نتایج سالیابی کربن ۱۴ بر روی هفت پوست‌نوشت قرآنی و یک پوست‌نوشت انجیل سریانی موزه ملی ایران

سید علی آقایی و میشائیل مارکس

چکیده

در مقاله پیش‌رو، نتایج سالیابی کربن ۱۴ بر روی هفت پوست‌نوشت قرآنی و یک پوست‌نوشت انجیل سریانی (پشیطا) که در موزه ملی ایران نگهداری می‌شوند، ارائه و با اطلاعات خط‌شناسی دست‌نوشته‌های کهن قرآنی به خط کوفی مقایسه می‌شود. این برای نخستین بار است که آزمایش کربن بر روی نسخه‌های قرآنی در مجموعه‌ای ایرانی انجام شده است. این دست‌نوشت‌ها عبارتند از یک دست‌نوشت به خط کوفی سبک B، یک دست‌نوشت به خط کوفی سبک C، و پنج دست‌نوشت به خط کوفی سبک D. نتایج سالیابی کربن ۱۴ انجام‌شده بر روی دست‌نوشت‌های قرآنی موزه ملی ایران تاریخ‌گذاری نسبی بر مبنای سبک‌شناسی خط کوفی را تایید می‌کنند. در عین حال، این نتایج شواهدی به دست می‌دهند که می‌توان بر مبنای آن تاریخ دست‌نوشت‌های قرآنی به خط کوفی سبک D را به دوره‌ای متقدم‌تر بازگرداند. برای مسئله پیچیده تاریخ‌گذاری، روش سالیابی کربن نقاط اتکای ارشمندی فراهم می‌آورد که هم برای درک تاریخ تطور قرآن‌های کهن به طور خاص کارگشاست، زیرا این روش امکان فهمی تازه از خط‌شناسی قرآنی را فراهم می‌آورد که در آن مساله تاریخ‌گذاری همچنان گشوده است، و هم شناخت ما از تاریخ نسخه‌های خطی به طور عام را دقیق‌تر می‌کند، چنانکه از نتیجه این آزمایش بر روی انجیل سریانی موزه ملی ایران پیداست. در مجموع توصیه می‌شود برای تولید فهرست‌های جامع از مجموعه‌های نسخ خطی از روش‌های علمی و آزمایشگاهی برای تاریخ‌گذاری نسخه‌های خطی استفاده شود.

واژگان کلیدی: سالیابی کربن ۱۴؛ دست‌نوشت‌های قرآن؛ کوفی؛ انجیل سریانی، پشیطا؛ پوست؛ خط‌شناسی؛ نسخه‌شناسی؛ تاریخ مادی؛ موزه ملی ایران؛ اردبیل؛ پروژه ایرانکران؛ مرکز پژوهشی کرپوس کرانیکوم؛ فرهنگستان علوم برلین - برندنبورگ؛ وزارت آموزش و پرورش آلمان.

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Carbon Dating of Seven Parchment Qurʾān Manuscripts and One Syriac Bible of the National Museum of Iran

Ali Aghaei[a] and Michael Josef Marx[b]

Abstract

This paper presents the carbon dating results of seven Qurʾān manuscripts and one Syriac Bible (Peshitta) of the National Museum of Iran (NMI) in the context of palaeography of early Qurʾān manuscripts. The carbon age measurements, for the first time obtained from a collection in the Eastern lands of Islam, include results from one manuscript in script style *kūfī* B, one in *kūfī* C, and five in *kūfī* D. Measurements from carbon analysis of the Qurʾāns of the National Museum confirm the relative chronology of script styles in Qurʾānic palaeography. Obtained measurements from the Qurʾāns of NMI, however, give evidence for an early dating of *kūfī* D script styles. For the intricate question of date, carbon dating provides essential anchor points in chronology, beneficial for a historical understanding of Qurʾāns specifically and manuscripts in general, as the carbon date results of the Syriac Bible of NMI show. Scientific dating is recommended for producing comprehensive catalogues of manuscript collections as it reveals a new perception of Qurʾānic palaeography where chronology remains unexplored.

Keywords: Carbon Dating; *Kūfī*; Qurʾān Manuscripts; Syriac Bible, Peshitta; Parchment; Palaeography; Codicology; Material History; National Museum of Iran; Ardabil; Project Irankoran; Project Corpus Coranicum; Berlin-Brandenburg Academy of Sciences and Humanities; German Federal Ministry of Education and Research.

a. Associate Researcher. Paderborn Institute of Islamic Theology, Padeborn University, ali.aghaei@uni-paderborn.de
b. Director of Research Centre Corpus Coranicum, Berlin-Brandenburg Academy of Sceinces and Humanities, marx@bbaw.de

Introduction

The National Museum of Iran (NMI) holds a little-known collection of manuscripts in its unique collection of artefacts and objects in stone, metal, porcelain, cloth and wood. These Arabic and Persian manuscripts are mostly from the library of the shrine of Šayḫ Ṣafī ad-Dīn Isḥāq Ardabīlī (d. 735/1334), the eponymous ancestor of the Safavid dynasty (1501-1736), in the city of Ardabil. Until the 19th century, the shrine hosted a great library substantially enriched by the endowments (*waqf*) of Shah ʿAbbās I (1571-1629). Its first catalogue was prepared by order of the Custodian of the Shrine, Sayyed Moḥammad Qāsem Beg, in 1167/1752 (see *Ganǧīneh-ye Šayḫ Ṣafī* 1348 Š/1969; about rare documents from the Library of the Shrine, see Weaver 1971, 3-9). At the end of the last Russo-Persian War (1826-1828), a large part of this library was taken by General Ivan Paskevich (d. 1856), who had conquered Ardabil in 1828, and the books were sent as military booty to Saint-Petersburg. The National Library of Russia preserves this collection today as "fond Ardabil" (Wassiljewa 2004; Weaver, 1986; Barthold, 1984, 217; for the origin of the collection from Ardabil, see also Ǧawāher Kalām, 1311 Š/1932, 40-43; 1313-1314 Š/1934-35).

Few manuscripts remained in Ardabil, hidden away from the Russian troops, and were transferred to Tehran in 1314 Š/1935 by the Ministry of Education and Endowments (*Wezārat-e Maʿāref wa-Awqāf*). They belong today to the Islamic section of NMI. Only a few manuscripts are on display, their majority remain locked in the museum's depot (for a recent publication, see Seyed Bonakdār and Emāmī Ǧomʿeh 1399 Š/2021). Among 280 manuscripts, 188 are Qurʾāns, and ninety-two contain other Arabic or Persian texts. Twenty-three Qurʾāns are manuscripts on parchment, 165 on paper[1]. Beyond Islamic manuscripts, NMI preserves two "Christian" manuscripts, both on parchment: A prayer book written in Ancient Ethiopian (Ge'ez) (no. 22642) and a large fragment of a Bible codex (Peshitta) in Estrangelo script, typical for the "Eastern Syriac Tradition" (no. 9212)[2].

The Challenge of Dating

Little is known of the provenance of the early Qurʾāns of NMI. The size of manuscripts contributes to their mobility, making tracing their provenance difficult. Even if many manuscripts come from the Library of the Shrine of Ardabil, the place where these documents had been produced might be elsewhere. No manuscript explicitly states the date of its production. Neither authentic colophons, signatures of a scribe[3], notes of pious endowment (*waqfiyya*) nor similar scribal notes provide us evidence of their history.

Three NMI Qurʾān's have colophons claiming that ʿAlī b. Abī Ṭālib or Ḥasan b. ʿAlī respectively wrote the text (nos. 4247, 4248, and 4279). These notes are presumably inauthentic because they are written by a pen and in an ink different from the manuscript's text. In one case, there is a trace of erasure of the

1. In the project "Irankoran" (see footnote 7), all Qurʾān fragments written on parchment (nos. 3452, 3454, 4243, 4246, 4247, 4248, 4249, 4250, 4251, 4253, 4254, 5256, 4279, 4289, 4293, 4300, 4317, 4319, and 9211a-e) and a limited selection of earlier codices on paper (nos. 3610, 3617, 4236, 4255, 4264, 4271, 4298, 5305, 4312, and 4314) of NMI are digitised and will soon be made accessible online via Irankoran's digital catalogue (irankoran.ir), and via the online catalogue "Manuscripta Coranica" (ed. by M. Marx) of Corpus Coranicum (corpuscoranicum.de).

2. These two manuscripts are wrongly classified in the internal catalogue of NMI as "a New Testament in Amharic script" and "a commentary of New Testament in Armenian script", respectively.

3. Colophons are texts in which the scribe registers the date and/or the place of the manuscript's accomplishment. They often contain the name of the scribe and mention other circumstances of the manuscript's production. The absence of colophons might be because many manuscripts are damaged and most of them are fragments and that no scribal note (colophon) has survived. This hypothesis would imply that some ancient manuscripts did initially have colophons. We cannot be sure, however, if there were in fact ancient Qurʾān manuscripts with colophons, thus one can also imagine a specific scribal culture in which an act of copying the holy text of the Qurʾān was not seen as a regular product of a secular document to be signed by the scribe. From the two "genizahs" of Qurʾān manuscripts, from the Mosque of ʿAmr b. al-ʿĀṣ (al-Fusṭāṭ, Old-Cairo) and the Great Mosque of Sanʿāʾ, we have no Qurʾān manuscript written in *kūfī* or *ḥiǧāzī* with a colophon of which we are sure that the scribe of the manuscript has written it.

original text overwritten the pseudo-colophon with a different ink (see figures 1 and 2). The lack of evidence for their production dates is typical for early Qurʾāns. Before the year nine hundred of the common era, evidence from endowment notes or colophons is rare, making chronological questions a challenge for historical research.

Carbon Dating

The problem of dating ancient Qurʾāns pushes us to look for approaches outside of palaeography. Since the discovery of radiocarbon by William Libby (1908-1980) in 1950, it took still decades to apply and refine this discovery for historical dating. As a dating technique, radiocarbon analysis was first used in archaeology, where it is considered today a reference technique for dating organic material up to 50.000 years back in the past. Beyond archaeology, carbon dating was reluctantly introduced into manuscript studies, among other reasons, because the technique requires a sample to be cut out from the writing surfaces of the manuscript. The need for carbon dating has thus far not arisen in disciplines of the antiquities, like Greek or Latin literature, where palaeography has a differentiated system and scribal notes (colophons) give sufficient information. In the study of ancient Qurʾānic manuscripts, the situation is quite the opposite. No colophons tell us the date of production, and limited comparative data is available.

Since dating is the key to any historical understanding, carbon dating allows us to gain a more solid ground for scholarly discussion. This ground is less dependent on subjective categories with vague terms (such as *ḥiǧāzī* or *kūfī*, among others) and disputed relationship of these terms to concrete objects. Considering this background, we believe that carbon dating provides a technique qualified to introduce an independent criterion that helps us see the historical development of Qurʾānic scripts from another perspective. Preceding research efforts carried out by M. Marx and T. Jocham (2019) have already shown the significance of this approach and found proof that early parchment Qurʾāns written in *ḥiǧāzī* and similar styles can be dated to a time as early as the seventh century.

Within the framework of a "Memorandum of Understanding" between NMI and the Berlin-Brandenburg Academy of Sciences and Humanities (Berlin-Brandenburgische Akademie der Wissenschaften, BBAW) signed on 16.4.1396 Š/7.7.2017, a measuring campaign was planned as a cooperation project in order to better understand the history of the ancient Qurʾānic manuscripts kept in NMI. No manuscript similar in script to *ḥiǧāzī* codices like Arabe 328a (Paris) or Or. 2165 (London) exists among the parchment Qurʾān manuscripts kept in NMI. The texts in the NMI are neither in early *kūfī* B styles (like B.Ia or B.Ib, see Tübingen Qurʾān) nor in *kūfī* style A, a transitional style showing *ḥiǧāzī* and *kūfī* letter shapes at the same time[4]. Nevertheless, the NMI collection offers us a beautiful sample of Qurʾān manuscripts written in distinctive styles of *kūfī*. The collections offer a taste of the spirit of Muslim calligraphy and spirituality.

In January 2019, samples from the parchment of eight manuscripts, including seven Qurʾān manuscripts on parchment (nos. 3452, 4247, 4251, 4256, 4279, 4293, 4319), and the Syriac Bible manuscript no. 9212 were taken in Tehran and subjected to carbon analysis in Zurich[5]. The carbon dating was carried out by

4. When Déroche (1983, 37) describes script style B.Ia, he uses the label *ḥiǧāzī* as this style shows ancient features.

5. Samples were taken by Ali Aghaei (Irankoran, BBAW), Michael Marx (Corpus Coranicum, BBAW), Faranak Bahrololoumi (Climate Management in History of Art Museum, Vienna) and Farah Sadat Madani (Research Centre for the Conservation of Cultural Relics, Research Institute of Cultural Heritage and Tourism) in collaboration with the restauration department of NMI. Our special thanks go to the director of the Museum Dr Jebrael Nokandeh and the deputy director Dr Fereidoun Biglari for their support of our research project. We would like to also thank Karam Mirzaei (Head of the Museum of Archaeology and Art of the Islamic Era, NMI), Masoumeh Ahmadi (Head of Legal Affairs and International Relations, NMI), late Parvaneh Soltani (Head of Protection and Restoration, NMI) Zahra Ghalamkar (Trustee in charge of the Museum Property of the Islamic Era, NMI) for all their work and support. All operative details of our bilateral cooperation are specified in the minutes dated 15.1.2019 (25.10.1397). We are also grateful to Tobias J. Jocham (Berlin) for his advice and assistance in

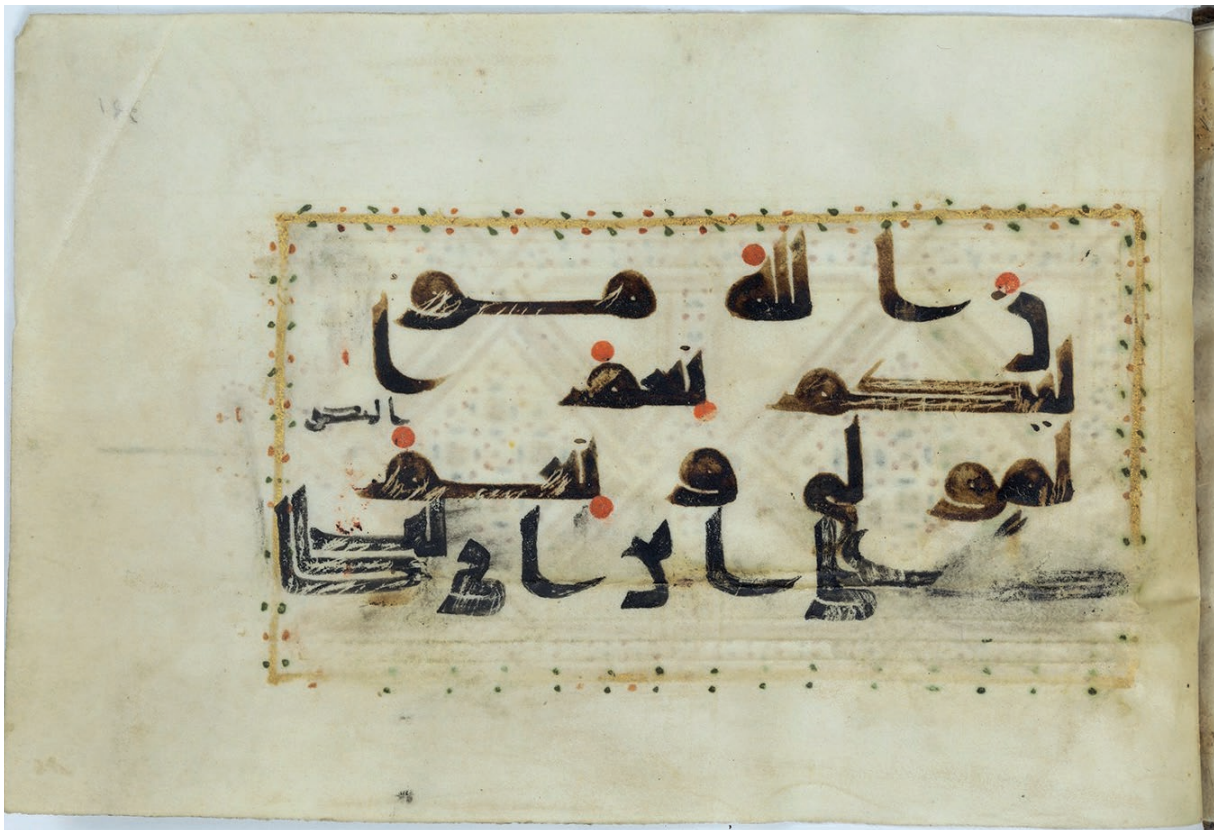


Fig. 1. NMI 4248, p. 164

the laboratory of Ion Beam Physics of ETH Zurich, under the supervision of Irka Hajdas[6]. Our research was generously funded by two research projects, "Irankoran" (BMBF/BBAW) [7]

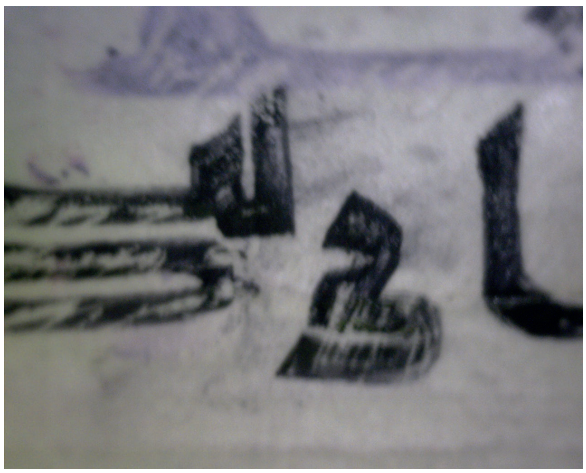


Fig. 2. NMI 4248, detail from page 164 in ultraviolet light, showing that the ink of the "colophon" (black ink) is different from the manuscript's text (in light blue).

and "Corpus Coranicum" (BBAW)[8] as host institution of "Irankoran". In the present article,

this project. Thanks are also due to Omar Abd El-Ghaffar (Harvard) for the revision of the English text.

6. See https://ams.ethz.ch.

7. The project "Irankoran" (2017-2020), funded by the German Federal Ministry of Education and Research (BMBF) and directed by Ali Aghaei, provides a digital catalogue of the Qurʾānic manuscripts kept in Iranian libraries and museums. In cooperation with the project "Corpus Coranicum" (see footnote 8), the early Qurʾānic manuscripts of the National Museum of Iran (NMI) have been digitised (9,000 images in high resolution), catalogued, and philologically analysed. For the first time, Qurʾānic manuscripts of the National Museum are going to be made digitally accessible via the online catalogue "Bibliotheca Coranica Iranica" (irankoran.ir). For each manuscript, a detailed philological analysis, including (a) codicology, (b) palaeography, (c) dating, and (d) variant spellings and readings, has been created. From a selection of the manuscripts, samples were taken and dated in collaboration with ETH Zurich. In addition to the digital publication, which will remain accessible via BBAW, the digital tools (including a Transliteration and Transcription Editor for Qurʾānic Manuscripts, created by Irankoran) will be further developed in the project "Corpus Coranicum" in the coming years.

8. The project "Corpus Coranicum" of the Berlin-Brandenburg Academy of Sciences and Humanities (Berlin-Brandenburgische Akademie der Wissenschaften, BBAW) is studying the history of the Qurʾān (corpuscoranicum.de). It is giving access to relevant source material, for the context of the Qurʾān as well as for the history of the Qurʾānic text. For the textual history, the project publishes an online database of early Qurʾānic

the results of this dating campaign are presented (see tables 1 and 2). Combined with the results of previous carbon dating efforts, the measurements obtained which we present here invite us to reappraise the dating of *kūfī* Qur'āns. We wish that the openness and generosity of NMI in our cooperation is followed by other institutions in Europe and the Middle East.

Technical Notes

For each sample, the registration number of the Laboratory of Ion Beam Physics of ETH-Zurich (Switzerland), e.g., "ETH-97568", and the registration number for the carbon dating campaign of Corpus Coranicum[9] are given, e.g., "CC-Sample No. 116". The measured carbon date is given as a figure, a three or four-digit number, to which a two-digit number is added, separated by a comma, e.g., 1187,20 (for ETH-97568 = CC-Sample No. 116). This figure contains two specifications: the age of the carbon: 1187, meaning 1187 years "before present" (BP), and the figure after the comma: 20, giving the standard deviation. To obtain dates in the Christian calendar or Common Era[10], the value of carbon date, in the given case 1187 BP, is interpreted by using Oxcal 2020, the calibration program of Oxford University[11]. This software uses known measurements of carbon-dated material of which the precise date is known (e.g. by dendrochronology[12]) and converts carbon age into a period of dates in the Common Era (CE). The calibration diagram, produced by Intcal 2020 (see Reimer et al 2020), contains the measured carbon date on the y-axis (vertical axis). Because of the standard deviation (Gaussian distribution), it appears as a bell-shaped curve in red colour. The section of the y-axis "covered by" the calibration curve (blue) that is "falling" from left to right provides us with the temporal interval. This operation leads to the dark-grey curve placed on the x-axis (horizontal axis). This curve on the x-axis contains two types of information: First, the section of the x-axis covered by the grey curve indicates the time period in the Christian calendar to which the obtained result is traced. Secondly, the thickness of the grey curve stands for the "amount of probability". The thicker the grey curve is, the more likely the date is, whereas the thinner the curve, the less likely the date. As the calibration curve with plateaus and oscillations is not falling steadily, precision, i.e., the interval's width, depends on the calibration curve (Youssef-Grob 2019; Marx and Jocham 2019).

Different radiocarbon years are often obtained as results when more than one sample of the same manuscript is analysed. If we consider all these samples coming from one sheep hide—which is probably not the case, but we can assume at least that the hides were made of the skin of sheep living at the same time—we can merge the obtained results following statistical rules. The calibration program "Intcal" of Oxford University provides such a tool. When results are combined, a statistical control mechanism called the "Chi-Square Test" (χ^2) must be used. This test controls if the different results have "sufficient overlap" to be merged statistically. In case the combination is statistically proven, the combined result of the carbon age is considered valid. In some cases, a combination of results can "shorten" the time span. This might appear as a manipulation of results, but statistically, this operation is legitimate because by dealing with probabilities of

manuscripts (cf. corpuscoranicum.de/handschriften), and about the context of the Qur'ān it provides a database of Late Antique source texts (cf. corpuscoranicum.de/kontexte).

9. This last number also appears in the minutes and the documentation of the measuring campaign.

10. The world's most widely use calendar era. In the given context, for dates of the first millennium and beyond, until 1582, it refers to the "Julian calendar" (reform by Julius Caesar), for dates after 1582 to the "Gregorian calendar" (reform by Pope Gregory XIII). Since the difference between Julian and Gregorian calendar consists in 13 days, it is of negligible importance for this report in which only the term "Common Era" (CE) is used.

11. For information about the calibration program provided by Oxford university, see https://c14.arch.ox.ac.uk/oxcal.html.

12. By dendrochronology or "tree-ring dating" tree rings can be dated to exact year, i.e., the year in which the tree ring was formed. This technique is useful for determining the precise age of samples of wood, organic material that can also be dated by measuring its carbon. Based on a large and growing number of samples of wood the calibration curve for radiocarbon dating is build.

measured results we are not violating the nature of the obtained data.

All obtained measurements (seven Qurʾāns and one Syriac Bible) show dates before 1000 CE[13]. The results appear as time periods with 95.4% probability. All results identify the date of the writing surface of the manuscripts—i.e., the parchments—from which samples were taken and *not* the ink of the manuscripts. Parchment produced from animal skin is subjected to chemical treatment; the precise circumstances and employed chemical treatments remain still unknown. Although the laboratory of ETH Zurich did not observe any indication of contamination, we cannot exclude the fact that exterior substances have interfered with the analysed material, implying a possibility of error for the result of a carbon dating analysis. We hope that in follow-up research some questions relevant to what appears as aberrant measurements (in two cases, see tables 1 and 2) can be researched to advance in the explication of unexplained qualities of the analysed parchments.

Since we measure the age of the writing surface, one might imagine a gap of time between the slaughtering of the animal (mostly sheep) and the production of parchment and between the production of parchment and the writing of the manuscript. It is possible to imagine that the hides of sheep were stored for a period of time before parchment was produced out of them. The hypothesis that parchments were stored for a long time before a scribe used them is possible, though for economic reasons it appears to us slightly implausible when generalised. Both scenarios, however, appear unlikely since parchment was, and still is, an ex-

13. There is one exception: ETH-97575 for manuscript NMI-4251 (pp. 228-229) with the result 1001,23 BP (corresponding to 992-1048, 1082-1129, 1138-1150 CE in calibrated calendar years, see below) was a fragile sample. The laboratory team was facing difficulties while cleaning and they were finally able to extract an insufficient amount of carbon. We have doubts that this measurement is valid.

	ETH-Sample	CC-Sample	Call no., folio/pages	Material	Carbon date
1	ETH- 97568	no. 116	NMI-4256, fol. 1	parchment	1187,20
2	ETH- 97569	no. 117	NMI-4256, fol. 8	parchment	1322,20
3	ETH- 97570	no. 118	NMI-4256, fol. 224	parchment	1174,20
4	ETH- 97571	no. 119	NMI-4319, pp. 105-106	parchment	1273,20
5	ETH- 97572	no. 120	NMI-4319, pp. 47-48	parchment	1299,20
6	ETH- 97573	no. 121	NMI-4319, pp. 91-92	parchment	1283,20
7	ETH- 97574	no. 122	NMI-4251, pp. 168-169	parchment	1324,20
8	ETH- 97575	no. 123	NMI-4251, pp. 228-229	parchment	1001,23*
9	ETH- 97576	no. 124	NMI-4279, pp. 82-83	parchment	1152,20
10	ETH- 97577	no. 125	NMI-9212, pp. 219-220	parchment	1134,20
11	ETH- 97578	no. 126	NMI-9212, pp. 63-64	parchment	1152,20
12	ETH- 97579	no. 127	NMI-4247, pp. 44-45	parchment	1116,20
13	ETH- 97580	no. 128	NMI-4247, pp. 36-37	parchment	no result**
14	ETH- 97581	no. 129	NMI-4293, pp. 141-142	parchment	1222,20
15	ETH- 97582	no. 130	NMI-3452, pp. 247-248	parchment	1195,20

Table 1. Synopsis of carbon dating of manuscripts of the National Museum of Iran

* This was a fragile sample, the laboratory team were facing difficulties while cleaning from which they were finally able to extract an insufficient amount of carbon, which is 0.20 mg of carbon whereas all other samples are based on 1 mg of carbon (see table 2).

** During the cleaning treatment this sample dissolved, no carbon could be analysed by the laboratory and, regretfully, we have not obtained a result. During our campaign (120 carbon measurements during 2014 and 2018), we had two similar cases before as there is always a risk that samples do not "survive" the alternated treatment with acids and bases to obtain pure carbon to be measured out.

ETH-Code	Sample Code	Manuscript Call No	Material	^{14}C age BP	±1σ	F^{14}C	±1σ	δ^{13}C ‰	±1σ	mg C	C/N at
97568	No. 116	NMI-4256, fol. 1	parchment	1187	20	0.863	0.002	-8.6	1.0	0.99	3.26
97569	No. 117	NMI-4256, fol. 8	parchment	1322	20	0.848	0.002	-8.8	1.0	1	3.21
97570	No. 118	NMI-4256, fol. 224	parchment	1174	20	0.864	0.002	-8.1	1.0	0.99	3.21
97571	No. 119	NMI-4319, p. 105-106	parchment	1273	20	0.853	0.002	-13	1.0	1	3.28
97572	No. 120	NMI-4319, p. 47-48	parchment	1299	20	0.851	0.002	-10.8	1.0	0.99	3.18
97573	No. 121	NMI-4319, p. 91-92	parchment	1283	20	0.852	0.002	-18.3	1.0	1	3.65
97574	No. 122	NMI-4251, p. 168-169	parchment	1324	20	0.848	0.002	-14.1	1.0	0.99	3.25
97575	No. 123	NMI-4251, p. 228-229	parchment	1001	23	0.883	0.003	-	1.0	0.2	12.29
97576	No. 124	NMI-4279, p. 82-83	parchment	1152	20	0.866	0.002	-11.5	1.0	0.83	3.26
97577	No. 125	NMI-9212, p. 219-220	parchment	1134	20	0.868	0.002	-20.9	1.0	0.99	3.28
97578	No. 126	NMI-9212, p. 63-64	parchment	1152	20	0.866	0.002	-20.2	1.0	0.99	3.05
97579	No. 127	NMI-4247, p. 44-45	parchment	1116	20	0.87	0.002	-12.3	1.0	0.8	3.63
97580	No. 128	NMI-4247, p. 36-37	parchment	-	-	-	-	-	-	-	-
97581	No. 129	NMI-4293, p. 141-142	parchment	1222	20	0.859	0.002	-11.4	1.0	0.79	3.34
97582	No. 130	NMI-3452, p. 247-248	parchment	1195	20	0.862	0.002	-11.4	1.0	1	3.19

Table 2. Results of radiocarbon analysis: measured F^{14}C and corresponding ^{14}C age, δ^{13}C measured by AMS on graphite sample, amount of carbon used for AMS analysis (graphite target). The C/N atomic ratio is based on data from graphitisation.

pensive writing surface[14]. Economically, this is an argument against the idea that parchments were produced as writing material to be stored for a longer time rather than used for a planned writing project. However, as material history is only vaguely accessible by scholarly and narrative sources, the question of parchment production and its use has to be researched, especially with regard to Arabic book production.

Despite these concerns, carbon dating is a well-developed dating technique able to contribute to a better understanding of the history of old Qurʾān manuscripts, complementing palaeography. In this article, combining scientific results with palaeography, we refer to Déroche's typology of script styles for the classification of NMI documents because his palaeography is used as an established reference today in Qurʾānic studies (see Déroche 1983; 1992)[15]. Pace Déroche (1983; 1992), we use the term kūfī as an established category because, since the tenth century, it has been a common term, even if it is an imprecise label for ancient script styles of the Qurʾān[16].

Presentation of Carbon Dating Results

(1) Manuscript no. 4256 (Qurʾān, parchment)

Three samples from the manuscript no. 4256 have been taken: folios 1 (Sample ETH-97568

14. Today, a parchment produced from a sheep hide measuring 80 x 60 cm, or 0.48 square meters costs ca. 50 Euro (see e.g. www.der-roemer-shop.de). Déroche (2003, 261) noted that several large Qurʾān manuscripts (e.g., BNF, ms. arabe 324) had folios measuring 68 x 53 cm (or 0.3604 square meters), each of which would have required the hide of a single animal, and that six hundred folios (=600 sheep) would have been required.

15. A description of script styles is given by Déroche (1983, 35-47), though without explicit chronology. Cf. Déroche (1992), where he slightly modified his typology and assigned dates to each Qurʾān fragments if its script style is identified. In the appendix of his book *The Rise of Arabic Calligraphy*, Alain George (2010, 147-161) presents guidelines to Déroche's script style classification with reference to examples of manuscripts typical for each of the styles and most of their categories.

16. The term is attested from the tenth century onwards in the Islamic literature and adopted by European scholars as early as the 17th century. In Ibn ad-Nadīm's *Fihrist* (2009, 14-15), *kūfī* is listed as one of many regional styles, whereas Abū Ḥayyān at-Tawḥīdī al-Baġdādī (d. 414/1023), aṣ-Ṣafadī (d.734/1333), or al-Qalqašandī (d. 821/1418) used it as a term that refers to ancient script style of Qurʾāns and inscriptions. The term is widely used in architecture and archaeology as descriptions of inscriptions on Sāmānid pottery, for instance, use the term *kūfī*.

= CC-Sample no. 116), 8 (Sample ETH-97569 = CC-Sample no. 117), and 224 (Sample ETH-97570 = CC-Sample no. 118). Respectively, the obtained carbon age results are 1187,20 BP, 1322,20 BP, and 1174,20 BP. The carbon ages of folio 1 (1187,20 BP) and folio 224 (1174,20 BP) correspond to the time periods 773-891 CE and 772-950 CE (772-793, 800-896, 924-950), respectively. The obtained measurement (1322,20 BP) of folio 8 (see figure 3), corresponding to the period 655-774 CE (655-704, 740-774), is not congruent with the obtained results for folios 1 and 224 (see fugure 4). Not excluding lapses by measurements that can happen, one can hardly imagine that the parchment of one folio of the manuscript was so much older than the material of the others, if no traces of reused parchment (palimpsest) are observed. Contamination might be a reason for this odd result, though the laboratory of ETH Zurich could not find any indication of that. Thus, the carbon age 1322,20 BP for folio 8 (Sample ETH-97569) appears as an aberrant result which cannot be explained. The ink of fol. 8 needs to be analysed to better understand the measuring result, which is incompatible with the two others.

For manuscript no. 4256, we have results from three different samples. Two of the carbon age results (folio 1, 1187,20 BP and folio 224, 1174,20 BP) are close to each other and statistically compatible. The combined result for fol. 1 and fol. 224 is 1181,15 BP, corresponding to 772-893 CE (more precisely, between 772-793 and between 801-893 CE). Results of the third sample (fol. 8) with the result 1322,20 BP, however, is 148 carbon years earlier. We can merge—in theory—the three results and obtain 1229,12 BP as a statistically combined carbon age of the parchment, which points to four periods of time: 706-737 CE, 772-779 CE, 785-839 CE and 846-878 CE. We obtain four intervals stretching between 706 and 878 CE but the problem is that the χ^2-test does not allow this merging operation. Carrying out additional measurements from the same folio and other folios of the manuscript will be necessary to obtain a precise date estimate for this manuscript. Such studies will bring in additional data for the research about the history of this important codex with sister fragments in other collections.

Fig. 3. NMI 4256, f. 8r

Fig. 4. NMI 4256, f. 1r (left) and 224v (right)

The script style of the Qur'ān codex no. 4256 is *kūfī* C.III (cf. Déroche 1992, 61, where he presents another fragment, KFQ 44, that has once belonged to the same codex identifying the script of this folio as intermediate between C.II and C.III and dating it to the ninth century CE), a style dated by Déroche (1992, 64-66, for three documents: KFQ 63, KFQ 45, and KFQ 57) between "the second half of the ninth to the early tenth century".

(2) Manuscript no. 4319 (Qur'ān, parchment) Samples from pages[17] 105-106 (ETH-97571 = CC-Sample no. 119), 47-48 (ETH-97572 = CC-Sample no. 120), and 91-92 (ETH-97573 = CC-sample no. 121) have been analysed (see figures 6, 7, and 8 with images of three analysed folios), and the obtained results for the date of the parchment are within a close range: 1273,20 BP, 1299,20 BP, and 1283,20 BP, with a probability of 95.4%. The calibrated periods are 670-776 CE, 663-775 CE (or more precisely, 663-709 and 723-775 CE), and 671-774 CE, respectively (see figure 9a).

Because we took three samples from no. 4319, assuming that the three parchment folios were produced from contemporaneous sheep hide, we are allowed to merge the three results as the χ^2-test passes. Based on the three samples, the combined result is 1285,12 BP, corresponding to the period 670-776 CE (see figure 9b). The difference between the three individual (non-combined) results is slight as the combined interval ends in 775 (the individual calibrated results end in 775 CE, 774 CE and 776 CE). The beginning of the calibrated interval starts in 670 CE based on intervals of 663 CE, 671 CE and 670 CE. The shortened interval here is less important than the fact that the three results are compatible, which entitles us to claim that parchment of no. 4319 was produced between 670 and 776 CE.

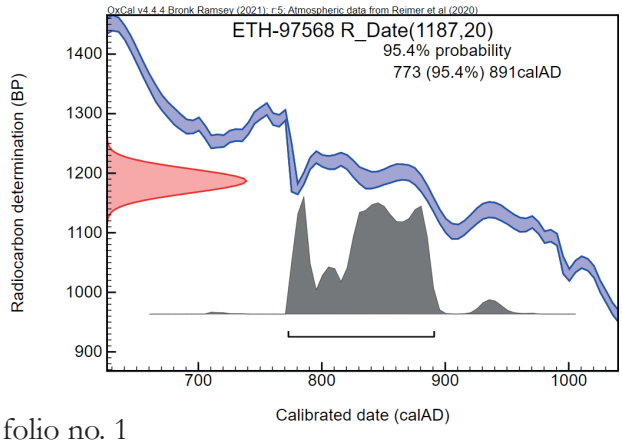
In Déroche's palaeographic typology, the script style of no. 4319 would be close to *kūfī* D.IV, and Qur'āns in that script style are usually dated to the ninth century CE (see Déroche 1992, 82: KFQ 29, 87: KFQ 41, 92: KFQ 53). The date of the parchment of no. 4319 is, therefore, according to the obtained three measurements and the combined result almost 150 years earlier than Déroche's date estimate based on his tentative palaeographical chronology.

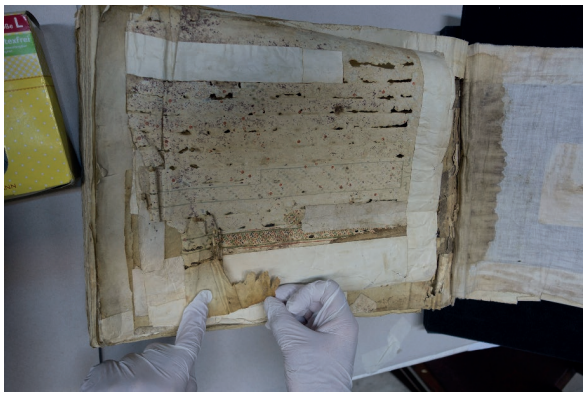
(3) Manuscript no. 4251 (Qur'ān, parchment) Two samples from pages 168-169 (Sample ETH-97574 = CC-Sample no. 122) and 228-229 (Sample ETH-97575 = CC-Sample no. 123) were analysed, of which the analysis of the second sample was problematic (see figures 10 and 11). Since this sample taken for p. 228-229 was fragile (ETH-97575), only 0.2 mg of carbon could be extracted by the Zurich laboratory leading to a questionable result (1001,23 BP) as the obtained carbon age is based upon a tiny amount of carbon (see table 2). In contrast to

17. Apart from no. 4256 which counts folio numbers, pages of Qur'ān manuscripts of NMI are usually counted by page numbers.

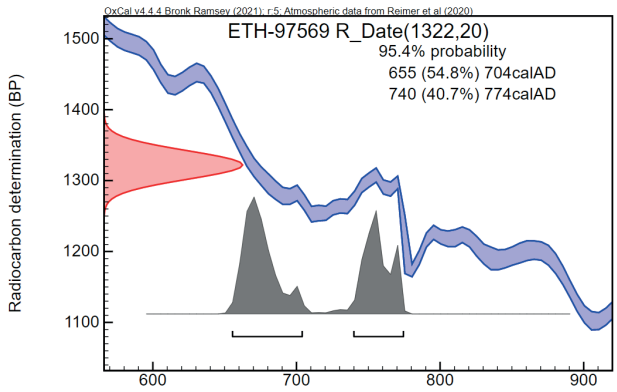
calibration diagram

sample taken from the folio

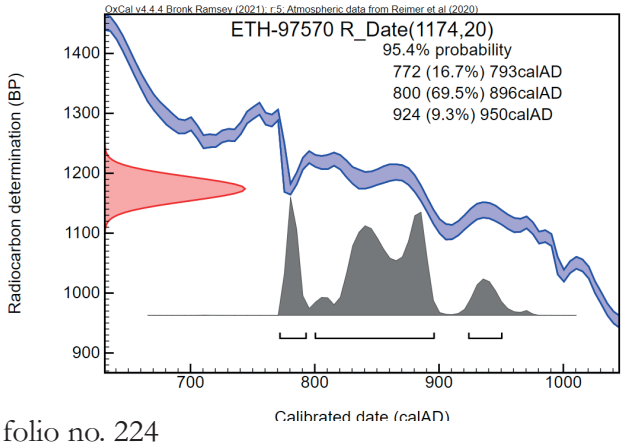




folio no. 1



folio no. 8



folio no. 224

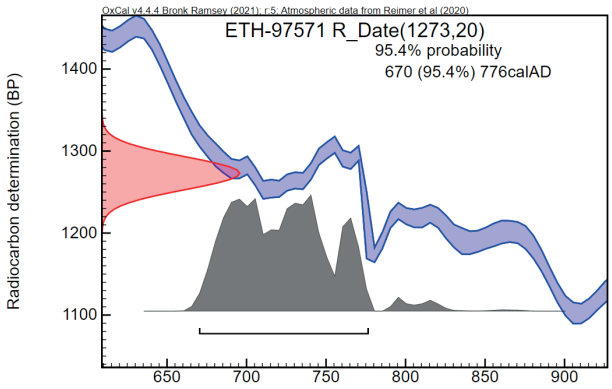
Fig. 5. Calibrated dates of NMI 4256

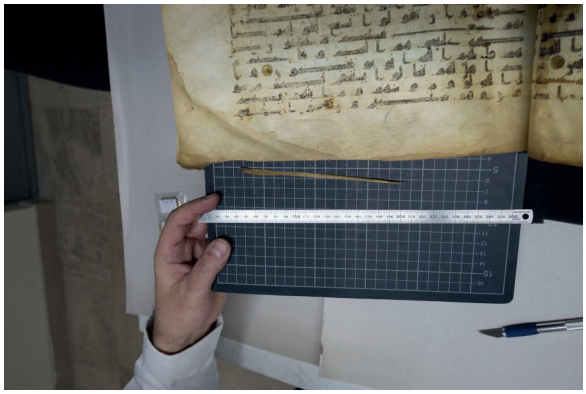
Fig. 6. NMI 4319, p. 48

Fig. 7. NMI 4319, p. 91

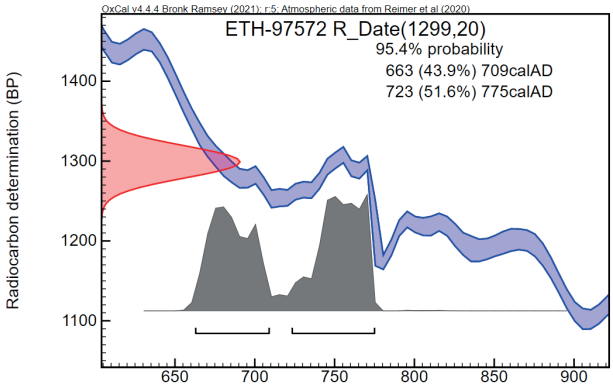
Fig. 8. NMI 4319, p. 106

calibration diagram | sample taken from the folio

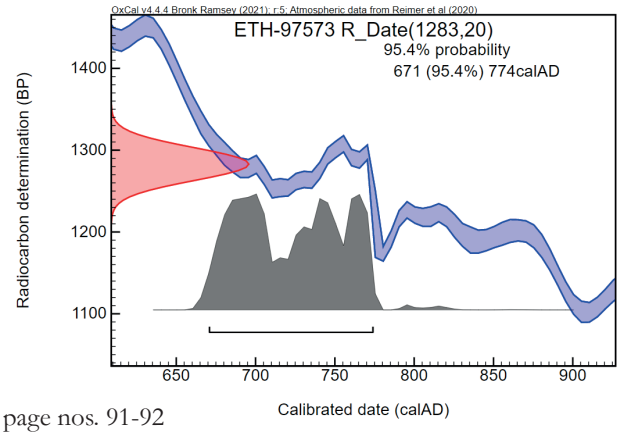




page nos. 105-106



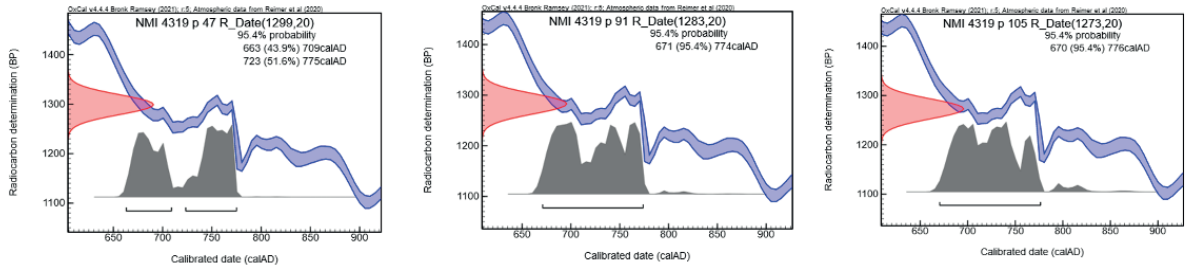
page nos. 47-48

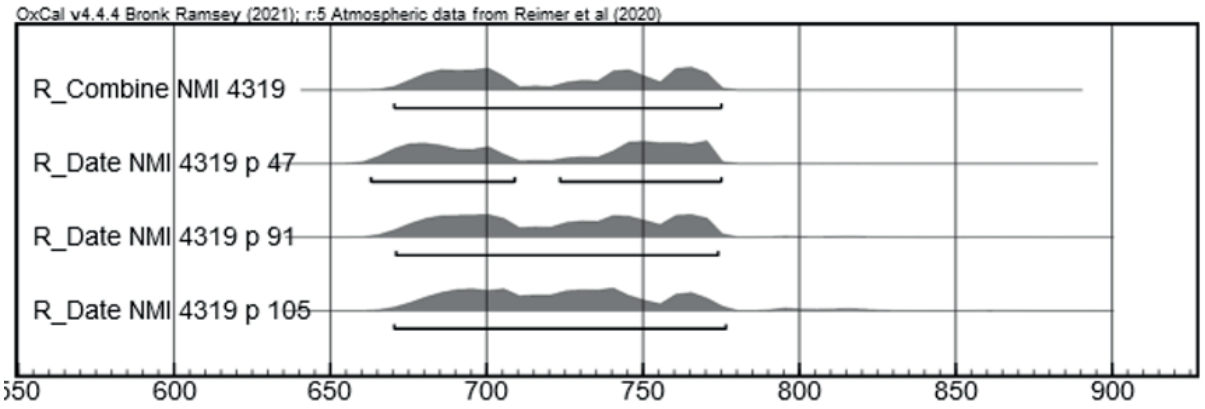


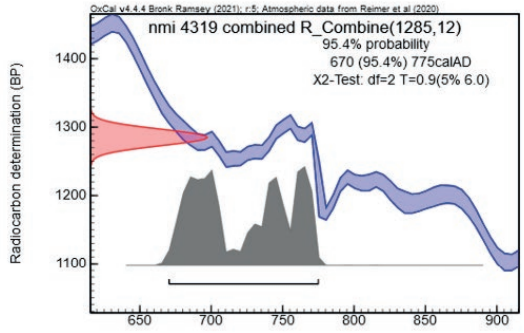
page nos. 91-92

Fig. 9a. Calibrated dates of NMI 4319

the sample taken from p. 168-169, which had a regular amount of carbon, the obtained carbon age should be understood as valid. Combining the measurements results following the rules of statistics is unwarranted. This is because we obtain—as it has happened with the "deviant" measurement for no. 4256—a negative χ^2-test. It is highly recommended to carry out measurements of additional samples from the same folio and from other folios of this manuscript in order to determine the age of no. 4251 in a more solid way.







Name		Unmodelled (BC/AD)			Select	Page break
Show all Show structure		from	to	%	All Visible	
R_Date fol.47		663	775	95.4	2	
R_Date fol.91		671	774	95.4	3	
R_Date fol.105		670	776	95.4	4	
R_Combine nmi 4319 combined		670	775	95.4	5	

Fig. 9b. Calibrated dates of NMI 4319 (combined results)

The date of the first sample (ETH-97574) is 1324,20 BP, corresponding to the interval between 655 and 774 with 94.5% probability, including two time periods 655-704 CE and 740-774 CE, with a probability of 56.5% and 39.0% respectively (see figure 12). The calibrated time range points to a date much earlier than Déroche's date estimation for manuscripts written in script style *kūfī* B.II (Déroche 1992, 52-56: KFQ 13, KFQ 14, QUR 48 and QUR 80). Déroche argues that manuscripts in script style B.II are dated to the ninth century. It is safe to say that no. 4251 appears with a reasonable probability as a manuscript produced during the eighth century. If we exclude dates earlier than 700 CE considering comparative palaeographic evidence[18], we can consider this manuscript as a document produced in the eighth century before 774 CE.

(4) Manuscript no. 4279 (Qur'ān, parchment)
One sample from pages 82-83 of this parchment Qur'ān was analysed (Sample ETH-97576 = CC-Sample no. 124). Its carbon age

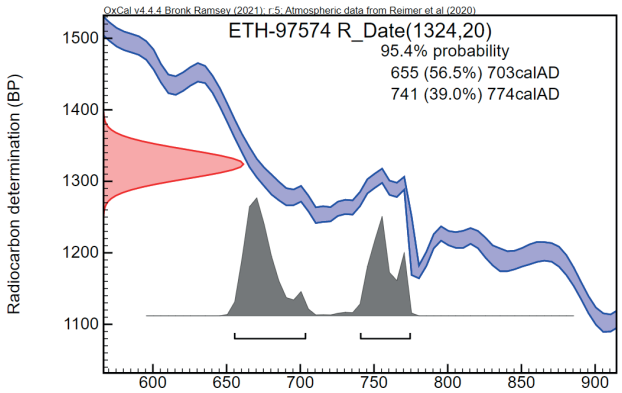
18. Script style *kūfī* B.II is quite distinct from *kūfī* B.Ia or B.I.b, script styles that contain features close to *ḥiǧāzī*. Déroche (1992, 53-54: KFQ 27, KFQ 28) dates fragments written in styles B.Ia and BI.b to the second half of the eighth century or early ninth century. For documents in script style *kūfī* B.I early results had been obtained; see Marx and Jocham 2019, 213, table 6.1: Berlin, Wetzstein II 1913: 1300,27 BP, 1305,19 BP, and 1313,19 BP; Leiden Cod.or.14.545a: 1335,24 BP, 1322,24 BP; and Cod.or.14.545b/c: 1327,24 BP, 1331,24 BP; Tübingen Ma VI 165: 1357,24 BP, 1388,24 BP, 1319,24 BP.

measured as 1152,20 BP corresponds to a calibrated period of 773-977 CE (or more precisely, 773-788, 827-905, 912-977 CE) with a probability of 95.4%. This time range of carbon comprises nearly two hundred years. Since the calibration curve shows wiggles and plateaus, the calendar age is located in three different time periods with different levels of probabilities, among which the period 827-905 CE and 912-977 CE have the highest probabilities with 39.2% and 47.9%, respectively (see figure 13). The script style and page format of no. 4279 resembles fragment KFQ 55 in the Khalili Collections (London), classified by Déroche (1992, 71) under style D.I and dated to the ninth century. On page 99, we find a colophon that uses red dots as diacritics (see figure 14), whereas, in all ancient manuscripts, diacritics are always

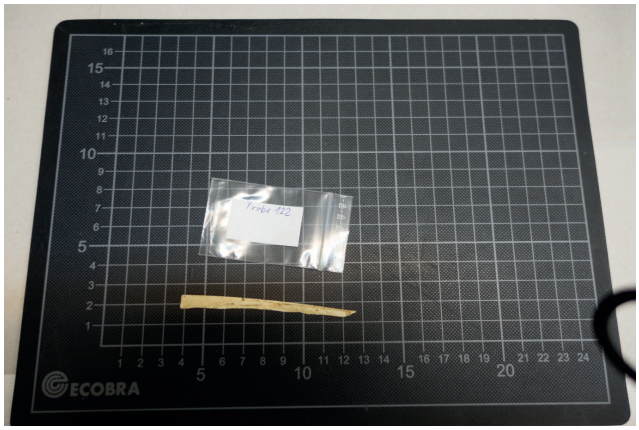
Fig. 10. NMI 4251, p. 168

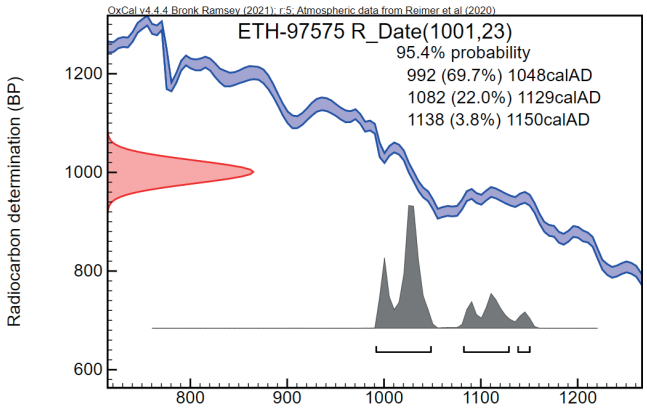
Fig. 11. NMI 4251, p. 228

calibration diagram | sample taken from the folio



page nos. 168-169





page nos. 228-229

Fig. 12. Calibrated dates of NMI 4251

written with the same ink in which the letters of the text are written. This awkward use of the coloured dots is an argument against the authenticity of this colophon, produced by a later scribe who was unaware of the meaning of the coloured vowel signs. This pseudo colophon reads: *katabahū ʿAlī ibn ʾAbī Ṭālib* ("ʿAlī b. Abī Ṭālib has written it [= this codex]").

(5) Manuscript no. 9212 (fragment of a Syriac Bible, parchment):

Two samples from pages 219-220 (Sample ETH-97577 = CC-Sample no. 125) and 63-64 (Sample ETH-97578 = CC-Sample no. 126) of this Syriac Bible (127 folios) written in Eastern Syriac script style have been analysed with the following results: 1134,20 BP and 1152,20

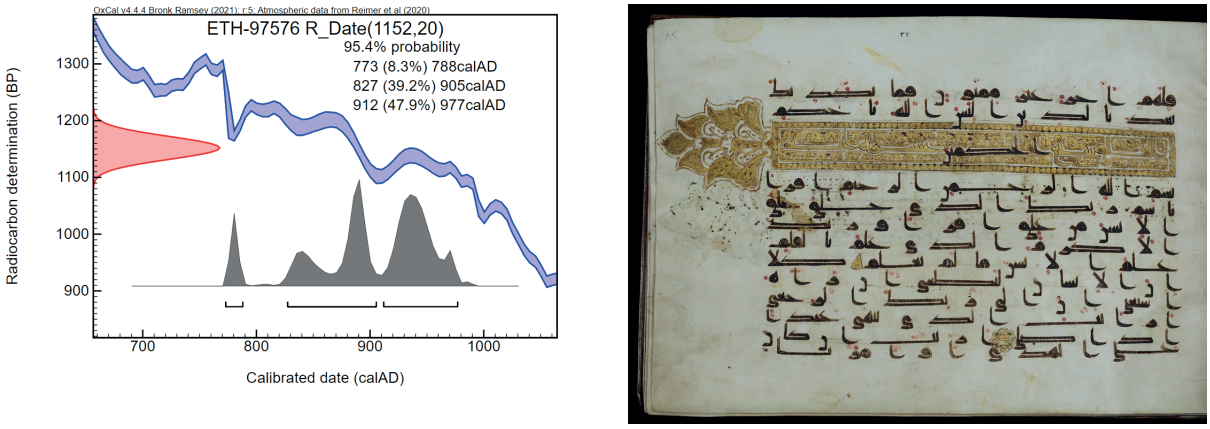


Fig. 13. Calibrated date of NMI 4279, p. 28

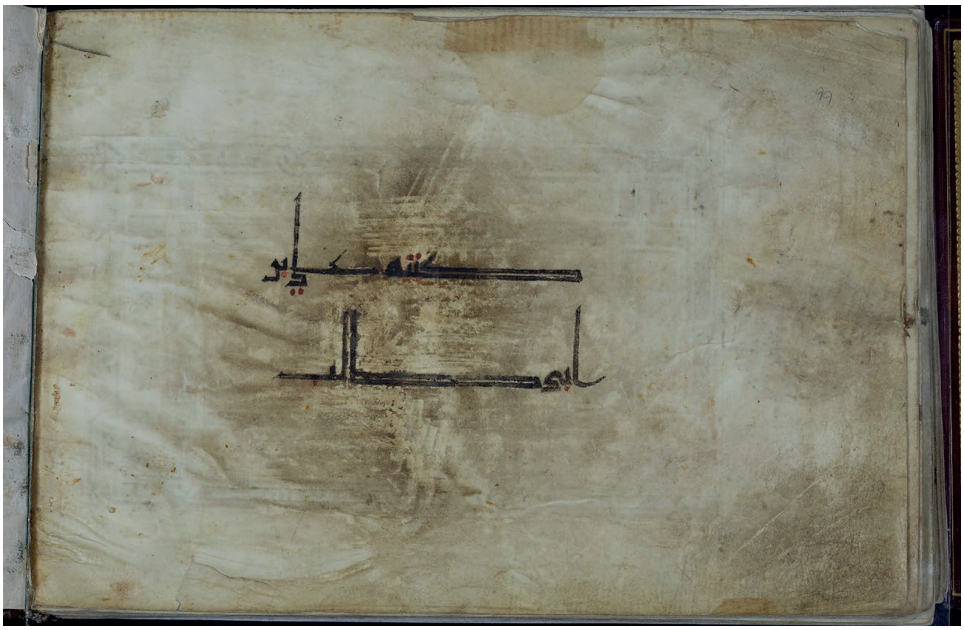


Fig. 14. Pseudo-colophon of NMI 4279, p. 99

BP, which correspond to calibrated years in time periods 775-990 CE (775-783, 880-990 CE) and 773-977 CE (773-788, 827-905, 912-977 CE) with a probability of 95.4%. For the first sample (Sample ETH-97577), the interval includes two sections with the time span of 775-783 CE with a low probability of 1.6%, which can be discarded considering the other time span of 880-990 CE with a high probability as 93.8% (see figure 15). Calibrated dates for the second sample cover the years 773 to 977 CE, an interval including three different time periods: 773-788 CE with 8.3% probability (see figure 15), 827-905 CE with 39.2% probability, and 912-977 CE with 47.9% probability. The combined result of the measurements is 1143,15 BP, in calibrated years: 774-784 (3,2% probability) and 878-978 CE (92,3% probability).

In an overview catalogue of Syriac manuscripts kept in American collections, this manuscript (18 fol.) MS Sy 30, today in the possession of the Chicago Oriental Institute, is dated to the 13th century and suggests Iranian origin[19]. The origin mentioned in the American catalogue is confirmed by the manuscript of the National Museum of Iran, whereas its date estimate in the American catalogue needs to be corrected as the manuscript appears to be very likely a manuscript produced between 878 and 978 CE.

(6) Manuscript no. 4247 (Qurʾān, parchment)
Two samples from pages 44-45 (Sample ETH-97580 = CC-Sample no. 128) and 36-37 (Sample

19. See University of Chicago Library, Goodspeed Manuscript Collection: "Ms. 823, New Testament. Syriac. Peshitta (Teheran Gospel Fragments). 13th century".

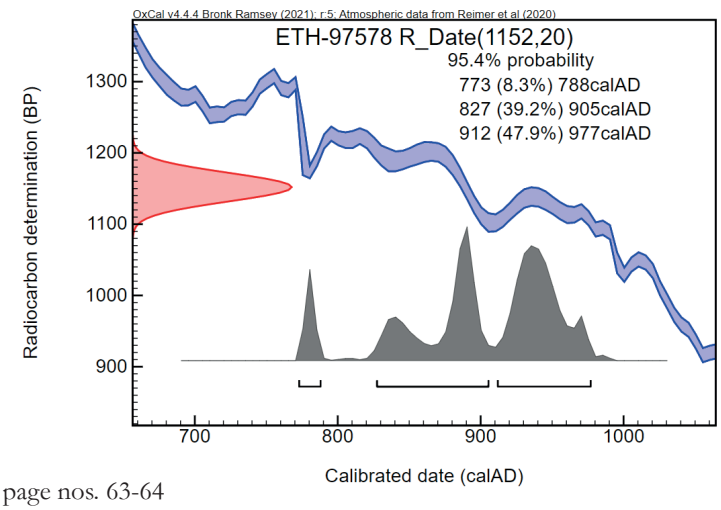
ETH-97579 = CC-Sample no. 127) have been taken, of which the second sample (pp. 36-37) could not be analysed because it dissolved during the treatment at the Swiss laboratory. The carbon of pages 44-45 (Sample ETH-97580) has the age of 1116,20 BP, corresponding to 891-991 CE (see figure 16). The script style and page format of no. 4247 resembles fragments KFQ 82, QUR 49, QUR 285, and KFQ 2 in the Khalili Collections (London), classified by Déroche (1992, 97-101) under style D.Va and dated to the end of the ninth century or first half of the tenth century. The last two pages of the manuscript contain a colophon, split into two parts and written below the Qur'ānic texts in a clearly different hand (see figure 17), using a different pen and not the initial ink. The colophon reads: *katabahū Ḥasan ibn ʿAlī ibn ʾAbī Ṭālib* ("Ḥasan b. ʿAlī b. ʾAbī Ṭālib has written it [this codex]").

(7) Manuscript no. 4293 (Qurʾān, parchment)

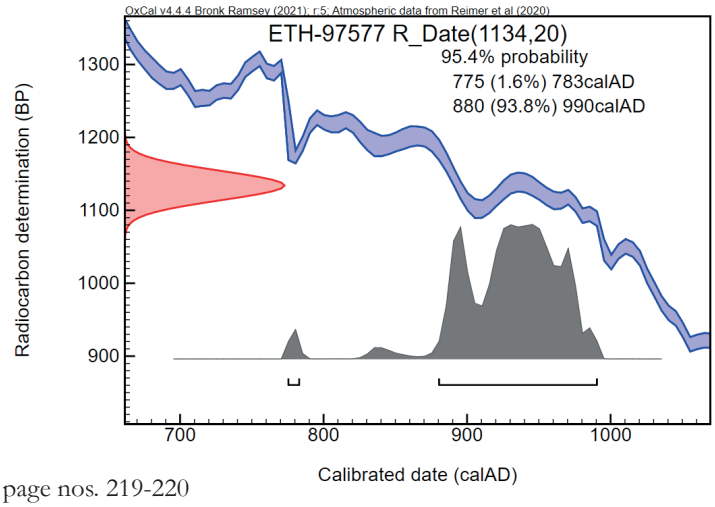
One sample of pages 141-142 (Sample ETH-97581 = CC-Sample no. 129) has been measured, and its carbon is dated to 1222,20 BP, corresponding to calibrated years 706-882 CE (706-735, 772-882 CE) with 95.4% probability (See figure 18). The interval includes two sections: the period 706-735 CE with a more negligible probability of 9.5%, and the period 772-882 of hundred-ten years with a probability as high as 85.9%. Fragments of the Khalili

calibration diagram

sample taken from the folio



page nos. 63-64



page nos. 219-220

Fig. 15. Calibrated dates of NMI 9212 (Syriac Bible)

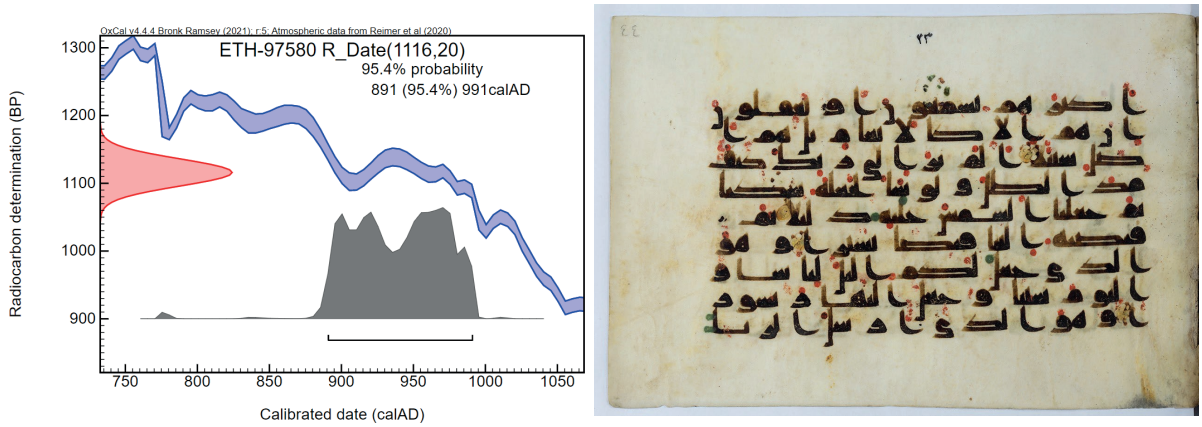


Fig. 16. Calibrated date of NMI 4247, p. 44

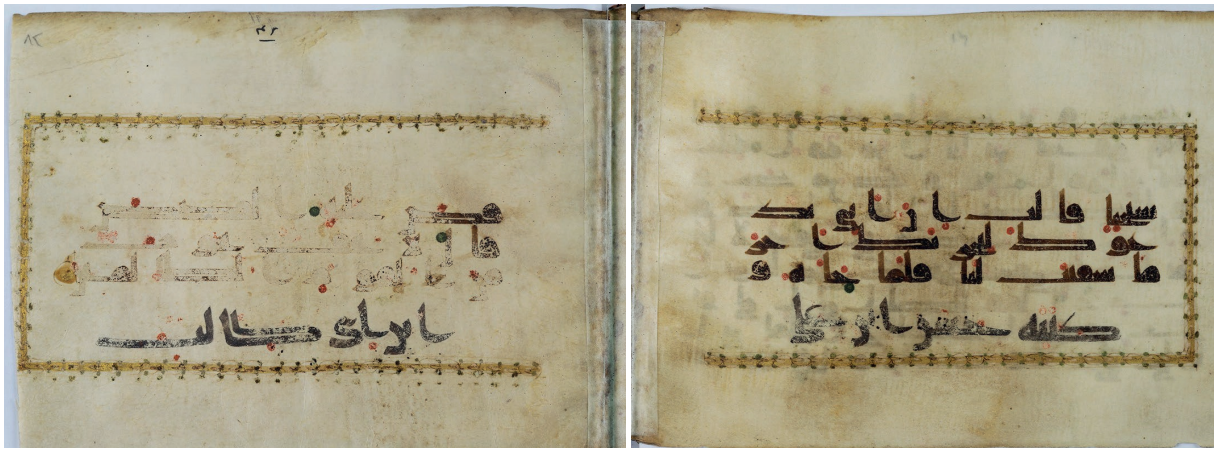


Fig. 17. Pseudo-colophon of NMI 4247, pp. 81-82

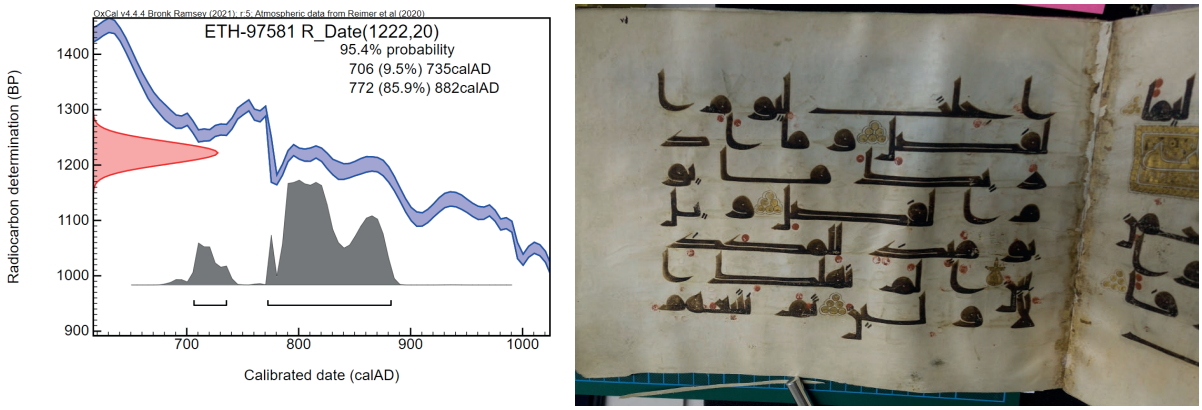


Fig. 18. Calibrated date of NMI 4293, p. 141

Collections (London), KFQ 84, KFQ 67, KFQ 68, and KFQ 64[20], all written in style *kūfī* D.I resemble no. 4293. These fragments are dated by Déroche (1992, 67-70) to the ninth century.

On the last page of this manuscript (p. 162), a colophon has been added by a later hand in different ink (see figure 19), stating that this manuscript had been written by ʿAlī b. Abī Ṭālib. This pseudo-colophon reads in Arabic *katabahū wa-ḏahhabahū ʿAlī ibn ʾAbī Ṭālib sabʿa hiǧriyya* ("ʿAlī b. Abī Ṭālib has written and illuminated [this codex] with gold in the year seven AH"). The obtained carbon dates

20. Fragment KFQ 64 belongs to a codex to which once also fragment no. 10950 (Central Library of the University of Tehran) has belonged. Its carbon age was measured in 2019 to 1223,20 BP, corresponding to calibrated years 706-736 CE and 772-882 CE, with probability of 10.8% and 84.7, respectively. See Aghaei et al, forthcoming.

show that this scribal note is a later addition and cannot be authentic.

(8) Manuscript no. 3452 (Qur'ān, parchment)
One sample from pages 247-248 of this manuscript (Sample ETH-97582 = CC-Sample no. 130) has been analysed, and the carbon age 1195,20 BP was obtained, resulting in a time span between 774-886 CE with a probability of 95.4% (see figure 20). The script style of manuscript no 3452 resembles that of fragment KFQ 18 identified by Déroche (1992, 105) as style D.Va and dated to the end of the ninth century or the first half of the tenth century. The obtained carbon age of no. 3452, however, allows an earlier time interval.

Conclusion

We have selected manuscripts with the oldest script styles among the NMI Qur'āns: one manuscript in *kūfī* B.II, one in *kūfī* C.III, and five in *kūfī* D[21] (see table 3).

(1) We obtained only one valid result for, no. 4251 (style *kūfī* B.II). The other measurement giving a result for a too-small amount of

21. NMI holds no Qur'ān written in *ḥiǧāzī*, *kūfī* A, *kūfī*

Fig. 19. Pseudo-colophon of NMI 4293, p. 154

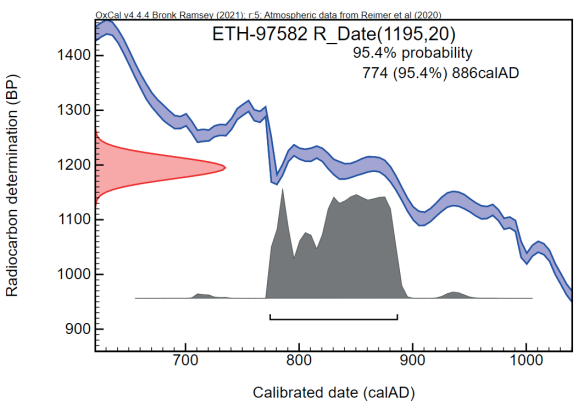


Fig. 20. Calibrated date of NMI 3452, p. 247

No.	Manuscript	Style	Carbon age BP	Calibrated age CE
1	No. 4251	*kūfī* B.II	1324,20 (p. 168-169)	655-704, 740-774
			[1001,23 (p. 228-229)]	[992-1048, 1082-1129, 1138-1150]
2	No. 4319	*kūfī* D.IV	1285,12 (combined result)	670-776
3	No. 4293	*kūfī* D.I	1222,20	706-735, 772-882
4	No. 3452	*kūfī* D.V	1195,20	774-886
5	No. 4256	*kūfī* C.II	1187,20 (f. 1)	773-891
			1174,20 (f. 224)	772-793, 800-896, 924-950
			[1322,20 (f. 8)]	[655-704, 740-774]
6	No. 4279	*kūfī* D.I	1152,20	773-788, 827-905, 912-977
7	No. 4247	*kūfī* D.I	1116,20	891-991

Table 3. Obtained carbon dating results for seven Qurʾānic manuscripts of the National Museum of Iran (Tehran) listed in decreasing order of their carbon age.

carbon appears to be questionable. We believe that additional samples could clarify the situation. The valid result when calibrated dates the parchment of this manuscript between 655 and 774 CE (with 56.5% probability of being produced in the time periods 655-704 CE). This makes no. 4251 the oldest codex in the National Museum of Iran.

(2) Our study shows that no. 4319 (style *kūfī* D.IV) is a fragment of a very old codex. According to the three consistent results, its parchment was produced before 775 CE. Considering palaeography, we are reluctant to suggest a date before 700 CE and would consider the production date between 700 and 775 CE.

(3) It is unlikely that no. 4256 (style *kūfī* C.III) is older than the two other manuscripts. Two of the three measurements suggest a date between 772 and 950 CE, but one measurement points to a much earlier date (see above and postscript). We can identify no reason for this discrepancy at the moment. Considering palaeography, the ninth century is the most probable time for the production of no. 4256, a date estimate confirmed by two of the three measurements.

(4) The results of the four other fragments in *kūfī* D style show that this script style was practised over a longer period: no. 4293 (1222,20 BP; 706-735, 772-882 CE) and no. 3452 (1195,20 BP; 774-886 CE) were produced between the end of the eighth century and the end of the ninth century CE.

(5) Results obtained for no. 4279 (1152,20 BP; 773-788, 827-905, 912-977 CE) and no. 4247 (1116,20 BP; 891-991 CE) date the manuscript to the tenth century. According to these results, one could claim that *kūfī* D was a style used from the eighth to the tenth centuries. Results for the five *kūfī* D manuscripts (nos. 3452, 4247, 4279, 4293, and 4319) show that no. 4319 appears as the oldest of them. No. 4319 represents a different, larger codex, quite distinct from the four other selected *kūfī* D-manuscripts. In script style, page design, as well as size, no. 4319 is more representative and looks like a reference codex (it reminds the famous "Blue Qurʾān"; see Déroche 1992, 92-95, and Fraser 2021), whereas the four other ones are probably booklets (*ǧuzʾ*) for recitation practices.

(6) The dating results of no. 4319, date this Qurʾān in *kūfī* D style to a period earlier than expected based on palaeography. It is also remarkable that *kūfī* D appears over an extended period. Our data shows a strong likelihood that this script style was still practised during the tenth century. As our first research mission could only deal with a small portion of manuscripts, we are convinced that new samples from other manuscripts of NMI in *kūfī* D (nos. 4289, 4244, 4254, 4250, 4253, 4249, 4248, 4246, 4317, or 9211) could be a solid contribution to palaeography with regard to the history of this particular style.

Postscript

Following the submission of this article, sister fragments of the National Museum's co-

B.I, *kūfī* E, or *kūfī* F.

dex no. 4256 were announced for sale at the auction house Million (Paris) (lot 127, cf. catalogue Millon, Arts d'Orient et de l'Inde, Mercredi 15 juin 2022, Jeudi 16 juin 2022, Paris, p. 53). During a visit to Paris on 10th June 2022, we were given permission to see the 21 damaged folios that are written in the same script and style and contain text missing in the National Museum's codex as well as all other known folios of its sister fragments from private collections in Iran as well as in Europe and the United States of America. Interestingly, the auction house had commissioned a carbon dating analysis on a sample taken from one of the folios, which obtained 1326,26 BP as age of the parchment's carbon (651-774 CE in calibrated years with 95.4% probability). This measurement and the obtained measurement of fol. 8 of no. 4256 (1322,20 BP) reported in our article (cf. page 214), support the hypothesis of an early date of the National Museum's codex. At the same time, the question remains how the two results of folio 1 and fol. 224 (cf. page 214) suggesting younger ages can be explained. A detailed description about the fragment offered by the auction house Millon with an updated overview of other sister fragments is in preparation. This recent emergence of 21 sister fols. containing text otherwise missing shows that the history of this outstanding codex written in a unique and sophisticated style deserves observation and documentation (Berlin, June 16th, 2022).

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