., 2019). The amplitude of this fluctuation in GH17-05 exceeds 1 ‰ and includes both the most negative and the least negative δ18O value of the entire record…

"Thus, we expect a. relative rainfall variation of 15-30% (200-300 mm change relative to 1000-1300 mm annual precipitation) during the 4.2 ka event at Hermes Cave and potentially enhanced at lower elevation sites….

Aegean Collapse at Early Helladic III / 2200 BC

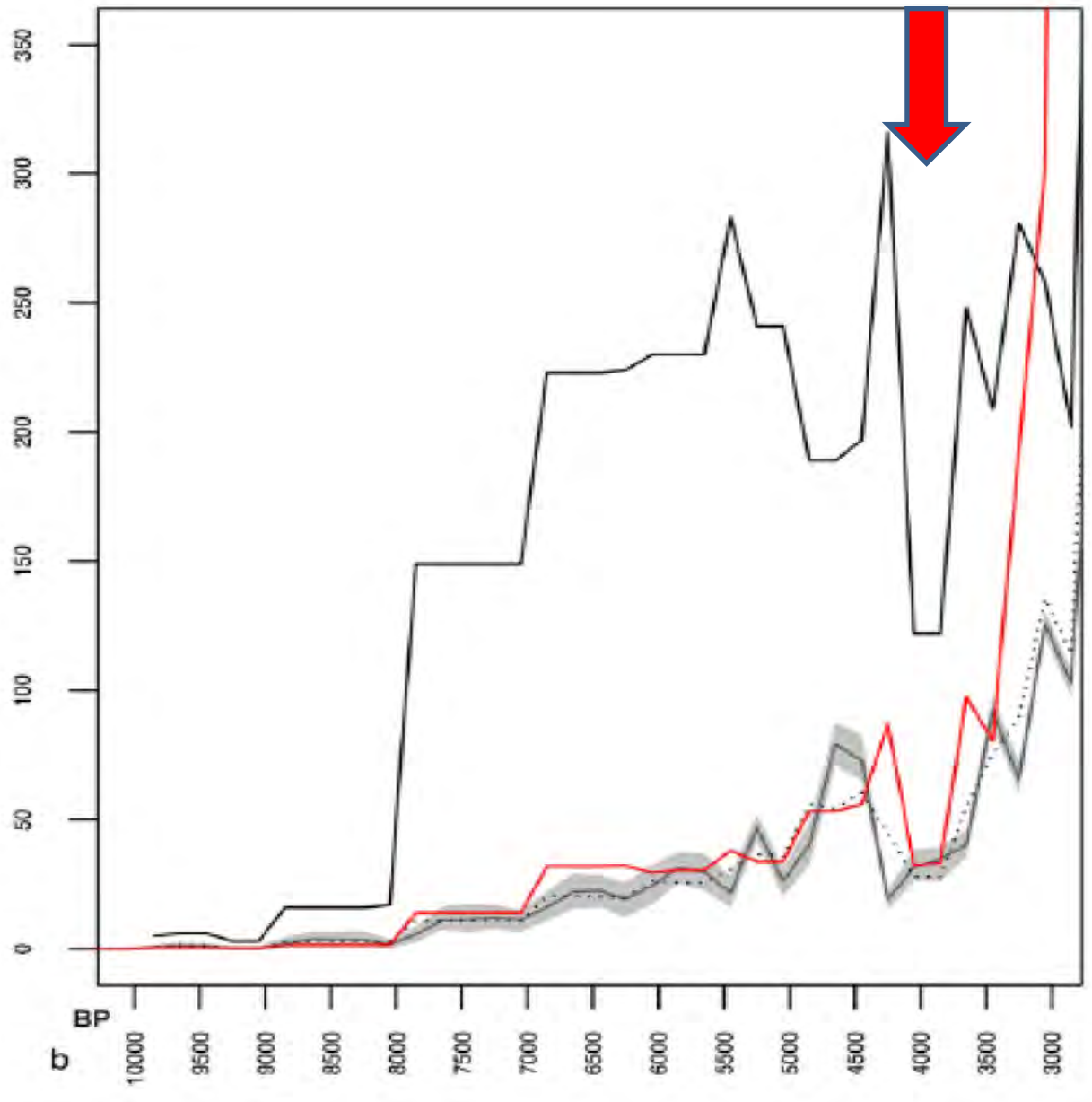


Greece: Sites Occupied Third Millennium BC

Weiberg and Finné 2013

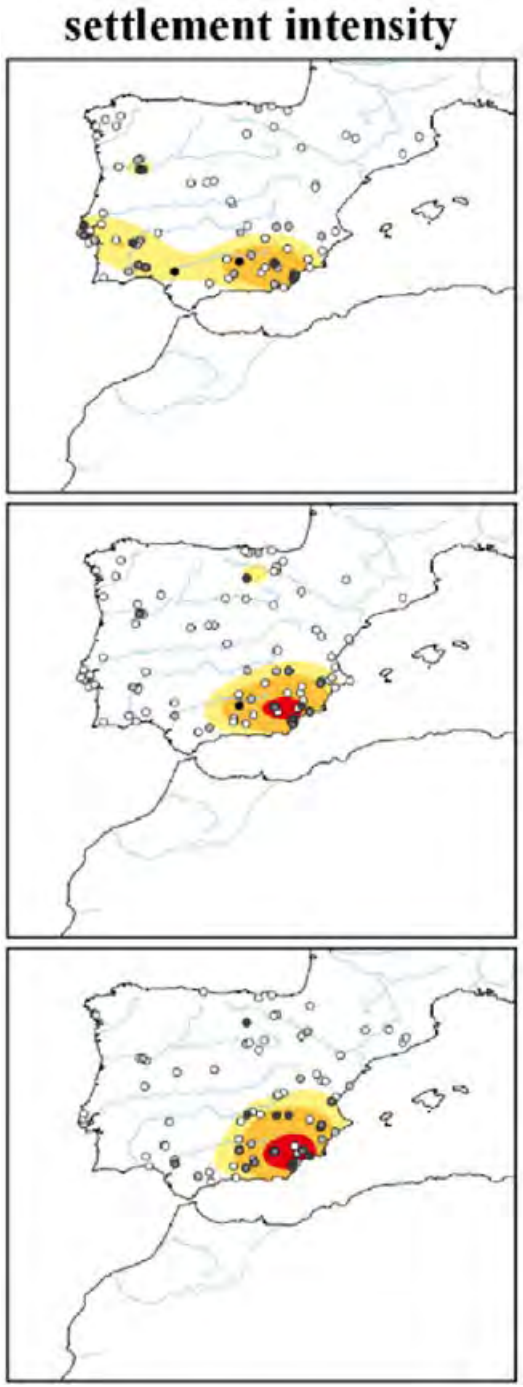
Tyrhennian central Italy collapse at 4.2 ka BP

solid = raw site counts, red = summed settlement areas.



Stoddart et al 2019

Spain Chalcolithic settlement collapse at 4.2 ka BP BP



4400-4200 BP Chalcolithic settlement

Lull et al 2010;
Carozza et al 2015

4200-4000 BP abandonment of Southwest habitat-tracking to Southeast

"…water scarcity was likely a cause of land abandonment."
Brisset et al 2020

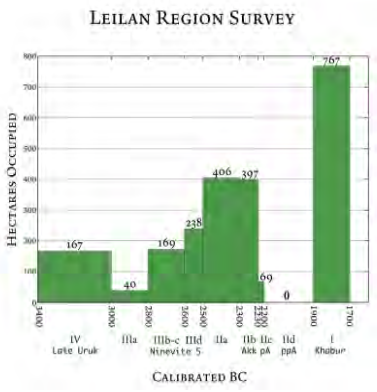
4000-3800 BP El Argar rainfed + irrigation agriculture

Schirrmacher et al 2020

Synchronous collapse processes at ca. 2200 BC

Mesopotamia

end Leilan IIc
2240-2196 (95.4%)
Weiss et al 2012
Manning 2017
Arrivabeni 2021



Weiss et al 2012

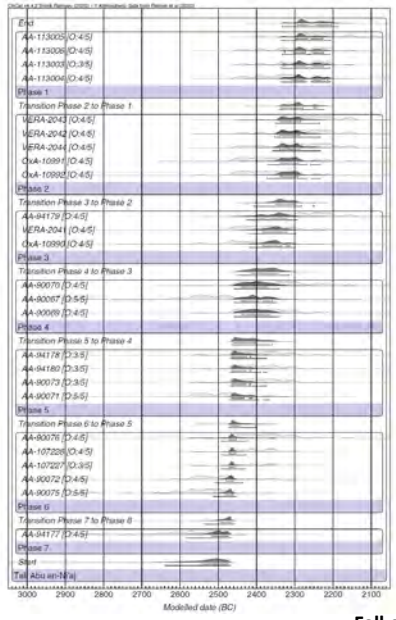
Egypt

begin FIP
2208±29 (68.2%)
Ramsey et al 2010
Weiss 2021
Manning 2021

Weiss 2021

Levant

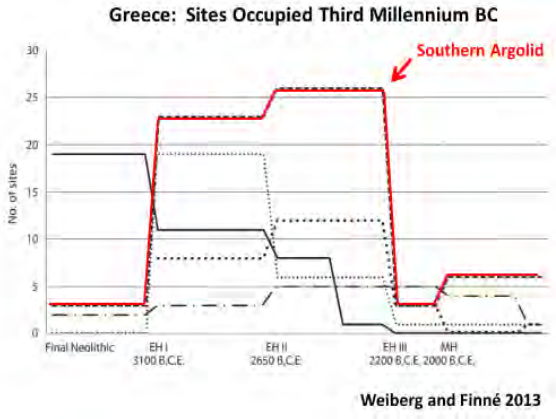
end EB IVa
2300-2200 (68.2%)
Fall et al 2021



Fall et al 2021

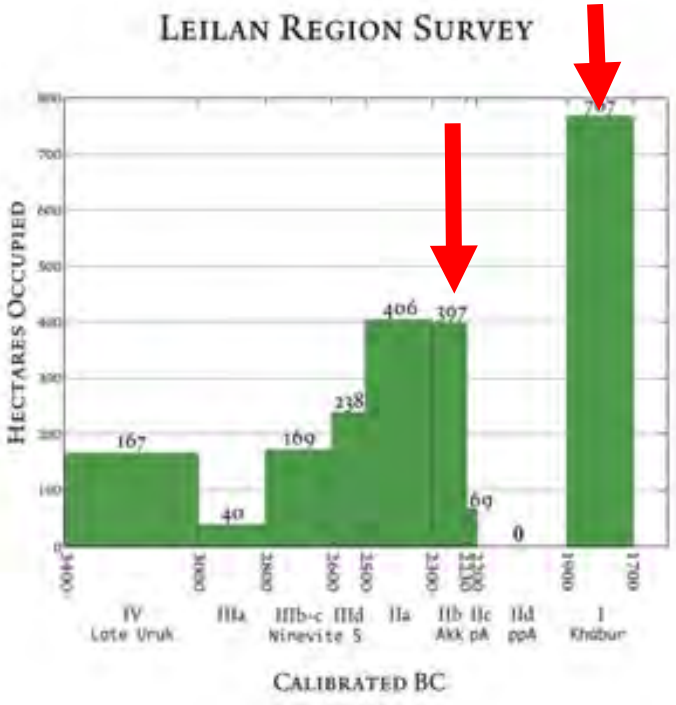
Greece

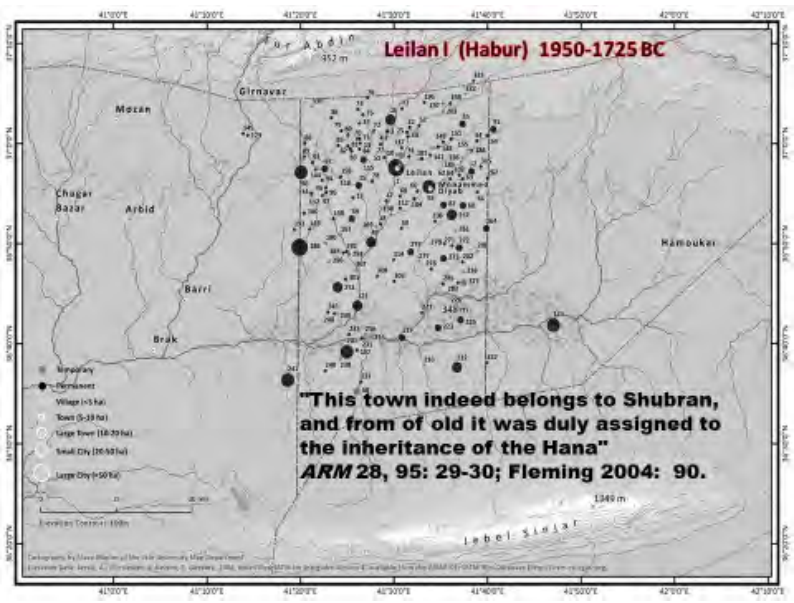
begin EH III
2253±62 (68.2%)
Arvaniti and Maniatis 2018



Weiberg and Finné 2013

Did Akkadian period agriculture and taxation exceed Khabur Plains "carrying capacity", increase "vulnerability" and cause collapse?





1. Khabur Plains' LRS Khabur period (1950-1700 BC) population *ca. 94% greater* (synchronous occupation?) than Akkadian period, *without collapse*, and was succeeded by 17th century early Mitanni settlement.

2. Leilan Lower Town South population abandoned Leilan *after* removal of Akkadian imperial taxation

3. 4.2 ka BP megadrought (4-stage, ca 30%, ca 200 years) --> synchronous rainfed agriculture collapses from Spain to Iraq, *across varied and some underpopulated biomes*, including irrigated Nile delta.

Thank you