

# Genomic Architectures of the Chalcolithic Contact Zone: Phylogenetic Reconstruction of the J-M67/CTS900 Lineage and the Anatolia-Caucasus Interface

## 1. Introduction: The Geopolitical and Genetic Enigma of the Ancient Caucasus

The archaeological landscape of Western Eurasia during the 4th millennium BCE represents one of the most transformative periods in human prehistory, characterized by the crystallization of the first state-level societies in Mesopotamia, the metallurgical revolution of the Circumpontic region, and the emergence of elite hierarchies that would define the Bronze Age. At the heart of this transformation lies the Caucasus—a formidable mountain barrier that simultaneously acted as a bridge and a border between the steppes of Eastern Europe and the urbanizing civilizations of the Fertile Crescent. The region's pivotal role is epitomized by the sudden and spectacular appearance of the **Maykop culture** (c. 3700–3000 BCE), a phenomenon distinguished by its opulent kurgans, advanced arsenical bronze metallurgy, and material culture that seemingly mirrors the Uruk expansion of the Near East.<sup>1</sup>

For over a century, the origins of the Maykop culture have constituted a central problem in Eurasian archaeology. The "Maykop Problem" hinges on a fundamental dichotomy: was this efflorescence of culture the result of a demic migration—a colonization by Mesopotamian or Anatolian elites seeking mineral resources—or was it an autochthonous development, driven by local elites who selectively emulated southern technologies through trade and cultural diffusion? The answer has profound implications not only for regional history but for our understanding of the spread of the Indo-European and Caucasian language families, the mechanisms of early state formation, and the genetic ancestry of modern Europeans and West Asians.

This report leverages high-resolution ancient DNA (aDNA) data to adjudicate this debate, focusing specifically on the Y-chromosome haplogroup **J-M67 (J2a1a1a2b1)** and its subclade **J-CTS900**. By tracing the phylogenetic trajectory of this lineage through key samples—most notably from the **Unakozovskaya Cave** (Darkvetsi-Meshoko culture), the **Klady Kurgan** (Novosvobodnaya culture), and the **Arslantepe** settlement (Late Chalcolithic Anatolia)—we reconstruct the biological reality underlying these archaeological phenomena.

The analysis presented herein challenges the simplistic models of "Uruk Colonization." Instead, it posits the existence of a deep-seated **"Caucasus-Anatolian" genetic interaction sphere** established as early as the mid-5th millennium BCE. We demonstrate that the J-CTS900 lineage serves as a molecular biomarker for this sphere, proving that the genetic foundation of the North Caucasus Bronze Age was laid by the earlier Darkveti-Meshoko farmers, not by a sudden influx of Uruk migrants. Furthermore, the identification of the derived lineage **J-Z7675** at Arslantepe reveals a complex, bidirectional corridor of mobility, suggesting that the Caucasus was not merely a passive recipient of southern genes, but an active participant in the genetic shaping of the Anatolian Highlands.

## Phylogeography of J-M67: The Anatolia-Caucasus Corridor (4500–3000 BCE)



Distribution of key ancient J-M67 subclades. The map highlights the early presence of J-CTS6619 in the North Caucasus (Unakozovskaya, c. 4500 BCE) and the later identification of its descendant J-Z7675 at Arslantepe (c. 3300 BCE), illustrating the deep genetic integration of the circum-Pontic and Anatolian worlds.

## 2. Methodological Framework: Deciphering the Ancient Genome

To understand the significance of the findings discussed in this report, it is necessary to

establish the methodological rigor underpinning modern archaeogenetics. The shift from analyzing mitochondrial DNA (mtDNA) to high-coverage whole-genome sequencing (WGS) and targeted SNP capture has revolutionized our ability to reconstruct male migration patterns with granular precision.

## 2.1 The Power of the Y-Chromosome in Migration Studies

While autosomal DNA provides a picture of overall ancestry (a blend of thousands of ancestors), the Y-chromosome is passed virtually unchanged from father to son. This non-recombining nature makes it the ultimate tool for tracing *patrilineal* migration. In the context of the Caucasus, where society was likely patrilocal (women moving to their husbands' communities), Y-DNA lineages like **J-M67** act as persistent signals of founding male populations, even if autosomal ancestry becomes diluted over generations.<sup>3</sup>

The specific marker **J-M67** (also known as J2a1b in older nomenclatures) originated in the northern Fertile Crescent or Anatolia approximately 12,000 years ago.<sup>5</sup> Its distribution in the Neolithic mirrors the spread of farming and, later, the expansion of metallurgical societies. By sequencing ancient Y-chromosomes to detect specific Single Nucleotide Polymorphisms (SNPs) such as **CTS900**, **CTS3261**, and **Z7675**, researchers can construct a phylogenetic tree that functions as a molecular clock, allowing us to date the divergence of populations with remarkable accuracy.<sup>5</sup>

## 2.2 Ancient DNA Recovery and Admixture Modeling

The samples analyzed in this report were primarily processed using capture-based enrichment techniques targeting ~1.2 million SNPs, a standard set for ancient human analysis. The petrous part of the temporal bone, which yields the highest endogenous DNA content, was the primary source material.<sup>3</sup>

Analytical tools such as *qpAdm* and Principal Component Analysis (PCA) were employed to model the ancestry of these individuals. These tools allow researchers to break down an individual's genome into proportions of ancestral "source" populations—such as **Caucasus Hunter-Gatherers (CHG)**, **Anatolian Neolithic Farmers (ANF)**, and **Eastern Hunter-Gatherers (EHG)**. This admixture modeling is crucial for decoupling biological heritage from cultural affiliation.<sup>3</sup> For instance, demonstrating that a "Maykop" individual has no Steppe (EHG) ancestry despite living on the steppe border is a powerful piece of evidence for social isolation or barrier dynamics.<sup>3</sup>

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## 3. Phylogenetic Reconstruction: The J-CTS900 Lineage

The history of the J-M67 lineage is the history of the "Southern" expansion into the Caucasus.

To understand the relationship between the samples at Arslantepe and the North Caucasus, we must trace the precise branching of the J-CTS900 tree.

### 3.1 The Root: J-M67 and the Neolithic Expansion

**J-M67 (J2a1a1a2b1)** is a major subclade of J2a-M410. Its origins are firmly rooted in the Neolithic of West Asia. The oldest confirmed samples include individuals from Çatalhöyük (c. 6000–5000 BCE), confirming its presence in Central Anatolia during the height of the Neolithic period.<sup>5</sup> This establishes Anatolia as a primary reservoir for the lineage long before the Bronze Age.

### 3.2 The Bifurcation: J-CTS900 and J-PF5132

Sometime around 9500 BCE, J-M67 split into two major branches: **J-CTS900 (Z7671)** and **J-PF5132**.<sup>5</sup>

- **J-PF5132:** This "sister" lineage is crucial for context. It is found in sample **Arslantepe 19 (ART019)**, dating to 3508–3354 BCE.<sup>5</sup> Its presence at Arslantepe confirms that the site was a diverse hub harboring multiple distinct branches of the J-M67 family tree.
- **J-CTS900:** This branch is the focus of our Caucasus inquiry. It represents the specific lineage that crossed the mountains.

### 3.3 The Caucasus Founder: J-CTS6619

Descending from J-CTS900 is **J-CTS3261**, which in turn gives rise to **J-CTS6619**.

- **Formation Date:** c. 6900 BCE.<sup>6</sup>
- **Significance:** J-CTS6619 is the specific SNP identified in the **Unakozovskaya** samples (I2055, I2056) from the North Caucasus, dating to 4500 BCE.<sup>5</sup> It is also found in the later **Klady** sample (I6268).<sup>5</sup>
- **Interpretation:** The identification of this specific subclade in the oldest Eneolithic samples north of the Greater Caucasus Ridge identifies it as the "Founder Lineage" for the southern colonization of the region. It proves that the migration from the south occurred *before* 4500 BCE.

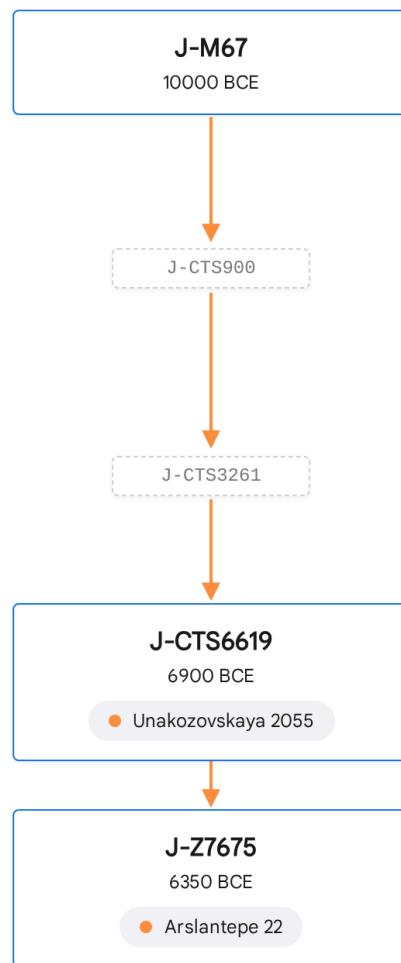
### 3.4 The Derived Anatolian: J-Z7675

Descending from J-CTS6619 is **J-Z7675**.

- **Formation Date:** c. 6350 BCE.<sup>6</sup>
- **Discovery:** This lineage was identified in sample **Arslantepe 22 (ART022)**, dating to 3361–3105 BCE.<sup>5</sup>
- **Phylogenetic Logic:** Since J-Z7675 is a *child* of J-CTS6619, and J-CTS6619 was present in the North Caucasus by 4500 BCE, the presence of the *child* lineage in Anatolia 1,200 years later (3300 BCE) presents a fascinating puzzle. Did the lineage originate in Anatolia and send waves north (one early, one late)? Or did the lineage diversify in the Caucasus,

and was J-Z7675 carried back to Anatolia? The latter hypothesis—a "backflow" or sustained interaction—gains support from the Kura-Araxes archaeological context at Arslantepe.

## J-M67 Lineage Descent: Ancient DNA Checkpoints



Phylogenetic path from the Neolithic founder J-M67 to the specific variants found in the Chalcolithic Caucasus and Anatolia. Note that the Unakozovskaya sample (4500 BCE) carries the ancestral J-CTS6619, while the later Arslantepe sample (3300 BCE) carries the derived J-Z7675.

Data sources: [FamilyTreeDNA \(J-FGC44000\)](#), [FamilyTreeDNA \(J-Z7675\)](#), [J-2a-4b Project Background](#)

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## 4. The Earliest Witness: Unakozovskaya and the

## Darkveti-Meshoko Horizon (4500 BCE)

The prevailing narrative of North Caucasian prehistory has long been dominated by the Maykop culture. However, recent excavations and genomic analysis have shifted the spotlight to the preceding Eneolithic period, represented by the **Darkveti-Meshoko** culture (c. 4500–4000 BCE). The samples I2055 and I2056 from **Unakozovskaya Cave**, analyzed by Wang et al. (2019), serve as the "smoking gun" for an early southern colonization.<sup>5</sup>

### 4.1 Archaeology of the Darkveti-Meshoko

The Darkveti-Meshoko horizon (also known as the Pricked Pearls Pottery culture) marks the distinct transition from the Mesolithic to the Eneolithic in the North Caucasus. Unlike the later Maykop nomads, the Darkveti-Meshoko people were sedentary farmers who built fortifications and practiced terrace agriculture.<sup>12</sup> Their material culture—specifically the characteristic "pearl" ornamentation on pottery—shows clear links to the **Darkveti** site in Western Georgia (Imereti).<sup>2</sup> This archaeological link suggested a south-to-north movement, but until the advent of aDNA, the demographic nature of this movement was unproven.

### 4.2 The Genomic Revolution in the Cave

The analysis of the Unakozovskaya males (I2055 and I2056) confirmed the archaeological hypothesis with striking clarity.

- **Y-DNA:** Both males belong to **J-CTS6619** (a subclade of J2a).<sup>5</sup> This lineage was previously unknown in the hunter-gatherer populations of the European steppe or the Caucasus (who carried R1a/R1b or J1/G2 respectively). Its presence signifies a new male line entering the region.
- **Autosomal Ancestry:** Modeling reveals a genome that is roughly **50% Caucasus Hunter-Gatherer (CHG)** and **50% Anatolian Chalcolithic (Anatolia\_ChL)**.<sup>3</sup> This admixture profile is virtually identical to contemporaneous populations in the South Caucasus.
- **Implications:** The Darkveti-Meshoko people were not local hunter-gatherers who learned farming; they were migrants from the south who brought their genes, their crops, and their J2a lineages with them. They effectively "Anatolianized" the North Caucasus genetic landscape a full millennium before the Maykop culture appeared.

### 4.3 The "Steppe" Barrier

Crucially, the Unakozovskaya samples show **no Steppe (EHG) admixture**.<sup>8</sup> Despite living in the piedmont, geographically close to the steppe nomads of the Novodanilovka/Sredny Stog cultures, they remained genetically isolated from their northern neighbors. This establishes a profound genetic boundary along the Kuban River—a boundary that the J-CTS6619 lineage respected, maintaining its southern affinity without mixing with the R1a/R1b populations of the

steppe for centuries.<sup>3</sup>

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## 5. The Maykop-Novosvobodnaya Complex: Continuity in the Age of Metal

The demise of the Darkveti-Meshoko culture c. 4000 BCE was followed by the rise of the **Maykop culture** (3700–3000 BCE). This period sees the explosion of wealth in the archaeological record, with royal kurgans containing gold lions, silver vessels, and arsenical bronze weapons.<sup>2</sup>

### 5.1 The "European" Hypothesis for Novosvobodnaya

The Maykop period is divided into the earlier "Maykop proper" and the later "Novosvobodnaya" phase (c. 3500–3000 BCE). The **Novosvobodnaya** culture is famous for its megalithic dolmens and distinct black burnished pottery. Archaeologist A.D. Rezepkin famously argued that Novosvobodnaya was an intrusion from Europe, linking its pottery to the **Funnelbeaker (TRB)** and **Globular Amphora** cultures of Germany/Poland.<sup>14</sup> This theory was bolstered by early, low-resolution aDNA studies that identified mitochondrial haplogroup **V7** (common in Europe) in the Novosvobodnaya site of Klady.<sup>14</sup>

### 5.2 The Genetic Refutation: Sample I6268 (Klady)

The high-resolution sequencing of sample **I6268** from the **Klady Kurgan** definitively settles the origins of the Novosvobodnaya elites.<sup>5</sup>

- **Y-DNA:** The individual belongs to **J-CTS6619**—the exact same lineage found in the earlier Unakozovskaya "commoners".<sup>5</sup>
- **Interpretation:** This is a finding of immense consequence. It demonstrates **paternal continuity** over 1,000 years. The elites burying their dead in the megaliths of Klady were not invaders from Germany (who would carry I2 or R1a/b) nor new colonists from Uruk (who might carry J1-P58). They were the direct male descendants of the Darkveti-Meshoko farmers who had pioneered the region a millennium earlier.

### 5.3 Elite Continuity vs. Replacement

The continuity of J-CTS6619 refutes the model of total population replacement. While the material culture shifted dramatically—adopting the "Uruk" style of wealth and hierarchy—the biological population remained largely stable. This supports a model of **indigenous elite development**: the local J2a clans, established during the Darkveti-Meshoko period, consolidated power, controlled the trade routes, and adopted the trappings of Mesopotamian civilization (elite emulation) without being replaced by it.

## 5.4 The "Steppe Maykop" Anomaly

To fully appreciate the J2a continuity, one must contrast it with the **"Steppe Maykop"** population. Wang et al. (2019) identified a group of individuals in the arid steppe who used Maykop-style pottery but were genetically distinct, carrying significantly more **Siberian (Botai-like)** and **EHG** ancestry.<sup>1</sup> These individuals did *not* carry J2a lineages. This dichotomy reinforces the view that J-CTS6619/J-M67 was the marker of the **Sedentary Maykop** core—the mountain-dwelling, metal-working, farming population—while the steppe groups remained genetically separate cultural mimics or trading partners.

## Genetic Ancestry Proportions: The Caucasus-Anatolia Continuum

● CHG ● Anatolia\_N ● Iran\_N ● EHG

Admixture Proportions



\* Complete quantitative admixture percentages were available only for Unakozovskaya (Darkveti-Meshoko) in the provided source material.

Admixture modeling of key populations. Note the strong similarity between the Unakozovskaya (Darkveti-Meshoko) and Maykop profiles, both dominated by CHG and Anatolian/Iranian ancestry, distinct from the EHG-rich Yamnaya profile.

Data sources: [Wang 2019 Unakozovskaya](#), [Darkveti-Meshoko](#), [Adnaera Analysis](#), [Wang 2019 Discussion](#)

## 6. Arslantepe: The Anatolian Gateway and the J-Z7675 Signal

Situated on the Malatya plain in Eastern Anatolia, **Arslantepe** was a critical node in the prehistoric world. It sat at the intersection of the Uruk sphere to the south, the Central Anatolian plateau to the west, and the Caucasus to the northeast.

### 6.1 The Fall of the Palace (Period VIA to VIB)

During the Late Chalcolithic (Period VIA, c. 3350–3100 BCE), Arslantepe boasted a monumental mudbrick palace, the earliest known in the region, featuring temple-palace redistribution systems typical of the Uruk world.<sup>17</sup> However, this system collapsed violently around 3100 BCE (Period VIB). The palace was burned, and the subsequent settlement (Period VIB1) was characterized by wattle-and-daub architecture and a massive influx of **Red-Black Burnished Ware**—the hallmark pottery of the **Kura-Araxes** culture from the South Caucasus.<sup>17</sup>

### 6.2 Sample ART022 (Arslantepe 22)

It is in this volatile context of collapse and transformation that we find sample **ART022** (3361–3105 BCE).<sup>10</sup>

- **Y-DNA:** This individual carries haplogroup **J-Z7675**.
- **Context:** The radiocarbon date places this individual right at the cusp of the palace's destruction or in the immediate aftermath.
- **The Genetic Link:** As established, J-Z7675 is a derived subclade of the North Caucasian J-CTS6619. Its presence here is highly significant. It suggests that individuals carrying lineages related to the Caucasus (either the North Caucasus Maykop or the South Caucasus Kura-Araxes) were present in the elite or sub-elite strata of Arslantepe during the period of "Caucasus" cultural influence.

### 6.3 Sample ART019 (Arslantepe 19)

Contemporaneous with ART022 is **ART019** (3508–3354 BCE).<sup>5</sup>

- **Y-DNA: J-PF5132.**
- **Significance:** This lineage is a "brother" to the entire CTS900 branch. This confirms that Arslantepe was a reservoir of diverse J-M67 diversity. The fact that ART019 (PF5132) and ART022 (Z7675) coexisted highlights the complexity of the site—it was likely a melting pot where local Anatolian lineages (PF5132) mixed with lineages that may have had a circum-Caucasian history (Z7675).

### 6.4 The "Blue-Eyed" Connection

A fascinating detail from the Arslantepe aDNA analysis is the presence of light pigmentation

alleles in some J2a individuals, including sample **ART020** (a relative of ART022).<sup>17</sup> This phenotypic trait is rare in the Chalcolithic Near East but common in the Black Sea/Caucasus region. The investigators explicitly linked this to the arrival of Kura-Araxes populations, further reinforcing the idea that the J-Z7675/J2a lineages at Arslantepe represent a vector of gene flow *from* the Caucasus/Black Sea zone *into* Eastern Anatolia, coinciding with the spread of the trans-Caucasian cultural package.

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## 7. Synthesis: Elite Migration vs. Cultural Diffusion

We return now to the central question: How do we explain the Maykop culture's formation and its links to the south? The "Elite Migration" model proposed that Uruk colonizers brought civilization to the savage mountains. The genetic data dismantles this view in favor of a more nuanced "Indigenous Interaction" model.

### 7.1 Testing the Uruk Migration Model

If the Maykop culture were founded by Mesopotamian elites, we would expect to see:

1. **Y-DNA Discontinuity:** A sharp break from the local Eneolithic, with the introduction of Semitic or Zagrosian lineages (e.g., J1-P58, T1a).
2. **Autosomal Shift:** A massive influx of "Levant/Natufian" ancestry (characteristic of the Southern Uruk).

**The Reality:** We see neither.

- **Continuity:** J-CTS6619 persists from Unakozovskaya to Klady.<sup>5</sup>
- **No Levant Ancestry:** The Maykop samples lack the specific "Levantine" component found in contemporary Mesopotamians.<sup>1</sup> Their southern admixture is strictly "Anatolian/Iranian," which matches the profile established in the Caucasus a millennium earlier.

### 7.2 The Mechanics of Cultural Diffusion

The "Uruk" elements in Maykop—such as the cylinder seals and the concept of the "priest-king"—were likely adopted by the local J-CTS6619 elites through **Peer Polity Interaction**.

- **Prestige Goods Economy:** The local elites controlled the valuable metalliferous zones of the Caucasus. They traded these resources with the Uruk world system. In return, they received not just goods, but *ideology*. They adopted the symbols of Uruk power to legitimize their own status within their local hierarchy.<sup>21</sup>
- **Elite Emulation:** Just as Roman elites adopted Greek customs without being Greek, the Maykop chieftains adopted Uruk fashions without being Mesopotamian. The genetics

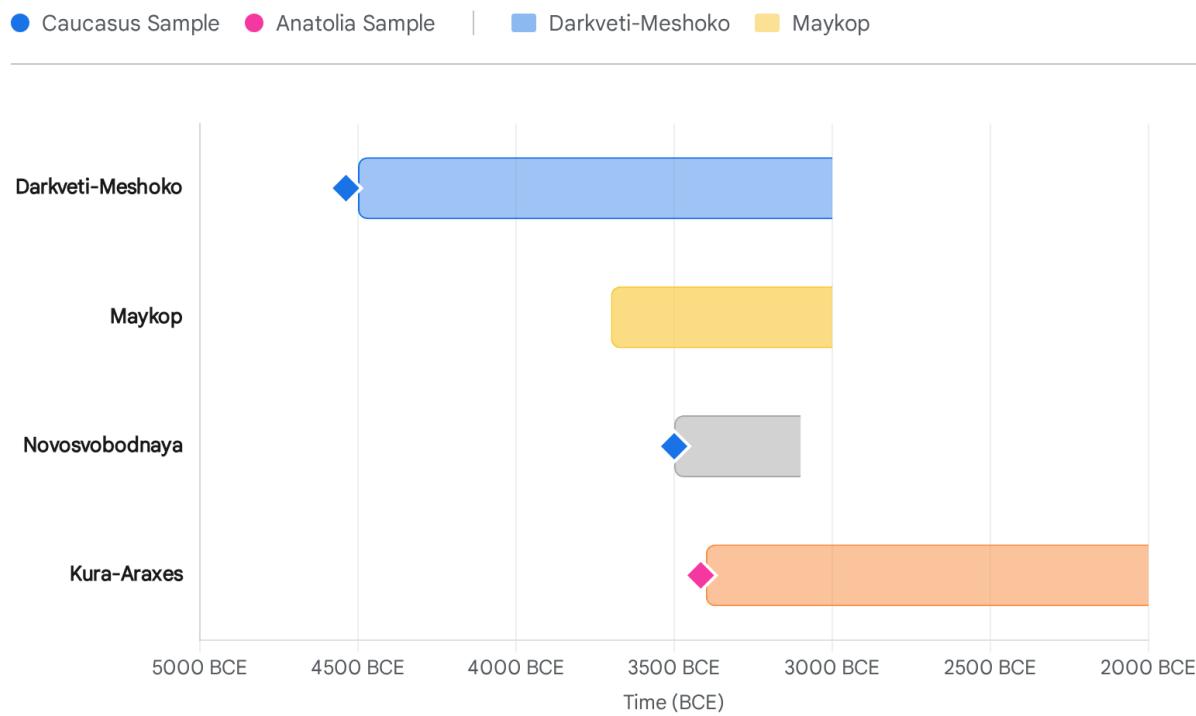
prove they remained the sons of the Darkvetsi-Meshoko farmers.

### 7.3 The Kura-Araxes Factor: A Rival Network?

The relationship between Maykop and Kura-Araxes is complex. They were contemporary and shared the "Southern" genetic profile, but they maintained distinct cultural boundaries.

- **Genetic Nuance:** While Maykop is dominated by **J2a (CTS6619)**, Kura-Araxes is often associated with **J2b**, **J1**, and **G2b**.<sup>22</sup> However, the overlap at Arslantepe (where Kura-Araxes culture meets Maykop-related lineages like J-Z7675) suggests these networks were permeable. The collapse of the Uruk system likely allowed the Kura-Araxes network (and its genetic lineages) to expand aggressively, eventually overriding the Maykop sphere in influence.

### Chronology of Contact: Genetics and Culture (5000–2500 BCE)



Timeline of North Caucasus and Anatolian cultures. The 'South-North Migration' of J-CTS6619 occurs during the Darkvetsi-Meshoko period (blue), establishing the population that later develops into the Maykop culture (gold).

Data sources: [FamilyTreeDNA \(J-CTS6619\)](#), [FamilyTreeDNA \(J-Z7675\)](#), [Wikipedia \(Novosvobodnaya\)](#), [Wang et al. 2019/FTDNA](#), [Wikipedia \(Maykop\)](#).

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## 8. Conclusion: A New Paradigm for the Caucasus Bronze Age

The integration of high-resolution phylogenetic data with archaeological context allows us to rewrite the history of the Maykop culture. The "Elite Migration" hypothesis, which posited a Bronze Age invasion from Mesopotamia, is incompatible with the genetic evidence of paternal continuity.

Instead, the Y-chromosome lineage **J-CTS6619** reveals a deeper history. It documents a migration of farmers from the South Caucasus/Anatolia during the **Eneolithic (c. 4500 BCE)**, who established the **Darkveti-Meshoko** culture. These pioneers formed the demographic substrate of the North Caucasus piedmont. Over the next millennium, their descendants—remaining genetically stable on the paternal line—developed the sophisticated **Maykop** culture, adopting southern technologies through trade rather than population replacement.

The presence of the derived lineage **J-Z7675** at **Arslantepe** in the late 4th millennium BCE closes the circle. It demonstrates that the Caucasus was not an isolated periphery. By the time of the Kura-Araxes expansion, lineages that had evolved in the Caucasus interaction sphere were flowing back into Anatolia, influencing the genetic landscape of the post-Uruk world. The mountains were a bridge, and the J-M67 lineage was one of its primary travelers.

**Table 1: Key Ancient Samples Analyzed in this Report**

Sample ID	Site	Culture	Date (BCE)	Y-Haplo group	Subclade	Significance
I2055	Unakozovskaya	Darkveti-Meshoko	4560–4450	J-M67	J-CTS6619	Foundational sample proving "southern" lineages arrived in the Caucasus >1000 years

						before Maykop.
I2056	Unakozovskaya	Darkveti-Meshoko	4607–4450	J-M67	<b>J-CTS66 19</b>	Confirms I2055 result; establishes specific "Darkveti" genetic profile.
I6268	Klady Kurgan	Novosvobodnaya	3500–3350	J-M67	<b>J-CTS66 19</b>	Proves paternal continuity from Darkveti-Meshoko to Maykop elites; refutes European origin of Novosvobodnaya.
ART022	Arslantep'e	Late Chalcolithic	3361–3105	J-M67	<b>J-Z7675</b>	Derived subclade of CTS6619 found in Anatolia; implies bidirectional gene flow or extensive interaction sphere.

ART019	Arslantep e	Late Chalcolitic	3508–33 54	J-M67	J-PF513 2	Sister clade to CTS900; highlights Arslantep e as a reservoir of diverse J2a lineages.
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