



MANUSCRIPT TRADITION AND PRACTICAL KNOWLEDGE IN MEDIEVAL CENTRAL ASIAN SCIENTIFIC TEXTS

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Abstract. *This article examines the relationship between manuscript tradition and practical knowledge in medieval Central Asian scientific texts from the perspective of source-study analysis. Manuscript tradition is treated not as a neutral medium of preservation but as a historical mechanism through which applied knowledge was selected, structured, interpreted, and transmitted. Drawing on treatises related to astronomy, medicine, mineralogy, mathematics, paper technology, and juridical practice, the study identifies how observation, measurement, classification, calculation, diagnosis, and procedural instruction were embedded within scientific writing. Particular attention is given to copying, commentary, marginal glosses, and translation as instruments that shaped the practical content of texts. The findings confirm that theoretical reasoning and applied procedure were inseparable within the written culture of the region.*

Keywords: *manuscript tradition, medieval Central Asian science, practical knowledge, source studies, scientific texts, empirical observation, measurement, textual transmission, commentary tradition, intellectual history.*

Annotatsiya. *Maqolada o'rta asr Markaziy Osiyo ilmiy matnlaridagi qo'lyozma an'anasi va amaliy bilimning o'zaro munosabati manbashunoslik nuqtai nazaridan tahlil qilinadi. Tadqiqot davomida qo'lyozma an'anasi shunchaki matnni saqlash vositasi emas, balki amaliy bilim tanlanadigan, tartibga solinadigan va uzatiladigan tarixiy mexanizm sifatida ko'rib chiqilgan. Ish doirasida astronomiya, tibbiyot, mineralogiya, riyoziyot, qog'ozshunoslik va huquqiy amaliyotga oid*

manbalar tahlil etilib, ularda kuzatish, o'lchov, tasnif, hisoblash, tashxis va amaliy ko'rsatmalar qanday ifodalanganligi yoritildi. Nusxa ko'chirish, sharh, hoshiya va tarjima jarayonlari amaliy bilimni nafaqat saqlash, balki o'zgartirish vositasi ekanligi ko'rsatildi. Natijalar Movarounnahr ilmiy madaniyatida nazariya va amaliyot yagona matn maydonida birlashtirilganini tasdiqlaydi.

Kalit so'zlar: *qo'lyozma an'anasi, o'rta asr Markaziy Osiyo fani, amaliy bilim, manbashunoslik, ilmiy matnlar, empirik kuzatuv, o'lchov, matn uzatilishi, sharh an'anasi, intellektual tarix.*

Аннотация. *Статья посвящена анализу соотношения рукописной традиции и практического знания в средневековых научных текстах Центральной Азии. Рукописная традиция рассматривается не как простой способ сохранения текста, а как исторический механизм отбора, систематизации, истолкования и передачи прикладного знания. На материале трактатов по астрономии, медицине, минералогии, математике, бумажному делу и юридической практике показано, каким образом наблюдение, измерение, классификация, вычисление, диагностика и прикладные рекомендации фиксировались в составе научных сочинений. Особое внимание уделено роли переписки, комментирования, маргиналий и перевода в формировании практического содержания текста. Полученные результаты подтверждают неразрывность теоретического и прикладного слоёв в письменной культуре региона.*

Ключевые слова: *рукописная традиция, средневековая наука Центральной Азии, практическое знание, источниковедение, научные тексты, эмпирическое наблюдение, измерение, передача текста, комментаторская традиция, интеллектуальная история.*

1. INTRODUCTION. The scientific culture of medieval Central Asia is preserved primarily in the form of manuscripts. These objects functioned simultaneously as carriers of authorial argument, as instruments of teaching, as references for administrative and legal practice, and as compendia of procedural

instruction. A medieval treatise on astronomy, medicine, or mineralogy was rarely a closed authorial work; it circulated through copies, commentaries, marginal notes, abridgements, and translations, each of which left traces of how scholars and practitioners actually used the text. For this reason, the study of practical knowledge in the region cannot be separated from the study of manuscript transmission itself.

The problem treated here concerns the way in which applied forms of reasoning – observation, measurement, classification, calculation, diagnosis, and procedural recommendation – were integrated into the written scientific tradition, and how the manuscript form mediated their preservation and reuse. Earlier scholarship has emphasized the intellectual achievements of individual authors. Less attention has been paid to the fact that those achievements survived because they were embedded within a manuscript culture that combined material technology, scribal craft, and scholarly commentary [Khadjimetrov, Madraimov, 2023, p. 1442–1443]. The present article approaches the question through a source-study lens: it asks how the codex itself acted as an active scientific instrument [Saidova, 2023, p. 59–61].

The aim is to clarify how practical knowledge was articulated, classified, and circulated through the manuscript tradition of medieval Central Asia. The study pursues three connected tasks: to identify the principal forms in which applied reasoning was expressed in the examined texts; to describe the role of copying, commentary, and translation in stabilizing and transforming that reasoning; and to assess the source-study significance of the relationship between theoretical and practical layers within a single codex.

2. MATERIALS AND METHODS. The materials examined in this study are drawn from scholarly literature devoted to the manuscript heritage of medieval and early modern Central Asia, including codicological surveys, philological editions, and analytical studies on specific treatises, observatories, and craft traditions. The works consulted for this study cover several thematic groups: studies on the manuscript collections of the Al-Biruni Institute of Oriental Studies in Tashkent [Efthymiou, 2015, p. 4–5]; analyses of Timurid-period manuscript production

[Khadjimetov, Madraimov, 2023, p. 1443–1445]; investigations of paper technology and its regional varieties [Friedrich, Helman-Ważny, 2018, p. 1–3; Begmatov, 2025, p. 7–8]; studies on juridical compilations of practicing qadis [Mukhammadaminov, 2017, p. 4–5]; and modern interpretive works on the astronomical, mathematical, and medical sciences of the region [Trigg, 2016, p. 11–12; Iqbal, 2007, p. 16–17].

The analytical framework combines four complementary procedures. Source-study analysis is used to examine the bibliographic, codicological, and material features of the manuscripts and their reported descriptions, including paper type, scribal practice, and binding. Textual analysis serves to identify the specific genres through which practical knowledge was articulated: tables, recipes, juridical formulas, observational records, and procedural descriptions. The historical-comparative method allows the situating of Central Asian texts within the wider transmission of Greek, Indian, and Arabic scientific writing [Mesheznikov, Shomakhmadov, 2020, p. 26–28]. Finally, conceptual and terminological analysis is applied to the specialized vocabulary of measurement, weighing, and observation, particularly in texts associated with the science of weights and astronomy [Abattouy, 2006, p. 2–4].

All claims advanced in the present study rest on page-specific evidence drawn from the source-study materials. The aim is not to summarize the historiography but to reconstruct the relationship between manuscript form and applied scientific content as it appears in the documented evidence.

3. RESULTS.

3.1. The codex as an active scientific instrument. The examined sources indicate that medieval Central Asian manuscripts functioned as working scientific tools, not merely as repositories of completed knowledge. Their material structure was deliberately adapted to specific intellectual tasks. Different categories of paper – silk paper (*karghaz-i silk*) reserved for luxury manuscripts and royal decrees, smoother grades treated with rice or wheat starch for high-quality codices, and coarser varieties for everyday use – corresponded to different functions of the written

object [Saidova, 2023, p. 61–62]. Surveys of Timurid-period codices held in Tashkent collections show that within a single courtly manuscript different papers could be used for the main text, for the borders, and for miniature painting, indicating a precise correspondence between physical support and scholarly purpose [Khadjimetov, Madraimov, 2023, p. 1444–1445].

3.2. Astronomy: observation, table-making, and the commentary tradition. The astronomical tradition centered on Samarqand provides one of the clearest examples of the integration of practical knowledge into manuscript culture. The observatory founded under Ulugh Beg produced a stellar catalogue whose latitude for Samarqand ($39^{\circ} 37' N$) corresponds closely to modern values, demonstrating an exceptionally high level of observational precision [Knobel, 1917, p. 10–12]. The catalogue contains 1018 stars, the great majority observed directly, while a smaller subset was derived from the older Ptolemaic tradition. The pedagogical setting in which such tables were produced is documented in the commentaries of Faḥḥallāh al-Shirwānī on Ṭūsī's *Tadhkira*, which preserve accounts of lectures and discussions involving Qāḍīzāde al-Rūmī and Ulugh Beg himself [Trigg, 2016, p. 12–23]. These commentaries show that practical instrument-making, theoretical astronomy, and optical theory were taught and read together; the manuscript commentary itself became the device through which observational practice was transmitted to later students.

3.3. Mineralogy and the science of weights. Treatises on weights and specific gravity provide a second locus where practical procedure was inseparable from manuscript form. Al-Bīrūnī's *Maqāla fī al-nisab allatī bayna al-filizzāt wa-l-jawāhir fī al-ḥajm wa-l-wazn*, composed between 1010 and 1017, set out an experimental procedure for measuring the relative weights of metals and precious stones, accompanied by the description of an apparatus subsequently associated with his name [Kuranbaeva, 2025, p. 33–34]. Al-Khāzinī's *Kitāb mīzān al-ḥikma* (1121) incorporated this material directly into a broader encyclopedia of statics and hydrostatics, presenting the theory of the centre of gravity in conjunction with

detailed descriptions of an ideal balance [Abattouy, 2006, p. 3–8]. The manuscript transmission of these works enabled a coherent body of metrological knowledge to circulate from one generation of practitioners to another, with the apparatus surviving in textual form long after the physical instruments had been lost [Hassaan, 2015, p. 29526–29528].

3.4. Juridical compilations as repositories of applied knowledge. The genre of the *jung* – collections compiled by practicing judges (*qāḍīs*) and legal advisers (*muftīs*) – represents a distinctive form in which applied reasoning was preserved. A single such codex from the late sixteenth century may contain several hundred authentic legal documents, formulas, and certified opinions. Manuscript No. 9749, for example, comprises 445 documents, of which 422 are *riwāyāt* and the remainder are formularies and certified attestations [Mukhammadaminov, 2017, p. 9–10]. These compilations were not abstract digests of *fiqh*; they recorded the practical work of named jurists, often with their seals, and served as direct references for further casework. As source-study objects, they document a continuum between scholarly authority and daily administrative practice.

3.5. Medicine, mineralogy, and procedural instruction. Medical writings such as Ibn Sīnā's *Qānūn fī al-ṭibb* combine theoretical exposition with detailed surgical, pharmaceutical, and diagnostic procedure. Its second book functions as a pharmacopoeia of more than seven hundred substances of plant, mineral, and animal origin, while its fourth book treats fractures, dislocations, wound management, and cauterization through step-by-step descriptions of operations and the instruments required [Gavin, 2018, p. 1]. Comparable engagement with applied chemistry appears in the same author's discussion of mercury and cinnabar [Abdisattarova, 2020, p. 80]. In mineralogy, al-Bīrūnī's *al-Jamāhir fī ma'rifat al-jawāhir* offers a systematic classification of gems together with criteria for assessing their authenticity, integrating natural-philosophical argument with applied evaluative procedure [Ganiyev, 2023, p. 355–356].

3.6. Mathematics for practitioners. Mathematical writing similarly carried a strong practical orientation. The *Risāla* of Abū al-Wafā' al-Būzjānī, dedicated to a Buyid patron at the end of the tenth century, presents ruler-and-compass constructions intended for use by craftsmen. The author explicitly omits formal proofs in order to make the procedures accessible to non-mathematician practitioners, while preserving the rigour of the Euclidean constructions themselves [Hogendijk, 2008, p. 3–5]. Comparable practical orientation appears in algebraic writing addressed to problems of inheritance, partition, surveying, and canal excavation [Benaferi, 2021, p. 1–2].

3.7. Paper technology and the geography of transmission. Finally, the manuscript tradition itself depended on a paper industry whose technical vocabulary mapped onto centres of production: *Samarqandī*, *Bukhārī*, *Khitā'ī*, *Kashmīrī*, *Iṣfahānī* [Khadjimetrov, Madraimov, 2023, p. 1442]. Chemical analysis of Qur'ān manuscripts in the Al-Biruni Institute has shown that paper conventionally called "Kokand" is in fact predominantly composed of cotton fibres, with characteristic large wire-lines and a low degree of pulp refinement [Efthymiou, 2015, p. 5–6]. The transfer of papermaking from Samarqand to Kashmir during the reign of Sultan Zayn al-ʿĀbidīn (1420–1470) illustrates how the material substrate of scientific writing followed identifiable lines of craft transmission [Khan, Shah, 2024, p. 187–191].

4. DISCUSSION. The evidence assembled above suggests that the dichotomy between "theoretical" and "practical" knowledge, often imposed retrospectively on medieval scientific texts, does not correspond to the way these works were actually organized. In the astronomical commentaries of the Samarqand circle, observational practice, theoretical argument, and optical theory were taught and read within a single textual environment, in which a commentary served simultaneously as a teaching aid and as a record of working scholarly debate [Trigg, 2016, p. 23–192]. The manuscript commentary thus performed a function analogous to that of a modern research seminar transcript: it preserved not only conclusions but procedures of reasoning, including disagreements and revisions.

A second observation concerns the role of material craft. Studies of paper technology – its raw materials, its boiling and beating procedures, its surface treatment, and its polishing with stone or shell – show that the production of scientific manuscripts was itself a domain of refined practical knowledge [Saidova, 2023, p. 62; Marozikov, 2023, p. 3778–3779]. The development of recognizable regional varieties of paper, and their differentiation by intended use, indicates that the manuscript was a product of integrated craft and scholarly judgement rather than a passive vehicle for text. The same source-study perspective that interprets a treatise must also interpret the support on which the treatise is written.

A third point concerns transmission. The history of paper itself constitutes a case in which a practical technology, originally acquired in Samarqand after 751, generated a chain of regional specializations that extended to Kashmir, to the Kokand workshops of the eighteenth and nineteenth centuries, and to peripheral markets where particular grades were employed for distinct genres of writing [Friedrich, Helman-Ważny, 2018, p. 2–3; Begmatov, 2025, p. 7–11]. The fact that an Arabic grammar produced in Kokand in 1873 was copied on a silk-fibre variety reserved for elevated religious and scholarly texts demonstrates that genre, material, and use remained correlated into the late period [Begmatov, 2025, p. 8]. The codicological surface of a manuscript carries, in this sense, an embedded judgement about its expected function.

A fourth point relates to the source-study significance of compilation genres. The *jung* of a working judge differs from a theoretical work of *fiqh* in that its evidential value lies in the assembly of authentic documents, seals, and formulary models rather than in original juridical argument. Such codices are unusually rich sources for the historian of practice, because they record what jurists actually wrote rather than what theoretical works idealized [Mukhammadaminov, 2017, p. 4–9]. Their study requires an attention to compilation strategy, scribal selection, and the relation between the inserted documents and the surrounding annotations.

Finally, the integration of measurement, classification, and procedure into theoretical scientific writing – from Bīrūnī's specific-gravity apparatus to Ibn Sīnā's surgical protocols and Abū al-Wafā's craftsman-oriented geometry – suggests that medieval Central Asian science cultivated what might be called a disciplined practical culture, in which empirical operation was articulated through the same conceptual vocabulary as theoretical demonstration [Abattouy, 2006, p. 13; Hogendijk, 2008, p. 3]. The manuscript tradition was the medium in which this synthesis was both preserved and constantly renewed by readers, copyists, and commentators.

5. CONCLUSION. First, the manuscript tradition of medieval Central Asia must be understood as an active mechanism for the formation and transmission of practical knowledge, rather than as a passive system of textual preservation. The material features of a codex – paper, layout, binding, and marginal apparatus – were integral to its scholarly function.

Second, the principal forms of practical reasoning identified in the examined sources are observation, measurement, classification, calculation, diagnosis, recipe, and procedural instruction. Each of these forms appears within recognizable textual genres: astronomical tables, mineralogical treatises, medical canons, juridical compilations, and craft-oriented mathematical works.

Third, theoretical and applied knowledge were not separated into distinct corpora. A single treatise could combine demonstrative reasoning, observational record, and detailed procedural description, while the manuscript transmission preserved these layers together.

Fourth, commentary, gloss, and translation operated as instruments through which practical content was both stabilized and transformed. The reception of a text within later teaching circles can be reconstructed from the structure of its surviving copies and annotations.

Fifth, source-study analysis is therefore indispensable for the history of medieval science in the region. Authorship, place and date of copying, manuscript

provenance, scribal hand, and material support all carry evidential weight for understanding how practical knowledge functioned.

Sixth, the documented continuity between paper technology, scribal craft, and scholarly content demonstrates that the scientific culture of medieval Central Asia integrated artisanal expertise and learned argument within a shared written environment.

Seventh, further codicological and comparative work on the manuscripts held in the major regional collections is required in order to refine the typology of practical genres and to clarify the patterns of textual transmission across the longue durée.

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