INDO-EUROPEAN COURSE · MODULE 2

02

The Steppe and Its Neighbours: Archaeology

Eneolithic clines, Yamnaya, Corded Ware, Sintashta, Andronovo and the Oxus civilisation



YSATIS

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What this module covers

1 Before the Yamnaya

Eneolithic cultures, c. 5000–3300 BCE: Khvalynsk, Serednii Stih, Maikop and the three genetic clines that fed the Yamnaya.

2 The Yamnaya and daughters

Kurgans, wagons and herds; Afanasievo, Corded Ware, Bell Beaker and Catacomb, c. 3300–2200 BCE.

3 Towards Asia

Sintashta chariots, Andronovo and the Bactria–Margiana complex (BMAC), c. 2100–1500 BCE.

Each part pairs the archaeology with what the supplied ancient-DNA papers add.

Course plan. Module 3 gives the DNA in full; Module 5 follows the Indo-Iranians.

What archaeology can and cannot show

It can show

Dates, burial rites, wagons, metal, herding. Where objects and ideas travelled, and when.

It cannot show

A language. No pot says what its maker spoke. Languages are inferred by linking cultures to words and to DNA.

So we ask

Do culture, ancestry and language move together here? Sometimes yes; each case must be argued.

Tiers used on every slide: **A** checked in a supplied paper **B** standard background, to verify **C** interpretation or debated

Method note (tier A for the reasoning; see Module 1 for the three hypotheses).

The steppe: a grassland corridor

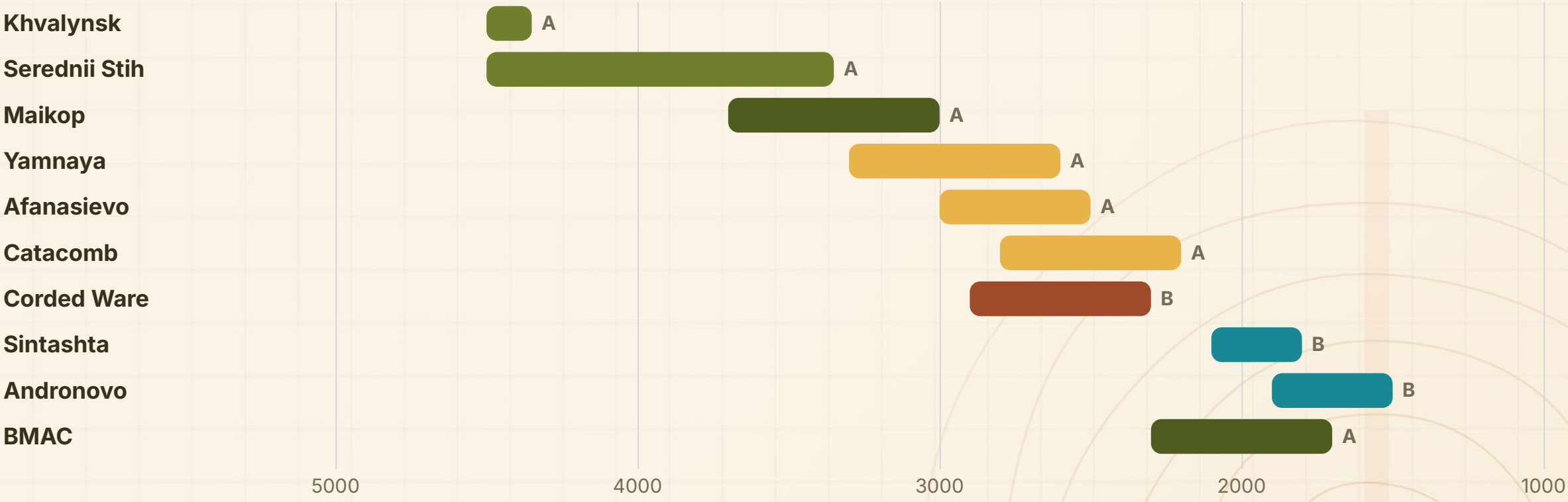


Why geography matters

- A belt of grassland runs from the Danube mouth to the Altai, about 5,000 km.
- Four river systems form corridors: Dnipro, Don, Volga and Ural.
- The Caucasus is the wall to the south; the forest zone lies north.
- South of the steppe lie the Turan oases, where the BMAC later grew.

Tier B: physical geography (Natural Earth). The 5,000 km figure follows the Yamnaya sampling span in Lazaridis et al. 2025.

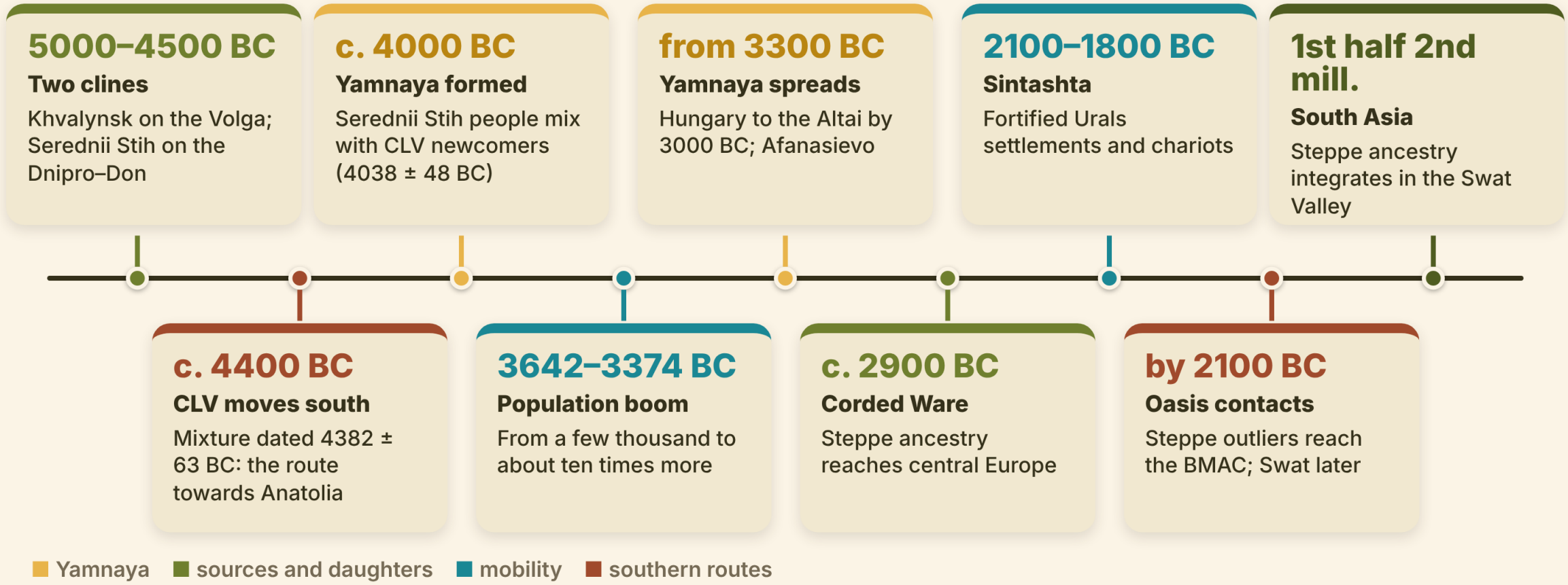
The cultures on one timeline (BCE)



Tier letter at the end of each bar: A = dates from a supplied paper; B = conventional span.

Lazaridis et al. 2025; Ghalichi et al. 2024, Nature 635:917–925; Narasimhan et al. 2019; Damgaard et al. 2018. Spans approximate.

From mixture to empire: nine steps, 5000–1500 BC



Tier A/B: dates as stated on slides 12, 16, 17, 19, 31, 37, 45 (Lazaridis et al. 2025; Haak 2015; Narasimhan 2019). Sintashta dates tier B.

The steppe package

Kurgans

Burial mounds. Used c. 5000–3000 BC by Caucasus–Volga groups, long before the Yamnaya.

Wagons

Wheeled vehicles drawn by oxen. The Yamnaya are credited with "horse-wagon technology".

Herding

Mobile pastoralism over open grass, with cattle, sheep and horses.

Posture

On the back, knees raised, red ochre on the pit floor: shared by almost all steppe groups.

No single item is "Indo-European". Together they describe a way of life that could move fast.

Tier A: Lazaridis et al. 2025 (sections "The CLV cline" and Discussion). Wagon details are tier B; see slide on wagons and horses.

PART 1

01

Before the Yamnaya

Eneolithic steppe, c. 5000–3300 BCE: three genetic clines



Three ancestries meet on the steppe

EHG: the Volga north

Eastern hunter-gatherers across the Volga and Karelia. The earlier-established population of the middle Volga.

UNHG: the Dnipro west

Ukraine Neolithic hunter-gatherers on the Dnipro rapids, c. 6242–4542 BC; mixed EHG and western hunter-gatherer ancestry.

CHG and Caucasus Neolithic: the south

Caucasus hunter-gatherer ancestry in Georgia; Neolithic farmers at Aknashen and Masis Blur, Armenia.

Where and when these three streams mixed decides where the Yamnaya came from.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, sections "Three pre-Bronze Age genetic clines" and "The Dnipro cline".

Three clines on the Eneolithic map

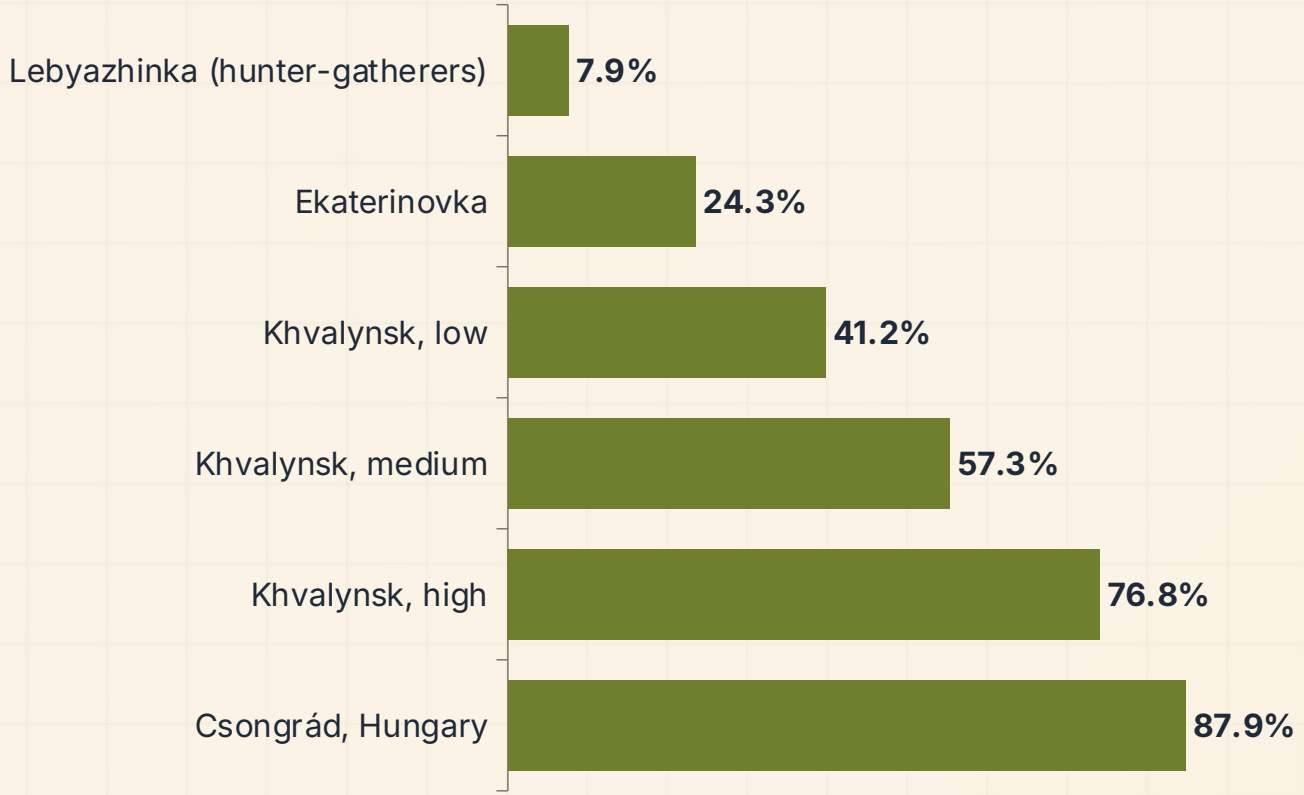


Reading the map

- **Volga cline:** upriver hunter-gatherers mix with lower-Volga people (Khvalynsk).
- **Dnipro cline:** Serednii Stih and, later, the Yamnaya.
- **CLV cline:** Caucasus to lower Volga, with Maikop and Remontnoye in between.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, Fig. 1 and Fig. 2. Site positions approximate (gazetteer), arrows schematic.

Khvalynsk: a population still mixing



Share of lower-Volga (BPgroup) ancestry, % (±1–4)

- Khvalynsk cemetery, c. 4500–4350 BC, on the middle Volga.
- Individuals range from 14% to 89% lower-Volga ancestry: a population caught mid-mixture.
- Balkan copper reached Khvalynsk, so long-distance exchange already linked the steppe to Europe.
- A Hungarian individual of the same ancestry shows steppe-like people far to the west by c. 4300 BC.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, section "The Volga cline", Fig. 1c.

Burial customs: steppe versus Caucasus

Group	Body position	Mound
Ekaterinovka, Lebyazhinka (Volga)	On the back, knees raised; earliest 4838–4612 BC	Not stressed
Serednii Stih (Dnipro–Don)	On the back, knees raised, red ochre	Not stressed
Remontnoye (lower Don–Manych)	Contracted on one side	Kurgan
Maikop (north Caucasus)	Contracted on one side	Kurgan (Klady, Dlinnaya Polyana)
Yamnaya (later)	On the back, knees raised	Kurgan

The Yamnaya burial pose follows the steppe line; the kurgan follows the Caucasus–Volga line. Both streams meet in them.

Tier A: Lazaridis et al. 2025, Nature 639:132–142. Yamnaya row follows the paper's statement that the pose was "later typical of the Yamnaya".

Serednii Stih: the Dnipro–Don heartland

13

individuals sampled, 4996–3372 BC (uncorrected dates)

4038 ± 48

BC: average date of mixture in the Core Yamnaya ancestors

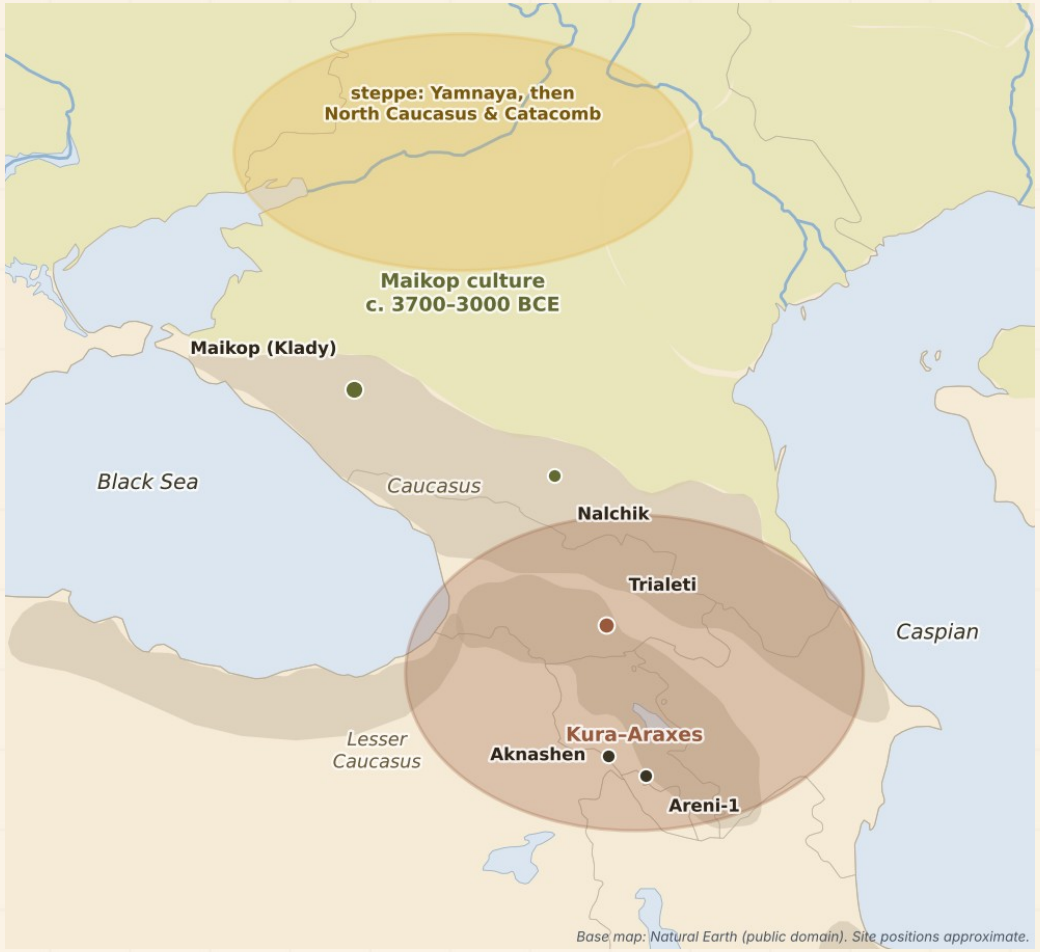
Don link

Don Yamnaya reused Serednii Stih settlements, unlike on the Volga–Ural steppes

Serednii Stih cluster	Sites	Position on the Dnipro cline
SShi	Vinogradnoe, Oleksandria, Igren	Closest to Core Yamnaya, but not a clade with them
SSmed	Kopachiv, Oleksandria, Deriivka	Middle of the cline
SSlo	Moliukhiv Bugor	Apart from the rest, close to UNHG

Tier A: Lazaridis et al. 2025, Nature 639:132–142, sections "The Dnipro cline", "Discussion". Date caveat: freshwater-fish reservoir effect.

Maikop and the Caucasus gateway



Maikop in context

- Maikop: rich kurgan burials in the north-west Caucasus, individuals dated 3932–2934 BC.
- Its people were largely Caucasus Neolithic (Aknashen-like) in ancestry: 86.2%.
- Kura–Araxes lay south of the range; Trialeti kurgans later (middle Bronze Age).
- The mountains were no barrier: gene flow crossed them in the Bronze Age.

Tier A: Lazaridis et al. 2025, Nature 639:132–142; Wang et al. 2019, Nat. Commun. 10:590; Ghalichi et al. 2024. Positions approximate.

The CLV cline: from the Caucasus to the lower Volga

Aknashen

Armenia, 5985–5836 BC. Caucasus Neolithic farmers

Maikop

North Caucasus. Kurgans at Klady; 86% Aknashen-like

Remontnoye

Steppe north of the Manych, 4152–3637 BC

Berezhnovka-2

Lower Volga, 4450–3960 BC

Decreasing Caucasus Neolithic ancestry, south to north →

Genes and geography do not always match: Progress-2 and Vonyuchka-1 in the north Caucasus had little Caucasus Neolithic ancestry.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, section "The CLV cline". Site dates are individual radiocarbon ranges.

Where did the Yamnaya come from?

About four-fifths

CLV ancestry: Caucasus-derived people who moved into the Dnipro–Don region and mixed with locals.

About one-fifth

Dnipro and Don hunter-gatherers (UNHG and related).

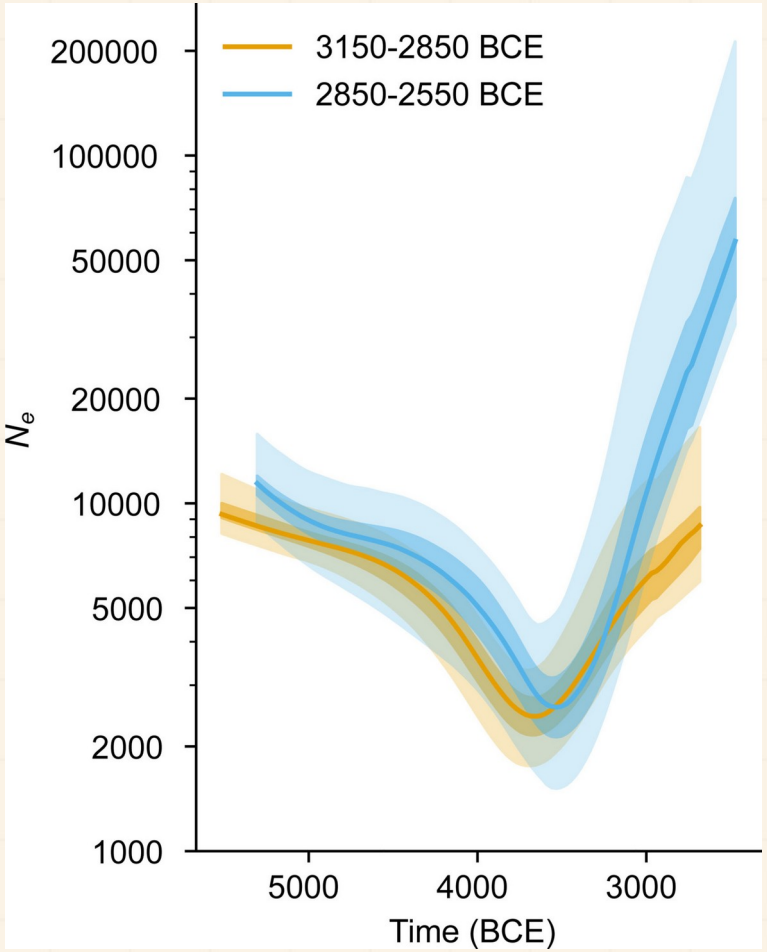
One best model

73.7% Serednii Stih (SShi) plus 26.3% Remontnoye-like people.

Not the Volga, not the north Caucasus: the Yamnaya grew from the Dnipro–Don Serednii Stih world. Tier C: the exact place (Dnipro or Don) is open.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, abstract and sections "The Dnipro cline", "The CLV cline". Place of origin: authors' inference.

Timing: from mixture to explosion



- **c. 4000 BC:** Yamnaya ancestors formed by admixture.
- **3642–3374 BC:** population grows from a few thousand to roughly ten times more.
- **c. 3300 BC:** Yamnaya complex appears archaeologically.
- **c. 3000 BC:** maximal extent, Hungary to Kazakhstan.
- A half-millennium gap separates the genetic formation from the visible expansion.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, Fig. 4 (CC BY 4.0, unaltered). Dates are model estimates with confidence intervals.

A southern branch: CLV people in Anatolia

c. 4400 BC

CLV people move south, admixing as they go. Mixture dated 4382 ± 63 BC.

c. 4000 BC

Areni-1, Armenia: 26.9% lower-Volga ancestry on a local Neolithic base.

2750–1500 BC

Central Anatolia (Ovaören, Kaman-Kalehöyük, Old Hittite): steppe-related plus Mesopotamian ancestry.

Tier C: the authors place the last unity of Indo-Anatolian in the CLV people, 4400–4000 BC. Linguists date the split differently; Module 4 and Module 1 compare the dates.

Tier A for the numbers, tier C for the language inference: Lazaridis et al. 2025, Nature 639:132–142, section on Anatolia and Discussion.

PART 2

02

The Yamnaya and their daughters

Kurgans, wagons and herds across Europe and Inner Asia, c. 3300–2200 BCE



The Yamnaya complex

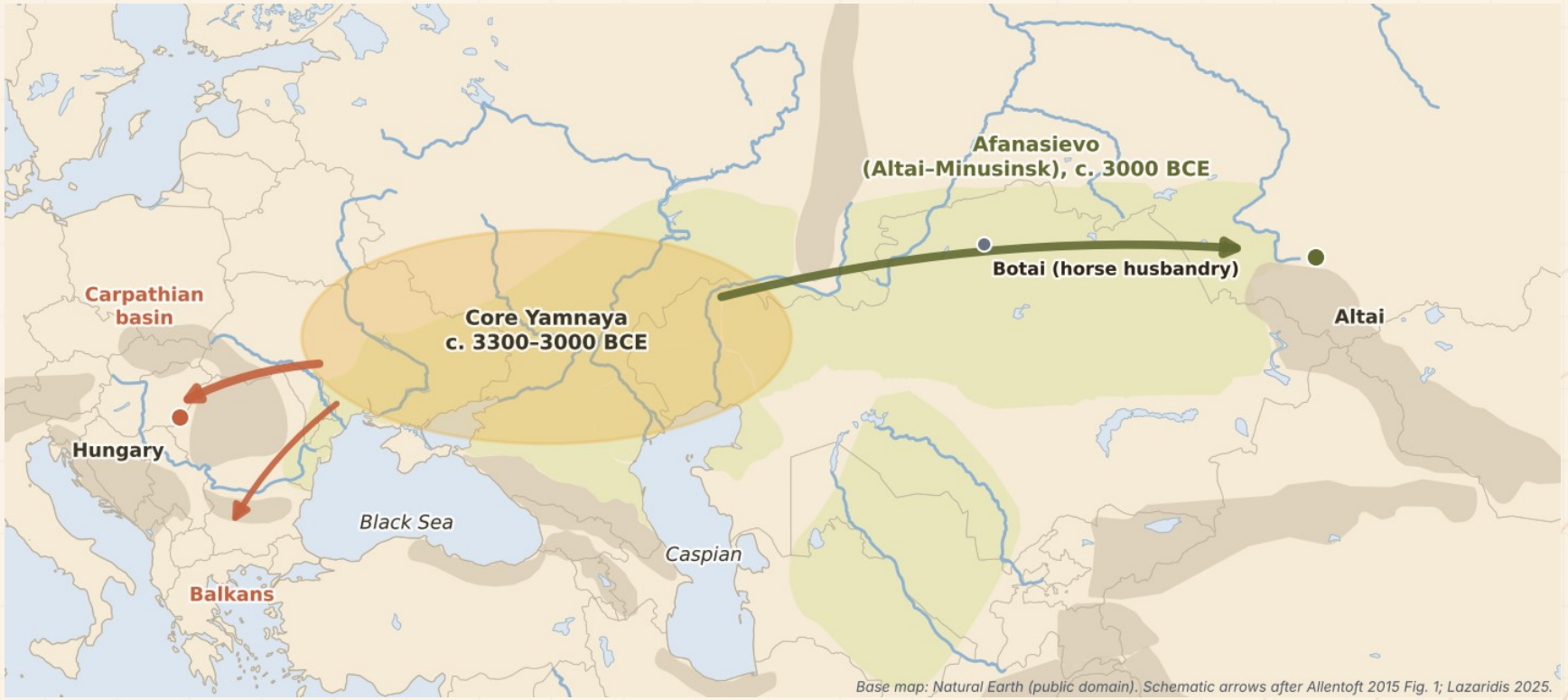


Yamnaya kurgan, Hungary. Cseh, Molnár, Makó & Sümegi, CC0 (Wikimedia Commons)

- Appears c. 3300 BC north of the Black and Caspian seas.
- By 3000 BC it spans Hungary to Kazakhstan.
- Core Yamnaya men: Y-haplogroup R-M269 in 49 of 51 (R-Z2103 in 41).
- Don Yamnaya: I-L699 in 17 of 20, tied to local ancestors.
- Burial: pit under a kurgan, body on the back with knees raised.

Tier A: Lazaridis et al. 2025, Nature 639:132–142 (abstract; "The Dnipro cline"; Y-chromosome section); Haak et al. 2015, Nature 522:207–211.

Yamnaya expansion, c. 3300–3000 BCE



Two directions

- West: into the Carpathian basin (Hungary) and the Balkans.
- East: Afanasievo in the Altai and Minusinsk basin, genetically indistinguishable from Yamnaya.
- Sampled Yamnaya stretch about 5,000 km yet stay genetically very close.

Tier A: Allentoft et al. 2015 Fig. 1 and Lazaridis et al. 2025; map by Claude on Natural Earth data. Arrows schematic.

Spread wide, yet strikingly uniform

104

Core Yamnaya individuals: a homogeneous high-quality subset

0.005

Mean FST between far-flung Yamnaya groups (very low)

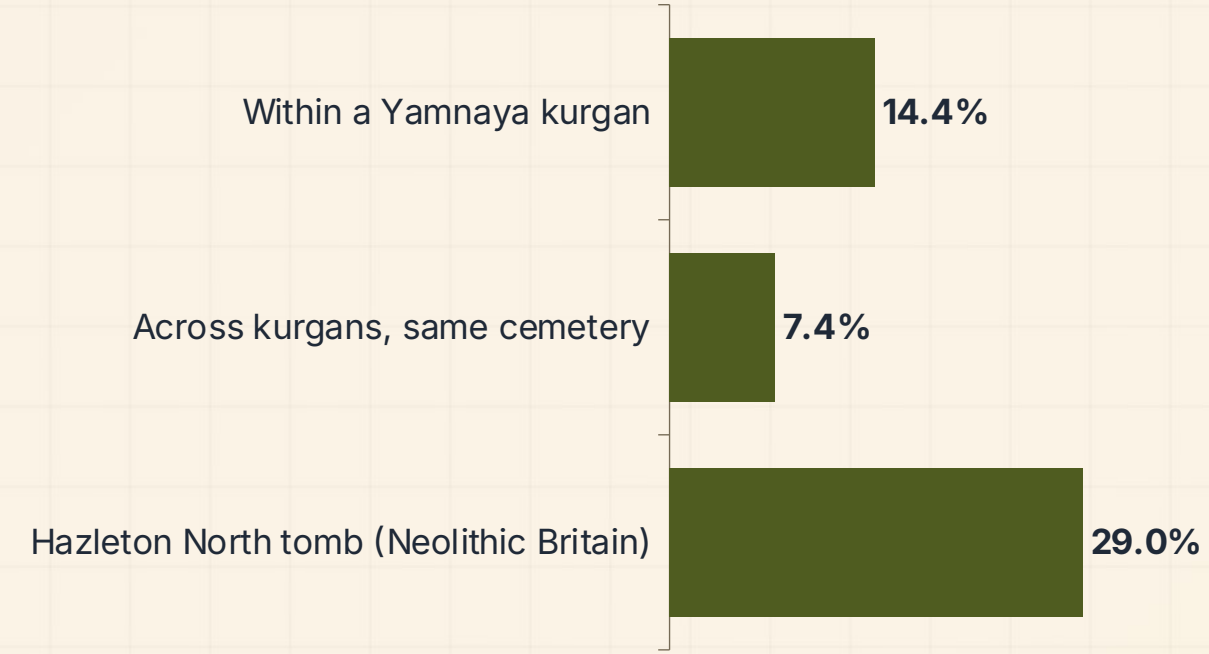
5,000 km

Span of the sampled Yamnaya, Hungary to southern Siberia

- A high-mobility elite buried in kurgans spread fast, with little mixing at first.
- The Don Yamnaya are a local exception, with about one-fifth Dnipro hunter-gatherer ancestry.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, sections "The Dnipro cline", "Discussion"; Extended Data Table 3. FST = genetic distance index.

Who was buried in a kurgan?



Share of individual pairs that were close relatives

- Kurgans were not simple family tombs.
- Most buried people were unrelated or only distantly related.
- Close ties inside a kurgan were mostly social, not biological.
- Kin networks still spread widely: shared long DNA segments span up to about 6,000 km.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, Fig. 5 and main text. Close relatives: about fifth-degree or closer.

Wagons came first

From c. 3500 BCE

Heavy disc-wheeled vehicles, drawn by cattle, carry goods and households.

Mobile homes

Yamnaya herders kept cattle, sheep and some horses; wagons let households follow the herds.

Shared words

Words for wheel, axle, nave, thill and yoke recur in several branches. Read as inherited vocabulary, but that is an inference (tier C).

The wheel and wagon came first. Horses bred for mobility came later (next slides).

Tier A: Lindner 2020, Antiquity 94:361–380; Kristiansen et al. 2017, Antiquity 91:334–347 (both CC BY). Vocabulary link: tier C.

Botai: early horse people, different horses

c. 3500 BCE
corrals and horse husbandry at Botai, northern Kazakhstan

2.7%
Botai-related ancestry in modern domestic horses (95% CI 2.0–3.8%)

Feral
Przewalski's horses descend from Botai-type horses, not from truly wild ones

Botai horse-keeping is real, but its horses are not the ancestors of the horses we ride.

Tier A: Gaunitz et al. 2018, Science 360:111–114 (text only); Librado et al. 2024, Nature 631:819–825; Damgaard et al. 2018 (Botai people).

Where modern horses come from

273

ancient horse genomes sequenced for this study and its comparisons

Volga–Don

lower Volga–Don steppe: the home of the DOM2 lineage

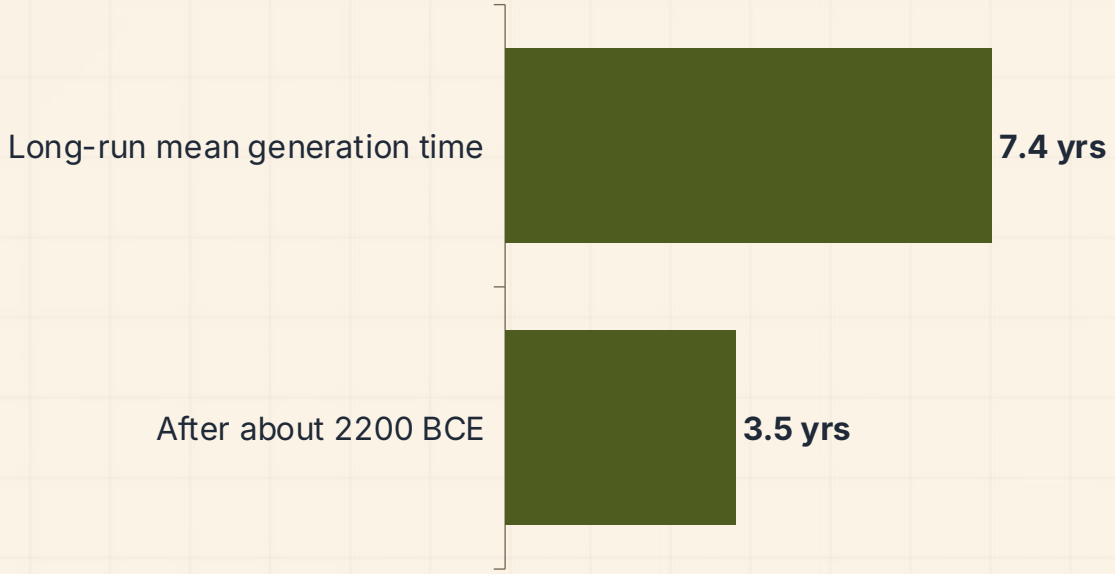
Not Anatolia

Anatolia is excluded as the source of modern domestic horses

All modern domestic horses descend from one steppe lineage, DOM2, from the late 4th to early 3rd millennium BCE.

Tier A: Librado et al. 2021, Nature 598:634–640 (CC BY). Selection signals are the authors' reading (tier C).

Breeding control by about 2200 BCE



- Bottleneck begins about 2664 BCE (3064–2564 BCE): about 500 breeding animals.
- Then a 13.7-fold expansion within 30 generations, before about 1864 BCE.
- Close-kin mating and a halved generation time show people controlling breeding.
- Widespread horse mobility dated to about 2190 BCE (2310–2160).

Horses bred for mobility are an invention of about 2200 BCE, not of the Yamnaya expansion.

Tier A: Librado et al. 2024, Nature 631:819–825 (CC BY); values re-plotted. Dates depend on assumed mutation and recombination rates.

Horses did not drive the Yamnaya spread

Place	First DOM2 horse (approx.)	What it shows
Corded Ware Europe (c. 2900–2300 BCE)	none (at most 1.7%)	Yamnaya spread without modern horses
Anatolia	c. 2125 BCE	Arrives after human steppe ancestry
Moldavia	c. 2063 BCE	Same window
Czechia	c. 2037 BCE	Same window
Carpathian Basin	turnover c. 2033–1945 BCE	Local horses replaced within decades

Modern horses reached Europe and Anatolia at least 600 years after steppe ancestry did.

Tier A: Librado et al. 2024, Nature 631:819–825; Librado et al. 2021, Nature 598:634–640 (both CC BY). Human-side mechanism: Kristiansen et al. 2017 (tier C).

Riders by 3000 BCE?

The skeletons

Five Yamnaya individuals, 3021–2501 cal BCE, show riding-related bone changes (4 or more of 6 traits).

The caution

The traits are not unique to riding, and there were no known riders for comparison.

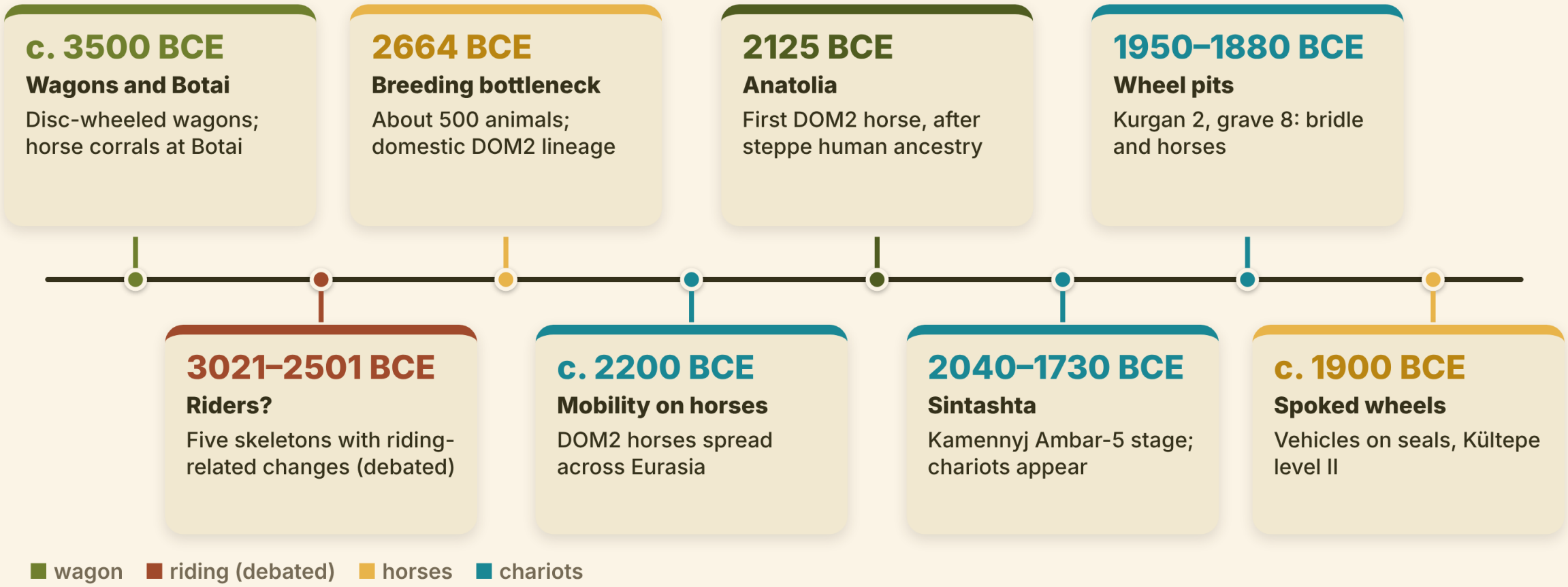
The tension

Genetics show mass horse mobility only from about 2200 BCE. So: a few riders early, large-scale breeding later.

Small-scale riding around 3000 BCE is possible; mass horse mobility is not shown before about 2200 BCE.

Tier A: Trautmann et al. 2023, Sci. Adv. 9:eade2451 (CC BY); Librado et al. 2024, Nature 631:819–825. Reading of the tension: tier C.

Wagon, rider, chariot: a technology timeline



Tier A: Librado et al. 2021, 2024; Trautmann et al. 2023; Lindner 2020 and the dates on slides 24 to 28 and 39.

Afanasievo: Yamnaya in the Altai

c. 3000 BCE

Afanasievo forms in the Altai–Sayan region, far to the east of the Yamnaya heartland.

Same genes

Genetically indistinguishable from Yamnaya: a migration, not copying of ideas.

Later fate

Replaced by Okunevo (c. 2500–2000 BCE), whose ancestry is local steppe hunter-herders.

Tier C: Afanasievo is often linked to Tocharian, the eastern-most Indo-European branch (manuscripts from the Tarim Basin, first millennium CE).

Tier A: Allentoft et al. 2015, Nature 522:167–172; Damgaard et al. 2018; Lazaridis et al. 2025, Nature 639:132–142. Tocharian link = inference.

The Yamnaya in south-east Europe

Early scouts, c. 4300 BC

Steppe-like graves at Mayaky (Ukraine) and Giurgiulești (Moldova); a Hungarian individual with Volga-cline ancestry.

Yamnaya, from c. 3300 BC

Yamnaya mix with Neolithic and Chalcolithic farmers in the Carpathian basin and Balkans in the late fourth millennium BC.

Greek and Armenian lines

Yamnaya ancestry contributed to the Balkans from the Early Bronze Age and to Armenians after 2500 BC.

The first steppe contacts with Europe precede the Yamnaya by about a thousand years.

Tier A: Lazaridis et al. 2025, Nature 639:132–142, sections "The Volga cline", "Discussion"; Allentoft et al. 2015.

Corded Ware: the steppe reaches central Europe

73.1%

Yamnaya-related ancestry in German Corded Ware (± 2.2)

79 / 17 / 4

% Yamnaya-like / early farmer / hunter-gatherer: three-way model

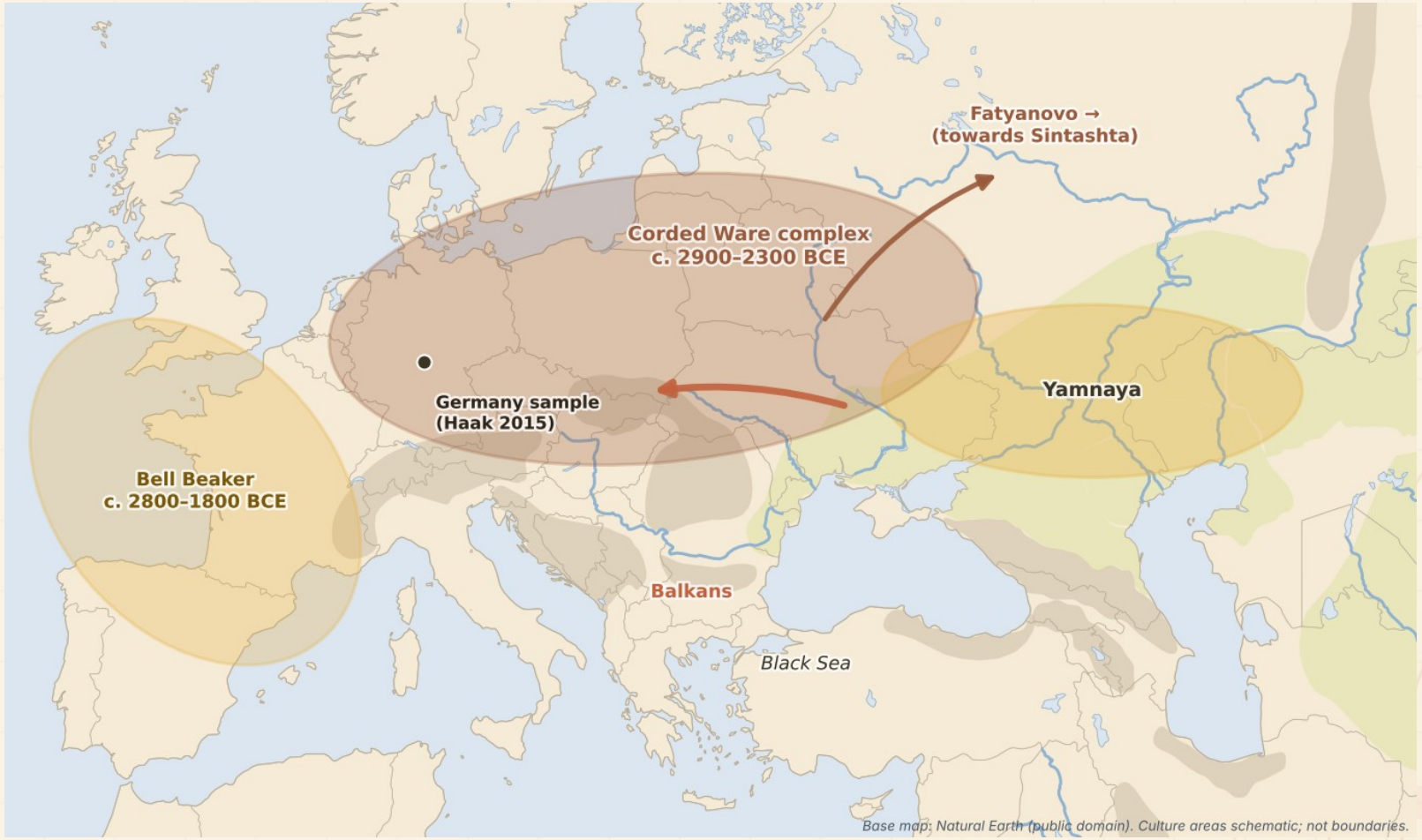
2,600 km

Distance from the sampled Yamnaya (Samara) to the German samples

- Sudden, not gradual: later cultures did not drift steadily away from the Middle Neolithic.
- Y-lineages R1a and R1b replace early-farmer G2a across Late Neolithic and Bronze Age Europe.
- Caution: the Samara Yamnaya may not be the direct source; a more western steppe group could be.

Tier A: Haak et al. 2015, Nature 522:207–211; Allentoft et al. 2015; Lazaridis et al. 2025, Nature 639:132–142. Corded Ware dates: Haak sample ~2,500 BC; Allentoft "by 2800 BC".

Corded Ware and Beaker Europe



Two western daughters

- Corded Ware: from the Rhine to the Volga forest zone; steppe ancestry arrives with it.
- Bell Beaker: a western, partly overlapping complex, linked to Yamnaya-related ancestry.
- Fatyanovo, on the upper Volga, is a stepping stone to Sintashta.

Tier B for culture areas (schematic ellipses, not boundaries); tier A for ancestry links: Haak 2015; Lazaridis 2025.

How the steppe reached Europe: men, marriage and war-bands

Mostly men first

About 90% of early Single Grave burials in Jutland were male.

Women from elsewhere

28–42% of adult women in southern German Corded Ware cemeteries were non-local.

Not always peaceful

The Eulau and Tiefbrunn burials show violence between newcomers and locals.

The mechanism (migrant men, local brides, war-bands) is the authors' model, tier C; the gene flow itself is tier A.

Tier A for the figures: Kristiansen et al. 2017, Antiquity 91:334–347 (CC BY). The mechanism is an interpretation (tier C).

Yamnaya and its relatives, side by side

Group	Region	Genetic link to Yamnaya	Tier
Yamnaya	Pontic–Caspian steppe, to Hungary and Altai	Core group, very uniform	A
Afanasievo	Altai–Minusinsk	Indistinguishable from Yamnaya	A
Corded Ware	Rhine to upper Volga	About 73–79% Yamnaya-related, plus early farmers	A
Bell Beaker	Western Europe	Y-lineage R-L51 related to Core Yamnaya R-Z2103	A/B
Catacomb, North Caucasus	North Caucasus steppe	Continuity with Yamnaya (North Caucasus)	A
Okunevo	Minusinsk basin	Not Yamnaya: local steppe hunter-herders	A

Tier A/B as marked: Allentoft 2015; Haak 2015; Ghalichi 2024; Lazaridis et al. 2025, Nature 639:132–142; Damgaard 2018.

Staying power on the steppe: Catacomb and relatives

3300–2800 BC

Yamnaya in the North Caucasus: three local sources, steppe, Maikop and Ukrainian Neolithic.

2800–2200 BC

North Caucasus culture and Catacomb: genetic continuity with the earlier Yamnaya.

Late Bronze Age

New gene flow from several sources as steppe cultures decline; steppe ancestry absorbed by highland groups.

The Early to Middle Bronze Age steppe was genetically stable for about a thousand years.

Tier A: Ghalichi et al. 2024, Nature 635:917–925; Wang et al. 2019, Nat. Commun. 10:590.

PART 3

03

Towards Asia: chariots and oases

Sintashta, Andronovo and the Bactria–Margiana complex, c. 2100–1500 BCE



Sintashta: the chariot makers

Urals, c. 2100–1800 BCE

Fortified settlements, rich graves, chariots and trained horses. Tier B for dates and settlement details.

Corded Ware cousins

Genetically close to Corded Ware: a long chain of eastward moves via Fatyanovo.

A mixed community

Kamennyi Ambar 5: 50 individuals; several outlier groups dated alongside the main cluster.

Tier C: whether Sintashta speakers were already Indo-Iranian is debated; see Module 5.

Tier A: Allentoft et al. 2015; Narasimhan et al. 2019, Science 365:eaat7487; Lazaridis et al. 2025, Nature 639:132–142. Dates and Arkaim: tier B.

The chariot horizon, c. 2000–1800 BCE

Spoked wheels, light cars

Chariots and carefully shaped horse cheek pieces appear in graves, and the innovation spreads across Europe and Asia.

A wide net

Similar cheek pieces 2000–1800 BC mark an expanding set of cultures, not one people.

Debate

Did chariot-riders carry Indo-Iranian languages south? Linguists and archaeologists disagree.

The chariot spread fast; a language spreading with it is a hypothesis, not a finding.

Tier A for distribution: Allentoft 2015 Fig. 1; Damgaard 2018 suppl. Tier C for language link.

Dating the first chariot

Evidence	Date (cal BC)	Note
Sintashta stage (Kamennyj Ambar-5 model)	2040–1730	95.4% range
Kurgan 2, grave 8: wheel pits, bridle, horses	1950–1880	after Bayesian modelling
Spoked-wheel vehicles on seals, Kültepe level II	c. 1900	late 20th to early 19th century
Horses in Sintashta chariot graves	DOM2 lineage	modern-type horses (Librado 2021)

The steppe chariot is no younger than the Near Eastern ones. Which came first is still debated (tier C).

Tier A: Lindner 2020, Antiquity 94:361–380 (CC BY); Librado et al. 2021, Nature 598:634–640. Order of invention: tier C.

Andronovo: a huge horizon of herders

Same gene pool

Closely related to Sintashta: Andronovo extends the Sintashta people in space and time.

Distinct from Yamnaya

Clearly different from both Yamnaya and Afanasievo.

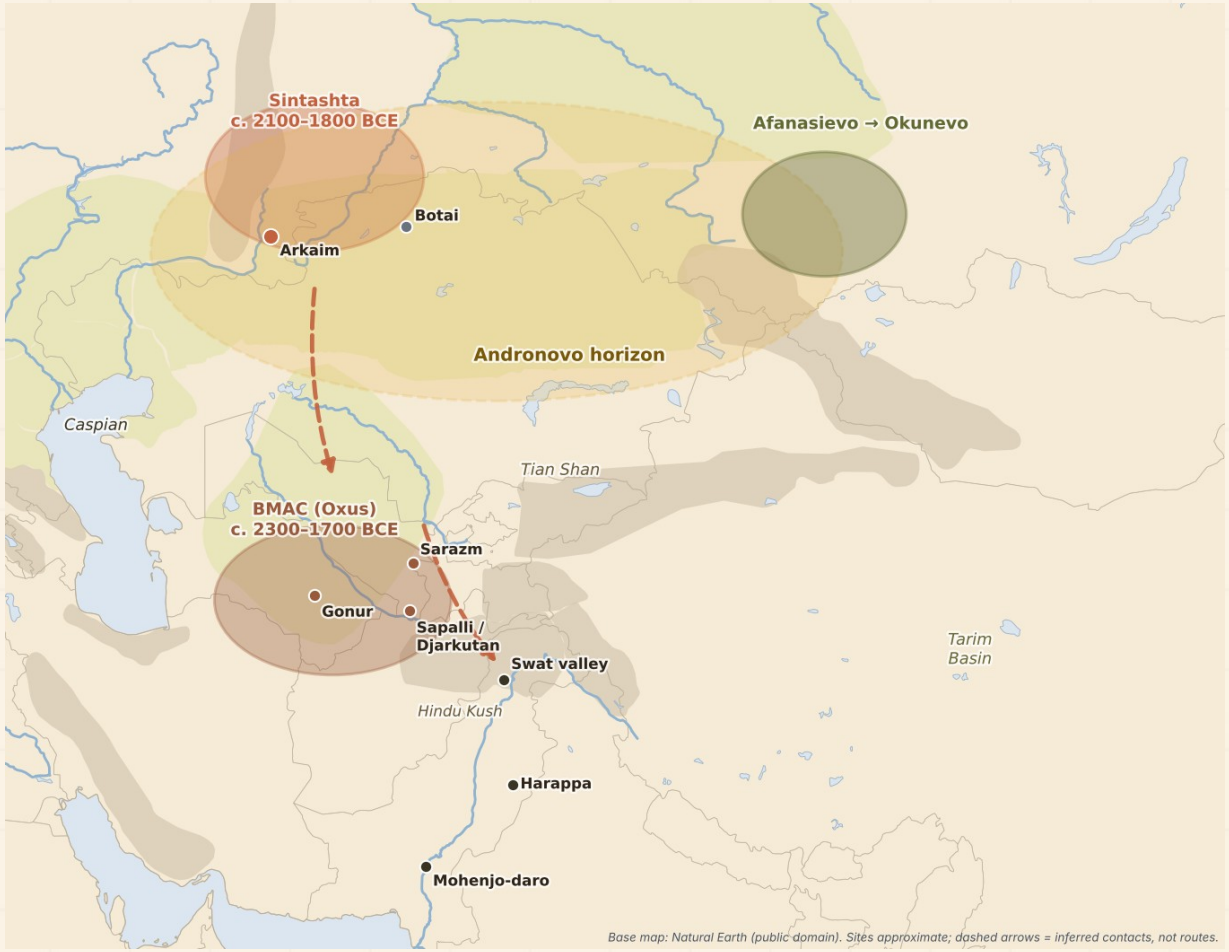
c. 1500 BCE: replaced

Karasuk, Mezhovskaya and Iron Age cultures follow, with gradual East Asian admixture.

West Eurasian ancestry remains higher in Iron Age Central Asia than in present-day neighbours.

Tier A: Allentoft et al. 2015; Narasimhan et al. 2019; Damgaard et al. 2018 (and supplement).

Sintashta, Andronovo and the Oxus oases



Reading the map

- Sintashta (Urals) c. 2100–1800 BCE; Arkaim as a type-site.
- Andronovo horizon spreads across Kazakhstan and the Siberian steppe.
- South of the steppe, the BMAC oases lie on the Oxus; the Indus lies beyond the mountains.
- Dashed arrows: contacts inferred from DNA outliers, not routes.

Tier B for positions and spans (schematic); contacts: Narasimhan 2019; Damgaard 2018 suppl. Base map: Natural Earth (public domain).

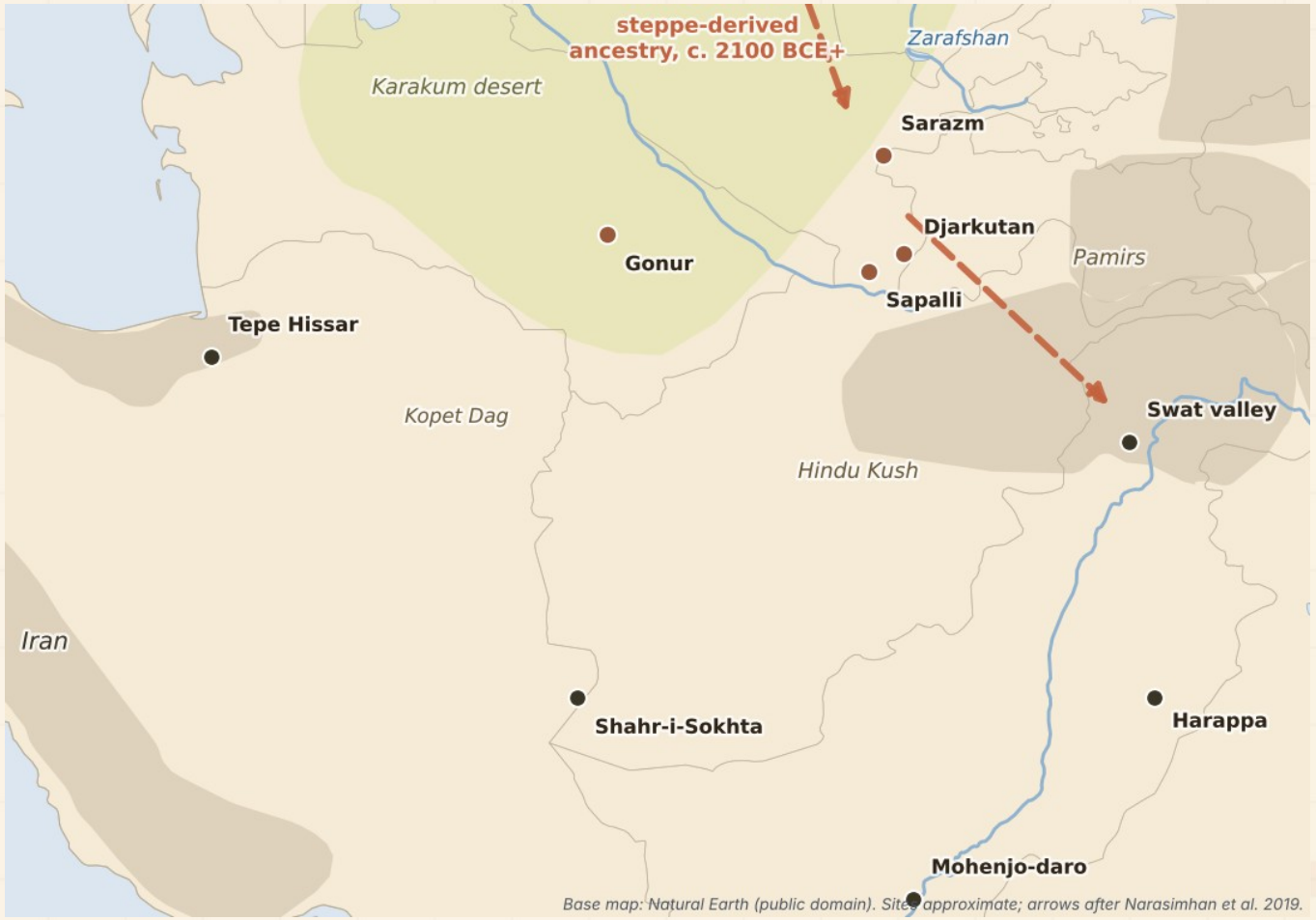
The BMAC: oasis farmers, not steppe pastoralists

Ancestry source	Share in main BMAC cluster
Early Iranian farmer-related	about 60–65%
Anatolian farmer-related	about 20–25%
West Siberian hunter-gatherer-related	about 10%
Andamanese-related (South Asia)	about 2–5%
Steppe pastoralist-related	none before 2100 BCE; outliers after

The BMAC population came from the Iranian plateau and Turan, with no steppe ancestry in its main cluster. Its steppe contacts were real but mostly outside the main population.

Tier A: Narasimhan et al. 2019, Science 365:eaat7487, section "People of the BMAC were not a major source of ancestry for South Asians".

Steppe and oasis: how close was the contact?



A contested frontier

- Andronovo-type pottery occurs at BMAC sites, mostly in northern Bactria.
- Sarianidi: fewer than 100 such sherds in all southern Turkmenistan.
- Anthony argued steppe tin mining and chariots gave the edge; the supplement tests and questions each claim.
- DNA: steppe ancestry in BMAC outliers by about 2100 BCE.

Tier A for DNA outliers (Narasimhan 2019); tier C for the interpretation (Damgaard 2018 suppl. A). Positions approximate.

Gonur: the excavator's reading and its critics

Question	Excavator's reading	Critical reading
Date of Gonur	2300–1600 BC (Dubova)	last century of 3rd and early 2nd millennium BC (Lamberg-Karlovsky)
Horses and chariots	no horse or chariot evidence cited	absent from BMAC sites
Fire, Water, Earth; Soma-Haoma	proto-Zoroastrian cult	accepted by only a few scholars
Contacts	Mediterranean and Near Eastern links stressed	steppe contact real but thin; e.g. one Zerafshan tomb

The BMAC was a settled oasis civilisation. Calling it Indo-Iranian or proto-Zoroastrian is an interpretation, tier C.

Tier A for what each paper says: Dubova 2016; Lamberg-Karlovsky 2002 (both pre-2019 and not open licence: text only). Tier C for the readings.

From the oases to South Asia

By 2100 BCE

Steppe-derived ancestry reaches the BMAC oases through outlier individuals.

1st half 2nd mill. BCE

Steppe ancestry appears in the Swat Valley, north Pakistan.

Not from the BMAC

The oasis people were not the major source of South Asian ancestry.

Module 5 follows the Indo-Iranians from here, with the languages as well as the archaeology.

Tier A: Narasimhan et al. 2019; Damgaard et al. 2018. Language reading: tier C.

Module 2 in numbers

13
individuals at Serednii Stih (4996–3372 BC)

4038
± 48 BC: mixture date of Core Yamnaya ancestors

104
Core Yamnaya individuals, high quality

0.005
mean FST between far-flung Yamnaya groups

5,000 km
Yamnaya sampling span, Hungary to Siberia

73.7%
Serednii Stih share in the best model (+ 26.3% Remontnoye-like)

3642–3374
BC: population grows to about ten times

2.7%
Botai ancestry in modern domestic horses

273
ancient horse genomes in the comparisons

13.7×
population expansion after the breeding bottleneck

73.1%
Yamnaya ancestry in German Corded Ware

~90%
of early Jutland Single Grave burials were male

Tier A: values as on slides 12, 15, 16, 21, 24, 25, 26, 31, 33 (Lazaridis 2025; Librado 2021, 2024; Haak 2015; Allentoft 2015).

The cultures at a glance

Culture	Dates BCE	Where	Marker	Language link
Khvalynsk	4500–4350	Middle Volga	Mixed cemetery, Balkan copper	Debated (C)
Serednii Stih	c. 4500–3350	Dnipro–Don	Yamnaya ancestors	Pre-Yamnaya (C)
Maikop	c. 3700–3000	North Caucasus	Rich kurgans	Debated (C)
Yamnaya	3300–2600	Pontic–Caspian	Pit-grave kurgans	Proto-Indo-European (C)
Afanasievo	c. 3000–2500	Altai	Yamnaya-like	Tocharian? (C)
Corded Ware	c. 2900–2300	N. and E. Europe	Cord-marked pots	Many branches (C)
Sintashta	c. 2100–1800	Urals	Chariots, forts	Indo-Iranian? (C)
Andronovo	c. 1900–1500	Central steppe	Wide pottery horizon	Indo-Iranian? (C)
BMAC	c. 2300–1700	Oxus oases	Cities, no steppe core	Substrate loans? (C)

Tier B for dates (conventional spans; see timeline); language column tier C. Sources as on preceding slides.

Who's who in steppe archaeology

David Anthony

The Horse, the Wheel and Language (2007); steppe, horse and wagon

J. P. Mallory

In Search of the Indo-Europeans (1989); archaeology and language

Kristian Kristiansen

Corded Ware and mobility; steppe migrations into Europe

Elena Kuzmina

The Origin of the Indo-Iranians (2007): Andronovo and the steppe

Viktor Sarianidi

Excavator of Gonur and the BMAC; reads it as an Indo-Aryan site

C. C. Lamberg-Karlovsky

Critic of the excavator's dating and interpretation

Lazaridis, Reich et al.

2025: CLV source and the formation of the Yamnaya

Haak, Allentoft et al.

2015: steppe migration into Europe and Bronze Age replacements

Librado et al.

2021, 2024: horse genomes, DOM2 and the date of breeding control

Tier A/B: roles as in slides 44 and 50 and the key literature; Anthony 2007, Mallory 1989, Kuzmina 2007, Kristiansen: background to verify (see Sources 2 of 2).

Open questions

Where exactly?

Dnipro or Don for the Yamnaya core? The Volga and north Caucasus are excluded as direct sources by the 2025 paper, but sampling is thin.

Which route south?

Did Indo-Anatolian speakers go via the Caucasus around 4400 BC, or does the Anatolian story differ? The linguistic dates and genetics must be reconciled.

Horse and wagon?

Wagons came first; breeding control dates to about 2200 BCE. But how common was riding around 3000 BCE (five skeletons), and was the chariot a steppe invention?

From culture to language?

Even where ancestry moves with a culture, the language link is an inference.

Tier C throughout: open questions. Module 3 (DNA), Module 4 (language), Module 5 (Indo-Iranian).

Check your understanding

1. Name the three ancestry streams that meet on the Eneolithic steppe.
2. Where did about four fifths of Yamnaya ancestry come from?
3. When did the Yamnaya ancestors form, and by what process?
4. Why are kurgans not simple family tombs?
5. When do disc-wheeled wagons appear?
6. When did breeding control of horses begin, and what is DOM2?
7. What is Afanasievo, genetically?
8. What does Corded Ware show about the Yamnaya (two facts)?
9. What marks the Sintashta culture?
10. Was the BMAC a steppe culture? Give the main ancestry shares.

Questions drawn from slides 6 to 45.

Check your understanding: answers

1 **EHG, UNHG, CHG**
Volga and Karelia, Dnipro and the Caucasus south.

2 **CLV people**
Caucasus-derived people who moved into the Dnipro–Don region.

3 **About 4000 BC**
Admixture of Serednii Stih and CLV newcomers: 4038 ± 48 BC.

4 **Mostly unrelated**
Most buried people were unrelated or only distantly related.

5 **About 3500 BCE**
Cattle-drawn wagons with disc wheels.

6 **About 2200 BCE**
The bottleneck starts about 2664 BCE; DOM2 is the lineage of modern domestic horses.

7 **Yamnaya in the Altai**
Genetically indistinguishable; a migration, not copied ideas.

8 **73.1% steppe; male-biased**
About 90% of early Jutland Single Grave burials were male.

9 **Fortified Urals settlements**
Chariots, rich graves and trained horses, c. 2100–1800 BCE.

10 **No**
About 60–65% Iranian farmer, 20–25% Anatolian farmer, about 10% West Siberian hunter-gatherer.

As above.

Key terms

Eneolithic
Copper Age: roughly 5000 to 3500 BC on the steppe.

Cline
A gradient of ancestry between two ends, across space or among groups.

CLV
Caucasus-Lower Volga: source of about 4/5 of Yamnaya ancestry.

EHG
Eastern hunter-gatherer: northern Volga and Karelia ancestry.

UNHG
Ukraine Neolithic hunter-gatherers of the Dnipro rapids.

Kurgan
A burial mound, typical of the steppe.

Catacomb
A culture of burials in side chambers, c. 2800–2200 BC.

Chariot horizon
Spoked-wheel vehicles and horse gear spreading about 2000–1800 BC.

DOM2
The horse lineage that gave all modern domestic horses.

FST
A measure of genetic difference between groups; low means very similar.

Admixture date
The estimated time two source populations mixed.

Bottleneck
A sharp, temporary fall in population size.

Definitions summarised from this module.

Key takeaways

- **Three clines, one outcome.** The Yamnaya came from a Dnipro–Don population (Serednii Stih) plus CLV people from the Caucasus–lower Volga.
- **A half-millennium gap.** Yamnaya ancestors formed about 4000 BC; the complex is visible about 3300 BC.
- **Uniform and mobile.** Core Yamnaya are genetically homogeneous across 5,000 km; kurgans were not family tombs.
- **Daughters in every direction.** Afanasievo east; Corded Ware and Beaker west; Catacomb at home; Sintashta and Andronovo via Corded Ware cousins.
- **Wagons first, horses later.** Disc-wheeled wagons from about 3500 BCE; modern horses bred for mobility from about 2200 BCE; the first chariot about 1950–1880 BCE.
- **The BMAC is not the steppe.** Oasis farmers with steppe contacts, not a steppe people.

Summary of Module 2. Next: Module 3, ancient DNA in detail.

Sources for Module 2 (1 of 2)

- Allentoft, M. E. et al. 2015. Population genomics of Bronze Age Eurasia. Nature 522:167–172.
- Damgaard, P. de B. et al. 2018. The first horse herders and the impact of early Bronze Age steppe expansions into Asia. Science 360:eaar7711 (manuscript and supplement).
- Ghalichi, A. et al. 2024. The rise and transformation of Bronze Age pastoralists in the Caucasus. Nature 635:917–925 (open access).
- Haak, W. et al. 2015. Massive migration from the steppe was a source for Indo-European languages in Europe. Nature 522:207–211.
- Lazaridis, I. et al. 2025. The genetic origin of the Indo-Europeans. Nature 639:132–142 (CC BY).
- Narasimhan, V. M. et al. 2019. The formation of human populations in South and Central Asia. Science 365:eaat7487.
- Wang, C.-C. et al. 2019. Ancient human genome-wide data from a 3000-year interval in the Caucasus. Nat. Commun. 10:590 (CC BY).

Continued on the next slide: horse, wagon, chariot and Corded Ware sources.

Sources for Module 2 (2 of 2)

- Gaunitz, C. et al. 2018. Ancient genomes revisit the ancestry of domestic and Przewalski's horses. Science 360:111–114.
- Kristiansen, K. et al. 2017. Re-theorising mobility and the formation of culture and language among the Corded Ware Culture in Europe. Antiquity 91:334–347 (CC BY).
- Lamberg-Karlovsky, C. C. 2002. Archaeology and language: the Indo-Iranians. Current Anthropology 43:63–88.
- Librado, P. et al. 2021. The origins and spread of domestic horses from the Western Eurasian steppes. Nature 598:634–640 (CC BY).
- Librado, P. et al. 2024. Widespread horse-based mobility arose around 2200 BCE in Eurasia. Nature 631:819–825 (CC BY).
- Lindner, S. 2020. Chariots in the Eurasian Steppe: a Bayesian approach to the emergence of horse-drawn transport in the early second millennium BC. Antiquity 94:361–380 (CC BY).
- Trautmann, M. et al. 2023. First bioanthropological evidence for Yamnaya horsemanship. Science Advances 9:eade2451 (CC BY).
- Dubova, N. 2016. Gonur Depe and the Mediterranean (ATINER MDT2016-2037). Images: horses (YegorGeologist, CC BY-SA 4.0), kurgan (Cseh et al., CC0), HapNe figure (Lazaridis 2025). Maps: Natural Earth.

Background (tier B) to verify when a readable copy arrives: Anthony 2007; Mallory 1989; Kuzmina 2007; Kristiansen & Larsson 2005.