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Eurasian textiles: Case studies in exchange during the incipient and later Silk Road periods

Paula N. Doumani Dupuy [a, b, *], Robert N. Spengler III [a, c], Michael D. Frachetti [a]

[a] Washington University in St. Louis, Anthropology Department, CB 1114, One Brookings Dr., St. Louis, MO, 63130, USA
[b] Nazarbayev University, Sociology and Anthropology Department, Astana, 010000, Kazakhstan
[c] Institute for the Study of the Ancient World, New York University, 15 E 84th St, New York, NY, 10028, USA

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1. Introduction

The social and economic value of exotic commodities fueled the development and flourishing of the well-known "Silk Roads," which saw the transport of not only silks but also a wide array of valuables across Eurasia from the Han period (206 BCE–CE 220) onward (Davidovich, 1998; Liu, 2010; Kuz'mina, 2008; Wood, 2004). In addition to textiles produced from a variety of raw materials, merchants carried furs, stone wears, ceramic vessels, salt, dried fruits and fish, wine, and associated social and political ideas and new religions that collectively shaped cultures across the Old World for millennia. The agrarian civilizations of China, India, and the Mediterranean, without question, guided much of the production and demand for wares that traversed this transregional exchange web through time (Boulnois, 2012). However, anthropological and historical studies of the societies that inhabited Central Asia/Eurasia from antiquity have found that mobile pastoralists too were essential actors (and consumers) in the overland routes that crossed the vast steppes, deserts, and mountain passes between east and west Eurasia (Christian, 2000; Frachetti, 2008). Archaeobotanical remains, for example, attest to such trans-Eurasian interaction and exchange in the early third millennium BC and make a much deeper origin for the Silk Roads a likely prospect (Betts et al., 2014; Jones et al., 2016; Spengler et al., 2014a).

In this article, we introduce a new line of evidence for the passage and consumption of one commodity––textiles––into the Dzhungar Mountains of southeastern Kazakhstan during the incipient (i.e., Bronze Age), and later (i.e., Iron Age and Medieval Period) Silk Road periods. Although woolen textiles are known for neighboring western China from several discoveries of clothing in its prehistoric cemeteries (e.g., Beck et al., 2014; Good, 1998), poorer preservation of textile remains across the interior length of central Eurasia has hindered comprehensive documentation of the full range of fibers used to produce textiles in antiquity, or of their exchange overland. Thus, the present study aims to provide new insight into the geographic distribution of fiber technologies across areas of settled agricultural and mobile pastoralists through applying multi-technique analytical approaches to three recently discovered and fragmentary pieces of textile data from southeastern Kazakhstan. Two of our cloth samples were individually preserved through carbonization and metallic oxidation, and a third sample was preserved as an impression in pottery. The samples indicate other fiber sources alongside wool were present in pastoralist sites. Our identification of the weaves and raw materials used to manufacture them suggest early transmissions of exotic cloth and production techniques along the ancient land routes of Eurasia. This finding has implications for understanding mobile-sedentary interactions and the complexity of Eurasian exchange in antiquity.

The several narrow navigable passes that cut through the Dzhungar Mountains of southeastern Kazakhstan served as a conduit for exchange and interaction in the past (Bartol'd, 1962–1963). Pedestrian surveys and excavations throughout these mountains (e.g., Frachetti, 2008) document campsites and burials of some of the earliest pastoral societies along the steppe-mountain interface of central Eurasia. The study zone figures prominently in studies on the multiregional development of pastoralism and is conventionally considered as a 'pastoral realm,' inhabited by mobile populations that began to incorporate cereal agriculture during the Bronze Age (Motuzaite Matuzeviciute et al., 2015; Spengler et al., 2014b). Along its southern rim large fortified centers, smaller sedentary villages, and pastoral campsites provide an ideal setting for charting mobile and sedentary interactions

* Corresponding author. Nazarbayev University, Sociology and Anthropology Department, Astana, 010000, Kazakhstan.
E-mail addresses: paula.dupuy@nu.edu.kz (P.N. Doumani Dupuy), rs5899@nyu.edu (R.N. Spengler), frachetti@wustl.edu (M.D. Frachetti).

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through time (Rouse and Cerasetti, 2014). On account of their patterned movements, regional pastoralists were thus ideally placed to facilitate the long distance transfer of goods and technology between areas variously inhabited by settled and mobile populations beginning in the Bronze Age (3500–1000 BCE) (Frachetti, 2012). Starting in the third millennium BC, incipient connections are archaeologically present across central Eurasia and then in the second millennium BC there is widespread regional integration as shown in ritual and domestic contexts documenting the spread of bronze metallurgy and trade, horse riding and chariot technology, and the appearance of new dairy and agricultural products (Doumani et al., 2015; Linduff, 2006; Liu et al., 2016; Sherratt, 2006; Spengler et al., 2014a; Taylor, 2016; Xie et al., 2016). By the first millennium BC, more extensive exchange ties and related material styles are attested through the common use of motifs in metal objects, rock art, and textiles in archaeological sites of central Eurasia. By the Iron Age (800 BCE – CE 400), the solidification of interconnected trade networks and linked stylistic traditions are understood as one of the results of emergent nomadic confederacies, interregional contact, and higher mobility (Beckwith, 2009; Kuz'mina, 2008; Chang, 2008; Wagner et al., 2011).

Following this period, a sequence of cultural processes occurred that simultaneously drove the Silk Roads to their apex in the late first millennium CE, and a flourishing of commerce and the arts led to prosperity across diverse Central Asian populations (see Wertmann, 2015). Thriving exchange through the northern routes of Central Asia continued through the first centuries of the second millennium CE, as the Song Dynasty (CE 960–1279) opened regulated markets along the peripheries of their empire. By this time, in the Medieval Period, oasis cities of the Central Asian deserts also grew in size and wealth, emerging as centers of power and commerce, although power struggles between Chinese and Central Asians for control over the routes continued throughout the first and early second millennia CE (Beckwith, 1993). A steady flow of goods through northern Central Asia (including southeastern Kazakhstan) continued under the Qarakhanids (CE 840–1212) as Turkic influence grew (Nabhan, 2014). Medieval documents attest to significant trade between southern Central Asia and the steppes of Eurasia in this period (Christian, 2000:6; Davidovich, 1998:119) along with the adoption of Islam in the 10th c. CE and clashes between different dynasties in Central Asia and neighboring territories.

2. Materials and methods

The three samples discussed in this paper were collected from the pastoral campsite of Begash, Kazakhstan by members of the Dzhungar Mountains Archaeology Project in 2005 and 2006 (Frachetti and Mar'yashev 2007), and from the nearby cemetery of Karatal by a local team of archaeologists in 2006 (Mar'yashev et al., 2006). Situated in the Koksu River Valley, Begash and Karatal occupy a strategic geographic setting for merchants traveling along the northern Silk Roads that connected eastern and western Asia. Populations inhabiting the Dzhungar foothills practiced transhumance between highland summer and lowland winter pastures (Chang, 2008; Frachetti, 2008), with the elevation and lowland semi-arid steppe setting surrounding Begash and Karatal making it likely that mobile populations invested in these places during the winter.

Begash is well-known for its early occupation and pastoral history that spans the mid-third millennium BC to the modern era (Frachetti and Mar'yashev, 2007; Frachetti and Benecke, 2009). The site's archaeology attests to involvement in multiregional exchange and ritual practice (Frachetti et al., 2010) and localized participation in regional potting and fiber traditions (Doumani and Frachetti, 2012). Excavations at Begash uncovered a multi-period pastoral settlement with architecture consisting of rectangular pit houses with stone foundations and postholes associated with ephemeral superstructures, stone-lined pit hearths, and intramural burials. Textile-impressed ceramics were discovered in Bronze Age layers at Begash that document the utilization of simple woven and finger twined cloths to line molds used in the manufacture of clay vessels (Doumani and Frachetti, 2012). Cultural fill inside the Bronze Age Phase 2 dwelling (1690–1000 cal BC) at Begash (Frachetti and Mar'yashev 2007: Table 1) yielded a potsherd containing a well-preserved and clear textile impression (Sample 1) that contains unique attributes not found among the earlier assemblage, so we present it in this paper. The textile impression and a cast of the impression were examined at × 22.3 magnification through a binocular microscope to record the weave structure and technique of the original textile. Flotation of soils collected from a hearth pit in the Begash settlement also yielded a preserved textile fragment (Sample 2). Charcoal collected from the hearth was radiocarbon dated to 360–50 BCE, thus placing it in the Iron Age (Frachetti and Mar'yashev 2007: Table 1). The interlaced elements of the textile fragment were examined at × 80 magnification through a binocular microscope, and a compound light microscope (×400 magnification) further assisted the identification of the raw fiber used for its construction. Both Sample 1 and Sample 2 were examined using facilities in the Ethnobotany Laboratory in the Anthropology Department at Washington University in St Louis.

Archaeological investigations at Karatal were conducted as a reconnaissance excavation that targeted a cemetery containing kurgan and slab burials. One of the burials (K2-01) contained a highly fragmented and disarticulated human skeleton eroding from a ravine cut by a seasonal stream. The proximal end of the single femur recovered in the excavation was wrapped with a copper band that was once part of the pants or boots worn by the individual. A cloth fragment (Sample 3) lined the interior surface of the copper band that had preserved through copper oxidation after being in contact with the metal. A tooth from the interred individual's mandible was submitted for carbon dating, thus providing a corresponding date for the textile fragment in the Medieval Period (Table 1). The textile fragment was viewed using a Scanning Electron Microscope (×500), and also underwent a chemical phloroglucinol test in order to identify the fiber source of the cloth. Ultimate fibers from the sample were mounted in five percent aqueous phloroglucinol solution and then irrigated with hydrochloric acid (HCl) for this test. The SEM analysis was conducted in the Imaging Center of the Department of Earth and Planetary Sciences at Washington University in St. Louis. The phloroglucinol test was then run in the Ethnobotany Laboratory in its Anthropology Department, at a high-power stereoscopic light microscope.

3. Results

3.1. Bronze Age textile-impressed potsherd from Begash

The textile-impressed potsherd from Phase 2 Begash (Sample 1) consists of a textile preserved as an imprint along the interior surface of a ceramic vessel measuring approximately 5 × 8 cm square (Fig. 2a). The impression shows a twill pattern with even 2/2 diagonal binding (Fig. 2b and c). The original woven elements consisted of single ply threads with a Z-twist (Fig. 2d) on a fabric with a medium range thread count (Table 2). However, it should be noted that measurements of the woven elements are estimations because clay shrinks in size when fired. The characteristic feature of the 2/2 twill sample is its “stepped” appearance that is caused from

Table 1
Calibrated ranges (CE) of AMS date from the Karatal cemetery. Calibration curve IntCal 13 (Reimer et al., 2013).

Archaeological site	Lab. index	Material	Date B.P.	Calibrated date	
				68.2% (1σ)	95.4% (2σ)
Karatal	OS-97862	Human bone	1030 ± 25	994–1020 CE	972–1032 CE

OxCal version 4.2 (Bronk Ramsey, 2009).

consecutive weft rows being offset resulting in the cloth showing a diagonal pattern along a 45° angle. Thus, the 2/2 even binding of the original cloth would have been achieved by passing the weft and warp elements over and under equal numbers of the opposite set, with interlacing following a consistent over-2-under-2 pattern (see Emery, 1966:92–3). Although the technical manipulation of woven elements in Sample 1 yielded an even 2/2 structure, some distortion is visible in the print itself that may have derived from the potter applying uneven tension to the cloth when stretching it over the mold. Another possibility is that the weaver produced twill with a slight weft or warp-faced appearance.

3.2. Iron Age cloth fragment from Begash

The preserved cloth fragment from Iron Age Begash (Sample 2) consists of a carbonized textile approximately 4.5 mm in length (Fig. 3a). The fragment is all that remains of an astonishingly fine and delicate twill with a high range thread count (Table 2). The fragment contains a 2/1 or 1/2 diagonal binding that is seen clearly in two single ply threads that detached from the original piece. Those fragments retained the form of having been woven into an under-2-over-1 pattern. A magnified image of the cloth itself further shows the thread count, element characteristics, and fineness of the fragment (Fig. 3b and c). The uneven 2/1 structure would produce opposite patterns on the opposite faces of the twill and this feature would be more pronounced if the original cloth was polychrome. Unfortunately, the original color of our twill was lost through carbonization. In not having a preserved selvage edge that could be used to distinguish the active and passive threads; the thickness of the woven elements were used as proxies to distinguish warp from weft because the warp is generally thicker. Fig. 3 shows the weft fibers (i.e., *x* element) are single-ply and s-spun and very fine with each thread measuring approximately 0.2 mm in diameter. The warp (i.e., *y* element) consists of a two-ply yarn that is z-plied and roughly twice the thickness of the weft elements (Table 2). Even so, it should be noted that lignified tissues could shrink and distort when carbonized thus restricting the precisions of these measurements.

However, carbonization made the textile fragment less susceptible to chemical or biological deterioration over time. Its preservation through carbonization is a likely indicator that the fibers are vegetable-based and not animal hair or wool because plant fibers

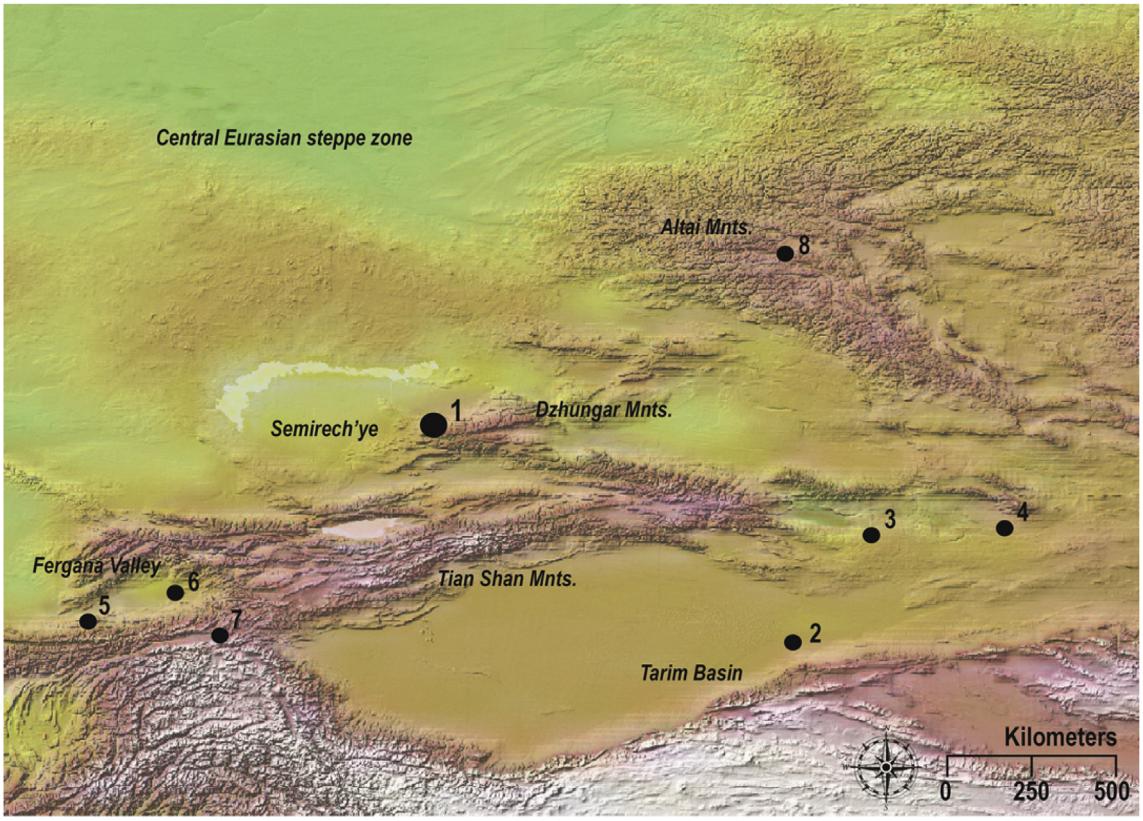

Fig. 1. Bronze and Iron Age twills of central Eurasia with a geographic concentration along its foothill and oasis zones. Sites present in the map include: 1) Begash (1690–1000 cal BC; 390–50 cal BC); 2) Cherchen, Tarim Basin (ca. 1000 BCE); 3) Yanghai, Turfan Oasis (ca. 1250–202 cal BC); 4) Qizilchoqa (Hami), Tarim Basin (ca. 1200 BCE); 5) Dal'verzin, (Chust), Fergana Valley (2nd/1st millennium BC); 6) Eylatan (Chust), Fergana Valley (2nd/1st millennium BC); 7) Daraut-Kurgan, Fergana Valley (2nd/1st millennium BC); 8) Pazyryk, Russia (300 cal BC).

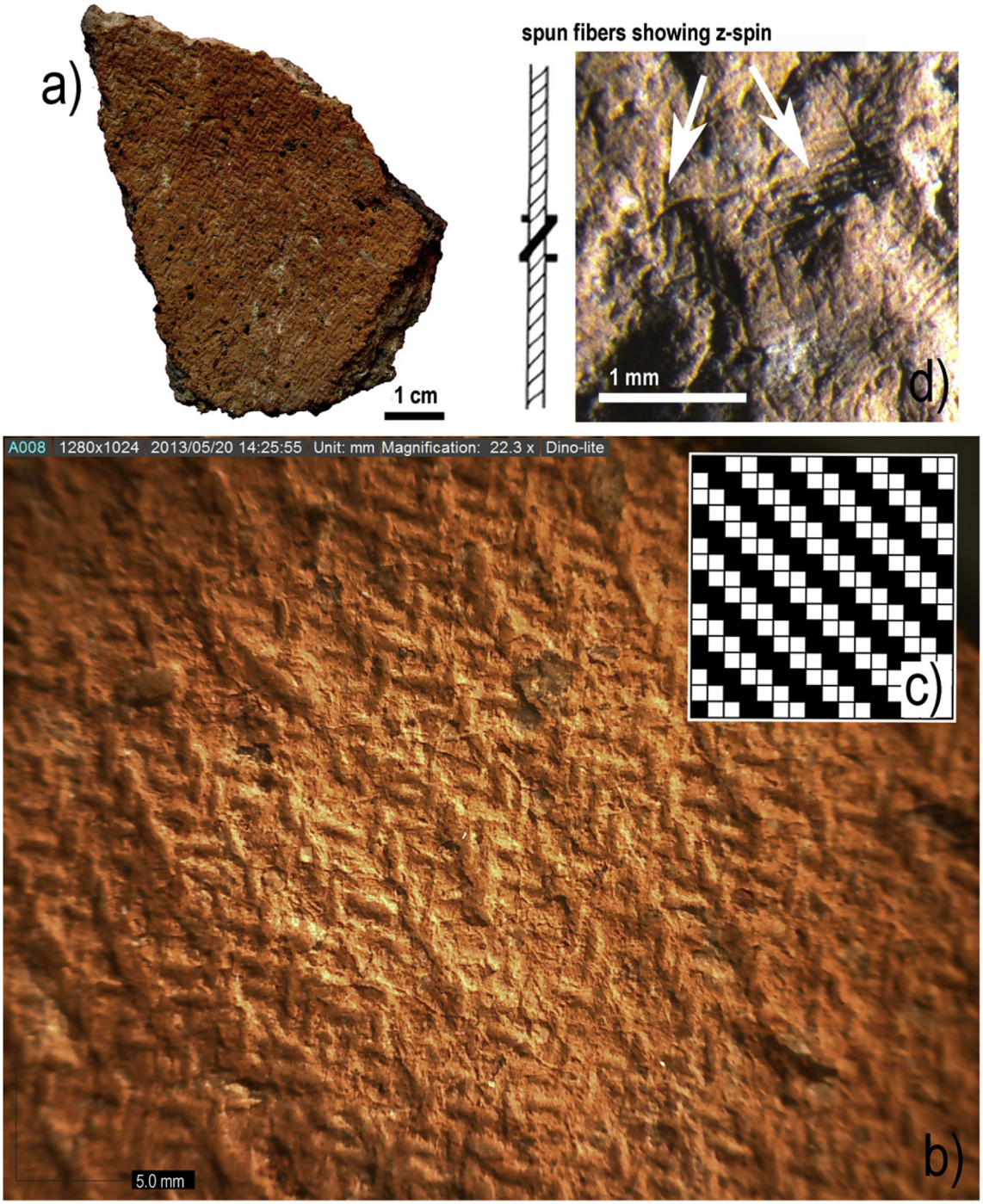

Fig. 2. Sample 1 textile impression from Bronze Age Begash (1690–1000 cal BC) preserved in a potsherd, a byproduct of shaping ceramics on cloth-lined molds: a) potsherd showing negative impression of the twill cloth; b) magnified (×22.3) image of impression (in the negative) showing interlacing elements of twill with an even 2/2 structure; c) schematic of even 2/2 and diagonal twill; d) magnified image of impression (positive view) shows the z-spin of passive and active elements that are <1 mm wide.

contain either lignin or cellulose, which do not degrade as readily as the protein molecules of animal fibers when exposed to heat (Simpson and Ogorzaly, 1995). The raw fibers in the Sample 2 twill are highly processed with a complete lack of articulated parenchyma tissue (i.e., pulp) present, although taphonomic processes may have altered the textile making the fibers appear to have undergone more extensive processing. The long strand phloem cells of bast fibers are common among members of the Malvales clade and certain Rosales, and each species contains different surface characteristics, chemical composition, cross section, and shape. Even so, the significant overlap in these characteristics makes it difficult to distinguish among bast species (see Haugan and Holst, 2014), while some have found success with scanning electron microscopy techniques (Bergfjord et al., 2012; Wright et al., 2012).

Under magnification our sample shows a number of traits that suggest the threads derived from single-celled bast fibers (Fig. 3e). Binocular stereoscopic and compound light microscopy revealed an S-twist, which corresponds with the natural spin direction (i.e., fibrillar orientation) of flax (*Linum usitatissimum*) or nettle (*Urtica dioica*) fibers (Bergfjord and Holst, 2010: Table 1). The sample also

Table 2
Twill evidence in Eurasia in the Bronze Age and Iron Age (4th-1st millennium BC) including Samples 1 and 2 from Begash. Key to citations: 1) Barber, 1991a,b:168; 2) Barber, 1991a,b:212; 3) Good, 1995:322; 4) Beck et al., 2014; 5) Kramell et al., 2014; 6) Good 1995; 7) Good, 1998:666; 8) Korobkova, 1962:232; Table LXXIV; 9) Korobkova, 1962:232; Table LXXV; 10) Korobkova, 1962:232; Table LXXVI; 11) Gleba and Mannering, 2012; 12) Rudenko, 1970:204, Pl. 133B; 13) Rudenko, 1970:203, Pl. 133C; 14) Rudenko, 1970:206, Fig 105; 15) Hajdas et al., 2004 Table 3.

Date		Site/Geographic region	Twill evidence	Cloth structure	Element thickness (mm)	Thread count (cm)	Citations
4th mill. BC		Alishar, Turkey	woolen cloth fragment	2/2 diagonal			1
3rd mill. BC		Markopi, Georgia	cloth fragment	2/2 diagonal			2
2nd mill. BC	**1690–1000 BCE**	**BEGASH, Sample #1**	**impression in pottery**	**2/2 even diagonal**	**0.5/0.5**	**15/15**	/
	ca. 1400 BCE	Anyang, China	silk fragment	woven damask			3
	1122–926 BCE	Yanghai (M21), China	woolen trousers	2/2 weft faced			4,5
	1261–1041 BCE	Yanghai (M157), China	woolen trousers	broken, weft faced			4
	ca. 1200 BCE	Qizilchoqa, Hami, China	woolen cloth fragment	2/2 diagonal		16/16	6
	ca. 1000 BCE	Cherchen, China	woolen overcoat	3/1 weft faced			7
2nd/1st mill. BC transition		Dal'verzin, (Chust)	impressions in pottery	diagonal	0.6/1.1	5/?	8
		Eylatan, (Chust)	impressions in pottery	2/2 diagonal	0.3/0.3	14/14	9
		Eylatan, (Chust)	impressions in pottery	diagonal	0.8/0.5	8/10	9
		Daraut-Kurgan, (Chust)	impressions in pottery	2/2 diagonal	1.1/1.0	6/8	10
		Daraut-Kurgan, (Chust)	impressions in pottery	herringbone	0.6/0.6	10/10	10
1st mill BC	from 700 BCE	Europe, (e.g., Hallstatt C & D)	plant and woolen cloths	large variety	large variety	large variety	11
	390–50 BCE	**BEGASH, Sample #2**	**bast cloth fragment**	**2/1 uneven diagonal**	**0.4/0.2**	**30/50**	/
	398–202 BCE	Yanghai (M18), China	woolen cloth fragment	2/2 float			5
	300 BCE	Pazyryk Barrow 2	woolen cloth fragments	1/3 weft-faced diagonal		60/15	12, 15
	300 BCE	Pazyryk Barrow 2	woolen cloth fragments	Large variety, weft-faced diagonals		18/19, 15/29,20/35	13, 15
	300 BCE	Pazyryk Barrow 3	silk cloth fragment	1/3 weft patterned		24/18	14, 15

shows thin ultimate fibers (around 15 μm) that are associated more with flax and jute (*Corchorus* sp.) (Bergfjord and Holst, 2010: Fig. 2). Finally, the thin ultimate fibers of our sample contain thick walls, thin lumen, with a tapered end, and a fairly constant fiber width across its length, which resembles the morphology described for flax in particular (Ilvessalo-Pfäffli, 1995:337). Based on our examination of the 1) natural twist, 2) width, and 3) lumen structure of the fibers we cautiously classify the Iron Age twill from Begash as linen (Fig. 3e). Without a comprehensive comparative collection of flax and other bast varieties, and with keeping in mind the possible effects of carbonization and taphonomic processes, we do not rule out possibly a wild relative with similar morphology.

3.3. Medieval cloth fragment from Karatal

The Medieval cloth fragment from Karatal (Sample 3) consists of two woven pieces of cloth sandwiched together that lay against the metal trapping of a pant leg or boot strap (Fig. 4). One cloth layer that lay in direct contact with the metal band was fashioned from a coarsely textured fiber. A second layer was fashioned from a much finer material that we examined using scanning electron microscopy. The fibers show flake-like or twisted forms that look like flat ribbons under high magnification (Fig. 5). This ribbon-like appearance is a known diagnostic of processed cotton (*Gossypium* spp.) (Florian, 1990:39). Cotton has fine hairs that cover the primary and secondary cell walls and when the plant is processed the lamellae of cotton hairs pull apart and cause this ribbon-like morphology. In finding morphological traits that were cotton-like in the Medieval textile fragment from Karatal we then ran a chemical phloroglucinol test on the hair fibers to verify our findings by checking for the presence of lignin. While bast fibers, such as flax, hemp, and nettle, are composed of lignin, cotton fibers are made of cellulose and will, therefore, show up negative in such a test, indicating they are not lignin-based (Florian, 1990:39–41). Using the phloroglucinol test can selectively stain for lignin. Our test returned a negative result. Thus, the distinct ribbon-like morphology, and the results of the phloroglucinol test on our sample strongly support that the Karatal textile was woven from cotton.

4. Interpretation and discussion

4.1. Twill textiles in central Eurasia during the Bronze and Iron Age

Wool and twill are cited as mutually linked technologies and when used together they are especially beneficial by achieving both a warm and strong fabric (Barber, 1995:347). Archaeological documentation of twill textiles in Eurasia suggests it developed following the widespread growth in pastoral economies that kept wooly sheep (Barber, 1991a). As the fleeces of wooly sheep contain a number of properties that lend them to spinning and weaving, wool made an immense contribution to the "secondary products" revolution in Eurasia (Sherratt, 1981, 1983), and arguably to the spread of twill technology. Perhaps not coincidentally, wooly sheep and the first twills appear in areas of Turkey, Iran, and Georgia in the fourth and third millennia BC (Barber, 1991a: 2, 212). In Western Europe the first twills are also woolen, but they do not appear until the first millennium BC, such as in the well-studied Hallstatt salt mines in Denmark (Grömer et al., 2013). The European twills initially consisted of 2/2 woolens but then changed to finely woven flax twills that hosted a greater range of structural forms, such as the 2/1 twill (Gleba and Mannering, 2012).

The widespread emergence of animal husbandry in Eurasia during the late third millennium BC also coincides with the appearance of sheep and woolen textiles in settlements and cemeteries of the Eurasian forest-steppe (e.g., Chernai, 1985; Glushkov and Glushkova, 1992). However, comprehensive survey and analysis of preserved Bronze Age textiles and cloth-impressed pottery from this area shows a complete lack of twills in the Eurasian steppe/forest-steppe region (Glushkova, 2004: 227). The known central Eurasian twills are instead found among archaeological sites that span the mountain foothills and oases located along the steppe margin. Specifically, the twills are found in western China (Beck et al., 2014; Barber, 1991b), Uzbekistan (Korobkova, 1962), Russia (Rudenko, 1970), and of course, in our samples from Kazakhstan (Fig. 1). The geographic and chronological proximity of these examples to the Kazakhstan twills from the Bronze and Iron Age have the most direct bearing on the Begash material in a regional context.

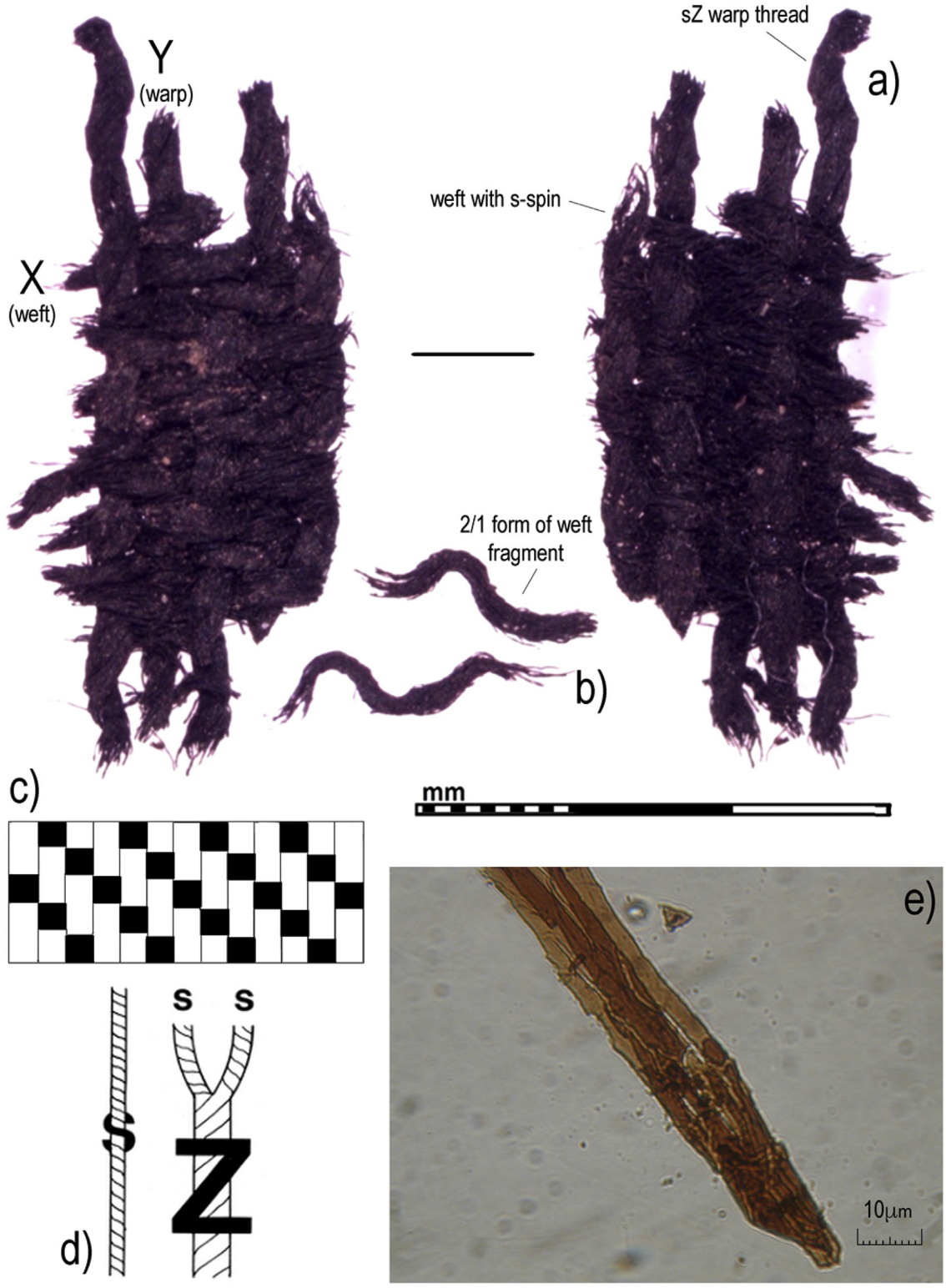

Fig. 3. Sample 2 textile from Iron Age Begash (360-50 cal BC) preserved through carbonization; a) fine and delicate twill fragment measuring around 4.5 mm with uneven 2/1 diagonal binding at × 80 magnification, with s-spin (weft) and z-ply (warp) labeled; b) two stray threads that retained the form of the 2/1 weave pattern; c) schematic of uneven 2/1 diagonal twill; d) schematic of single ply s-spin and two ply z-twist that describes the sample (after Gleba and Mannering, 2012); e) Ultimate fiber of the cloth fragment resembling flax shows thick cell wall, thin lumen, and tapered natural end.

Handmade ceramics from settlements of the so-called "Chust culture" in Uzbekistan's Fergana Valley show textile-impressions that document both twill and non-twill weaves (Table 2) (Korobkova, 1962). With dates in the late second/early first millennium BC (Askarov, 1992:439), ceramics from three Chust villages show both diagonal and herringbone twills were used to line molds for shaping ceramic vessels. The pottery containers were manufactured using the same molding technique described for the

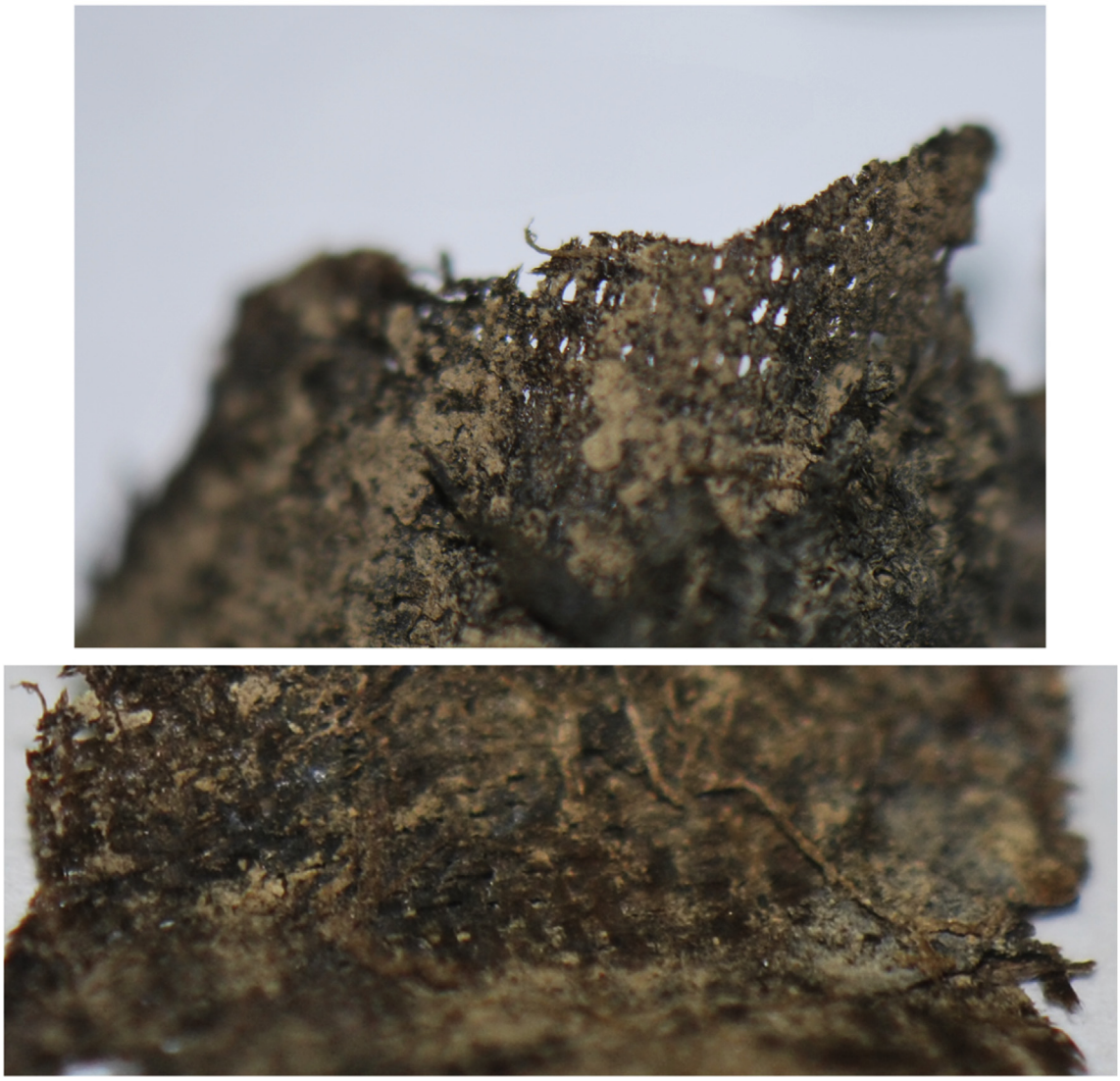

Fig. 4. Sample 3 textile from Medieval Period Karatal (972–1032 cal CE) preserved through copper oxidation. Two compressed textile fragments include one of a coarse, plain-interlaced fiber and another fine textile woven from cotton.

textile-impressed ceramic assemblage from Bronze Age Begash (Doumani and Frachetti, 2012), and demonstrate a point of intersection in the craft production techniques used in the mountain foothill zones of central Eurasia during the mid-late second millennium BC. To the east, cemeteries in the Lop Nor region of the Tarim Basin (Barber, 1991b, 1998; Good, 1995, 1998) and Turfan Oasis (Beck et al., 2014; Kramell et al., 2014) in western China have yielded the largest group of Bronze and Iron Age textiles in central Eurasia. The richness and condition of preservation of this collection allows scholars to examine some of the clothing styles and material industries that existed for a period spanning the early second to first millennium BC, and later. Woolen garments and other articles exist in the form of felts, tabbies, and twills. The western Chinese twill assemblage includes 2/2 diagonal, broken, or weft-faced patterns all woven from wool (Table 2). However, there is mention of silk 'twills' in eastern China but their method of manufacture was unverified (Good, 1995:322). The earliest textiles among the western Chinese assemblage consist of felt and tabbies. It is not until the last half of the second millennium BC that twills appear in western China, thus making them roughly contemporary with the Bronze Age twill from Begash.

Connections between societies of Fergana and western China during the second/first millennium BC have been cited previously based on similarities in the material culture (Askarov, 1992:441) and textiles (Debaine-Francfort, 1987:203; Sylwan, 1941:89–98) of both regions. Their twills boast a broad array of structures, with 2/2 twills are the most common type (Table 2). The discovery of twill at Begash lessens the geographic gap between these two isolated points for twill consumption. A similar thread count and thickness (Table 2) in the central Eurasian twill assemblage also makes it possible that the original fabrics would have resembled one another in weight and texture. Preserved textiles from the Tarim Basin and Turfan Oasis also show the principle use of wool, and while we do not have the preserved twills from the Fergana and Begash assemblages to compare directly, we tentatively propose they derived from wool as well. Finally, the 2/2 twill from Phase 2 Begash quiet possibly belong to the closing end of the period (1690–1000 BCE) based on the published dates for the Tarim Basin, Turfan Oasis, and Fergana Valley textiles in the late second millennium BC.

Compared to the widespread consumption of twill textiles in Iron Age Western Europe (e.g., Grömer et al., 2013) there are just a

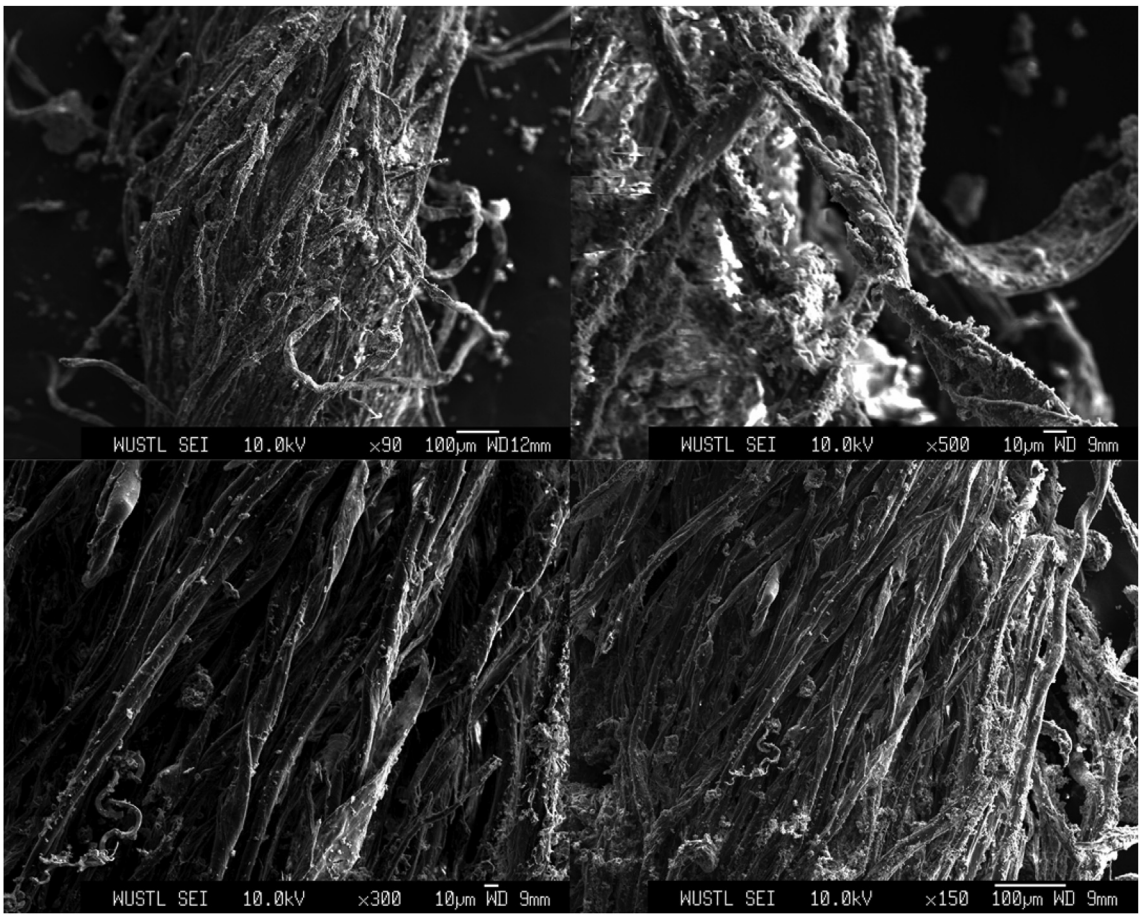

Fig. 5. Scanning electron micrograph (×500) of cotton fibers from the Sample 3 textile, showing the ribbon-like and twisted appearance of the fibers and their dimensions.

few locations in central Eurasia where twill is documented for the late first millennium BC. Specifically, in the Turfan Oasis of western China (Kramell et al., 2014), Tuva in the Altai Mountains of southern Russia (Glushkova, 2004: Table 14; Hajdas et al., 2004: Table 3), and at Begash (Table 2, Fig. 1). The discovery of an Iron Age twill woven from a plant fiber at Begash was unprecedented considering that twill and wool pair so well. But the plant material used further illustrates the diversification of textile and fiber industries in Iron Age in Eurasia following the wider appearance of 2/2 woolen twills of the Bronze Age. The Pazyryk cemetery of Tuva, for example, contains frozen barrows well known for their high preservation of textiles and leather among countless other organic products and human remains (Rudenko, 1970). Among its textile assemblage wool and possibly silk were used to produce an array of fine and light to coarse and heavy twill textiles (Glushkova, 2004: Table 14; Rudenko, 1968:71). The Iron Age Begash twill consists of a high-range thread count that is comparable, but not identical, to the range of twills from Pazyryk (Table 2). Moreover, the two assemblages are different based on the use of wool (at Pazyryk) and linen (at Begash) to achieve such fine cloths. The Iron Age twill from the Turfan Oasis is also woolen (Table 2). Other textiles have been documented in the regional surrounds of these three areas that exhibit interlaced patterns other than twill, such as the site of Berel in northern Kazakhstan (Samashev, 2011:183), and in the Altai Mountains (Polosmak and Barkova, 2005:30–33). Overall, a wider exploitation of fiber sources and structural variation that appear from the Iron Age implies greater specialization among weavers who had obtained skills to wield woolen, plant, and silk fibers into differently weighted and textured fabrics.

4.2. Bast cultivation and processing in central Eurasia during antiquity

Wool consumption followed the use of wild and domesticated plant materials in early central Eurasian textile industries. In Southwest Asia, flax textiles were present from the Neolithic based on finds of linen in archaeological sites across the area (McCorriston, 1997). Flax appeared not long after in Central Asia along with other crops from Southwest Asia (Willcox, 2012). By the Bronze Age, textiles woven from a range of bast fibers are documented in the Caucasus (Shishlina et al., 2003), Iran (Good, 2007), Indus Valley (Wright et al., 2012)], and northern Kazakhstan (Olsen and Harding, 2008). Hemp textiles are also documented in China (ca. 2000 BCE) (Lu and Clarke, 1995), and the plant remains are also known at Harappan sites, and at the later site (1300–600 BCE) of Senuwar in India (Saraswat, 2004). In Ukraine, impressions found on pottery bases belonging to Tripillyan farming settlements have been categorized as flax or hemp textiles (Kordysh, 1951:112). Following the first millennium BC in central Eurasia, the evidence for hemp use increases at which time it was employed not just for its fiber but also for its phytoactive properties (Herodotus, 2003: book IV, section 75; Russo et al., 2008).

Turning our attention to flax specifically, evidence for its cultivation in antiquity, either for oil or fiber, clusters around areas where there was known agriculture (e.g., McCorriston, 1997). The wild plant is generally found in wet climates as it requires a lot of water, and growing it for fiber relies on high labor input, as well as irrigated fields in areas of lower rainfall (McCorriston, 1997:522–3; Zohary et al., 2012). Early linen remains in Central Asia consist of

"*Linum* sp." seeds and seed impressions in mudbrick from Shortughai, Afghanistan (third/second millennium BC) (Willcox, 1991:149), and seeds from Bronze Age levels at Miri Qalat (Tengberg, 1999), Pirik (Costantini, 1979), and across the Harappan world (Fuller, 2008). A single flax seed was also recovered in a cache of mixed crops from a pastoral campsite in the Murghab alluvial fan of Turkmenistan (ca. 1400 BCE) (Spengler et al., 2014a: Table 2) that could have been obtained from one of the many nearby agricultural urban centers.

Historically, flax is associated with urban or sedentary regions where more labor-intensive crops were cultivated, and in central Eurasia these regions cluster around the agricultural centers of Central Asia as outlined above. Consequentially, the likelihood of finding linen textiles outside farming regions is low unless they are exchanged. Linen was grown across large areas of Central Asia by the late first millennium BC making the Iron Age twill from Begash rather late in the regional chronology for flax (as well as hemp and other bast fibers). Even so, the Begash sample offers the first indication that objects manufactured from this cultivated plant were consumed in the small, seasonally inhabited mobile pastoral sites situated in the foothills of central Eurasia. As the piedmont steppe of the Dzunhgar was too dry to grow this high-labor crop without irrigation, alternative locations for its production require investigation. We expect the object followed exchange routes along those mountain foothill passes of Central Asia that links regions where flax cultivation is known. Another possibility requiring further investigation is the possibility for exchange ties with Europe where flax cultivation and twills are well documented for the first millennium BC. Whatever is origin, the Iron Age flax textile from Begash was likely imported, not only due to the poorly suited ecological environment that would severely restrict its cultivation around Begash, but due to its twill weave that is uncommonly associated with the production activities of mobile pastoral campsites.

4.3. Twill production and the implications for exchange at Begash

The warp-weighted loom is normally associated with the manufacture of prehistoric twills (Belanová Štolcová and Grömer, 2010), that is, prior to the invention and use of new weaving devices after the Han period (Geijer, 1979:35; 58). Use of a patterned rod or entirely manual techniques can also be used to create twills, but they are less efficient due to the absence of the shedding mechanism that allows the position of the warp to be changed with each consecutive weft passage (Broudy, 1979:45). Warp-weighted looms are well known components of domestic assemblages in Europe where they are identified archaeologically through loom weights and weaving pits in sedentary villages (Gleba and Mannering, 2012, Ed. Volume). On account of their size and many moving parts, such looms are not typically affiliated with societies that relocate regularly. Landscape and archaeological analyses of the occupation patterns and subsistence economy practiced by prehistoric groups from the Begash campsite, for example, support that it was seasonally inhabited by populations who migrated between highland and lowland pastures to feed their animals (Chang, 2008; Frachetti, 2008). This system of frequent mobility would have lent itself to a textile industry consisting of lighter and easily transportable weaving devices, and thus not those capable of producing twill.

Very little material information exists today on the range of weaving devices used by mobile pastoralists of central Eurasia prior to the ethnographic period. The ethnographic documentation shows a preponderance of light, small, and portable tensioned looms such as horizontal ground looms or back-strap looms that are easy to transport and reassemble (e.g., Wulff, 1966: 201; Wertime, 1978: 15). The mechanical capabilities of these looms lend themselves to tabby and of course twined varieties without the assistance of a device at all, and both types are widely documented among central Eurasian textile assemblages (see Doumani and Frachetti, 2012). Importantly, twill is not typically associated with mobile groups of central Eurasia neither ethnographically nor in antiquity, as the examples covered in this paper demonstrate. The Ferghana Valley and western Chinese twills from the second millennium BC are suspected to be of local origin based on technical features of the textiles themselves and based on the remains of weaving tools in those sites (Beck et al., 2014; Good, 1995:332; Zadneprovski, 1962:41). The degree to which the inhabitants of those sites were mobile or sedentary is unknown, but contacts between western China, the Dzhungar, and Tian Shan Mountains is now widely acknowledged (Debaine-Francfort, 1987; Spengler et al., 2014a). In light of our assumption, we propose that the Bronze and Iron Age twills from Begash entered the site as exchange goods from areas where the appropriate looms were in use, and furthermore where flax was cultivated for the Iron Age sample in particular.

4.4. Cotton cultivation and exchange in Eurasia

Cotton (*Gossypium arboretum* or *G. herbaceum*) is documented archaeologically in the Indus Valley from the sixth millennium BC site of Mehrgarh (Moulherat et al., 2002), and then later during the Harrappan period (Fuller, 2008; Wright et al., 2012). Evidence of its production in southern Central Asia has preserved in the form of fibers, seeds (Meadow, 1996), and impressions of woven textiles in pottery (Bird, 1956). However, the late and early frosts, and lower rainfall typical of the Eurasian steppe formed an ecological barrier to cotton production for much of its earlier use. Outside of reports of cotton textiles in Bronze Age cemeteries of the Caucuses (Shishlina et al., 2003:334), the archaeological and historical evidence for cotton outside of South Asia is primarily restricted to the Common Era, in Sasanian period Turkmenistan, early Classical Europe (Nesbitt, 1993, 1994), and along the Mediterranean (Pliny the Elder in his *"Naturalis Historia"* CE 77–79).

Just as with flax, cotton processing is labor and time intensive requiring a frost-free environment and high even rainfall (Fuller, 2008:5, 6) that is not met in the continental climate of Dzhungar Mountains. Archaeological remains of cotton do exist in South Asia where the environmental prerequisites for growing the water demanding and high-labor crop have supported agriculture for millennia. The fragment of cotton clothing that preserved on the buried individual in the Karatal cemetery dates to approximately 1000 CE (Table 1) in the Medieval Period at a time when cotton textiles had spread across the Old World and the Silk Roads exchange extended far into the Mediterranean and China, with Central Asian cities occupying significant wealth from the trade. Archaeobotanical studies at the large oasis Silk Roads city of Merv in Turkmenistan, for example, document domesticated fruits, grains, and legumes, along with an abundance of cotton seeds throughout the site deposits (Herrmann and Kurbansakhatov, 1994:71–73). Merv was a key strategic 'fueling station' along the Silk Roads and cotton was clearly a significant crop that may have brought additional wealth to the city in the form of woven goods. In fact, in Central Asia cotton textiles are cited as late 10th century CE exports alongside numerous other locally produced items (quoted in Bartol'd, 1977: 235–36). Christian (2000:9) has linked the military security and commercial wealth of cities like Khorezmia to their interaction and exchange with Eurasian pastoralists' who occupied the lands along their trade routes. Indeed, cotton textiles from this period (between 960 and 1127 CE) are known to have reached as far as China (Lu and Clarke, 1995:29). The Karatal cotton

fragment was likely an exchange good, as cotton could not be grown in the regions surrounding Karatal. Moreover, the site is located along trade routes of the Qarakhanid period when a steady flow of goods were passed along the routes, and the mountain passes of the Dzhungar Mountains would have been well placed to host the transport of textiles and countless other goods between China and Central Asia.

5. Conclusion

Textiles are one of the most highly suited commodities for exchange, being lightweight, durable, and prized for bringing social and economic status to those who procure or wear them. Among the multitude of fiber types used to manufacture fabrics, some are not accessible in the regions where they are ultimately consumed or purchased. Consequentially, textiles are well suited to acquire the reputation of luxury items when the knowledge, tools, or materials needed for their manufacture are absent (e.g., such as silk outside of dynastic China) (Currie, 2001:4). Despite there being little evidence for silks along the early Silk Roads, textiles were among the wealth of objects that moved along the mountain passes and stretches of steppe and deserts of Asia in antiquity. In this paper we have outlined three specimens of textiles from the Begash settlement and Karatal cemetery located in southeastern Kazakhstan that demonstrate such movement. The dataset also demonstrates mobile pastoralists' participation in exchange and technology transfer at different times during the Silk Roads' operation. Specifically, we document early twill preserved as an impression on a Bronze Age potsherd from Begash; a preserved twill textile woven from flax fibers dating to the Iron Age also from Begash; and a cotton textile from the early Medieval Period from Karatal.

Assessment of our two twill examples in their regional context suggests Bronze and Iron Age twills were restricted to the mountain foothill and oasis regions of central Eurasia, while being entirely absent in the neighboring steppe/forest-steppes zones. This clustering of prehistoric twills along the mountain foothill zones suggests the transfer of twill production techniques followed a similar geographic route to that proposed for the spread of domestic crops between China and Southwest Asia (Spengler et al., 2014a). The correspondence of these technological and economic practices along the regions that would later on become the Silk Roads highlights an early interaction sphere and transfer in fiber, crop, and weaving technology that concentrates on the southern regions of central Eurasia, and not along the steppe belt to the north.

Returning to our samples specifically, structural analysis of the Bronze Age textile-impression indicates pastoralists of southeastern Kazakhstan consumed medium density 2/2 twills, possibly woven from wool starting in the last half of the second millennium BC. The sample represents the only and earliest evidence for twill cloth in prehistoric Kazakhstan, and this weave follows long after the appearance of other interlaced textile varieties at Begash and woolly sheep in central Eurasia in general (as outlined in Doumani and Frachetti, 2012). We propose that it was an exchange item based on twill's association with the warp-weighted loom and sedentary sites. The transport of twills indicates woven products were transported along the mountain zones of Central Asia long before the historically documented Silk Roads. Such exchange continued into the Iron Age. Analysis of the Iron Age twill fragment from Begash shows lighter and fine 2/1 linen twills were transported along the Silk Roads in the late first millennium BC into sites inhabited by mobile pastoralists. This Iron Age textile is one among few preserved fragments from this geographic region at a time conventionally associated with higher mobility and specialized pastoralism. As twill technology had been around for hundreds of years leading up to the Iron Age, trade between centers of specialized craft production plausibly contributed to the spread of knowledge relating to the manipulation of plant fibers to achieve this more difficult weave. Much later in time, the Medieval cotton textile fragment from Karatal shows cotton textiles were among the goods moving along the Silk Roads during the first centuries CE. Although cotton and cotton textiles were in use long before this period in China and Central Asia, the Karatal cotton is among the early finds of this non-local commodity in northern Central Asia and, therefore, reduces the geographic distance between locations of cotton textiles along the Medieval Silk Roads.

The Silk Roads are named for their transport of silken textiles but only a few preserved remains of this commodity are reported from central Eurasia (e.g., Chang and Grigoriev, 1999; Askarov, 1973 unpublished: 133–134). The three textile samples discussed in this paper, twill, linen, and cotton, demonstrate a much more varied industry of weaving and fiber manipulation across this territory during the incipient and later periods of trans-Eurasian exchange systems.

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