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KHUMDAN – A BRICK-FIRING KILN: TRADITION, TECHNOLOGY, AND PROSPECTS FOR PRESERVATION IN CENTRAL ASIA

Nafisa Gilmanova
Doctor of Architecture (DSc), Leading Researcher Institute of Art Studies,
Academy of Sciences of the Republic of Uzbekistan, Tashkent

Abstract:
This article examines khumdans, traditional kilns used for firing building bricks in Central Asia. Such kilns are significant not only as production structures but also as an important component of the region's construction history and traditional craftsmanship. The study is based on data concerning the khumdan in the village of Taib-Ata, Urgut District, Samarkand Region, surveyed by architect E. I. Karaev in 1976, as well as materials relating to the construction of an experimental kiln for producing restoration bricks in Shakhrisabz in 1983. Central Asian two-tier kilns dating from the 10th to the 20th centuries are compared with analogous kilns from Kazakhstan, Iran, the Middle East, and East Asia, as well as with modern industrial kiln systems. The study demonstrates that the khumdan cannot replace large-scale industrial production under contemporary conditions. Nevertheless, it may be effectively employed for the manufacture of small batches of restoration bricks, experimental research, and the transmission of traditional craft skills. The article proposes measures for documenting surviving kilns, investigating raw materials and firing regimes, training craftspeople, reducing harmful emissions, and establishing educational and demonstration centres.

Keywords: Khumdan, khumdon, brick-firing kiln, fired brick, Central Asia, Samarkand, Urgut, Taib-Ata, Shakhrisabz, restoration brick, traditional technologies, built heritage.

1. Introduction

Fired brick was one of the principal building materials of Central Asia. Its strength, durability, regular geometry, and suitability for both masonry and architectural decoration contributed to its widespread use in major buildings in the medieval cities of Mawarannahr. In Central Asia, khumdans–brick-firing kilns–were constructed in craft quarters as well as in the immediate vicinity of major construction sites [1]. Archaeological discoveries at Chupan-Ata near Afrasiab indicate that a developed brick-production industry already existed in Samarkand in the 10th–12th centuries [2].

The source materials describe an early-20th-century khumdan located in the village of Taib-Ata, Urgut District, near the Taib-Ata Mosque. In November 1976, architect E. I. Karaev surveyed the kiln and prepared measured drawings. According to accounts provided by local residents, the structure was associated with the master craftsman Usta Ablakul Khidirov (1874–1959) from the village of Tuse. His father, Usta Makhkam Ablakulov, was also a master craftsman.

2. Sources and Methodology

The study employs several methods: (1) examination of E. I. Karaev's field materials dating from 1976–1983; (2) analysis of plans and sections of kilns in the Urgut District of the Samarkand Region; (3) comparison with archaeological kilns of Central Asia described in scholarly literature; (4) comparison with international experience in the production of restoration bricks; and (5) assessment of the possibilities for preserving and applying this technology today, taking into account brick quality, energy consumption, and the transmission of craftsmanship to future generations.

In comparative analysis, brick-firing kilns should be distinguished from pottery kilns. Although the principles governing hot-air circulation and draught control are similar, the scale, loading methods, and firing regimes differ. The examples presented below are therefore used solely for structural and technological comparison and do not demonstrate the direct derivation of one kiln type from another.

3. The Taib-Ata Khumdan: Architectural and Structural Characteristics

According to E. I. Karaev's field description, the khumdan was nearly square in plan. Its internal working area measured approximately 4.3 x 4.5 m. The kiln consisted of two principal parts. The lower section contained the firebox and grate system with arched elements constructed of fired brick. Above it was the chamber in which the bricks were stacked for firing. This chamber was enclosed by thick pakhsa (rammed-earth) and adobe walls with the necessary openings. Hot gases rose from the lower firing zone, passed through channels and gaps between the stacked bricks, and gradually heated the entire load.

Square bricks were identified in the masonry of the grate. E. I. Karaev suggested that this feature might indicate the reuse of an earlier foundation. At present, however, this remains a hypothesis. More precise dating of this part of the kiln requires additional investigation, including analysis of masonry stratigraphy, mortar and brick, laboratory testing, and comparison with other structures in the area.

Parameter	Information
Location	village of Taib-Ata, Urgut District, Samarkand Region
Dating	early 20th century (according to the source description)
Measured drawings	E. I. Karaev, November 1976
Internal dimensions	approximately 4.3 × 4.5 m
Type	two-part brick-firing kiln
Lower section	firebox/hearth; arched grate system
Upper section	loading and firing chamber; pakhsa (rammed-earth)/adobe walls
Historical fuel	firewood; controlled, cleaner heat sources are preferable for modern reconstruction
Cooling	1–2 days according to the source description

4. Technological Cycle and the Practical Relevance of the Khumdan

Brick production involved several stages: preparation of loess or another suitable clay, brick moulding, preliminary drying, loading into the kiln, gradual heating, firing, soaking, and slow cooling. The source text states that active firing lasted 6–12 hours, while cooling required 1–2 days. These figures relate to a specific traditional practice and should not be regarded as a universal standard. The duration and temperature of firing depend on brick dimensions, moisture content, clay composition, stacking density, fuel type, draught, and the required quality of the finished product.

The khumdan was particularly well suited to Central Asian conditions for several reasons. First, it could be constructed from locally available materials–loess, adobe, and fired brick–directly adjacent to the construction site. Second, its two-tier configuration separated the fuel from the bricks and directed hot gases through the entire load. Third, the kiln could be repaired without sophisticated equipment, making it practical for craft workshops. Fourth, the firing regime could be adjusted by the master to produce bricks comparable to historic material in terms of density, porosity, colour, and strength. This is especially important in the conservation and restoration of architectural monuments.

At the same time, the traditional technology should not be idealised. Conventional wood-fired kilns generally consume more fuel, provide less stable temperature control, generate higher emissions, and do not always ensure uniform quality throughout an entire batch. Consequently, the khumdan is most appropriate today for small-scale restoration production, research, and training. For greater precision, the kiln may be equipped with temperature sensors, firing-temperature variations

may be systematically recorded, and cleaner, controllable fuels may be used wherever feasible.

5. Historical Analogues in Central Asia

Archaeological evidence indicates that two-tier kilns were used in Central Asia over many centuries. Circular kilns with separate firing and firing chambers are documented for the 9th–11th centuries, while rectangular two-tier structures were also employed in the 11th–12th centuries [1]. Brick-firing kilns dating to the Karakhanid period have been discovered at Chupan-Ata near Afrasiab, demonstrating the existence of specialised building-brick production in Samarkand [2]. In medieval Merv, complexes comprising several kilns have been identified, suggesting that production may have been concentrated in specialised craft areas of the city [1, 3].

Comparable kilns dating to the 13th–14th centuries have also been investigated in Kazakhstan, including at Kyshkala, Otrar, Saraishyk, Zhaiyk, and other sites. The kiln at Kyshkala contained separate firing and firing-product zones and is associated by researchers with the broader brick-production tradition of the Golden Horde period [4]. At Kultobe, a 14th–15th-century kiln was discovered with a sunken firing chamber and traces of transverse vaulted partitions. Researchers note that comparable structures were distributed across a broad geographical area extending from Central Asia to Southeastern Europe [5].

Ethnographic evidence complements the archaeological record. A. K. Pisarchik documented the term “khumdon” among craftsmen of the Fergana Valley in the 19th and early 20th centuries; in Khorezm, related terms such as “khumbuz/kumbuz” were used for kilns [4, 6]. This terminological variation reflects regional craft traditions, while the fundamental structural principle–the separation of the combustion zone from the firing zone and the regulation of draught–remained consistent.

6. Similarities with Kilns of Other Regions and Periods

Type/region	Period	Common features	Key difference
Central Asian khumdan	10th–20th centuries	two-zone arrangement, upward gas flow, brick/earthen enclosure	local adaptation to loess and building-brick production
Kumbuz/kumdan of Kazakhstan	13th–14th centuries	firing and firing-product chambers, vaults, sunken construction	archaeologically documented regional variants
Pottery kilns of Panjakent/Samarkand/Merv	early and high Middle Ages	separation of firebox and chamber, draught control	smaller scale and different loading system
Iranian and Middle Eastern periodic kilns	various periods	periodic loading, brick enclosure, natural draught	different chamber forms and fuel types
Chinese mantou kilns	from the Tang period onward	controlled hot-gas flow, vaulted chamber	horizontal/inclined flow, primarily ceramic production
Modern tunnel kiln	20th–21st centuries	controlled heating and cooling	continuous process, automation, high reproducibility

The comparison indicates that the khumdan belongs to the category of periodic kilns: bricks are loaded, fired, cooled, and only then unloaded. Firing quality depends not only on the maximum temperature reached, but also on the path of hot gases through the kiln, the uniformity of heating, and the rate of cooling. East Asian mantou-type kilns employ a different organisation of heat flow and are primarily associated with ceramic production. A direct historical connection with the khumdan therefore cannot be asserted [7]. Their similarity is best understood as a functional response to a common technological problem: achieving stable heat using locally available materials.

7. The 1983 Shakhrisabz Experiment and Restoration Practice

An important example is the experiment conducted in 1983, when E. I. Karaev was assigned to Shakhrisabz, where a khumdan modelled on the Urgut kiln was constructed and tested. A kiln with an internal volume of approximately 12 m^3 was built at the Special Scientific Restoration Production Workshops (SNRPM). A shelter was erected to protect the structure from precipitation, a working area was prepared, and a 3 x 5 x 1.5 m pit was constructed for soaking loess. The delivery of raw

materials, preparation of the clay mixture, and moulding of bricks were also organised.

This experiment is significant because the traditional technology was deliberately revived for restoration purposes. Contemporary international practice in the conservation of earthen and brick architecture likewise demonstrates the need for preliminary testing and practical training of craftspeople before large-scale production is undertaken. UNESCO materials emphasise that merely reproducing an old kiln is insufficient: the clay, fuel, quality of the resulting bricks, and the entire production process must be tested and evaluated [8, 9].

8. International Experience: Applicable Practices

International experience may broadly be divided into two approaches. The first concerns industrial production. Modern tunnel and periodic kilns enable automated temperature control, partial heat recovery, reduction of defective products, and emissions monitoring. The second approach relates to heritage conservation. Historic buildings sometimes require bricks with specific properties that are difficult or economically impractical to reproduce on a large industrial production line. In such cases, small specialised facilities are established in which traditional hand moulding is combined with modern control of firing temperature and product quality.

For Uzbekistan, a combined approach may be appropriate: preserving the form and fundamental operating principle of the khumdan, hand moulding of bricks, and local clay compositions while introducing modern monitoring methods. These may include measuring the moisture content of unfired bricks, laboratory analysis of clay composition, installing temperature sensors in different parts of the kiln, recording data from each firing cycle, monitoring flue gases, and using a consistent, predetermined type of fuel. Such an approach would preserve the traditional technology while improving the stability and reproducibility of the results for scientific restoration.

9. Proposals for Preserving the Brick-Firing Tradition

– Undertake comprehensive documentation of surviving khumdans in Uzbekistan, including measured drawings, photogrammetry, and 3D scanning, and record the masonry, fireboxes, channels, and traces of high-temperature exposure.

– Compile a register of craftspeople and families who continue to preserve this craft, and document their knowledge concerning brick moulding, drying and stacking, fuel types, and the visual indicators used to determine completion of firing.

– Establish small experimental khumdans at restoration centres in Samarkand, Bukhara, Khiva, and Shakhrisabz for training purposes and the production of restoration bricks.
– Prepare a technical record for each batch of restoration bricks, specifying the origin and composition of the clay, dimensions, shrinkage, water absorption, density, strength, colour, and firing temperature.
– Avoid the use of traditional wood firing without an assessment of its environmental impact. Training kilns should employ controlled fuel and include monitoring of smoke and gaseous emissions.
– Compare newly produced bricks with historic bricks not only visually but also in terms of strength, density, water absorption, and other physical properties in order to ensure material compatibility during restoration.
– Develop an educational course entitled “Traditional Brick of Central Asia” for conservation architects, archaeologists, technologists, and craftspeople, with mandatory practical training covering the complete brick-production cycle.
– Establish a digital archive of research on khumdan kilns and supplement it with contemporary 3D reconstructions and the results of laboratory investigations.

10. Conclusions

The khumdan is not merely a kiln for firing bricks; it is also important material evidence of the building traditions of Central Asia. Its structure reflects principles employed in the region over many centuries: separation of the combustion zone from the firing chamber, movement of hot air by natural draught, prolonged heat retention by thick walls, and the use of locally available raw materials for both construction and production. Archaeological evidence from Samarkand, Merv, Otrar, Kyshkala, and other centres demonstrates the widespread use of comparable principles.
Today, the khumdan should not be regarded as a competitor to modern brick factories. Its principal value lies in its application to restoration and in the preservation of traditional craft knowledge. In the repair and conservation of historic buildings, it is essential that newly produced bricks remain compatible with historic material in their physical and mechanical properties. Small-scale, controlled brick production based on traditional technology may therefore be both useful and justified.
The most appropriate strategy is to preserve the khumdan through practical but controlled use. This requires detailed documentation of historic structures, construction of experimental kilns, measurement of temperature and other firing parameters, reduction of harmful emissions, and training of younger craftspeople.

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Under this approach, the khumdan can simultaneously be preserved as an element of cultural heritage, employed in restoration research, and used as an educational facility.

Illustrative Materials:

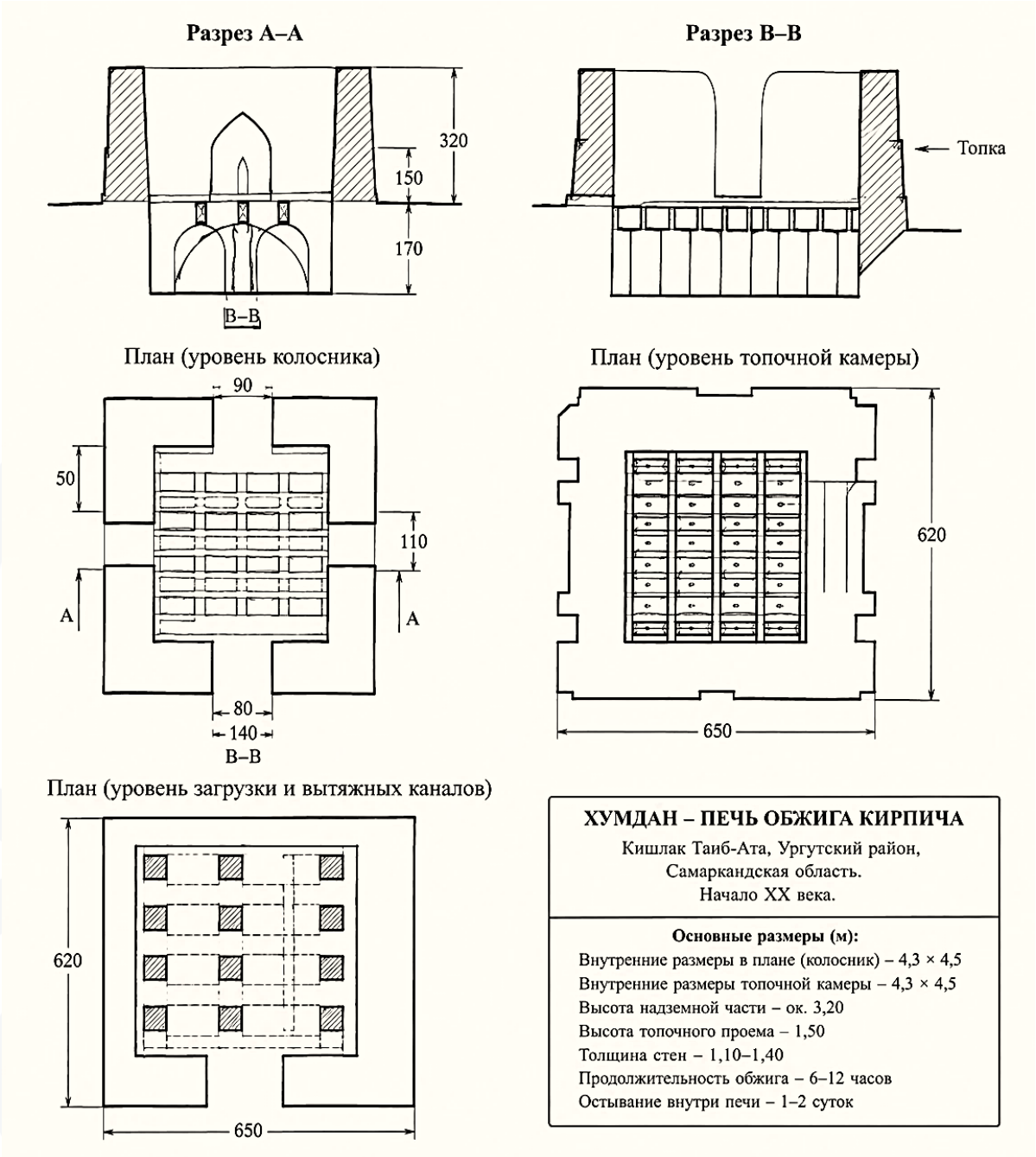

Fig. 1. Measured drawing sheet of the khumdan in the village of Taib-Ata: plans and sections. The drawing shows the form of the kiln, the arrangement of its principal components, and the dimensions recorded during E. I. Karaev's survey in 1976.

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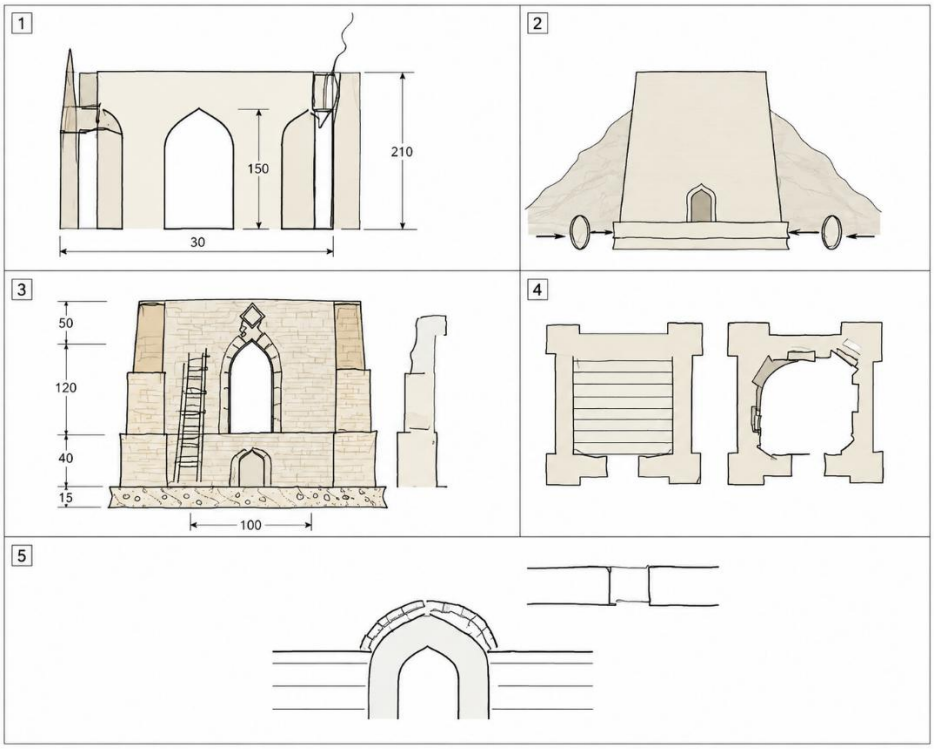

Fig. 2. Field sketch of the façade/section and plan of the khumdan, showing arched openings and approximate elevation marks, based on sketches by E. I. Karaev.

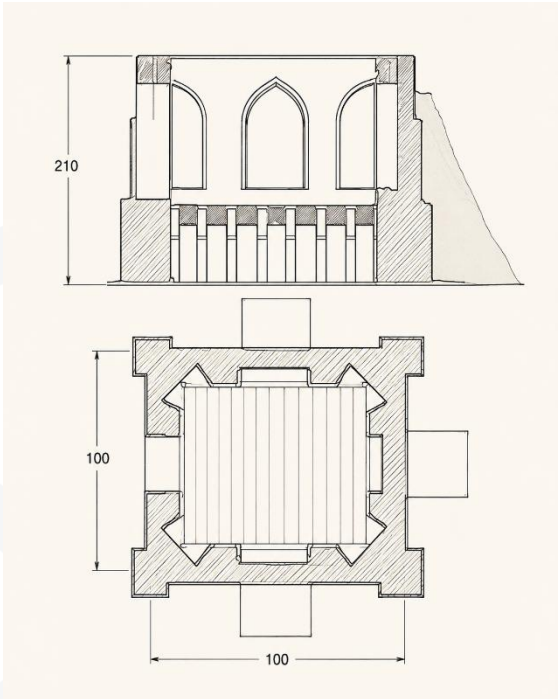

Fig. 3. Field sketch of the khumdan by E. I. Karaev. The drawing records the overall appearance of the kiln and its structural features during the field survey.

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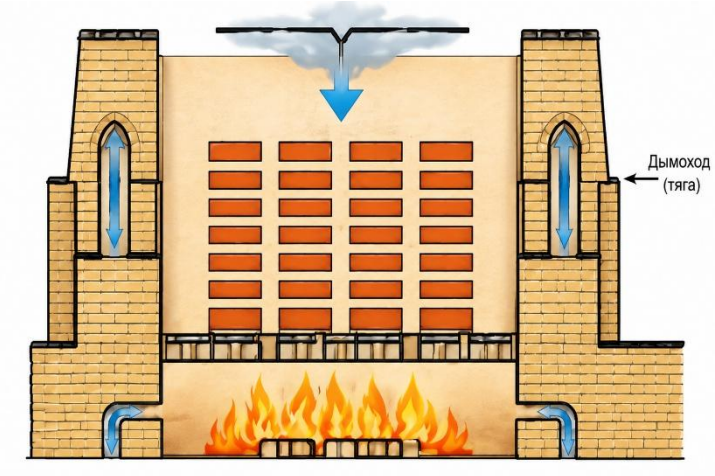

Fig. 4. Operating diagram of the khumdan. The arrows indicate the movement of hot gases from the lower firing zone upward through the stacked bricks and the direction of natural draught.

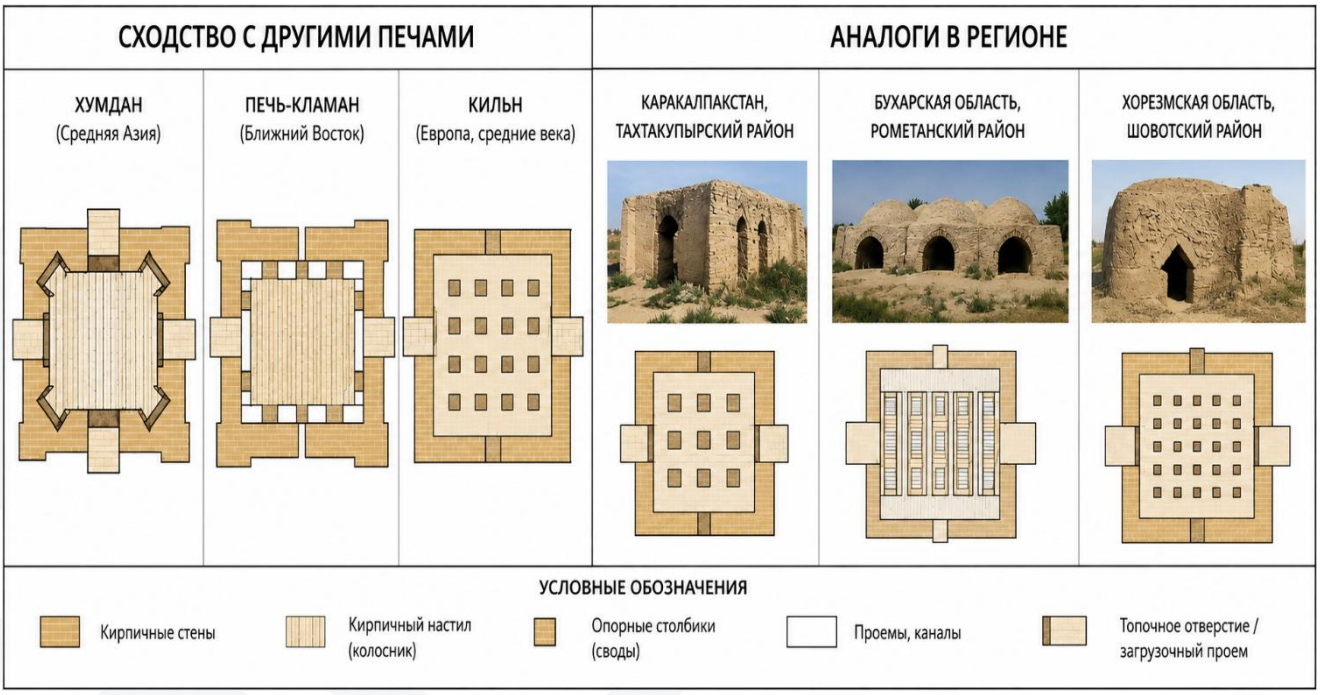

Fig. 5. Analogues of khumdan-type kilns in other regions. The illustrations demonstrate comparable arrangements of firing and firing-product zones and enable comparison among different firing traditions.

Photo 1. Measurement of the arched firebox opening of the khumdan in Shakhrisabz. The photograph documents the measurement of the arched opening during the construction and testing of the kiln. Archival photograph, 1980s.

Photo 2. Construction and reconstruction of a brick khumdan kiln in Shakhrisabz. The photograph documents the process of erecting the walls and structural components of the kiln. Archival photograph, 1980s.

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