Changing Clays: Raw material preferences in the ‘Neolithic’ ceramic assemblages of the Upper Vitim Basin

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Appendix S.1. the analytical sample list

These samples were used as the basis for the analysis in this paper. Each of these samples was confidently attributed to an individual vessel on the basis of macroscopic analysis.

|  | *Sample no.* | *Sherd context notes* | *Vessel attribution* | *Microscopic group* |
| --- | --- | --- | --- | --- |
| 1 | P-USKA001 | Ust’-Karenga XIV, 12: 1/15 | UK (Layer 7) | 2.2 |
| 2 | P-USKA002 | Ust’-Karenga XII, 3: 6/13 | UK (Layer 7) | 1.3a |
| 3 | P-USKA003 | Ust’-Karenga XIV, 12: 1/24 | UK (Layer 7) | 1.1a |
| 4 | P-USKA004 | Ust’-Karenga XII, 3: 3/14 | UK (Layer 7) | 1.2f |
| 5 | P-USKA005 | Ust’-Karenga XII, 3: 3/5 | UK (Layer 7) | 1.3b |
| 6 | P-USKA007 | Ust’-Karenga XII, 3: 7/20 | UK (Layer 7) | 1.2c |
| 7 | P-USKA008 | Ust’-Karenga XII, 3: 7/2 | UK (Layer 7) | 4.1 |
| 8 | P-USKA010 | Ust’-Karenga XIV, 12: 4/8 | UK (Layer 7) | 4.1 |
| 9 | P-USKA011 | Ust’-Karenga XII, 3: 8/25 | UK (Layer 7) | 3.1b |
| 10 | P-USKA013 | Ust’-Karenga XII, 3: 6/3 | UK (Layer 7) | 1.3a |
| 11 | P-USKA015 | Ust’-Karenga XIV, 12: 4/16 | UK (Layer 7) | 1.1b |
| 12 | P-USKA016 | Ust’-Karenga XII, 14: 9/15 | UK (Layer 7) | 1.1b |
| 13 | P-USKA017 | Ust’-Karenga XII, 3: 6/4 | UK (Layer 7) | 4.2 |
| 14 | P-USKA018 | Ust’-Karenga XII, 3: 2/21 | UK (Layer 7) | 4.1 |
| 15 | P-USKA020 | Ust’-Karenga XIV, 12: 1/24 | UK (Layer 7) | 4.2 |
| 16 | P-USKA021 | Ust’-Karenga XVI, 5: 4/2 | UK (Layer 7) | 1.1a |
| 17 | P-USKA022 | Ust’-Karenga XVI, 5 | UK (Layer 7) | 1.3a |
| 18 | P-USKA024 | Ust’-Karenga XVI, 5: 1/24 | UK (Layer 7) | 1.2b |
| 19 | P-USKA025 | Ust’-Karenga XVI, 5: 12/5 | UK (Layer 7) | 1.2a |
| 20 | P-USKA026 | Ust’-Karenga XII, 3: 9/21 | UK (Layer 7) | 1.3b |
| 21 | P-USKA027 | Ust’-Karenga XII, 3: 2/13 | UK (Layer 7) | 3.1a |
| 22 | P-USKA029 | Ust’-Karenga XII, 3: 2/20 | UK (Layer 7) | 1.1b |
| 23 | P-USKA030 | Ust’-Karenga XII, 3: 13/4 | UK (Layer 7) | 1.1a |
| 24 | P-USKA031 | Ust’-Karenga XVI, 5: 4/23 | UK (Layer 7) | 1.1a |
| 25 | P-USKA033 | Ust’-Karenga XII, 3: 4/21 | UK (Layer 7) | 4.2 |
| 26 | P-USKA034 | Ust’-Karenga XVI, 5: –/14 (?) | UK (Layer 7) | 1.2d |
| 27 | P-USKA035 | Ust’-Karenga XII, 3: 15/18 | UK (Layer 7) | 4.1 |
| 28 | P-USKA037 | Ust’-Karenga XIV, 12: 1/19 | UK (Layer 6) | 1.1a |
| 29 | P-USKA038 | Ust’-Karenga XIV, 12: 1/14 | UK (Layer 6) | 4.1 |
| 30 | P-USKA039 | Ust’-Karenga XIV, 12: 1/11 | UK (Layer 6) | 4.2 |
| 31 | P-USKA040 | Ust’-Karenga XIV | UK (Layer 6) | 4.2 |
| 32 | P-USKA041 | Ust’-Karenga XIV, 12: 1/8 | UK (Layer 6) | 1.1a |
| 33 | P-USKA044 | Ust’-Karenga XIV, 12: 1/Int. | EMA (WP) | 6.1a |
| 34 | P-USKA045 | Ust’-Karenga XII, 13: 2/13 | UK (Upper Layers) | 1.1b |
| 35 | P-USKA046 | Ust’-Karenga XII, 13: 9/2 | UK (Upper Layers) | 2.2 |
| 36 | P-USKA047 | — | UK (Upper Layers) | 1.1a |
| 37 | P-USKA048 | Ust’-Karenga XII, 3: 8/24 | UK (Upper Layers) | 2.1a |
| 38 | P-USKA049 | Ust’-Karenga XII 13: 2/7 | UK (Upper Layers) | 1.1c |
| 39 | P-USKA052 | Ust’-Karenga XII, 13: 6/22 | UY/ RP | 1.2d |
| 40 | P-USKA054 | Ust’-Karenga XII | UY/ RP | 3.1a |
| 41 | P-USKA055 | Ust’-Karenga XII, 14: 9/7 | EMA (CM) | 1.3b |
| 42 | P-USKA056 | Ust’-Karenga III: Sh. 2/2 | EMA (PL) | 1.1c |
| 43 | P-USKA057 | Ust’-Karenga XII, 13: 2/7 | UY/ RP | 5.1 |
| 44 | P-USKA059 | Ust’-Karenga XII, 13: 2/2 | UY/ RP | 1.2d |
| 45 | P-USKA061 | Ust’-Karenga XII, 14: 9/15 | EMA (CM) | 6.1b |
| 46 | P-USKA062 | Ust’-Karenga XII, 14: 9/13 | UY/ RP | 1.3a |
| 47 | P-USKA063 | Ust’-Karenga XII, 13: 6/11 | UY/ RP | 6.2 |
| 48 | P-USKA065 | Ust’-Karenga III: Sh. 12/6 | EMA (SM) | 6.2 |
| 49 | P-USKA066 | Ust’-Karenga XII, 3: 12/5 | EMA (CM) | 6.1d |
| 50 | P-USKA067 | Ust’-Karenga XII, 13: 6/8 | UK (Upper Layers) | 2.2 |
| 51 | P-USKA068 | Ust’-Karenga III: ShP. 13/4 | UK (Upper Layers) | 1.3c |
| 52 | P-USKA069 | Ust’-Karenga XII, 3: 1/3,4,5 | EMA (CM) | 1.3b |
| 53 | P-USKA070 | Ust’-Karenga XII, 3: 7/3 | EMA (CM) | 6.2 |
| 54 | P-USKA071 | Ust’-Karenga XII, 14: 2/15 | EMA (PL) | 1.2b |
| 55 | P-USKA072 | Ust’-Karenga XII, 14: 2/2 | UY | 1.2d |
| 56 | P-USKA073 | Ust’-Karenga XII, 13: 2/1 | UY/ RP | 1.2d |
| 57 | P-USKA075 | Ust’-Karenga XII, 3 | EMA (CM) | 4.2 |
| 58 | P-USKA077 | Ust’-Karenga XII, 13: 8/13 | EMA (PL) | 5.1 |
| 59 | P-USKA078 | Ust’-Karenga XII, 13: 2/1 | EMA (PL) | 2.1a |
| 60 | P-USKA080 | — | UY | 6.3 |
| 61 | P-USKA081 | Ust’-Karenga XII, 13: 4/20 | EMA (SM) | 5.1 |
| 62 | P-USKA082 | Ust’-Karenga III: ShP. 11/1 | UY/ RP | 1.2d(?) |
| 63 | P-USKA083 | Ust’-Karenga III: ShP. 13/3 | UY/ RP | 2.1b |
| 64 | P-USKA084 | Ust’-Karenga III: –/2 | EMA (SM) | 6.1b |
| 65 | P-USKA085 | Ust’-Karenga III: ShP. 13/6 | EMA (PL) | 6.2 |
| 66 | P-USKA086 | Ust’-Karenga III: ShP. 12 | EMA (PL) | 1.1c |
| 67 | P-USKA087 | Ust’-Karenga XII, 3: 7/8 | EMA (CM) | 1.3a |
| 68 | P-USKA088 | Ust’-Karenga III: ShP. 12/6 | EMA (CM) | 2.1b |
| 69 | P-USKA089 | Ust’-Karenga III: ShP. 12 | EMA (SM) | 6.2 |
| 70 | P-USKA090 | Ust’-Karenga III: ShP. 11/5 | EMA (PL) | 2.1b |
| 71 | P-USKA091 | Ust’-Karenga III: ShP. 12/5 | EMA (SM) | 6.2 |
| 72 | P-USKA092 | Ust’-Karenga XII, 3: -/12 | UY | 1.3b |
| 73 | P-USKA093 | Ust’-Karenga III: SF | UY | 6.1a |
| 74 | P-USKA094 | Ust’-Karenga III: ShP. 4/ Pit 3 | UY | 1.3a |
| 75 | P-USKA095 | Ust’-Karenga III: ShP. 11/11 | UY | 6.1b |
| 76 | P-USKA097 | Ust’-Karenga III: SF | UY | 6.1b |
| 77 | P-USKA098 | Ust’-Karenga X: ShP. 49/1 | UY | 2.1b |
| 78 | P-USKA099 | Ust’-Karenga X: ShP. 49 | UY | 2.1b |
| 79 | P-USKA100 | Ust’-Karenga III: ShP. 4/5 | UY | 6.1a |
| 80 | P-USKA101 | Ust’-Karenga III: SF | UY | 6.1a |
| 81 | P-USKA102 | Ust’-Karenga III: Sh. 1/1 | UY | 2.1b |
| 82 | P-USKA104 | Ust’-Karenga XII, 14: 9/15 | UY | 6.1c |
| 83 | P-USKA106 | Ust’-Karenga III: SF | UY | 6.1a |
| 84 | P-USKA107 | Ust’-Karenga XII, 14: 9/12 | UY | 6.1a |
| 85 | P-USKA108 | Ust’-Karenga VIII: SF | UY | 2.1b |
| 86 | P-USKA109 | Ust’-Karenga IX: SF | UY | 6.1a |
| 87 | P-USKA110 | Ust’-Karenga III: SF | UY | 5.1 |
| 88 | P-USKA111 | Ust’-Karenga III: SF | UK (Upper Layers) | 6.1d |
| 89 | P-USYU001 | Ust’-Yumurchen VIII: 2/1 | UK (Upper Layers) | 2.2 |
| 90 | P-USYU002 | Ust’-Yumurchen VIII: 2/15 | UK (Upper Layers) | 1.2d |
| 91 | P-USYU005 | Ust’-Yumurchen VIII: Sh. 1–2/15 | UK (Upper Layers) | 1.1c |
| 92 | P-USYU007 | Ust’-Yumurchen VIII: 2/1 | UK (Upper Layers) | 1.2e |
| 93 | P-USYU009 | Ust’-Yumurchen VIII: 1/8 | UK (Upper Layers) | 1.1b |
| 94 | P-USYU010 | Ust’-Yumurchen VIII: 2/15 | UK (Upper Layers) | 1.3a |
| 95 | P-USYU011 | Ust’-Yumurchen XII, 21 | UY | 6.1a |
| 96 | P-USYU012 | Ust’-Yumurchen: P/- | UY | 1.1b |
| 97 | P-USYU013 | Ust’-Yumurchen: 2/4 | UY | 1.1d |
| 98 | P-USYU014 | Ust’-Yumurchen VIII: -/2 | EMA (SM) | 1.2d |
| 99 | P-USYU015 | Ust’-Yumurchen XII, 21 | UY | 6.1a |
| 100 | P-USYU016 | Ust’-Yumurchen VIII: -/4 | UY | 6.4 |
| 101 | P-USYU017 | Ust’-Yumurchen VIII | UY | 2.1a |
| 102 | P-USYU018 | Ust’-Yumurchen VIII: -/4 | UY | 2.1a |
| 103 | P-USYU019 | Ust’-Yumurchen VIII: -/3 | UY | 6.1a |
| 104 | P-USYU020 | Ust’-Yumurchen VIII: -/3 | UY | 2.1a |
| 105 | P-MOGO001 | Mongoy I: SF | UY | 3.1a |
| 106 | P-MOGO002 | Mongoy I: SF | UY | 6.1b |
| 107 | P-UBUG001 | Ust’-Bugarikhta: Sh. 1 | UY | 6.1d |
| 108 | P-UKND001 | Ust’-Konda II: Sh. 1 | UY | 6.3 |
| 109 | P-UKND002 | Ust’-Konda II: Sh. 1 | UY | 6.1c |
| 110 | P-VTIM002 | Ingur Cave II: SF | EMA (CM) | 6.1b |
| 111 | P-VTIM003 | Ust’-Kholoy: SF | UY/ RP | 6.3 |
| 112 | P-VTIM007 | Ust'-Oktorokon | EMA (PL) | 1.1b |
| 113 | P-VTIM009 | Ust’-Ashigly IV: ShP.1/3–4  | UY | 2.1b |
| 114 | P-VTIM010 | Ust’-Sivakon I | UY/ RP | 6.1d |
| 115 | P-VTIM011 | Ust’-Guloni I | EMA (CM) | 6.1a |
| 116 | P-VTIM012 | Ust’-Oktorokon I, Р | EMA (PL) | 1.2d(?) |
| 117 | P-VTIM013 | Ust’-Bombando I: Sh. 1/1 | EMA (CM) | 1.2c |
| 118 | P-VTIM014 | Romanovka X: Sh. 2/5 | EMA (SM) | 6.3 |
| 119 | P-VTIM015 | Ust’-Neregda: SF | EMA (CM) | 6.1c |
| 120 | P-VTIM016 | Ust’-Ashigly I: Sh. 1/1 | EMA (WP) | 6.1c |
| 121 | P-VTIM017 | Ust’-Ashigly IV: Sh. 1/3–4  | UY/ RP | 2.2 |
| 122 | P-VTIM018 | Ust’-Ashigly I: Sh. 2/5 | EMA (PL) | 4.1 |
| 123 | P-VTIM019 | Ust’-Neregda I: SF | EMA (PL) | 6.1c |
| 124 | P-VTIM020 | Ukshaki: SF | EMA (PL) | 6.2 |
| 125 | P-VTIM021 | Ust’-Konda III: Sh. 1/1 | EMA (PL) | 6.1c |
| 126 | P-VTIM022 | Glubokoe: SF | EMA (PL) | 1.1b |
| 127 | P-VTIM023 | Ust’-Sherebakhta: Sh. 1/1 | EMA (PL) | 1.2c |
| 128 | P-VTIM024 | Ust’-Sherebakhta: Sh. 1/1 | EMA (PL) | 1.2c |
| 129 | P-VTIM025 | Nizhnyaya Dzhilinda I | UY | 7.1 |
| 130 | P-VTIM026 | Ust’-Konda III: Sh. 1/1 | EMA (PL) | 1.1c |

Appendix S.2. Mineralogical Comments: Fabric by Fabric

Coarse of Habit: The Primary/Residual Superfabric

###### 1.1a—Perthite Granite Fabric

Fabric 1.1a was among the coarsest and most ‘monolithic’ of the Primary or Residual fabric groups. Rock fragments and monocrystalline grains of orthoclase-albite perthite accounted for around 50% of all inclusions and 75­–85% of all feldspars – with quartz and varying amounts of plagioclase and ‘plain’ orthoclase feldspar and biotite making up the balance. Iron oxides (principally magnetite) were present as minor components in all samples except P-USKA021 and 031– in which they were abundant (NB: All P- numbers refer to the Analytical Sample Number in Appx S.1). Neither microcline nor hornblende was present in any of the samples associated with this fabric. This may be an indication that this fabric was not immediately local to the site.

All of the local granitic rocks and sediments sampled in the raw materials survey around *Ust’-Karenga* were dominated by microcline and microcline-albite perthite, and microcline was the dominant feldspar in all of the local sands and sediments sampled (NB: The two type sites, *Ust’-Karenga* and *Ust’-Yumurchen,* are italicised, here and henceforth, to distinguish them from the cultures of the same name).

###### 1.1b—Re-deposited Perthite/Microcline Granite Fabric I

Fabric 1.1b was in some respects similar to 1.1a, but differed significantly in grain-size distribution, having a lower overall proportion of inclusions (30–40%) of which a greater proportion were in the silt to fine sand size range. The degree of weathering and the proportion of sub-rounded to rounded grains was slightly greater than either 1.1a or 1.1d.

Although there was a clear lithological relationship between most of the monocrystalline grains and rock fragments, P-USKA029 and P-VTIM022 contained a few lithologically ‘inconsistent’ medium sand-sized inclusions of dioritic rock.

In general, samples attributed to this group had a slightly more mature mineralogy and were rich in quartz (up to 40% of all inclusions), both mono and polycrystalline, including many examples with extensive recrystallisation, coarse granoblastic, and granophyric texture. Other mineral species represented (both as free grains and in rock fragments) were microcline, microcline perthite (NB: orthoclase perthite was rare), and plagioclase alongside a greater range (if not a greater quantity) of micaceous and mafic inclusions than was seen in 1.1a. These were predominantly found within the very fine sand–silt size range and included fine biotite and white mica laths—the latter also present as part of larger agglomerated grains (eg, P-USKA015), green hornblende, pistacite (eg, P-USKA045), orthopyroxene, clinopyroxene (eg, P-USKA029/P-VTIM022), clinozoisite (eg, P-USKA051), and occasionally minute, high-relief zircons and small grains of sphene (eg, P-USYU008). Opaque iron oxides were relatively common in all samples. Organic inclusions were present in abundance in samples P-USYU009 and (to a lesser extent) P-USYU008 and were noted as clusters of small round and oval voids of fairly consistent size.

At this stage, conclusive comments on provenance for this group are premature. A local origin for the material recovered from *Ust’-Karenga* was possible, though the precise combination of minerals in the ceramics was not encountered in any of the local geological samples. The picture is further complicated by the fact that compositionally similar raw materials are found across large areas of the plateau. In such cases, provenance may possibly be decided on the relative abundance of rarer minerals. The comparative abundance of zircon and sphene in samples from *Ust’-Yumurchen* may prove to be significant in this context.

###### 1.1c—Re-deposited Perthite/Microcline Granite Fabric II

In terms of its mineralogy, 1.1c differed little from 1.1b, though some of its ‘transported’ characteristics were amplified: slightly greater proportion of quartz present, slightly lower proportion of more weathering susceptible mafic inclusions. In some samples (eg, P-USKA056 & 086), there was also a significantly higher proportion of zircon and sphene (present as unusually large monocrystalline grains). Several samples (eg, P-USYU-004) contained fragments of an isotropic mineral tentatively identified as apatite (confirmed under the Scanning Electron Microscope [SEM]). These grains were present both as free minerals and grains within rock fragments. The principal differences between this and the other re-deposited ‘residual’ fabrics was the comparatively low incidence of silt and the presence of a significant amount of organic material, specifically smooth walled, oval, and elongate voids of a consistent size (around 80–150 µm diameter/width) with an even distribution throughout the fabric of the samples (eg, P-USKA056 & P-USYU003). These could represent the addition of animal hair into the ceramic paste. The fabric also showed constrained shrinkage voids. A related sample P-VTIM026 had a virtually identical composition to the main group except for the addition of a number of silt-sized altered olivine fragments and a few rounded grains of basalt. The incidence of organic inclusions was also lower.

 This fabric showed connections with various other samples across the assemblage, including P-USYU004 and 010 (Fabric 1.3a), P-USKA024 and P-USKA071 (Fabric 1.2c), and possibly also P-USKA034 and 052 (Fabric 1.2d), though the latter connections were more speculative. The relatively high shrinkage seen in this fabric may indicate differences in clay composition. These features were not unique to this fabric. The occurrence of this fabric at *Ust’-Yumurchen* might suggest an origin upriver of *Ust’-Karenga*, but for the moment this remains mere speculation.

###### 1.1d—Perthite Granite with Volcanic Glass Fabric

Fabric 1.1d was, in general, compositionally similar to Fabric 1.1a, but displayed a more positively skewed grain size distribution and a higher density of poorly-sorted fine silt and sand inclusions. The sample also contained significantly fewer coarse sand-sized inclusions than seen in Fabric 1.1a. Considerably more distinctive, however, was an abundance of well-rounded to sub-rounded grains of a clear, mid-brown isotropic material identified as glassy volcanic ejecta (due to the well-rounded form of many grains [often essentially spherical] and the apparent fusing together of others). Given that these grains show little sign of de-vitrification, it is logical to suggest that they are associated with a relatively recent phase of volcanism and therefore tied either to the Vitim or Udokan Volcanic Fields (Rasskazov 1994). The recovery of the sample at *Ust’-Yumurchen* strongly indicates the former.

###### 1.2a–Microcline/Orthoclase Granite Fabric I

Fabric 1.2a was a characteristically ‘colluvial’ fabric dominated by quartz, orthoclase, and microcline feldspar, both within rock fragments and as discrete monominerallic grains. Plagioclase was present but not common. Accessory minerals, principally biotite and iron oxide, were also common with occasional small grains of hornblende, muscovite, and sphene. Though sufficiently different in character to justify separation, granitic rocks with a similar composition are likely to be common across the plateau, and further definition of provenance does not seem realistic at this stage. A local origin is possible, though difficult to demonstrate on the basis of the available evidence.

###### 1.2b—Microcline/Orthoclase Granite Fabric II

Fabric 1.2b was one of the more macroscopically and texturally distinctive fabrics in the assemblage. However, its aplastic content, dominated by fragments of quartz, orthoclase, and microcline-rich granite, and associated mineral grains (some of which showed graphic and granophyric texture [eg, P-USKA071]), was fairly non-diagnostic. Its texture, on the other hand, was extremely unusual and showed some similarities with 1.1c. It was, however, substantially finer in texture. Accessory minerals—principally biotite and iron oxide with occasional small grains of hornblende, muscovite, and sphene—were quite common. Unusual, rounded, bright red, amorphous textural features were very common in this fabric and had a similar appearance to the altered olivine crystals seen in other fabrics (eg, Fabric 6.3). These, however, lacked relief and were shown, under the SEM, to be clay pellets. Without comparable samples from the field, the origins of this fine clay could not be confidently defined. It is possible, given the large particle size seen in the clay matrix, that this may be yet another kind of primary clay, though the rounded grains in some samples (eg, P-USKA024) seem to suggest some mixing, whether natural or intentional.

###### 1.2c—Re-deposited Microcline Granite Fabric I

Fabric 1.2c was separated from Fabric 1.2a on the basis of granulometry rather than mineralogy and was a slightly more silty, better-sorted variant with a greater degree of rounding in its inclusions. Some differences were noted in the proportions of minerals present (relative abundance of mafic minerals and mica) but the differences were minor. (Related samples P-VTIM023 and 024 were compositionally similar to the main group but contained more silt-sized grains.)

###### 1.2d—Re-deposited Microcline Granite Fabric II

Fabric 1.2d was distinguished from 1.2c by the greater abundance of plagioclase feldspar and slightly strained polycrystalline quartz fragments and by the greater degree of ‘roundness’ across the fabric. Though it lacked the density of silt and mineralogical range of any of the ‘detrital’ fabrics or clay samples, the presence of high-sphericity sub-rounded grains were an interesting feature of this fabric, ranging in abundance from 5–30% of total inclusions present (cf*.* P-USKA059 & 072). For P-USKA072 these could plausibly be referred to as temper, though, with various intermediate examples within the group, a natural origin could not be ruled out. The presence of an unusual abundance of fine–medium sand-sized clay pellets (often with shrinkage cracks) was also noted. P-USYU002 and 014 were similar to the main group compositionally (closest to P-USKA073), but were, respectively, more extensively weathered and more organic tempered. P-USYU002 shared its weathered appearance and some compositional similarities with P-USYU004 and 010 (Fabric 1.3a) and the members of Fabric 1.1c (notably the presence of large sphene inclusions). The consistent form of the organic temper in P-USYU014 connected it to organic ‘tempered’ samples in 1.1c. Although problems of provenance definition discussed earlier apply equally to this group, the recurrent connection between large grains of sphene and abundant organic inclusions in samples from the site of *Ust’-Yumurchen* is probably of interest.

###### 1.2e—Re-deposited Microcline Microgranite Fabric

Fabric 1.2e was distinguished by a greater abundance of microcline and presence of microgranite or microgranite porphyry rock fragment (grain size: *c.* 0.2–0.4 mm). Common accessory minerals (principally muscovite, biotite, and occasional silt-sized hornblende) were more abundant in this fabric, though they did not account for more than 2% of the total. In terms of granulometry, 1.2e had a greater, or at least more variable quantity of silt-sized inclusions (NB: visible differences were noted in the grain size distribution of adjacent coils in P-USYU007).

Microgranites have a restricted distribution across the plateau, however, they were encountered in our raw materials survey on the left bank of the Vitim opposite the mouth of the Karenga and can reportedly be found within 7 km of the mouth of the Yumurchen. Larger formations are known in the highlands to the south (*c.* 30–40 km) along the Yumurchen (Malyshev 1964; Pobedash & Pavlova 1966). Given that the only samples attributed to this fabric were excavated at *Ust’-Yumurchen,* these latter source regions seem most plausible.

###### 1.2f—Microcline/Magnetite Granite with Rhyolite/Dacite and Grog Fabric

Fabric 1.2f was primarily distinguished by the presence of two discordant materials in relative abundance:

* sub-rounded to sub-angular grains of cryptocrystalline (partly chalcedonic) silica with unidentifiable weathered phenocrysts (identified as rhyolite or dacite);
* angular to sub-angular, predominantly elongate argillaceous inclusions containing a non-diagnostic range of minerals (provisionally identified as grog).

The presence of acid-intermediate volcanic rock fragments, presumably from a sedimentary origin, plausibly ties it to the fabrics of Group 3 (discussed below).

###### 1.3a—Granite/Granodiorite Fabric

Fabric 1.3a was characterised by a mineralogical composition dominated by quartz and plagioclase feldspar with a relative abundance of mafic minerals (principally hornblende, biotite, with some clinopyroxene and rarer pistacite and sphene). The lithology of the sample was between granite and granodiorite: quartz was present as both mono and polycrystalline grains—the latter sufficiently common in most samples to indicate the effects of regional metamorphism within the parent rock. The feldspars were split between plagioclase (*c.* 55–65%) and orthoclase, though occasionally with some microcline (eg, P-USKA087), myrmekite (eg, P-USKA013), or blebby anti-perthite (P-USKA014). Well-formed muscovite was present in a few samples (P-USKA006 & 068) as were small fragments of olivine (P-USKA087), and a heavily weathered mineral tentatively identified as altered tourmaline (P-USKA009 & 062). Few large rock fragments were seen across the group, but those identified were compatible with smaller grains and free inclusions. Some potentially significant variation was observed across the fabric, which might reflect the qualities of different raw material sources.

Granodiorite forms the geological pavement across large parts of the plateau, and without further research, attempts to identify specific provenance were not considered plausible at this stage. The nearest clearly identified formations to *Ust’-Karenga* are exposed between 7 and 9 km from the site (Goloshchukov *et al.* 1971).

###### 1.3b—Biotite Granite/Granodiorite Fabric

Fabric 1.3b had a similar range of felsic inclusions to 1.3a, but a slightly greater proportion of plagioclase. The principal differences were its relatively low density of inclusions, especially in the fine–medium sand fraction, and a narrower range of accessory minerals, dominated by biotite and iron oxide with occasional grains of chlorite. The absolute quantity of biotite was variable across the group, from around 3–15% (compare P-USKA005 & P-USKA092), and it was considered likely that these represented different raw material sources. In the latter case (P-USKA092), biotite was clearly weathering into the clay itself and was sometimes difficult to resolve it from the matrix. In hand-specimen, the presence of abundant biotite was not recognisable. Organic inclusions were noted across the fabric, but were generally few and varied (*c.* 1–2%).

A related sample (P-USKA026) shared characteristics with both 1.3a (in terms of its felsic component) and with Fabric 1.3b in terms of its grain size distribution. More especially it shared the large volume of biotite seen in P-USKA092, which was even greater in P-USKA026 and distinctively fresh and unweathered.

The only comparable samples collected in the field came from weathering deposits at *Ust’-Ugdamiya*. Though no exploitable clays were identified in the immediate vicinity, the similarity in terms of composition and weathering state to P-USKA092 was striking.

###### 2.1a—Granite and Quartz Diorite Fabric

Fabric 2.1a shared a number of textural features with members of Fabric 1.3b (especially P-USKA092) and had a similar mineralogical range to 1.3a. As with other samples it was dominated by quartz and more or less weathered feldspars (primarily plagioclase). In these samples, however, fragments of green hornblende were present both in the coarse and fine fraction alongside numerous oxyhornblende grains (red-brown, strongly pleochroic with anomalous interference colours) (eg, P-USYU018), altered olivine (P-USYU020), and large polyminerallic quartz-diorite rock fragments. Occasional larger agglomerations of clinozoisite (eg, P-USKA048) and mica were also noted.

Although the main fabric seemed to have a strong archaeological connection with *Ust’-Yumurchen*, the known intermediate intrusions (diorite and gabbro-diorite) in the vicinity do not (from their descriptions) provide an obvious match (Pobedash & Pavlova 1966). However, the effects of quartz concentration through weathering and lack of differentiation between diorites and quartz diorites make it difficult to rule out this connection without further comparative samples from the site.

###### 2.1b—Re-deposited Dioritic Fabric

Fabric 2.1b was a more problematic group, straddling the compositional line between the somewhat tautologically named ‘re-deposited residual’ fabrics and the ‘Secondary/Alluvial’ group proper. Its three distinguishing features were: a lower density of fine inclusions, a lesser degree of sorting, and the presence of a significant amount of angular material of various sizes. Like 2.1a the group was essentially composed of plagioclase, quartz, hornblende, and biotite (in order of abundance), with numerous small rock fragments of similar composition, occasional grains of sphene, and rare agglomerations of clinozoisite. P-USKA078 and 058 stood out for their greater density of coarse inclusions and greater volume of weathered biotite.

This group is one of the few in the assemblage for which it is possible to confidently support production in the immediate vicinity of *Ust'-Karenga*. The justification for this is twofold. Firstly there is the very strong similarity with the re-deposited residual samples collected along the Bereya—the only difference being the lack of the largest inclusions in the ceramic (a fact easily explained either by simple clay processing or local sedimentary variations). The second is more direct and relates to the fact that sample P-USKA058 was not a fragment of pottery, but one of a small number of pressed and rolled lumps of clay tossed in to the hearth at the *Ust'-Karenga* X site. Its composition was absolutely identical to P-USKA078. These lumps were the only plausible direct indications of production to come from the site and were associated with material attributed to the Ust’-Yumurchen culture (eg, Vessel/Sample Group number USKA-UY-1). Other samples in the group generally fell between P-USKA078 and P-USKA098 both compositionally and texturally and, in the absence of evidence to the contrary, were assumed to derive from the same source.

###### 2.2—Hornblende Diorite and Devitrified Volcanic (?) Glass Fabric

Fabric 2.2 was one of the most distinctive in the assemblage, and all members of the main microscopic group were identified macroscopically (Macroscopic Group 5). Its principal components were free minerals and rock fragments consisting of plagioclase feldspar and light green to greenish-blue hornblende (with low to moderate birefringence), with clinopyroxene (including various clinopyroxene-hornblende intergrowths), chlorite, muscovite, fine textural features (clay pellets) (eg, P-USKA001), and more rarely, altered olivine (eg, P-USKA046) and orthopyroxene. An important characteristic of this fabric was the almost complete absence of quartz and biotite and the presence (at around 6% of total) of what appeared to be devitrified glassy inclusions with perlitic texture and skeletal mineral inclusions (consistent in composition with the rest of the body). It seems probable that these represent the remains of interstitial glassy areas within the parent rock, though it is possible that they had a related volcanic origin. The group was extremely homogenous in virtually all respects, though P-USYU001 was slightly more dominated by feldspar than the other samples. As a whole, the group was much finer-grained than the residual *granitic* fabrics and its larger grains more commonly rounded. It showed none of the mixing or weathering that was associated with the Secondary/Alluvial fabrics. The freshness of the feldspars and the absence of inconsistent grains (including quartz) were particularly striking. For this reason, it was grouped as a Primary or Residual fabric.

Outcrops of diorite have been found across the plateau, five or six of which are located within 10 km of *Ust’-Karenga*; these are all relatively small (only a few hundred metres across) and discontinuous. They did not seem particularly likely sources for these quartz-free fabrics. Geographically extensive formations of diorite have a more restricted distribution in the Vitim Basin, though they are common along the neighbouring Nercha Basin. The nearest of these significant formations is between 12 and 25 km away to the south-east in the upper reaches of the Bereya creek. Conversely the site of *Ust’-Yumurchen* is less than two kilometres downstream of a moderately large gabbro diorite intrusion. P-USYU001 could plausibly be attributed as local to this site, whereas the Fabric 2.2 samples from Ust’-Karenga were probably non-local.

A related sample (P-VTIM017) from *Ust’-Ashigly* was coarser-grained, and texturally more similar to the residual granitic fabrics. Mineralogically, it was dominated by plagioclase and a small amount of quartz but contained less hornblende and a greater abundance of altered olivine, biotite, and pyroxene, and it was considered to have separate provenance within a more basic igneous formation. However, since the hills behind *Ust’-Ashigly* are composed of diorite with numerous pyroxenite dykes it seems likely, or at least plausible to suggest, that the raw materials used in its production were local to the site (Malyshev 1964).

###### 3.1a and 3.1b—Rhyolite/Dacite Fabrics

Fabric 3.1 was another distinctive Primary/Residual group with geographically restricted associations. The parent rocks from which it was ultimately derived could be confidently described as extrusive or sub-volcanic with a composition between rhyolite and dacite. Composition across the fabric was variable, probably reflecting different raw material sources. However, the fragmentary nature of the rock and the extensive weathering were often a barrier to further identification.

Across the fabric, samples were primarily composed of more or less weathered rock fragments with just a few quartz, plagioclase, and iron oxide inclusions. P-USKA027 was the most similar in granulometry to the other residual groups. P-USKA054 was a little more varied and more sedimentary in character, containing both rounded and angular fragments of rhyolite/dacite, grains of polycrystalline quartz and granitic rock, numerous muscovite and biotite laths, with occasional fine hornblende, pyroxene, and pistacite crystals. P-MOGO-001 was similar, in that it showed a greater degree of transportation, a wider mineralogical range and, in this case, a greater degree of weathering and included a number of weathered dolerite inclusions (rounded), which at first glance appeared to merge with the matrix.

Inclusions within P-USKA011 and 028 (Fabric 3.1b) were initially characterised as fragments of altered phyllite, but upon closer inspection they were determined to be heavily weathered felsic volcanic rock similar to the inclusions seen in P-USKA027 and to the geological sample RIKA 014 (Hommel 2012). Many of the quartz grains in this fabric showed signs of strain, suggesting that the parent rock had seen some physical alteration after it was formed.

The most likely origin for the clays used in the production of Fabric Group 3.1 material from *Ust’-Karenga* is about 30–40 km (geodesic) upstream along the Karenga, just beyond *Ust’-Purani* (which has been identified as a locus of occupation during the later Neolithic), where rocks and sediments related to Jurassic volcanism lie in a band across the uplands on either side of the Basin (Smelovskim *et al.* 1962).

P-MOGO 001 (from *Mongoj I*) probably had a separate, local origin within the Upper Amalat Basin, probably within a large felsic volcanic formation between *Arbazhankit* and *Rossoshino* (the closest edge of which is about 20 km upstream of Ust’-Mongoj).

###### 4.1—Schist/Quartzite Fabric

Fabric 4.1 was distinguished by the abundant metamorphic rock fragments within it, the largest of which could be tentatively described as schist or schistose quartzite. Composed of quartz with more or less weathered foliations of mica and varying degrees of ductile deformation and in a few instances brittle fracture (eg, P-USKA035), these fragments were the dominant phase within all the samples in this Fabric. P-USKA035 and 038 and P-VTIM018, which were all made from fairly typical ‘residual’ clays, were characterised by the relatively fine-grained nature of the schistose fragments and the presence of a number of grains of granitic origin (granodiorite—plagioclase and quartz with some monazite inclusions). It is possible that this sub-grouping is related to 1.3a, though the proportions of metamorphic textured fragments was significantly greater in these samples, and the quantity of mafic inclusions considerably lower.

P-USKA008 and 032 represent a different sub-grouping and had a slightly more sedimentary character, indicated by the presence of a few large rounded grains of microcline granite and dacite and its more silty fabric. The metamorphic fragments were coarser-grained with more obvious foliation (muscovite) and were accompanied by the presence of unidentifiable lumps of extensively sericitised feldspar (?), perhaps indicating some association with hydrothermal activity/mineralisation. It was also noticed that biotite was very rare in these samples. Other mafic minerals (with the exception a few epidote and pyroxene crystals) were entirely absent.

P-USKA010 was finer and perhaps more sedimentary but lacking very fine silt and having a very open-spaced distribution. Its metamorphic component was almost entirely composed of polycrystalline quartz and often showed significant intergranular formation of clay minerals and iron oxide. A large altered and rounded fragment almost entirely degraded, its siliceous crystalline structure only dimly perceptible, probably originates within the same formation and almost certainly provides the source for the reddish textural features and clay pellets, which were noted in the finer fractions. With the exception of a very few silt-sized sphene, biotite, and hornblende grains, mafic minerals were absent.

Given the wide distribution of metamorphic formations in the region, it was expected to be difficult to indicate source locations for this group. P-USKA035 and 038 and P-VTIM018 could perhaps be connected with zones of metamorphism formations immediately local (> 6 km) to their respective findspots (*Ust’-Karenga* & *Ust’-Ashigly*), though for *Ust’-Karenga* at least, the size of these formations was relatively small, and their composition, derived from the local granite, was not likely to be a close match to the material seen in the ceramics. The presence of sericitisation at the extreme level seen in samples P-USKA008 and 032 may prove to be a useful indicator of provenance. Significant zones of sericitisation are often mapped because of their associations with gold mineralisation and other rare metals and rare earths. Interestingly, the nearest (25.5 km north-west of *Ust'-Karenga*) of these zones, in the headwaters of the Ima creek (a minor left-hand tributary of the Vitim) is actually set within a large metamorphic formation and associated with a significant deposit of kaolinite. Further geological exploration and sampling is necessary to test these ideas.

In between Fabrics 4.1 and 4.2 was sample P-USKA018, the only sample of well-packed silty clay to be attributed to a residual origin. All of the material within it was consistent with the weathering and disaggregation of a fine-grained quartzite or meta-siltstone. The predominant mineral phase was quartz with some biotite and muscovite (?) laths and rounded agglomerations of sericite. Also present were occasional silt-sized, well-rounded grains of chalcedonic quartz. The latter were not seen within the resistate rock fragments and were directly associated with large rounded inclusions of shale or clay pellets. It was not clear how significant the latter were in terms of provenance.

###### 4.2—Granite Cataclasite/Mylonite with Mudstone Fabric

Fabric 4.2 was differentiated from the granitic fabrics, with which it otherwise shared many mineralogical features, on the basis of two characteristics which it did not: the abundance within the fabric of rock fragments with cataclastic (brittle-fractured, ground, and strained) textures and the presence of what appeared to range from sub-angular to well-rounded grains of gritty mud/claystone. The former were primarily quartz and made up around one third of the inclusions present. The latter accounted for between 5 and 15% of inclusions. The remainder were a mixture of strained1 microcline granite fragments (quartz, microcline, plagioclase, and orthoclase feldspar, and some orthoclase/albite and microcline/albite perthite [P-USKA020]) and loose monominerallic fragments with the same overall composition attended by some of the usual accessory minerals (which varied in range and abundance between samples). These included:

* P-USKA020 & 039: mafics rare/absent, some sericite agglomerations (silt-size), iron oxides, and hydroxides;
* P-USKA017: few mafics, some biotite (weathered), larger muscovite fragments relatively common;
* P-USKA040: biotite, opaque minerals, and dark green, strongly pleochroic hornblende common, some muscovite, one small spinel.

The granulometric character of this group is typical of the residual groups, though of the three, P-USKA017 is the most sedimentary. Interestingly, it also contains the most mudstone.

On the subject of these ‘mudstones’, it is important to recognise that, though they appear to show bedding structures and, in some cases, slaty cleavage, a few show flow, rather than bedding, and it is possible that the appearance of bedding in the others is a function of their small size. The presence of one clearly identifiable fragment of protomylonite (P-USKA020) with similar optical properties in PPL would tend to support this view, though other indications (eg, the preservation of quartz ‘porphyroclasts’; see Trouw *et al*. 2010, 265–8) do not.

This also applies to related sample P-USKA033, which had a very distinctive composition, derived from the disaggregation of an extensively sericitised cataclastic rock. Related to this were the strained quartz grains, which formed the bulk of the inclusions alongside weathered granitic fragments and the sub-rounded–sub-angular clay rich lumps. This fragment had a slightly sedimentary character, but it seemed this was a result of the process of disaggregation rather than a sign of significant transport. P-USKA033 also contains a high concentration of organic inclusions. This was the only feature it shared with the other related samples P-USKA074 and 075. These, for they were from the same vessel, showed a more plausibly sedimentary face and were dominated by granitic inclusions similar to Fabric Group 1.1b (though with a greater proportion of hornblende and biotite) alongside a series of fragments with mortar texture, or cataclastic ‘matrix’ fragments possibly suggestive of a localised shear zone rather than a large cataclastic formation.

Fault lines craze the plateau, but significant cataclastic and mylonitic formations seem to be relatively few and far between (Fig. 7; grey dotted zones). The nearest to *Ust’-Karenga* is around 15 km northwest along the Vitim, with others 40–50 km to the south and south-east). Major formations have also been described between the *Ust’-Kalakan* and *Ust’-Kalar* and throughout the Tsipa Basin; these sources are all more than 75 km from *Ust’-Karenga*. If the identification of mudstone/shale is correct then the range of possible sources is somewhat more restricted. Possible associations with silty-pelites in Cambrian formations or with cretaceous shales (Fig. 7) can be suggested. However, the level of mapping available and the level of detailed description associated with it precluded any more definite discussion. Further research and fieldwork will be required to resolve these questions.

###### 5.1—Clay-Tempered Weathered Biotite-Rich Gneissose Granite Fabric

This is an unusual, homogenous, semi-coarse fabric, characterised by moderately-/poorly-sorted, open-spaced, silty matrix with poorly-sorted, sub-angular to rounded inclusions derived, predominantly, from the weathering, breakdown, local transport, and re-deposition of medium-grained, biotite-rich, intermediate igneous/metaigneous rocks, composed primarily of more or less sericitised feldspar (predominantly plagioclase, occasionally perthite, and/or orthoclase and microcline), biotite and quartz (poly and monocrystalline) with iron oxide, small hornblende crystals, and more rarely epidote, zircon, and sphene. These minerals were found singly and as part of the larger, rounded, weathered rock fragments. The precise lithology of these fragments was difficult to determine due to the effects of extensive chemical alteration (primarily sericitisation) and mineral replacement. The visible textures were igneous, though the quartz component showed evidence of metamorphic alteration and, occasionally, foliation. The most plausible candidate was therefore a gneissose biotite-rich microgranite. Also present, though rare, were rounded fragments of a weathered cryptocrystalline rock. As with other fabrics with similar inclusions, these were considered to be intrusive and non-local, though the relationship between these compositional elements was not clear. Organic ‘inclusions’ were common in some samples (eg, P-USKA53 & 60), seen as sinuous channels and clusters of regular round/oval voids precisely similar in form and distribution (clustered) to those seen in P-USYU009.

More unusually, two samples in this group (P-USKA077 & 081) showed evidence of clay mixing: ptygmatic textures in the matrix composed of a finer clay with noticeably less weathered inclusions. However, its limited distribution even within this group did not support the idea of an intentional technological practice. It seems more probable that, like Fabric 2.1b, this is a reflection and a reminder of the potential proximity in the real world of what we have defined and divided as ‘transported residual’ and ‘detrital’. A relatively close match for the biotite-rich rocks in this fabric was found in the weathered sediments collected below *Ust’-Bugarikhta* (see Fig. 7), though as was noted in the discussion of Fabric 1.3b, biotite granites are relatively common across the plateau.

Fine and Sandy: The Secondary/Alluvial Superfabric

###### 6.1a—Alluvial Silt and Granitic Sand A Fabric

Fabric 6.1a is a well-packed, silty fabric with around 30% mineral inclusions and 3–8% voids, mostly burnt-out organics. Variation was generally minor and appeared to be quite specific to individual sites. For example, samples from *Ust’-Yumurchen* were characterised by an abundance of fine mica laths, slightly coarser silt inclusions, and slightly more sand than either the ceramics or raw materials samples from *Ust’-Karenga*.

Fabric 6.1a samples from *Ust’-Karenga* were an extremely good match for the local raw materials samples and may have had immediately local origin—although without wider samples to explore variation in alluvial clays across the plateau it is difficult to be more confident.

###### 6.1b—Alluvial Silt and Granitic Sand B Fabric

Fabric 6.1b differed from 6.1a only in the density of coarse inclusions and the degree of mineral weathering, both of which were significantly greater. This is a heterogeneous group of samples that were distinctive in various ways, but closer to each other than to any of their potential ‘relatives’. It included:

* P-VTIM002: occasional bright red altered olivine crystals distributed across the matrix, similar to those seen in the basaltic sand fabric (6.3).
* P-USKA061 and P-USKA097: numerous silt-sized grains of clinozoisite with a few larger fragments of pyroxene. In P-USKA061, one large, heavily-weathered, and well-rounded fragment of rhyolite or dacite was also noted.
* P-MOGO-001 and P-USKA084: rich in orthoclase/albite perthite with a proportionally greater abundance of muscovite mica. In P-USKA084, a number of large anorthic nodules and quartzite grains with cataclastic texture were identified.

###### 6.1c—Alluvial Silt and Granitic Sand C Fabric

Fabric 6.1c was differentiated from the other fabrics in this broad group on lithological grounds, though larger average grain size was characteristic of P-USKA104 and P-VTIM015 and 016. The defining characteristics of the group were the high proportion of plagioclase feldspar in the sand-sized fraction and the high proportion of biotite in the silt. P-USKA104 was notable for its finer silty fraction and the greater angularity of its larger grains. P-VTIM015 contained one very coarse grain of granodiorite (which was the overall composition of the coarse fraction in this fabric) and a large amount of oxyhornblende and biotite with extreme pleochroism and anomalous interference. It shared the latter characteristic with P-VTIM019. P-VTIM016 contains much more abundant hornblende grains than the other samples in this group and is sufficiently ‘dioritic’ to justify a comparison with Fabric 2.1b, to which it is probably related (P-VTIM009 in particular). P-UKND 002 was considerably coarser than the rest of the group, and contained a number of very large, almost spherical inclusions of plagioclase feldspar.

###### 6.1d—Alluvial Silt and Granitic Sand D Fabric

Fabric 6.1d was distinguished by a lower density of silt inclusions and significantly lower abundance of hornblende and biotite within it. P-USBU 001 contained a small fragment of felsic hypabyssal igneous rock with a doleritic texture and an unusual number of large, iron-enriched spherical textural features (anorthic nodules). This was also the case for P-VTIM10, though they were smaller and denser in this fragment. P-USKA111 was notable for the significant secondary (?) deposits of iron within its matrix and for the presence of a number of bright red inclusions, which are visually similar to altered olivine, but lacking relief and pleochroism. Similar inclusions were noticed in only one other sample (P-USKA024) and were found, under the SEM, to be clay pellets rich in iron and potassium.

Although it was difficult to suggest any geographical provenance for the fabric, it was interesting to note that felsic hypabyssal rocks identical to the grain seen in the ceramic sample from *Ust’-Bugarikhta* (P-USBU 001) were collected from the cliffs around the confluence during geological sampling.

P-USKA066 is distinguished by a slightly greater abundance of silt but was quite similar, texturally, to 6.2, though it lacks abundant organic inclusions. Another fine-grained, felsic sub-volcanic rock fragment was noted in this fabric, though it does not display the pronounced doleritic texture seen in P-USBU 001.

*6.2—Fine Alluvial Silt, Coarse Sand and Organics Fabric*

Group 6.2 was very similar to 6.1a and was distinguished on the basis of three ­­­criteria. The first was the finer grade of silt, which was the norm across the fabric; the second was the presence of relatively few, but coarse or very coarse and well-rounded inclusions; the third was the presence of an unusually large number of organic inclusions with a relatively consistent character.

Mineralogically, the core of the group (P-USKA065, 085, 089, 091) was essentially similar to 6.1a and though the outliers showed some similarities with members of 6.1c and 6.1d, the correspondence between dense fine silt, coarse sand, and organics was not encountered elsewhere, either in the ceramics or in the raw materials samples and was considered sufficiently distinctive to justify the subdivision. Variation was primarily located in the coarse fraction, though some difference in the abundance or density of silt was observed and range of variation across the group ran from P-VTIM020 to P-USKA070. As for Fabric 6.1a it is tempting to assume that many of these samples were made from materials local to *Ust’-Karenga*.

Minor compositional differences distinguished two samples from the core group. P-USKA063, which contained an unusual quantity of clinopyroxene and hornblende and a huge, well-rounded monocrystalline plagioclase inclusion (*c.* 6 mm). A similar fragment, though somewhat larger and more angular, was also identified in P-VTIM020. This sample was slightly less fine and slightly richer in hornblende, pyroxene, and plagioclase than the main group and showed some similarity with 6.1c. P-USKA070 was mineralogically similar to the rest of the group, but characterised by abundant and extremely fine silt inclusions.

###### 6.3—Alluvial Silt and Basaltic Sand Fabric

This fabric is a more heterogeneous variant of 6.1a, distinguished by the presence of basalt grains. Variation in apparent texture is partly attributable to firing. In other respects, this moderately well-packed, silty clay fabric has a similar range of inclusions to 6.1b.

P-UKND 001 has fewer unweathered plagioclase and a significant amount (*c.* 1% of total) of altered olivine in the matrix, both as monocrystalline fragments and as part of medium-grained basalt lumps. IP-VTIM003 contained fewer hornblende grains and was generally more sandy (*c.* 15% sand including four coarse grains identifiable as basalt). In this specimen, the basalt was noticeably richer in iron and displayed a much finer grain-size. A related sample (P-VTIM014) was similar to UKND 001 but less densely silty and characterised by the presence of clay pellets (showing particle alignment) together with well-rounded grains of volcanic glass. Sample P-USKA080 was also less densely silty and contained a greater quantity of well-rounded, well-sorted sand grains (potentially added temper?) alongside more angular grains of basalt, microcrystalline quartzite, and plagioclase feldspar.

In samples from *Romanovka* (P-VTIM014), *Ust’-Kholoj* (P-VTIM003), and *Ust’-Konda* (P-UKND 001) the presence of basalt can be regarded as an indication of a broadly local origin within the Vitim Volcanic Field. The situation was rather different for P-USKA080 since the nearest basalt outcrops to the site are more than 50 km to the north-northeast or 150 km to the southwest.

###### 6.4—Alluvial Silt and Dacite Sand Fabric

Fabric 6.4 (P-USYU016) was a very distinctive fabric similar to 6.1a, but dominated by large sub-angular–sub-rounded grains of dacite. Felsic volcanic rocks, though exotic to *Ust’-Karenga,* are relatively abundant in the area around *Ust’-Yumurchen* and were ascribed a local origin for samples in this region. In addition to the dominant inclusions were fine/medium sand-sized monominerallic grains of quartz, plagioclase feldspar, and sphene. Grains of other fine-grained igneous rocks (difficult to identify with confidence due to their size and state of weathering) and a number of fragmented, fibrous spherulites—displaying pseudo-uniaxial extinction—were also noted.

###### 7.1—Fine, Diorite Sand Tempered Fabric

P-VTIM025 was distinctive and the only sample in the assemblage to display clear evidence of intentional mineral tempering. The matrix was fine and virtually free from the silt inclusions characteristic of the other detrital clays. The matrix texture was closest to P-USKA071 (thought to be related to 1.1c) with fine, well-rounded sand inclusions, displaying moderate to high sphericity. These inclusions were similar to the alluvial terrace sediments at *Ust’-Karenga* in granulometry, though not in mineralogy, and had a decidedly ‘transported’ appearance (high-energy, short distance). The dominant phases were quartz, plagioclase feldspar, and hornblende with some small grains of muscovite and iron oxide. Organic inclusions were indicated in the form of some of the voids, but these were few and varied in character.

Endnotes

1 Only the quartz showed undulose/stepped extinction. Feldspars showed no signs of strain. This is typical of many cataclastic rocks; though quartz is more stable and less prone to weathering, it is very susceptible to deformation in metamorphic conditions (Trouw *et al.* 2010).

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