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Earth pigments and magnificent Stone Age burials on the shores of Lake Burtnieks

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Keywords

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Abstract

This study aims to investigate the availability of earth pigments in the Lake Burtnieks area in Latvia and to analyse the use and symbolic significance of ochre during the Stone Age.
Within the study, potential earth pigment samples were collected during the survey. These samples were analysed by laboratory methods — X-ray powder diffraction (XRD) and X-ray fluorescence (XRF) spectroscopy — and compared to ochre samples obtained from archaeological contexts (the Riņņukalns settlement and Zvejnieki archaeological complex). The use of ochre during the Stone Age was characterised by analysing the archaeological context, specifically focusing on the Zvejnieki burial ground.
The results of this study reveal a great variety of ochre use in the burial traditions of the Zvejnieki cemetery. Furthermore, significant chronological differences in the use of ochre in the burials were distinguished. From an ethnographic and folkloric perspective, it is likely that ochre, with its red colour, had a deep symbolic value and was an integral part of the burial process.
Chemical and mineralogical analysis shows that although ferric sediments are widespread in the surroundings of Lake Burtnieks, none of the samples collected corresponded to those from the archaeological context. However, significant similarities between archaeological samples from Zvejnieki and Riņņukalns were identified.

Introduction

Ochre is an earth pigment which consists of iron oxides in combination with clay and carbonate minerals as well as organic matter. The colour of this pigment can range from violet and red to brown, yellow, green, blue and black. Ochre, depending on its colour, consists of different primary minerals, such as goethite (FeO(OH)) and hematite (Fe_2O_3) minerals, the first giving ochre a yellow shade and the second a red shade.

In nature, ferric earth pigments form in boggy areas and places where groundwater seeps out of the ground. They are found in association with freshwater limestone under the topsoil or directly on the ground surface (Fig. 1).

Ethnographic data indicates that ochre served multiple practical purposes, including as an antiseptic compound, a cosmetic product, a paint, and also for embalming the deceased. Researchers emphasise that ochre, especially red ochre, had a deeply symbolic meaning, as it was used in funerary rites and similar activities (Bower 2003; Vianello 2004; Wynn et al. 2024).

Archaeological research in the eastern Baltic has yielded a large amount of information regarding the use and significance of ochre during the Stone Age. In this area, traces of ochre have been found in Mesolithic and Neolithic settlements and cemeteries, such as Spiginas and Duonkalnis in Lithuania, Ģipka, Zvejnieki and Riņņukalns in Latvia,

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Figure 1. Spring with ferric sediments near Līdaciņas settlement (photograph by I. Zagorska).

and Valma, Koljala, Koonu in Estonia (Jaanits et al. 1982; Zagorskis 1987; Butrimas 2004; 2012; Loze 2006).

One of the regions in the eastern Baltic where evidence of a wide use of ochre by the Stone Age communities has been identified is in the vicinity of Lake Burtnieks. Archaeological data indicates that in this region, ochre was prepared and used as a pigment for colouring (Riņņukalns settlement) as well as richly used in burial rites (Zvejnieki burial ground) (Zagorskis 1987; Bērziņš 2018; Spataro et al. 2021). Furthermore, several geological studies indicate that this region is rich in earth pigments, which suggests preparation and usage of local raw material by the Stone Age communities (Grewingk 1889; Mellis 1938; Kuršs and Stinkule 1997; Kokins and Kostjukovs 2017; Kokins 2020). This makes the region of Lake Burtnieks one of the most promising for the study of the raw materials and their use by the Stone Age peoples. Thus, the aim of this study is to determine the availability of earth pigments in the Lake Burtnieks area, and the use and symbolic significance of ochre during the Stone Age.

To achieve this aim, several methods will be applied: analysis of archaeological material where ochre has been found and survey of the earth pigments in the vicinity of Lake Burtnieks, as well as chemical analysis — XRF and XRD (discussed in detail in the 'Material and methods' section).

1. Obtaining raw materials: survey of the earth pigment deposits

Based on geological studies and reports from locals, earth pigment deposits can be found quite close to Stone Age sites. Earth pigments including limonite have been recorded in several locations near the River Salaca's outflow from Lake Burtnieks, where at least three Neolithic settlements have been identified: Riņņukalns, Kaulēnkalns and Līdaciņas.

The closest deposits to the Zvejnieki archaeological complex and Riņņukalns settlement, are reported to be on the northwestern shore of Lake Burtnieks, ca. 2 km from the mouth of the River Seda, as well as at two locations on the opposite shore of the lake, downhill from the manors of Bauņi and Mīlīši (Mellis 1938; reported by local researcher L. Liepnieks to Ilga Zagorska in the 1980s).

Notably, earth pigment deposits have been located in the vicinity of Staicele city and an inlet of the River Salaca into the Baltic Sea (Mellis 1938; Kokins and Kostjukovs 2017; Kokins et al. 2018) — a possible waterway used by the Stone Age communities to reach the Baltic. Thus, it is likely that earth pigments were also collected in these areas mentioned.

Unfortunately, for the majority of the deposits, located during the previous geological research, no precise

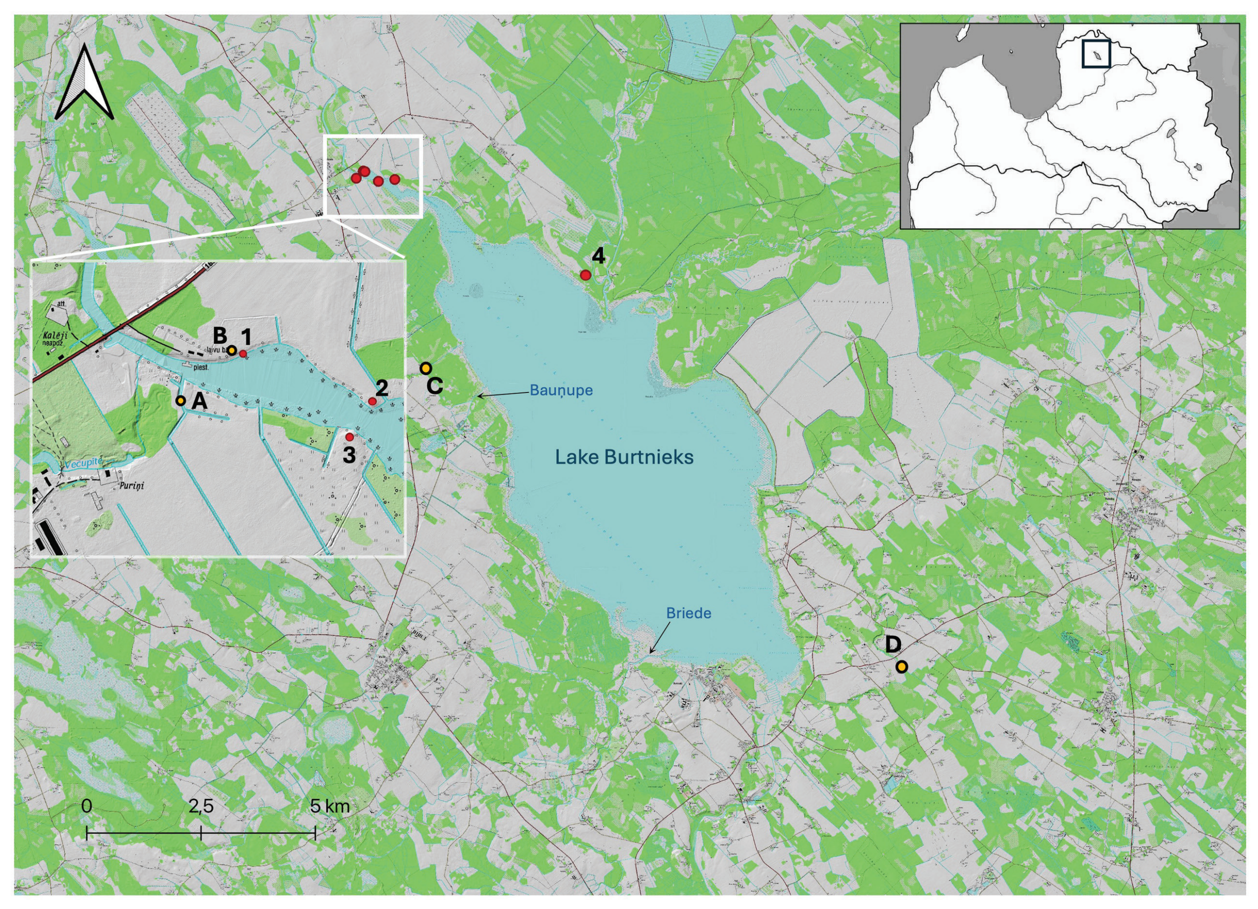

Figure 2. Location of the archaeological sites mentioned (in red, 1. Līdaciņas; 2. Kaulēnkalns; 3. Riņņukalns; 4 . Zvejnieki) and samples collected during the survey (in yellow/black, A — RIN, RIN2; B — VEC1, VEC2; C — OZO1; D — DUR1, DUR2) (Map: LVM GEO Topographic map 1:10 000 with relief shadowing, created with QGIS by V. Haferberga).

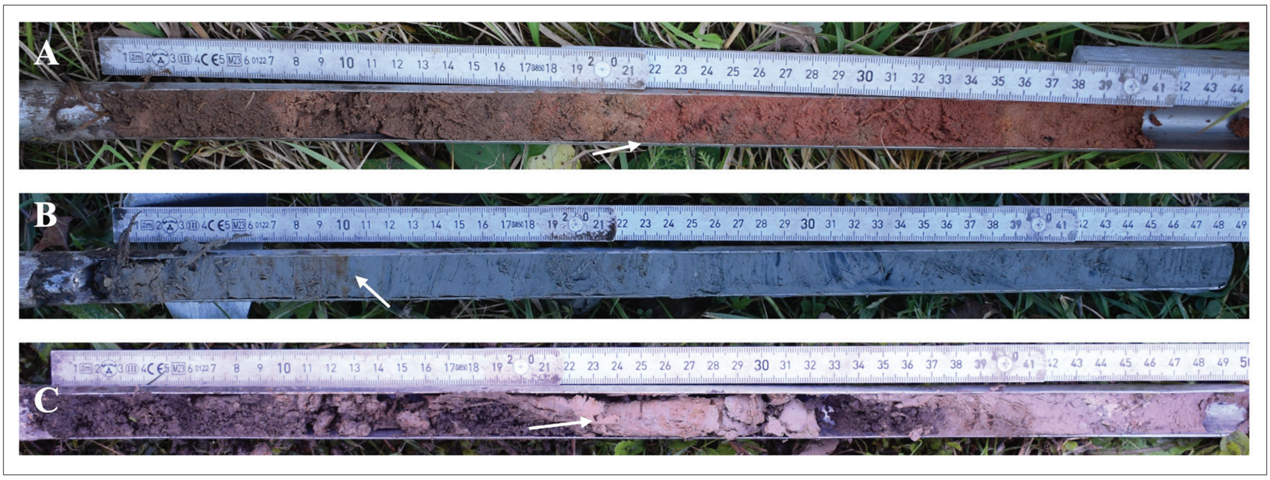

Figure 3. Drillings with possible iron-rich sediments (white arrow) in the soil (photograph by V. Haferberga).

Table 1. Information of the samples collected during the survey.

No.	Sample	Coordinates	Description	Sample Type
1	DUR1	57.699062, 25.344757	Drilling: red, possibly iron-rich soil under the topsoil	Iron-rich sand
2	DUR2	57.699118, 25.344378	Drilling: red, possibly iron-rich soil under the topsoil	Iron-rich sand
3	OZO1	57.757276, 25.170626	Outcrop on the shore of the River Ozoliņupīte: pieces of orange-ish iron-rich soil in the outcrop	Iron-rich silty soil
4	RIN	57.794443, 25.145086	Drilling: clay with orange-ish inclusions (sediments from iron-rich water?), deeper only bluish grey clay	Clay
5	RIN2	57.794443, 25.145086	Outcrop in the culvert: muddy soil mixed with reeds on which ferric sediments were observed	Mud and reeds with ferric sediments
6	VEC1	57.795522, 25.146985	Reeds with ferric residues	Reeds with ferric sediments
7	VEC2	57.795735, 25.148282	Drilling: under topsoil dark brown clayey silt, afterwards light grey silt with orange-ish ferric inclusions	Silt with inclusions of ferric sediments

location were given, thus, in autumn of 2024 a survey was conducted in order to identify and gather earth pigment samples.

Based on the previously mentioned information, several areas were selected for surveying earth pigment deposits, namely the surroundings of Mīlītes village, both shores of the mouth of the Salaca River, and the shores of the Bauņupe, Briede and Mellupe (also known as Dūre) Rivers (Fig. 2).

Locals encountered during the survey emphasised that the bodies of water (rivers and Lake Burtnieks) have a high concentration of iron. They reported that using water from these bodies daily creates a large number of ferric sediments.

During the survey, no traces of iron-rich sediments were found on the shores of the Bauņupe and Briede Rivers. Although red sand (likely rich in iron) was observed in the vicinity of Mellupe (samples DUR1 and DUR2), no direct traces of earth pigment deposits were identified (Fig. 3.A).

However, traces of ferric sediment (possibly earth pigment) were found on both sides of the mouth of the Salaca River into Lake Burtnieks. This was particularly evident in the culvert (samples RIN and RIN2) on the left bank, where inclusions of iron-rich sediments in blue-grey clay were observed (Fig. 3.B). Such sediments were also identified on the reeds on the right bank of the river (sample VEC1). Drilling on the opposite bank revealed iron-rich sediment inclusions in the silt (sample VEC2) (Fig. 3.C).

On the left bank of the Ozoliņupīte River, near the village of Mīlītes, an orange-coloured, iron-rich silty soil, possibly earth pigment was identified (sample OZO1) (Fig. 4). This consisted of multiple substantial inclusions in the soil and was not in a uniform layer. Although reported, no limonite or other such earth pigment was observed in the Mīlītes area during the survey. A local in Mīlītes confirmed that no deposits resembling limonite were found during construction works in the surroundings of her property. Overall, this result does not indicate the complete absence of earth pigment deposits in this area.

During the survey, a total of seven samples were collected for further analysis (Table 1).

2. Material and methods

Three types of sources were analysed within this study: soil samples collected during the survey and ochre found at the archaeological sites from both settlement and burial contexts.

Three ochre samples from the Riņņukalns and Zvejnieki archaeological sites were selected for analysis. The Riņņukalns samples (RIN40 and RIN342) were collected during archaeological excavations in 2017 and 2018 (led by Valdis Bērziņš). These samples were found within the cultural layer and were not associated with the burials found during these excavations (Bērziņš 2018; 2020). Both samples were brown in colour (Munsell: 7.5YR 4/4 and 7.5YR 5/4) and consisted of a very fine powder.

An ochre sample from Zvejnieki (sample ZV) archaeological complex was collected during the excavations in 2005 (led by Ilga Zagorska). This sample is likely to be associated with a ruined grave as ochre in this site was only found in the context of burials (Zagorska 2006; Rudoviča et al. 2007). In terms of texture, this sample is similar to the Riņņukalns ones, but much brighter in colour (red) (Munsell: 10R 4/8). Unfortunately, ochre samples from Zvejnieki burial ground, with a few exceptions, were not collected during the excavations and thus are not available for analysis.

The surveyed raw materials were of a different nature: some were found in the soil during drilling (DUR1,

Figure 4. Iron-rich sediments (orange soil) in the outcrop of the Ozoliņupīte River (photograph by V. Haferberga).

DUR2, VEC2), others were found in outcrops (OZO1 and RIN2) and as ferric sediments on reeds (VEC1 and RIN).

Three samples (DUR1, DUR2 and OZO1) seemed the most promising to be identified as earth pigment. OZO1 can be characterised as a brownish-yellow, iron-rich silty soil (Munsell — 10YR 6/8). After firing at 400°C, this sample turned dark red (2.5YR 3/6) and strongly resembled the ochre found at Stone Age sites. Samples DUR1 and DUR2 consist of iron-rich, fine-to-medium coarse sand of a reddish-yellow colour (7.5YR 6/6). After firing sample DUR2 at 400°C, it turned red (2.5YR 5/8); however, its texture did not resemble the ochre found in archaeological contexts.

Overall, seven samples were further analysed in this study (Table 2).

Two laboratory methods were used to determine chemical and mineralogical composition of the ochre and raw materials: XRD and wavelength dispersive XRF.

For XRD analysis, samples were ground into a uniform powder and analysed using a Bruker D8 Discover Powder X-ray diffractometer. Phase composition was identified using the ICDD PDF-2 2021 database within the Bruker EVA 6.0 software. Quantification of the identified phases was performed using Rietveld refinement in Profex 5.0 software (Doebelin and Kleeberg 2015; Louër 2017).

Conversely, for XRF, samples in both powder and solid form were analysed, as for some of the samples it was not possible to create a powder. Samples were analysed with a Bruker S8 Tiger spectrometer. The radiation size of the sample holder was dependant on the size of the sample: for smaller samples (reeds) it was 8 mm, and for powdered samples 34 mm. Powdered samples were put on a polypropylene film (with a thickness of 5 μm). Full analysis in a helium atmosphere was conducted to determine the concentration of the heavy elements in their oxide form. For each sample, one measurement was conducted, and obtained concentration values were normalised.

Due to the quality of the samples, some of them (DUR1, RIN and VEC2) could not be analysed using these methods. These samples contained a small number of iron-rich sediments and were too mixed with the dominant soil and therefore impure. Similarly, due to their structure, i.e. reeds and muddy soil, it was impossible to analyse samples RIN2 and VEC1 and VEC2 using XRD, despite them being rich in ferric sediments. Sample DUR1 was not analysed by either XRD or XRF as it was identical to sample DUR2.

Thus, five samples (RIN40, RIN342, OZO1, DUR2 and ZV) were analysed using XRD; however, seven samples were analysed using XRF (including samples RIN and VEC1). One sample (OZO1) was analysed twice using XRD, once unfired and once fired, to determine whether its mineralogical composition contains goethite, hematite or other key minerals, which could help to confirm whether it can be considered to be ochre (Upīte 1987; Elias et al. 2006).

3. Results of the chemical and mineralogical analysis

3.1. Chemical composition of soil samples and ochre

The results of the XRF show that the samples analysed are not uniform in terms of their chemical composition and contain different concentrations of the elements detected (Table 3).

Table 2. List of the samples analysed (XRF — X-ray fluorescence spectroscopy; XRD — X-ray powder diffraction spectroscopy; RR — Rietveld refinement).

No.	Sample	Context	Analysis Conducted	Notes
1	DUR2	Surveyed sample	XRF, XRD, RR	
2	OZO1	Surveyed sample	XRF, XRD, RR	XRD was also conducted on this sample after firing it at 400°C (name — Ozo400°C), however, no RR was conducted on this sample
3	RIN	Surveyed sample	XRF	Due to the sample type (sediments on reed) it was impossible to conduct XRD
4	RIN40	Riņņukalns settlement	XRF, XRD, RR	Name in XRD analysis — 40
5	RIN342	Riņņukalns settlement	XRF, XRD, RR	Name in XRD analysis — 342
6	VEC1	Surveyed sample	XRF	Due to the sample type (sediments on reed) it was impossible to conduct XRD
7	ZV	Zvejnieki site	XRF, XRD	Name in XRD analysis — zvejnieki

Table 3. Concentration of the elements in the form of oxides in the samples identified by XRF.

Element, %/Sample	DUR2	OZO1	RIN	RIN40	RIN342	VEC1	ZV
SiO_2	67.3	46.7	29.6	1.2	2.4	27.7	22.0
Fe_2O_3	6.2	38.7	48.7	76.4	51.1	24.6	36.7
CaO	0.7	2.4	10.4	17.4	33.5	14.5	18.0
Al_2O_3	17.3	6.6	5.0	0.2	0.5	2.3	5.0
K_2O	4.8	2.6	1.9	-	0.3	1.5	2.1
P_2O_5	0.3	0.8	1.1	3.6	10.8	18.0	0.4
MgO	2.0	0.6	1.6	0.8	0.7	2.6	8.3
MnO	-	-	0.3	0.2	0.2	0.3	-
TiO_2	0.9	0.2	0.4	-	-	-	0.2
BaO	-	-	0.2	-	0.2	-	-

The majority of samples had a high concentration of silicon, especially the surveyed samples DUR2 and OZO1. Notably, in both samples from the Riņņukalns settlement (RIN40, RIN342) the concentration of this element did not exceed 2%.

The data shows that the highest concentration of iron was seen in the ochre samples from the Riņņukalns settlement (RIN40, 342), reaching up to 76%, while ochre found at the Zvejnieki site had a much smaller concentration of this element, reaching up to 37%. Of the samples collected during the survey, only two (OZO1 and RIN) had a significant iron concentration, reaching up to 49%.

Three samples from the Stone Age sites contain a high amount of calcium, reaching as high as 34%. Quite a high concentration of this element was identified in two raw material samples (RIN and VEC1) while in the samples DUR2 and OZO1 the concentration of calcium was significantly smaller.

In the majority of samples, aluminium did not exceed a concentration of 7%. Furthermore, in both ochre samples from the Riņņukalns settlement, it did not reach more than 0.5%, while in the sample DUR2 the aluminium concentration reached 17%. This is the only sample with such a high concentration. A similar situation is seen with the concentration of phosphorus, whereby in sample VEC1 the concentration of this element reaches up to 18%. Quite a high amount of phosphorus is seen in one of the Riņņukalns samples (RIN342), reaching 11%, whereas in the rest of the samples analysed this element did not exceed 4%.

The concentration of magnesium in all the samples, except the one from Zvejnieki, did not exceed 3%. In the case of the sample ZV, the concentration of this element reached 8%. Manganese was identified in small concentrations in all of the samples, except for DUR2 and OZO1. It is worth noting that in the sample ZV the manganese concentration did not exceed 0.06%.

In turn, potassium was absent in only the Riņņukalns settlement sample RIN40. Notably, sample RIN342 contained a small concentration of this element. The highest concentration of potassium was observed in two raw material samples (DUR2 and OZO1) where it reached 5% and 3%, respectively.

Lastly, titanium was recorded in all the raw material samples and the sample from the Zvejnieki site, while barium was identified in only two samples (RIN and RIN342). Both samples show similar concentration levels.

3.2. Mineralogical composition of soil samples and ochre

The results of the XRD analysis show clear mineralogical distinctions between the archaeological samples and the ones obtained during the survey (Fig. 5).

Two of the raw material samples (DUR2, OZO1) from the survey contain quartz, feldspars (anorthite or microcline) and mica (muscovite). However, unlike OZO1, sample DUR2 contains kaolinite. Notably, there are no significant differences in the mineralogical composition of the sample OZO1 in its fired and unfired states, i.e. no traces of hematite were identified after firing. This indicates that this sample is simply iron-rich soil which could be used as a general pigment (iron oxide pigment) but is not identifiable as ochre based on its mineralogical composition (Fuller 1988).

Samples from the archaeological context are also diverse. Although both Riņņukalns samples contain calcite, hematite and maghemite, as well as hydroxylapatite, sample RIN342 also contains quartz and muscovite. The Zvejnieki sample has quite a different mineralogical composition, consisting of quartz, muscovite, microcline, hematite and dolomite.

Rietveld refinement from XRD measurements reveals clear differences in the amount and type of minerals from surveyed and archaeological samples (Table 4; Appendix A).

Neither of the surveyed samples contained any particles of hematite or maghemite (both indicators of ochre pigment). Samples DUR2 and OZO1 both have a high amount of quartz particles (0.557 and 0.672, respectively), however, there are differences in values of other minerals in these samples. For example, muscovite is much higher in the DUR2 sample (0.314) than in OZO1 (0.057), while microcline mass particles are higher in sample OZO1 (0.16).

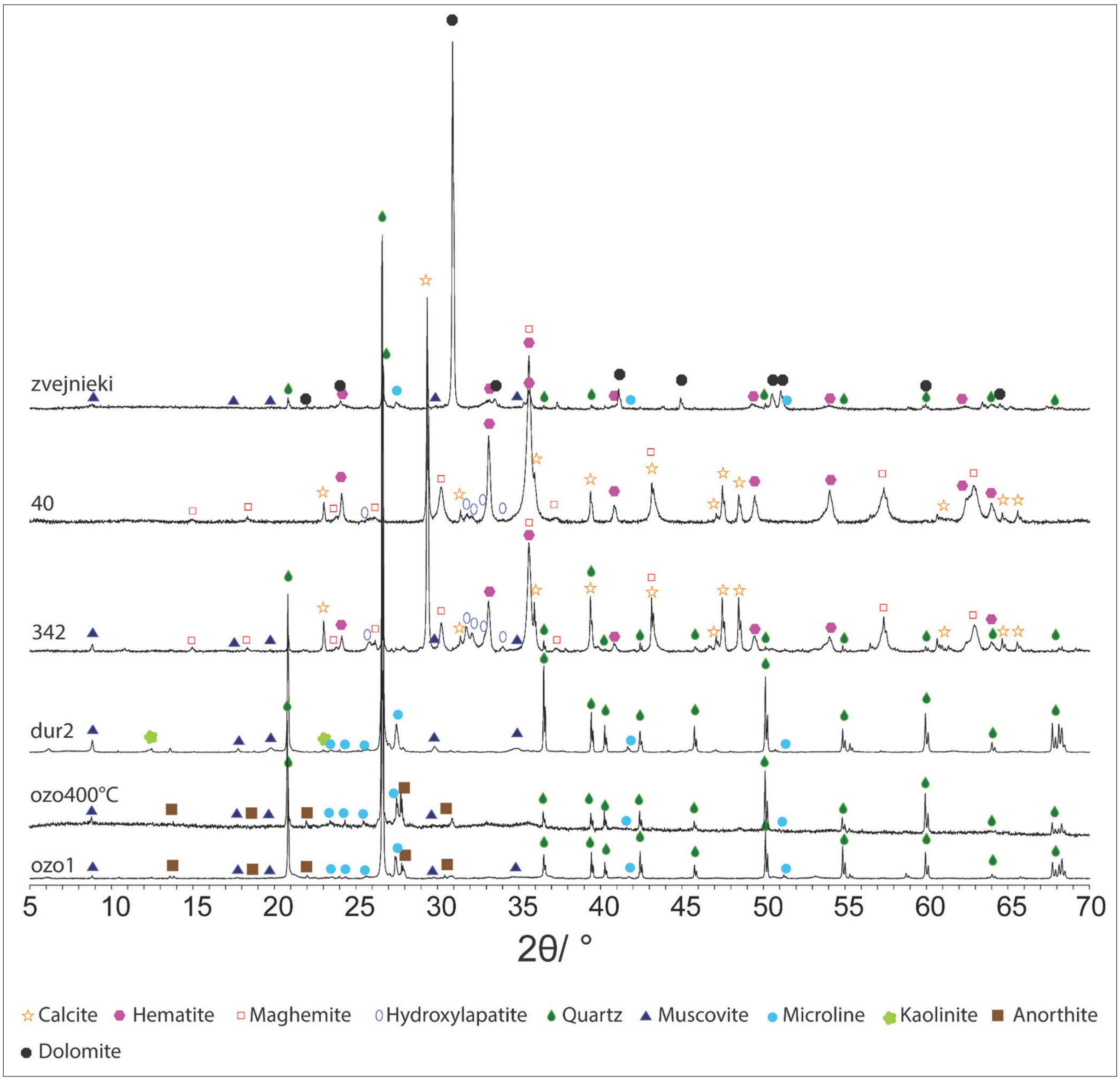

Figure 5. Diffractogram of the XRD results (created by A. Kons).

Table 4. Results of the Rietveld refinement.

Mineral, m/Sample	DUR2	OZO1	RIN40	RIN342
Quartz	0.557±0.008	0.672±0.010	-	0.082±0.001
Muscovite	0.314±0.010	0.057±0.010	-	0.057±0.004
Kaolinite	0.055±0.002	-	-	-
Microcline	0.074±0.003	0.16±0.01	-	-
Anorthite	-	0.111±0.006	-	-
Calcite	-	-	0.251±0.004	0.390±0.003
Hematite	-	-	0.211±0.003	0.117±0.002
Maghemite	-	-	0.449±0.004	0.198±0.002
Hydroxylapatite	-	-	0.089±0.002	0.156±0.002

The Riņņukalns settlement samples have quite a high amount of maghemite (0.449 and 0.198, respectively) and hematite (0.211 and 0.117). Notably, maghemite is much more abundant in these samples than hematite, especially in sample RIN40.

3.3. Correlation between chemical and mineralogical composition of samples

Overall, the chemical and mineralogical compositions of the samples analysed in this study are consistent. An exception is sample OZO1, which includes the fired sample. Mineralogically, there is no explanation for the high iron concentration in this sample. Although some of the minerals identified in the sample might contain iron oxide inclusions (e.g. quartz, muscovite and microcline), these do not lead to a significant iron oxide concentration.

The high concentration of aluminium in the sample DUR2 can be explained by the kaolinite recorded during the XRD analysis, as it consists mainly of aluminium silicate minerals (Deer et al. 1992). High calcium concentrations (and calcite and hydroxylapatite minerals) identified in the Riņņukalns samples can be explained by the archaeological context of the settlement, i.e. thick midden layers containing a large amount of mussel shells, fish bones and other such materials, as well as other additives of animal origin (Bērziņš et al. 2014; Brinker et al. 2020; Kleijne et al. 2024), with calcite being attributed to the mussel shells, while hydroxylapatite is a constituent of mature bones and teeth (Ulian et al. 2021; Lolas et al. 2023).

It is noteworthy that the XRD results show that in sample RIN40 no traces of quartz mineral have been identified, whereas sample RIN342 shows small traces of quartz and muscovite minerals (for more detail, see the previous section 'Mineralogical composition of soil samples and ochre'). This is also confirmed by XRF analysis, which shows a small concentration of silicon in both samples. This could be explained by the purity and mineralogy of these ochre samples. Although rare, ochres with low silicone (quartz mineral) have been observed in other regions (Elias et al. 2006, p. 79). The large concentration of calcium in sample ZV can be explained by the dolomite mineral identified in this sample. Lastly, in all archaeological samples, the high iron concentration can be attributed to the maghemite and hematite minerals identified.

Comparing the Zvejnieki sample analysed in this study with those analysed by Astra Upīte in the 1980s, it becomes apparent that only one sample (from burial no. 132) contains dolomite and hematite, just like sample ZV (Upīte 1987, p. 118). However, the former also contains clay minerals not found in sample ZV, such as illite and kaolinite. This indicates that the ochre found in burial no. 132 was not as pure as the other samples studied, which consisted of quartz and hematite and no other minerals. Notably, this sample contains a small amount of iron just like the ones from Riņņukalns. Unfortunately, in the case of sample ZV, it is unclear whether it was intentionally mixed with kaolinite and prepared for future funerary activities or was already used in the burial process.

In 2008, another ochre sample from the Zvejnieki burial ground was analysed by Prof. Andris Actiņš (ordered by Ilga Zagorska; Appendix B). The XRD results of this sample differ from the others as, alongside hematite and quartz, minerals like calcite, maghemite and feldspar were identified. Apparently, this sample is mineralogically more similar to ones found at the Riņņukalns settlement.

4. Use of ochre in archaeological sites of Lake Burtnieks

Ochre has so far been identified in two archaeological sites in Lake Burtnieks — the Riņņukalns settlement (Middle Neolithic, 4100–2900 cal BC) and the Zvejnieki archaeological complex (Middle Mesolithic to Middle Neolithic, 8300–2900 cal BC).

As previously stated, the ochre identified in the Riņņukalns settlement was not associated with any burials but was found in a household context. Studies (Bērziņš 2018; 2020; Spataro et al. 2021) show that inhabitants of Riņņukalns processed ochre (indicated by ochre layers and stones with residues of this pigment) and stored it in clay vessels which were also painted with it, whereas in the Zvejnieki archaeological complex, ochre was solely used in funerary rites.

4.1. Stone Age ochre graves in the Zvejnieki burial ground

During the Stone Age, the area of the Zvejnieki archaeological complex was an island, while nowadays it is a ridge consisting of light sand and gravel. Due to the light colour of the bedrock, burials were easily identifiable (Eberhards 2006; Kalniņa 2006). The ochred graves were distributed all over the territory of the burial ground.

In Zvejnieki burial ground, out of 330 graves discovered, ochre was found in 164 (Zagorskis 1987; 2004; Zagorska 2008; Larsson et al. 2017). The characteristics of graves containing ochre were not uniform. Some of the burials were fully covered with dense ochre layers, especially the graves of children (Fig. 6.A). The colour of ochre in these graves varied from dark red to violet. In some of the graves, ochre layers were rather moderate or even thin. Here, the colour of the ochre was mostly red. Notably, in these burials ochre was placed in specific areas — head (dominant), elbows, knees or feet of the deceased. In separate cases in these areas, grave goods were found. All the graves which contained ochre were rich in finds, such as bone, stone and flint tools, amber jewellery and especially animal tooth pendants (Zagorska and Lõugas 2000; Macāne 2022).

Based on the typology of grave goods and radiocarbon dates (Meadows et al. 2016; Zagorska et al. 2018), it is possible to determine the chronological change in ochre use in burial traditions during the whole Stone Age.

4.2. Middle Mesolithic (8300–6000 cal BC)

In this period, single male graves dominated. The individuals were buried in an extended supine position and densely covered with ochre (burials no. 305 and 170). In burial no. 170, black soil was also identified at the bottom of the pit, and one of the female burials (no. 313) was arranged with only a black charcoal-rich soil.

Worth mentioning is a double burial (no. 319/320) of two children (ca. 5 and 3 years old) who were placed on a thin layer of black soil and densely covered with ochre, while the pit itself was filled with a dark soil.

In the majority of cases, animal tooth pendants were placed in burials as grave goods. Notable in this respect is burial no. 170, where a headdress made from 167 tooth pendants from elk, wild boar and aurochs was discovered (Zagorska and Lõugas 2000). The double child burial also contained elk tooth pendants. Eleven of these tooth pendants were placed in a half-circle around the smallest child's ankles.

Archaeological data indicates that during the Middle Mesolithic, along with the grave goods, the contrast between red and black colours, created by ochre and dark soil, was an important part of the funerary rites.

4.3. Late Mesolithic to Early Neolithic (6000–4400 cal BC)

During this period, the tradition of dense ochre use in burials continued and the deceased were still placed in an extended supine position. In double burials, ochre was densely added, for example, in the burial no. 122/123 (male with a young child).

However, changes in these traditions also occurred. In this period, ochre was mainly found around the skeleton, whereas burial pits were filled with light grey to dark grey gravel or black soil (for example, burials no. 76, 100 and 119). In some burials, the ochre layers became thinner.

Just like during the Middle Mesolithic, animal tooth pendants were predominantly placed as grave goods. However, the range of species became more diverse: alongside the previous species, teeth of badger, marten and dog, as well as bones from beaver and birds, were now given to the deceased (graves no. 153 and 300).

Especially interesting is burial no. 45, which was surrounded with a dense layer of ochre

and buried with a full set of hunting weapons — seven spearheads. Also noteworthy is the burial of an elderly female (burial no. 57). This burial was quite deep, reaching a depth of more than one metre. The top of the grave was covered with a stone setting, while the sides of the burial were covered in ochre from top to bottom (Fig. 6.B). The skeleton was surrounded by a thick layer of ochre. A large number of grave goods were identified in this burial, such as stone, flint, bone and antler tools, as well as animal tooth pendants. Notably, some of the tooth pendants were placed in a group in a patch of ochre further from the deceased. This is the richest female grave found in the whole burial ground, standing out against the background of predominantly male burials. This indicates a special role for this particular female within the Late Mesolithic community (Zagorska 2008).

During the second phase of this period (the Neolithic), it was more characteristic to densely cover separate areas of the burial with ochre, i.e. head, pelvis or hands. In the majority of cases, grave goods were placed in these areas. Notably, in the Early Neolithic the burials were marked by separate stones or stone settings.

All the child graves, including ones buried together with adults (burials no. 83, 100, 119 and 122/123, 173/173a, 132/132a) had been densely covered with ochre. The majority of child burials of this period contained a large number of animal tooth pendants.

4.4. Middle Neolithic (4400–2900 cal BC)

Overall, during the Middle Neolithic, burial practices changed. The fill of the burials usually consisted of black soil or, rarely, grey gravel. Grave goods were not so common in this period.

However, some of the previously carried out traditions continued. For example, some male graves found were covered in ochre and with animal tooth pendants around the neck area, as well as animal bones placed near the deceased. Burials with ochre placed in specific areas, mainly the head area, were also identified (burials no. 124, 146 and 160). These graves were also rich with animal tooth pendants (specifically in the head area).

Unlike in other periods, during the Middle Neolithic collective graves appeared, consisting of up to seven individuals (Fig. 7). In all of these burials, a dense layer of ochre was scattered on the deceased. In these collective graves, males and females were buried with children. The grave goods consisted of amber jewellery, bone fishing and hunting tools, and slate rings, as well as clay figurines and pottery. Quite rarely, the head of the deceased was plastered with clay mixed with ochre. Some of the deceased

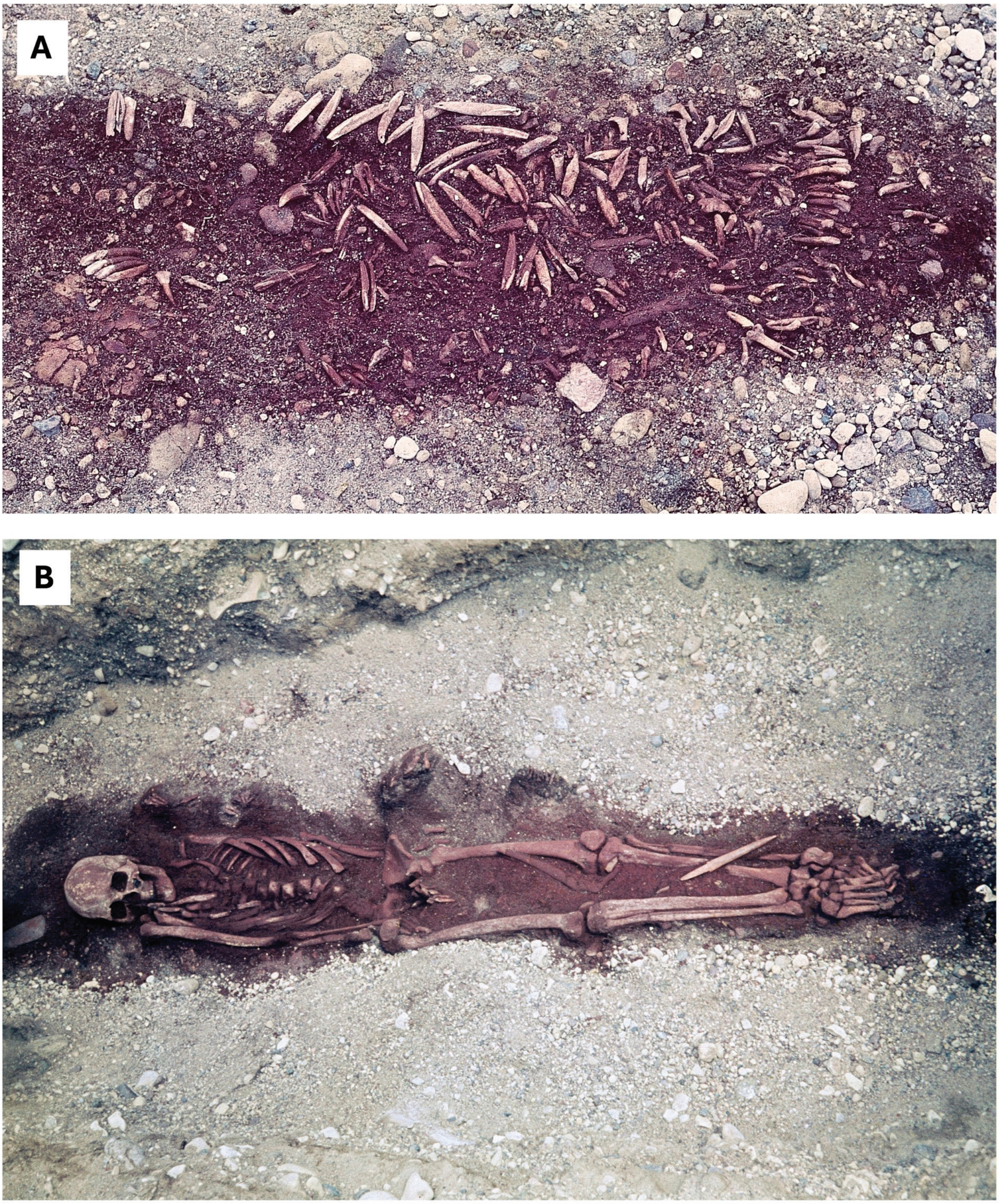

Figure 6. Burials with dense ochre layer (A — burial no. 190, child; B — burial no. 57, adult female) (photograph by F. Zagorskis).

with clay plaster on the face had amber rings placed on the eye sockets (burials no. 225, 255, 263 and 275) (Zagorska 1997).

A rich double burial (no. 316–317) of a male (25–30 years old) and a female (36–40) can be attributed to the Middle Neolithic (Fig. 8). The fill of the pit of this burial consisted of dark brown to black fill, likely a cultural layer of the settlement. The deceased were in the extended position and surrounded by scattered red ochre (Larsson 2010). The thickness of ochre in this burial varied, however, the densest area was around their heads. A high number (hundreds) of grave goods were given to both the deceased. The female had amber pendants arranged in eight rows, whereas the male had flint and bone tools, amber and bone pendants.

Lastly, so-called 'votive deposits' were also identified at Zvejnieki. These deposits consisted of often broken grave goods placed on dense ochre patches near the edges of burials. Such deposits were discovered in both single and collective burials (nos. 252, 206–209, 263–264, 274–278) (see in Zagorskis 1987, 10. att.).

However, in graves dated to the Late Neolithic and some later periods (Bronze to Iron Ages) ochre was not used. It seems that the tradition of using ochre in burials at Zvejnieki had completely disappeared by the end of Stone Age.

4.5. Symbolic meaning of ochre in graves

Use of ochre during the Stone Age was determined by various cultural traditions and the changes in them over the time. The most intensive use of ochre in burials was during the Middle Mesolithic, while at the beginning of the Neolithic the number of the graves with ochre decreased. The areas of the burials where the ochre was scattered also changed during this period — it was mostly identified in specific areas of the deceased.

Figure 7. Middle Neolithic collective burial (no. 206–209) of three individuals (photograph by F. Zagorskis).

Figure 8. Upper area of the double burial no. 316–317 (photograph by L. Larsson).

The use of ochre in burials increased again during the Middle Neolithic, when the collective burials and special votive deposits appeared. This tradition was likely brought by newcomers from territories to the north and east of present-day Latvia — the Pit-Comb Ware culture (Zagorskis 2004, p. 93; Mökkönen 2013; Nordqvist 2018, pp. 93–103; Ahola et al. 2025, pp. 13–14).

Within the prehistoric communities, the use of ochre was deeply symbolic. The red colour of ochre is reminiscent of natural substances that share the same colour as blood and flames, which are essential for life. The red colour might symbolise the transition of the deceased from one state to another, representing rebirth and the afterlife. The abundance of red ochre in the burials suggests a magical route to the afterlife (Zvelebil 2003; Butrimas 2012, p. 87).

The contrast between red (seemingly rebirth) and black (death) was observed in Zvejnieki burial traditions, where these colours were often combined in one grave. Concentrated ochre areas mostly contained broken artefacts — flint bifaces, bones and pottery. It seems to have been a widespread practice connected with the symbolic killing of things (Nunez 1986). In the territory of Latvia, the tradition of breaking tools continued periodically up until the Iron Age and even later.[1] Breaking tools in the context of funerary rites is often interpreted as releasing the 'soul' of the grave goods by 'killing' them, so they could follow their owner to the afterlife (see, for example, Šturms 1937, p. 361; Kursīte 1999, p. 255).

Traditions which were connected to the colour red persisted for a long period of time within the prehistoric communities around the world. For example, in Latvian folk songs devoted to funerary rituals, it is emphasised that it is crucial to provide blood for the deceased by slaughtering cattle, cocks (for males) or hens (for females) (Šmits 1926, p. 63).

[1] During the Bronze Age in the territory of Latvia, broken tools were found only in deposits, whereas during the Iron Age (in Courland), the tradition of broken tools as an additive for the cremated deceased was widespread.

In some cultures, ochre still bears a significant role in various rituals. Mentionable in this respect is Australia, often called the 'land of red ochre'. Here, various types of ochre are known to the native tribes and each of them holds its own symbolic meaning. Red ochre holds an important role in funerary rites. One of which is a path of scattered ochre from the house of the deceased to the burial ground — as a symbolic red way to the life beyond. It was crucial for the deceased to be returned to and buried at their place of birth and this path was a way to achieve this aim (Ilga Zagorska obtained this information during a conversation with Peter Sutton in 2007).

Thus, it is possible that the burial traditions during the Stone Age in the eastern Baltic indicate that the use of ochre is deeply connected to the firm belief in the life beyond the grave.

Discussion

Archaeological data indicates that during the Stone Age in the Lake Burtnieks area, ochre was used in two contexts — settlements and burial grounds. Evidence shows that ochre was used for burial rites and as a pigment for colouring clay vessels. However, the meaning behind this practice could be associated with the possible function of the pottery, i.e. as a container for the prepared ochre (Spataro et al. 2021). Nevertheless, the most detailed data regarding the use of ochre is from the Zvejnieki burial ground, where a high number of burials contained ochre.

The results of the survey conducted within this study indicate that iron-rich sediments are common in the close vicinity of Lake Burtnieks, meaning that earth pigments were accessible locally to the Stone Age communities in this area. However, the samples obtained, as shown by the XRF and XRD analysis, were not the ones used by the Stone Age communities of Lake Burtnieks. Furthermore, none of the samples collected contained goethite, hematite or maghemite — the key minerals of the earth pigments. This suggests that earth pigments were collected from other nearby regions during the Stone Age. The two most promising areas with earth pigments deposits which are easily accessible are in the vicinity of Staicele village and near the inlet of the Salaca River (Mellis 1938; Kokins and Kostjukovs 2017).

Upīte, based on the presence of hematite in the ochre samples from Zvejnieki burial ground, interprets that the ochre added to the graves was burnt (Upīte 1987). This assumption is based on the fact that goethite (the base mineral in yellow ochre) when burned transforms into hematite (the base mineral of red ochre) (Lin et al. 2021). However, it is not certain that the ochre was burnt, as earth pigments can also consist of hematite in their unprocessed form, i.e.

red ochre in the natural environment contains hematite as well (Teklay et al. 2023).

This raises the question of whether ochre found in the Zvejnieki burial ground and Riņņukalns settlement was natural red ochre or it was goethite-based ochre and was processed by burning. Bearing in mind that the majority of burials from Zvejnieki had red-coloured ochre added, it might be that the ochre was not burned. Maghemite mineral identified in one of the ochre samples from Zvejnieki (analysed by Actiņš in 2008; Appendix B) is indicative of this possibility as well, as maghemite, in the burning process, can transform into hematite (Sidhu 1988). However, to definitively determine whether ochre was processed by the Stone Age communities, more thorough analysis is needed, such as a wide range of experiments and thorough surveys.

At the Zvejnieki burial ground, no ochre preparation areas have been discovered, thus it is possible that the pigment was prepared for the funerary rites in the settlement. The data shows significant similarities in the mineralogical composition of ochre from Riņņukalns and Zvejnieki. This could indicate that ochre for the Zvejnieki funerary rites during the Middle Neolithic was prepared in the Riņņukalns settlement. However, as there is a lack of material for future studies, it is impossible to determine whether this thesis is plausible.

Data from the previous investigations of ochre samples from the Zvejnieki burial ground suggests that specially prepared ochre and soils were used in the funerary rites. There is evidence that the ochre in each grave was different: some were made as a lumpy mixture containing clay, gravel, quartz and dolomite, others were a very pure, dark red powder (from the memory of Ilga Zagorska). There are a few possibilities to explain the diversity of ochre in graves: a) each family group prepared each burial separately for only their own family; b) it was part of funerary rites dedicated for specific individuals within the community (pure ochre powder vs. an unpure mixed mass); c) the lack of availability of pure earth pigment, i.e. it could be that large amounts of ochre was not available at the time of the funerary activity (for example, during winter or because the deposit had emptied), thus it was mixed with other materials.

Either way, ochre bears a significant symbolic role in the funerary rites and belief system about the afterlife within the Stone Age communities of Lake Burtnieks.

Conclusions

The surroundings of Lake Burtnieks can be considered as one of the key microregions in the territory of Latvia during the Stone Age. Data gathered from the numerous archaeological excavations provides meaningful information regarding the life and death of the Stone Age communities, including the role of ochre in everyday life and special occasions.

The result of this study shows that ochre and other iron oxide pigments are common in the Lake Burtnieks environs, though no raw samples compatible with the archaeological material were obtained during this study. It is possible that the ochre was obtained from a little bit further away, in areas such as Staicele or the inlet of Salaca River ,where deposits of earth pigments and limonite have been identified.

Chemical and mineralogical analysis of ochre from the archaeological context shows similarities between some of the Riņņukalns and Zvejnieki samples, which could indicate that the pigment was prepared and stored at the settlement before being used for funerary activities during the Middle Neolithic. However, no archaeological data can confirm this thesis.

In burials, ochre was used in various ways and proportions according to the changing traditional tendencies over time during the Stone Age, and the differences in ochre quality in graves (mixed or pure) is indicative of either social, symbolic, traditional or materialistic reasoning.

Archaeological data shows a significant chronological difference in ochre use during funerary activities — from densely covering the deceased with this pigment (Middle Mesolithic) to scattering ochre in specific areas of the body (Early to Middle Neolithic). Rare but symbolically significant were ‘votive deposits’ and clay-ochre face masks.

Further studies are needed to determine a more precise distribution of earth pigments, their typology and correlation with archaeological material. The question of specific ochre processing (burning) during the funerary rites also remains for now unanswered.

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Abbreviations

Acta Archaeolog. – Acta Archaeologica

Archaeol. Anthropol. Sci – Archaeological and Anthropological Sciences

Archeol. Baltica – Archaeologia Baltica

Eur. J. Archaeolog. – European Journal of Archaeology

FA – Fennoscandia Archaeologica

J. Archaeol. Sci. Rep. – Journal of Archaeological Science: Reports

Mater. Sci. Eng. B. – Materials Science and Engineering: B

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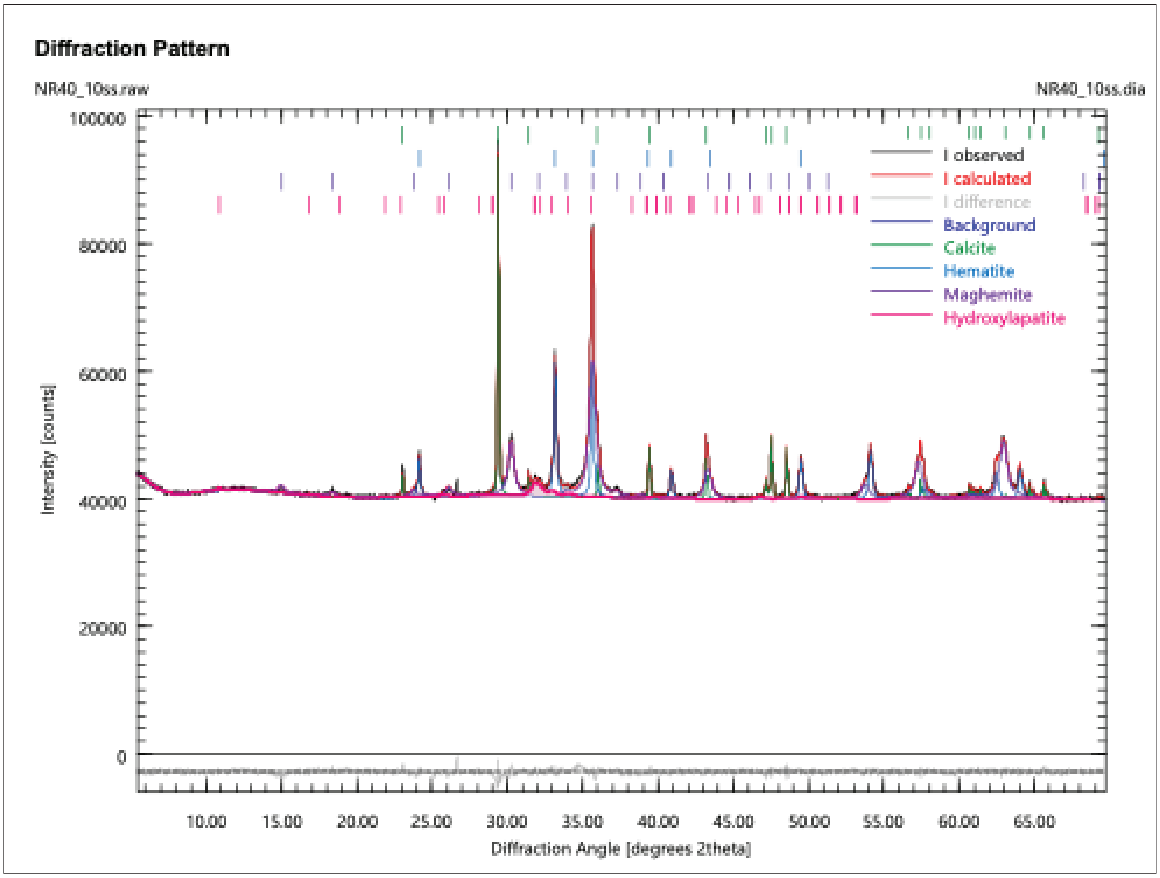
Appendixes

Appendix A — Raw data of the results of Rietveld refinement

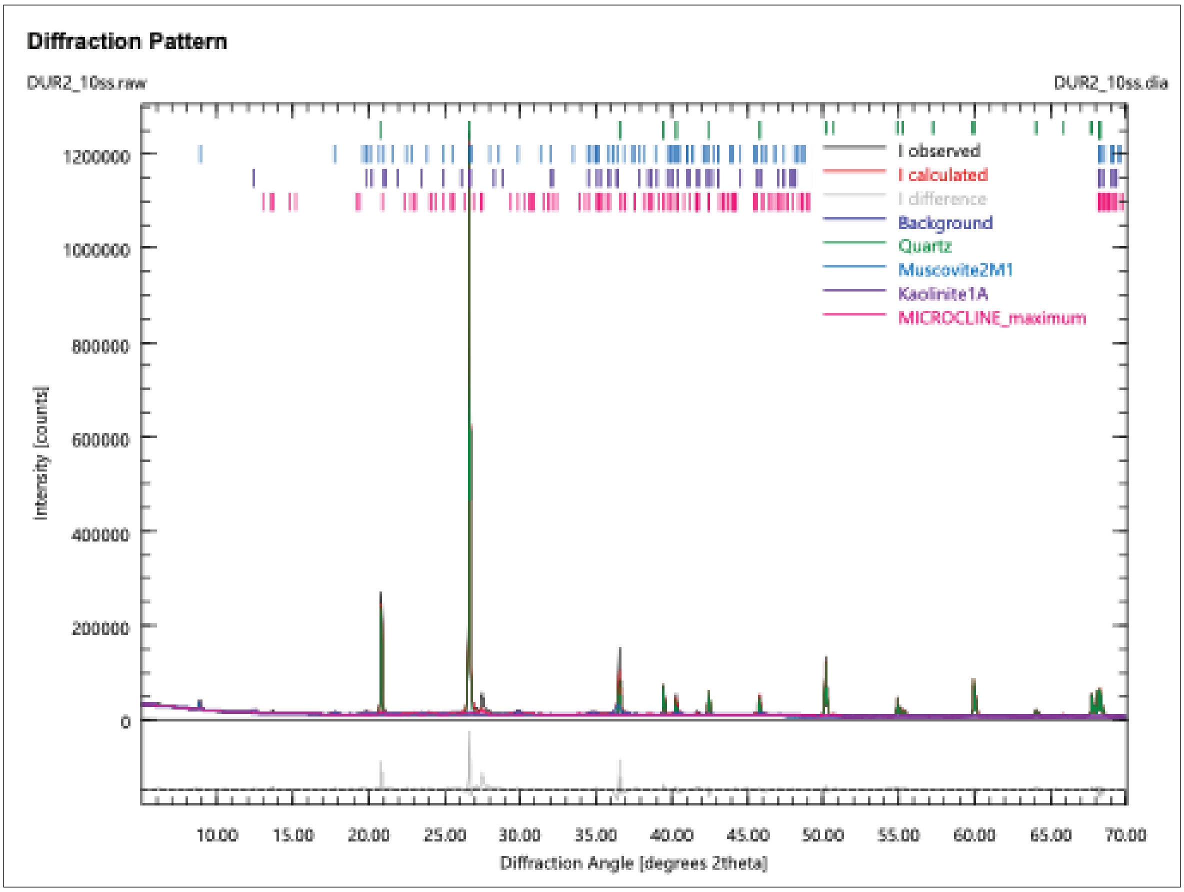
Sample	**NR40_10ss.dia**			
Instrument configuration	D8-discover-fds-Riga.geq			
Wavelength	CU (1.5406 Å)			
Statistics	R_{wp} = 0.67	R_{exp} = 0.49	X^2 = 1.8696	GoF = 1.3673

Parameter	Value	ESD
Qcalcite	0.251	0.004
Qhematite	0.211	0.003
Qmaghemite	0.449	0.004
Qhydroxylapetite	0.089	0.002



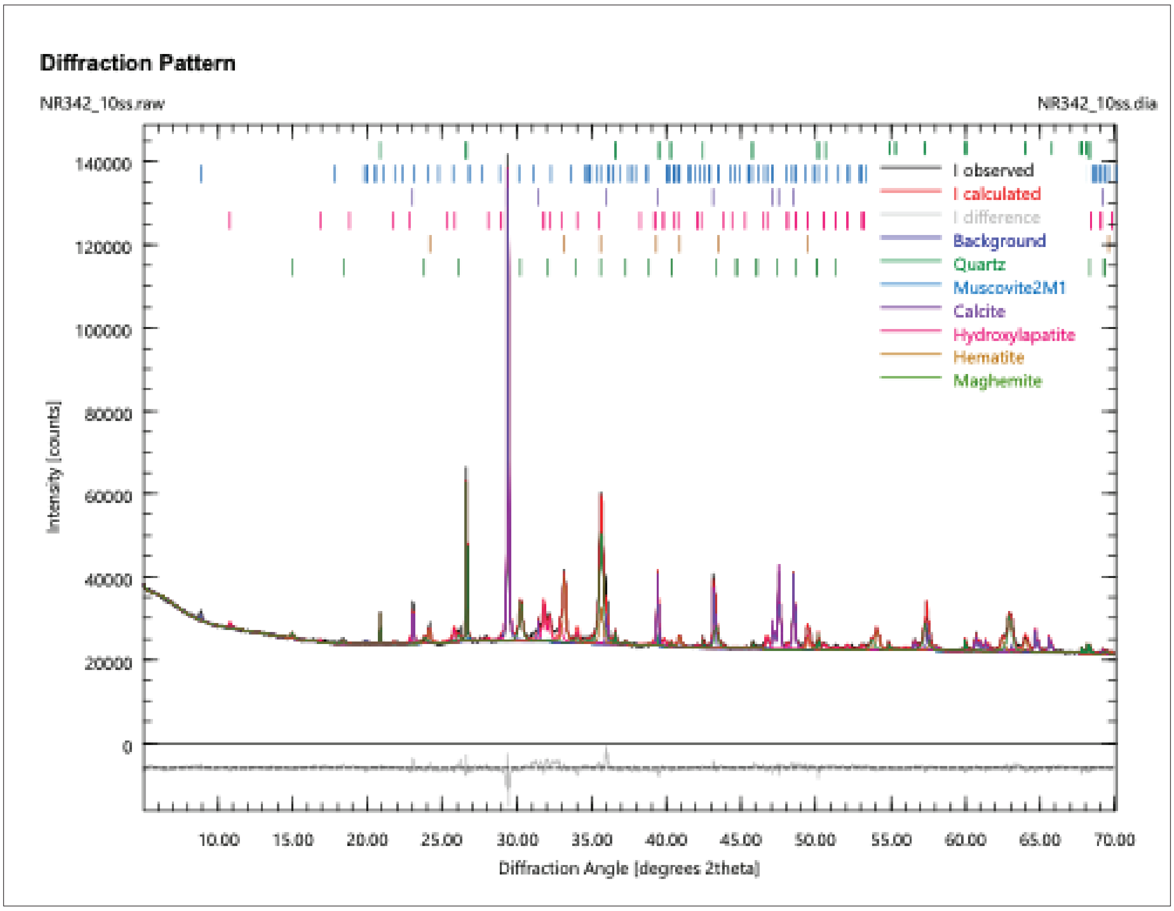
Sample	**NR342_10ss.dia**			
Instrument configuration	D8-discover-fds-Riga.geq			
Wavelength	CU (1.5406 Å)			
Statistics	R_{wp} = 1.70	R_{exp} = 0.65	X^2 = 6.8402	GoF = 2.6154

Parameter	**Value**	**ESD**
Qquartz	0.082	0.001
Qmuscovite2M1	0.057	0.004
Qcalcite	0.390	0.003
Qhap	0.156	0.002
Qhematite	0.117	0.002
Qmaghemite	0.198	0.002



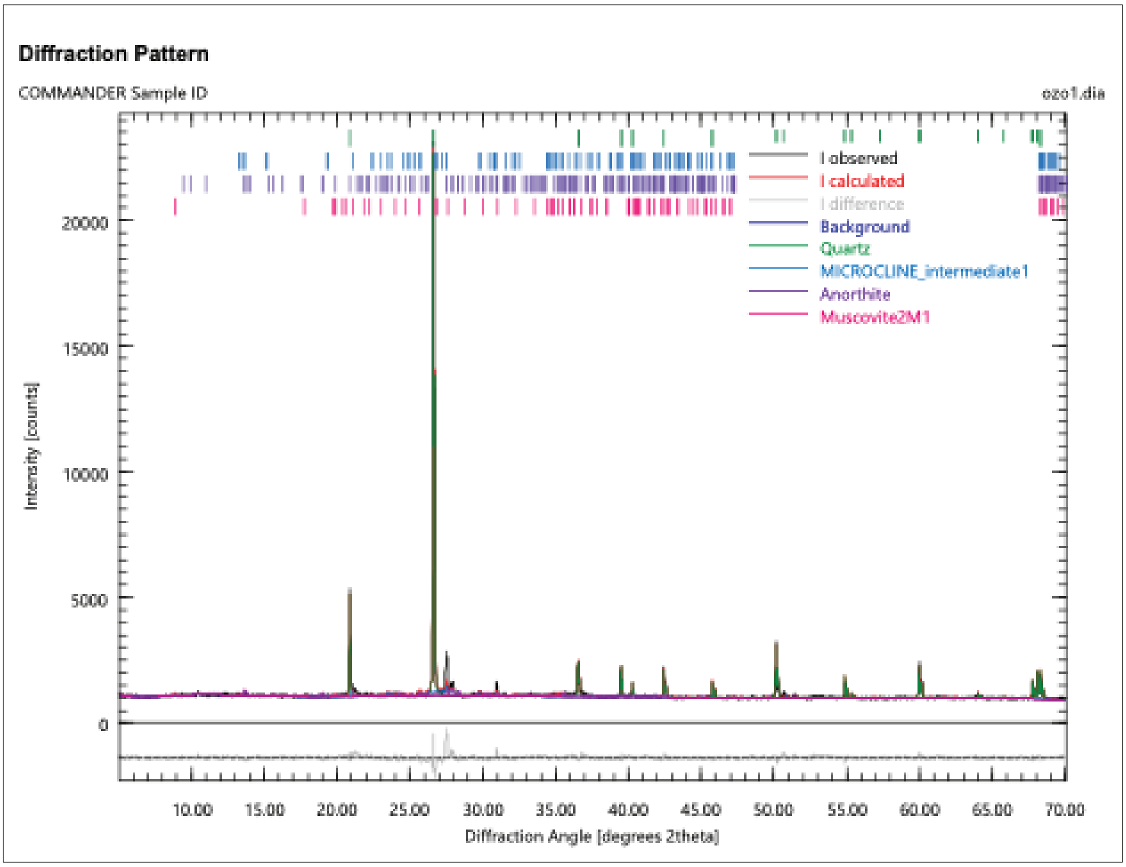
Sample	**DUR2_10ss.dia**			
Instrument configuration	D8-discover-fds-Riga.geq			
Wavelength	CU (1.5406 Å)			
Statistics	R_{wp} = 7.50	R_{exp} = 1.04	X^2 = 52.0063	GoF = 7.2115

Parameter	Value	ESD
Qquartz	0.557	0.008
Qmuscovite2M1	0.314	0.010
Qkaolinite1A	0.055	0.002
Qmicromax	0.074	0.003



Sample	**ozo1.dia**			
Instrument configuration	D8-discover-fds-Riga.geq			
Wavelength	CU (1.5406 Å)			
Statistics	R_{wp} = 4.55	R_{exp} = 3.03	X^2 = 2.2550	GoF = 1.5017

Parameter	Value	ESD
Qquartz	0.672	0.010
Qmicroint1	0.16	0.010
Qanorthite	0.111	0.006
Qmuscovite2M1	0.057	0.010



Appendix B — Report of analysis conducted by Andris Actiņš in 2008

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RESULTS OF OCHRE ANALYSIS

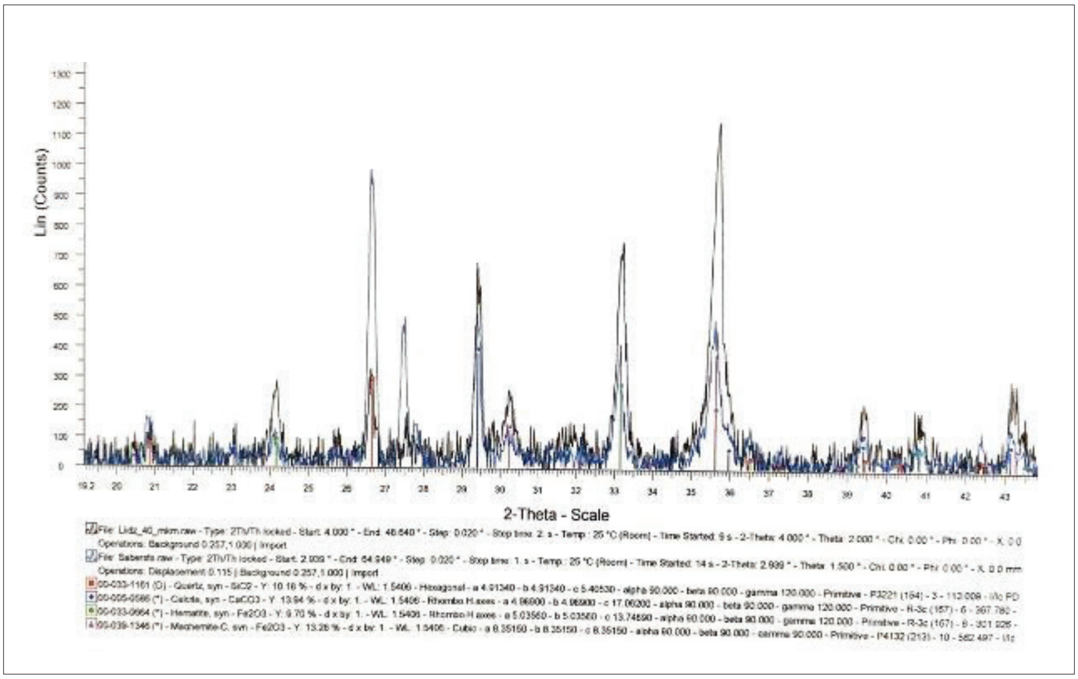
1. One sample without fractioning (sieving) – crushed in the pestle and studied using XRF spectroscopy Concentration of elements in their oxide form shown in % as follows:

Al_2O_3 – 4,4; SiO_2 – 25; P_2O_5 – 19; SO_3 – 0,6; K_2O – 0,5;

CaO – 16,7; TiO_2 – 0,26; MnO_2 – 0,21; Fe_2O_3 – 33

2. XRD analysis was conducted to this sample as well. Particles in size less than 40 μm were separated from the sample before the analysis and measured separately as well.

Crystalline phases	**Crushed sample**	**Fraction – less than 40 μm**
SiO_2 – α-quartz	25	7
$CaCO_3$ – calcite	29	22
Fe_2O_3 – hematite	16	21
Fe_2O_3 – maghemite	27	50
$KAlSi_3O_8$ – feldspar	3	<1



Dr. Chem., asoc.prof. A. Actiņš

16.04.2008.

(translated by V. Haferberga)

Žemės pigmentai ir įstabūs akmens amžiaus laidojimo paminklai Burtniekų ežero pakrantėje

Vanda Haferberga, Artis Kons, Ilga Zagorska

Santrauka

Burtniekų ežero apylinkės pasižymi itin gausia archeologinių paminklų koncentracija. Tarp jų išsiskiria Riņņukalno gyvenvietės ir Zvejniekų archeologinis kompleksas, kuriuose abiejuose užfiksuotos ochros naudojimo žymės. Geologiniai tyrimai rodo, kad šiame regione aptinkama spalvotųjų mineralų telkinių (1, 2 pav.). Šio tyrimo tikslas – įvertinti žemės pigmentinių medžiagų prieinamumą Burtniekų ežero apylinkėse ir išanalizuoti ochros naudojimo mastą bei simbolinę reikšmę akmens amžiaus bendruomenėse.

Tyrimo metu atlikti žvalgymai ir paimti dirvožemio mėginiai – potencialūs žemės spalvotųjų medžiagų šaltiniai. Surinkta medžiaga, taip pat archeologinių radimviečių mėginiai buvo analizuojami taikant rentgeno fluorescencijos (XRF) ir rentgeno difrakcijos (XRD) metodus, siekiant nustatyti cheminę ir mineraloginę pigmentų sudėtį (3–5 pav.). Gauti rezultatai atskleidė, kad nors netoli archeologinių vietovių aptikta geležies oksidų pigmentų, tačiau žemės spalvų, kurias būtų galima tiesiogiai sieti su archeologiniais radiniais, nenustatyta. Tikėtina, kad šios nuogulos tiesiog nebuvo aptiktos vykdytų žvalgymų metu. Vis dėlto neatmestina prielaida, kad akmens amžiaus bendruomenės ochros žaliavą rinko kitose vietose – galimai lengvai pasiekiamose Salacos upėje, ypač ties jos intako Staicelės žiotimis.

Riņņukalno ir Zvejniekų kapinyno ochros mėginių mineraloginė sudėtis yra gana panaši, o tai leidžia kelti prielaidą apie galimą bendrą jų kilmę. Tikėtina, kad bent jau vidurinio neolito laikotarpiu laidojimams Zvejniekuose naudota ochra buvo ruošiama ir kaupiama Riņņukalno gyvenvietėje. Archeologiniai duomenys, taip pat XRD ir XRF analizės rodo, kad į kapus barstyta ochra pasižymėjo nevienoda kokybe – ji galėjo būti maišyta su kitomis nuogulomis ar priedais arba naudota kaip gryni milteliai (5–8 pav., 1–4 lentelės, A, B priedai). Šiuos skirtumus galima sieti tiek su simboliniais aspektais, tiek su praktiniais sumetimais.

Zvejniekų kapinyne išsiskiria itin įvairios ochros naudojimo formos, kurios taip pat kinta chronologiškai. Vidurinio mezolito laikotarpiu mirusieji dažniausiai buvo gausiai užberiami tankiais ochros sluoksniais ir laidojami kartu su gausiomis įkapėmis. Ankstyvajame neolite ši tradicija ryškiai pakito – ochrą imta berti ne visame kape, o tam tikrose jo vietose, dažniausiai ties galva, dubeniu ar rankomis. Vidurinio neolito laikotarpiu ochra dažniausiai buvo beriama tik galvos srityje. Retesnė, bet išskirtinė tradicija buvo mirusiojo galvą padengti molio ir ochros mišiniu. Tuo pačiu laikotarpiu fiksuojami ir vadinamieji „votyviniai radiniai“, aptinkami šalia mirusiųjų.

Remiantis etnografinėmis ir folklorinėmis paralelėmis, galima teigti, kad ochra Zvejniekų kapinyne simbolizavo ugnį bei kraują ir veikė kaip esminis mirusiojo palydėjimo į pomirtinį pasaulį elementas.