

Reconstructing pharyngealized vowels for *Qieyun* Division II in Middle Chinese

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It is widely accepted that Middle Chinese Division II, a syllable category in Middle Chinese, originates from the Old Chinese medial $*-r-$, yet its reconstruction remains debated. Existing proposals assign Division II a palatal, velar, or r-colored feature or segment. Building on Gong (2018), this study integrates comprehensive evidence to identify Division II as characterized by an additional vowel quality that exhibits vowel lowering, *a*-fronting, and slight *e*-backing effects, and is compatible with the low front vowel, uvulars, and retroflexes.

A systematic evaluation demonstrates that Division II is best interpreted as palato-pharyngealization, a type of pharyngealization observed in North-east Caucasian languages. We reconstruct three (palato-)pharyngealized vowels $[e^{\text{f}}, o^{\text{f}}, a^{\text{f}}]$ as Division-II vowels for the *Qieyun* 切韻 system, deriving from a pre-*Qieyun* medial $*-\text{ʕ}-$, itself the outcome of decoronalization of the Old Chinese medial $*-r-$ before fusing with the following vowel. We further outline the full development of Division II from Old Chinese to Mandarin.

Keywords: Middle Chinese, pharyngealization, retracted tongue root, rhotic, decoronalization

1. Introduction

1.1 Divisions and Ranks in Middle Chinese

Division (等 *děng*) refers to the classification of Middle Chinese (MC) syllables by the quality of their medials and vowels¹ (Baxter 1992: 42–43). Rhyme tables (韻圖 *yùntú*) of Late Middle Chinese (LMC) distinguish four Divisions, I to IV. This

1. In this paper, we treat medial and coda segments as consonants instead of vowels, e.g., $[j, w]$ instead of $[i, u]$. In particular, the semivowel corresponding to $[i \sim u]$ is represented as the velar approximant $[ɣ]$ ($[ɣ]$ in narrow transcription). The term “vowel” is therefore used exclusively for the syllable nucleus, i.e., the main vowel.

framework is extended backward to the *Qieyun* 切韻 system (QYS; representing the phonology of the 601 CE rhyme book *Qieyun*) and still earlier stages of Early Middle Chinese (EMC). However, syllable classes in EMC differ from those in LMC in two respects: the *Qieyun* Division of a character may differ from its rhyme table Division (Shen 2017; Hill 2019: 95–99; Shen 2020: 30–35; Mai 2022), and *Qieyun* Division III comprises multiple Subdivisions (see Appendix A.2). To avoid ambiguity, we follow Norman (2006) and recent scholarship (e.g., Shen 2017; Hill 2019: 95–99) in using “Division” to refer only to EMC categories and “Rank” for the rhyme table categories of LMC.

A more effective hierarchical categorization of EMC syllables divides them into two primary categories: Type A (Divisions I, II, and IV) and Type B (all Subdivisions of Division III). This dichotomy, first proposed by Pulleyblank (1977), is now widely accepted for Old Chinese (OC) and EMC (Shen 2017).

For the phonetic basis of the Type A vs. Type B contrast in OC, Norman’s (1994) proposal, that Type-B syllables have plain consonants *C- as initials, while Type-A syllables have retracted tongue root (RTR) consonants *C̣- as initials,² has become the dominant view and is adopted by Baxter and Sagart (2014).

The phonetic basis of the contrast in EMC, however, remains debated. Major proposals include:

- a. Type B with high front medials/vowels [j/i] vs. Type A without them (e.g., Baxter 1992: 69);
- b. Type B with high non-back medials/vowels [j/i, ɣ/i] vs. Type A without them (e.g., Huang 1995: 52–66);
- c. Type B with high vowels [i, i, u] vs. Type A without them (Pulleyblank 1977);
- d. Type B with tense vowels vs. Type A with lax vowels (Starostin 1989: 18–21);
- e. Type B as lax syllables vs. Type A as tense syllables (Ferland 2009).

Furthermore, as Norman’s proposal for OC can be extended to certain EMC initials (Baxter & Sagart 2014: 75) and Sino-Xenic evidence supporting Norman’s proposal persists into the EMC period (see §2.6), a sixth possibility emerges:

- f. Type B with plain initials vs. Type A with RTR initials.

While proposals (a) and (b) have been predominant since the late 20th century, proposal (f) also merits serious consideration. Further discussion is given in Appendix A.1.

2. Norman’s (1994) original description of OC Type A is “pharyngealized syllables”. Baxter and Sagart (2014) notate OC Type-A initials as pharyngealized consonants *C̣-. Following the framework in §3.1 and the discussion in §5.2, we consider OC Type-A initials as RTR consonants. The IPA diacritic [̣] represents RTR.

1.2 Origin and reconstructions of Division II

It is now widely accepted that Division-II syllables originate from the OC medial $*-r$ -³ (Shen 2017; Hill 2019: 175–176; Shen 2020: 76–77; Xu 2023). More specifically, they originate from OC Type-A syllables with medial $*-r$ - as well as from OC Type-B sibilant initials plus medial $*-r$ -, i.e., from OC onsets $*\text{Çr}$ - and $*\text{Tsr}$ - (Baxter & Sagart 2014: 74–75).⁴

Despite the consensus on its OC origin, the phonetic nature of Division II in MC remains debated, with no single proposal achieving wide acceptance. Some reconstructions do not assign a unique feature or segment to Division II (e.g., Karlgren 1922; Baxter 1992; Huang 1995), while others (especially recent ones) propose specific medials, vowel qualities, or off-glides. The proposed phonetic qualities can be grouped into four broad categories:

- a. Palatal color, including the weak palatal medial [i] (Karlgren 1915–1926: 631), the orthographic medial *e* (Lamasse & Jasmin 1934: 25), and the lax palatal medial [e] (Wang 1985: 50, 114–133);
- b. Velar color, including the velar medial [u] (Xu & Pan 1985, 1994), [ʊ] (Pan 2023), [uɣ] (Shen 2020), or [ɤ] (Zhengzhang 1987; Pan & Zhang 2015), (pre-)velarized vowels [ʏV] (Ferlus 2009), and diphthongs with velar off-glides [Vi] (Pulleyblank 1991: 12–13);
- c. R-color, including the retroflex medial [r] (Huang 2002a) or [ɻ] (Huang 2006) and retroflex vowels [Vʀ] (Pulleyblank 1984: 191–193) or [ʏ] (Starostin 1989: 16);
- d. Pharyngeal color, as the pharyngeal medial [ʕ] (Gong 2018).

Combinations of these features have also been proposed, e.g., the *r*-colored velar medial [rʊ] (Mai 1992) or [rɣ] (Mai 2022).

The present study aims to identify the most plausible feature for Division II from these proposals and beyond. To achieve this, we first establish the core properties of Division II (§2), then explore types of pharyngealization and RTR (§3), before evaluating competing hypotheses and demonstrating that palato-pharyngealization provides the most compelling account of Division II (§4). Finally, we present a full statement of the pharyngealization theory, tracing the development of Division II from OC to Mandarin (§5).

3. The symbol [r] does not necessarily represent only the alveolar trill [r], but often covers the alveolar tap [ɾ] (Anselme et al. 2023). Similarly, OC $*-r$ - is not necessarily a trill, and a tap [ɾ] is highly likely to exist as its allophone.

4. Some scholars also suggest an OC $*r$ - prefix as a source of Division II (see Handel 2002 and references therein). Whether as a prefix or a medial, the influence of $*r$ on the syllable can be considered equivalent.

Some of the arguments were first outlined in Gong (2018), but the present paper significantly expands and refines the earlier account. In particular, we incorporate rhyming practice (§2.1.1) and the peculiarities of the 梗 *Gěng* rhyme group (§2.4) as key evidence, and newly identify the *e*-backing effect (§2.4) and compatibility with the low front vowel (§2.5) as diagnostic properties of Division II, resulting in a complete and more convincing theory.

1.3 Vowels of the QYS

This paper follows Baxter’s (1992: 27–85) transcription of the QYS, incorporating some of the modifications from Baxter and Sagart (2014: 20). Reconstructions of the QYS differ in the number of vowels (Table 1; see Dong 2016 for a review). For clarity, we adopt a ten-vowel set for the QYS (Table 2) based on Baxter’s transcription, vowel distribution patterns (Huang 2002b), and evidence from rhyming practice (Zhou 1996; Zhang 2008).

Table 1. Reconstructions of vowels in the QYS

	High			Mid 1			Mid 2		Low	
	真	殷	東	青	登	冬	耕	江	庚	陽
Baxter (1992)	<i>i</i>	<i>i</i>	<i>u</i>	<i>e</i>	<i>o</i>	<i>ow</i>	<i>ɛ</i>	<i>æw</i>	<i>æ</i>	<i>a</i>
Baxter & Sagart (2014)	<i>i</i>	+	<i>u</i>	<i>e</i>	<i>o</i>	<i>ow</i>	<i>ea</i>	<i>aew</i>	<i>ae</i>	<i>a</i>
Huang (2002b: Table 2E)	<i>i</i>	<i>i</i>	<i>u</i>	<i>e</i>	ə	o	æ	ɐ	a	ɒ
Starostin (1989: 45–47)	<i>i</i>	<i>i</i>	<i>u</i>	<i>e</i>	Λ, ə	o	ä	au	a, ʌ	a, â
Pan & Zhang (2015)	<i>i</i>	<i>i</i>	<i>u</i>	E, e	ɣ, ə	ɔ, o	ɛ	ɔ	æ	a, ʌ
Pan (2023)	<i>i</i>	<i>i</i>	<i>u</i>	E, e	ɣ, ə	ʊ, o	ɛ	ɔ	æ	a, ʌ
This paper, §5	<i>i</i>	<i>i</i>	<i>u</i>	<i>e</i>	ə	o	e ^ɕ	o ^ɕ	a, a ^ɕ	ɑ
Available Type-B Divisions	III	III	III	III	III	III			III	III
Available Type-A Divisions			I	IV	I	I	II	II	II	I

Example rhymes are listed in the table header for each vowel: 真 *Zhēn* (-in), 殷 *Yīn* (-in), 東 *Dōng* (-uwnɡ), 青 *Qīng* (-eng), 登 *Dēng* (-ong), 冬 *Dōng* (-owng), 耕 *Gēng* (-eang), 江 *Jiāng* (-aewng), 庚 *Gēng* (-aeng), and 陽 *Yáng* (-ang). In other rhymes, vowel correspondences may differ across reconstructions. Baxter (1992) treats the vowel roundness of 冬 *Dōng* and 江 *Jiāng* as coda labialization (-wng), so we list -w together with the nuclei. Where reconstructions split a vowel by Type, both vowels are shown in the same cell, with the Type-B vowel given first. Underdot ⟨ ˙ ⟩ = retroflex vowels [V˙]; ⟨ ä ⟩ = [ɛ]; ⟨ â ⟩ = [a]; ⟨ ɛ ⟩ = [ɐ].

It is crucial to note that the *Qieyun* often splits a single linguistic rhyme (nucleus plus coda) into multiple “rhymes” (chapters) based on medial differ-

Table 2. Ten-vowel analysis of the QYS arranged by height and frontness *

[-back]	[+back]	[+back]
	[-round]	[+round]
真 <i>i</i>	殷 <i>i</i>	東 <i>u</i>
青 <i>e</i>	登 <i>o</i>	冬 <i>ow</i>
耕 <i>ea</i>		江 <i>aeu</i>
庚 <i>ae</i>	陽 <i>a</i>	

* Following the convention established in *SPE* (Chomsky & Halle 1968: 305), phonologists typically use the feature [back] rather than [front] to represent a binary front–back distinction (Flemming 2003), even when the distinction is phonetically front vs. non-front, as in the QYS (Table 1). Therefore, in the vowel system of the QYS, [-back] = front vowels, and [+back] = non-front vowels. The latter can be phonetically central, e.g., *o* can be [ə].

ences, making a *Qieyun* rhyme often a finer-grained unit than a linguistic rhyme (Wang 1936; Yuchi 2003; Zhang 2008: 140–142; Shen 2020: 120–126). For example, the linguistic rhyme 先仙 *Xiān–Xiān* (-*en*) is separated into 先 *Xiān* (*en*) and 仙 *Xiān* (*jen*) in the *Qieyun* according to the presence or absence of the medial -*j*-. In this and similar cases, however, no evidence from rhyming practice or Sino-Xenic data indicates that the medial distinction affected the phonetic value of the rhyme. This undermines the earlier assumption that each *Qieyun* rhyme corresponds to a unique linguistic rhyme (e.g., Karlgren 1915–1926: 79–80; Pan & Zhang 2015), which leads to an unnecessarily inflated vowel inventory. The ten-vowel analysis adopted here suffices to account for actual linguistic rhymes and observed rhyming practice. A complete reconstruction of the rhymes based on the ten-vowel set is given in Appendix B.2.

2. Properties of Division II

In this section, we first argue that the distinctive property of Division II is an additional vowel quality (§2.1). We then examine its diachronic effects (§2.2–§2.4) and its compatibility with various phonetic or phonological features (§2.5–§2.7). For reference, all Division-II rhymes⁵ in the QYS are listed in Table 3.

5. The QYS has four tones: *píng* 平 ‘level’, *shǎng* 上 ‘rising’, *qù* 去 ‘departing’, and *rù* 入 ‘entering’. In the *Qieyun*, a single rhyme is assigned different rhyme names depending on the tone. In this paper, we follow the convention of using *píng*-tone rhyme names to represent rhymes across all four tones (舉平以賅上去入 *jǔ píng yǐ gāi shàng qù rù* ‘enumerate *píng* to cover *shàng*, *qù*, and *rù*’), except for 泰 *Tài* (-*aj*), 祭 *jì* (-*ej*, Division III), 夬 *Guài* (-*aej*), and 廢 *Fèi* (-*oj*, Division III), whose regular syllables occur only in the *qù* tone. *Rù*-tone rhymes (checked syllables) cor-

Table 3. Division-II rhymes and their related rhymes arranged by coda

Division-II rhyme		Related rhyme(s)	
佳 Jiā	-ea	支 Zhī	-e
麻 Má	-ae	歌 Gē	-a
皆 Jiē	-eaj	灰哈廢 Huī-Hāi-Fèi & 齊祭 Qí-Jì	-oj & -ej
夬 Guài	-aej	泰 Tài	-aj
肴 Yáo	-aew	豪 Háo & 蕭宵 Xiāo-Xiāo	-aw & -ew
山 Shān	-ean	先仙 Xiān-Xiān	-en
刪 Shān	-aen	寒 Hán	-an
咸 Xián	-eam	鹽添 Yán-Tiān	-em
銜 Xián	-aem	談 Tán	-am
耕 Gēng	-eang	庚清 Gēng-Qīng	-aeng/-eng
庚 Gēng	-aeng	庚清 Gēng-Qīng	-aeng/-eng
江 Jiāng	-aewng	冬鍾 Dōng-Zhōng & 東 Dōng	-owng & -uwng

The “related rhyme” here is one that had rhymed with the corresponding Division-II rhyme in the Liu Song 劉宋 dynasty (420–479) (see §2.1.1), based on Wang (1936) and Zhou (1996). Note that 麻 Má and 庚 Gēng also contain Division-III syllables.

2.1 Additional vowel quality

That the defining characteristic of Division II in the QYS is an additional vowel quality (i.e., a secondary articulation), rather than simply a medial, can be demonstrated by diachronic changes in rhyming practice (§2.1.1), internal synchronic phonological inference (§2.1.2), *fǎnqiè* 反切 patterns (§2.1.3), and external Sino-Xenic materials (§2.1.4).

2.1.1 *Rhyming practice changes in the Northern and Southern dynasties (420–589)*

During the Southern Qi 齊 dynasty (479–502),⁶ a notable change occurred in rhyming practice: most Division-II rhymes became strongly independent, tend-

respond to *píng*-tone rhymes by replacing the nasal codas -*m*, -*n*, and -*ng* with the corresponding oral codas -*p*, -*t*, and -*k*; for example, the *píng*-tone rhyme 登 Dēng (-ong) corresponds to the *rù*-tone rhyme 德 Dé (-ok).

6. The rhyming practice of the Northern dynasties was broadly similar to that of the Southern dynasties of the same period (Zhou 1996: 7, 706; Zhang 2008: 140). Although minor differences exist, they are not relevant to the discussion in this paper. Therefore, we refer to the periods during the Northern and Southern dynasties by naming only the Southern dynasties.

ing to rhyme exclusively with themselves (Zhou 1996: 703). This stands in contrast to the preceding Liu Song 劉宋 dynasty (420–479) and earlier periods, when Division-II syllables frequently rhymed with syllables in other Divisions (Table 3). For example, the 刪 *Shān* rhyme (-*aen*) frequently rhymed with the 寒 *Hán* rhyme (-*an*) before the Southern Qi, but ceased to do so thereafter (Starostin 1989: 32; Zhou 1996: 714–715, 725–726; Zhang 2008: 52–58).

The main exception to this trend involves the 麻 *Má* (-*ae*) and 庚 *Gēng* (-*aeng*) rhymes, whose Division-II finals (*ae* and *aeng*) rhymed with their Division-III counterparts (*jae* and *jaeng*) before and after the Southern Qi (Yuchi 2003; Zhang 2008: 30–38, 84–88). Their Divisions II and III are also not separated in the *Qieyun*. We will return to this point in §2.5.

In summary, from the end of the Southern Qi to the publication of the *Qieyun*, i.e., in the 6th century, Division-II rhymes were fully distinct from Division-I rhymes, Division-IV rhymes, and most Division-III rhymes. This independence largely reflects the separation of *ea* from *e* and *ae* from *a* (Table 3). Therefore, we can characterize these rhyming changes as an *e*-*ea* split and an *ae*-*a* split. In addition, -*aewng* (the 江 *Jiāng* rhyme) was primarily separated from -*owng*, though the phonetic value of its vowel needs further discussion below.

2.1.2 Vowel uniqueness of Division II within Type A

The Division-II vowels (*ea* and *ae* in Baxter's transcription) that resulted from these splits are distinct from other Type-A vowels (Divisions I and IV) (Table 1). Do they form a unique natural class? Given that Division II constitutes an independent and internally coherent category distinct from Divisions I and IV, both in its diachronic developments (§2.2–§2.4) and synchronic phonotactics with initials (Baxter 1992: 67–69), Division-II vowels must share a unique distinctive feature marking them off as a natural class. Without such a feature, Division II could not maintain itself as an independent category. What, then, is this feature that makes Division-II vowels a unique class?

Division-I vowels are non-front and Division-IV vowels are front (Table 2). Given that Division IV always has the vowel *e*, many proposals assign front vowels lower than *e* to Division II as the “feature” for Division II. However, this approach is unsatisfactory due to three issues.

First, in this approach, the height contrast within Division II itself requires at least two vowels lower than *e*, namely *ea* and *ae*. This leads to a four-way height contrast of front vowels: *i/e/ea/ae*, which is, of course, phonetically possible (e.g., Ladefoged & Maddieson 1996: 289–290), but phonologically problematic if analyzed purely as four distinct heights. Mainstream phonology theories (e.g., Chomsky & Halle 1968: 304–309) define no more than three vowel heights, unless additional features such as [advanced tongue root] ([ATR]) or [tense] are intro-

duced (see Pulleyblank 2011 for a review). Moreover, rhyming evidence from the 6th century places the 山 *Shān* rhyme (-*ean*) closer to the 先仙 *Xiān–Xiān* rhyme (-*en*) than to the 刪 *Shān* rhyme (-*aen*) (Wang 1936; Zhang 2008: 52–58), suggesting that the vowel *ea* is a mid vowel, or at least phonologically so. Therefore, a more parsimonious solution is to identify another feature to account for the contrast between the two mid vowels *e* and *ea*, and, by extension, for the potential four-way height contrast.

Second, the 江 *Jiāng* rhyme (-*aewng*) almost certainly contains a non-front vowel, which contradicts the above assumption that all Division-II vowels are front. In the 6th century, syllables with front vowels rarely rhymed with those with non-front vowels (Zhou 1996: 7; Zhang 2008: 140–142). However, 江 *Jiāng* only rhymed with rhymes with non-front vowels, including 東 *Dōng* rhyme (-*uwng*), 冬鍾 *Dōng–Zhōng* (-*owng*), and 陽唐 *Yáng–Táng* (-*ang*), while it never rhymed with those with front vowels (Zhou 1996: 707–709, 721–723; Zhang 2008: 25–27, 107–115). In addition, in Sino-Japanese *go-on* 吳音, Division-II vowels are usually rendered as *a* and *e* (§2.3.1), but 江 *Jiāng* appears as -*aũ* and -*oũ* in *go-on* (Li 2014: 44–46). Readings of -*oũ* further indicate that the 江 *Jiāng* rhyme has a non-front vowel. Therefore, it is not appropriate to simply treat all Division-II vowels as front.

Finally, the phonotactics of Type-A finals with initials in the QYS suggest that Divisions I and IV pattern together (Baxter 1992: 66; Norman 1994; Baxter & Sagart 2014: 16; Hill 2019: 98), while Division II forms a separate class. Grouping Divisions II and IV into the same “front-vowel” class therefore contradicts the phonotactic evidence.

From these arguments, it is clear that neither vowel height nor frontness/backness can account for Division II. Nor can roundedness, since there is already a *kāikǒu* 開口 (unrounded) vs. *hékǒu* 合口 (rounded) contrast. With all three basic vowel features excluded, we must therefore conclude that Division II is characterized by a unique feature outside the basic vowel space: an additional vowel quality.

2.1.3 Division II in *fǎnqiè* 反切 spellings

Is this additional vowel quality distinctive (i.e., phonemic) or merely an allophonic outcome conditioned by certain medials? Although phonemic analyses are not unique, evidence from *fǎnqiè* spellings can help address this question.

In the *Qieyun*-series rhyme books (《切韻》系韻書 *Qìeyùn-xì yùnnshū*), Division-related medials are often indicated by both the *fǎnqiè* onset speller (反切上字 *fǎnqiè shàngzì* ‘*fǎnqiè* upper word’) and the *fǎnqiè* rhyme spellers (反切下字 *fǎnqiè xiàzì* ‘*fǎnqiè* lower word’) (Shen 2020: 108–109, 140–141). Division-II syllables are usually spelled with Division-I and Division-IV onset spellers rather

than with Division-II onset spellers (Luh 1963). This suggests that Division II, like Divisions I and IV, may lack a distinct medial of its own. Accordingly, the feature of Division II appears to lie in the vowel.

In addition, in the *Qieyun*-series rhyme books, syllables with simpler finals are generally preferred as onset spellers in order to expose the annotated onset/initial and facilitate the spelling process (Luh 1963; Huang 2012). Division-II syllables, however, are rarely adopted as onset spellers (Luh 1963; Huang 2002a).⁷ This indicates that Division-II finals possess an excess quality that complicates the spelling process, supporting the existence of the additional vowel quality.

2.1.4 External evidence suggesting the existence of the quality

The existence of the additional vowel quality is also supported, directly or indirectly, by some external evidence, although this does not provide a specific phonetic value for the quality.

In Sanskrit-Chinese transcriptions by Xuanzang 玄奘 (602–664), Division-II characters are rarely used, unless the initial is retroflex, which can only combine with Division-II and Division-III finals (Shi 1983). Similarly, in *man'yōgana* 萬葉假名, an ancient system using Chinese characters to represent Japanese syllables in the 7th century or earlier, Division-I characters are preferred over Division-II characters when phonetically transcribing the Japanese vowel *a*. Specifically, among phonetical characters for Japanese syllables with *a* (excluding *ta*, *da*, *na*, and *ra*, since their corresponding Division-II syllables are inherently rare in MC) in Ōno's (1977: 336–337) list of *man'yōgana*, there are 51 Division-I characters but only 13 Division-II characters. If the Division-II vowel *ae* were only a plain front vowel, it would be unconvincing to claim that the central vowel *a* in Sanskrit and Japanese could only be suitably transcribed in MC as a back vowel *a* (non-Division II) instead of *ae* (Division II). Therefore, the limited use of Division-II characters in transcribing Sanskrit and Japanese indicates that Division II possesses a quality largely specific to Chinese and would therefore sound somewhat “alien” when used to represent sounds in these languages.

In principal Sino-Xenic readings (Sino-Japanese, Sino-Korean, and Sino-Vietnamese), there is no uniqueness of Division-II vowels compared to other

7. There are two exceptions: the Division-II characters 山 *shān* (*srean*) ‘mountain’ and 下 *xià* (*haeX*) ‘down’, which are slightly more frequently used as onset spellers (Luh 1963). The preference for these two characters originated from two now-lost dictionaries compiled in the Jin 晉 dynasty (266–420), the *Yunji* 韻集 by Lü Jing 呂靜 and the *Zilin* 字林 by Lü Chen 呂忱 (Ota 2023). At the time, the reading of 山 *shān* was in Division III, *srjen* (Baxter & Sagart 2014: 214, 395–396; see also end of §5.2), so it was not considered an exception. These dictionaries prioritize glyph simplicity over phonetic constraints when choosing onset spellers (Ota 2023), which explains the adoption of the easy-to-write character 下 *xià* despite its Division-II quality.

Divisions. The low Division-II vowel *ae* and the low Division-I vowel *a* usually both correspond to *a* in these readings (some instances of *ae* correspond to *e* in Sino-Japanese *go-on*, which we will discuss in §2.3.1). In contrast, Sino-Tangut materials show a bidirectional correspondence between Chinese and Tangut Division-II syllables (Hashimoto 1963; Sofronov 1980). However, the phonetic value of Tangut Division II remains largely unclear, with new hypotheses proposing a medial *-r- (Zhengzhang 2016) or a medial *-ʃ- (Gong 2020), so it does not provide insights into the phonetic value of Chinese Division II. Nevertheless, it suggests that a unique feature exists in Chinese Division II.

In conclusion, Division II in the QYS should be understood as a unique quality of the vowel itself, instead of only as a medial segment. This quality does not fall under basic vowel dimensions such as height or frontness/backness. Below, we examine the correlates of this additional quality.

2.2 Vowel lowering

The most important diachronic behavior of Division II from EMC to LMC is its vowel-lowering effect.

During the Sui 隋 dynasty (581–618) (Zhang 2008), the two front Division II vowels, *ea* and *ae*, merged into the lower one, i.e., *ea* > *ae* (Pulleyblank 1984: 111; Huang 1995: 176–177; Xu 2020, 2023). This vowel lowering can be regarded as a unique behavior caused by the intrinsic quality of Division II (Xu & Pan 1994). Some may challenge the uniqueness of Division-II vowel lowering by citing examples of Division-I vowel lowering of *o* > *a* in the 哈 *Hāi* (-*oj*)–泰 *Tài* (-*aj*) merger and the 覃 *Tán* (-*om*)–談 *Tán* (-*am*) merger that occurred after the *Qieyun* (Huang 1995: 175–176). However, this Division-I vowel lowering occurred later than the Division-II vowel lowering (Pulleyblank 1984: 180), and is primarily limited to the lingua franca (or Proto-Mandarin), with southern dialects typically preserving the 哈 *Hāi*–泰 *Tài* and 覃 *Tán*–談 *Tán* distinctions (Wang 1999; Ma 2005). In contrast, reliable distinctions between the two front Division-II vowels in modern dialects are very rare. The temporal and geographical prevalence of Division-II vowel lowering over that of Division I suggests that Division II indeed has the vowel-lowering effect.

There is one exception to the vowel lowering: Division-II vowels in the 梗 *Gěng* rhyme group raised from [a] to [ɛ] in the lingua franca of the Tang 唐 dynasty (618–907) (Huang 1995: 207–210; Xu 2023). This does not refute the vowel-lowering effect of Division II, as this raising occurred to all Divisions in the 梗 *Gěng* rhyme group, e.g., 京 QYS *kjaeng* (Division III) > mid-Tang [kɣɛŋ] >

jīng ‘capital city’ paralleling 更 QYS *kaeng* (Division II) > mid-Tang [kɛŋ] > *gēng* ‘change (v.)’ (mid-Tang cited from Huang (1995), with the medial revised following Appendix A.3). The cause of this raising is unclear; it may be due to assimilation to [+high] codas [ŋ, k] (Zeng 2021) or a push effect from the 江 *Jiāng* rhyme (-*aeuŋ*) (Xu 2023). Nevertheless, we can assume that the rule of 梗 *Gěng* group vowel raising applied synchronically or diachronically after the rule of Division-II vowel lowering, thus making the vowel lowering ineffective. We will return to this in §2.4.

2.3 A-fronting

2.3.1 Formation of the Division-II vowel *ae*

The *ae*–*a* split in Type-A syllables during the Southern Qi (§2.1.1) suggests the presence of certain elements in Division-II syllables that have an *a*-fronting effect leading to the formation of the front vowel *ae* from *a*.

The frontness of *ae* has phonetic support in Sino-Japanese *go-on*.⁸ As noted in §2.1.4, QYS Division-II *ae* corresponds not only to *a* but also to *e* in *go-on*, the latter being attested in the readings of a number of characters (Li 2014: 380–382), e.g., 家 (*jiā* ‘household’) QYS *kae* > *go-on ke* and 版 (*bǎn* ‘plank, formwork’) QYS *paenX* > *go-on pen*. Note that the Japanese vowel *a* is central, so the use of the vowel *e* is to reflect the frontness of the Chinese vowel *ae* (Pulleyblank 1984: 185–186; Starostin 1989: 33; Xu & Pan 1994; Gong 2018).

2.3.2 Palatalization of Division-II *kāikǒu* 開口 (unrounded) dorsals and laryngeals

The palatalization of the 見 *Jiàn* group (K-) and 影 *Yǐng* group (ʔ-) initials (dorsals and laryngeals) occurred in Division-II *kāikǒu* syllables in several MC descendants, with Mandarin⁹ being the best-known example. From LMC to Early Mandarin, a medial [j] is inserted (or developed) after Division-II *kāikǒu* dorsals and laryngeals, e.g., 家 QYS *kae* > Early Mandarin [kja] > *jiā* ‘household’.

8. Gong (2018) also presents examples from Southern Min and Old Sino-Vietnamese as support for the frontness, which are not repeated here, as they reflect earlier stages and may not be applicable to the QYS.

9. Southern Mandarin dialects may be excluded from §2.3.2, because they have a certain number of colloquial readings without medial [j] for Division-II *kāikǒu* dorsal and laryngeal characters (Zhang 1993; Wang 2017).

This sound change occurred throughout the Song 宋 dynasty (960–1279) and its early traces are already reflected in Sino-Khitan materials in the 11th–12th centuries. In Sino-Khitan transcription in Khitan small script, many Division-II *kāikōu* dorsal and laryngeal syllables are transcribed with the front vowel *ä*,¹⁰ while other Division-II syllables are transcribed with the back vowel *a* (Ōtake 2017; Takeuchi 2023). However, since Khitan syllables do not permit medial glides (Shen 2007; Ōtake 2017), the Sino-Khitan evidence does not indicate that the medial [j] insertion was complete in Chinese at this stage, but only that this sound change was already in progress.

The first confirmed instance of completed medial [j] insertion is in the 13th-century rhyme book *Menggu Ziyun* 蒙古字韻 (Shen 2020: 249–250). In the *Menggu Ziyun*, there is a plain vs. palatalized contrast of dorsal and laryngeal initials (*k*- vs. *kj*- in Table 4), which mostly corresponds to the rhyme table Rank III vs. Rank IV contrast (Coblin 2007: 93–95; Hamada 2019; Mai 2022). Interestingly, the Division-II *kāikōu* dorsal and laryngeal initials generally belong to the palatalized group (mostly from Rank IV) instead of the plain group (mostly from Rank III) in the *Menggu Ziyun*, suggesting that the palatalization tendency of Rank II is stronger than that of Rank III (Mai 2022). The distinction between the plain and palatalized dorsals is retained in the colloquial readings (白讀 *báidú*) of some dialects in Shandong 山東 and Shanxi 山西, where palatalized dorsals (including Division-II words) have merged with certain coronals (Zhang 1993; Liu 2017), e.g., **kj* > [ts] in Rongcheng 榮成 (Table 4). This confirms the truthfulness of the documentation in the *Menggu Ziyun* and supports the strong palatalization tendency of Division II.

Sino-Vietnamese presents a more extreme case: the 見 *Jiàn* group initials have been palatalized under the Division-II *kāikōu* condition but remain velar elsewhere (Table 5) (Karlgren 1915–1926: 353–354; Pulleyblank 1984: 93–94; Nguyễn 2011: 93–99; Shimizu 2020). In other words, the palatalization tendency of Divi-

10. Scholars used to transcribe this vowel as *ia* (e.g., Chinggeltei 2002: 90; Kane 2009: 75). We follow Ōtake's (2017) reinterpretation as *ä*, since Khitan phonotactics do not permit medial glides. In addition, the vowel *ä* itself is represented by Khitan small script character 335 𐰺 (numbered by the Khitan Script Research Group 契丹文字研究小組 *Qìdān Wénzì Yánjiū Xiǎozǔ*). This character also denotes the Khitan word for 'elder brother' (Chinggeltei 2002: 91). Shen (2007) suggests that *ä* is in fact a guttural consonant (with an inherent vowel *a*) based on comparisons with related languages, e.g., Middle Mongolian *aqɑ* 'elder brother'. However, this hypothesis lacks support from other evidence (Kane 2009: 33), and the proposed cognation between Khitan *ä* and Middle Mongolian *aqɑ* is questionable, as few kinship terms appear to be shared between Khitan and Mongolian (Chinggeltei 2002: 18). (Were Shen's hypothesis to be correct, this would offer new Sino-Xenic evidence for the additional vowel quality of Division II in §2.1.4.)

Table 4. An example of Division-II *kāikǒu* dorsal palatalization, compared with related syllables

	Div.	Rank	QYS	VN	MZ	RC	BJ	Gloss
肝	I	I	<i>kan</i>	<i>can</i> [kan ^{A1}]	𪛗𪛗 <i>kan</i>	kan ¹	<i>gān</i>	‘liver’
建	III	III	<i>kjonH</i>	<i>kiến</i> [kiən ^{B1}]	𪛗𪛗𪛗 <i>ken</i>	cian ⁴	<i>jiàn</i>	‘set up’
繭	IV	IV	<i>kenX</i>	<i>kiến</i> [kiən ^{C1}]	𪛗𪛗𪛗 <i>kjen</i>	tsian ³ , cian ³	<i>jiǎn</i>	‘cocoon’
間	II	II	<i>keanH</i>	<i>gián</i> [zan ^{B1}]	𪛗𪛗𪛗 <i>kjan</i>	tsian ⁴ , cian ⁴	<i>jiàn</i>	‘gap’
箭	III	IV	<i>tsjenH</i>	<i>tiễn</i> [tiən ^{C2}]	𪛗𪛗𪛗 <i>tsjen</i>	tsian ⁴	<i>jiàn</i>	‘arrow’

Div. = Division; VN = Vietnamese with IPA of the Hanoi dialect (Kirby 2011); MZ = *Menggu Ziyun* 蒙古字韻 with Coblin’s (2007) reconstruction; RC = Rongcheng 榮成 Mandarin (Wang 1995); BJ = Beijing Mandarin. For characters with two readings in Rongcheng Mandarin, the first is the colloquial reading (白讀 *báidú*) and the second is the literary reading (文讀 *wéndú*).

sion II here is the strongest among all Divisions. Moreover, a similar Division-II *kāikǒu* vs. elsewhere dichotomy of the initial 見 *Jiàn* (*k-*) is observed in the Old Sino-Zhuang readings (老借詞 *lǎo jiècì*) in Shanglin 上林 Zhuang as [kʰ] vs. [k] (Zhang et al. 1999: 260–262), and in Southern Pinghua 平話 in Binyang 賓陽 as [ts] vs. [k] (Zeng 2021; Teng 2022: 30–31, 80–81). Given the close relationship between Sino-Vietnamese, Old Sino-Zhuang, and Pinghua, all of which are probably descendants of a popular southern variant of MC (Li 2002), the reflections of Division-II palatalization in these languages imply that the strong palatalization tendency of Division II is not limited to Mandarin but is also present in the south.

Table 5. Initials of the 見 *Jiàn* group (*K-*) characters in Sino-Vietnamese

MC Initial	Division-II <i>kāikǒu</i>	Elsewhere
見 <i>k-</i>	<i>gi-</i> [z]	<i>c-/k-/q-</i> [k]
溪 <i>kh-</i>	<i>x-</i> [s]	<i>kh-</i> [x]
羣 <i>g-</i>		<i>c-/k-/q-</i> [k]
疑 <i>ng-</i>	<i>nh-</i> [ɲ]	<i>ng-/ngh-</i> [ŋ]

Based on Nguyễn (2011:105) with IPA of the Hanoi dialect (Kirby 2011). The initial 羣 *g-* has only Division-III syllables. Following Ferlus (1992) and Shimizu (2020), the development of *gi-* and *x-* from Division-II 見 *k-* and 溪 *kh-* can be reconstructed as *kj, *k^hj > Ancient Vietnamese (15th-century) *kj, *tj > Middle Vietnamese (17th-century) [j, ɕ] > Modern Hanoi [z, s].

Regarding the origin of the palatalization, there are two main theories: palatalization induced by the front vowel *ae*, and palatalization induced by the fronting of the Division-II medial (see Zeng 2021 for a review). Nevertheless, since the vowel *ae* ultimately originated from Division II (§2.3.1), both theories

ultimately analyze the palatalization in relation to the frontness of Division II. In summary, based on the examples of palatalization presented above, Division II *kāikǒu* dorsals and laryngeals exhibit a strong tendency toward palatalization, even stronger than that of Divisions III and IV.

2.4 Slight *e*-backing

Another notable diachronic behavior of Division II is its slight yet present tendency to move the mid front vowel *e* backward, which can be discovered from the peculiarities of the development of the 梗 *Gěng* rhyme group: upon a careful inspection of the materials from §2.3.2, we can find that the Division-II palatalization is often bypassed in the 梗 *Gěng* rhyme group.

In northern Mandarin dialects, including Beijing Mandarin, only part of the 梗 *Gěng* group Division-II *kāikǒu* dorsal and laryngeal characters have undergone the medial [j] insertion (Xu & Pan 1985; Wang 2017), e.g., 行 QYS *haeng* > *xíng* ‘walk’ while 衡 QYS *haeng* > *héng* ‘balance’. In Central Plains Mandarin, e.g., Kaifeng 開封 and Luoyang 洛陽 dialects, the pattern is more evident: most Division-II *kāikǒu* dorsal and laryngeal syllables in the 梗 *Gěng* rhyme group lack the medial [j], while such syllables in other rhyme groups regularly have it. The 14th-century official rhyme book *Hongwu Zhengyun* 洪武正韻 also exhibits a pattern similar to that of Central Plains Mandarin. The unpalatalized instances in the 梗 *Gěng* rhyme group in northern Mandarin dialects are attributable to influence from Central Plains Mandarin or *lingua franca* varieties like the *Hongwu Zhengyun* (Wang 2017).

Similarly, in Sino-Vietnamese, Old Sino-Zhuang, and Pinghua, the palatalization of Division-II 見 *Jiàn* group initials uniformly did not occur in the 梗 *Gěng* rhyme group (Pulleyblank 1984: 93; Nguyễn 2011: 93–99; Zeng 2021; Teng 2022: 80–81).

The phenomenon of bypassing the medial [j] insertion and the palatalization, exclusive to the 梗 *Gěng* rhyme group, is quite intriguing. Its occurrence in both Mandarin and these southern languages is unlikely to be coincidental (Xu & Pan 1985). It appears to be linked to the other phenomenon unique to the 梗 *Gěng* rhyme group: the [a] > [ɛ] vowel raising (end of §2.2). The resulting non-low vowel would be exempt from the *a*-fronting effect of Division II (§2.3) and thus from its consequent strong palatalization tendency (Teng 2022: 30).

However, this explanation does not complete the story, at least for Mandarin.¹¹ From a typological perspective, it is implausible that a low front vowel would trigger palatalization while higher front vowels would not (Chen 1973; Bateman 2007: 62–75). Therefore, there must be something that has moved the vowel [ɛ] slightly backward in order to weaken the 梗 *Gěng* group Division-II palatalization. Attributing this *e*-backing effect to the velar codas [ŋ, k] of the 梗 *Gěng* rhyme group (e.g., Huang 2002a) is not ideal, as these codas are very likely to have gained palatal colors in LMC (Pulleyblank 1984: 118–120; see Dong 2016 for a review). We therefore propose a slight *e*-backing effect that should be attributed to Division II, in addition to its *a*-fronting effect. Only by adequately accounting for both the fronting and backing effects can the development of Division II be satisfactorily explained.

The *e*-backing effect could also account for the *e*–*ea* split during the Southern Qi (§2.1.1) and the subsequent contrast between *e* and *ea* in the QYS (§2.1.2).

2.5 Compatibility with the low front vowel

Having examined the diachronic behavior of Division II, we now turn to its synchronic relationships, specifically its compatibility with certain phonetic or phonological features in the QYS. The first concerns the low front vowel *ae*.

Within Type A, the uniqueness of *ae* as a Division-II vowel has been discussed in §2.1.2. Its occurrences in Type B also warrant attention: it appears in both Divisions II and III of the 麻 *Má* (*-ae*) and 庚 *Gēng* (*-aeng*) rhymes. Since Division-II and Division-III syllables of these two rhymes rhymed freely (§2.1.1), the phonetic value of *ae* in both Divisions should be identical, or at least very close.

This requires that the properties of Division II do not significantly alter the quality of *ae*; otherwise, the rhyming harmony between the two Divisions would be disrupted. In other words, the properties of Division II should be compatible with the low front vowel.

11. For the three southern languages, the absence of the palatalization in the 梗 *Gěng* rhyme group may be attributed to a phonotactic constraint prohibiting the medial [j] preceding front vowels, so LMC [kɛŋ] (Division II) can only be rendered as *kɛŋ instead of *kjɛŋ. However, this constraint obviously does not exist in LMC and Early Mandarin, where [kjɛ] frequently occurs.

2.6 Compatibility with uvulars

The Division-I and Division-II¹² 見 *Jiàn* group initials (*K*-) correspond to uvulars in various Sino-Xenic materials dating from Late OC to MC in the Tang dynasty. These include Chinese loanwords or readings in Sui, Miao, and Bai (reflecting Late OC and EMC), in Orkhon Turkic and Sogdian (reflecting EMC and LMC), and in Old Uyghur (reflecting LMC) (Yoshida 1994; Zeng 2003; Wang 2006:141–143; Shōgaito 2021; Wang 2023:318–308) (Table 6), as well as Chinese transcriptions of Orkhon Turkic and Old Uyghur (reflecting EMC and LMC) (Pulleyblank 1964; Kasai 2014). These materials indicate that the Division-I and Division-II 見 *Jiàn* group initials were phonetically uvulars at the time, or, as Norman (1994) has proposed for OC (see also Baxter & Sagart 2014:70, 383), phonologically pharyngealized/RTR dorsals.¹³

It should be noted that in Orkhon Turkic and Old Uyghur, *k* and *q* are allophones of each other: *k* occurs with front vowels and *q* occurs with back vowels (Shōgaito 2021). In addition, Chinese loanwords in later Sogdian materials (reflecting LMC) were likely influenced by or directly borrowed from Old Uyghur (Yoshida 1994). Therefore, these materials are less convincing as evidence for uvular initials in LMC, although Pulleyblank (1964) has argued that in these transcriptions, the faithfulness of the velar–uvular distinction was prioritized over that of vowel frontness, as seen in Sanskrit–Uyghur and Turkic–Chinese transcriptions. Nevertheless, at least in EMC, uvular initials are reliably supported by Sui, Miao, Bai, and early Sogdian materials.

In order to ensure the uvular quality of the 見 *Jiàn* group initials in Division II, the properties of Division II should be compatible with uvulars.

12. For materials reflecting Late OC and EMC, Division IV is also involved, i.e., the entire Type-A 見 *Jiàn* group initials correspond to uvulars. In LMC, Division IV had merged with Division IIIA (Appendix A.4), so former Division-IV 見 *Jiàn* group initials appear as velars in materials reflecting LMC.

13. To our knowledge, the first to link the Type-A 見 *Jiàn* group with uvulars is the hypothesis by Luh (1940).

Table 6. Examples of Chinese loanwords reflecting the velar (Division III) vs. uvular (Divisions I & II) distinction of the initial 見 *Jiàn* (k-)

	Div.	QYS	Sui	Miao	PB	OT	OU	Sog.	BJ	Gloss
工	I	<i>kuwng</i>	qoŋ ¹						<i>gōng</i>	‘work’
甘	I	<i>kam</i>		qaŋ ¹			Q [’] M		<i>gān</i>	‘sweet’
高	I	<i>kaw</i>			qaŋ ¹	<i>qo</i>	Q [’] W		<i>gāo</i>	‘high, tall’
公	I	<i>kuwng</i>				<i>qun</i>	QWNK	<i>xwn</i>	<i>gōng</i>	‘public; father’
夾	II	<i>keap</i>	qap ⁷	qei ⁷	gæ ⁴		Q [’] P		<i>jiā</i>	‘press between’
角	II	<i>kaewk</i>		qo ⁵	qɔ ⁴				<i>jiǎo</i>	‘corner’
甲	II	<i>keep</i>			qæ ⁴		Q [’] P	<i>x’p</i>	<i>jiǎ</i>	‘first heavenly stem’
江	II	<i>kaewng</i>			qoŋ ¹		QWNK		<i>jiāng</i>	‘river’
金	III	<i>kim</i>	tum ¹	tɕen ¹			KYM	<i>km</i>	<i>jīn</i>	‘metal’
鋸	III	<i>kjoH</i>	tu ⁵	tɕu ⁵					<i>jù</i>	‘saw (n.)’
軍	III	<i>kjun</i>			kroŋ ¹	<i>gün</i>	KWN	<i>kwn</i>	<i>jūn</i>	‘army; camp’
己	III	<i>kiX</i>					KY	<i>kyy</i>	<i>jǐ</i>	‘sixth heavenly stem’
結	IV	<i>ket</i>	qut ⁷						<i>jié</i>	‘tie (v.)’
雞	IV	<i>kej</i>		qei ¹	qɛ ¹				<i>jī</i>	‘fowl, chicken’
經	IV	<i>keng</i>					KY		<i>jīng</i>	‘sacred texts’
堅	IV	<i>ken</i>					KYN		<i>jiān</i>	‘firm, strong’

Div. = Division; Sui = Sandong 三洞 Sui (Zeng 2003); Miao = Yanghao 养蒿 Miao (Wang 2023: 375–279, 395–414); PB = Proto-Bai (Wang 2006: 141–143); OT = Orkhon Turkic (Barat 1996); OU = Old Uyghur (Yoshida 1994; Zhu 2022); Sog. = Sogdian (Yoshida 1994); BJ = Beijing Mandarin. Old Uyghur and Sogdian forms are transliterations; their scripts have no independent vowel letters, with ⟨ ’ ⟩ (*aleph*) representing [a~ə] in these words. Glosses are for Chinese and may not correspond exactly to meanings in these languages. ⟨t⟩ = voiceless alveolo-palatal plosive [ç].

2.7 Compatibility with retroflexes¹⁴

The close relationship between Division II and retroflex initials has been widely discussed (e.g., Pulleyblank 1984: 191–193; Huang 2002a; Mai 2022). We summarize the main points as follows: (a) Division II originates from the OC medial

14. “Retroflex” is, strictly speaking, a misnomer. The retroflex color (*r*-color) can be achieved through various tongue shapes without necessarily involving a true retroflex articulation (§3.3.1). For MC “retroflex” initials, there is no evidence indicating whether they are true retroflexes. Nevertheless, we continue to use the term “retroflex” for convenience and convention.

*-r- (§1.1); (b) Division-II finals are the only Type-A finals that can combine with retroflex initials; (c) syllables with sibilant retroflex initials (the 莊 *Zhuāng* group, *Tsr-*) are all listed as Rank II in the rhyme tables regardless of whether they are in Division II or III in the QYS, termed 莊三化二 *Zhuāngsān-huà'èr* ‘*Tsr*-III becomes II’ by Huang (2006); and (d) Division-II *fǎnqiè* rhyme spellers can indicate retroflexion of coronal initials. In summary, Division II should be compatible with retroflexes.

The properties of Division II are comprehensively collected now, and we are in a position to evaluate candidate proposals for Division II based on these properties. However, before doing so, we need to clarify some of the features involved in these proposals, namely the different types of so-called pharyngealization and RTR.

3. Pharyngealization and RTR

3.1 General introduction and our framework

What is described in the literature as “pharyngealization” actually encompasses a wide variety of phenomena with different articulatory and acoustic effects. Early awareness of this variation can be traced to preliminary discussions by Delattre (1971) and Catford (1977a: 192–193). Subsequent studies (e.g., Hess 1998; Bellem 2008; Moisik 2013; Sylak-Glassman 2014; Evans et al. 2016; Moisik et al. 2021) identify different types of pharyngealization and provide detailed descriptions and comparisons from phonetic and phonological aspects.

Based on these findings, the *SPE*’s specification of uvulars as [–high, +back] and pharyngeals as [+low, +back] (Chomsky & Halle 1968: 304–309) has been criticized and disfavored (see Sylak-Glassman 2014: 109–124; Zeroual & Clements 2015; Flynn 2024 for reviews). However, new theories continue to emerge, and no consensus has been reached. Further complicating matters, certain pharyngealization is also often conflated with RTR (Zeroual & Clements 2015).

In this paper, we refrain from making phonological claims about pharyngealization and RTR. Instead, we introduce an acoustic framework to characterize these secondary features according to their acoustic effects on vowel quality (i.e., vowel coloration). We identify three representative types of these features in the framework: uvulo-pharyngealization, palato-pharyngealization, and vertical RTR. The first two terms follow Bellem (2008: 93, 142), while the third is a provisional term coined in this paper to represent a narrower, more typical form of RTR (see below).

Uvulo-pharyngealization has *lowering* and *backing* effects on vowels, i.e., raising the first formant (F_1) and lowering the second formant (F_2). This type is exemplified by the typical realization of emphatic consonants in Arabic, e.g., /t^ɕ, s^ɕ/ (Zeroual & Clements 2015). It involves retracting both the tongue body (*backing*) and the tongue root (*lowering*). Retraction of the tongue root causes laxing or lowering of the tongue body, therefore producing the *lowering* effect. This tongue root retraction mechanism applies to all three representative types in our framework. Uvulo-pharyngealized vowels are also available, as observed in various German dialects (Khan & Weise 2013) and Northwestern Qiang (Evans et al. 2016).

Palato-pharyngealization has *lowering* and *fronting* effects on most vowels, i.e., raising both F_1 and F_2 . This type is exemplified by pharyngealized vowels in Northeast Caucasian languages.¹⁵ It involves raising the anterior tongue body toward the palate (*fronting*) and retracting the tongue root (*lowering*) (Catford 1977a: 182). However, on non-low front vowels, in addition to the *lowering* effect, it exhibits a slight *backing* effect instead of a fronting effect. For example, in Tsakhur, the six plain vowels /i, e, a, o, u, ʏ/¹⁶ have their pharyngealized counterparts being: /i^ɕ, e^ɕ/ *backed* and *lowered*, /a^ɕ/ *fronted*, and /o^ɕ, u^ɕ, ʏ^ɕ/ *fronted* and *lowered* (Catford 1977b, 1983; see Hussain & Mielke 2021 for F_1 – F_2 plots). We will discuss this type further in §3.2.

RTR has a *lowering* effect on vowels, i.e., raising F_1 , but whether it has effects on F_2 (fronting or backing) is controversial (see Beltzung et al. 2015; Makeeva & Kuznetsova 2022; Akinbo et al. 2024 for reviews). Nevertheless, in some languages, RTR has the *lowering* effect only, without significant or consistent effects on F_2 , i.e., involving tongue root retraction without specific horizontal movement of the tongue body. We provisionally term it “vertical RTR” as it lacks horizontal vowel coloration, and include it as one of the representative types. Pure vertical ATR–RTR contrasts are observed in languages such as Akebu (Makeeva & Kuznetsova 2022), Maa (Guion et al. 2004), and Tima (Tabain et al. 2024).

A mixture of uvulo-pharyngealization and vertical RTR is also observed in languages such as Akan (Hess 1992; Ladefoged & Maddieson 1996: 305), Imilike Igbo (Akinbo et al. 2024), and Khalkha Mongolian (Svantesson 1985; Kenstowicz 2023), where RTR manifests as both *lowering* and *backing* on certain vowels (usually non-front vowels) but only as *lowering* on others. This suggests a continuum between uvulo-pharyngealization and vertical RTR, which can be considered as RTR in a broad sense, since the entire continuum is characterized by tongue root

15. Sound samples of Archi (Chumakina et al. 2007) and Tsakhur (Sackett et al. 2022) are available online. Vowels become pharyngealized after pharyngealized consonants in Archi.

16. In §3, following the transcription conventions of relevant works, [æ] = low front vowel, and [a] = low central or back vowel. The palato-pharyngealized [a^ɕ] is acoustically front.

retraction. Indeed, uvulo-pharyngealization, including that in Arabic, has been represented as the feature [+RTR] in some works (see Zeroual & Clements 2015; Flynn 2024 for reviews), and conversely, RTR has also been referred to as pharyngealization (e.g., Svantesson 1985).

The nomenclature for uvulo- and palato-pharyngealization also remains highly controversial. Some scholars argue that uvulo-pharyngealization is uvularization rather than pharyngealization, either in Arabic (McCarthy 1994; Hess 1998:117–173; Moisik et al. 2021) or cross-linguistically (Colarusso 1981; Sylak-Glassman 2014:69–70). On the contrary, it has also been claimed that palato-pharyngealization is palatalization rather than pharyngealization (Hess 1998:33). To remain neutral, we adopt Bellem’s (2008:93, 142) terms, uvulo- and palato-pharyngealization.

Additional acoustic cues may accompany these features, including a lower third formant (F_3) (§3.3.1), a wider F_1 bandwidth (Hess 1992; Akinbo et al. 2024), a lower harmonics-to-noise ratio (Kenstowicz 2023), and irregular phonations (McCarthy 1994; Hess 1998).

3.2 Palato-pharyngealization in Northeast Caucasian and beyond

Palato-pharyngealization in Northeast Caucasian languages is very distinctive. It was first noticed by Trubetzkoy (1931), described as “*emphatische Mouillierung*” (‘emphatic softening’), a term close to Bellem’s (2008:142) palato-pharyngealization (emphatic = pharyngealized; softening = palatalizing). However, labeling it as “palatalized” is insufficient. As noted in §3.1, it also produces a slight *backing* effect on non-low front vowels.

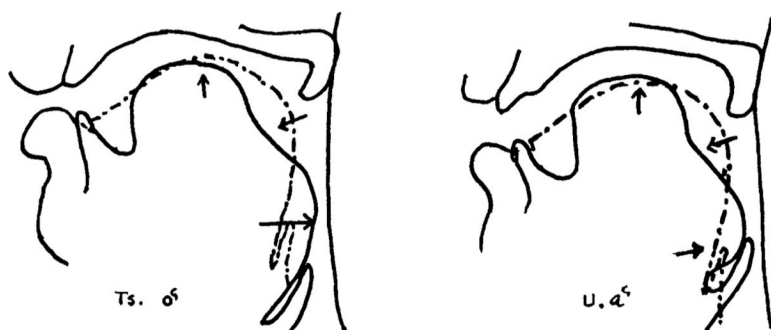


Figure 1. Tongue shapes (solid lines) of Tsakhur /o̞/ and Udi /a̞/ with reference natural tongue shapes added (dashed lines) (reproduced from Catford 1983; based on X-ray photos in Gaprindashvili 1966)

The tongue configuration of palato-pharyngealization is also distinctive. It involves a double-bunching tongue shape (raised tongue body and retracted tongue root) (Figure 1), which arises from the depression of the back of the tongue body opposite the uvula (Catford 1983; Moisik 2013: 489–491). The seemingly contradictory *fronting–backing* effects stem from this configuration. The anterior bunching toward the palate naturally produces the fronting effect on low and back vowels. However, on front vowels, the effect is reversed: the anterior bunching restricts the horizontal articulatory space available for vowels, preventing them from achieving full frontness unless they are low (Hussain & Mielke 2021).

The acoustic effects of palato-pharyngealization are therefore also described as *lowering* and *centralizing* (Catford 1983; Hussain & Mielke 2021). However, its *fronting* effect on low and back vowels appears overall more prominent than its *backing* effect on non-low front vowels, not only by acoustic parameters but also by phonological processes. In some Northeast Caucasian languages, pharyngealized vowels can become “real” front vowels in the inventory, e.g., Tsakhur /u^ɕ, o^ɕ, a^ɕ/ > Sabunchi dialect [y, ø, æ], and vowels in pharyngealized environments can be realized as “real” front vowels, e.g., Avar /u, o/ → [y, ø] (see Sylak-Glassman 2014: 70–73 for more examples). Interestingly, in Udi, a Northeast Caucasian language, both /æ/ and /a/ exist, but only /a/ has a pharyngealized counterpart /a^ɕ/ while /æ/ lacks one, probably because the quality of *[æ^ɕ] is so similar to [æ] that they cannot contrast (Moisik 2013: 495). In Lak, another Northeast Caucasian language, velars and /l/ even tend to have palatalized allophones in pharyngealized contexts (Anderson 1997).

Palato-pharyngealization may occur beyond Northeast Caucasian languages. In Abkhaz, a Northwest Caucasian language, a sound change of [ʃ^w] > [q^ɕ] > [q] is observed across dialects (Colarusso 1981), suggesting that this [ʃ^w] is a labialized palato-pharyngeal consonant. In Amis, an Austronesian language, /u/ following pharyngeals is acoustically lowered and fronted (Maddieson & Wright 1995). In Inland Salish, /a/ adjacent to a pharyngeal consonant is realized as [æ] (Kinkade 1967). A similar sound change is also found historically in Akkadian, where Proto-Semitic *a > Akkadian e when adjacent to *ḥ or *ʕ (Huehnergard 2011: 40, 587). Although these instances lack physiological data to confirm the nature of the pharyngeals involved, they nevertheless demonstrate that the connection between fronting and (palato-)pharyngealization extends beyond Northeast Caucasian.

For languages with palato-pharyngealized vowels, failure to recognize the pharyngealization quality can result in a skewed vowel system with an excess of front vowels, e.g., Lak’s vowel inventory [i, e, œ, æ, a, u] is actually [i, i^ɕ, u^ɕ, a^ɕ, a, u] (Catford 1977b; Anderson 1997).

3.3 Pharyngealization and rhotacization

3.3.1 Similarity

Another particularity of palato-pharyngealization is its high similarity to rhotacization. In addition to the aforementioned effects, Northeast Caucasian pharyngealization often significantly lowers F_3 , which is also the acoustic clue for *r*-color (i.e., rhoticity) (Hussain & Mielke 2021). Indeed, Americans often perceive these pharyngealized vowels as rhotacized (Catford 1983). Our small-scale casual survey also found that Mandarin speakers tend to perceive them as *erhua* 兒化 ‘ér-ization’, which is vowel rhotacization in Mandarin. Readers may be interested in the sound samples of the pharyngealized vowels in Footnote 15.

There are two types of tongue shape realizations of American English /ɹ/ and /ɻ/: retroflex (where the tongue tip curls upward) and bunched (where the tongue is raised toward the palate with the tip pointing downward), with the latter being more popular (Delattre & Freeman 1968; Westbury et al. 1998). The vowel /ɻ/ and the *erhua* suffix /ɹ/ in Beijing Mandarin (Lee 2005; Xing 2021) and other northern Mandarin dialects (Chen et al. 2024) also have both retroflex and bunched realizations.

Bunched variants of these English and Mandarin rhotic sounds also involve tongue root retraction. Therefore, they are essentially double-bunching (Delattre 1971), nearly identical to the configuration of Northeast Caucasian pharyngealization (Figure 1) (Catford 1983) and the pharyngeal fricative /ħ/ in some Arabic dialects (Delattre 1971; Hess 1998:169–171). Notably, there are rhotic vowels that lack retroflex variants, e.g., /ɻ/ and *erhua* vowels in some Cheng-Yu 成渝 dialects of Southwestern Mandarin (Huang et al. 2024) as well as rhotic vowels in Kalasha, an Indo-Aryan language (Hussain & Mielke 2021), although these rhotic vowels arose from the fusion of retroflexes and vowels. Some scholars further argue that rhotic vowels without retroflex variants are the same as pharyngealized vowels (Catford 2001:161–162; Hussain & Mielke 2021). Interestingly, Lass (1984:158) describes the New York City English /ɹ/ as a “pharyngealized palato-velar approximant”, only a pharyngealized sound instead of a rhotic.

Retroflex variants also acoustically resemble bunched variants and Northeast Caucasian pharyngealization. This is because retroflexion, tongue bunching, depression of the back of the tongue, and pharynx constriction all contribute to F_3 lowering, as explained in numerous works (e.g., Delattre & Freeman 1968; Espy-Wilson et al. 2000; Johnson 2012:140). Moreover, when coarticulated with vowels, retroflex variants may tend to be replaced by the acoustically similar but gesturally more economical bunched variants (Huang et al. 2024).

3.3.2 Decoronalization of rhotics

By juxtaposing rhotic vowels in these languages, a decoronalization chain can be observed: retroflex plus vowel > retroflex vowel > rhotic vowel with retroflex and bunched variants > rhotic vowel with bunched variants only > pharyngealized vowel. In this process, the *r*-color shifts from coronal to guttural while being preserved.

This process also applies to consonants. The alveolar trill /r/ often exhibits secondary pharyngeal articulation in the world's languages (Boyce et al. 2016). It can be reduced to approximants with retroflex and bunched variants like /ɹ/ in American English. Retroflex variants can then be lost, and the remaining bunched variants can be recategorized as pharyngeal.

This rhotic-to-pharyngeal shift parallels the well-known rhotic-to-uvular shift (Torp 2001; Kümmel 2007: 228–229) as in French and German. However, there are almost no well-documented complete instances of the former shift. Danish *r* may be one such case. While the contemporary Danish *r* is customarily transcribed as a uvular fricative/approximant [ʁ/ʁ̥], scholars claim that it is a (uvulo-)pharyngeal approximant [ʕ],¹⁷ rather than a uvular (Catford 1977a: 163; Ladefoged & Maddieson 1996: 170, 323; Grønnum 2005: 141, 158). Furthermore, the coronal realization of *r* is no longer accepted in Standard Danish, even in opera singing (Torp 2001), indicating that the decoronalization process has been completed. If the claim of the pharyngeal quality is true, Danish *r* constitutes a complete instance of the rhotic-to-pharyngeal shift.

4. Evaluation of proposals for Division II

4.1 Identifying the best candidate

After a detailed examination of pharyngealization and RTR, we can proceed to evaluate the potential features for Division II in §1.2, using the properties identified in §2 as evaluation criteria. The candidate features and the properties are presented in Table 7. *R*-color, or rhotacization, as a candidate feature, can be divided into retroflex and non-retroflex types. Since non-retroflex rhotacization is very similar to certain forms of pharyngealization (§3.3.1), only true retroflexion is included as distinct from other pharyngeal colors in Table 7.

17. Sounds transcribed as [ʕ] in the world's languages are usually approximants rather than fricatives (Laufer 1996; Pulleyblank 2003), so there is no need to explicitly write [ʕ] for a pharyngeal approximant.

Table 7. Matching candidate features with properties of Division II

	No	Palat.	Velar	Retro.	U-ph.	P-ph.	VRTR
Additional vowel quality				✓	✓	✓	✓
Vowel lowering				✓	✓	✓	✓
A-fronting		✓				✓	
Slight <i>e</i> -backing			✓	✓	✓	✓	
Compatibility with the low front vowel	✓	✓				✓	✓
Compatibility with uvulars	✓			✓	✓	✓	✓
Compatibility with retroflexes	✓		✓	✓	✓	✓	✓

The candidates are: no specific color, palatal color, velar color, retroflexion, uvulo-pharyngeal color, palato-pharyngeal color, and vertical RTR. “✓” indicates a match between the feature and the property.

The candidate “no specific color” is naturally compatible with all constraints but fails to meet any vowel-coloring criteria. For palatal and velar colors, their effects (fronting/backing and raising) fall within major vowel qualities. Palatal color conflicts with retroflexes (Hamann 2003: 77–78) and velar color conflicts with the low front vowel. Both colors involve [+ATR] or [+high], so they conflict with uvulars.¹⁸ As a result, each meets only two criteria. Next, retroflexion and uvulo-pharyngeal color have identical evaluation results. They both trigger vowel lowering (Hamann 2003: 99–100; §3.1) and are compatible with each other. However, they both conflict with front vowels and vowel fronting (Flemming 2003; Hamann 2003: 94–111; §3.1). Surprisingly, palato-pharyngeal color meets all criteria, stemming from its unique fronting–backing duality (§3.2) and similarity to *r*-colors (§3.3), aside from its lowering effect (§3.1) and compatibility with the low front vowel (§3.2). Finally, vertical RTR lacks fronting or backing effects (§3.1).

Thus, palato-pharyngeal color emerges as the best candidate and the only one that satisfies all criteria. However, conclusions cannot yet be drawn.

4.2 Refuting the velar medial theory

Despite the shortcomings of velar color as a candidate, previous proposals of the velar medial theory (§1.2) assume dissimilation between the medial and the vowel to resolve the shortcomings: Division-II vowels underwent lowering and fronting

18. Here, “conflict” does not imply impossibility. Phonologically palatalized uvulars, e.g., /qʲ/, are attested in Northwest Caucasian languages; nevertheless, they are extremely rare cross-linguistically (Sylak-Glassman 2014: 21–28).

due to dissimilation or repulsion from the [+high, +back] velar medial (Xu & Pan 1994).

However, the dissimilation assumption is highly unnatural and questionable in the context of the *ae*–*a* split during the Southern Qi (§2.3.1). In Type-A syllables, the low vowel became [–back] *ae* in Division-II environments and [+back] *a* in Division-I environments. If Division II featured a [+back] medial [ɣ~ʉ] while Division I lacked it, it would be very unlikely for the low vowel in Division II to develop a fronter quality than in Division I. In Type-B syllables (only available without codas; see §2.1.1), the low vowel became [–back] *ae* when following coronal (acute) onsets while remaining [+back] *a* elsewhere (Pulleyblank 1984: 221–223). This is clearly a process where the frontness of the vowel *assimilated* to the coronality (acuteness) of the preceding segment (Flemming 2003), aligning with the common pattern of vowel–medial harmony in Chinese (Lin 2002). It is implausible for the same vowel to have conversely *dissimilated* from a medial in Type-A syllables.

There is yet another critical issue with the velar medial theory. This theory attributes the palatalization of Division-II *kāikǒu* dorsals and laryngeals (§2.3.2) to the fronting of the Division-II medial [w] > [i] > [ɨ]. However, the [ɨ]-like medial of rhyme table Rank III, which is fronter than [w], did not trigger palatalization at the time (§2.3.2). It is implausible that [w] would take precedence over [ɨ] in triggering palatalization.

In addition, Xu and Pan (1994) enumerate several Jin and Southern Wu dialects where readings of a few Division-II characters have additional medials and interpret these as descendants of the hypothetical Division-II velar medial. However, dialect comparisons suggest that these medials arose from later vowel breaking, e.g., [ɛ] > [ja] in Jin (Wang 1990) and [ɔ] > [wa] (which further developed into [ʉa] after labial initials) in Southern Wu (Sun 2012). Therefore, these materials cannot be taken as evidence for the velar medial.

In summary, the arguments for the velar medial theory fail to address its clear shortcomings, not to mention that the *fǎnqiè* patterns in §2.1.3 already argue against the existence of a Division-II medial. Our evaluation remains robust, allowing us to confidently conclude that palato-pharyngeal color is the most suitable feature for Division II. In the next section, we will present the pharyngealization theory and tell the complete story of the development of Division II.

5. The pharyngealization theory

5.1 Division II in the QYS

Which segment in the syllable carries the (palato-)pharyngeal color in the QYS? Given the uniqueness of most Division-II vowels in the QYS (§2.1.2) and the *fǎnqiè* patterns arguing against a Division-II medial (§2.1.3), this color is best attributed to the vowels. We reconstruct three pharyngealized vowels for Division II: [e̠, o̠, a̠], corresponding to *ea*, *aew*, *ae* in Baxter's transcription. Rewriting these "front" vowels in Baxter's transcription as pharyngealized vowels parallels Catford's (1977b) treatment of the Lak vowel system (end of §3.2).

One issue arises from the free rhyming between *ae* in Divisions II and III (§2.5). Is it phonetically natural for the Division-II pharyngealized vowel [a̠] to rhyme with the Division-III plain vowel [a]? Given that the uvulo-pharyngeal approximant [ʕ] can be regarded as a low back semivowel [ɑ̠] (Pulleyblank 2003; Mazaudon 2007), the palato-pharyngeal approximant [ɕ] can also be regarded as a low front semivowel [a̠]. With [ʕ] ≈ [ɑ̠], we have [a̠] ≈ [a̠] = [a]. That is, the palato-pharyngealized low front vowel [a̠] is approximately equivalent to or perceptually indistinguishable from the low front vowel [a] itself. This parallels the absence of the plain–pharyngealized contrast for the low front vowel in Udi (§3.2). This is also similar to the lack of ATR–RTR contrast for low vowels in some ATR languages, e.g., Maa and Yoruba, because the low tongue body of low vowels limits tongue root movement, resulting in difficulty in ATR–RTR distinction (Casali 2008; Moisik 2013: 513). Thus, [a̠] can naturally rhyme with [a].¹⁹ The issue is resolved.

By adopting pharyngealized vowels, the vowel system of the QYS presented in Table 2 can be revised as shown in Table 8.²⁰ Going one step further, we pro-

19. Following the examples of Udi, Maa, and Yoruba, it would be reasonable to simplify the Division-II vowel [a̠] as identical to the Division-III [a]. However, it is preferable to keep the [a]–[a̠] distinction orthographically, to clearly indicate their Divisions.

20. An anonymous reviewer raised the potential issue that the ratio of plain to pharyngealized vowels (8:3) appears imbalanced and typologically unnatural. Indeed, in Northeast Caucasian languages with pharyngealized vowels, each plain vowel usually has a pharyngealized counterpart (Ladefoged & Maddieson 1996: 306). However, extreme exceptions exist: Hinukh is reported to have six plain vowels /i, y, u, e, o, a/ but only two pharyngealized vowels /e̠, a̠/ (Isakov & Khalilov 2004). Moreover, the vowel imbalance in the QYS primarily results from the imbalanced vowel distribution between Types A and B, which is a consequence of OC Type-A high vowel lowering (§5.2). If we restrict our view to Type A, where only five plain vowels [u, e, ə, o, ɑ] occur, we obtain a more balanced plain-to-pharyngealized ratio of 5:3. In any case, this is the actual vowel system of the QYS, as evidenced by rhyming practice (§2.1.1).

vide in Appendix B.2 our reconstruction of all rhymes in the QYS based on the pharyngealization theory.

Table 8. Vowels of the QYS based on the pharyngealization theory

	Plain vowels			Pharyngealized vowels		
	[-back]	[+back]		[-back]	[+back]	
		[-round]	[+round]		[-round]	[+round]
[+high, -low]	真 i	殷 i	東 u			
[-high, -low]	青 e	登 ə	冬 o	耕 e ^ɕ		江 o ^ɕ
[-high, +low]	庚 a	陽 a		庚 a ^ɕ		

For the 庚 *Gēng* rhyme (-aeng), Division-III vowel = [a] and Division-II vowel = [a^ɕ].

5.2 Division II from OC to EMC

Norman's (1994) reconstruction of OC Type-A initials as “pharyngealized” consonants is widely adopted (§1.1). However, based on our framework of pharyngealization and RTR (§3.1), the nature of Norman's “pharyngealization” and Baxter and Sagart's (2014) notation *C^ɕ- deserves reconsideration. We argue that it is more appropriate to interpret this feature as RTR and transcribe OC Type-A initials as *C̣-. Currently, only two lines of evidence shed light on the quality of this feature: the uvular quality of Type-A dorsal initials (§2.6) and Type-A high vowel lowering (or breaking) from OC to MC (Schuessler 2006; Ferlus 2009; Baxter & Sagart 2014: 211–212). Type-A high vowels evolved as: OC *C̣i, *C̣i, *C̣u > *C̣i, *C̣i, *C̣u > EMC [Ce, Cə, Co] in most cases. This sound change suggests vertical RTR as the feature of Type-A initials, since it shows no diachronic fronting or backing effects. However, we cannot rule out a mixture of uvulo-pharyngealization and vertical RTR as observed in the languages in §3.1,²¹ since there is no further evidence for its phonetic realization. Nevertheless, interpreting the feature as RTR in a broad sense is reasonable, and OC Type-A initials can be transcribed as *C̣-.²²

21. Interpreting this feature solely as vertical RTR presents two typological issues. First, non-guttural consonants inherently bearing [+ATR]/[+RTR] do not appear to be attested in any typical ATR/RTR language. Second, vertical RTR does not appear to be reported to induce /k/ → [q]. Conversely, interpreting it solely as uvulo-pharyngealization, such as Gong's (2018) uvularization, also poses a problem: the backing effect of uvulo-pharyngealization conflicts with the fronting effect of Division II (§2.2) in EMC, when the feature in question was still present (§2.6).

22. The use of the IPA diacritic for RTR on consonants, [C̣], may appear unfamiliar. Although it is indeed rare, as are typical non-guttural [+RTR] consonants, there are instances where [C̣] is used to transcribe “pharyngealized” consonants (e.g., Moisik et al. 2021; Flynn 2024). In addition, [+RTR] consonants may also be introduced for MC (see Appendices A and B.1).

This RTR-induced high vowel lowering process can have a parallel in rhotics: decoronalization. As noted in §3.3, rhotics often exhibit secondary pharyngealization. We can expect that the RTR context of OC Type-A syllables could promote the medial *-r- to develop secondary pharyngealization and progressively encourage its pharyngealization to become evident. Finally, the pharyngeal articulation could replace the coronal as the primary articulation, completing a rhotic-to-pharyngeal shift (§3.3.2): OC *Çr- > *Çr̥- > pre-QYS EMC *Cɣ-, parallel to Type-A high vowel lowering. In contrast, in the non-RTR context of Type-B syllables, pharyngeal articulations were generally inhibited, so OC *-r- was better preserved in EMC as a coronal rhotic, e.g., [ɹ], as indicated by Sanskrit-Chinese transcriptions (Shi 1983; Mai 1992).

Before the Southern Qi, Division II shared all its vowels with other Divisions (§2.1.1), indicating that its feature was not in the vowels. We reconstruct a palato-pharyngeal approximant medial [ɣ] for pre-QYS Division-II syllables. In this way, we have pre-QYS EMC *Cɣe, *Cɣo, *Cɣa > QYS [Ce̞, Co̞, Ca̞], a fusion of [ɣ] with the vowels. The emergence of pharyngeal vowels made Division-II rhymes independent of other Type-A rhymes (§2.1.1). A real-world parallel of this fusion can be seen in Maltese, where it was well-documented before the eventual loss of pharyngeal quality, e.g., 19th-century *ghamilt* [ɣa'milt] > 20th-century [a̞:'milt] > contemporary [a:'milt] 'I did' (Puech 2018).

Some earlier Type-B syllables with sibilant retroflex initials (< OC *Tsr-) also became Division II in the QYS (Baxter & Sagart 2014: 74–75). Examples include 山 *shān* 'mountain' and 殺 *shā* 'kill' (Baxter & Sagart 2014: 214), whose early readings were in Type B (Division III) as *srjen [ʃjɛn] and *srjet [ʃjɛt], but became Type A (Division II) in the *Qieyun* as *srean* [ʃe̞'n] and *sreat* [ʃe̞'t]. This sound change can be attributed to the frequent co-occurrence of secondary pharyngealization with retroflexes (Hamann 2003: 34–38; Boyce et al. 2016; see also §3.3.1). Pharyngealization, initially serving as an acoustic cue for retroflex initials, could later be phonologized as a pharyngeal medial, e.g., OC *tsr- > *tɣ- (Type B) > *tɣ̥- > pre-QYS EMC *tɣɣ- (Type A) > QYS *tsr-* [tɣ̥-].

5.3 Division II from EMC to LMC

During the Sui dynasty, pharyngealized mid vowels became low vowels (§2.2) due to the lowering effect of pharyngealization (§3.1): QYS [e̞] > LMC [a̞]. This parallels the neutralization of mid and low vowels to low in pharyngeal contexts in Syrian Arabic (McCarthy 1994) and Tamashek Berber (Sylak-Glassman 2014: 65). The exact phonetic value of the lowered outcome of [o̞] is unclear, pos-

sibly [v̥].²³ Later, vowel raising of the 梗 *Gěng* rhyme group in the Tang dynasty (§2.4) dragged the vowel of the 梗 *Gěng* rhyme group higher again: [a'ŋ] > [ɛ'ŋ].

In LMC, the rhyme group (攝 *Shè*) served as a broader rhyming category (Pulleyblank 1984: 61): syllables in the same rhyme group generally rhymed regardless of their Ranks. Rhyme groups are classified as higher (內轉 *nèizhuǎn* 'inner turn') and lower (外轉 *wàizhuǎn* 'outer turn') according to vowel height. An overview of all rhyme groups and the rhyme correspondence between the QYS and LMC are provided in Appendix C.

In lower rhyme groups, exemplified by the 山 *Shān* rhyme group (Table 9), Huang's (1995) phonetic reconstruction shows that while Rank-I and Rank-II vowels contrast, each is in complementary distribution with Rank-III and Rank-IV vowels, conditioned by different medials. One can expect an additional underlying distinction between Ranks I and II to reduce all these surface vowels to a single underlying representation, /a/. Attempts have been made: Lamasse and Jasmin (1934: 25) and Wang (1985: 50) assign an *e*-like medial to Rank II, and Pulleyblank (1984: 81) analyzes the Rank-II vowel as a long vowel (Table 9). However, these remain more *ad hoc* solutions than true phonetic explanations. Under the pharyngealization theory, we can reintroduce an underlying palato-pharyngeal medial /ʕ/ for Rank II and represent the lower Rank-II vowel as /ʕa/. In this way, all surface allophones of /a/ can be naturally derived via medial-to-vowel coloring (Table 9), where /ʕ/ functions in parallel with other medials, even if no overt pharyngeal quality may surface.²⁴ A comparable analysis is also found in Maltese studies, where a virtual /ʕ/ (= [a]) is reintroduced to explain unstressed long vowels, e.g., deriving [a:'milt] from /ʕa'milt/ 'I did' (Puech 2018).²⁵

23. The fronting effect of palato-pharyngealization might lead one to expect [œ̥]. However, rhyming practice does not support this. In the Tang dynasty, this vowel primarily rhymed with itself and, when it rhymed with others, it was consistently with back vowels, most often [a], the vowel of the 陽唐 *Yáng-Táng* rhyme (-ang) (Huang 1995: 213). Therefore, we propose a pharyngealized back vowel [v̥].

24. We refrain from using Tangut data to argue for the phonetic nature of LMC ranks, as doing so introduces the risk of circularity; the native Tangut analysis of phonological "Grades" was itself modeled on the LMC system. Nevertheless, evidence *internal* to Tangut historical phonology, independent of the LMC model, indicates that Tangut Grade II, which corresponds to LMC Rank II in transcriptions, functioned as a segmental medial. This is demonstrated by the epenthesis of *Qi into /Qʕi/ (Gong 2017). For example, the Tangut word 𐰽𐰚𐰚 *gái'* [G'ɛ'ɪɪ] 'difficult' develops from a precursor that would otherwise yield [†]*gi'*. Such a development requires the presence of a distinct segment and constitutes additional support for analyzing LMC Rank II as a segmental medial.

25. From the perspective of /ʕ/ = [a], Pulleyblank's (1984: 79–84) [a:] (Table 9) is already equivalent to /ʕa/.

Table 9. Reconstructions of LMC finals in the ㄣ Shān rhyme group

	I	II	III	IV
Lamasse & Jasmin (1934)	<i>an</i>	<i>ean</i>	<i>yan</i>	<i>ian</i>
Pulleyblank (1984: 106)	an	aan [a:n]	ian	jian
Wang (1985: 276, 285)	an	ean	ǣn	ǣn
Huang (1995: 216)	an	an	ien	jien
This paper	an [an]	ʎan [an]	ʎan [ʎen~ʎɜn]	jan [jen]

For simplicity, *hékǒu* 合口 (rounded) finals are omitted. Lamasse and Jasmin (1934) also add a diacritic to these finals to mark different EMC sources, yielding *eân*, *ȳan*, and *îan*; these are not included in the table. Wang (1985) does not distinguish between Ranks III and IV.

In higher rhyme groups, vowels are already in complementary distribution across the four ranks, since higher Rank II only exists after sibilant retroflex initials (the 莊 *Zhuāng* group, *Tsr-*) where Rank I is absent. Therefore, higher rhyme groups also require only one underlying vowel, /i/ (or /ə/). Note that Division-III syllables in the QYS with sibilant retroflex initials had become Rank II (Huang 2006; see also §2.7 and Appendix A.4), i.e., QYS *tsrj-* [tʂɿ-] > LMC /tʃʃ-/ , producing higher Rank II. The motivation for this change is akin to that of OC **tsr-* (Type B) > QYS [tʂ-] (Type A) (end of §5.2).

These analyses lead to a vertical vowel system for LMC of just two underlying vowels, /i/ and /a/. Although this interpretation may appear over-analyzed, it is faithful to the rhyme table system and LMC rhyming practice: each rank corresponds to a distinct underlying medial, and each rhyme group represents a single underlying rhyme (Appendix C.2). Two-degree vertical vowel systems are rare but have been proposed for languages such as Margi, Arrernte, Ubykh, and Abkhaz (Ladefoged & Maddieson 1996: 286).²⁶

26. Beijing Mandarin can also be analyzed as having a three-degree vertical vowel system: /i, ə, a/ (see Duanmu 2007: 35–39 for a review), though such a treatment is considered an over-analysis (Duanmu 2007: 13). Pulleyblank (1977) even suggests a two-vowel system for OC with only /ə, a/, which is criticized as being inconsistent with OC rhyming practice (Baxter 1994). While these vertical vowel treatments may be inappropriate, we believe that the vertical vowel treatment for LMC is reasonable, as the rhyme groups and ranks were explicitly proposed and applied by Chinese phonologists at the time, and correspond to actual rhyming practice of the period. It is worth noting that the two-vowel analysis for LMC was proposed as early as in Lamasse and Jasmin (1934: 28), which is, to our knowledge, the first systematic two-vowel proposal for LMC.

5.4 Division II from LMC to Mandarin

5.4.1 Palatalization of *kāikǒu* 開口 (unrounded) dorsals and laryngeals

Throughout the Song dynasty, the front Division-II vowel [a] triggered the palatalization of *kāikǒu* dorsals and laryngeals (§2.3.2), e.g., [ka] > [kja] or [ca]. Adopting the underlying representations from §5.3, this process can be reinterpreted as palatalization induced by /ʕ/ due to its fronting effect, e.g., /kʕa/ > /kja/, as seen phonetically in Lak (§3.2). Specifically, the palato-pharyngeal /ʕ/ requires bunching the anterior tongue body toward the palate (§3.2), which could have induced the palatalization of dorsal initials.

However, the palatalization of laryngeal initials, at least of the initial 影 *Yǐng* (?-) itself, remains difficult to explain, since laryngeals do not necessarily involve dorsal articulation. Karlgren (1922) pointed out this difficulty, but ultimately conceded that “this apprehension has to give way for the very serious advantages in other respects of Maspero’s theory [the theory of palatalization triggered by front vowels]”. While this difficulty requires further investigation, it appears to have minimal impact on the validity of our theory, as Karlgren conceded.

For *hékǒu* 合口 (rounded) syllables, the presence of the *hékǒu* medial -w- naturally blocked palatalization, since its rounding quality could neutralize the fronting effect of Division II.

For the 梗 *Gěng* rhyme group, whose vowel had been raised to [ɛ] in LMC (§5.3), palato-pharyngealization exerted its slight backing effect on [ɛ] (§3.2) instead of fronting. Therefore, in the LMC Division-II 梗 *Gěng* rhyme [ʕɛŋ], the vowel can be phonetically backer than a plain [ɛ], and may thus fail to trigger the palatalization of dorsals and laryngeals. This accounts for the minimal 梗 *Gěng* group Division-II palatalization in Central Plains Mandarin, and may also account for the absence of 梗 *Gěng* group Division-II palatalization in Sino-Vietnamese, Old Sino-Zhuang, and Pinghua (§2.4). The unique fronting-backing duality of palato-pharyngealization provides a clear and phonetically grounded explanation for the weaker Division-II palatalization tendency of the 梗 *Gěng* rhyme group, while other proposals cannot naturally account for this phenomenon.

5.4.2 The end of pharyngealization

Another development during the Song dynasty was the change of lower Division-I finals to Division-II in specific environments with coronal (acute) initials, reflected in the 11th-century innovative rhyme table *Shengyin Changhe Tu* 聲音唱和圖 (Pulleyblank 1984: 84) and in most modern dialects (Wang 1999; Zheng 2011) (Table 10). Phonetically, these Division-I finals underwent vowel fronting under the influence of coronality (acuteness) (Flemming 2003; Zheng 2011), e.g.

丹 (*dān* ‘cinnabar’) QYS *tan* [tan] > mid-Song [tan], and merged with former Division-II finals, e.g., [an], whose vowel frontness had been conditioned by the medial /ʃ/. This sound change blurred the boundary between Divisions I and II, signaling the disintegration of Division II as a distinct natural class.

Table 10. Examples of the rephonologization of Division-I finals

	Div.	QYS	SCT	GZ	NC	SZ	MZ	BJ	Gloss
肝	I	<i>kan</i>	I kan	kɔn ¹	kɔn ¹	kø ¹	𪛗𪛗 <i>kan</i>	<i>gān</i>	‘liver’
丹	I	<i>tan</i>	II tan	tan ¹	tan ¹	te ¹	𪛗𪛗 <i>tan</i>	<i>dān</i>	‘cinnabar’
山	II	<i>srean</i>	II ʃan	san ¹	san ¹	se ¹	𪛗𪛗 <i>ʃan</i>	<i>shān</i>	‘mountain’
間	II	<i>keanH</i>	II kan	kan ³	kan ⁴	ke ⁴	𪛗𪛗𪛗 <i>kjan</i>	<i>jiàn</i>	‘gap’
割	I	<i>kat</i>	I kaʔ	kɔt ⁸	kɔt ⁶	kʏʔ ⁶	𪛗𪛗 <i>kɔ</i>	<i>gē</i>	‘cut (v.)’
擦	I	<i>tshat</i>	II ts ^h aʔ	ts ^h at ⁸	ts ^h at ⁶	ts ^h aʔ ⁶	𪛗 <i>ts^ha</i>	<i>cā</i>	‘wipe’
殺	II	<i>sreat</i>	II ʃaʔ	saʔ ⁸	saʔ ⁶	saʔ ⁶	𪛗 <i>ʃa</i>	<i>shā</i>	‘kill’
瞎	II	<i>xaet</i>	II xaʔ	haʔ ⁸	haʔ ⁶	haʔ ⁶	𪛗𪛗𪛗 <i>xja</i>	<i>xiā</i>	‘blind’

Div. = Division; *SCT* = *Shengyin Changhe Tu* 聲音唱和圖 Rank with modified Shen’s (2020) reconstruction; *GZ* = Guangzhou 廣州 Yue; *NC* = Nanchang 南昌 Gan; *SZ* = Suzhou 蘇州 Wu (literary readings omitted); *MZ* = *Menggu Ziyun* 蒙古字韻 with Coblin’s (2007) reconstruction; *BJ* = Beijing Mandarin. Dialect data are from *Hanyu fangyin zihui* (2003). The character 擦 *cā* does not appear in the *SCT*, but can be inferred to belong to *SCT* Rank II based on comparisons. Reflexes of both 丹 *dān* and 擦 *cā* in modern dialects parallel those of Division-II words, including the reflex of 擦 *cā* in Mandarin. ⟨ɛ⟩ = [ɛ].

The 13th-century Mandarin rhyme book *Menggu Ziyun* marks the eventual loss of the distinctiveness of Division II (Shen 2020: 250) and the complete disappearance of the medial /ʃ/. This loss occurred in both Mandarin and other dialects: the original phonetic distinctions between Division-I and Division-II finals were either neutralized (e.g., [an]–[an] merged) or transphonologized into pure vowel contrasts (e.g., [an, an] > /an, ɔn/) (Table 10). The specific pathway of the loss, whether neutralization or transphonologization, varied across rhyme groups and dialects; in all cases, Division II disappeared, thus ending the four-Division system of MC.²⁷

27. To our knowledge, no modern dialect phonologically retains the natural class of Division II, nor does any phonetically preserve its pharyngeal quality except after retroflex initials. Thus, the pharyngealization theory appears to find little phonetic support in modern dialects. However, since the decline of Division II began nearly a thousand years ago and was likely complete by the 13th century, this absence of modern evidence is unsurprising and does not undermine our theory.

6. Concluding remarks

By reexamining various properties of Division II, we propose the pharyngealization theory of reconstructing (palato-)pharyngealized vowels for Division II in the QYS and a pharyngeal medial for Division II in pre-QYS EMC as well as in LMC. This theory surpasses other proposals in several respects. Its core advantage lies in the unique combination of vowel-lowering, *a*-fronting, and *e*-backing effects of palato-pharyngealization, rooted in the distinctive double-bunching tongue shape, while no other candidate possesses all three effects simultaneously (Table 7).

The pharyngealization theory not only clarifies the phonetic quality of Division II but also optimizes the reconstructed phonological system. Introducing vowel pharyngealization into the QYS yields a more organized vowel system, consisting of eight plain vowels [i, ɪ, u; e, ə, o; a, ɑ] and three pharyngealized vowels [eʕ, oʕ; aʕ]. The adoption of the Division-II medial /ʕ/ for LMC simplifies its underlying vowel system to just two vowels, /i/ and /a/. The overall development of Division II from OC to MC can be summarized as: OC *C_rV > pre-QYS EMC *CʕV > QYS [CVʕ] > LMC /Cʕa/.

In closing, we would suggest that the contribution of the pharyngealization theory to Chinese historical phonology may be likened to that of the laryngeal theory in Proto-Indo-European (PIE) phonology. Both theories propose ancient guttural segments that have been lost in all modern descendants, yet the introduction of these segments is essential for adequately explaining the historical phonologies. The PIE laryngeal *h₂ is now typically considered a voiceless pharyngeal fricative [ħ] or a voiceless uvular fricative [χ] (Kümmel 2007:327–336) due to its *a*-coloring effect that lowers adjacent *e to *a. Similarly, MC Division II lowered *ea* to *ae*, and our pharyngeal interpretation parallels PIE *h₂. Just as the laryngeal theory has become foundational in PIE phonology, we believe that the pharyngealization theory will similarly enrich the foundations of Chinese historical phonology.

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Appendix A. Summary of *Qieyun* Divisions and rhyme table Ranks²⁸

A.1 Two approaches to reconstructing the Divisions

	RTR approach	ATR approach
Type A	With [+RTR] initial (<i>marked</i>)	Without ATR medial
Type B	With [–RTR] initial	With ATR medial (<i>marked</i>)

The reconstruction depends on the treatment of the distinction between Types A (with RTR quality in a broad sense) and B (with ATR quality in a broad sense) in EMC. Here, we present two possible approaches. The RTR approach, based on proposal (f) in §1.1, attributes RTR as the dominant (active/marked) feature, [+RTR], and ATR as the recessive (inert/unmarked) feature, [–RTR]. The ATR approach, combining proposals (b) and (c) in §1.1, conversely attributes ATR as the dominant feature by marking Type B with specific medials (Appendix A.2).

ATR and RTR are antagonistic, i.e., [+ATR] = [–RTR] and [–ATR] = [+RTR] (Beltzung et al. 2015). Therefore, the two approaches are logically equivalent by swapping dominant and recessive features (markedness reversal). The choice of the dominant pole depends on phonological evidence and transcription conventions, and it is also possible to adopt markers from both approaches simultaneously; a detailed discussion of this choice lies beyond the scope of this paper and will be left to a future publication. For consistency with conventions familiar to most readers, the ATR approach is adopted in the main text. Similarly, the distinction between Ranks I–II (broadly RTR) and Ranks III–IV (broadly ATR) in LMC can be treated using either approach (Appendix A.3). Diachronically, the system appears to have shifted gradually from RTR-dominant to ATR-dominant from OC to LMC.

²⁸. Appendix A reflects the contributions and opinions of the first author alone.

A.2 Description and reconstruction of Qieyun Divisions

Div.	Subdivision and conventional alias	Initial	Onset (RTR approach)	Onset (ATR approach)	Nucleus
I	/	Any	Ç(w)-	C(w)-	Plain, non-front
II	/	Any	Ç(w)-	C(w)-	Pharyngealized
IV	/	Any	Ç(w)-	C(w)-	Plain, front
III	/	Coronal	C(w)-	Cj(w)-/Cɹ(w)-	Plain
III	A = “ <i>chóngniǔ</i> IV”	Non-coronal	Cj(w)-	Cj(w)-	Plain, front
III	B = “ <i>chóngniǔ</i> III”	Non-coronal	Cɹ(w)-	Cɹ(w)-	Plain, front
III	C = “ordinary III”	Non-coronal	C(w)-	Cɣ(w)-	Plain, non-front

The Subdivision is called 類 *lèi* ‘type’ in Chinese-language literature, but we use the translation ‘Subdivision’ to avoid confusion with the terms Type A and Type B. Minimal pairs between Subdivisions A and B that differ only in the medial are known as *chóngniǔ* 重紐 ‘repeated syllables’ (Baxter 1992: 75–81; Baxter & Sagart 2014: 19; Hill 2019: 100–102; Shen 2020: 141–143). Division IIIA becomes Rank IV in the rhyme tables (Appendix A.4), so it is conventionally called “*chóngniǔ* IV”. There are no Subdivision distinctions when the initial is a coronal. The initial 以 *Yǐ* (y-) [j] can be classified as a coronal, or alternatively analyzed as a Division-IIIA zero initial. For more details on Subdivisions, see Chou (1970) and Huang (2012).

The rhoticity/cororality of the Division-IIIB medial [ɹ] is reflected in Sanskrit-Chinese transcriptions (Shi 1983; Mai 1992). It may have a bunched realization but without a secondary RTR gesture (§5.2). Under the RTR approach, Division IIIC is fully distinguishable from Division I by the [±RTR] value of the initial, so the Division-IIIC medial can be considered phonologically empty, if it phonetically exists at all. The same applies to Division-III medials following coronal initials. Under the ATR approach, by contrast, Division-III medials must be explicitly written as the markers of Type B. The high semivowels [j] and [ɣ] are inherently ATR (Beltzung et al. 2015), and [ɹ] here has an ATR realization as mentioned above. The Division-III medial following a coronal initial can be specified as either [j] or [ɹ], depending on the place of articulation of the initial and the accent of the rhyme book compiler (for details, see Mai 1992). A suitable solution based on the *Qieyun* is to assign [ɹ] after retroflex sibilants (the 莊 *Zhuāng* group, *Tsr-*) and [j] after other coronal initials. Finally, the medial [w] occurs only in *hékǒu* 合口 (rounded) syllables and it indicates labial rounding only, without specifying a dorsal height.

A.3 Description and reconstruction of rhyme table Ranks

Rank	Onset (RTR approach)	Onset (ATR approach)
I	Ç(w)-	C(w)-
II	Çʕ(w)-	Cʕ(w)-
III	C(w)-	Cɣ(w)-
IV	Cj(w)-	Cj(w)-

Under the RTR approach, similar to the treatment of the Division-IIIC medial, the Rank-III medial is also considered phonologically empty. Other descriptions are similar to those in Appendix A.2.

A.4 Evolution from Qieyun Divisions to rhyme table Ranks

Div.	Initial	Rank
I	Any	> I
II	Any	> II
IV	Any	> IV
III	莊 <i>Zhuāng</i> group (<i>Tsr-</i>)	> II
III	章 <i>Zhāng</i> group (<i>Tsy-</i>), 知 <i>Zhī</i> group (<i>Tr-</i>), and 來 <i>Lái</i> (<i>l-</i>)	> III
III	精 <i>Jīng</i> group (<i>Ts-</i>) and 以 <i>Yǐ</i> (<i>y-</i>)	> IV
IIIA	Non-coronal	> IV
IIIB	Non-coronal	> III
IIIC	Non-coronal	> III

Appendix B. Revised reconstruction of the QYS²⁹

B.1 Reconstruction of initials under both approaches

Labial		Alveolar		Retroflex	Palatal	Velar/uvular		Glottal	
-RTR	+RTR	-RTR	+RTR	/	-RTR	-RTR	+RTR	-RTR	+RTR
幫 <i>p</i>	<i>p</i>	端	<i>t</i>	知 <i>t</i>		見 <i>k</i>	<i>q</i>	影 <i>ʔ</i>	<i>ʔ</i>
<i>pj-</i>	<i>p-</i>		<i>t-</i>	<i>tr-</i>		<i>kj-</i>	<i>k-</i>	<i>ʔj-</i>	<i>ʔ-</i>
滂 <i>p^h</i>	<i>p^h</i>	透	<i>t^h</i>	徹 <i>t^h</i>		溪 <i>k^h</i>	<i>q^h</i>		
<i>phj-</i>	<i>ph-</i>		<i>th-</i>	<i>trh-</i>		<i>khj-</i>	<i>kh-</i>		
並 <i>b</i>	<i>b</i>	定	<i>d</i>	澄 <i>d</i>		羣 <i>g</i>			
<i>bj-</i>	<i>b-</i>		<i>d-</i>	<i>dr-</i>		<i>gj-</i>			
明 <i>m</i>	<i>m</i>	泥	<i>n</i>	孃 <i>ŋ</i>	日 <i>ɲ</i>	疑 <i>ŋ</i>	<i>ɳ</i>		
<i>mj-</i>	<i>m-</i>		<i>n-</i>	<i>nr-</i>	<i>ny-</i>	<i>ngj-</i>	<i>ng-</i>		
		精 <i>ts</i>	<i>tʂ</i>	莊 <i>tʂ</i>	章 <i>tɕ</i>				
		<i>tsj-</i>	<i>ts-</i>	<i>tsr-</i>	<i>tsy-</i>				
		清 <i>ts^h</i>	<i>tʂ^h</i>	初 <i>tʂ^h</i>	昌 <i>tɕ^h</i>				
		<i>tshj-</i>	<i>tsh-</i>	<i>tsrh-</i>	<i>tsyh-</i>				
		從 <i>dz</i>	<i>dʒ</i>	崇 <i>dʒ</i>	常 <i>dz</i>				
		<i>dzj-</i>	<i>dz-</i>	<i>dʒr-</i>	<i>dzy-</i>				
		心 <i>s</i>	<i>ʃ</i>	生 <i>ʃ</i>	書 <i>ɕ</i>	曉 <i>x</i>	<i>χ</i>		
		<i>sj-</i>	<i>s-</i>	<i>sr-</i>	<i>sy-</i>	<i>xj-</i>	<i>x-</i>		
		邪 <i>z</i>		俟 <i>ʒ</i>	船 <i>ʒ</i>	匣	<i>ɣ</i>		
		<i>zj-</i>		<i>zr-</i>	<i>zy</i>		<i>h-</i>		
		來 <i>l</i>	<i>ɭ</i>		以 <i>j</i>	云 <i>Ø, w</i>			
		<i>lj-</i>	<i>l-</i>		<i>y-</i>	<i>hj-</i>			

29. We provide two web applications to allow readers to conveniently look up the QYS pronunciations of characters according to the reconstruction in Appendix B: <https://nk2028.shn.hk/tshet-uinh-deriver/?schema=unt> and <https://semakosa.github.io/middle-chinese/>.

The initials listed are under the RTR approach, with [−RTR] and [+RTR] consonants treated as distinct phonemes. Their common Chinese names and corresponding spellings in Baxter’s transcription are also given. The uvulars [q, q^h, ɳ, χ, ʁ] represent the [+RTR] counterparts of the velars [k, k^h, ŋ, x, ɣ]. Under the ATR approach, as [−RTR] and [+RTR] consonants are in complementary distribution, all RTR diacritics [_r] can be omitted, and the uvulars can be transcribed simply as velars. The “retroflex” initials (which may not be true retroflexes; see Footnote 14) show no distinction between Type-A and Type-B syllables according to *fānqiè* patterns (Karlgren 1915–1926: 113–120; Luh 1940) and are treated here as lacking an [RTR] specification. The initial 云 *Yún* (*hj-*) is realized as zero initial in *kāikǒu* 開口 ‘unrounded’ syllables and as [w] in *hékǒu* 合口 ‘rounded’ syllables (Pulleyblank 1984: 164–167; Huang 1995: 30–34).

B.2 Reconstruction of rhymes based on the pharyngealization theory

		iŋ			uŋ	
		蒸 -ing			東 -uwng	
eŋ	eʰŋ	əŋ			oŋ	oʰŋ
青 -eng	耕 -eang	登 -ong			冬鍾 -owng	江 -aewng
aŋ (III) & aʰŋ (II)				aŋ		
庚 -aeng, 清 -eng				陽唐 -ang		
		i			u	
		脂 -ij			尤侯 -uw	
e	eʰ	ə			o	
支 -e	佳 -ea	魚 -o			虞模 -u	
a (III) & aʰ (II)				a		
麻 -ae				歌 -a		
(i)		ij				
(脂 -ij)		微 -ij				
ej	eʰj	əj				
齊祭 -ej	皆 -eaj	灰哈廢 -oj				
		aʰj				
		夬 -aej				
		泰 -aj				
iw				(u)		
幽 -iw				(尤侯 -uw)		
ew		əw				
蕭宵 -ew		豪 -aw				
		aʰw				
		肴 -aew				

in		in	un
真臻 -in		殷 -in	文 -un
en	e ^ɿ n	ən	
先仙 -en	山 -ean	元魂痕 -on	
	a ^ɿ n	an	
	刪 -aen	寒 -an	
im			
侵 -im			
em	e ^ɿ m	əm (III)	əm (I)
鹽添 -em	咸 -eam	嚴 -aem, 凡 -om	覃 -om
	a ^ɿ m	am	
	銜 -aem	談 -am	

These are surface representations of all rhymes (rhyme = nucleus + coda) in the *píng* 平 ‘level’ tone (see Footnote 5), annotated with *Qieyun* rhyme names and Baxter’s transcription. The *shǎng* 上 ‘rising’ tone can be marked with an acute [ˊ] on the vowel and the *qù* 去 ‘departing’ tone with a grave [ˋ], following Pulleyblank’s (1984, 1991) diacritics. The *rù* 入 ‘entering’ tone is indicated by replacing the nasal codas [m, n, ŋ] with corresponding oral codas [p, t, k].

For the 豪 *Háo* (-aw) rhyme, there is no definitive evidence to determine whether it is [əw] or [aw]; [əw] is used here following the first author’s opinion, since in Sino-Japanese *go-on* it has -ou readings besides -au (Li 2014: 148–151). Other modifications to Baxter’s vowels involve 蒸 *Zhēng* (-ing), 之 *Zhī* (-i), 虞模 *Yú-Mú* (-u), 清 *Qīng* (-eng), and 嚴 *Yán* (-aem, Division III). These modifications are based on other reconstruction systems and rhyming practice. The vowel [e] in 支 *Zhī* (-e) was likely realized as [ie] (Karlgren 1915–1926: 645). 覃 *Tán* (-om, Division I) and 嚴凡 *Yán-Fán* (-aem/-om, Division III) did not rhyme (Zhou 1996: 726; Zhang 2008: 135), but their phonetic difference remains unclear; we provisionally write them both as [ə̃m].

Dorsal codas [ŋ, k] following [u, o, o^ɿ, a] were likely realized further back and may therefore be transcribed as uvulars [ɳ, q] (Pulleyblank 1984: 227). Under this analysis, [a] and [a] are in complementary distribution and can both be simply transcribed as [a].

Appendix C. Rhyme groups of LMC

C.1 Underlying representations of the sixteen rhyme groups

止 <i>Zhǐ</i>	ij	遇 <i>Yù</i>	i	流 <i>Liú</i>	iw
蟹 <i>Xiè</i>	aj	果假 <i>Guǒ-Jiǎ</i>	a	效 <i>Xiào</i>	aw
臻 <i>Zhēn</i>	in			深 <i>Shēn</i>	im
山 <i>Shān</i>	an			咸 <i>Xián</i>	am
		曾 <i>Zēng</i>	iŋ	通 <i>Tōng</i>	iwŋ
梗 <i>Gěng</i>	ajŋ	宕 <i>Dàng</i>	aŋ	江 <i>Jiāng</i>	awŋ

Codas are based on Pulleyblank (1984:105–106). The 果 *Guǒ* and 假 *Jiǎ* rhyme groups are in complementary distribution and are best treated as the same underlying representation /a/ in this reconstruction system (Pulleyblank 1984:106). /ajŋ/ is realized as [ɛŋ] (end of §2.2). For simplicity, rhymes in the 入 *rù* ‘entering’ tone (checked syllables) are omitted.

C.2 Rhyme correspondence between the QYS and LMC

QYS rhyme		LMC rhyme group
[ə, o]	> 遇 <i>Yù</i>	/i/
[e ^ɛ ₁ , a, a ^ɛ]	> 假 <i>Jiǎ</i>	/a/
[a]	> 果 <i>Guǒ</i>	/a/
[i, i, ij, e]	> 止 <i>Zhǐ</i>	/ij/
[e ^ɛ ₂ , ej, e ^ɛ j, əj, a ^ɛ j, əj]	> 蟹 <i>Xiè</i>	/aj/
[iw, u]	> 流 <i>Liú</i>	/iw/
[ew, əw, a ^ɛ w]	> 效 <i>Xiào</i>	/aw/
[in, in, un, ən (I)]	> 臻 <i>Zhēn</i>	/in/
[en, e ^ɛ n, ən (III), a ^ɛ n, ən]	> 山 <i>Shān</i>	/an/
[im]	> 深 <i>Shēn</i>	/im/
[em, e ^ɛ m, əm, a ^ɛ m, əm]	> 咸 <i>Xián</i>	/am/
[eŋ, e ^ɛ ŋ, aŋ, a ^ɛ ŋ]	> 梗 <i>Gěng</i>	/ajŋ/
[iŋ, əŋ]	> 曾 <i>Zēng</i>	/iŋ/
[aŋ]	> 宕 <i>Dàng</i>	/aŋ/
[uŋ, oŋ]	> 通 <i>Tōng</i>	/iwŋ/
[o ^ɛ ŋ]	> 江 <i>Jiāng</i>	/awŋ/

Due to dialect mixture, words in the 佳 *Jiā* rhyme [e^ɛ] separated and developed into two rhyme groups: 蟹 *Xiè* /aj/ and 假 *Jiǎ* /a/ (Pulleyblank 1984:195–197; Xu 2020). The 元魂痕 *Yuán–Hún–Hén* rhyme [ən] also split: its Division-III syllables (元 *Yuán*) developed into the 山 *Shān* rhyme group /an/ and its Division-I syllables (魂 *Hún* and 痕 *Hén*) developed into the 臻 *Zhēn* rhyme group /in/.

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