SOCIAL DIMENSIONS OF TECHNOLOGY OF CERAMIC PRODUCTION IN SOUTHEAST BULGARIA IN 6th – 2nd mill. BC[1]

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ABSTRACT

The article presents activities and data obtained during the first year of the project. The research area encompasses Southeastern Bulgaria with nine main sites included. Object of instrumental research and archeological characteristic are the samples, which are divided into the following groups: denudated rocks, and used for inorganic temper; clays – tectonic and alluvial; ceramics- pottery fragments and burnt remains of stationary equipment; organic fillers, pigments and substances for painting and incrustation, organic residues and impressions of mats and baskets on the pottery bases. . Different methods and analyzes have been applied to solve the problems posed: cartographic analysis and description of the landscape, morphological and typological analysis, dating, instrumental methods, chemical analysis, scanning electron microscopy (SEM), petrographic analysis etc.

СОЦИАЛНИ ИЗМЕРЕНИЯ НА ТЕХНОЛОГИЯТА НА КЕРАМИЧНОТО ПРОИЗВОДСТВО В ЮГОИЗТОЧНА БЪЛГАРИЯ ПРЕЗ VI-II ХИЛ. ПР.ХР.

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РЕЗЮМЕ

В тази статия са представени дейности и данни, получени през първата година от проекта. Цел на проекта е изследването на технологията на керамичното производство през праисторията чрез прилагане на различни инструментални методи и опит за характеристика на социалните аспекти на това производство. Изследователският район обхваща Югоизточна България с включени девет основни обекта. Предмет на това инструментално изследване са образци от глини, керамика, отпечатъци от органични останки върху керамика, пигменти за рисуване, оцветяване и инкрустация, отпечатъци от рогозки и кошници. За разрешаването на поставените проблеми са приложени различни методи и анализи: картографски анализ и описание на ландшафта, морфологичен и типологичен анализ, датиране; инструментални методи; химичният състав на пробите, сканираща електронна микроскопия (SEM), петрографският анализ и др.

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INTRODUCTION

In this article are presented activities and data obtained during the first year of the project. They don't have concluding character. The basic purpose of the team was the information to be accumulated which is necessary for the creation of a base to be updated in the second year for the project.

This research area encompasses Southeastern Bulgaria with nine main sites included (Fig. 1). In the process of work, it was necessary to include reference materials from other sites, for example Constantia and Chavdarova cheshma near Simeonovgrad and Sokol (Fig. 2); thus the information of them was quite important for solving the tasks, defined in the project. All of them are in Southeastern Bulgaria and enter the research time-span.

The leading institution in preparation of the tests and the accomplishment of the analyses is Sofia University with its departments and the Centre of Archaeometry. Meanwhile, thanks to the increasing popularity of research and the international relationships of the team members, samples are sent for free of charge analyses in the labs of Nottingham, Oxford, Ankara, Istanbul and Athens. Collaboration is expected also with the lab of Archaeometry at the University of Yasi, Romania. In this way we will improve the methodology and widen the area of parallels and correlations. The international collaboration is stimulated by the fact that most archeological sites, included in the Project, are internationally recognizable, i.e. their exploration is of significance for the prehistory of Southeastern Europe and Asia Minor.

The presented results are from those analyses which were finished till 15.12.2017. Only the material from the University of Nottingham, Great Britain, was sent in the beginning of 2018. Many instrumental analyses still in due course but their results will be ready in the first months of 2018.

MATERIALS AND METODS

Structure of the database

Object of this instrumental research and the archeological characteristic are the samples, which are divided into the following groups: denudated rocks, serving for the base of tectonic clay formation, and used for inorganic temper; clays – tectonic and alluvial; ceramics- pottery fragments and burnt remains of stationary equipment; organic fillers, pigments and substances for painting and incrustation; organic residues and impressions of mats and baskets on the pottery bases. This information, presented with texts, photographs (field pictures, microscopic and macroscopic photos) and graphic (maps, scientific drawings, diagrams) type, which are synchronized. The external/internal colour of ceramic fragments is specified through the international standard *Munsell Soil Color Chart*. Digitalization is completed through the programs of Adobe Photoshop, Illustrator and Excel, as well as MIN 5, especially created for treatment of geochemical data. In process is the analyzing of the whole information in Access and GIS.

Specific methods

The aim of this research imposes the necessity of combining of conventional archeological methods for analysis with a wide spectrum of instrumental methods and techniques.

Among the archeological methods we should mention the following: cartographic analysis and landscape description, morphological and typological analysis, dating and cultural attribution, catalog description, macroscopic technological description and graphic records.

Instrumental methods are selected in order to obtain comprehensive information of the multi-step process involved in ceramic production, the function of implements and the different classes of pottery. From technological position, the focus is laid out on the selection and preparation of raw materials, selection of organic and inorganic temper, pottery shaping and decoration until the process of firing.

In order to obtain information on provenance of raw materials and clay matrix, inclusions (non-plastic particles naturally occurring naturally in clays) and tempers (non-plastic materials intentionally

added by potter to the paste) that compose a ceramic body, the mineral and chemical composition of the samples is examined. The character of inclusions and tempers is determined by **microscopic observations (thin-section analysis)**.

Scanning electron microscopy (SEM) gives the possibility by large magnification to observe the texture and the relationships between the minerals in the fired paste. This method also allows identification of plant remains (mats and baskets) used in vessel formation or drying and preserved as imprints on the exterior.

Petrographic analysis is combined with analysis of the chemical compositions of clay samples and pottery fragments. It is studied by **wet chemical analyses** to determine the macrochemical composition" (the contents of SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, etc.). The data from these analyses are used as internal standard for **LA-ICP-MS** analyses to obtain data about the concentrations of microcomponents and of the RRE in particular. The same analyses we use for the clay samples collected from outcrops, too, to correlate the results with these from the ceramic artefacts to establish the source of the raw material. On the base of the chemical composition the clays will be correlated to international rock-standards like North American Shell Composition to obtain a basic information about the geochemical characteristic of the clays.

The mineralogical composition of both clay samples and pottery sherds is studied by **X-ray powder diffraction** (XRD). It is useful to test the results of petrographic groups, defined by thin section, as well as to identify minerals too small to be detected by thin sections and microscope observation. By this method we can establish the firing temperature through the change of the structure of the primary clay minerals and the presence of minerals crystallized during the firing process and exposure to high temperatures (pyroxenes, etc.). The method is also applicable for the identification of minerals used in slip preparation. The pigments and coloring agents used in slip preparation or for pottery decoration (painting, encrustation) will be studied also by vibrational spectroscopic methods, such as **Raman spectroscopy**. The chemical composition of pigments and slips can be further identified by point chemical analysis by using **Scanning electron microscope combined with Energy Dispersive Spectrometry** (SEM-EDS).

Data concerning the modeling techniques can be obtained from the thin section study when peculiarities of the structure are visible (cracks between different elements of the clay are indicators 2 for coil building or slab building techniques; wheel turned vessels can be identified according to the visible orientation of non-plastic particles in the matrix).

The function and use of pottery can be identified by analysis of organic and inorganic residues preserved on the vessel's interior. The method for this investigation is **Gas** and **Liquid Chromatography with Mass spectrometry**.

The described analyses are integrated in the complex study in which the classical archeological methods for ceramic investigations have a leading position – formal and technological classification, synchronic and diachronic analysis, contextual and functional analysis, taxonomy, statistical analysis.

Expected results

Expected scientific results can be divided into three groups:

- Results, obtained through conventional archeological methods.
- Results obtained by using instrumental methods.

This group comprises the specific data that will be obtained from the natural-scientific analyses and provide information regarding: the raw material source of the pottery production; characteristics of the used clays and admixtures; modeling techniques; firing techniques; organic and inorganic substances used in the coloring of the slip and decoration of the vessels. These data will be used in the creation of a technological database that can be upgraded and developed if/ when the area will be extended by the inclusion of new sites and regions and with the inclusion of new research techniques as well.

Results based on the extracted data in the field of social archaeology.

Expected results in the third group are connected with interpretation of data within the area of humanities. It is obviously too early to sum up all the results.

The obtained data serve as a reference and a basis for the clarification of significant research questions regarding: the relationship between the technology and eco-environment; the level of the technological skills during the different periods and in the different regions; the mechanisms for transmitting and keeping the traditions and for penetration of the innovations, to tracing the direction and intensity in the contacts.

In particular, for the Neolithic period we expect to obtain results about the different types red slip; composition and method for the application of the pigments that are used in the monochrome and polychrome painting; characterization of the thermal processes in the production of luxury ceramics. These results will enable the comparable analysis with Southeast Europe and Northwest Anatolia and will help in establishing the ways that technology had been transferred, the mobility of people and ideas.

For the Bronze Age, we are focused on the color of the slips (intense black; raspberry-red; etc.); the innovations in the thermal techniques (adding grog); the substances used for the incrustation in various techniques (incised; corded ware; *Furchenstich*) typical for different stages of the period. We expect to establish the characteristics of the local production for every region and periods (examined in the project) and thus to be able to identify imports and local imitations. We also expect during the second year of our work to obtain results that can be interpreted in terms of the consumption of time and effort spent on the pottery production; the specialization of the production and its characteristics as a separate and independent craft.

For this purpose we will broaden our activity in three directions: selection of new samples; inclusion of new sites, both in Bulgaria in neighbor regions; and use information from similar areas of investigation – geomorphology, paleogeography, paleoclimatology, and other.

Sample description

Spatial distribution in micro-regions and objects (Figs.1-2)

As it is already said, the research is limited in Southeastern Bulgaria, which is divided into the following sub-regions and micro-regions:

The middle and a part of the lower valley of the Maritsa River, with Yabalkovo and Voden as main sites. The list is extended with the sites of Constantia and Chavdarova cheshma near Simeonovgrad, dated to the EBA and Early Neolithic respectively. Materials from Constantia are included because of the presence of probable imports from Northwest Anatolia, dating from the end of the 3rd mill. BC. Ceramics from Simeonovgrad (Chavdarova cheshma) has direct parallels with the materials from Yabalkovo. During the first year of the project samples were analysed from Yabalkovo (EN), Constantia (EBA 3) and Dana bunar 1 (ECh/LCh).

The middle valley of the Tundzha River.

Here the two main sites included in the project are the open air settlements known as Chokoba 18 and Chokoba 18A during the transitional period from the Late Neolithic to the Early Chalcolithic and in the Bronze Age.

The valleys of the Ovcharitsa and Sokolitsa rivers, flanking the north part of the Sakar mountain North. The basic sites are the sites of Kliselika, Madrets and Galabovo (Fig. 2).

Sveti Iliya hills. Tell Sokol is located in the southern slopes of the hills. The site has been included in the project for two reasons. First, this is the only mound from the first half of the 3rd mill. BC with on-going fieldwork research, and, second, the site is located in an area rich in graphite deposits. In the first year samples have been taken from pottery fragments and various clay installations.

Chronological distribution

The chronological framework of the project is from the beginning of 6th to the end of 2nd mill. BC, that includes the periods of Early, Middle and Late Neolithic (EN, MN, LN), Early and Late Chalcolithic (ECh and LCh), Early, Middle and Late Bronze age (EBA, MBA, LBA).

EN – Yabalkovo and Kliselika

MN – Yabalkovo

LN/ECh – Chokoba 18A;
ECh – Dana bunar 1, Madrets
LCh – Madrets, Galabovo, Dana bunar 1
EBA – Madrets, Sokol, Galabovo and Constantia
EBA 3/MBE – Galabovo
MBA – Chokoba 18
MBA/LBA – Chokoba 18A.

Archeological context of the selected fragments

The materials included in the project come from settlement sites and not from necropolises and sites of supposed ritual functions (sanctuaries). This is due to the fact that pottery in the latter types of sites has more specific functions and quite often is manufactured or selected especially for the rituals. Most of the settlements are investigated in the recent past i.e. there is reliable field documentation. Some settlements however are investigated more than 40 years ago (for example Constantia) and many of the details about fieldwork cannot be recovered. In spite of this are selected fragments because of their high scientific value (imports, ceramics thrown on a pottery wheel). The rest of the samples are with a certain context and come from pits, houses or secure closed complexes, for example ditches. Consequently, the information value of the samples given for analysis is high and the results can be defended with sure evidence from the sphere of field archeological documentation.

Types of samples

Subject to analysis are samples taken from denudated rocks, clays, pottery and remains of stationary equipment. The following signature has been used: abbreviation of the name of the site – type of the sample (clay, ceramic fragment, burnt clay) – date of the sample – number of the sample. For example: SMG_S.BA_008 refers to: tell Galabovo (SMG) – ceramic fragment/sherd(S), Bronze Age (BA), number 008.

Rock outcrops (Fig. 3)

Four samples have been taken from several places – from Sveti Iliya hills, north from Sokol, from the modern quarry south from Yabalkovo, from the hills north from Chokoba site and from the northern slopes of Sakar mountain. As the analyses haven't been finished, the results will be announced in the final report.

Clays (Figs. 3, 4, 5)

Eighteen samples from clay sources have been taken for provenance analysis.

Yabalkovo. The geomorphology of the region of Yabalkovo has already been studied and the base data are published, so they won't be repeated here. The research was carried out in 2010-2012 by Ph. Machev, D. Vangelov, L. Klain and V. Vangelova. Their data will be included in the final report and it will be explicitly stated, that those analyses are done prior to the project. We consider that because the authors participate in this project as well, their re-execution is not justified or reasonable.

Yabalkovo-profile, cut by the road connecting the villages Yabalkovo and Krum; coordinates: 42° 3'48.00"N, 25°29'11.00"E; approximately 740-750 m from the EN site of Yabalkovo. The terrain represents a low hill, above the old riverbed of the Maritza. The samples were taken at around 1.50 m below the top of the profile.

Yabalkovo-Sector North; approximate coordinates: 42°03'50.95"N, 25°28'39.07"E; sample has been taken from the area of the EN settlement. A small section has been made to the virgin soil (dark yellow sediment), from where the sample was taken, at round 0.30 m under the earliest EN settlement.

Yabalkovo-modern quarry, S/SE from Yabalkovo village; coordinates: 42°3'32.37"N, 25°27'32.99"E. The quarry is situated around 1.5 km W-SW from the central part of the prehistoric site. Five samples were taken, defined by the different coloring and structure of the clay and the rocky base.

Yabalkovo-South. In the land of the neighboring village of Kasnakovo archeological excavations are taking place, reaching the level of the virgin soil. The site is known in literature as "Sanctuary of

the nymphs", Kasnakovo; coordinates of the site: 42° 0'13.91"N, 25°30'7.55"E. The sanctuary stands at around 6.5 km S-SE from the central part of Yabalkovo site.

Sokol, Nova Zagora district. The region north from Sokol village is built of Paleozoic granitoids, which are fossilized and subsequently slightly altered. In addition, in the process of weathering and decomposition, they are cracked and form blocks with sizes of several dozen centimeters, which are easy to extract and use as a building material (Fig. 3.1). On a few of the fragile fault zones are developed tectonic rocks – cataclasites and ultracataclasites – tectonic clay, which is quite fine. This is a result mostly from the kaolinization of feldspar, a basic rock-forming material in the granitoids (Fig. 3.2-3). In their weathering these rocks disintegrate fast and form the so-called "grus" or sand from the basic rock-forming minerals. In the kaolinization process of the feldspar, it is often mixed with a clay weld and during hard rain it is exported in flood cones, which are most suitable for its exploitation. Characteristic for these rocks are also the quartz stems and quartz is a very hard mineral that could be used in many ways.

Chokoba, sites 18 and 18A. The region is built in its hilly part from upper cretaceous volcanic and hypoabyssal rocks (andesite, dacite and latites), which are distinguished by strength and cracks, a result of the decomposition and compression and extensive tectonic deformation. The preserved harder rock fragments are suitable for extraction and procurement and trough the fault zones, as a consequence of the crushing of the rocks, it is possible to reach fossilized and ultracatalasites (tectonic clay). In the locality of "Ostar kamak" and west from it are found traces of extraction activities. This conclusion is based on the difference of effect of the exogenous processes on the rocks or more precisely the formation of "patina" (a level of surface weathering or such in shallow penetrating micro-cracks), which have been determined by:

- natural weathering, distributed on large areas;
- small areas with traces of contemporary anthropogenic activity and lack of patina;
- those with a small effect on the exogenous processes.

On the basis of the duration of those processes and by analogy with other sites it could be concluded that the natural weathering or the penetrating patina date from 70-65 Ma, since when they have been brought on the surface, several decades for the current weathering with no traces of patina and several thousand years for the slightly patinated areas, all this suggesting the extraction of raw material a few thousand years ago, taking into account also the morphology of the natural erosion and the anthropogenic interference in the lay.

Chokoba 18 site is located on one of the segments of the contemporary neotectonic fault zone, dividing the hilly northern part, built by volcanic rocks with age 90-88 Ma, from the southern plane part of continental deposits with ages around several thousand years. This fault is followed by satellite synthetic zones. One of them, north of the hill "Ostar kamak", appeared to be 15 m thick and filled with tectonic clay created by the intense crushing of igneous rocks. It is probable that those clays are susceptible to extraction and processing.

Between those two faults is developed a system of sidelong faults with a downgrading of the western blocks. Tectonic clay is also visible in one of these faults, but more importantly, it drains water, which is captured and with a very good drinking quality. As we take into consideration the trend of reduction of flow of natural springs nowadays, it can be suggested the presence of other springs during the existence of the settlement. The presence of neotectonic system suggests an intense seismic activity as well.

Madrets. There are two tell sites in the vicinity of Madrets village. Tell Kliselika is located in the immediate vicinity of the main stream of river Sokolitsa, which shows an intense indent in an old overflowing terrace. This corresponds to the data for the region for tectonic sinking in the region with speed from approx. 1mm/y and morphologic manifestation of active faults on the slope of the hills south of the village. They are presented by a system of faults with a downgrade of the north blocks on the main orientation of the conjugated couple faults in the region – west-east, steep slopes on the south coast of the river and flat at north. The steep south slopes are located with indentation, a result of skew of the main cuts with rotation and lowering in their south-western edges, which besides the

fault speaks about a shifting component of translation. This explains also the zigzag geometry of the mainstream and its position in different parts close to the south or north slope and the meandering character is caused by the characteristic for the transtensive areas with the presence of saw cuts, the formation of small pull-apart pools, in which all the boards are active, but not at the same time.

The presence of those saw cuts and on the slope north of the river confirms the rotation of blocks between the conjugated couples of faults and the formation of local depot centers. This is characteristic for the whole region as it falls in the borders of the Maritsa zone of shearing, for which is proved a right shifting component. The high seismic activity in the region of the site is also proof for the contemporary activity of the faults and the common trend of sinking.

North of the settlement mound next to the river (Kliselika) are established traces of paleo-mainstream, which could be interpreted as: a) an old river bed; b) traces of temporary floods; c) constant migration of the mainstream as a result of the compensation of the accommodating space and temporary floods. It is proved by the big watershed upstream, the steep slopes, the lack of "traps" for territorial material, its inconsistent distribution and the discharge of the river during low water periods. This presupposes during hard rain, on one side floods in the terraces and on the other the formation of debit flows or high waves.

The situation is similar in the located just east alluvial pull-apart pool in the region of Vladimirovo village, after which the river enters in a region with a higher lay, created by Paleozoic granitoids with a metamorphic border and Triassic territorial rocks. These rocks form the mat are strongly weathered and offer a rich influx of territorial material as a consequence of intense erosion and the transportation during hard rain at long distances.

Traces of similar spills with sedimentation of big amounts of terrigenous material are observed east of the second settlement mound (Madrets 1), as well as on the terraces over which the mound is located. The higher terrace reaches the base of the upper settlement mound, which could be interpreted as discharge and overflow of large areas. The small displacements between these terraces (0.5 – 1.5 m) and the additionally developed on top of them local draining system indicates fast draining of the water as a consequence of some kind of cataclysm or a similar event connected to draining, probably an earthquake. Generally, floods are a very fast and dynamic process, while the drainage is much more time consuming and even longer or permanent overflows are possible, and their draining is caused only by a cataclysm. This could be confirmed by shallow drills of the terraces and an analysis of the sediments from the core.

The region is very interesting as an object for research of contemporary geodynamic processes, but it need further attention. These results are from the preliminary terrain observations and treatment of satellite pictures and for more factual results is necessary a more detailed terrain work.

The clay samples are submitted to wet chemical and LA-ICP-MS analyses. The objective is to compare them with the ceramic artifacts and to determine the provenance of clay sources used in pottery manufacture. Because the results from the examination of the clays were received too late, they are not processed in detail. They are presented in Table 1. The same can be said about the pottery samples. The results of their geochemical analyses are presented in Table 2.

Pottery samples

Pottery samples selected for petrographic and chemical analyses of the clay paste are taken from the following sites:

- Yabalkovo (EN) -25 fragments
- Chokoba 18 A (LN)-31 fragments
- Constantia (EBA) – 18 fragments
- Madrets (EBA) – 1 fragment
- Galabovo (EBA-MBA) – 31 fragments
- Chokoba 18 (MBA)11 fragments
- Chokoba 18A (MBA-LBA) – 6 fragments

One aspect of pottery technology is the use of woven and plaited goods, such as baskets and mats

in the production process. Samples of pottery fragments (pot bases) with mat/basket impressions were selected from one of the sites included in the project:

Dana bunar 1 (ECh-LCh) – 28 ceramic fragments

For identification of organic temper in clay paste, samples were taken from the following sites:

- Yabalkovo (EN) – 25 pieces of burnt clay used in the construction of houses and stationary equipment
- Dana bunar 1 (ECh-LCh) – 28 ceramic fragments
- Sokol (EBA) – 15 pieces of burnt clay used in the construction of stationary equipment
- Chokoba 18 (MBA) – 50 pieces of burnt clay used in the construction of stationary equipment
- Chokoba 18A (MBA-LBA) – 25 ceramic fragments

Samples of colored slips and pigments:

- Yabalkovo (EN) – 8 fragments with red slip (Ya_S.EN_018-025), from them 3 with white (Ya_S.EN_019-021), 3 with dark (Ya_S.EN_023-25) and 1 with polychrome (Ya_S.EN_022) painted decoration; 1 fragment with chequer board pattern and white incrustation (Ya_S.EN_009); 1 fragment, coated with red ochre(?) on the interior and supposed black painting (Ya_S.EN_012);
- Constantia (EBA) – 4 fragments with red slip /Con_S_001-003, 012/;
- Galabovo (EBA/MBA) – 2 fragments with red slip /SMG_S.BA_028, 031/ and 1 fragment with white incrustation (SMG_S.BA_027);
- Chokoba 18A (LBA) – 1 fragment with probable dark painting (Ch18A_S.BA_006).

It is supposed that some of these fragments are imports, which is subject to proof or rejection by instrumental methods.

RESULTS

Archeological analysis – technology and classification

Archeological activities are carried out in the field and in the lab.

Terrain work with specialists geologists include localization, mapping and testing of resourcing areas for each of the micro-regions included in the research. The places selected for testing are described, photographed and mapped.

Study work

Work with collections of ceramic materials from the sites included in the research, was carried out in three stages: selection of fragments, macroscopic description– and systematization. It is performed a technological and formal characterization of the ceramic fragments, from which are taken probes for analysis. Collections are stored in the museums of Sliven and Haskovo, archeological base Sokol and archeological base in the village of Mineralni bani, Haskovo district.

Selection. With purpose of obtaining adequate information from the investigations of fragments, through which to reconstruct the cycle of ceramic production during the respective age, a careful selection of the materials was done. All ceramic fragments were selected from secure archeological contexts and so-called "closed complexes" – situations, undisturbed by later periods – for each of the sites (Fig. 6).

Macroscopic description of ceramics. These fragments are characterized in detail in several aspects – technology, formal classification and decoration. For each site, included in the first year of the project is created a separated database. The compiled lists of selected materials are in MS Word and Excel. Also pending is the compiling of a catalogue with data-base in MS Access.

Ceramic technology. Fragments are separated in technological groups on the basis of technological attributes – wall thickness, clay fabric and temper, surface treatment. There are five basic groups of inclusions in clay paste (fine and coarse sand, tiny rock particles, mica and organic fillers) as they are described in concentration, visible in the fracture of the fragments. In the presence of additional coating (slip) of the pots, the description is on the basis of two criteria: colour and thickness (fine,

medium -thick, dense). Surface treatment is described as follows: unsmoothed, smoothed (unevenly smoothed; well-smoothed); burnished (matt, polished in stripes, evenly), polished. The surface colour and the colour of the fracture are defined with the help of Munsell Soil Color Chart.

Classification of ceramics. Samples are selected amongst individual fragments, which can be reliably defined in terms of category, shape and size.

Analysis of decoration. A grouping has been done according to the technology of decoration, the position of motives and compositions of decorative elements and the correlation between the last technological and formal groups.

The documentation of the selected materials included their technological description, graphic and photo documentation (Figs. 7-40). The applied illustrations present information for ceramics' manufacture of each object, its dating and cultural specifics.

Tests' preparation for lab analyses. Selection is done, signing of the corresponding specimen, selection of the most suitable method of analyses and choice of the most suitable place (surface) for preparation.

Macroscopic identification of mixtures. Types of temper. To define mixtures in clay mould, added by potters, investigations are laid out the mineral component of ceramic artifacts. Mixtures are characterized by a few criteria: size, shape, quantity and character. They are inorganic – minerals or fragments of rocks, organic (traces from plants, shells and bones) or anthropogenic, for example "grog" (grounded fragments from already fired ceramic pots). Identification of organic mixtures.

Archaeometric studies

Instrumental methods used in first year of the project.

Petrographic analyses. 33 thin cross sections are prepared, which are studied by optic microscopy (Figs. 41, 42). This method is used to examine the mineralogical and microstructural composition of ceramics.

Wet chemical analyses. This classical method is used to identify the macro chemical components of clays, taken after testing of rooted areas and of clays, from which are manufactured ceramic pots (chart 3, 4).

Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) analysis. It examines the concentrations of microelements and especially REE in analyzed ceramics and in clay samples (chart 3, 4).

Scanning electron microscopy. The method is used for identification of organic and inorganic admixtures in the clay fabric (Figs. 43.2; 45).

X-ray diffraction analyses is used to obtain information on the variety of minerals and colorant agents used in the preparation of coloured slips and in painted and incrusted decoration of vessels (Figs. 43.3, 44).

Gas and liquid chromatography and mass spectrometry (organic residue analyses). Organic residue analysis is initiated on a series of pottery samples from EN Yabalkovo, yet we are still expecting the results.

Institutions and laboratories

Sofia University "St. Kliment Ohridski" offered its facilities and laboratories for the realization of the project, as follows:

• Laboratory for preparation of rocks and mineral samples for ceramic petrography – it is equipped with a full set of crushing machines for sample preparation and separation of mono- mineral samples.

• Laboratory for microscopic analysis – preparation of petrographic thin sections and analysis with polarizing and electronic microscope and X-ray microprobe.

• Laboratory for x-ray diffractometry supplied with an x-ray apparatus TUR-M62.

Chemical laboratory – performs chemical analysis of rocks and minerals through wet silicate analysis

• Laboratory for Raman spectroscopy

• Laboratory for electronic microscopy
• LA-ICP-MS laboratory (in consortium with Geological institute at BAS)
• Centre of Archaeometry – coordinating organ between different labs, as well as between members of the team of different scientific departments. Equipped with storage and working rooms.

Apparatus for a fee is used for the following analyses: scanning electron microscope (Faculty of Physics, SU), LA-ICP-MS (GI at BAS), Gas and liquid chromatography (Faculty of Chemistry, SU). All analyses are made by members of the team.

Interim results

Clays

Geochemical investigations of clays and ceramic fragments.

Clay sources analysed during the first year of the project are from the vicinity of the EN site of Yabalkovo, from the land of Kasnakovo (in the valley of the Maritsa River), from the region of Sokol (Sveti Iliya heights), from the region of Chokoba (in the Tundzha River valley) and from the region of Gudzhova tell near the village of Madrets in the valley of the Sokolitsa River, north slopes of the Sakar mountain (Fig. 2). The results are presented in diagrams from figures 46 and 47, which summarize the details from Table 1. It is possible to define two groups of clays from the areas of Sokol, Chokoba and Madrets, on one hand, and from Yabalkovo and Kasnakovo, on the other.

Clays from the first group (red dots) show higher contents of alkaline components (Na_20 + K_2O).They form a cluster, which is pulled towards the top of the diagram. The second group of clays marked in green dots (Yabalkovo and Kasnakovo) is also similar in chemical composition and form quite a "compact" cluster. It is obvious that clusters do not match (Fig. 47.1). The two groups vary significantly in their chondrite-normalised REE pattern. The first group is characterized by a deep negative Europium anomaly (Eu anomaly), due to the low contents of CaO (Fig. 47.1). Clays from the second group, marked in green squares, are characterized by a shallow negative Eu anomaly, which is result from the higher contents of CaO (Fig. 47.2).

Correlation clays – ceramic fragments

Geochemical analysis is made on 26 ceramic fragments from the sites of Galabovo, Constantia, Chokoba18A and Madrets, all dating from the Bronze Age (Table 2).The results allowed the distinction of a group of six samples (Con_S_007 to Con_S_ 012). All of them derive from Constantia. No samples of clays from the region are taken (this will be a task for 2018). The chemical composition of the fragments differ significantly from that of the others, expressed in the high amounts of CaO (up to 17.91 %). This is not specific of clay rocks in the valley of the Maritsa. The total of the main petrogenic oxides in the six tests is quite low (up to 70%). It means that a high amount of carbonate minerals is present in the clay (probably calcite – $CaCO_3$). Higher contents of Sr (up to 599 ppm) in these samples may be due exactly to this reason but it might also be a result of the presence of the mineral Celestine, containing strontium sulfate ($SrSO_4$). Another distinctive feature of the six samples is the high concentration of REE, which are marked with green triangles in the figures (Figs. 46.2; 47.3). Yet another is the existence of a deep negative Ce anomaly, which is not established either in sampled clays or in any of the rest sampled pottery sherds. Beside this, the ratio of AL_2O_3 to SiO_2 in these tests separates them from both the fragments and the clays in the region (Fig. 46.3).

So far, we can assume that the six sampled vessels are not locally manufactured. Moreover, they do not constitute a homogeneous group, thus a heterogenic origin cannot be excluded, i.e. if these pots are imports in Constantia, they have been produced in different centers.

Pottery analysis

Galabovo (SMG_S.BA_031).

Two red-slipped fragments were analyzed with XRD method. The results however show there is no difference in the mineral composition of the coating and the clay matrix. The main materials are quartz, muscovite and plagioclase (Fig. 43.3). Non-destructive Raman spectroscopy was applied for control testing. The spectrum confirmed the results made by XRD. There are no visible peaks specific for substance with crystal structure, which could have been used as a clay colorant. In some

fragments, even macroscopic, is seen difference in coloring in the cross-section, yet no boundary is observed in the SEM image (Fig. 43). Thus, the coloring results most probably from the firing process. It is concluded that the same clay matrix is used both for the slip and for the pot, yet in the former it is purified in order to receive smoother and impermeable surface. Petrographic analysis was carried out on a selection of pottery fragments, macroscopically divided is the following technologicalgroups:

Group I-II – fine and semi-fine pottery

From this group 11 thin sections were prepared and analyzed under microscope (Fig. 41, SMG S.BA 001 to SMG S.BA 018). Analysis shows that rocky particles constitute ca. 90% of the fabric and the remaining part is clay. Mineral particles are mostly from feldspar (plagioclase and potassium feldspar, the latter is often identified as microcline) and quartz. White mica is rarely observed. The inclusions are shown as mono-mineral fragments and more rarely as poly-mineral aggregates (rocky pieces). Their size is irregular, as sometimes is above 2 mm. Their shape is predominantly angular which shows that they are probably crashed rocky pieces, mixed with clay. Rounded grains (river sand) are rare. No particular orientation of the inclusions is observed, however it seems that the larger ones are concentrated in the inner part of the cross-section.

Group III – semi-coarse pottery The fragments of this group are from thick-walled vessels. Five thin sections are prepared and analyzed (Fig. 41, SMG_S.BA_ 020 to SMG_S.BA_024). The mineral composition of the fabric is the same, however, the maximal size of the inclusions is larger (up to 4 mm) and polymineralic aggregates are more often present.

Yabalkovo

The investigations of ceramic fragments from Yabalkovo are made by X-ray diffraction phase identification analysis (XRD).

The object of analysis is the white substance on four ceramic fragments – samplesYa_S.EN_009, Ya_S.EN_019, Ya_S.EN_020, Ya_S.EN_021. In the first case the substance is used for incrustation, and in the rest – for painting, applied over the slip of the vessels. The results show that the mineral used in the preparation of the white pigment is calcite ($CaCO_3$). It is possible that white marbles were grounded as limestone (sedimentary rocks, built from calcite) most often are grey in colour. In one of the samples (Ya_S.EN_019) is established also the presence of talc and clinochlore. These two minerals are characteristic of altered ultrabasic rocks, i.e. they are much softer and probably that's why they have been a suitable substance for preparation of white paint (Fig. 44).

Chokoba 18

The petrographic analysis is based on 11 thin sections prepared on ceramic fragments from Chokoba 18 (Fig. 42). As opposed to the Galabovo samples, the clay matrix is quite fine. The rocky and mineral particles are with much smaller sizes. Rarely are seen such with size up to 2 mm and more. Another characteristic is the predominance of metamorphic rocks and the mineral composition is as a whole quite more diversified. Except quartz and plagioclase are established epidote particles and inclusions from low metamorphic and altered volcanic rocks.

Sokol

Research of spherical inclusions in the clay paste, macroscopically defined as looking like metal nodules. Microscopic analysis showed that these inclusions have the shape of a sphere, 3 to 6 mm in size, with two clearly separated parts. The inner part seems like a core, which is quite harder and more compact and has an outer shell, which is more fragile and with more porous texture (Fig. 45.1). These specifications are seen quite well under scanning electron microscope (Fig. 45.2). With the help of SEM/EDX analysis was created a spectrum for establishing the presence of chemical elements in the central part and the periphery (Fig. 45.3-4). The analysis shows predominant presence of Mn and little quantity of K and Ca. High contents of oxygen points to a manganese oxide. The inclusions are probably present in the initial clay. If it is of Oligocene age, the chemical composition is easily explained.

Oligocene age is known in geology for its manganese-bearing deposits. The manganese ore deposit 'Obrochishte' in NE Bulgaria is formed in Lower Oligocene sediments, and there manganese occurs in the shape of concretions of different size. It may be supposed that due to the high temperature (up

to 800 C) during the firing process, the manganese mineral has been melted down and today we are seeing it as a slag-like nodule (Fig. 45.4). The periphery of the inclusions has a much more specific and rich chemical composition (Fig. 45.3). Analysis of this content shows that it is for clay and it probably is from the resource, used for the making of object.

Data from archaeobotanical analysis

Organic remains in clays Tempering clay with organic fillers (especially plant remains) is of particular importance for the prehistoric pottery production. Little attention has been paid so far to the botanical identification of the organic temper. On the other hand, the analysis of fibre remains may produce valuable data for the reconstruction of different ceramic recipes, as well as for the exploitation of natural resources.

The samples subject to analysis are studied by optical microscopy NOVEX (30x magnification). Microphotographs are taken with a USB Digital Microscope (20x-200x magnification). Samples from pottery fragments and burnt pieces of stationary household equipment are selected from several sites: Yabalkovo, Chokoba, Sokol, Dana bunar 1.

Yabalkovo. The studied material from the Early Neolithic settlement includes pieces of burnt remains from house walls and stationary equipment. The observation revealed negative imprints of small twigs, stalks and seeds.

The results demonstrate that in the preparation of the clay fabric are used mainly dry stalks of different cereal crops (straw). Probably left accidentally after threshing, there were preserved also a few grains mainly of barley (*Hordeum vulgare),* einkorn *(Triticum monococcum)* and club wheat *(Triticum aestivo-compactum)*. Weeds are presented with brome grass (*Bromus* sp.) and annual meadow grass (*Poa annua*) (Fig. 48, 4-6).

Sokol. Samples have been taken from the remains of burnt stationary equipment (bins and granaries), excavated in the EBA layer of the tell (Fig. 45). Microscopic observations show high concentration of organic mixtures, with a dominant presence of barley (*Hordeum vulgare*). Different parts of the ear are added to the clay paste – grains, chaff, spikelet bases (Figs. 50, 51).

Dana Bunar 1. For the purpose of the project 28 ceramic fragments have been selected and studied (Fig. 52). On the surface of three of them are identified negative imprints of barley grains (*Hordeum vulgare*) and cereal chaff (*Triticum* sp.). The negatives of rye (*Secale* sp.) are found in two fragments (Figs. 53, 54).

Chokoba. The investigated materials from MBA-LBA are from sites 18 and 18A. They include thick- walled pottery fragments and pieces of burnt daub and remains of household equipment (Fig. 55). During the firing process organic filler is partly or completely destroyed, leaving negative imprints in the fabric. Daub pieces from Chokoba 18A contain mainly straw and cereal grains (*Triticum* sp.), as well as small negatives from burnt chaff (Fig. 56).

Traces of plant remains were found on daub pieces and ceramic fragments from Chokoba 18. Daub pieces contain imprints from einkorn (*Triticum monococcum*), emmer (*Triticum dicoccum*) and club wheat (*Triticum aestivo-compactum*), barley (*Hordeum vulgare*), rye (*Secale cereale*) and brome grass (*Bromus sp*.) (Fig. 57, 1-3). Again barley is best represented among the organic fillers. On the surface of the ceramic fragments and in the fresh fractures is established the presence of club wheat, cereal chaff (*Triticum* sp.) and barley (*Hordeum vulgare*).

The quantity of the investigated ceramic fragments and daub pieces from the different sites varies, that is why it is difficult to make a final conclusion. The results show a dominant presence of admixtures from different parts of wheat plants and barley.

Mat and basket impressions on pottery bases

The impressions give information for the technique of pottery manufacture and especially for the process of shaping and drying of pots prior to firing. The final results will be laid down in the PhD thesis of M. Andonova. Here a brief summary of the preliminary analysis is given.

Object of this research are 27 samples of pottery bases, with imprints of mats and/or baskets from the Chalcolithic layer of Dana Bunar 1.Two types of weaving techniques are presented: open/faced simple twinning with circular orientation and plain/checker weave with square orientation. In

circular items the passive elements, sourced from the centre, which initiated the weave, will be called warp, the active elements, which are twined in intervals between warps and are coiled from the centre towards the periphery – weft. In plaits with square orientation, passive elements will be called ribs, and active elements – weft.

The bases with imprints of circular weaves were subject to defining of the minimum or maximum possible diameter of the base and the weave. The minimal size was assumed according to the outer preserved arc, formed by the coiling of the weft, when it doesn't match the terminus of the pot base. The maximum diameter is established when the terminus of the pot base is present; in both cases were used graphic arcs for the establishment of the diameter.

In the macroscopic description of the types of weaves and elements casts were prepared from the negative impressions with the help of dental wax, heated to a maximum of 300° C. After that, an analysis with stereoscope and cold LED light was undertaken, as well as SEM images at low vacuum conditions of two fragments of each type of weave.

Mats/baskets with circular organization. Most of the studied material from Dana Bunar 1 consists of fragments or whole bases of ceramic pots with imprints of mats or baskets, made by open twining with circular orientation (18 out of 27 samples). In several cases the centre of the weave is preserved, the one that initiates the weaving: those are samples №, 3, 4, 9 and 16, as well as partially preserved centre in №17 and 19. The cases, in which we can presume that the edge of the woven object is present, are rare – for example in №14 and 15b. Some observations allow the assumption that at least in some case shallow containers made of plant materials were used in the process of shaping the body of the vessels.

The dominant weaving technique is open simple twining, with one exception – fragment №6, which has an impression from a weft-faced simple twining (Fig. 58.1). In the cases of open simple twining a square centre is present with an even number of initial stakes, placed at right angle, from where the actual stakes start, around which the weft strands are twined in a spiral. Several samples demonstrate the direction of weave – from left to right in the mark, which would be reciprocal in the original weaved object. In almost all cases of circular weaves, the stakes are hidden from the coils of the weft and thus their section and diameter remains invisible. The weft of all circular weaves is with circular section, which allows the measurement of its diameter. The diameter of the weft in almost all of the samples varies slightly from 2 to 3 mm, with one exception – №15b, where it is 5 mm. Several weaves (i.e. №3, 4 and other) are extremely regular and the size of the weft doesn't change, it keeps its value around 2 mm in diameter, with a constant, growing from the center to the periphery, interval between the stakes. Others are not so precise and their wefts' diameters vary, as well as the interval between warps is irregular (e.g. №1, 15b).

Precisely the weft is the main evidence, allowing speculation about the plant materials chosen. It has to be noted that no actual plant remains were recorded, but some of the impressions allow extrapolation of the plant morphology. In the cases of wefts with lower diameter values of diameter, with the help of stereoscope in combination with SEM images, there are clearly distinguishable vertical grooves, parallel to one another (Fig. 59). These common morphologic features (section, diameter, longitudinal ridges and grooves) of the leaf and/or stem, are in support of monocotyledonous plants, whose leaves and stems have a circular transverse section and their epidermis is saturated with parallel grooves along the leaves and the stem. Representatives of the monocotyledonous flora, traditionally exploited in basketry, could be types from the families *Poaceae, Cyperaceae, Juncaceae*. This list could be narrowed among those types, spread in the modern flora of the Balkans, in comparison with the available paleobotanical data and ethnographic fieldwork data. In the case of sample №15, the higher diameter (5mm), as well as the plain surface of the weft imprints could be explained in many ways but it could also testify for the use of dicotyledonous plant with a circular cross section. Those could be young twigs of similar diameter, chosen among several types of trees, spread in the Balkan flora, from the families *Salicaceae, Aceraceae, Fagaceae Betulaceae, Cornaceae, Malvaceae* and other.

Rectangular weaves. Without exception, these items are made in plain weave, where each weft goes alternately over and under each warp rib (1:1). The weave is quite dense and compact, with

the exception of fragments №21, 22, 24 and 27, where there is a greater distance between the ribs and the weft is less compact. It has to be noted that fragments №20, 23, 25 have extremely well preserved impressions of weaved structures (Fig. 60). The width of the weft varies between 5 and 11 mm in those fragments and in several places a doubling of the weft is recorded with the purpose of maintaining the desired width. All imprints represent flat cross-section and parallel grooves, again characteristic for the monocotyledonous plants.

As with circular weaves, here too actual plant remains are missing, but only the imprints of epidermal tissue of the plant leaves (Fig. 61). The transverse section of the leaf and its width, as well as the pronounced distance between the grooves, could be in favour of the choice of broad-leaved plants, for example from the families *Typhaceae* and *Poaceae*. Traces from rotation on the bases are not present and this allows the assumption that the pots have been placed on the plaited structures in the process of drying.

From a chronological point of view, the available evidence suggests that rectangular weaves are almost exclusively associated with Early Chalcolithic pottery, while the impressions of circular mats/baskets are mostly on pottery from complexes dated to a later stage of the Early Chalcolithic and the Late Chalcolithic. Whether this reflects a local/regional preference or it has a chronological meaning, could be judged after comparisons of the data from Dana bunar 1 and those from other Chalcolithic sites.

Identification of lipids

The testing of organic remains in cooking pots (so-called organic residue analysis) gives basic data for their use. In the first year of the project, samples are given from Yabalkovo (EN) – 2 fragments (Ya_S.EN_004 and 011). The results are positive. Gas-chromatography gives the presence of highly molecular organic compositions, which identification with mass-spectral analysis is forthcoming in 2018.

CONCLUSION OF THE INTERMEDIATE RESULTS AND PERSPECTIVES FOR THE DEVELOPMENT OF THE PROJECT

In conclusion of the report, it could be underlined that the work on the project is developing successfully and the accumulation of the necessary empirical data is in an advanced stage. It is early for interpretation. The main reasons are at least two – not all fields of the matrix are filled and not all tests undertaken in 2017 have presented their results. In addition, the team foresees an expansion of the scope of the work in several directions. There is now reason to doubt, that the chosen instrumental methods, the stages of work and the pace of processing of the field information and so on, will not lead to positive results.

Concluding the work made through the year, we reach the opinion, that it's necessary to develop the research in two directions: 1) further research of those objects, which exhibit have a potential for diachronic ("vertical") analysis within the stages of one era or between the different prehistoric ages;

2) increasing of the territorial range within the region with the attachment of new sites. With the purpose of correlation the data with the neighboring territories is necessary the inclusion of data from the western parts of the upper Thracian lowland; with East of Trace and Northwestern Anatolia; with the Bulgarian seaside at East and with North Bulgaria (Central and Northeastern). Enlargement is envisioned of the data base with the inclusion of information from the objects Nova Nadezhda, Chavdarova cheshma (Simeonovgrad), Aşağı Pınar (Kırklareli) and Hoca çeşme, Troy and other. It is possible the inclusion of data from the region the Marmara sea (Aktopraklık) and from the Black sea – Sozopol and Kiten. The correlation of the data in north could lean on the ceramic from objects of the sites north of Stara planina – for example Dzhulyunitsa – Early Neolithic (Veliko Tarnovo region) and Belokopitovo – Late Bronze age (Shumen region).

"The expansion" of the project in those directions will be made in the established time and financial constraints, object of Contract DN10/8 from 16.12.2016.

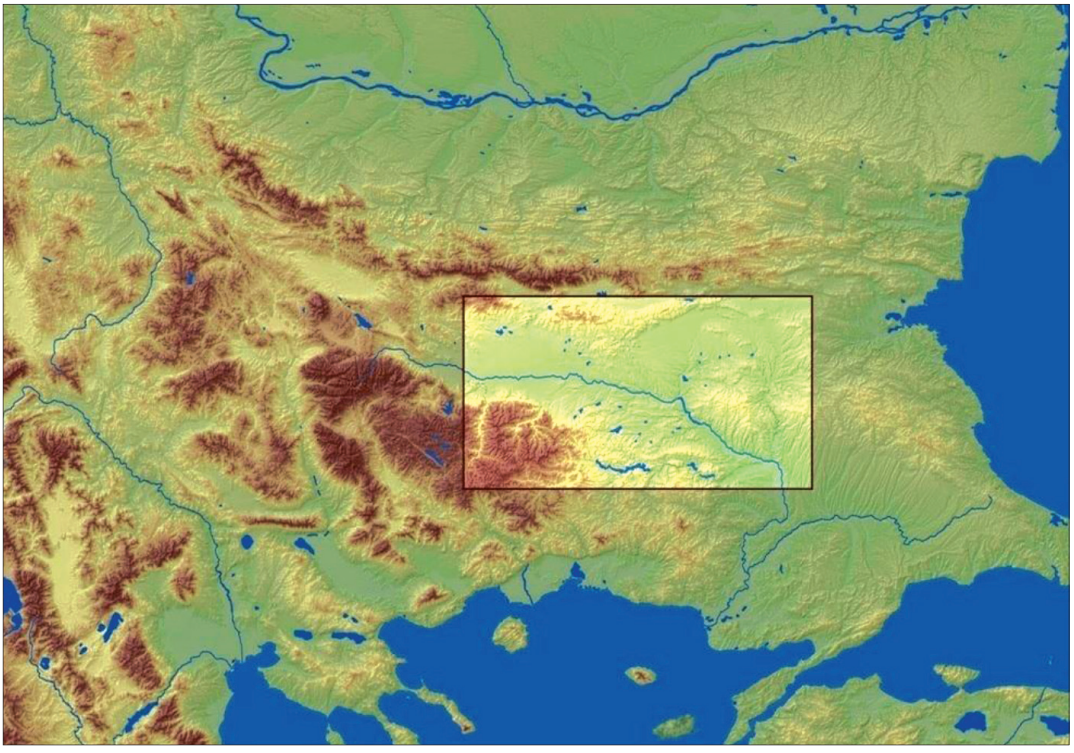


Fig. 1. Map of Bulgaria with the study area (highlighted).

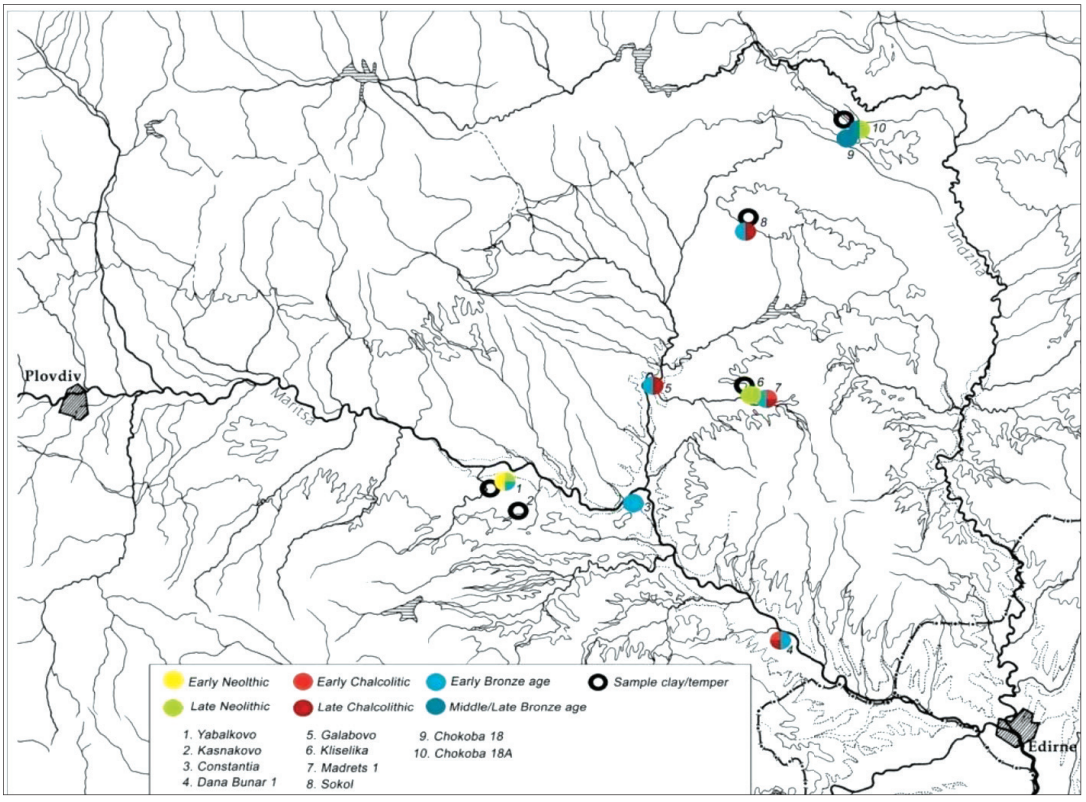
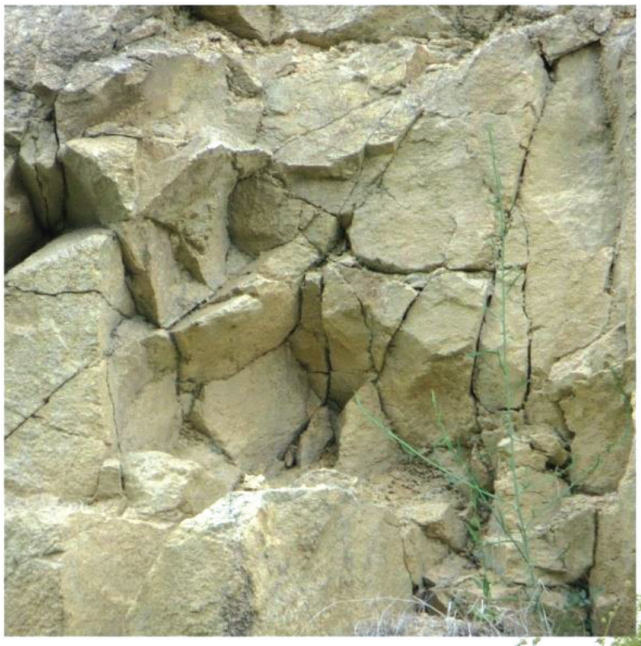


Fig. 2. Map of Upper Thracian lowlands with sites included in the project.



1. Granitoide cracks in the area of Sokol



2. Fault zones of tectonic clay



3. Fault zones of tectonic clay

Fig. 3. Granitoide cracks and fault zones of tectonic clay in the area of Sokol.



Sample Ya_R_01



Sample Ya_R_02



Modern quarry in the area of Yabalkovo

Fig. 4. Provenance of clay samples from the area of Yabalkovo.

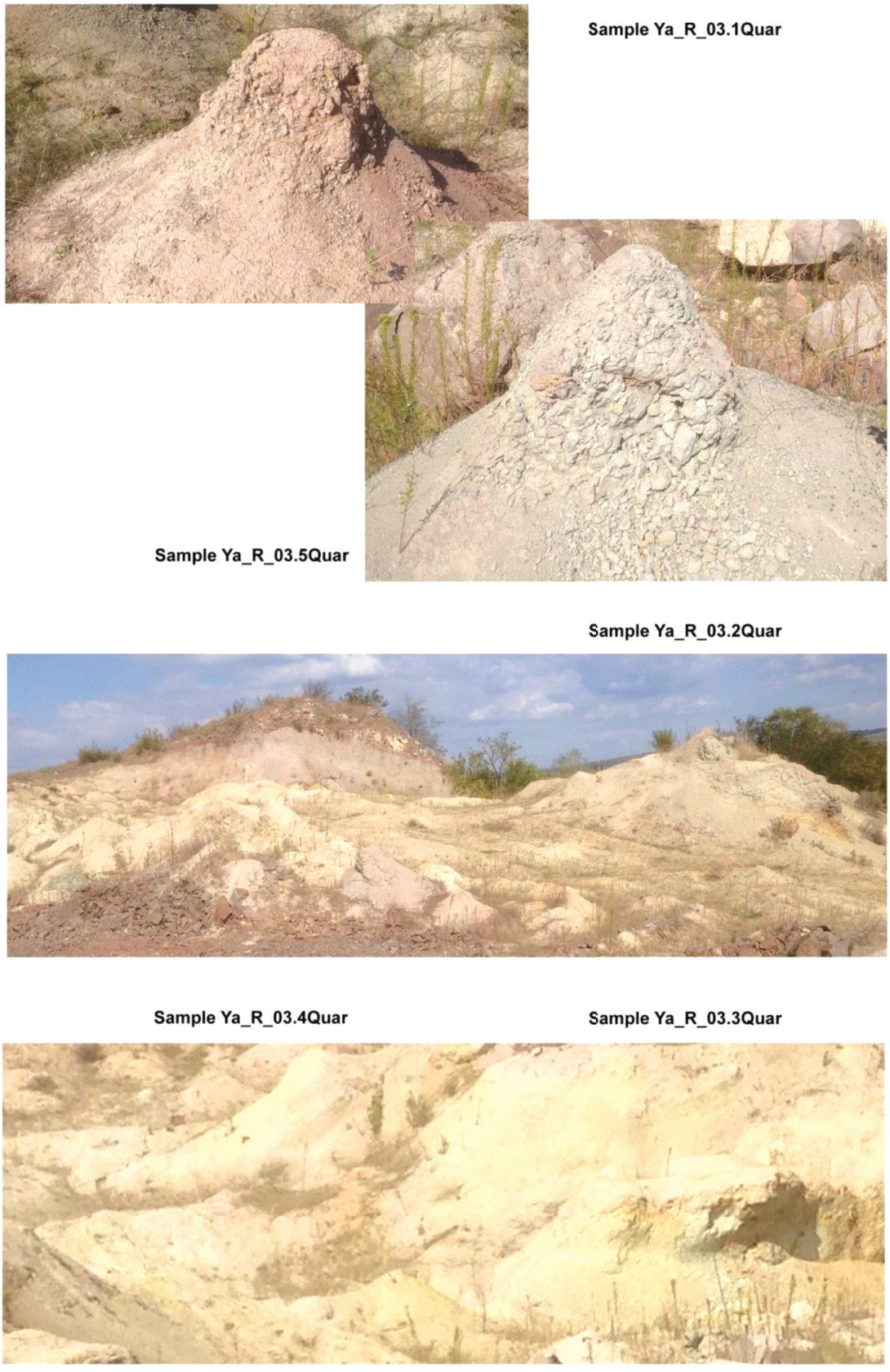


Fig. 5. Provenance of clay samples from the area of Yabalkovo (modern quarry samples).



Fig. 6. Work with pottery collections. Selection of sherds for analyses.

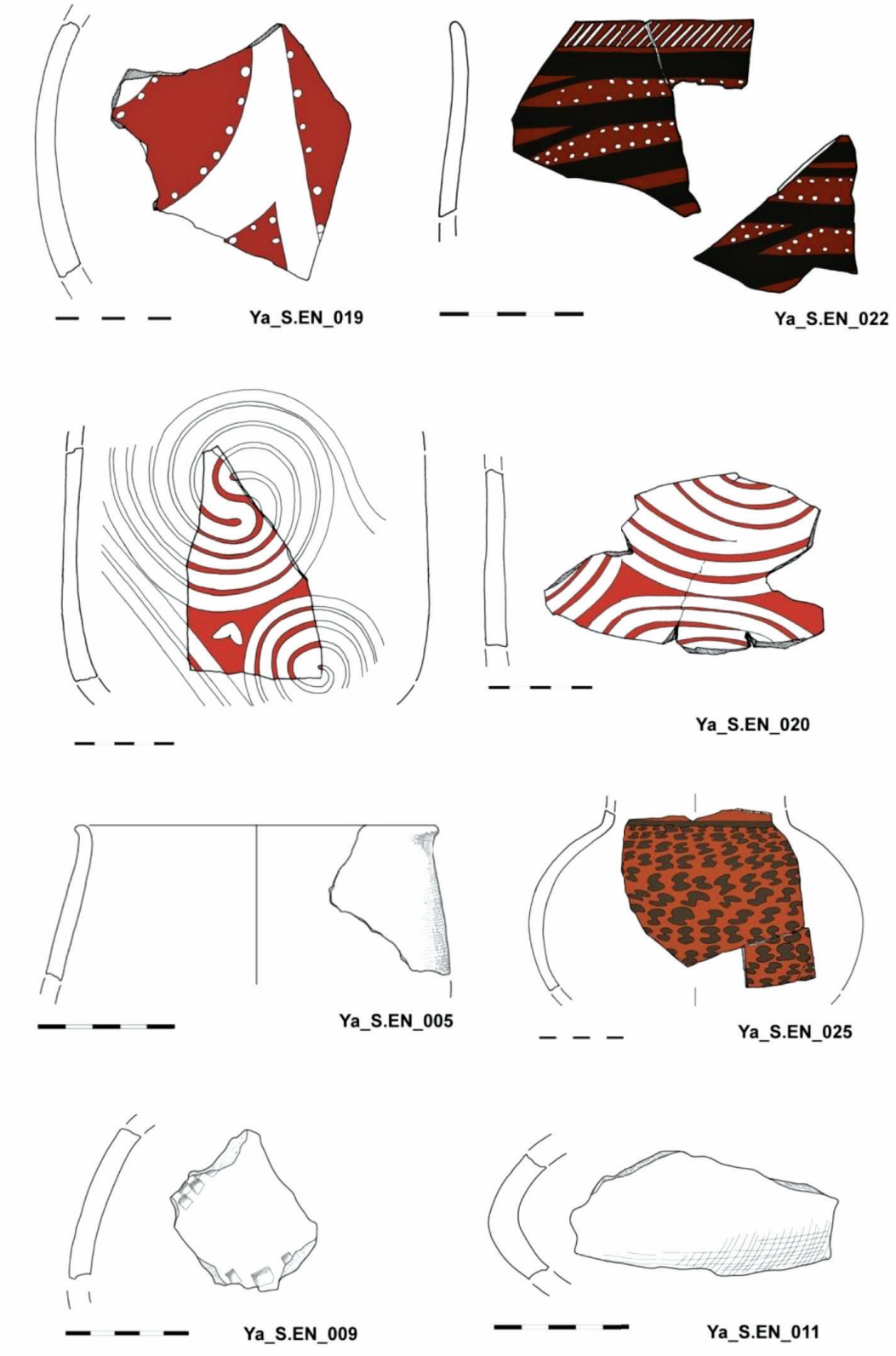


Fig. 7. Pottery sherds from Yabalkovo, Early Neolithic.

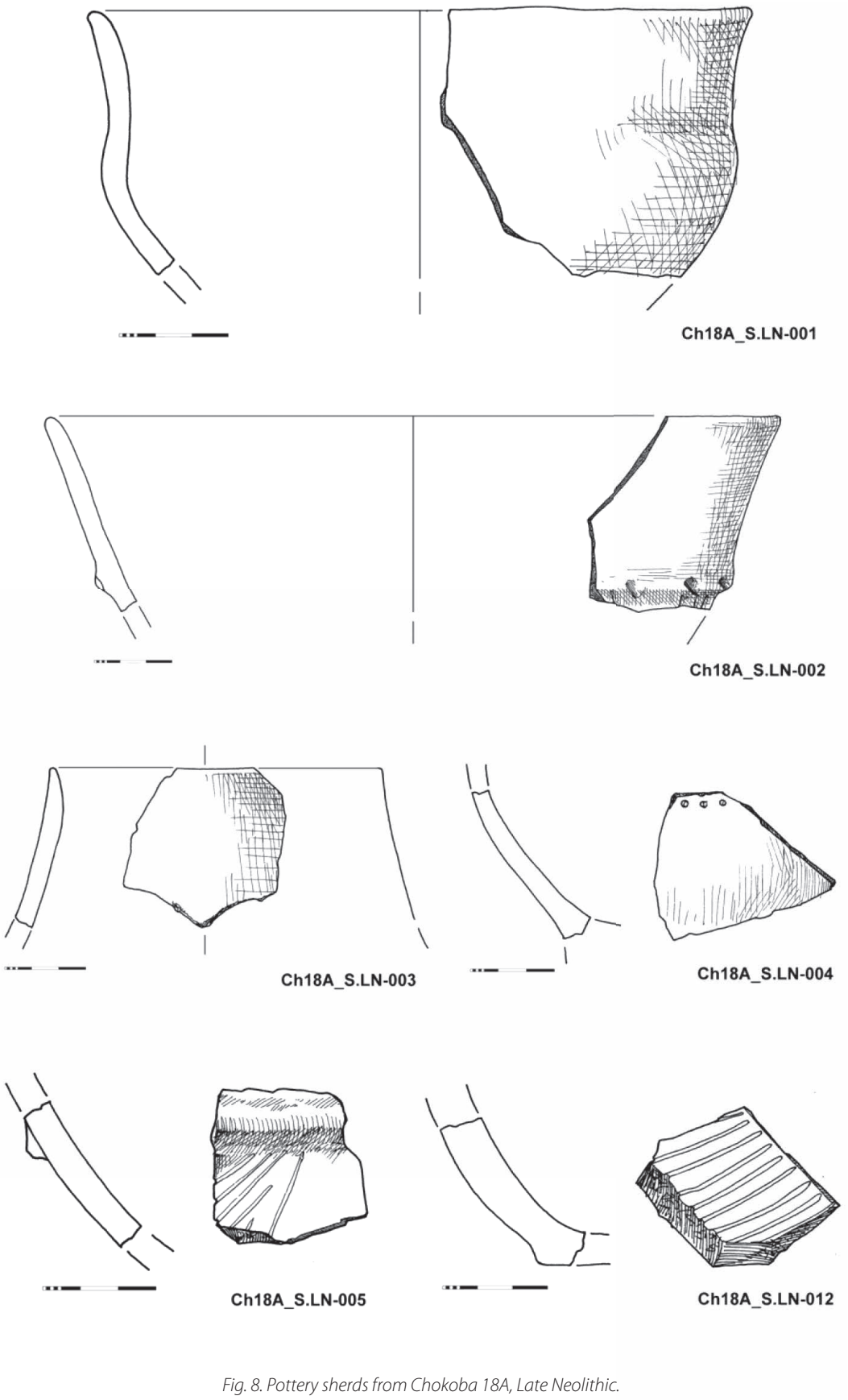


Fig. 8. Pottery sherds from Chokoba 18A, Late Neolithic.

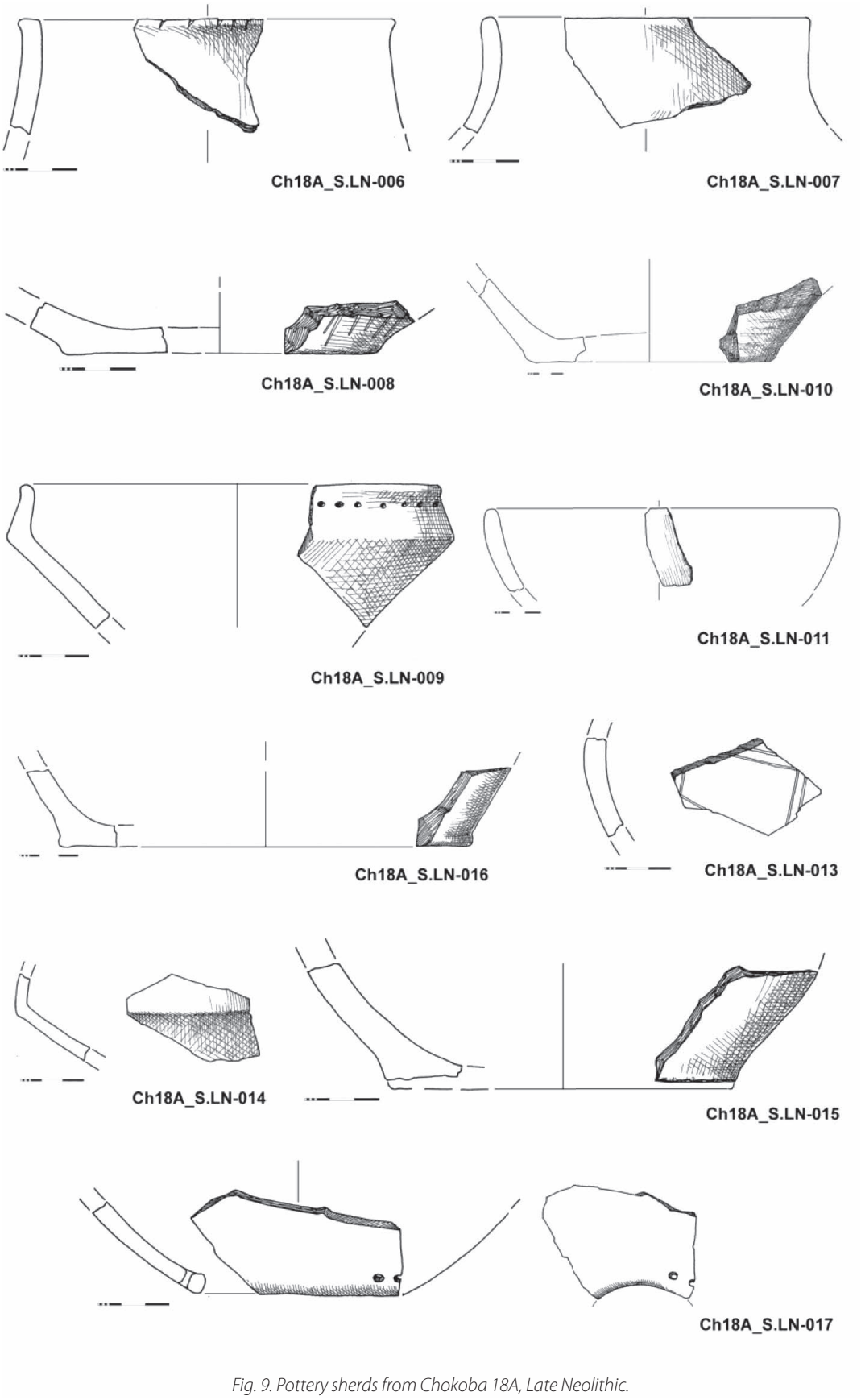


Fig. 9. Pottery sherds from Chokoba 18A, Late Neolithic.

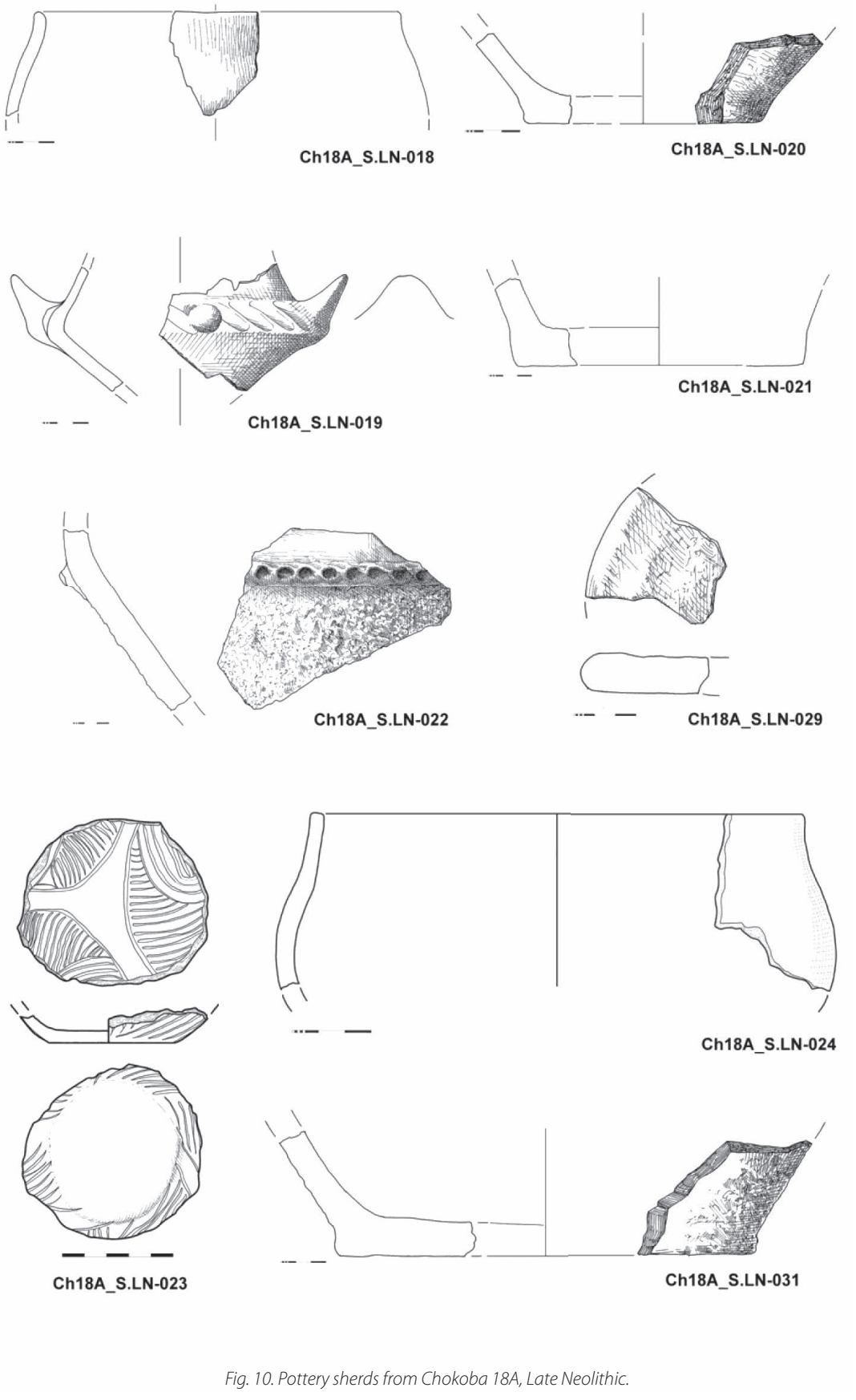


Fig. 10. Pottery sherds from Chokoba 18A, Late Neolithic.

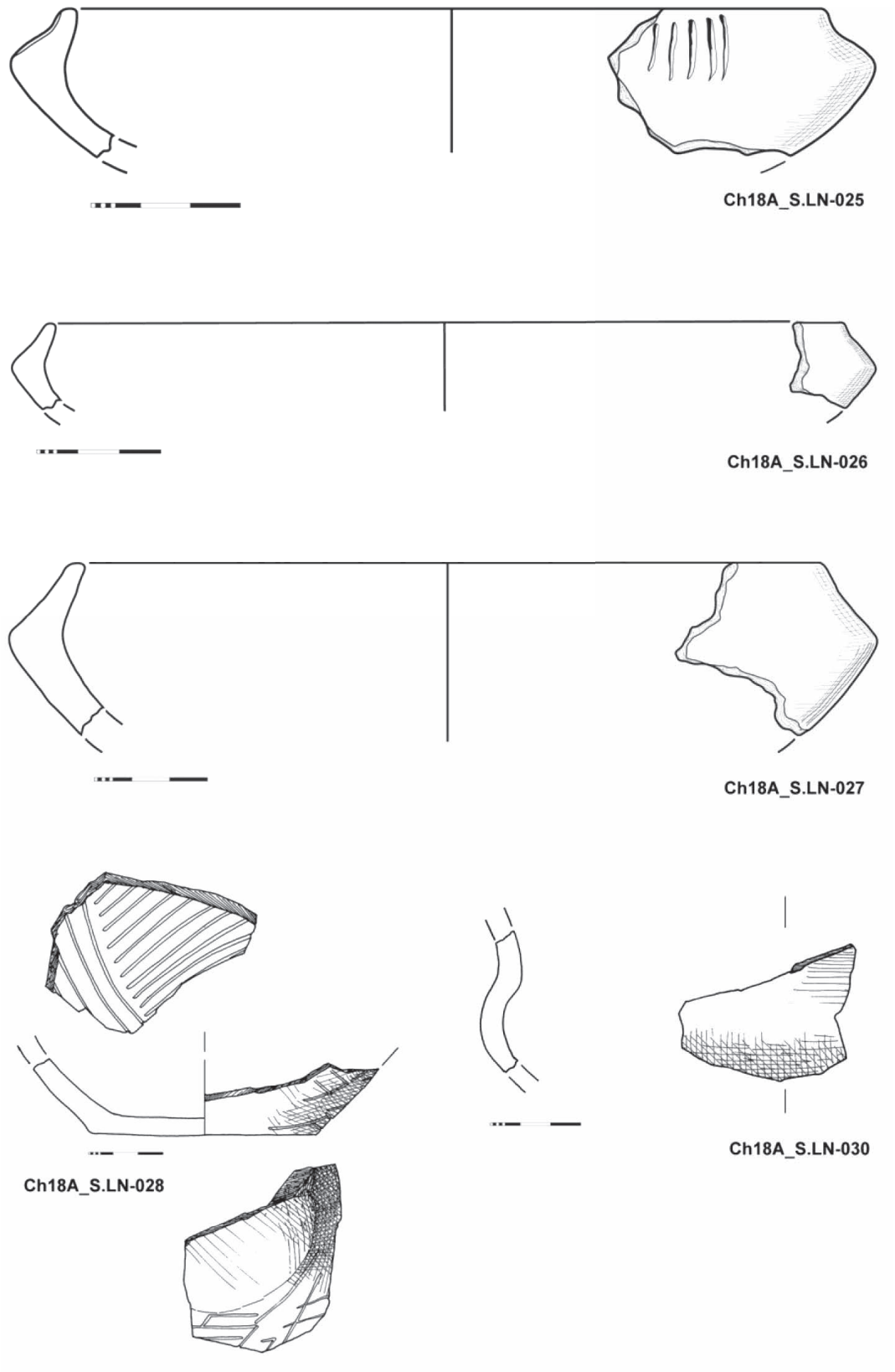


Fig. 11. Pottery sherds from Chokoba 18A, Late Neolithic.

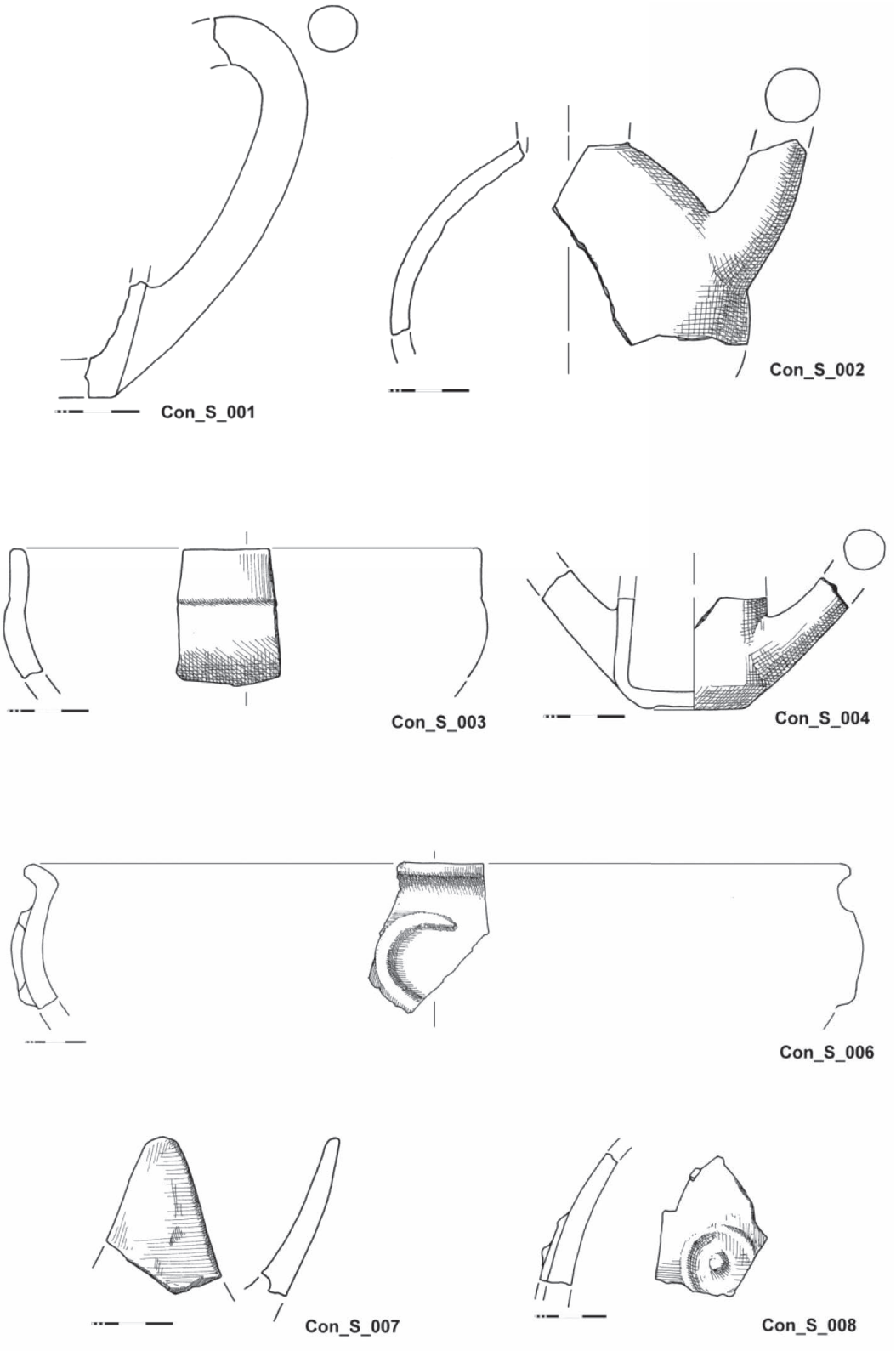


Fig. 12. Pottery sherds from Constantia, Early Bronze Age.

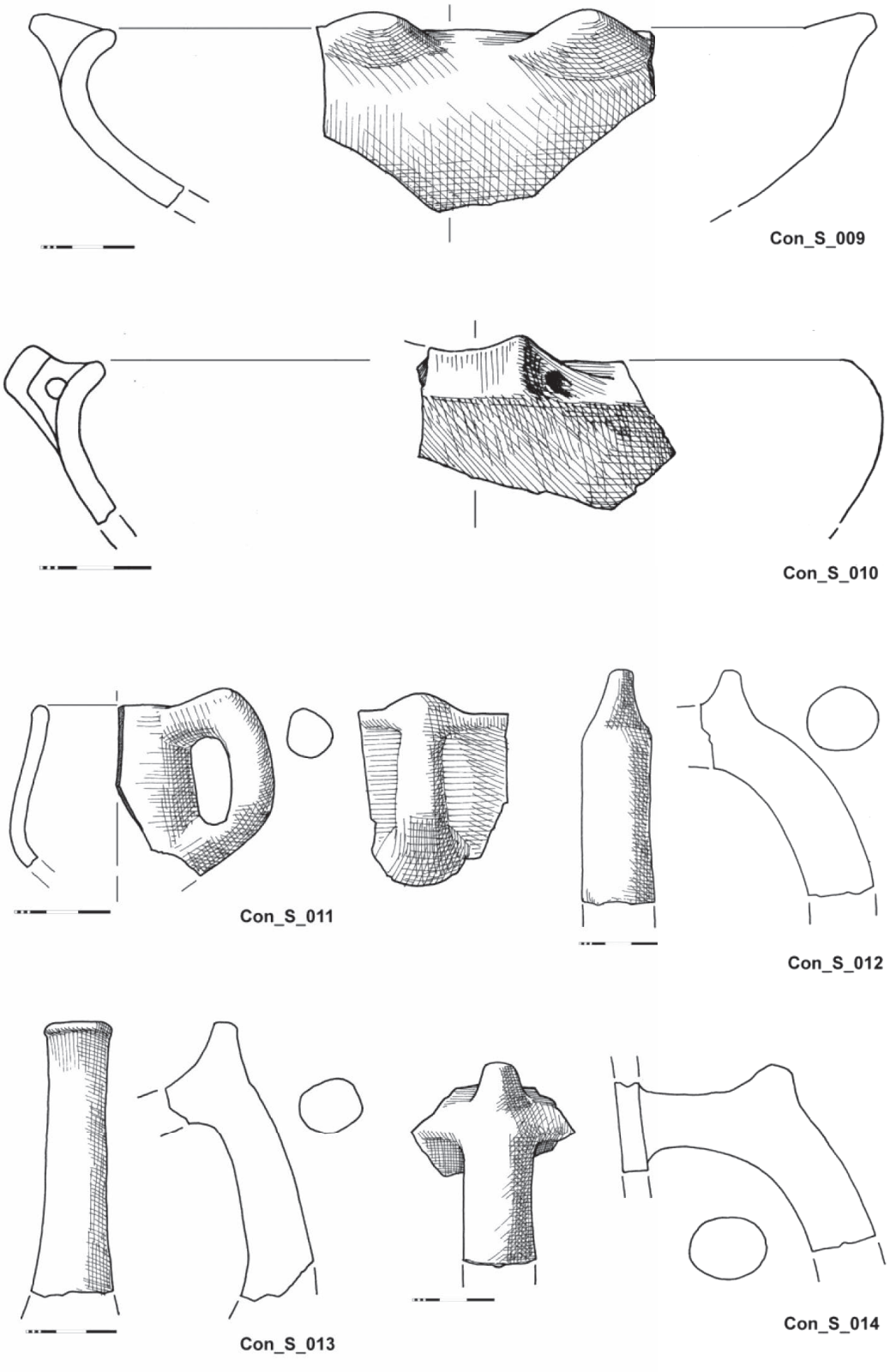


Fig. 13. Pottery sherds from Constantia, Early Bronze Age.

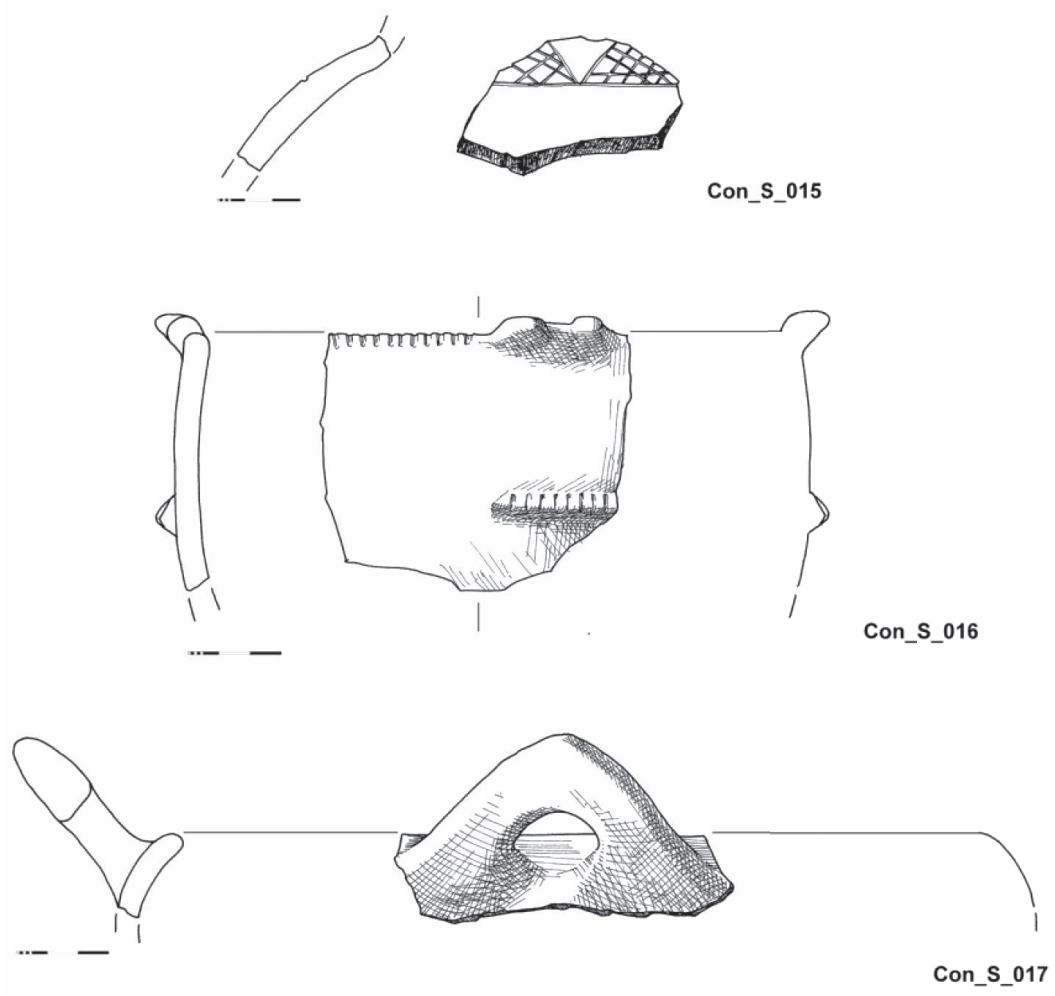


Fig. 14. Pottery sherds from Constantia, Early Bronze Age.

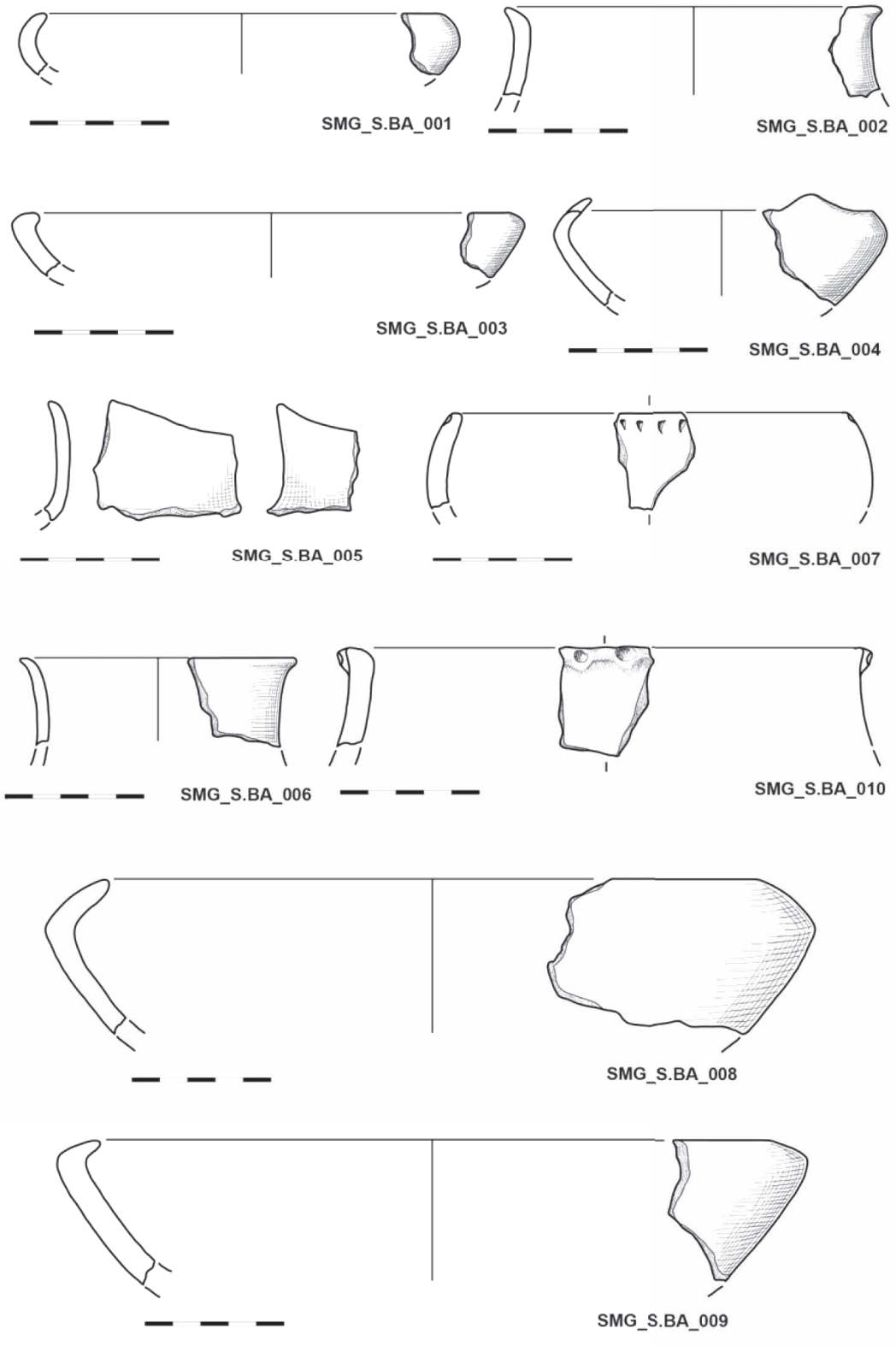


Fig. 15. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.

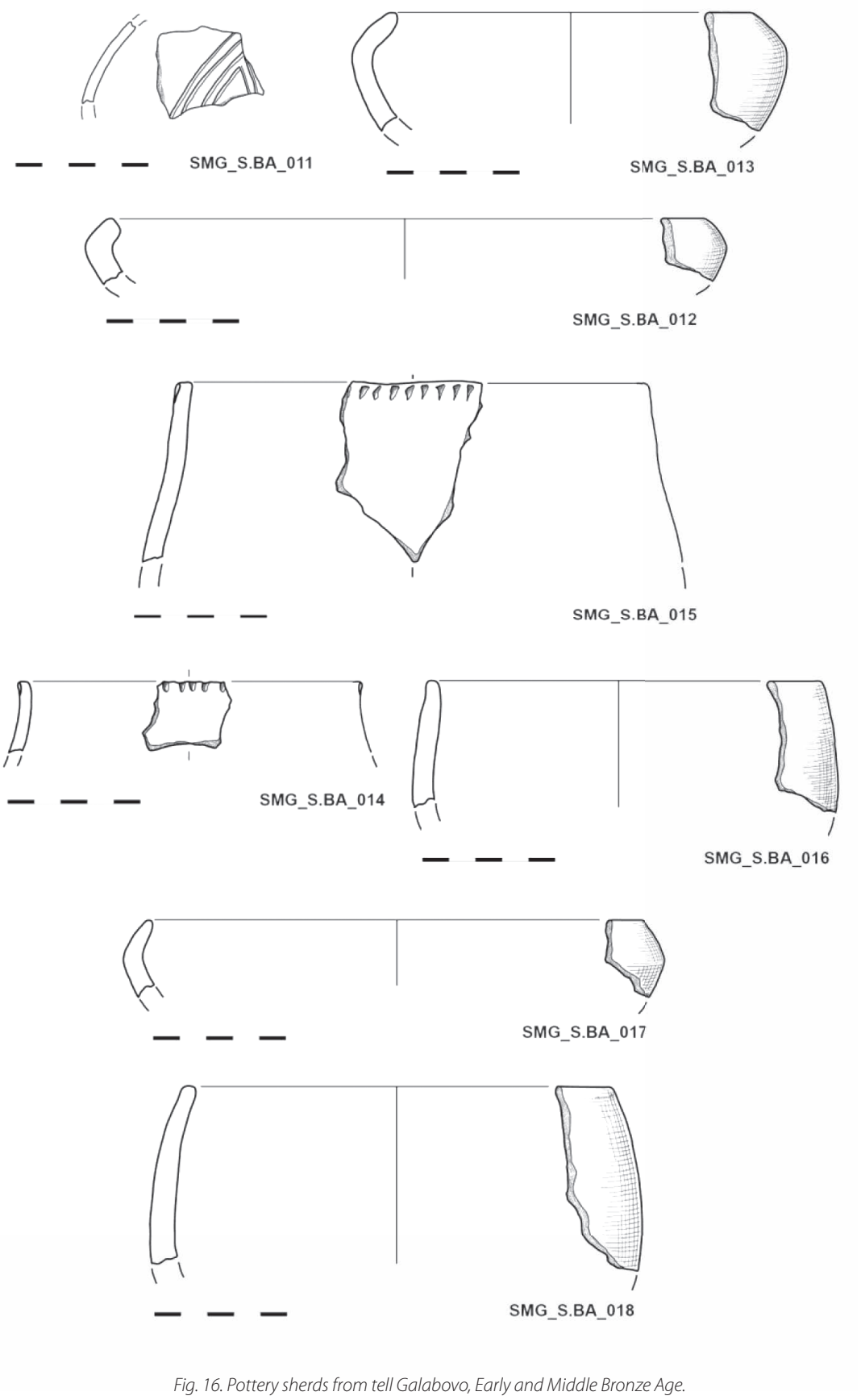


Fig. 16. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.

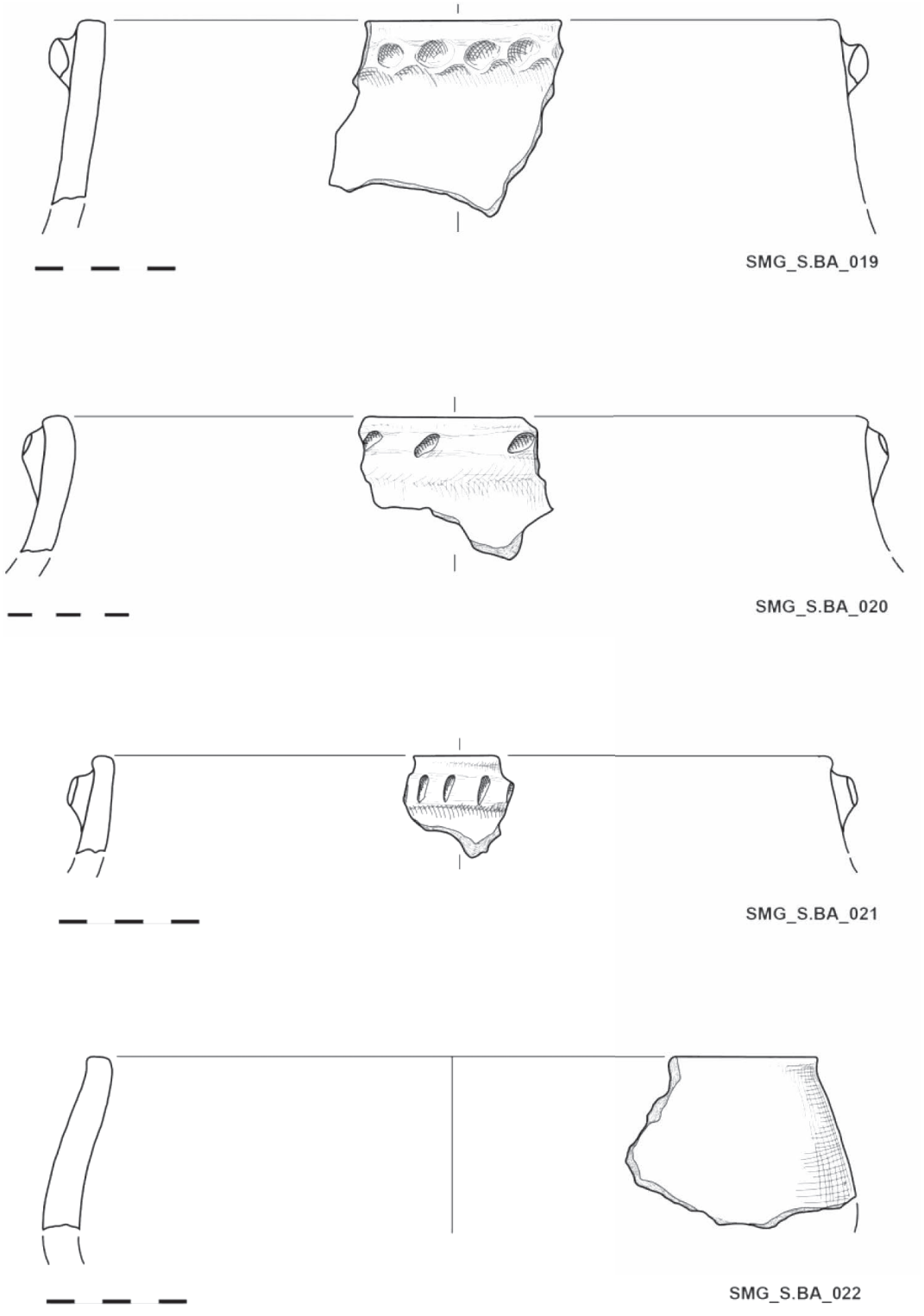


Fig. 17. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.

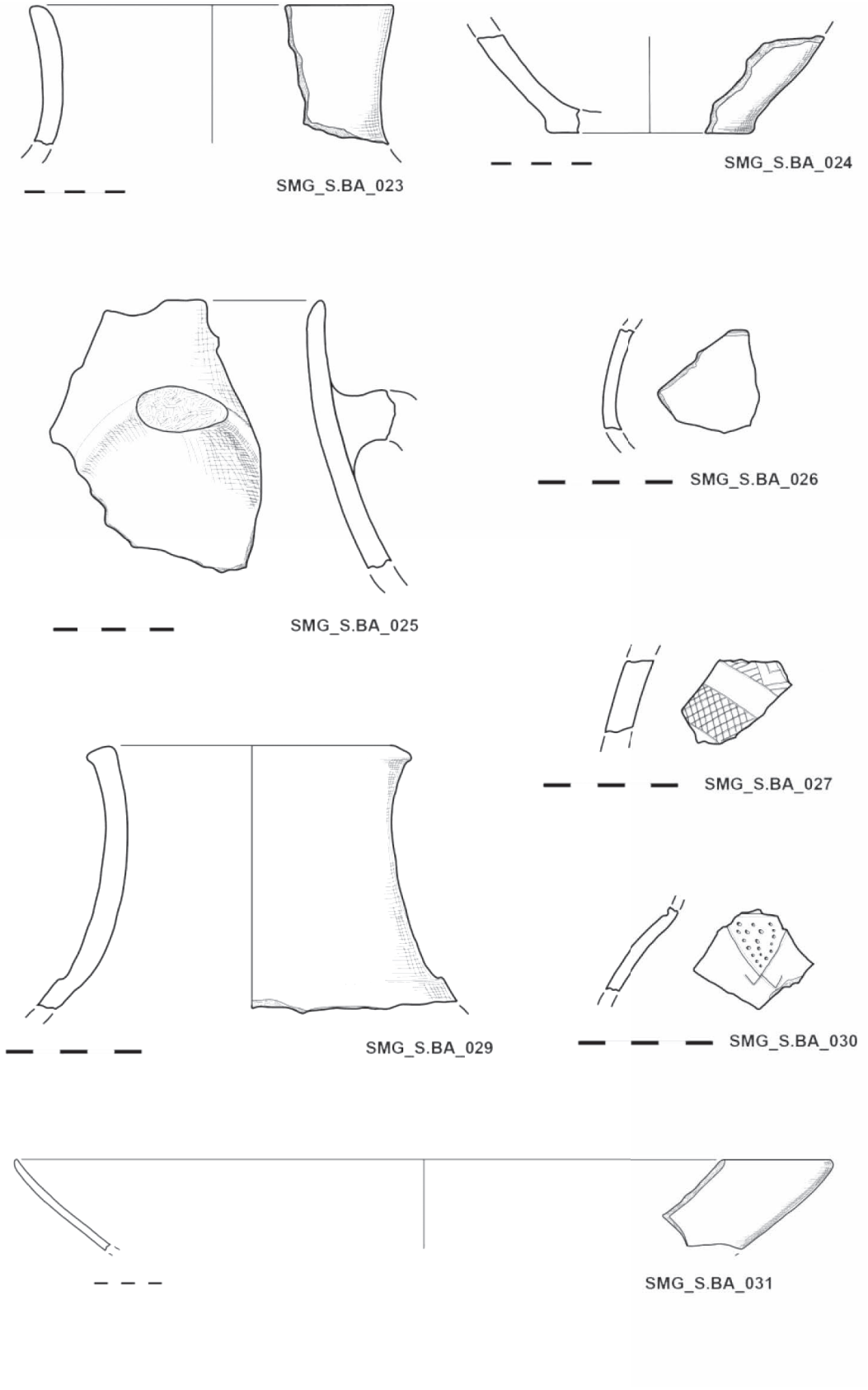


Fig. 18. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.

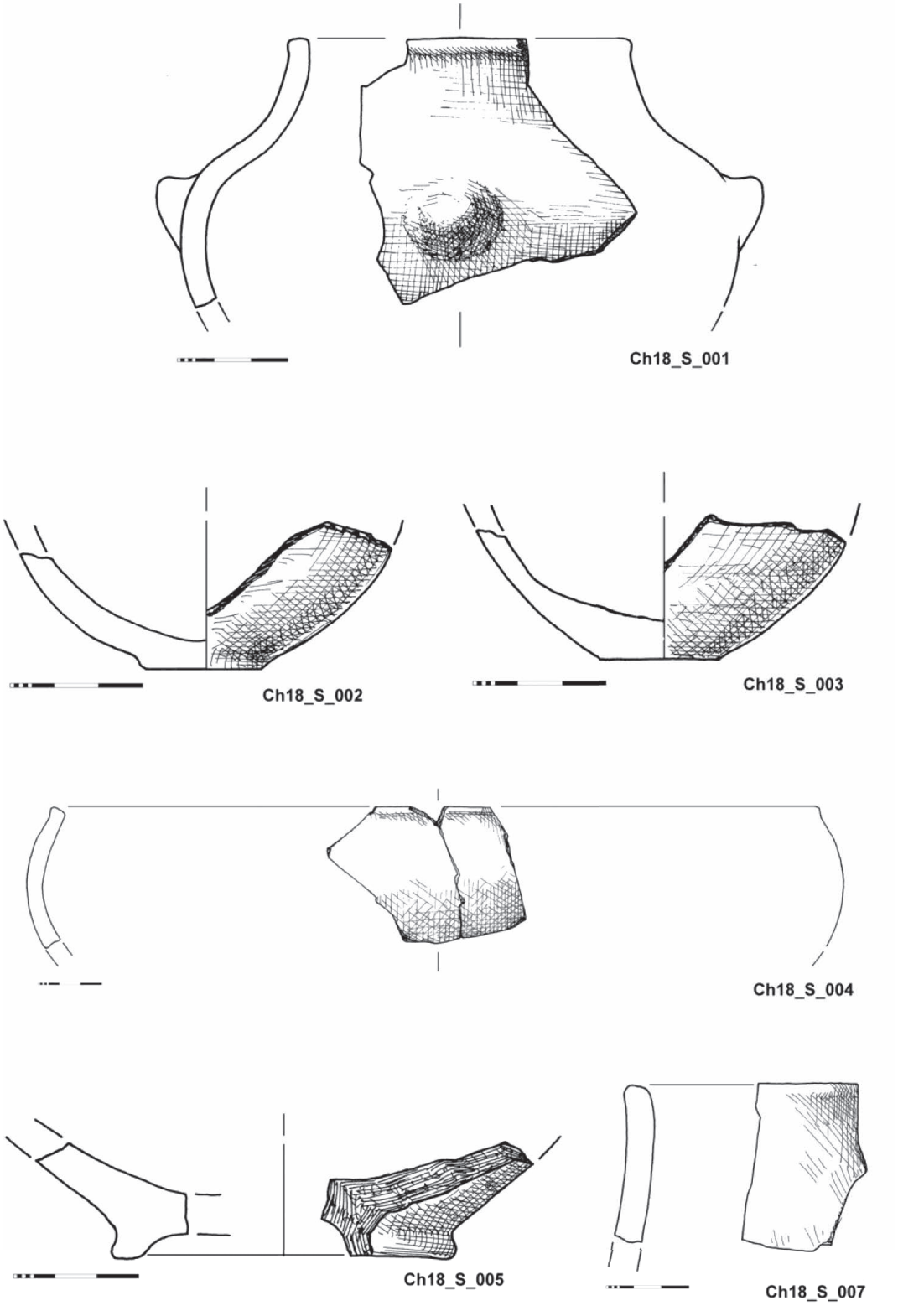


Fig. 19. Pottery sherds from Chokoba 18, Middle Bronze Age.

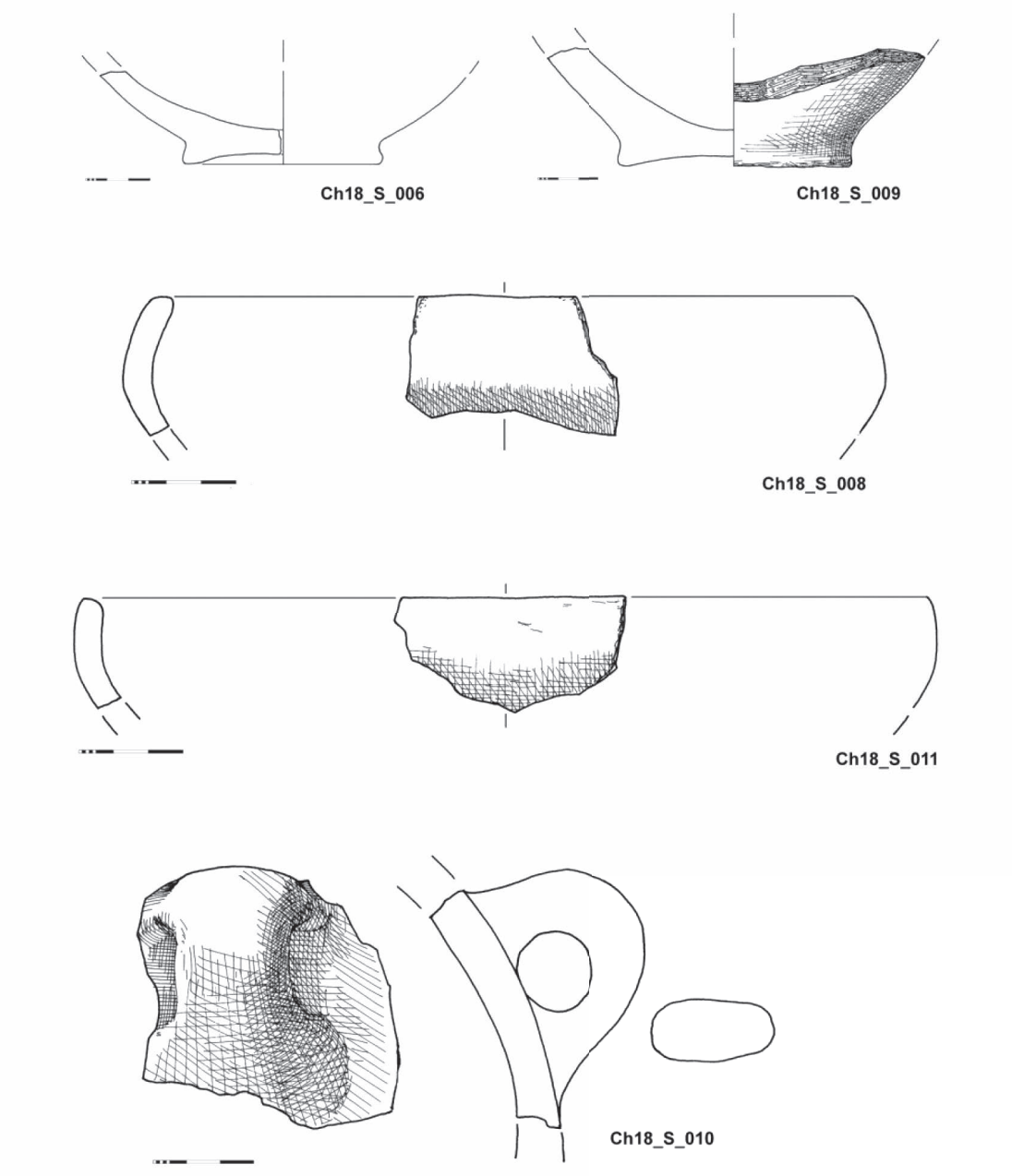


Fig. 20. Pottery sherds from Chokoba 18, Middle Bronze Age.

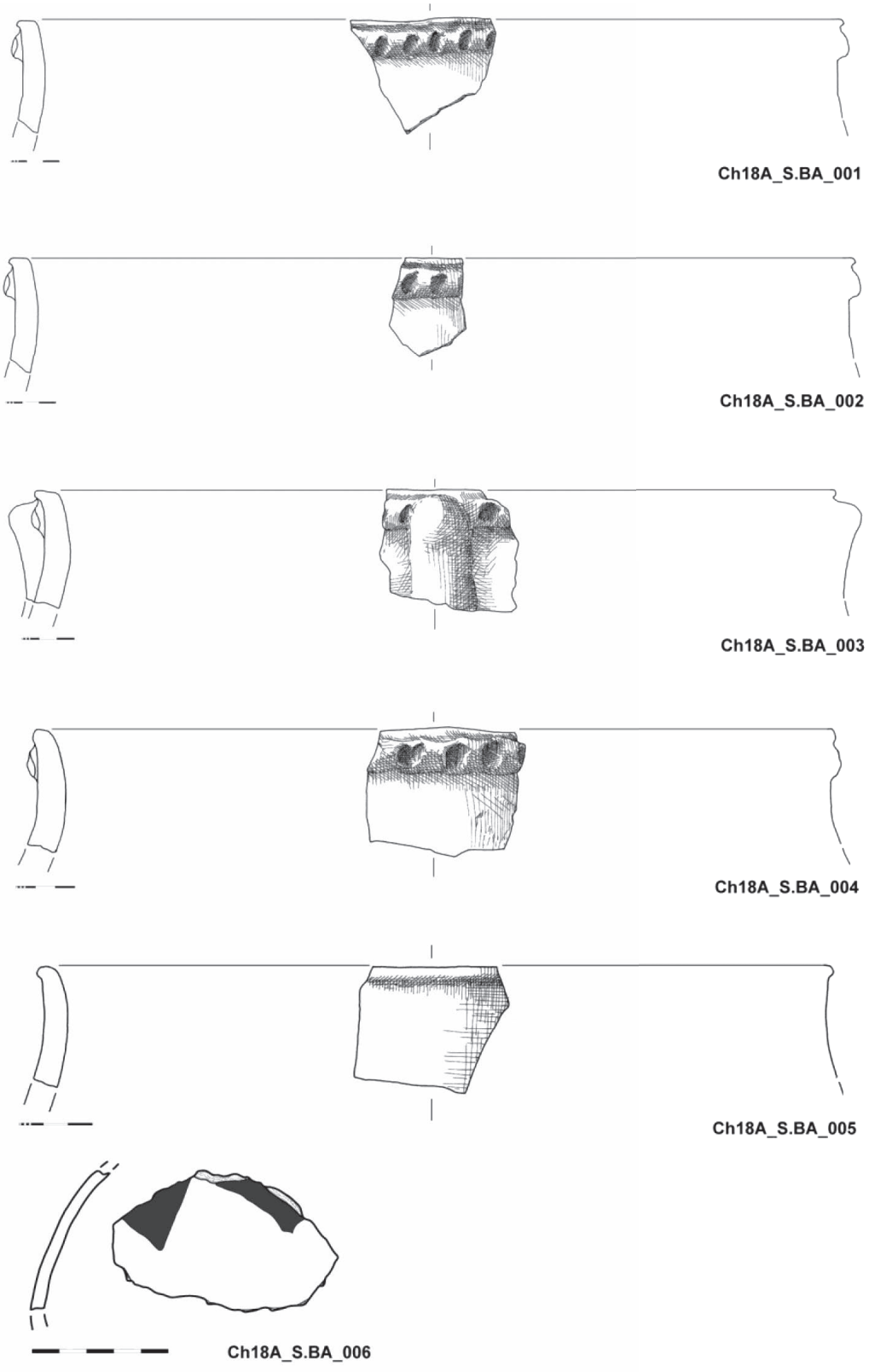


Fig. 21. Pottery sherds from Chokoba 18A, Middle and Late Bronze Age.

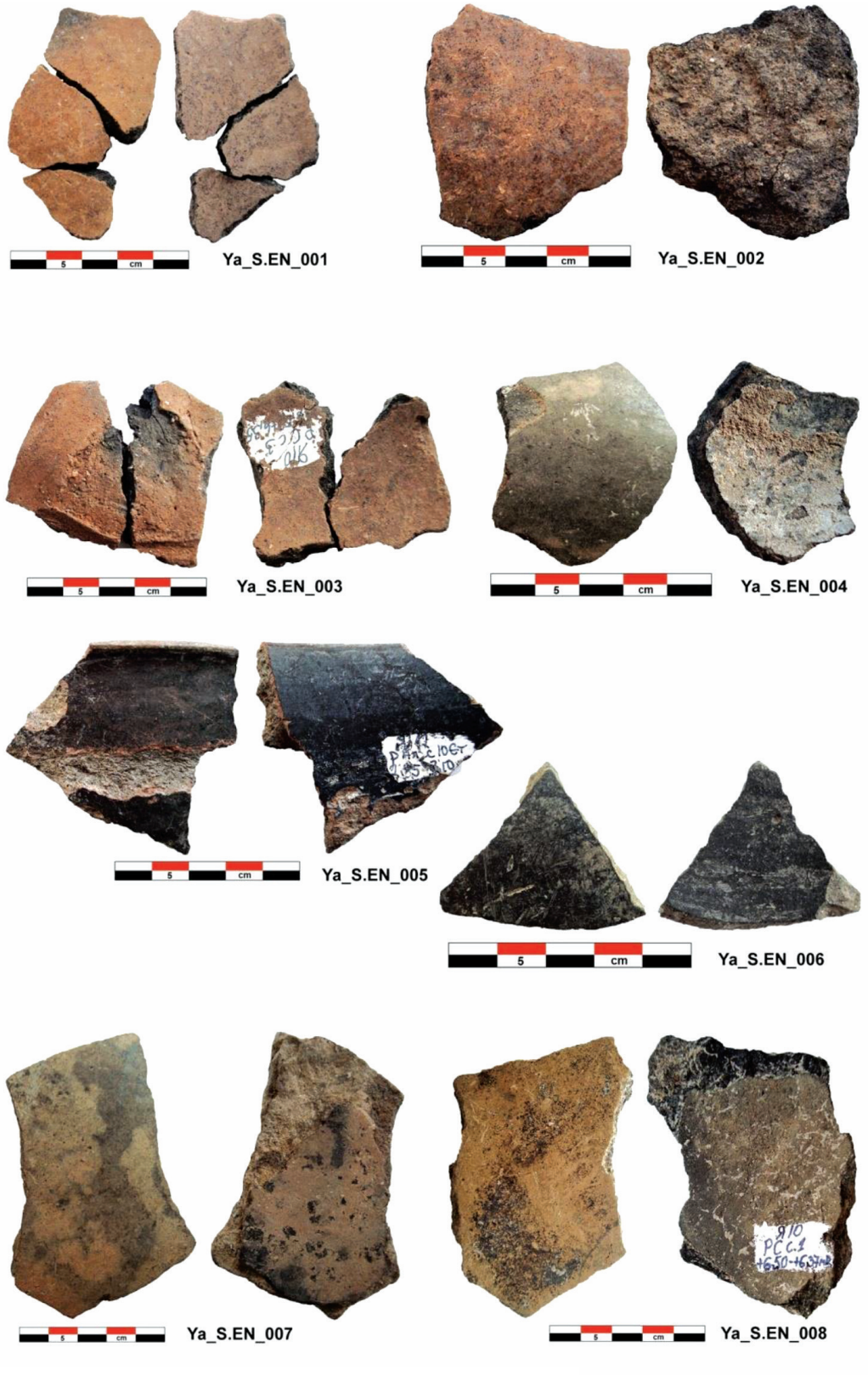


Fig. 22. Pottery sherds from Yabalkovo, Early Neolithic.

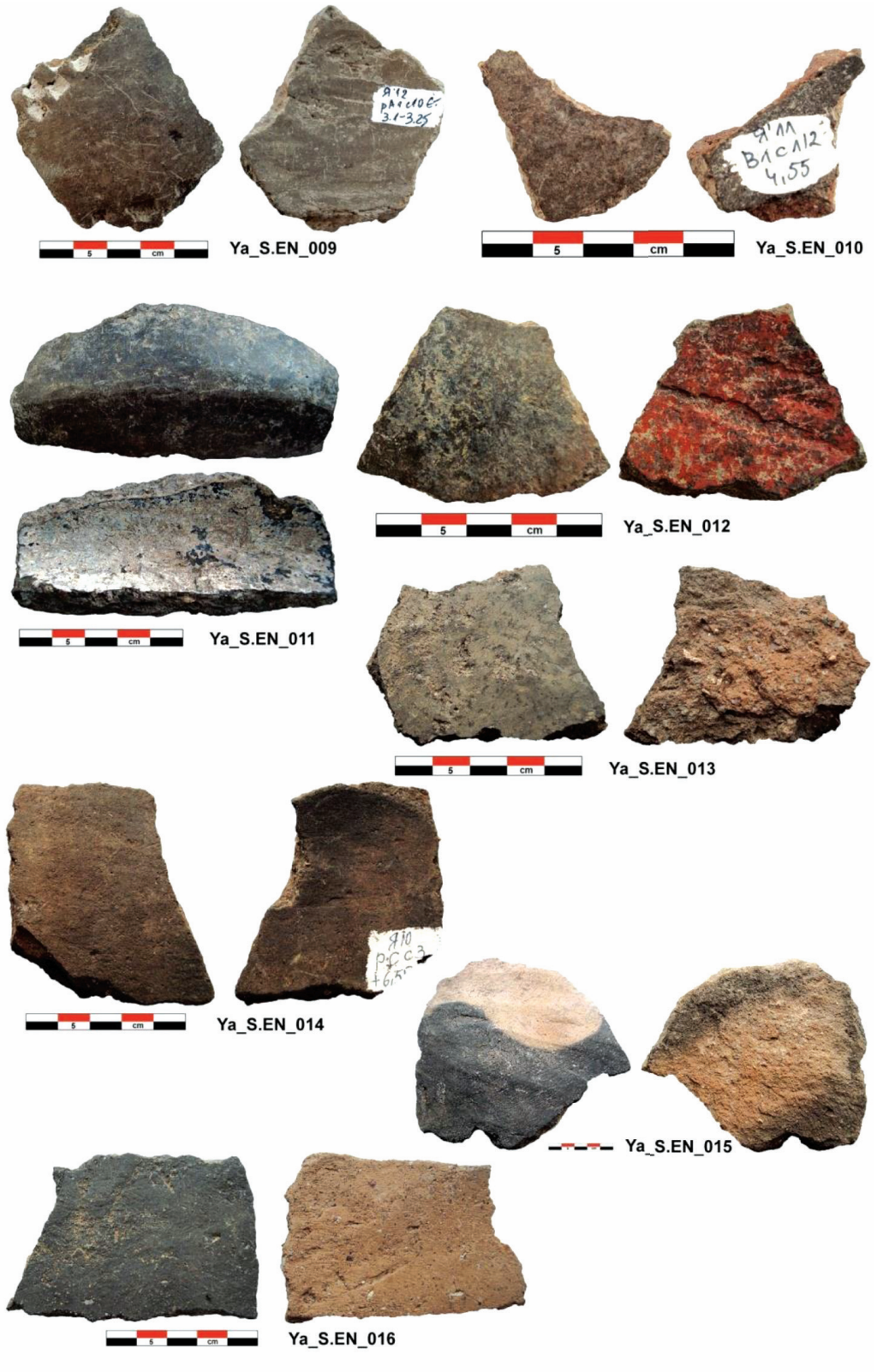


Fig. 23. Pottery sherds from Yabalkovo, Early Neolithic.

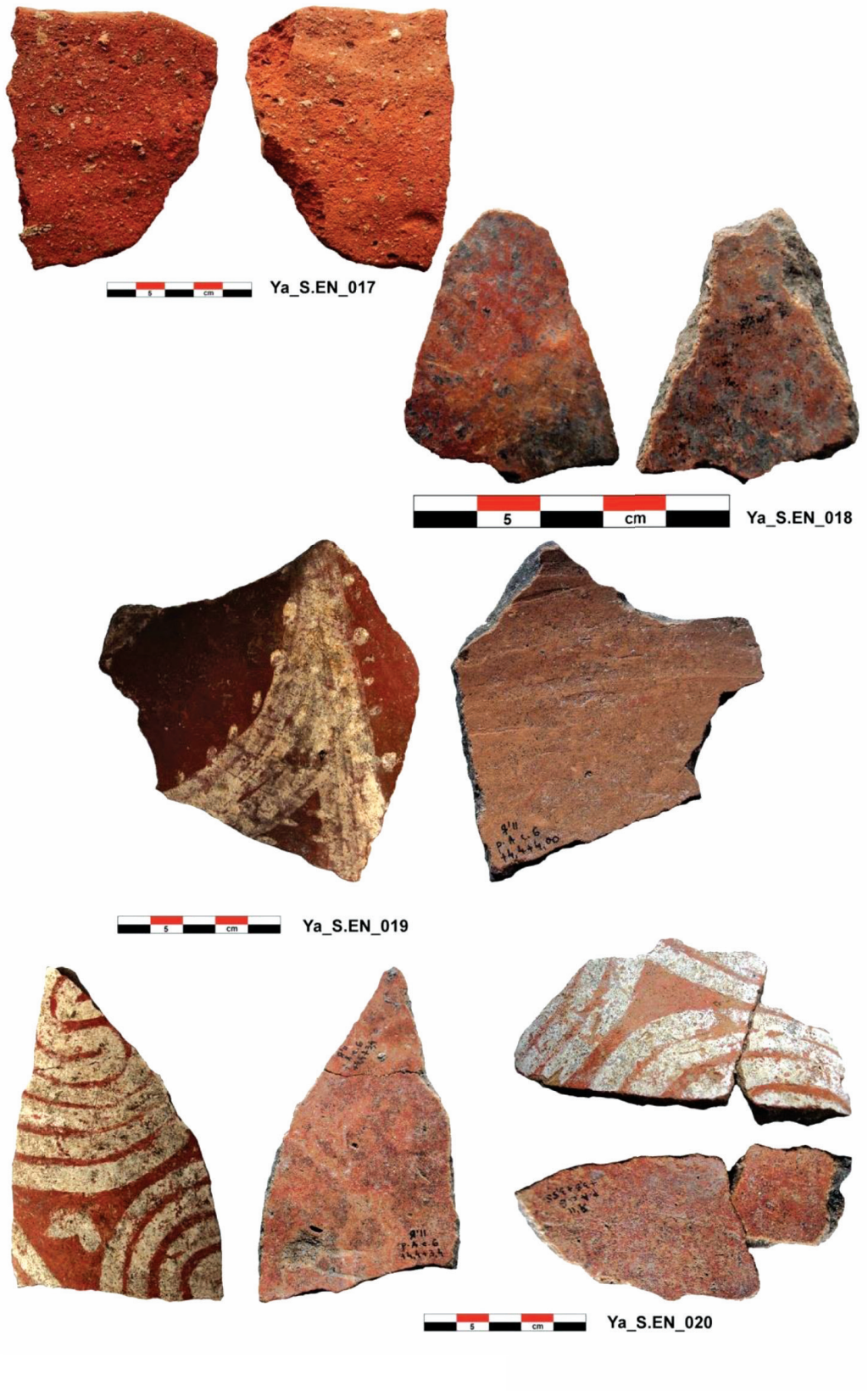


Fig. 24. Pottery sherds from Yabalkovo, Early Neolithic.

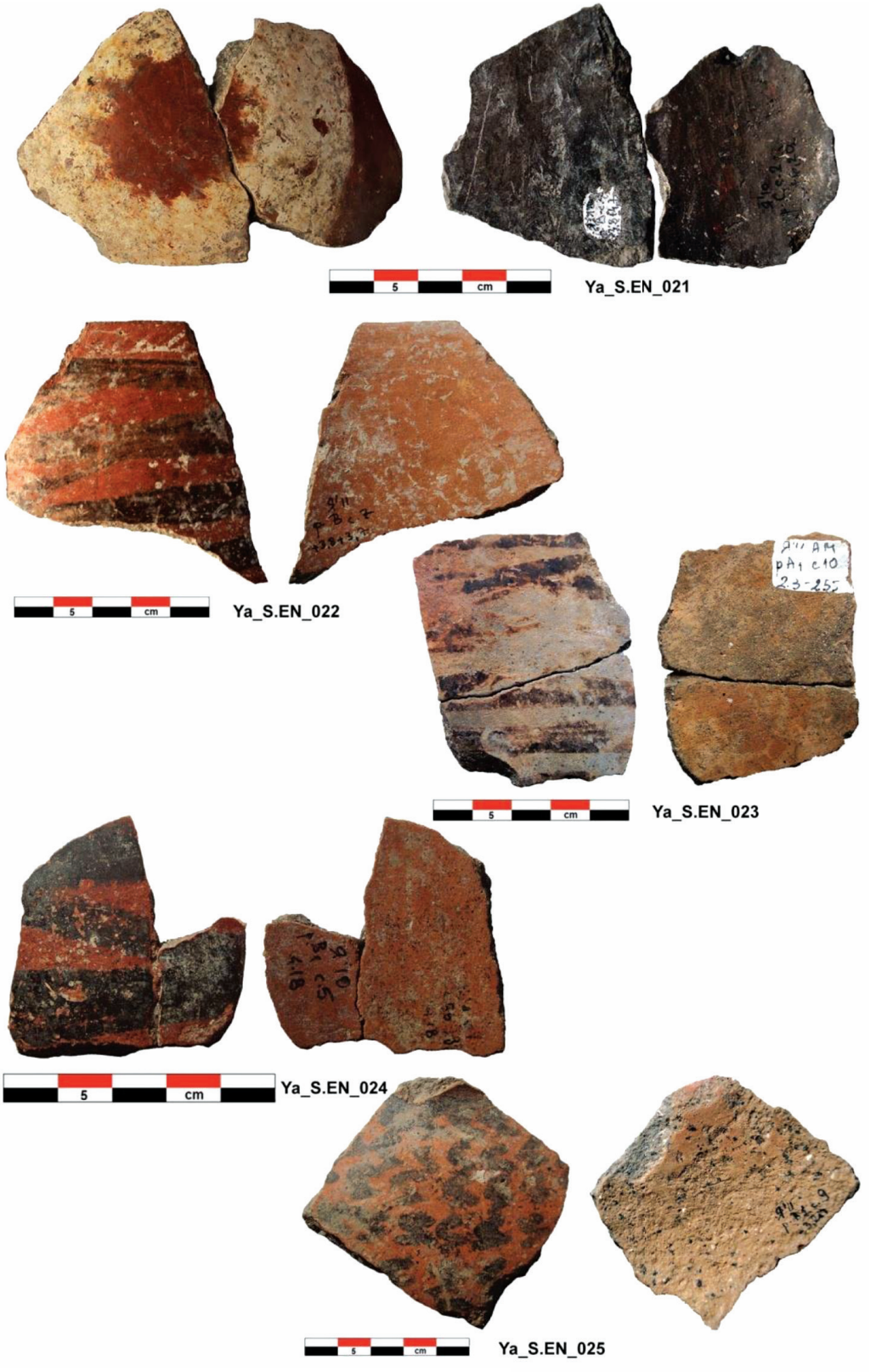


Fig. 25. Pottery sherds from Yabalkovo, Early Neolithic.

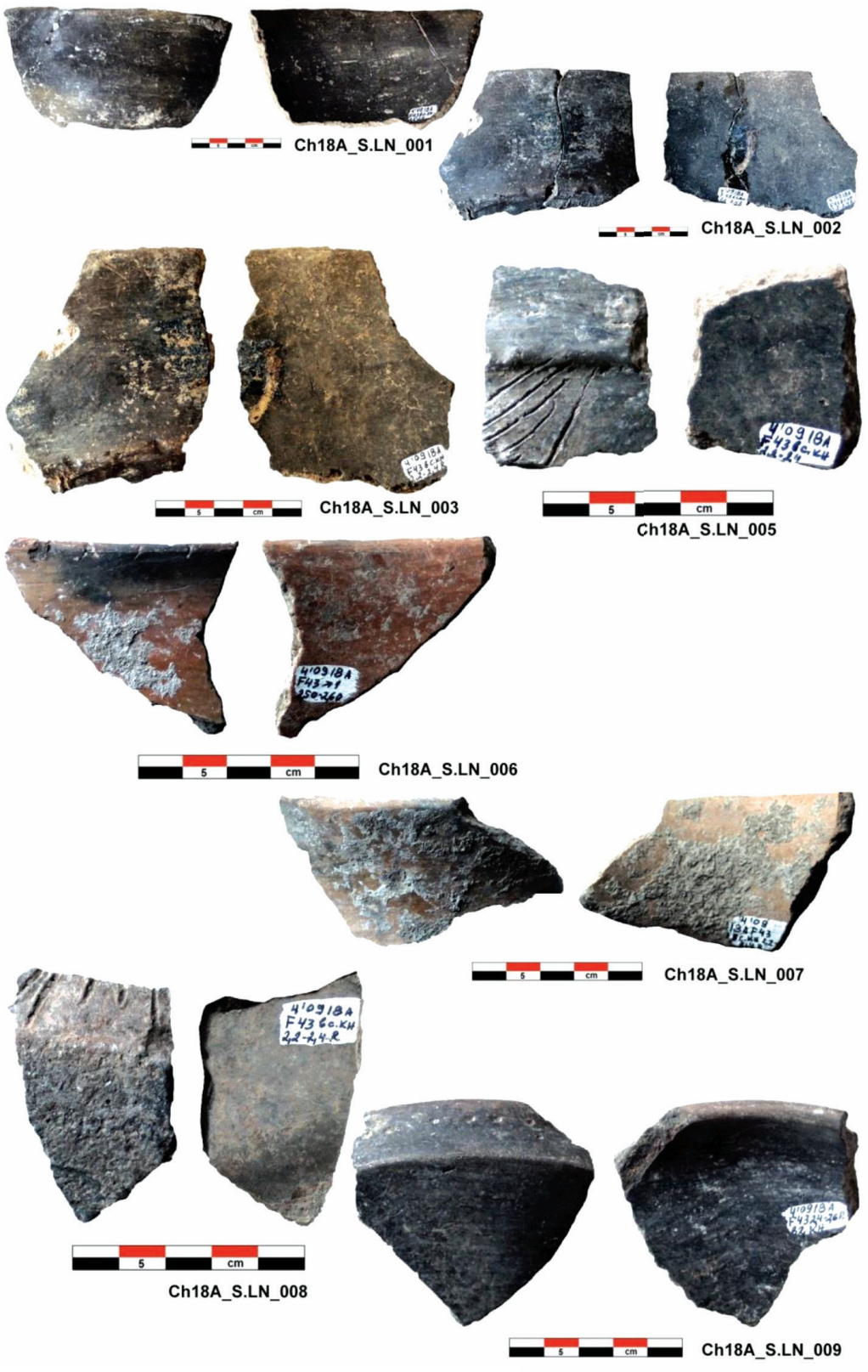


Fig. 26. Pottery sherds from Chokoba 18A, Late Neolithic.

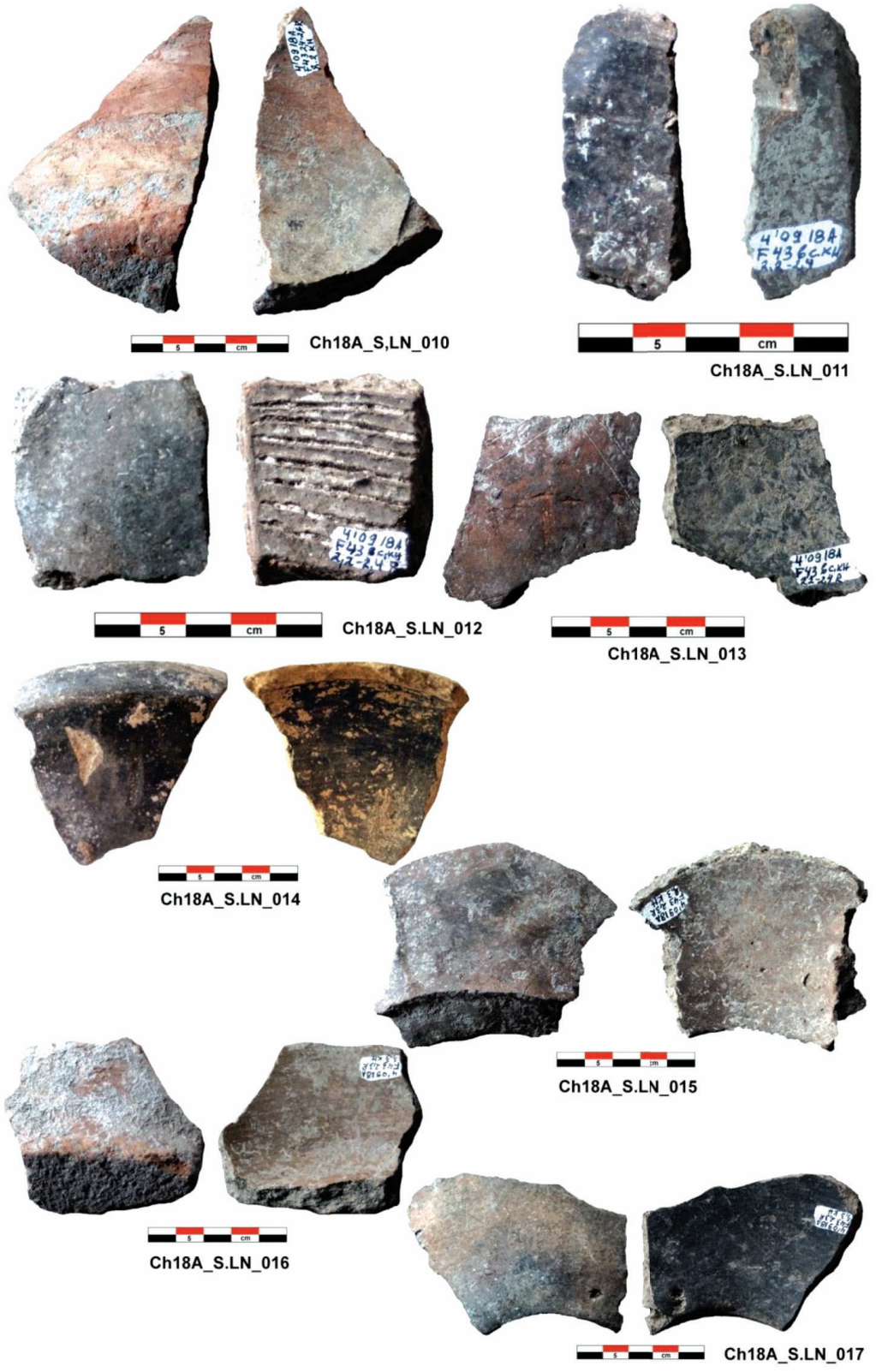


Fig. 27. Pottery sherds from Chokoba 18A, Late Neolithic.

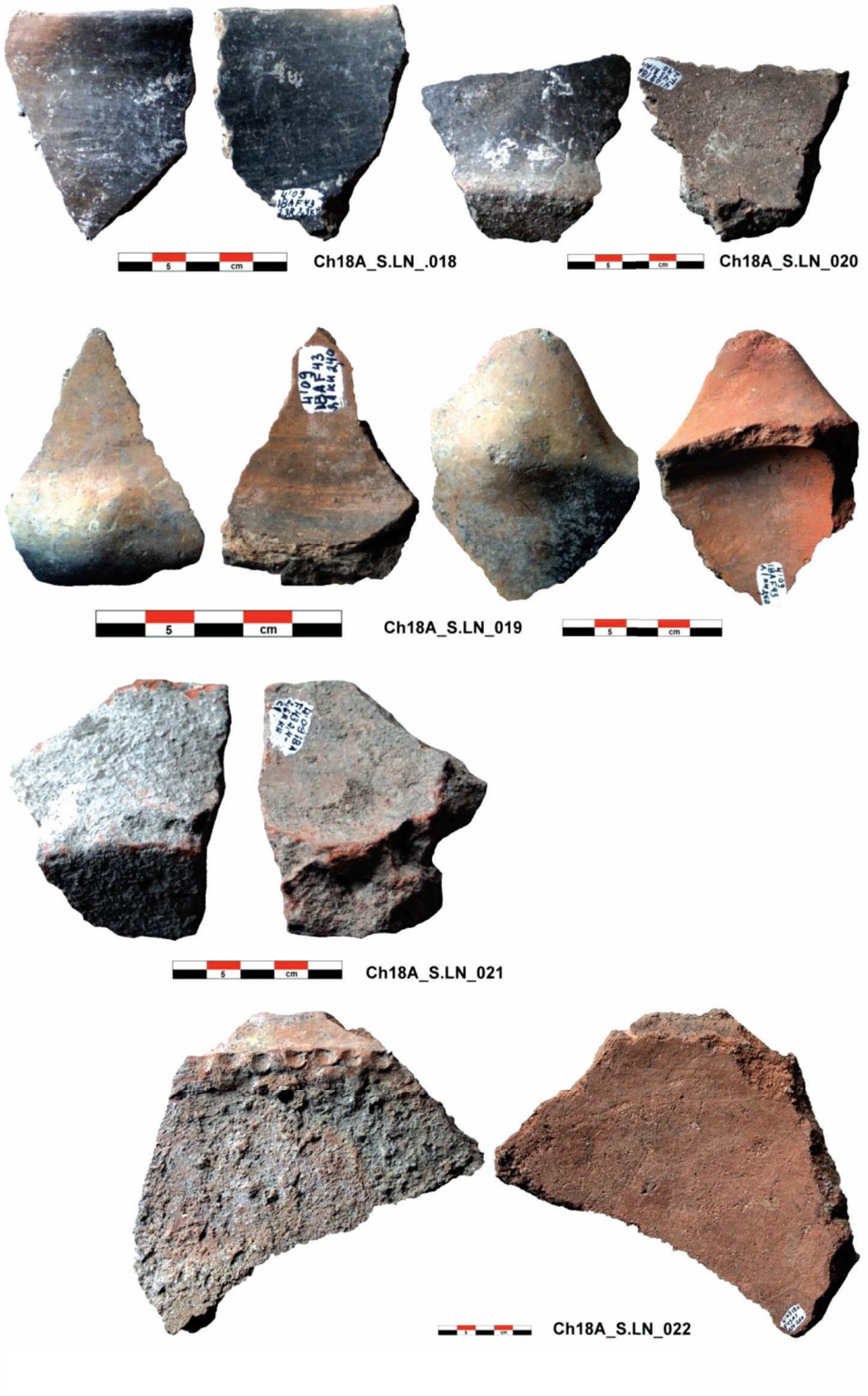


Fig. 28. Pottery sherds from Chokoba 18A, Late Neolithic.

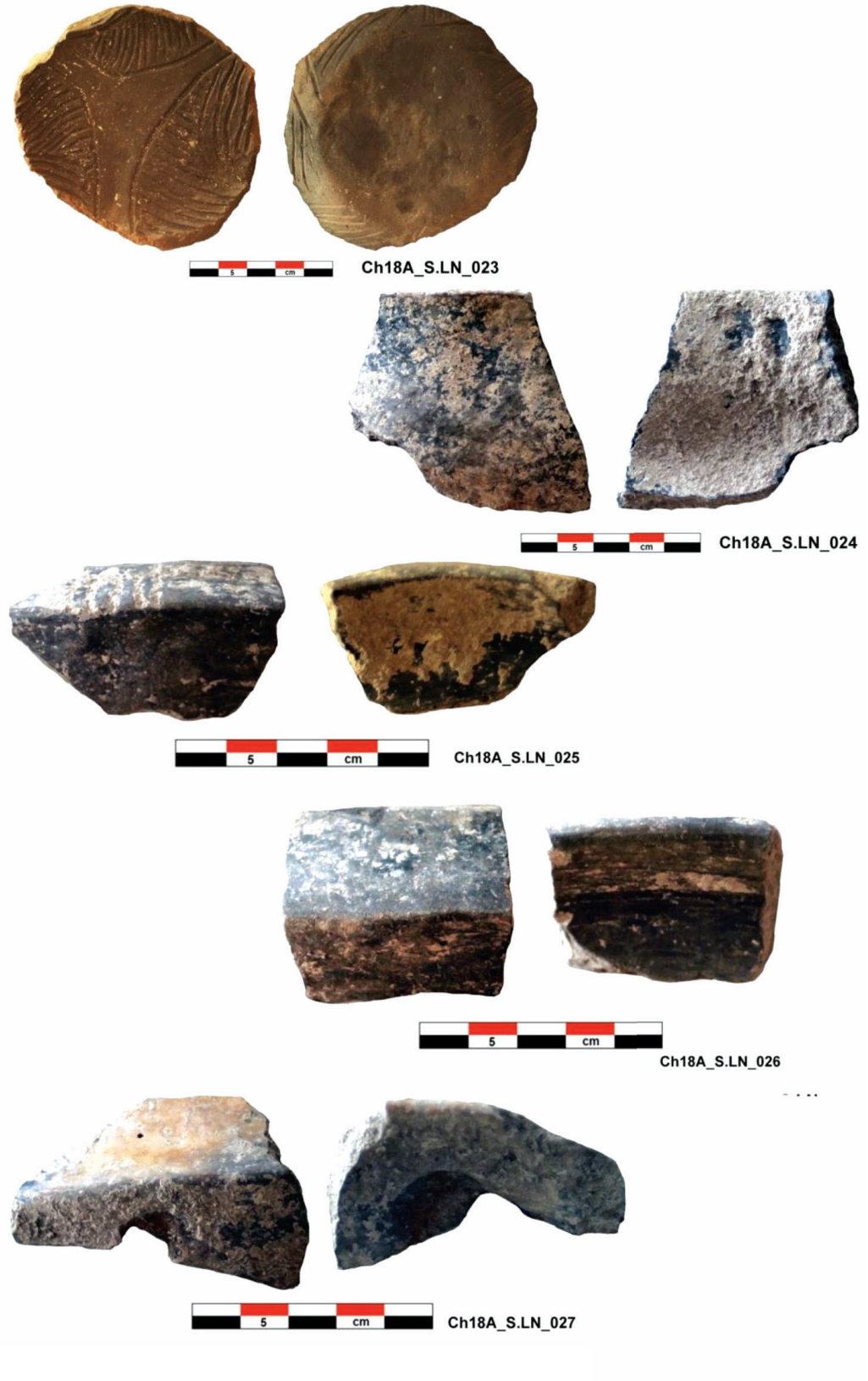


Fig. 29. Pottery sherds from Chokoba 18A, Late Neolithic.

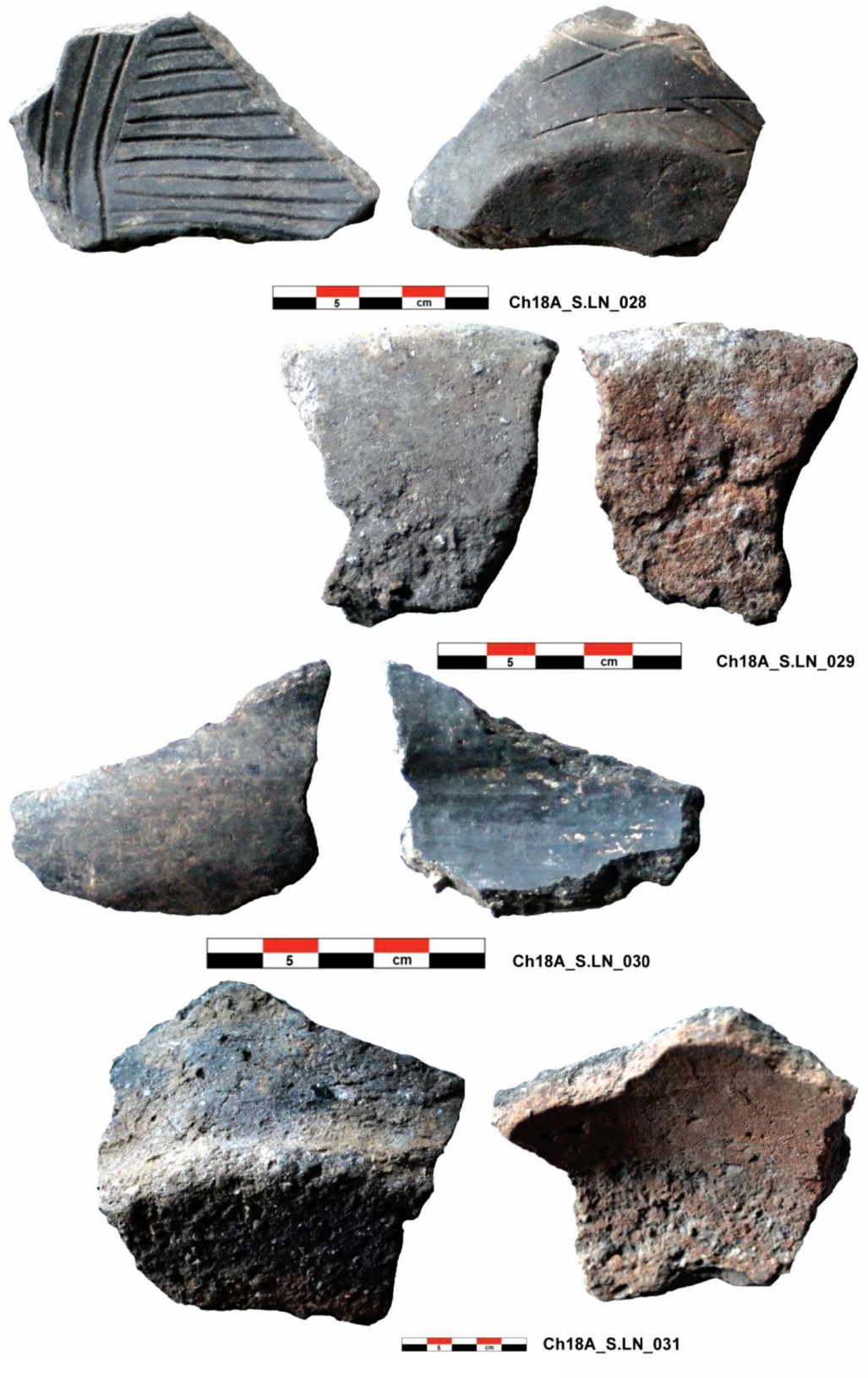


Fig. 30. Pottery sherds from Chokoba 18A, Late Neolithic.



Fig. 31. Pottery sherds from Constantia, Early Bronze Age.

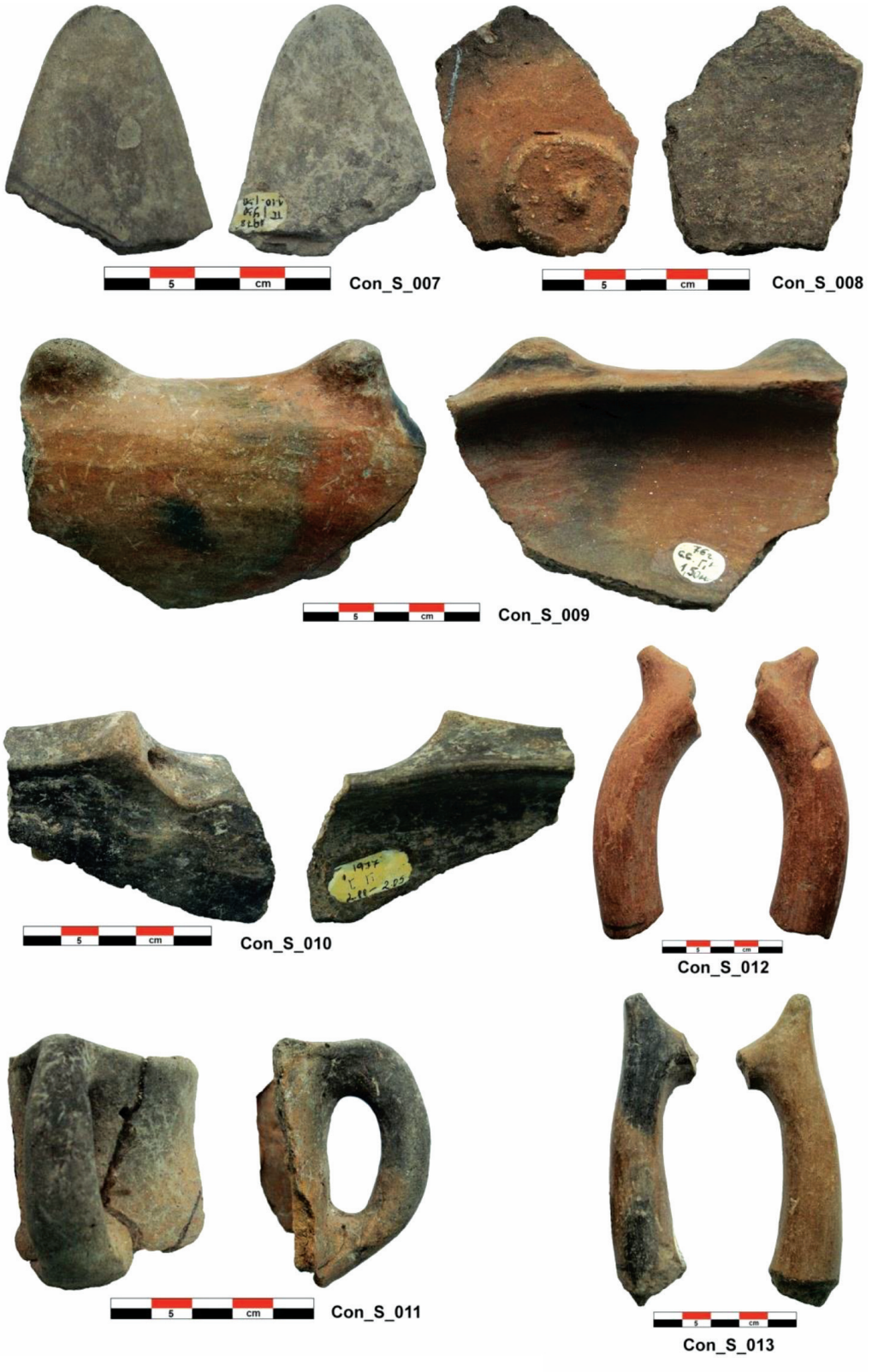


Fig. 32. Pottery sherds from Constantia, Early Bronze Age.



Fig. 33. Pottery sherds from Constantia, Early Bronze Age.

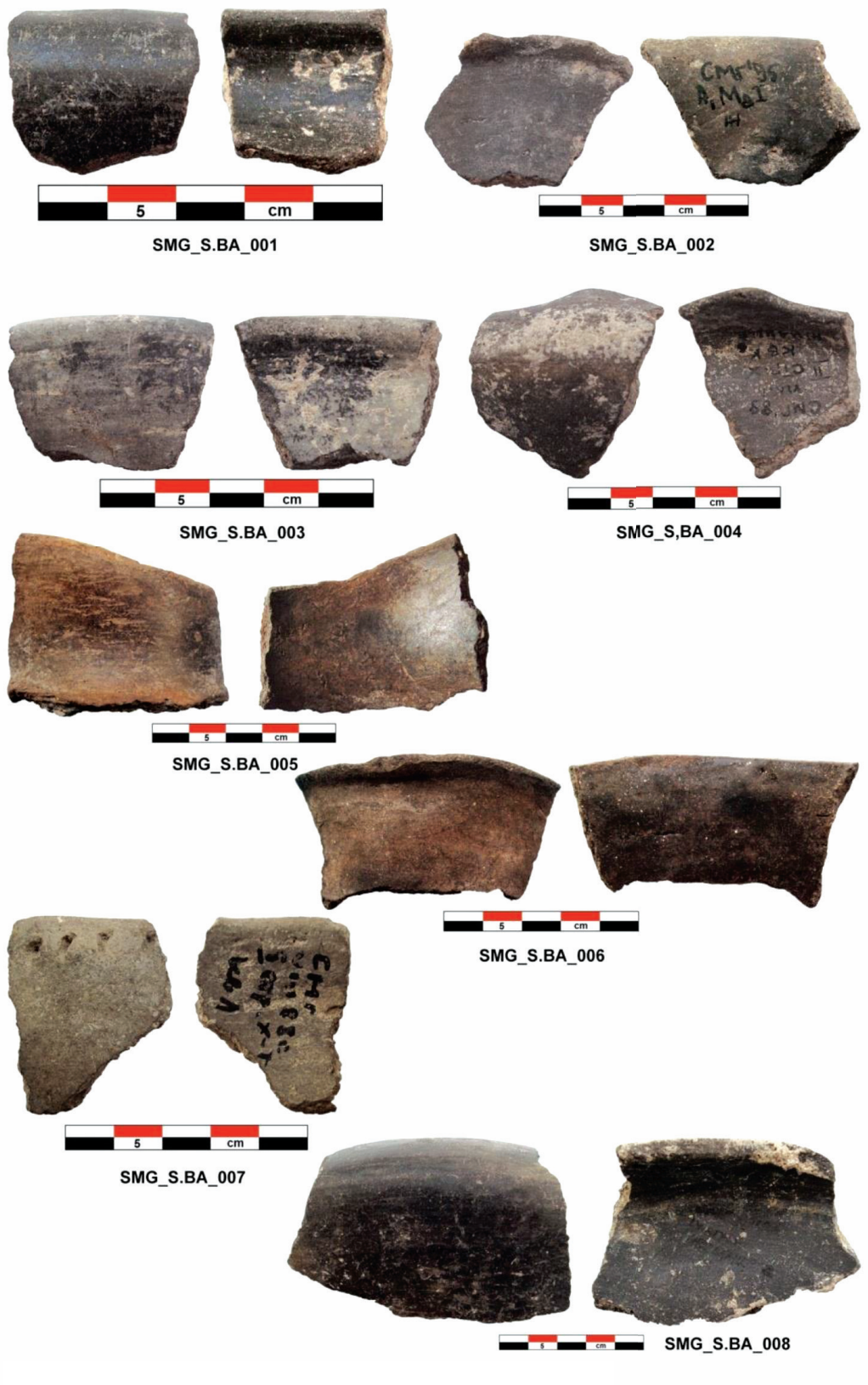


Fig. 34. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.

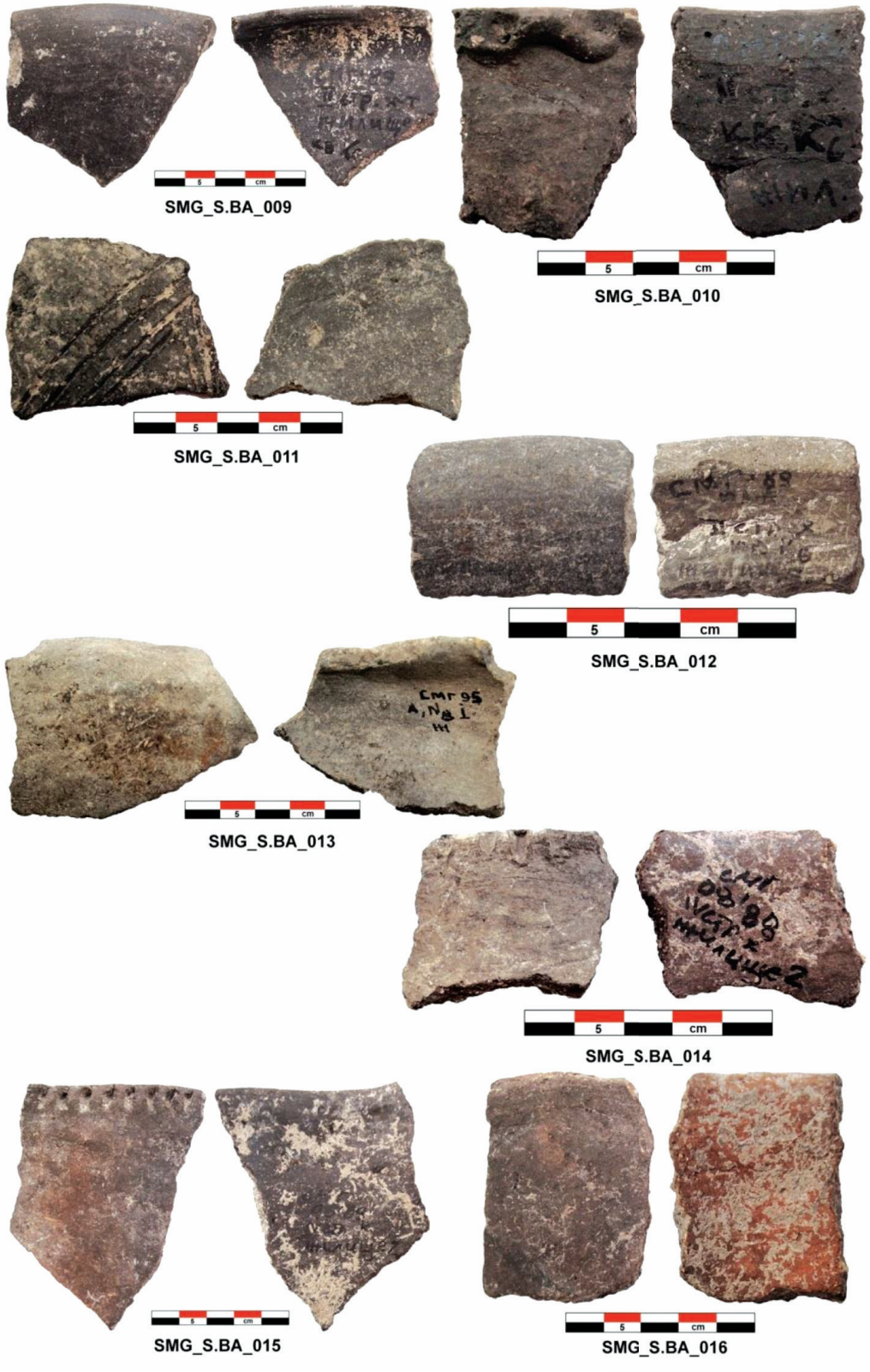


Fig. 35. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.

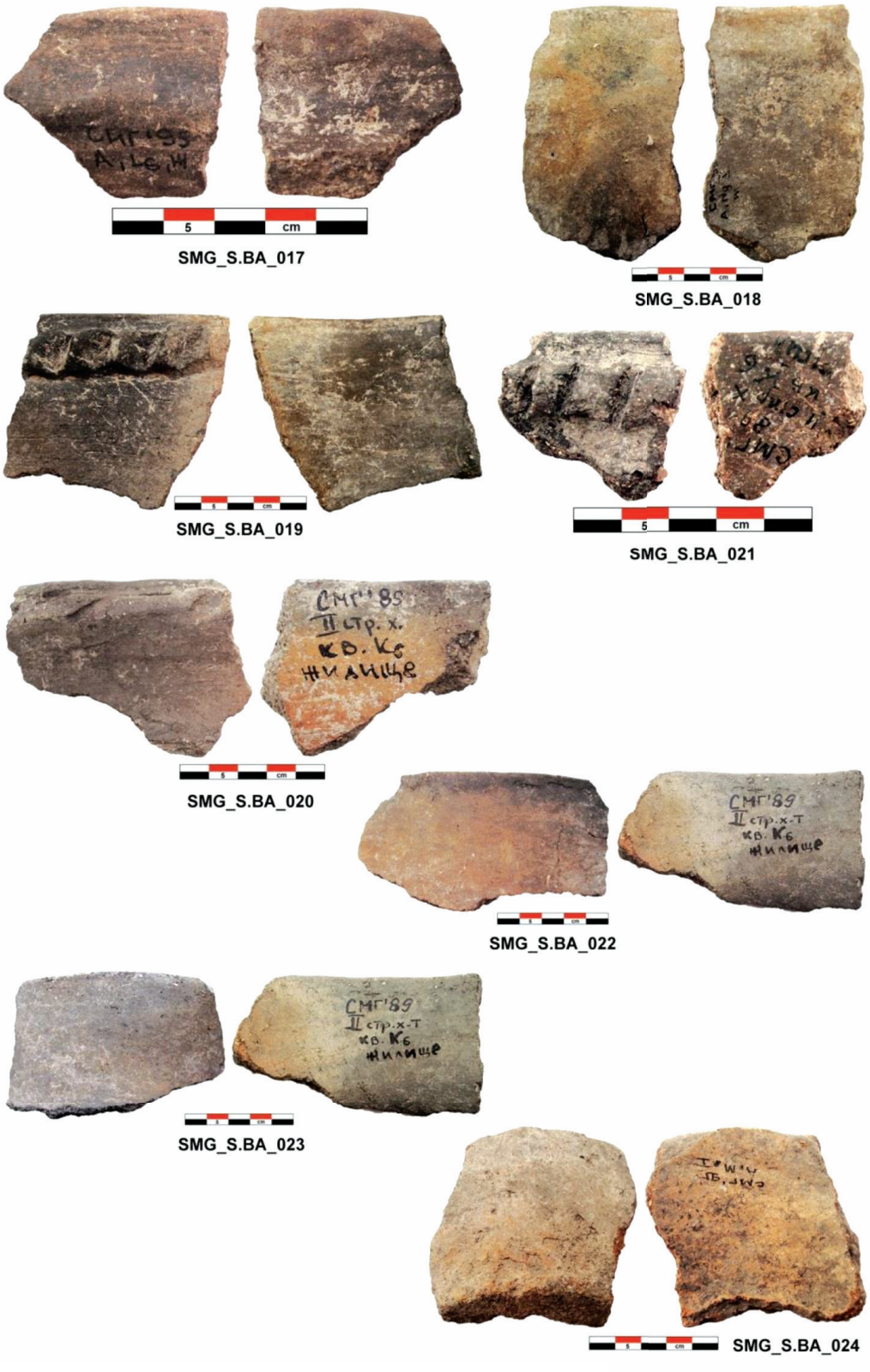


Fig. 36. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.

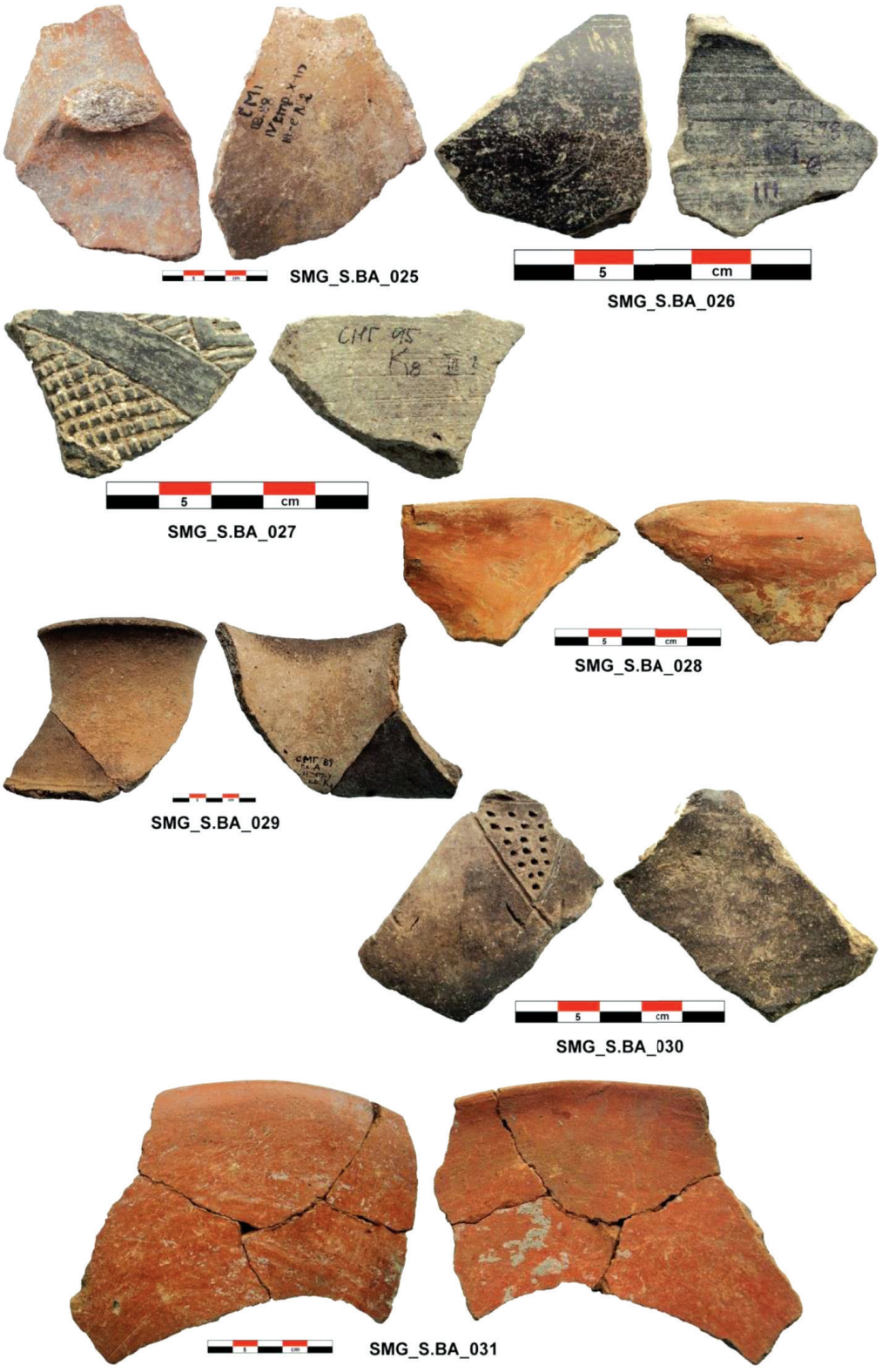


Fig. 37. Pottery sherds from tell Galabovo, Early and Middle Bronze Age.



Fig. 38. Pottery sherds from Chokoba 18, Middle Bronze Age.

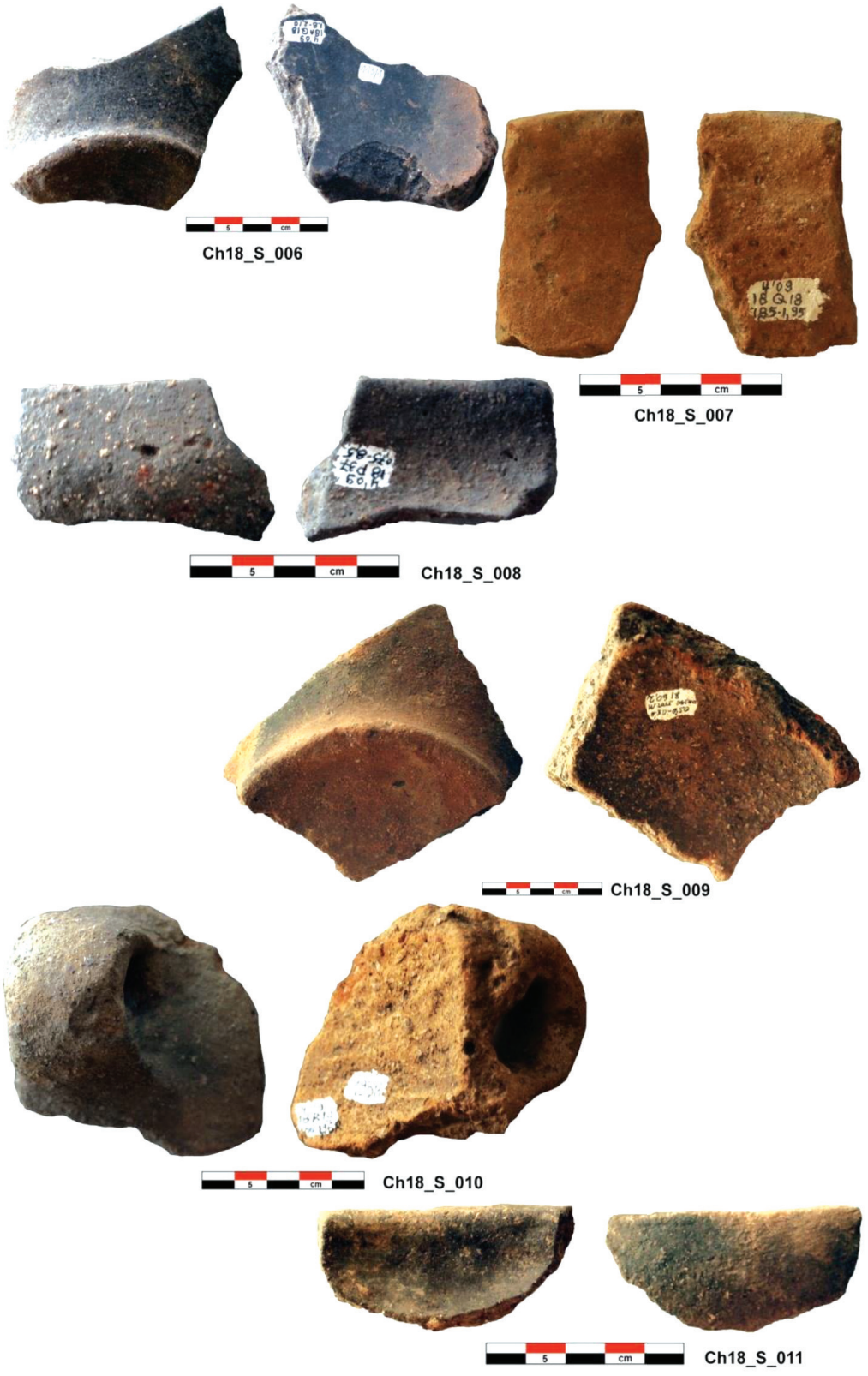


Fig. 39. Pottery sherds from Chokoba 18, Middle Bronze Age.

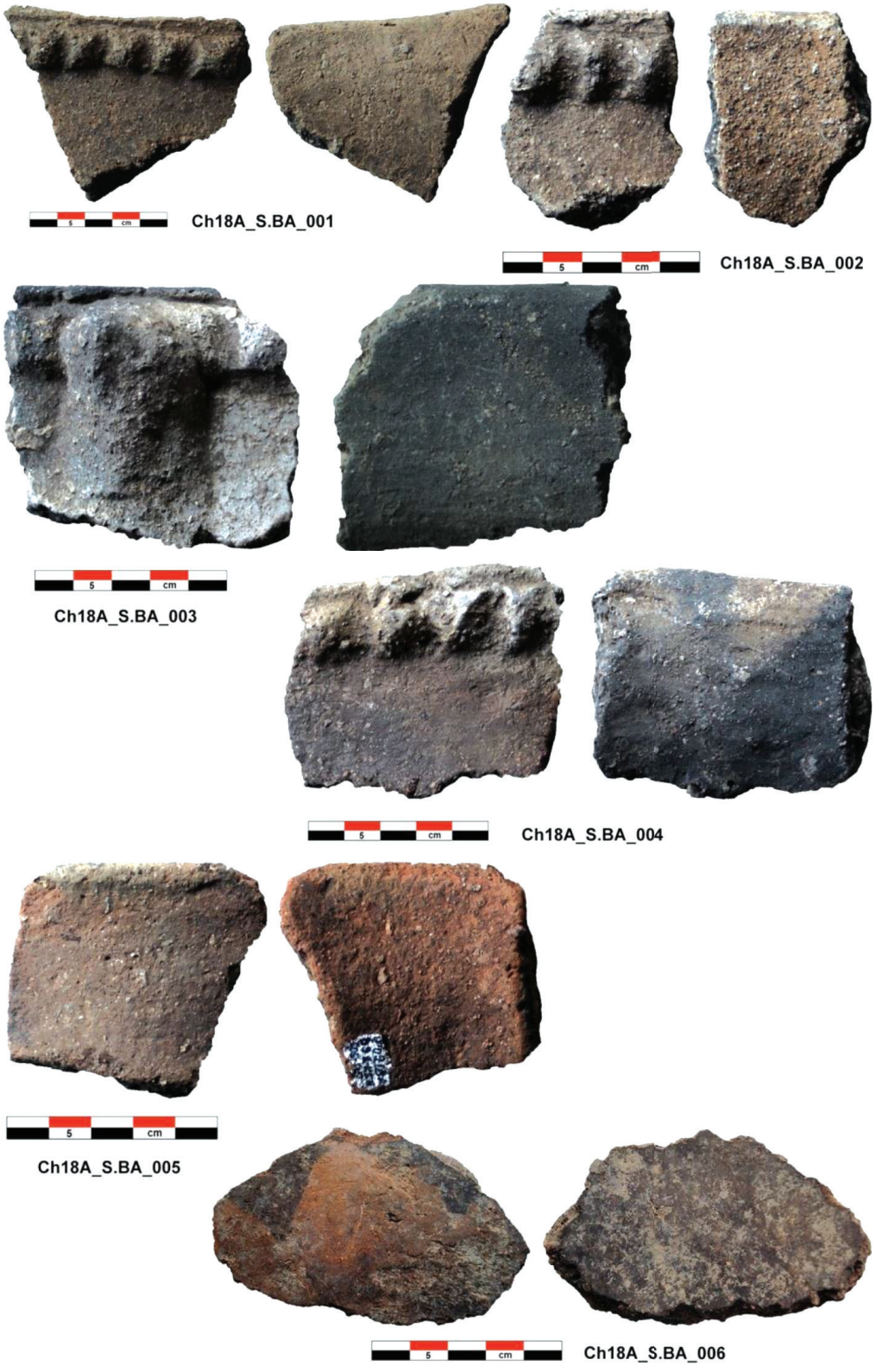


Fig. 40. Pottery sherds from Chokoba 18A, Middle and Late Bronze Age.

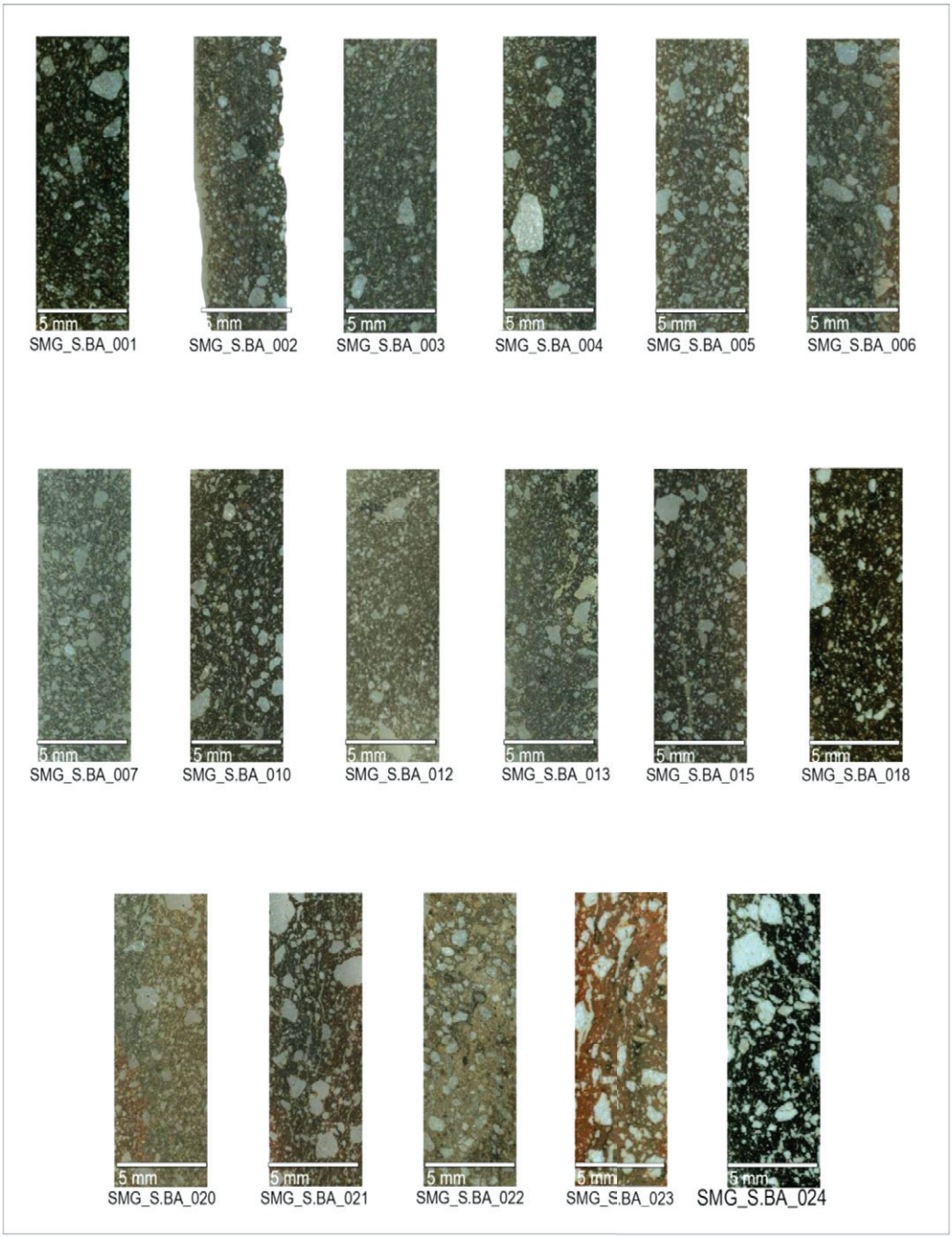


Fig. 41. Thin section macrographs of pottery samples from tell Galabovo, Early and Middle Bronze Age.

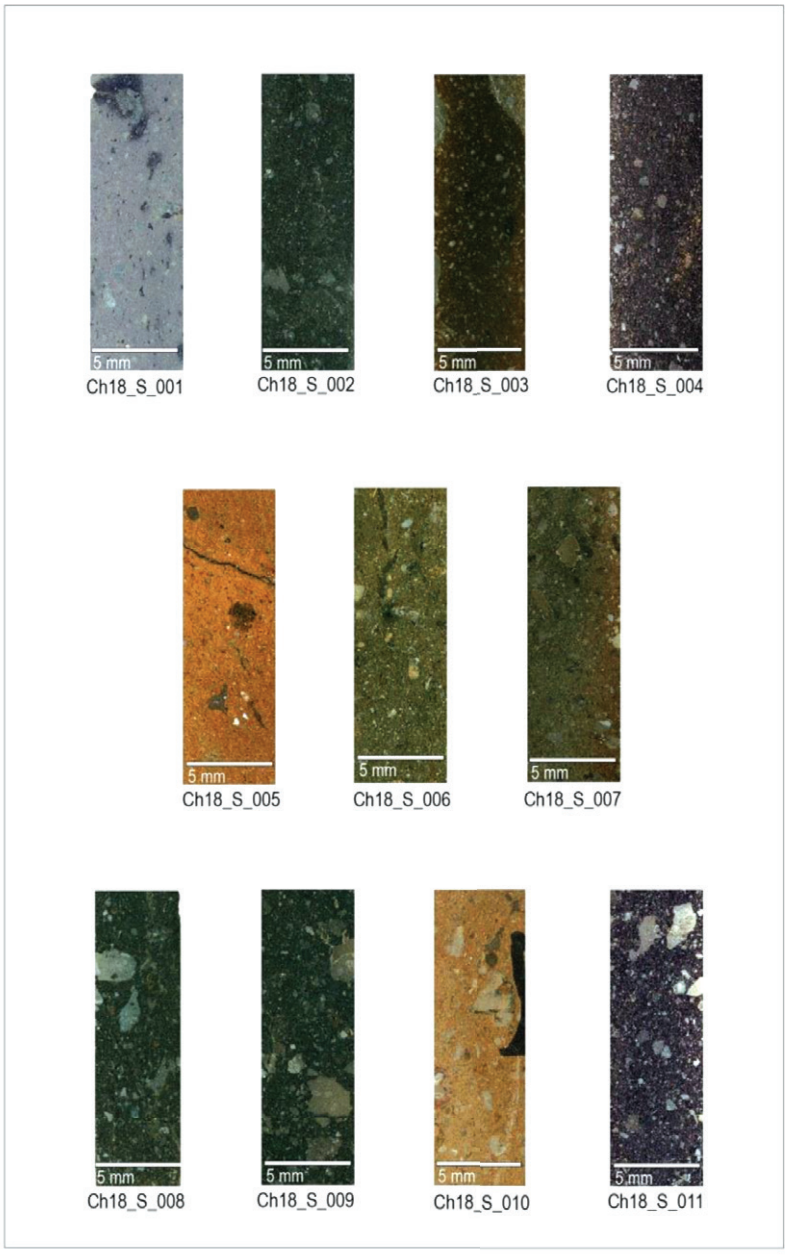


Fig. 42. Thin section macrographs of pottery samples from Chokoba 18, Middle Bronze Age.



Fig. 43.1. Thin section SMG_S.BA_031

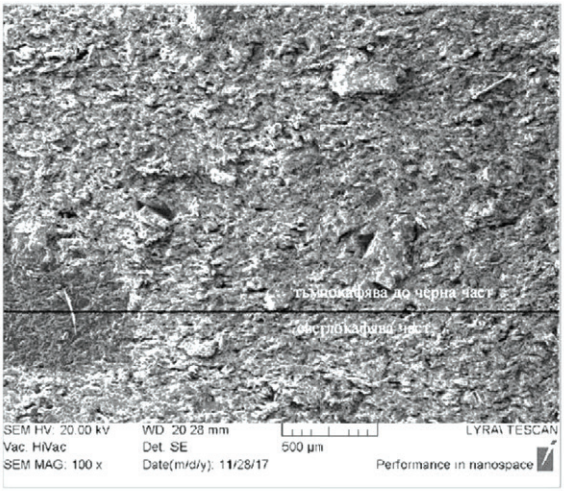


Fig. 43.2. SEM image of sample SMG_S.BA_031

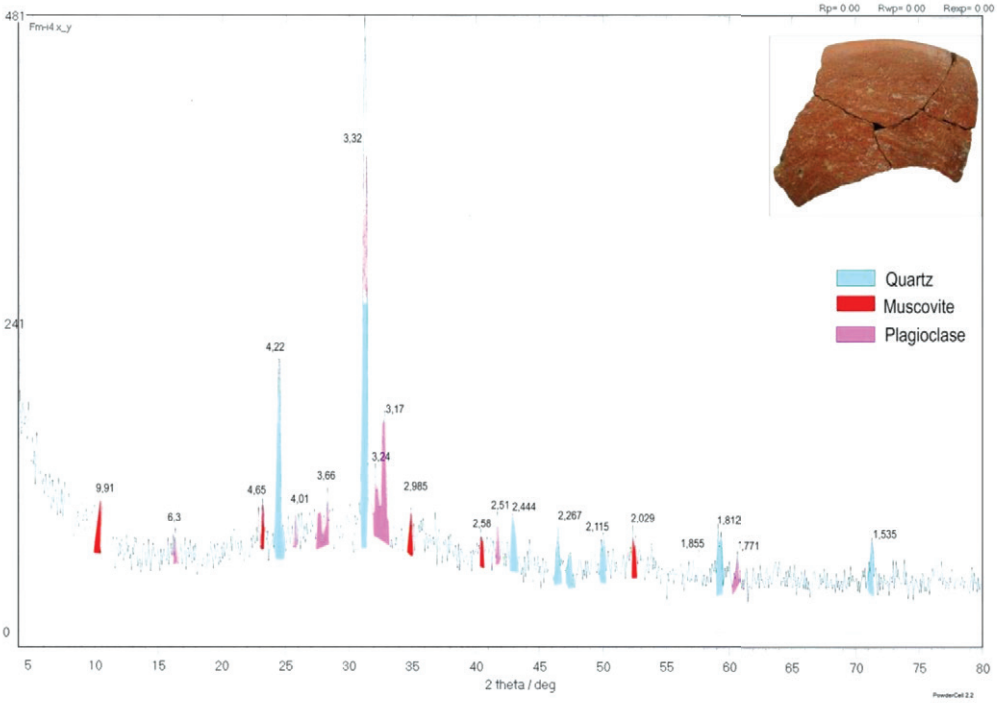


Fig. 43.3. XRD analysis of red slip from sample SMG_S.BA_031

Fig. 43. Instrumental analyses of a red-slipped sherd (SMG_S.BA_031) from Galabovo: thin section (top left), SEM image (top right), XRD analysis (bottom).

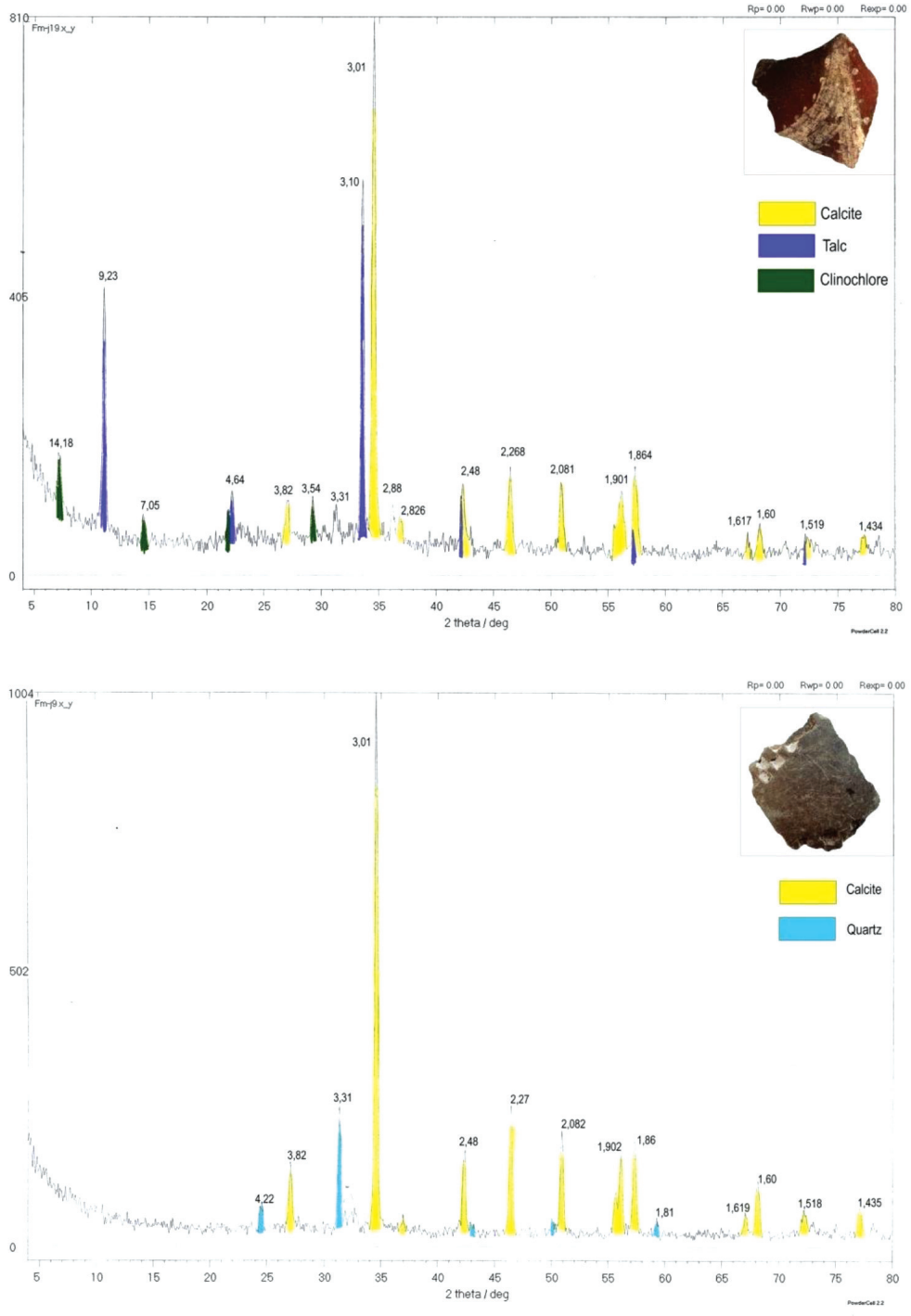


Fig. 44. XRD of white pigment from a white-on-red painted sherd (Ya_S.EN_019, top) and of white incrusted sherd (Ya_S. EN_009) from Yabalkovo, Early Neolithic.

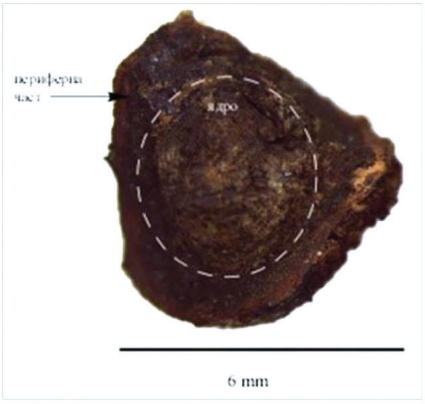


Fig. 45.1. Microphotograph of an 'inclusion'

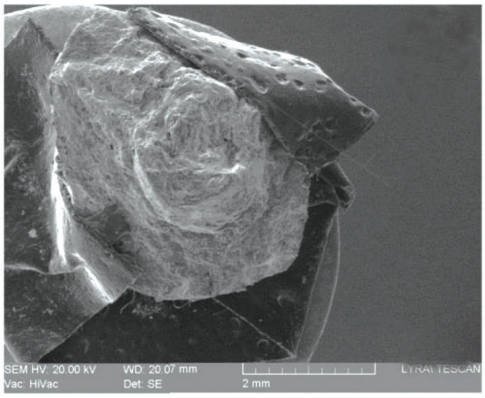
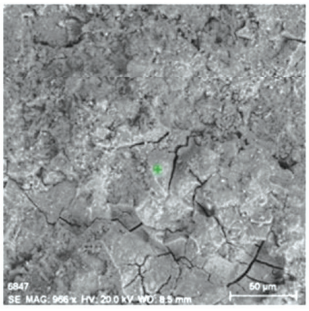
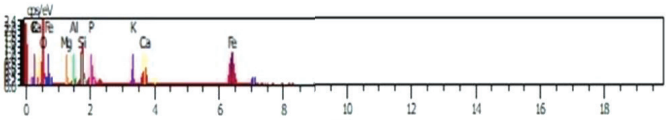


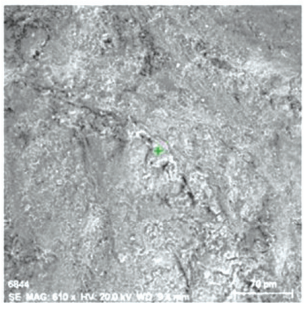
Fig. 45.2. SEM photo

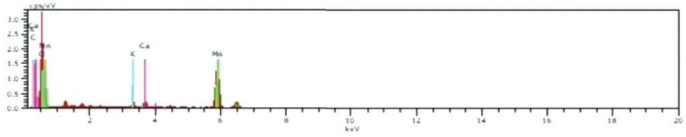




El	AN	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error [%]
O	8	K-series	40.76	43.01	60.54	5.6
C	6	K-series	5.99	6.32	11.85	1.5
Fe	26	K-series	27.45	28.96	11.68	0.8
Si	14	K-series	6.87	7.25	5.82	0.3
P	15	K-series	4.83	5.10	3.71	0.2
Ca	20	K-series	4.66	4.92	2.77	0.2
Mg	12	K-series	2.03	2.14	1.98	0.2
Al	13	K-series	1.21	1.28	1.07	0.1
K	19	K-series	0.98	1.03	0.59	0.1
Total:			94.78	100.00	100.00	

Fig. 45.3. EDX spectrum and semi-qualitative analysis of the periphery zone





El	AN	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error [%]
O	8	K-series	50.13	59.23	81.67	6.6
Mn	25	K-series	31.13	36.78	14.77	0.9
C	6	K-series	0.88	1.04	1.92	1.0
Ca	20	K-series	1.29	1.52	0.84	0.1
K	19	K-series	1.20	1.42	0.80	0.1
Total:			84.63	100.00	100.00	

Fig. 45.3. EDX spectrum and semi-qualitative analysis of the central zone

Fig. 45. Instrumental analyses of an "inclusion" in a clay object from Sokol, EBA.

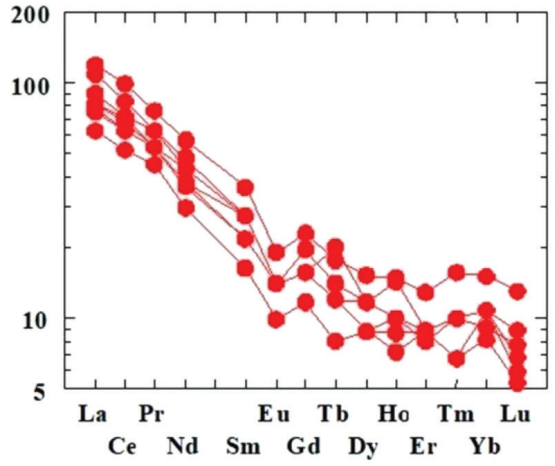


Fig. 46.1. Chondrite-normalized REE pattern of clay samples from Chokoba, Sokol and Madrets

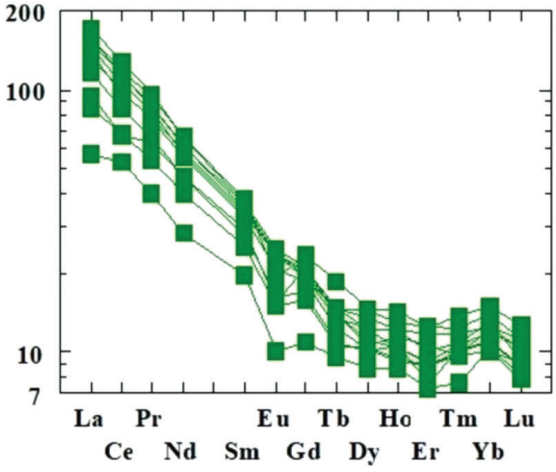


Fig. 46.2. Chondrite-normalized REE pattern of clay samples from Chokoba, Sokol and Madrets

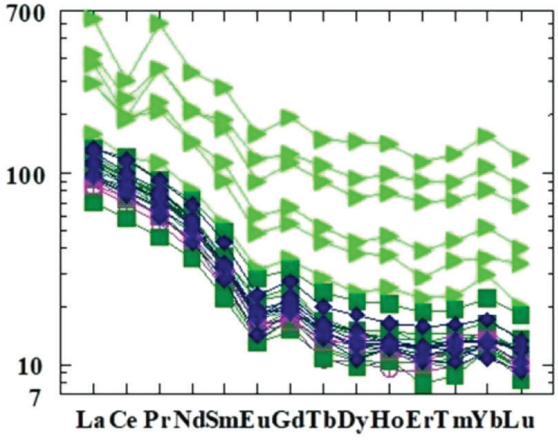
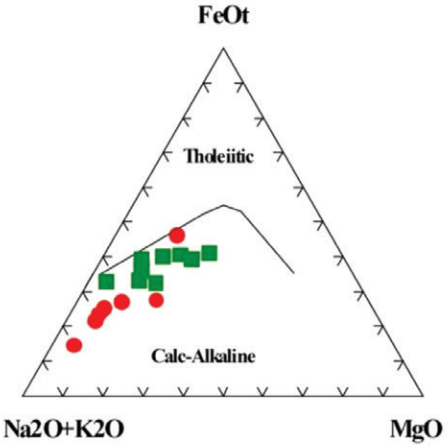
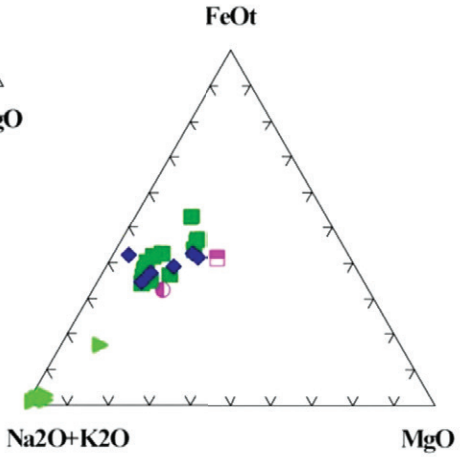


Fig. 46.3. Chondrite-normalized REE pattern of pottery sherd samples

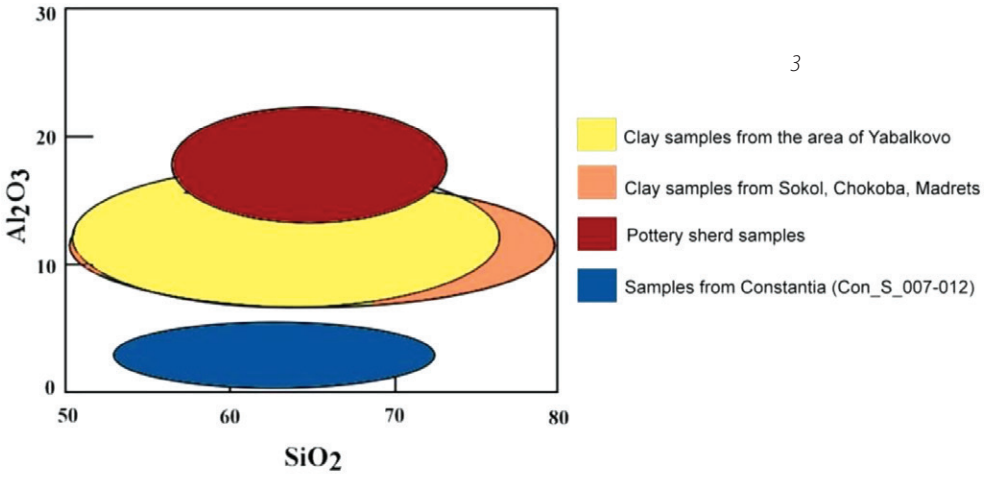
Fig. 46. Chondrite-normalized REE pattern of clay samples and pottery sherds.



1

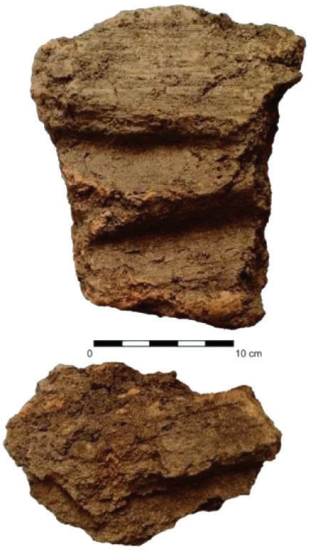


2



3

Fig. 47. AFM and binary diagrams: 47.1. AFM diagram of clay samples (top); 47.2. AFM diagram of pottery sherds (middle) and 47.3. Binary diagram SiO_2-Al_2O_3 (bottom).



1. Wall plaster with imprints of wooden posts



2. Wall plaster with imprints of stems and twigs



3. Wall plaster with imprints of chaff and *Triticum aestivum* grains



4. Close-up photo of stem imprints



5. Close-up photot of stem imprints



6. Close-up photo of stem imprints

Fig. 48. Wall plaster with organic inclusions from Yabalkovo, EN.

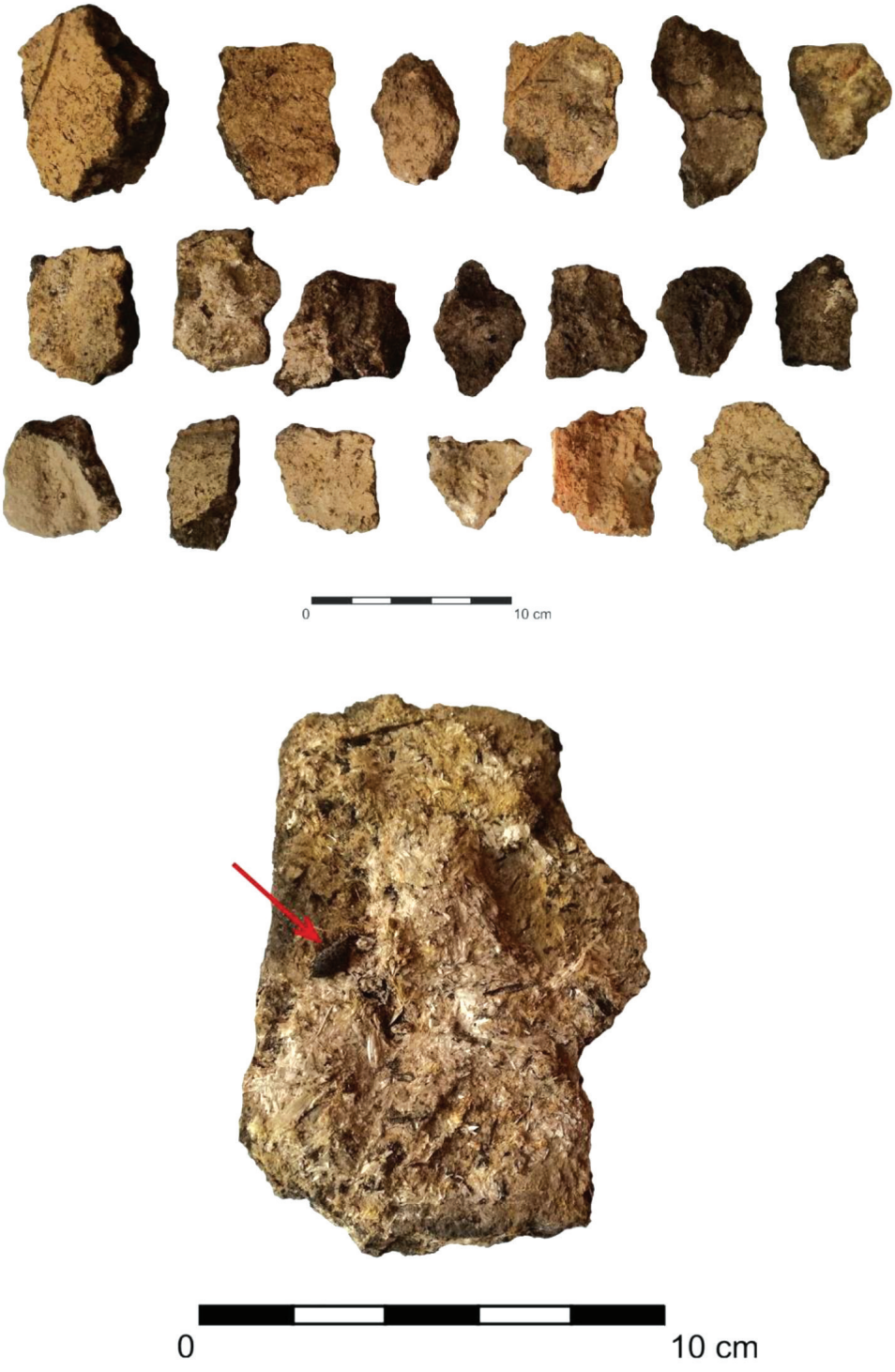


Fig. 49. Burnt clay debris with organic inclusions from tell Sokol, EBA.

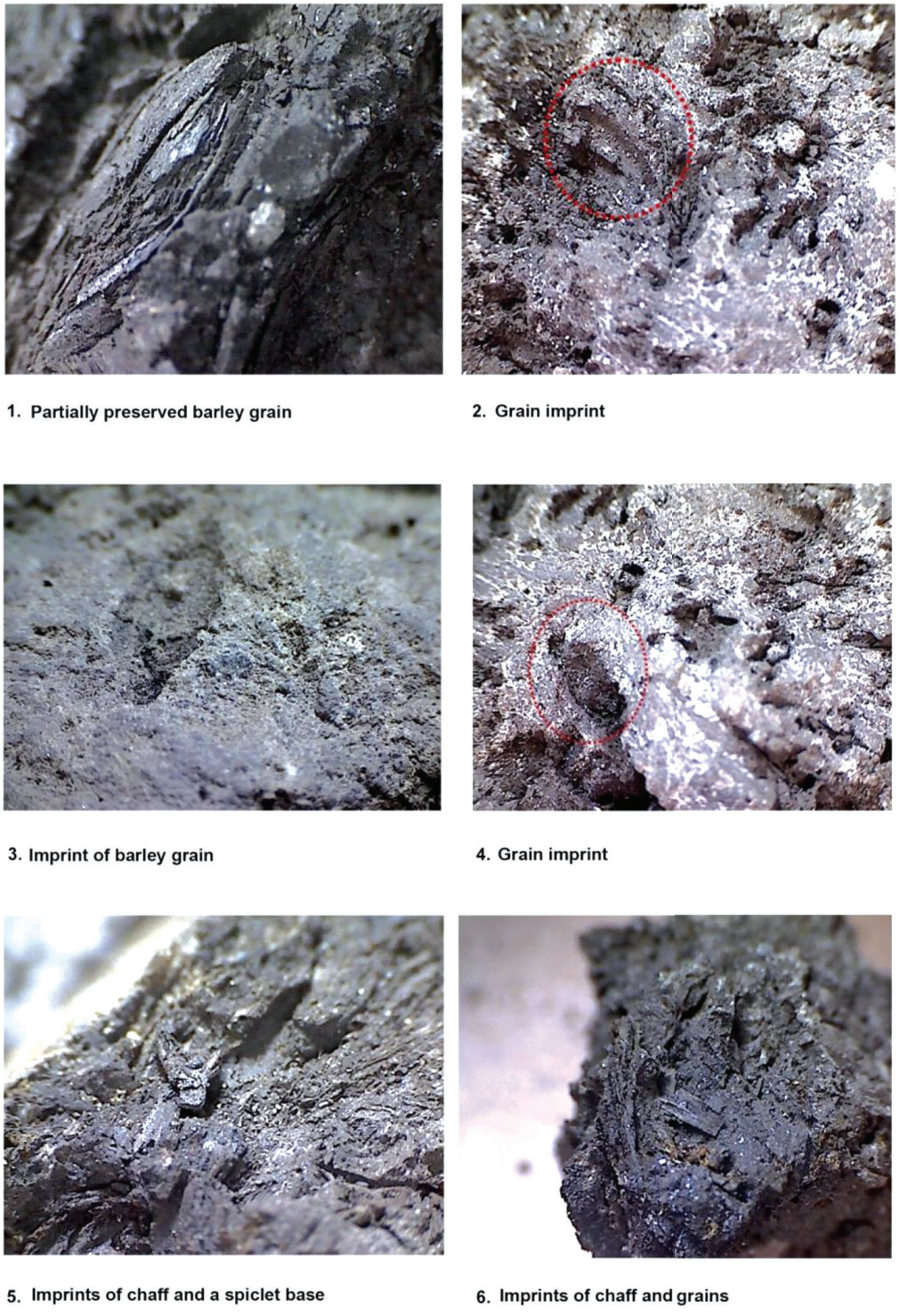


Fig. 50. Close-up images of organic inclusions in ceramic sherds and burnt clay from tell Sokol, EBA.



1. Carbonized barley grain



2. Partially preserved spikelet base



3. Ceraeal grain with partially preserved hulls



4. Imprints of barley grains



5. Part of a barley spikelet



6. Imprints of chaff and grains





7. Carbonized barley grain

Fig. 51. Close-up images of organic inclusions in the ceramics from tell Sokol.



Fig. 52. Pottery sherds with grain imprints from Dana Bunar 1, Chalcolithic period.



Fig. 53. Close-up images of organic inclusions in the ceramics from Dana bunar 1.



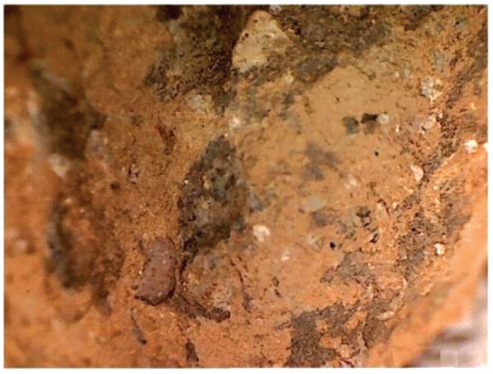
Fig. 54. Close-up images of organic inclusions in the ceramics from Dana bunar 1.



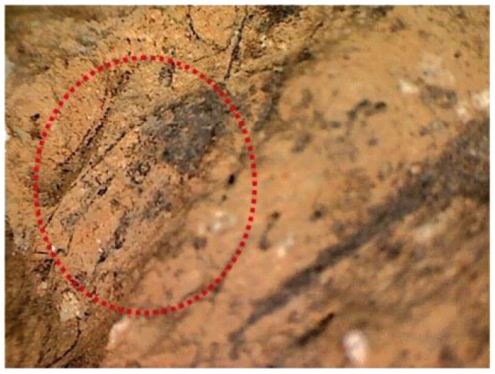
Fig. 55. Pottery sherds from Chokoba 18 and 18A, MBA – LBA.



1. Grain imprint



2. Imprints and blanks of decayed organic material



3. Imprints and blanks of decayed chaff



4. Blanks of decayed organic material



5. Imprint of a rye grain seed



6. Imprints of grains and chaff

Fig. 56. Close-up images of organic inclusions in ceramic sherds from Ckokoba 18 and 18A.



1. Stem imprints



2. Imprints of cereal grains



3. Imprint of barley grain



4. Blanks of organic material



5. Grain imprint



6. Grain imprint

Fig. 57. Close-up images of organic inclusion in ceramic sherds from Chokoba 18 and 18A.

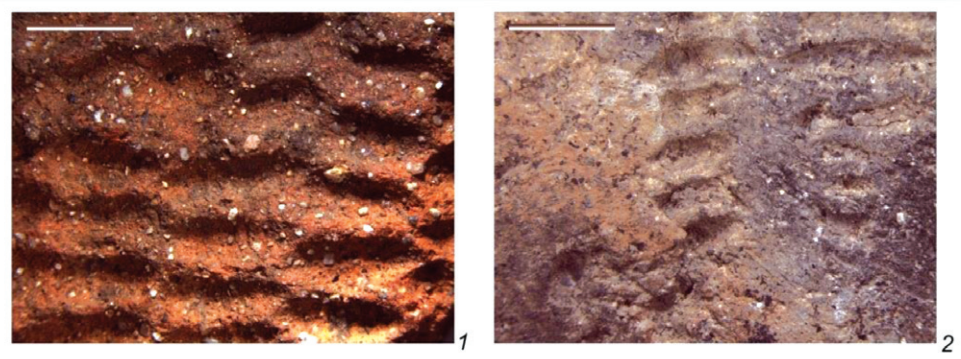


Fig. 58. Mat impressions: 53.1. Fragment No.6 – weft-faced simple twining; 58.2. Fragment No.17 – open simple twining.

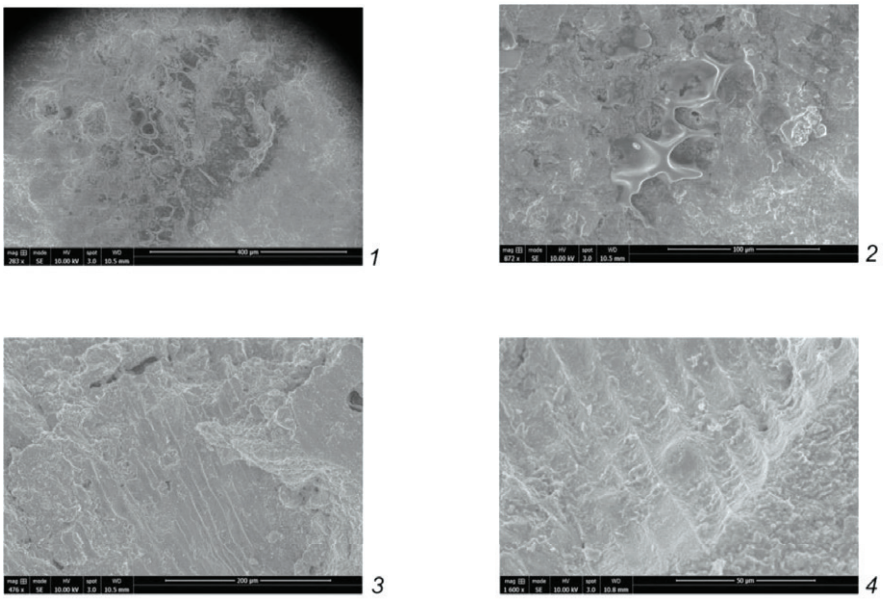


Fig. 59. Fragment No. 19: 1 and 2 – non-diagnostic cell walls of plant tissues; 3 and 4 – parallel grooves in the imprint of a leaf/stem of monocotyledon plant.

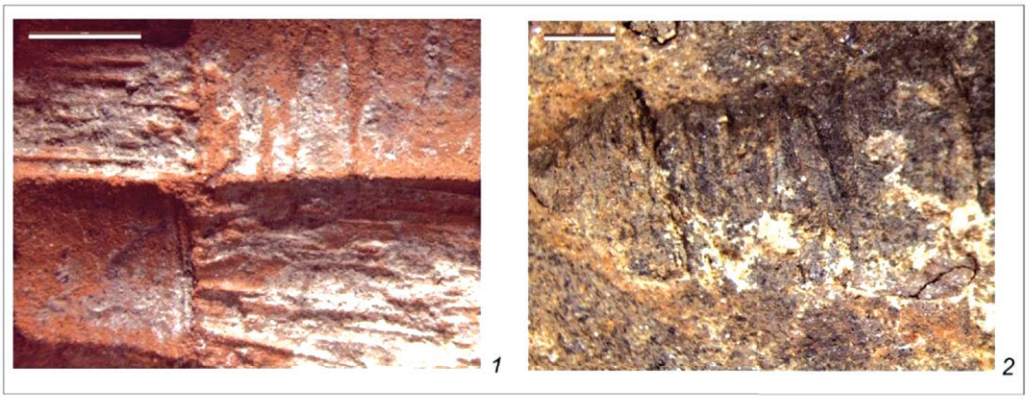


Fig. 60. Plain weave: 1. Fragment No.20; 2. Fragment No.23.

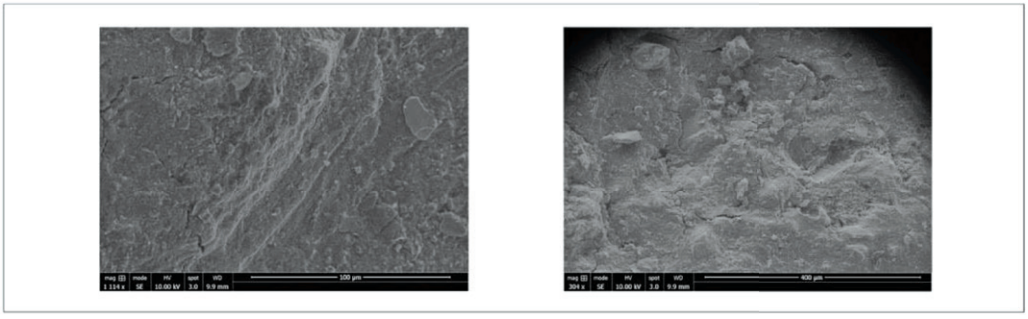


Fig. 61. Fragment No.20: parallel grooves on a flat-section leaf.

Table 1. Chemical composition of samples from clay deposits

	Ya_R_01	Ya_R_01a	Ya_R_02	Ya_R_03.1	Ya_R_03.2	Ya_R_03.3	Ya_R_03.4	Ya_R_03.5	Ks_R_01	Ks_R_02	S_R_01	S_R_02	S_R_02a	S_R_03	Ch_R_01	Ch_R_02	M_R_01	M_R_02
SiO2	42,27	59,85	62,92	52,88	49,95	51,65	49,83	54,49	62,55	53,44	69,24	63,82	69,27	69,87	60,39	61,89	66,85	65,92
TiO2	0,47	0,71	0,54	0,68	0,63	0,64	0,57	0,69	0,46	0,66	0,23	0,25	0,17	0,40	0,58	0,74	0,56	0,63
Al2O3	14,38	20,92	19,38	19,39	18,70	19,03	17,25	20,27	12,76	15,66	16,06	20,20	18,81	17,33	16,33	17,83	15,09	17,77
FeO	3,36	4,64	3,60	4,69	3,77	4,40	3,59	5,07	2,78	4,00	1,74	2,20	1,43	2,44	3,65	4,41	2,64	2,21
MnO	0,11	0,05	0,11	0,06	0,08	0,04	0,06	0,06	0,11	0,11	0,02	0,08	0,05	0,06	0,10	0,12	0,09	0,08
MgO	1,60	0,64	1,18	1,77	1,43	2,82	2,08	1,54	0,72	2,66	0,60	0,92	0,59	0,73	1,41	1,48	0,92	0,72
CaO	18,14	5,35	2,29	6,76	9,89	5,48	7,96	3,83	9,93	10,91	0,46	1,23	1,15	0,56	1,81	1,10	2,58	2,60
Na2O	1,49	4,03	1,91	2,30	2,39	1,54	1,57	2,18	1,07	1,06	2,38	2,35	2,76	2,67	2,85	1,20	1,71	3,30
K2O	1,87	4,85	3,31	2,95	3,80	1,98	1,88	4,92	2,51	3,48	3,35	5,70	5,27	3,77	2,78	2,45	3,36	3,24
P2O5	0,27	0,49	0,46	0,50	0,48	0,54	0,49	0,49	0,20	0,22	0,10	0,22	0,20	0,10	0,14	0,10	0,71	0,24
сума	83,95	101,55	95,71	91,99	91,12	88,11	85,28	93,54	93,10	92,21	94,19	96,96	99,70	97,92	90,05	91,32	94,50	96,71
Ba	2494,49	3420,73	765,03	3743,70	3452,75	2569,57	3168,21	2934,53	470,23	637,27	318,85	501,04	446,60	477,64	450,41	492,86	712,03	643,64
Rb	63,45	157,03	162,03	131,35	145,84	103,64	111,94	204,94	127,31	164,62								
Sr	785,33	1244,27	287,99	1133,45	1063,01	894,52	840,59	992,19	99,51	119,18	83,87	91,11	101,26	114,71	225,91	143,58	221,51	298,98
Cs	4,45	5,86	8,12	16,16	4,07	27,36	23,24	5,98	13,29	15,60	4,25	6,81	6,28	3,22	2,18	5,51	3,58	2,70
Ta	0,68	0,78	1,44	0,78	0,78	0,71	0,72	0,74	0,98	1,14	1,86	2,17	2,43	1,21	0,51	0,96	0,88	1,17
Nb	11,22	13,36	23,34	11,99	11,76	11,78	10,85	12,76	10,35	13,35	14,12	17,79	17,99	11,85	7,34	15,47	11,30	13,55
Hf	4,17	6,38	5,54	5,64	5,17	4,52	4,76	5,64	4,70	4,07	2,92	3,27	2,67	3,27	4,16	6,78	5,00	6,02
Zr	168,59	244,62	231,84	210,71	204,33	187,62	171,13	205,34	178,13	155,24	101,69	90,45	84,77	125,16	166,33	268,11	187,42	232,02
Y	19,94	21,13	29,19	24,17	22,49	19,23	26,91	21,53	15,10	26,69	14,58	20,74	17,80	19,55	19,69	29,57	20,68	21,10
Th	19,58	30,93	20,44	25,37	24,94	27,82	25,36	26,74	8,46	12,53	9,11	11,01	10,02	9,14	13,13	12,87	10,01	9,44
U	3,86	6,64	2,49	7,77	16,23	10,61	8,96	6,99	2,79	2,10	2,13	7,09	3,40	1,71	2,51	2,68	2,86	3,45
Cr	45,94	47,39	69,56	31,04	30,74	33,17	34,68	35,72	81,54	94,33	35,95	38,52	<30.94	47,37	55,01	112,80	62,04	62,34
Ni	16,06	<13.83	28,98	<12.87	<13.85	<9.78	<11.36	18,36	26,89	36,85	<10.93	<11.56	<11.0	15,35	17,23	38,79	25,34	13,67
Co	10,10	12,46	10,37	12,36	16,00	15,29	9,76	17,36	12,49	13,50	3,16	5,62	2,83	7,46	11,97	14,28	8,40	7,68
Sc	13,91	15,31	12,07	15,79	15,12	16,82	13,67	16,78	12,02	11,76	9,77	9,22	8,80	11,30	16,45	15,91	12,39	12,74
V	105,61	188,47	96,21	160,59	161,28	160,92	143,86	168,89	86,16	102,45	40,87	62,23	27,79	69,86	138,73	121,42	67,61	68,15
Pb	47,74	77,8	35,46	82,62	85,19	80,58	80,32	84,4	23,2	26,21	31,70	89,69	84,96	22,84	13,60	20,13	20,23	21,70
Zn	40,90	57,14	54,95	53,95	81,95	52,95	51,13	98,19	37,59	80,14	24,22	59,86	45,43	36,00	48,56	60,24	79,19	36,54
Ga	14,04	18,75	19,02	16,44	15,99	16,98	15,45	18,14	13,30	18,55	15,79	24,74	24,36	17,65	13,46	17,42	16,24	17,47
Ag	<0.37	<0.38	<0.37	<0.38	<0.39	<0.33	<0.36	<0.36	<0.44	<0.45	<0.38	<0.46	<0.41	<0.45	<0.28	<0.38	<0.31	<0.35
La	37,37	54,46	50,06	50,35	46,15	42,56	43,85	48,30	18,40	30,22	20,42	26,19	24,17	24,89	34,88	38,41	28,93	25,98
Ce	66,10	100,36	92,41	88,95	83,58	78,67	75,63	89,59	41,91	62,59	41,16	52,81	49,07	49,39	65,51	77,61	57,36	55,80
Pr	7,46	10,71	10,50	9,63	9,33	8,70	8,82	9,80	4,46	7,04	4,53	5,98	5,60	5,70	7,36	8,57	6,74	6,32
Nd	27,24	38,39	38,58	35,94	33,25	31,95	34,12	35,72	16,40	27,01	16,49	22,44	20,80	22,01	28,01	33,07	25,13	24,87

Table 1 (cont.) Chemical composition of samples from clay deposits

	Ya_R_01	Ya_R_01a	Ya_R_02	Ya_R_03.1	Ya_R_03.2	Ya_R_03.3	Ya_R_03.4	Ya_R_03.6	Ks_R_01	Ks_R_02	S_R_01	S_R_02	S_R_02a	S_R_03	Ch_R_01	Ch_R_02	M_R_01	M_R_02
Sm	5,08	6,77	7,06	6,45	6,17	6,05	6,32	6,72	3,63	5,42	3,17	5,14	4,15	4,37	5,30	6,61	5,35	5,12
Eu	1,17	1,73	1,37	1,70	1,68	1,47	1,66	1,65	0,71	1,10	0,68	1,11	0,85	0,95	1,08	1,35	1,00	1,06
Gd	4,25	5,40	6,06	5,00	5,17	4,82	5,32	4,88	2,81	5,32	3,09	4,16	3,69	3,94	3,96	5,89	4,19	4,70
Tb	0,54	0,69	0,93	0,67	0,70	0,62	0,74	0,73	0,48	0,74	0,44	0,63	0,63	0,58	0,58	0,88	0,59	0,67
Dy	3,43	3,82	5,00	4,21	3,68	3,49	4,60	4,19	2,94	4,90	2,57	3,87	3,39	3,41	3,36	5,24	3,48	3,76
Ho	0,75	0,72	1,00	0,84	0,80	0,65	0,85	0,73	0,60	0,91	0,46	0,69	0,60	0,58	0,68	1,04	0,69	0,71
Er	1,72	2,05	2,76	2,26	2,41	2,01	2,64	2,09	1,63	2,80	1,53	1,81	1,53	1,92	2,05	2,87	2,17	2,02
Tm	0,30	0,29	0,41	0,33	0,29	0,29	0,35	0,32	0,23	0,37	0,21	0,27	0,21	0,24	0,27	0,47	0,29	0,31
Yb	2,03	1,86	2,78	2,40	2,29	1,88	2,32	2,20	1,90	2,63	1,51	1,69	1,62	1,74	2,08	2,78	1,98	1,99
Lu	0,30	0,31	0,43	0,32	0,35	0,27	0,38	0,35	0,28	0,38	0,18	0,26	0,23	0,24	0,32	0,44	0,31	0,29
Au	0,29	<0.21	<0.20	<0.16	<0.19	<0.16	<0.17	<0.13	<0.20	<0.19	<0.16	<0.18	<0.19	<0.24	<0.13	<0.16	<0.15	<0.16

Table 2. Chemical composition of samples from pottery

Kod	Con_S_001	Con_S_002	Con_S_003	Con_S_004	Con_S_005	Con_S_006	Con_S_007	Con_S_008	Con_S_009	Con_S_010	Con_S_011	Con_S_012	Con_S_013	Con_S_014
SiO2	59,89	63,17	69,65	68,32	67,35	70,72	70,61	54,25	69,70	64,88	67,23	62,30	65,61	60,68
TiO2	0,94	0,74	0,58	0,68	0,70	0,55	0,10	0,09	0,11	0,11	0,13	0,26	0,71	0,91
Al2O3	20,21	19,09	14,58	17,06	19,42	15,58	2,15	2,64	2,33	2,37	3,19	5,09	17,59	19,33
FeO	6,14	5,33	3,10	3,43	4,18	2,85	0,07	0,13	0,09	0,09	0,13	0,26	3,67	5,30
MnO	0,09	0,06	0,08	0,05	0,13	0,10	0,08	0,07	0,06	0,04	0,07	0,07	0,08	0,11
MgO	2,43	2,34	0,74	1,25	1,93	0,89	0,08	0,35	0,10	0,10	0,15	0,15	0,95	1,28
CaO	3,01	2,68	1,72	1,89	1,88	1,23	7,70	17,91	4,87	4,20	4,99	3,90	2,11	2,81
Na2O	1,63	1,65	1,05	1,99	1,95	1,18	6,69	8,33	5,15	4,12	4,14	1,99	1,63	2,29
K2O	2,95	2,88	2,88	3,09	3,34	3,14	0,06	0,06	0,08	0,07	0,10	0,14	3,42	3,75
P2O5	0,34	0,18	0,36	0,12	0,15	0,16	0,14	0,82	0,12	0,09	0,24	2,20	0,42	0,51
сума	97,62	98,12	94,75	97,89	101,05	96,40	87,69	84,68	82,59	76,07	80,37	76,35	96,17	96,97
Ba	1273,55	829,01	1138,92	594,69	921,92	989,75	633,29	1031,39	535,09	388,20	570,08	770,44	1300,43	1063,80
Rb	118,95	116,78	101,97	102,45	142,78	115,29	364,69	396,56	302,95	263,82	217,40	151,91	126,27	105,76
Sr	269,50	201,63	199,18	174,36	289,00	196,20	388,34	599,92	353,84	318,08	468,62	701,86	273,75	375,68
Cs	11,67	6,21	3,85	4,99	8,24	5,12	53,96	32,17	29,96	20,78	12,17	9,89	4,11	3,56
Ta	1,12	1,01	1,09	0,86	1,09	1,02	12,39	6,16	5,90	4,64	2,88	1,90	1,20	0,85
Nb	15,54	12,11	16,24	11,19	15,85	12,54	118,77	61,98	71,67	50,15	38,49	22,03	15,20	13,05
Hf	6,57	4,39	6,30	4,64	4,93	3,96	64,82	23,36	36,87	21,99	14,86	10,14	5,75	5,10
Zr	254,83	173,87	247,70	173,82	194,70	165,72	601,69	279,15	522,75	396,37	383,67	310,10	218,41	199,17
Y	29,25	26,64	23,29	18,74	27,48	21,50	190,27	144,98	126,51	78,96	65,42	45,89	24,48	29,66
Th	15,73	10,94	10,54	7,87	18,43	11,74	94,81	58,66	53,66	37,16	37,82	19,78	17,12	12,33
U	4,35	2,18	2,39	2,46	4,02	1,96	23,13	18,93	15,85	8,54	7,19	3,97	2,90	2,15
Cr	177,21	229,08	70,91	80,18	144,62	71,47	354,55	1061,89	249,51	252,58	216,83	143,32	82,77	75,35
Ni	56,87	131,69	26,67	27,18	76,18	28,44	216,33	705,67	142,18	88,41	91,88	40,99	28,55	33,06
Co	18,26	20,59	9,13	9,32	15,90	11,11	87,38	167,03	60,52	33,88	32,39	24,54	11,06	16,04
Sc	21,75	20,73	12,32	14,42	16,13	12,84	112,95	129,05	62,52	52,95	33,00	27,50	14,68	18,16
V	151,21	132,54	88,29	101,34	111,19	71,24	358,17	414,23	301,82	238,28	215,53	173,34	104,82	176,57
Pb	28,30	22,00	20,47	18,33	41,06	25,49	131,91	84,91	90,39	65,00	65,65	42,66	19,75	17,49
Zn	84,34	88,53	55,56	58,06	74,83	53,66	286,21	344,60	236,24	138,65	141,99	124,73	52,99	65,37
Ga	17,92	17,81	14,21	14,87	19,59	16,26	121,55	108,87	79,16	62,54	43,23	30,19	19,41	20,25

Table 2 (cont.) Chemical composition of samples from pottery

Kod	Con_S_001	Con_S_002	Con_S_003	Con_S_004	Con_S_005	Con_S_006	Con_S_007	Con_S_008	Con_S_009	Con_S_010	Con_S_011	Con_S_012	Con_S_013	Con_S_014
Ag	<0.67	<0.578	<0.54	<0.71	<0.656	<0.75	<8.80	<3.31	<3.55	<2.91	<1.73	<0.801	<0.57	<0.54
La	39,05	31,11	29,86	22,71	40,27	29,62	203,22	118,31	132,89	92,58	93,57	51,02	33,58	36,11
Ce	73,68	61,52	66,99	45,86	76,23	85,67	235,66	153,76	191,24	147,77	155,36	95,69	68,11	74,30
Pr	9,05	7,36	7,25	5,19	8,41	6,73	67,08	39,15	39,25	25,95	23,52	12,48	8,08	8,38
Nd	34,09	29,06	27,48	20,76	31,07	25,35	192,18	120,24	123,97	84,56	83,05	46,40	30,14	33,44
Sm	6,62	6,02	5,42	4,12	6,01	5,19	51,38	35,00	31,39	20,58	16,79	10,06	5,95	6,59
Eu	1,56	1,25	1,13	0,92	1,24	0,95	11,17	8,41	6,29	4,27	3,44	2,23	1,19	1,53
Gd	6,35	5,30	4,46	3,87	4,84	4,30	49,11	32,41	28,79	16,82	13,99	9,07	5,19	5,98
Tb	0,83	0,81	0,67	0,54	0,79	0,63	7,43	5,38	4,42	2,57	2,15	1,40	0,68	0,86
Dy	5,04	5,06	4,01	3,27	4,79	3,62	49,78	32,24	25,58	15,06	13,02	8,11	4,24	5,13
Ho	1,06	0,95	0,79	0,74	0,90	0,83	9,92	6,86	5,46	3,26	2,59	1,75	0,81	1,05
Er	2,92	2,62	2,33	1,78	2,85	2,20	25,76	20,40	15,77	8,74	6,37	4,98	2,48	3,22
Tm	0,42	0,41	0,35	0,26	0,38	0,33	3,79	2,67	2,16	1,33	1,05	0,69	0,35	0,44
Yb	2,67	2,57	2,25	2,15	2,78	2,27	29,00	19,77	14,92	9,58	6,66	5,49	2,25	3,07
Lu	0,39	0,42	0,32	0,32	0,39	0,31	4,01	2,89	2,27	1,38	1,15	0,68	0,33	0,46
Au	<0.29	<0.15	<0.15	<0.18	<0.12	<0.21	<3.22	<1.37	<0.94	2,42	<0.59	<0.29	<0.24	<0.24
Pb	28,30	22,00	20,47	18,33	41,06	25,49	131,91	84,91	90,39	65,00	65,65	42,66	19,75	17,49

Table 2 (cont.) Chemical composition of samples from pottery

Kod	Con_S_015	Con_S_016	Con_S_017	Con_S_018	SMG_S.BE_026	SMG_S.BE_027	SMG_S.BE_028	SMG_S.BE_029	SMG_S.BE_030	SMG_S.BE_031	M_S.BE-001	Ch18A_S.BE_001
SiO2	67,54	69,81	71,45	67,77	64,48	61,86	64,41	64,59	63,92	61,37	55,83	64,45
TiO2	0,66	0,58	0,54	0,96	0,91	0,68	0,79	0,67	0,72	0,77	0,78	0,53
Al2O3	19,08	18,32	16,92	20,54	17,77	19,57	18,29	17,02	21,77	19,09	15,77	17,23
FeO	4,17	3,40	2,88	5,78	3,63	4,48	5,42	4,76	3,75	4,32	5,35	3,89
MnO	0,08	0,07	0,06	0,14	0,14	0,08	0,08	0,10	0,07	0,07	0,11	0,09
MgO	1,16	0,99	0,92	1,52	1,14	1,43	2,49	2,42	1,18	1,82	3,99	2,07
CaO	1,92	1,70	1,24	1,74	2,50	2,36	3,37	5,03	2,19	3,43	7,05	1,71
Na2O	1,58	1,80	1,42	1,50	2,16	1,63	2,18	1,57	2,72	1,39	1,29	2,84
K2O	2,87	3,21	3,18	2,08	2,80	4,07	2,66	2,69	3,21	3,51	2,87	3,20
P2O5	0,23	0,21	0,15	0,17	0,28	0,56	0,17	0,13	0,15	0,20	0,26	0,27
сума	99,29	100,09	98,75	102,20	95,83	96,73	99,85	98,98	99,69	95,96	93,30	96,29
Ba	757,46	835,74	897,11	787,43	1052,88	2222,10	678,25	578,52	620,67	822,42	818,02	732,93
Rb	123,73	113,03	123,08	88,11	118,16	167,71	97,34	103,35	135,08	123,27	114,71	98,28
Sr	183,84	218,99	199,49	143,79	302,90	403,73	436,83	207,66	215,38	224,57	265,67	223,09
Cs	4,95	4,58	5,60	5,54	3,78	6,92	4,70	4,34	4,67	6,42	6,89	2,87
Ta	0,90	0,88	1,19	0,91	1,74	1,23	0,84	1,00	1,71	1,02	0,77	0,41
Nb	13,48	12,56	13,07	13,56	18,95	15,98	11,50	11,98	19,03	14,09	11,15	6,81
Hf	7,48	4,88	5,10	6,34	8,40	6,10	4,90	3,56	6,71	4,97	4,22	3,92
Zr	286,41	188,09	184,48	243,71	326,52	222,28	186,64	125,75	241,88	183,09	168,68	145,83
Y	25,97	23,46	21,26	40,05	33,88	23,87	24,57	22,81	27,38	26,55	23,56	19,98
Th	12,99	14,94	12,42	10,58	13,69	26,56	11,55	12,18	13,13	12,69	10,10	10,38
U	2,74	2,38	2,58	2,30	4,78	7,44	2,57	1,52	4,17	2,97	1,95	2,05
Cr	107,27	87,27	56,51	101,99	79,36	74,12	118,04	238,94	73,69	107,50	395,68	52,89
Ni	44,70	25,48	27,46	44,99	27,81	34,36	55,55	184,20	29,05	42,86	243,59	27,44
Co	11,95	10,50	9,20	18,46	14,75	13,83	19,77	20,60	8,44	16,54	24,40	12,54
Sc	15,31	12,02	12,45	21,45	14,62	18,64	20,23	17,47	14,95	17,35	21,86	15,76
V	112,22	94,02	80,13	163,20	104,85	132,96	181,76	105,45	89,26	128,36	130,57	124,32
Pb	21,46	37,47	24,16	13,54	23,38	60,17	31,11	26,07	20,74	20,9	26,09	17,62
Zn	59,18	46,92	57,26	73,54	70,05	67,73	97,07	76,46	199,61	82,56	96,83	76,35
Ga	19,35	18,34	17,90	21,61	19,00	19,06	16,80	17,39	24,50	20,70	17,51	14,30

Table 2 (cont.) Chemical composition of samples from pottery

Kod	Con_S_015	Con_S_016	Con_S_017	Con_S_018	SMG_S.BE_026	SMG_S.BE_027	SMG_S.BE_028	SMG_S.BE_029	SMG_S.BE_030	SMG_S.BE_031	M_S.BE-001	Ch18A_S.BE_001
Ag	<0.61	<0.43	<0.55	<0.54	<0.43	<0.35	<0.42	<0.47	<0.45	<0.40	<0.60	<0.44
La	37,33	37,45	29,98	42,70	42,74	41,93	31,23	30,21	36,49	35,46	27,64	27,19
Ce	74,50	72,01	57,63	96,07	91,60	78,55	63,17	60,16	66,76	71,33	57,99	53,44
Pr	8,78	8,08	6,82	10,27	10,24	9,09	7,27	6,65	8,39	8,24	6,63	6,06
Nd	33,78	30,49	25,88	41,47	39,80	33,74	28,87	25,13	32,38	31,13	25,73	23,12
Sm	6,77	5,86	4,61	9,16	8,02	6,00	5,90	5,08	6,18	6,16	5,60	4,62
Eu	1,23	1,11	0,93	2,00	1,64	1,31	1,24	1,02	1,26	1,37	1,14	1,06
Gd	5,78	4,84	4,44	8,10	6,91	4,94	5,33	4,74	5,77	5,39	4,32	4,07
Tb	0,83	0,73	0,59	1,19	1,00	0,73	0,72	0,68	0,81	0,79	0,66	0,53
Dy	4,93	4,41	3,59	7,27	6,28	4,26	4,37	3,64	5,15	4,54	4,30	3,52
Ho	0,96	0,88	0,72	1,45	1,14	0,85	0,89	0,88	0,90	0,93	0,82	0,66
Er	2,95	2,37	2,30	4,15	3,54	2,33	2,79	2,50	2,74	2,82	2,23	2,01
Tm	0,38	0,34	0,29	0,58	0,48	0,31	0,35	0,36	0,39	0,40	0,38	0,30
Yb	2,61	2,34	2,18	4,11	3,17	2,50	2,36	2,00	2,48	2,46	2,45	2,09
Lu	0,38	0,35	0,28	0,61	0,45	0,40	0,35	0,31	0,40	0,41	0,33	0,30
Au	<0.23	<0.11	<0.19	<0.16	<0.15	<0.16	<0.16	<0.23	<0.18	<0.13	<0.15	<0.20
Pb	21,46	37,47	24,16	13,54	23,38	60,17	31,11	26,07	20,74	20,90	26,09	17,62