The phonology of Shaoxing Chinese

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3 The Underlying Vowel Inventory of Shaoxing

3.1 Introduction

All languages have an inventory of (possibly abstract) sound categories with which words are represented, referred to as 'phonemes' or 'segments'. These segments will be phonetically manifested differently in different phonetic contexts, due to both universal and language-specific factors (Goldsmith 1995: 2). It has often been observed that the typical Chinese language has a large number of allophones in complementary distribution, which can therefore be derived from a smaller number of phonemes (Yip 1996). This chapter will discuss the underlying vowel inventory in SX and the distribution of these vowels, to account for the nature of the basic units of speech sounds and the relationships between these units and their contextual variants. After presenting an analysis of the distribution of the 14 surface vowels of SX, I argue that the underlying vowel inventory of SX includes only six phonemic vowels: /i u e ɤ o a/, and thus constitutes a preferred vowel inventory among the world's languages that have a six-vowel system.

3.2 The Arrangement of Surface Vowels

Crothers (1978) presents a study of vowel inventories in the world's languages and formalizes general patterns in vowel systems, such as the following (de Boer 2001: 90):

a. The number of height distinctions in a system is typically equal to or greater than the number of backness distinctions.
b. Languages with two or more central[1] vowels always have a high vowel.
c. The number of vowels in a column of central vowels cannot exceed the number of vowels in the front or back column.
d. The number of height distinctions in front vowels is equal to or greater than the number in back vowels.

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[1] In de Boer (2001), the original word is 'interior', which is replaced by 'central' to fit in with the common description in general linguistics.

Maddieson (1984a) presents a systematic, statistical investigation of the 317 languages in UPSID and makes some interesting generalizations, e.g. that front vowels are usually unrounded (94.0%), and back vowels usually rounded (93.5%). This coincides with Jones' (1968) primary and secondary cardinal vowels; high front vowels are more frequent than high back vowels. According to Maddieson's (1984a) segmental analysis (based on 317 languages in UPSID), in a generally symmetric vowel system, there are obvious asymmetries, such as the one that vowels in the mid range are more common than high vowels; low vowels are substantially less common, amounting to only 20.5%; central vowels are considerably less common, amounting only to 22.2%; unrounded vowels are considerably more frequent than rounded vowels, namely 61.5% vs. 38.5%.

As was discussed in the previous chapter, there are 14 surface vowels in SX, including [ʅ i ɪ y e ɛ ɵ ə ɤ u o a ɑ ɒ], which, according to the major three vowel parameters of position, height, and rounding (Ladefoged & Maddieson 1996: ch. 9), can be classified as follows:

(1)	Front		Central		Back		Total
	−round	+round	−round	+round	−round	+round	
High	[i], [ɪ] [ʅ]	[y]				[u]	5
Mid	[e] [ɛ]		[ə]	[ɵ]	[ɤ]	[o]	6
Low	[a]				[ɑ]	[ɒ]	3
Total	6	1	1	1	2	3	14
	7		2		5		

The table in (1) presents the 14 surface vowels in SX, and shows that there are five high vowels, the same number as that of all back vowels; among the five high vowels, four are front while only one is back; there are two central vowels, i.e. fewer than front or back vowels; the number of high vowels is about 1.7 times more than that of low vowels; one out of seven of the front vowels is rounded and two out of five of the back vowels are unrounded. Although the arrangement of the 14 surface vowels of SX in table (1) gives a rather asymmetrical picture, it still follows the general pattern of vowel systems of the world's languages as observed by Crothers (1978) and Maddieson (1984a), as mentioned above. However, these 14 vowels in (1) all belong to the surface representation of SX. Vallée (1994, cited from de Boer 2001),[2] who investigated the UPSID, found that the maximum number of different vowel qualities used in any language in the sample is 15. SX seems to have almost the maximum number of vowels in a vowel system, though there is still a lot of room in both the articulatory and the acoustic space. In the next section, we examine the vowel system from a phonological perspective.

3.3 The Vowel Phonemes of Shaoxing

De Boer (2001) agreed, on the basis of his vowel simulation with standard parameter settings and through optimisation, that the most common vowel system (88% of the 49 vowel systems he analysed) is a symmetrical five-vowel system with /i u e o a/. The result of his vowel simulation is consistent with Maddieson's (1984a) statistics of the 317 languages in UPSID, from which he also concluded that the most common number of vowel phonemes in a language is five, and the most common number of distinctive vowel qualities in a language is also five, viz. /i u e o a/. In this chapter, I present my analysis of the vowel distribution in SX and I claim that out of the 14 surface vowels only six are underlying, phonemic vowels, viz. /i u e ɤ o a/, which is very similar to the widely attested and most common vowel system of the world's languages.

There are three principles which have to be taken into consideration when determining the underlying segment inventory of a language: (a) which allophone has the widest distribution; (b) which allophone most appropriately represents the phonetic range of variation of all allophones; (c) which allophone is the one from which other allophones can be most simply and naturally derived (Maddieson 1984a: 163). In this section I will present an analysis of the distribution and the phonological behaviour of these 14 surface vowels, aided by an extensive OT analysis, so as to identify which vowels are the underlying phonemes and explain how the 14 surface vowels can be reduced to only six phonemic vowels underlyingly. Yip (1996: 757) points out that 'to derive rich surface inventories from more parsimonious underlying inventories, it was necessary to postulate abstract underlying forms'. It is common cross-linguistically that the underlying representations (UR) can be very

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[2] There are languages that have more vowel phonemes, but these will use other processes, such as length, nasalization, and pharyngealization, not quality, in order to distinguish vowels.

abstract from the surface representations (SR). To establish certain relations between the abstract UR and the rich SR, rule-based theories are always inefficient, because the rule: A → B /__C does not tell why A will not become D, E or F when they exist in SR, which frequently requires more separate rules. In this case, a constraint-based approach is more economical, in which any abstract form can be the input and a set of outputs is generated for each input, and inspected by the ranked constraint set (see Yip 1996). However, the rule is also included in this chapter to describe the change that takes place. Sometimes, I use both the rule to describe how A becomes B and OT to explain why A becomes B not D, E or F.

This section presents an OT analysis of the relations between the abstract UR of the six vowels and the rich SR of the 14 allophones in SX. According to the three criteria mentioned above, i.e. their phonetic and phonological behaviour, and their distribution, the 14 surface vowels will be divided into four classes in the analysis: high front vowels, high back vowel, mid vowels, and low vowels.

3.3.1 High front vowels

Table (1) shows that in SX, there are four high front vowels in surface representation. They are [i], [y], [ɪ], and [ɿ], among which [ɿ] is an apical vowel, as was discussed in chapter 2. All these high front vowels can occur in the rhyme, either by itself of in a combination. Consider the following examples:

(2)	a.	[sɿ^{33}]	‘try’	[dzɿ^{31}]	‘late’
	d.	[tɕ^{h}i^{33}]	‘go’	[pi^{35}]	‘compare’
	c.	[ɦy^{13}]	‘rain’	[ʑy^{22}]	‘tree’
	b.	[mɪŋ^{22}]	‘life’	[zɪʔ^{3}]	‘enter’

The examples in (2) show that of the four high front vowels, three occur in open syllables and one in closed syllables in SX. It is remarkable that there are four high front vowels in one language. English has only two front high vowels: [i] and [ɪ] (Heffner 1949). However, these four high front vowels are in complementary distribution. I will argue that only /i/ is an underlying vowel in SX, and I will explain how the other three allophones are derived.

3.3.1.1 Distribution of high front vowels

First of all, front vowels are usually unrounded in most languages (Ladefoged & Maddieson 1990), so that rounded front vowels are always less frequent and less common in distribution in any language. The examples in (2) may suggest how the four high front vowels in SX are distributed. For example, [i] and [ɿ] cannot occur after the same consonant and neither can be followed by a consonant. In fact, the phonetic and phonological behaviour of [i] and [ɿ] and their distribution were discussed in chapter 2, where I postulated a phonological rule (see (65), ch.2) as in (3):

(3) $$/\text{i}/ \;\rightarrow\; [\text{ɿ}] \;/\; \begin{bmatrix}+\text{cons}\\ +\text{apical}\end{bmatrix} \_\_$$

The rule in (3) shows that /i/ is realized as [ɿ] when preceded by a [+apical] consonant in SX, indicating that [ɿ] is an allophone of /i/. This is also supported by the examples in (2). The consonants in (2a) are [s] and [dz], which are both dental sibilants, specified as [+apical], as discussed in chapter 2. [apical] is not an underlying feature, but a phonetic feature in SX. Usually, coronal sibilants (which include fricatives and affricates) can be classified into apical and laminal (see Ladefoged & Maddieson 1996: 164), as shown in (4):

(4) Types of sibilants:

a.	dental:	apical	e.g. [tsɿ], [ts^{h}ɿ], [dzɿ], [sɿ], [zɿ]
b.	post-alveolar:	laminal	e.g. [tʃi], [dʒi], [ʃi], [ʒi]
c.	alveolo-palatal:	laminal	e.g. [tɕi], [tɕ^{h}i], [dʑi], [ɕi], [ʑi]
d.	retroflex:	apical	e.g. [tʂʅ], [tʂ^{h}ʅ], [ʂʅ]

Types of sibilants (4) show that dental and retroflex sibilants are apical (see also Bright 1978) and apical sibilants precede apical vowels which complementarily distribute with non-apical high front vowel /i/. As was discussed in chapter 2, apical vowels are produced with the tongue in essentially the same position as in the corresponding sibilants. Thus, apical vowels must be different from the different articulators of the preceding apical sibilants, as shown in (4a) and (4d). SX has only dental apical fricatives and affricates, so that it has only one apical vowel [ɿ]. Mandarin has both dental and retroflex apical fricatives and affricates, so it also has the apical vowel [ʅ]. [s] and [z] in English are laminal alveolar (see Ladefoged & Maddieson 1996: 164), so that they allow such syllables as [si] and [zi].

Because apical sibilants are usually specified as [+strident], the following apical vowels also sound strident acoustically, which is realized by spreading a manner feature of the preceding consonant to the following vowel. Ladefoged & Maddieson (1996) refer to an apical vowel as strident. Strident vowels have a constriction between the part of the tongue below the epiglottis and the tips of the arytenoid cartilages in the upper part of the larynx. This constriction results in these vowels having a specific phonation type. Traill (1985) suggests that the strident vowels may be regarded phonologically as pharyngealized breathy voiced vowels. However, such a phonation type has a certain commonality cross-linguistically, e.g. in the Caucasian languages and the Khoisan languages (Traill 1985). The phonation type of strident vowels in SX resembles vowel devoicing in many languages. For example, in French, [i] is devoiced after a voiceless obstruent in the onset; in Japanese there is a contrast between the voiceless allophones of /i/ and /u/ between voiceless obstruents, as in [ki̥ʃi] 'shore' and [ku̥ʃi] 'comb'. In short, the apical vowel [ɿ], which has a strident phonation type, is an allophone of /i/ when preceded by an apical sibilant in SX, as shown in (3).

The examples in (2) also show that [ɪ] occurs in the rhyme of a syllable only when in combination with [ɪŋ] or [ɪʔ], whereas [i] cannot occur in either combination. Therefore, [ɪ] is also in complementary distribution with [i] and is likely to be an allophone of /i/. As was discussed in chapter 2, Yang and Yang (2000) assume that SX has no nucleus vowel [ɪ] in surface representation and that [ɪŋ] and [ɪʔ] do not occur either, but [iəŋ] and [iəʔ] occur instead, which are regarded as the finals Middle Chinese had (see Chao 1928). As a matter of fact, Modern SX did go through considerable phonological changes, especially in its rhymes, having lost many coda consonants such as [m], [p], [t] and [k], and having more simple rhymes instead of complex rhymes (Chao 1928). Systematically speaking, since modern SX has such final combinations as [ia], [ie], [io], [iɤ], [aŋ], [uŋ], [əŋ], and [ɒŋ], it is also likely to have /iŋ/ in its underlying system of syllable structure, or any of its allophones in such a combination. Thus, there is stronger motivation to allow for [ɪŋ] and [ɪʔ] rather than [iəŋ] or [iəʔ] in the surface SX final combinations. What is more important is that we do hear such rhymes as [ɪŋ] and [ɪʔ] in modern SX, as shown in (2). In conclusion, I claim that there is a surface high front vowel [ɪ] which only occurs in combinations of [ɪŋ] and [ɪʔ] in SX and is also an allophone of phonemic /i/. Its distribution can be formulated in the following rule:

(5) /i/ → [ɪ] / __ C

As was mentioned in chapter 2, vowel length is underspecified in SX, unlike Thai or Japanese (Rosner 1994). Instead, vowels in SX can be phonologically specified with [tense] as follows:

(6)	i	y	ɪ	ʅ	u	e	ɛ	ə	ɵ	ɤ	o	a	ɑ	ɒ
[tense]	+	+	−	+	+	+	−	−	−	+	+	+	−	−

Articulatorily speaking, [+tense] vowels are usually longer than [−tense] vowels. All the [+tense] vowels shown in (6) are bimoraic and can occur in stressed open syllables, which is required by the tonal system of SX. The well-formed syllable [ɪʔ] also satisfies the tonal system of SX, in which syllables ending with the glottal stop [ʔ] have *entering* (high level) tones, [5] or [3], differing in register, which are phonetically short but phonologically still bimoraic if stressed, since the syllable-final [ʔ] is also moraic in SX.[3] As a result, [ɪ] is licensed when followed by a consonant like other [−tense] vowels such as [ɛ] and [ə] in [ɛʔ] and [əʔ], respectively, which suggests that [−tense] vowels have to be followed by a consonant.

The examples in (2) show that [y] can also occur alone as the rhyme and can contrast with six phonemic vowels in certain environments, as shown in (7):

(7) a.[ɦi^{31}] 'move'
b.[ɦu^{31}] 'lake'
c.[ɦe^{22}] 'harm'
d.[ɦɤ^{31}] 'attend'
e.[ɦo^{31}] 'river'
f.[ɦa^{31}] 'shoe'
g.[ɦy^{31}] 'surplus'

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[3] The weight status of the syllable-final stop differs from Chinese dialect to dialect. In Cantonese, the syllable-final stop is weightless when it follows a long vowel, e.g. [taːp] 'pile' (see Yip 1996, 2002).

The examples in (7) give rise to the question whether [y] should be regarded as a phonemic vowel, just like the other six vowels, since the seven syllables above are minimal pairs in surface representation. This is a difficult topic. As the tables of the Finals by Chao and Campbell (see (38) and (39) in chapter 2) show that [y] cannot occur alone as a Final but occurs in combinations such as [yɥ] in both tables. Accordingly, the syllable in (7g) should be [ɦyɥ^{31}], which, I argue, is unacceptable in the SX surface representation because both [y] and [ɥ] are [+high, +front, +round] so that [yɥ] badly violates the OCP. I assume that [y] is only a surface vowel and its underlying form could be either /wi/ or /ju/ since we have two glides [j] and [w] in GV combinations in SX such as [wa], [we], [wo], [ja], [je], [jɤ] and [jo], which were discussed in chapter 2. As was also discussed in chapter 2, SX has GV combinations but not VG. In most of the world's languages, usually GV is a rising diphthong and VG is a falling diphthong, which means SX has rising combinations but no falling combinations. If there is any underlying diphthong in SX, it is most likely to be /iu/ rather than /ui/, because the former is a rising combination but the latter is a falling combination, according to the sonority scale (Durand 1990). However, as a GV combination, there may be /ju/ and /wi/ underlyingly in SX. I assume that [y] is the result of segment merger of /ju/ or /wi/ in surface representation in SX.

3.3.1.2 Segment merger

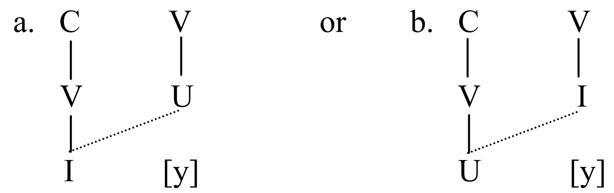
Merger is a phonological change in which a previously existing contrast between two or more phonemes is lost. There are two types of merger: a merger applying only in restricted contexts, thus introducing a neutralization, is a conditioned merger, and one which applies in all contexts, thus reducing the number of phonemes in the language, is an unconditioned merger (Trask 1996).

There is strong phonological motivation why underlying /ju/ or /wi/ should merge into [y] in surface representation in SX. First, as was discussed in chapter 2, OCP(H) (see (83), ch.2) rules out *[+high][+high] combinations in the SX surface representation, so that either [ju] or [wi] is not acceptable while [je], [jo], [ja], [jɤ], [wo], [wa], [we], [wɛ̃], and [wə̃] are well-formed in SX. Secondly, /j/ and /w/ are both specified for [−cons] and excluded from the onset position in SX (syllable structure in SX will be discussed in chapter 4), and each segment of the GV combination (/ju/ or /wi/) mainly differs in backness and roundedness. During the process of merger, /j/ or /i/ becomes [y] when rounded; or /w/ or /u/ becomes [y] when fronted, which is a result of merging the features of [−back] and [+round], formulated in such a rule as follows:

(8) $$\left.\begin{array}{l}\text{/j/ or / i/}\\ \text{/w/ or /u/}\end{array}\right\} \rightarrow [\text{y}] \left\{\begin{array}{l}\text{/ [}\underline{\text{+round}}\text{]}^{4}\\ \text{/ [}\underline{-\text{back}}\text{]}\end{array}\right.$$

The rule in (8) can also be expressed by element structure (as in Dependency Phonology, cf. ch.1), as shown in (9):

(9)



The element structure in (9) shows how the two elements of either /j/ and /u/ or /w/ and /i/ merge into [y]. This can be formulated in a simple rule, as shown in (10):

(10) $$\left.\begin{array}{l}\text{/ju/}\\ \text{/wi/}\end{array}\right\} \rightarrow \quad [\text{y}] \quad / \quad [\ ]$$

The rule in (10) says that underlying /ju/ or /wi/ merges into [y] in surface representation to avoid the violation of the OCP(H) in GV combination. More examples are given in (11):

(11)

[tɕ^{h}y^{35}]	'fetch'
[dʑy^{22}]	'live'
[pɪʔ^{5}ɕy^{33}]	'must'
[ɦy^{22}mɪŋ^{31}]	'fisher'
[ʔy^{52}ɕjoʔ^{5}]	'blood stasis'

In short, [y] is not an underlying vowel, but a merged vowel in surface representation, resulting from the neutralization of a combination, /ju/ or /wi/ in SX.

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4 The underlines in (8) mean where the underlying vowels or glides are.

3.3.1.3 Phonemic /i/

On the basis of the analysis presented above, I claim that of the four high front vowels in SX, only /i/ is a phonemic vowel. Both [ɿ] and [ɪ] are allophones of /i/, which can be formulated as follows:

(12)

$$/\text{i}/ \rightarrow \begin{cases} [\text{ɿ}] \ / \ [+\text{cons}, +\text{apical}] \ \_\_ & \text{(a)} \\ [\text{ɪ}] \ / \ \_\_ \ \text{C} & \text{(b)} \\ [\text{i}] \ / \ \text{elsewhere} & \text{(c)} \end{cases}$$

The rule in (12) shows that the three high front vowels are in complementary distribution in (a), (b) and (c) and that only /i/ is a phonemic vowel. The distribution in (12a) was discussed in chapter 2 and above in this subsection. We agreed that [ɿ] is an apical vowel with an articulation of the tongue in essentially the same position as in the corresponding apical sibilants. This strongly suggests a constraint that when the onset consonant is an apical sibilant, the following high front vowel will have the same value of [+apical], as stated below in (13):

(13) AGREECV[apical]
An apical consonant must agree with the following high front vowel in value for the status of apical.

AGREECV[apical] in (13) stipulates that [ɿ] in SX only occurs after apical dental consonants which include [ts ts^h dz s z] according to the types of sibilants proposed by Ladefoged & Maddieson (1996) (see also Williamson 1977; Bright 1978). The constraint AGREECV[apical] rules out such syllables as *[tsi], *[ts^hi], *[dzi], *[si] and *[zi] in SX.

The rule in (12b) shows that /i/ becomes [−tense] when followed by a consonant, which suggests a simple constraint: *[i]C.

3.3.2 The high back vowel

It is believed that all languages have /i u a/ (Maddieson 1984a; Ladefoged & Maddieson 1990, 1996). Naturally, SX also has these vowels. Compared with the four surface high front vowels in SX as shown in table (1), there is only one high back vowel [u], even in surface representation. The proportion of 4:1 between high front and high back is quite a striking asymmetry, which is very rare in the languages covered in Maddieson (1984a). In this subsection, I will discuss the distribution of /u/ and its possible allophone(s) and the phonological motivation for postulating a single high back vowel.

Unlike the high front phonemic vowel /i/ which has two allophones in complementary distribution, /u/ does not have any allophone in open syllables, so it has a wider distribution, as shown in the examples in (14):

(14) a. [pu^{35}] 'compensate'
b. [tu^{35}] 'block'
c. [su^{35}] 'count'
d. [ku^{35}] 'old'
e. [hu^{35}] 'fire'
f. *[ɕu]

The examples in (14) show that [u] can occur after many different initial consonants as a nucleus vowel, but not after alveolo-palatal consonants, including [tɕ], [tɕ^{h}], [dʑ], [ɕ], [ʑ], and [ȵ]. This suggests such a constraint in SX that [u] cannot occur after alveolo-palatal consonants, as stated in (15):

(15) *ALV-PAL[u]
[u] cannot occur after alveolo-palatal consonants.

In fact, not only is [u] disallowed after alveolo-palatal consonants, but no vowels except [i], [ɪ] and the glide [j] can occur after alveolo-palatal consonants. These consonants share the same specifications of [+high] and [−back] with the high front vowels, according to the *SPE* feature system (see Chomsky & Halle 1968). These two feature specifications for the alveolo-palatal consonants can be proved by the nasal palatalization rule that says the alveolar nasal [n] becomes the alveolo-palatal nasal [ȵ] when followed by a high front vowel. Palatalization results from spreading the feature of [+high] and [−back], so that [ȵ] is specified as [+high] and [−back]; so are the alveolo-palatal fricatives and affricates. Therefore, the distribution of alveolo-palatal consonants can be formalized in a constraint in (16):

(16) AGREECV[+H, −B]
A [+high, −back] consonant must agree with the following vowel in value for the features of [+high] and [−back].

However, the apical vowel [ɿ] is also specified as [+high, −back], because it is an allophone of /i/. But [ɿ] cannot occur after alveolo-palatal consonants, which suggests a constraint ranking that AGREECV[apical] dominates AGREECV[+H, −B] so that [ɿ] can only occur after [ts], [tsʰ], [dz], [s] and [z] but never occur after an alveolo-palatal, which can only precede [i], [ɪ] and [j] for their agreement in value of [+high] and [−back] between the onset consonants and the nucleus vowels.[5]

As was discussed in the previous subsection, we assume a /ju/ or /wi/ combination in SX underlyingly, which, however, violates the surface constraint OCP(H) so that /ju/ or /wi/ merges into [y]. [y] is also a [+high, −back] vowel and can also follow the alveolo-palatal consonants.

3.3.3 Mid vowels

3.3.3.1 Introduction

In the surface representation of SX, there are six mid vowels: [e], [ɛ], [ə], [ɵ], [ɤ] and [o], which, according to the place parameter, can be divided into three categories: front mid vowels [e] and [ɛ], central mid vowels [ə] and [ɵ], and back mid vowels [ɤ] and [o], two for each place, in a very symmetrical system. Mid vowels in SX share more in common with many other languages than the high front vowels, among which are the remarkable apical vowel [ɿ] and a merged [y] in surface representation, as was discussed previously. Among the six mid vowels, only the rounded central vowel [ɵ] and the unrounded back vowel [ɤ] are uncommon in the world's languages. According to Maddieson (1984a), among the 317 languages in UPSID, there are only five languages that have phonemic /ɵ/ and four languages that have phonemic /ɤ/. In this subsection, I will present my analysis of the distribution of the six surface mid vowels in SX and I assume that among these six surface mid vowels only /e/, /ɤ/ and /o/ are phonemic. My analysis in this section is mainly based on OT theories, in which any underlying representation will give the right output, if the phonotactic constraints outrank FAITHFULNESS (Yip 1996). The form of the phonotactic constraints is driven by the observed surface forms in SX.

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[5] [high] and [back] are not used for the consonant feature specifications in §2.2.5 in chapter 2. According to *SPE* (Chomsky & Halle 1968), post-alveolar, alveolo-palatal, retroflex, palatal and velar consonants are [+high]; velar and glottal consonants are [+back]. Thus, in SX, [+high, −back] consonants are only alveolo-palatal consonants, including [tɕ tɕʰ dʑ ɕ ʑ ȵ] (see (35) in chapter 2).

3.3.3.2 Major-feature constraints

It is usual to analyse Mandarin as having an underlying four vowel system of /i u a ə/, and to derive the mid vowels [e ɛ o ɔ] by spreading frontness or rounding from adjacent segments (Chao 1934). According to Chao (1934), Mandarin has rich surface mid vowels, excluding [e] and [o] as phonemic vowels (the discussion of Mandarin vowel system is outside the scope of my dissertation). In contrast, SX has more phonemic mid vowels, although some underlying representation forms can be very abstract from the surface forms. Consider the following examples:

(17)	a. [e]:	[de^{31}]	'lift'	[tze^{33}]	'vegetable'
	[ɤ]:	[dɤ^{31}]	'head'	[tzɤ^{33}]	'bad smell'
	[o]:	[do^{31}]	'take'	[tzo^{33}]	'wrong'
	b. [ɛ]:	[tɛʔ^{5}]	'build up'	[pɛ̃^{52}]	'class'
	[ə]:	[təʔ^{5}]	'get'	[nəŋ^{31}]	'able'
	[ɵ]:	[tɵ̃^{33}]	'stew'	[huɵ̃^{33}]	'happy'

The examples in (17a) show that [e], [ɤ] and [o] can stand alone as the rhyme and can occur after the same initial consonant and with the same tones, which suggests that [e], [ɤ] and [o] are all contrastive with each other and thus are presumably phonemic vowels (the contrastive distribution of [e], [ɤ] and [o] with different initials will be presented in table (54) in chapter 4). The examples in (17b) show that [ɛ], [ə] and [ɵ] do not stand alone or in oral contrast as the rhyme in the syllables. Instead, they are the rhyme only either when nasalized or when followed by a consonant. In chapter 2, I discussed vowel nasalization and the VC structure. That discussion showed that there are only three nasalized vowels: [ẽ], [ɛ̃] and [ɵ̃], which are contrastive with each other, as shown by the examples in (18):

(18)	a. [dzẽ^{31}]	'sink'
	b. [dzɵ̃^{31}]	'pass on'
	c. [dzɛ̃^{31}]	'disabled'

It was also discussed in chapter 2 that nasalized vowels only occur in surface representation, as shown in (18), and the underlying syllable structure of the nasalized vowels is assumed to be /VN/ (a vowel followed by a nasal) underlyingly, which was accounted for by the nasalization rule (see (71) and (72), ch.2). However, this leaves as yet unanswered the question what the underlying vowels are for the underlying /VN/ structure of the syllable rhyme.

We have postulated two phonemic high vowels: /i/ and /u/ in the two previous subsections; we have proposed three phonemic mid vowels: /e/, /ɤ/ and /o/, since these three mid vowels are in contrastive distribution (as mentioned above) and they can occur in open syllables after many different onset consonants; we also set up the low vowel /a/ as a phonemic vowel since it is believed that all the world's languages have /i u a/ (Maddieson 1984a; Rosner 1994; Ladefoged & Maddieson 1990, 1996). As a result, we have six phonemic vowels: /i/, /u/, /e/, /ɤ/, /o/, and /a/, as I suggested previously. Since there are five underlying GV combinations, viz. /ja/, /je/, /jɤ/, /jo/ and /ju/ ([y] in surface) in SX, I assume that the underlying vowels in /VN/ combinations of the nasalized vowels might be underlyingly represented as /iN/, /uN/, /eN/, /ɤN/, /oN/ and /aN/.[6]

I will present an OT analysis of the three nasalized vowels in the SX surface representation. If it is true that surface representation is derived from underlying representation by spreading certain features (Chao 1934), I invoke the well-established constraint IDENT-I/O(F) (Pulleyblank 1996; Kager 1999; Yip 2002) in order to formalize the relations between the allophonic vowels and the underlying phonemes in SX. I divide IDENT-I/O(F) into three different specific constraints according to the three major vowel parameters, as follows:

(19) IDENT-BACK
Input-output identity for the feature [back].

(20) IDENT-HIGH
Input-output identity for the feature [high].

(21) IDENT-ROUND
Input-output identity for the feature [round].

Before I can work out a constraint ranking, let us return to the arrangement of 14 surface vowels of SX in (1) and the vowel chart of SX (see (87), ch.2), both of which show that SX has more distinctions along

[6] The final /N/ is nasality. The possible phonemic nasals for /N/ will be discussed in detail in chapter 4.

the height dimension than along the front-back dimension. For example, all else being equal and only varying the height parameter, there are six front vowels from the highest point to the lowest, viz. [i], [ʅ], [ɪ], [e], [ɛ] and [a], while there are only two vowels going from front to back, as in the pairs of [y] and [u], [e] and [ɤ], [ɵ] and [o], or [a] and [ɑ] if only the parameter of position is changed with the other two parameters unchanged. Even in the primary Cardinal Vowel system described by Jones (1975), there are [i], [e], [ɛ] and [a] with four height levels while there are only [i] and [u], [e] and [o], [ɛ] and [ɔ], or [a] and [ɑ] with two positions at the same level. Both the surface vowel inventory of SX and the primary Cardinal Vowels suggest that the height dimension is more "active" and plays a more important role in constructing a vowel system. Ladefoged & Maddieson (1996) also find that all languages have some variations in vowel quality that indicate contrasts in the vowel height dimension, rather than in the front-back dimension and that the languages of the world make a much more limited use of the front-back and rounded-unrounded dimensions. The roundness parameter plays the least active role among the three parameters in constructing a vowel inventory, because great majority of the world's languages have a predictable relationship between the phonetic Backness and Rounding dimensions (Ladefoged & Maddieson 1996). Front vowels are usually unrounded and back vowels are usually rounded, so that the unroundedness of front vowels and roundedness of back vowels can be regarded as predictable. This is also true for the SX surface vowel system as illustrated in (1). Therefore, IDENT-HIGH is more highly ranked than IDENT-BACK and IDENT-ROUND is the least important of the three in formalizing the relations between allophonic vowels and underlying vowels. As a result, the constraint ranking is IDENT-HIGH ≫ IDENT-BACK ≫ IDENT-ROUND.

3.3.3.3 Tense vs ATR

The three constraints above concern the three major features based on the three parameters of constructing vowels in terms of height, position and rounding. Since SX has made a better use of the height dimension in constructing its vowels (which, however, fits into the tendency of the world's languages) the features of [±high] and [±low] are inappropriate to distinguish the four height levels of the 14 surface vowels in SX, which are classified as in (22):

(22)	[i], [ʅ], [y], [ɪ], [u]	[4 high]
	[e], [ə], [ɵ], [ɤ], [o]	[3 high]
	[ɛ]	[2 high]
	[a], [ɑ], [ɒ]	[1 high]

The binary feature framework with [±high] and [±low] can only distinguish three height levels, viz. [+high, −low], [−high, −low], and [−high, +low], excluding the possibility of *[+high, +low]. However, [e] and [ɛ] are a pair of [−high, −low] vowels in SX, as shown in (22), which is common in many other languages, e.g. [o] and [ɔ] in English (Jones 1975). The feature [tense] is usually used to distinguish between [i] and [ɪ], [u] and [ʊ], [e] ands [ɛ], and [o] and [ɔ]. The feature [tense] plays a role in the phonology of RP. For example, the [−tense] vowels cannot occur in final position in a stressed syllable while the [+tense] vowels can (cf. /biː/ *bee* and */bɪ/). The same is true in SX, as shown in (6). The phonological role of [tense] will be discussed later in this chapter.

Halle & Clements (1983) observe that ATR and tense do not seem to contrast in any language.[7] This leads one to assume that ATR and tense might be different names for a single dimension of contrast (see also Yip 1996). There has been some discussion about ATR and tense cross-linguistically (e.g. Stewart 1967; Lindau 1979; among others). Ladefoged & Maddieson (1996) propose that [ATR] should be reserved for the cases wherein tongue root position alone is distinctive. They assume that the distinction in Romance and other languages traditionally referred to in terms of [tense/lax] should not be expressed in terms of [ATR] because the tongue root gesture is not separable from the raising of the tongue body.

Articulatorily speaking, tense vowels are produced with a tongue body or tongue root configuration involving a greater degree of constriction than that found in their lax counterparts; this greater degree of constriction is frequently accompanied by greater length (tense vowels vs. lax vowels) whilst ATR vowels are produced by drawing the root of the tongue forward, expanding the resonating cavity of the pharynx and probably raising the tongue body. There can be some difference between ATR and tense in the articulation of some vowels, especially back vowels. Ladefoged & Maddieson (1996: 304) note: “The high back retracted tongue root vowel is always further back than its counterpart, rather than

[7] For a detailed explanation of [ATR], see Ewen & van der Hulst (2001: 14–21) and Ladefoged & Maddieson (1996: 300–305).

further forward, as in the case for the traditional lax back vowels. Lax vowels of all kinds are normally taken to be more centralized. Retracted tongue root vowels do not always have this characteristic.” Lindau (1979) also points out that there are differences between ATR and tense/lax characterizations of vowels in the acoustic domain.

However, the differences between ATR and tense are minor and differ among languages. Ewen & van der Hulst (2001) present their discussion of ATR and tense and find that the schwa [ə] is [−tense] in a language with [±tense] division, like English, and it is also [+ATR] in a language with ATR vowel harmony, like Akan. In SX, the apical vowel [ɿ] is produced with the tip of the tongue raising, touching the anterior portion of the palate and the body of the tongue being pulled back passed the hard plate to position of the posterodorsum, instead of advancing the tongue root. Thus, I assume that the apical vowel [ɿ] is [−ATR], although it is phonologically [+tense]. However, it is not necessary that both ATR and tense should be used for feature specifications in one language. With the additional minor feature [ATR] to the other four major features, the 13 surface vowels (except for the [+apical] vowel [ɿ]) in SX can be distinguished by the following feature specifications, as shown in (23):

(23)

	y	ɪ	i	u	a	e	ɤ	o	ɛ	ə[8]	ɵ	ɑ	ɒ
[high]	+	+	+	+	−	−	−	−	−	−	−	−	−
[low]	−	−	−	−	+	−	−	−	−	−	−	+	+
[back]	−	−	−	+		−	+	+	−	+	−	+	+
[round]	+	−	−	+	−	−	−	+	−	−	+	−	+
[ATR]	+	−	+	+	−	+	+	+	−	+	+	−	−

The feature specifications in (23) show that in distinguishing the 13 surface vowels in SX there are five features involved, among which four are major features ([high], [low], [back] and [round]), based on the three major parameters of vowels (height, position and roundedness), enough to distinguish the six underlying phonemic vowels (shaded part); [ATR] is a minor feature (so termed by Ladefoged & Maddieson 1996) applied to distinguishing the surface allophonic vowels in SX. The feature specifications in (23) also show that the vowels such as [a], [ə] and [ɵ] differ in the features of [tense] and [ATR].

[8] The central mid schwa [ə] is specified as [+back] in most languages.

According to the phonetic and phonological properties, [a] is unspecified for [back] (cf. Ewen & van der Hulst 2001). There is cross-linguistic evidence that specification of [back] for [a] differs from language to language (Ladefoged & Maddieson 1996, among others). For example, [a] is a front vowel in the Cardinal Vowel system (Jones 1975); [a] is [+back] in *SPE* (Chomsky & Halle 1968: 332); [a] is a low central vowel in a Bavarian dialect[9] (Traunmüller 1982, cited from Ladefoged & Maddieson 1996); [a] in SX is also unspecified for [back].

In (23), [e] and [ə] are distinguished by [back], and [e] and [ɛ] are distinguished by [ATR]. I do not mark the [nas] feature for nasalized vowels, because it is not distinctive for any possible underlying vowel but derives from an underlying nasal coda. We do not yet know what are the underlying vowels for the surface nasalized vowels. It is not necessarily the case that a nasalized vowel is an allophone of its oral counterpart if there is one. Maddieson (1984a) points out that vowels with nasalization sometimes have different qualities from their closest oral counterpart. There is an argument (Wright 1980) that the introduction of a nasal formant at low frequencies – around 200 Hz prompts the speaker to raise the first formant, i.e. produce a more open vowel quality, so as to make perceptual room for the nasal formant. There is certainly morphophonological evidence for such a mechanism in French, cf. synchronic *fine* [i] ~ *fin* [ɛ̃], *une* [y] ~ [œ̃], cf. Lat. *lento* ~ Fr. *lente* [ɑ̃]. However, an oral counterpart of the nasalized vowel is always an ideal candidate for its underlying form for the faithfulness. I will present my analysis of the phonological motivation for the vowel nasalization in SX and I assume vowel nasalization in SX may involve fronting rather than lowering.

For the addition of the minor feature [ATR], I propose one more IDENT-I/O(F) constraint as follows:

(24) IDENT-ATR
Input-output identity for the feature [ATR].

IDENT-ATR is a feature constraint that plays a lesser important role in the phonological system, e.g. with respect to syllable structure, as discussed in the previous section, so that it should be ranked lower than the constraints for major features. Thus, we propose a constraint hierarchy like the following: IDENT-HIGH ≫ IDENT-BACK ≫ IDENT-ROUND ≫ IDENT-

[9] A dialect of Old High German spoken in medieval Bavaria.

ATR, by which the three nasalized vowels are derived from some underlying vowels.

3.3.3.4 OT analysis

Bearing in mind the feature specifications in (23), we can work out the most suitable underlying phonemes of the nasalized vowels with the constraint ranking discussed above by means of an OT analysis. As I assume that vowel nasalization involves fronting, the underlying vowel for [ɵ̃] is proposed to be /o/. Consider the tableau in (25):

(25)

Input /o/	IDENT-HIGH	IDENT-BACK	IDENT-ROUND
a. ☞ [ɵ̃]		*	
b. [ẽ]		*	*!
c. [ɛ̃]		*	*!

According to the feature specifications in (23), the tableau in (25) shows that candidates (b) and (c) violate IDENT-ROUND, so that candidate (a), [ɵ̃], is the optimal output as the surface nasalized vowel of the underlying phonemic /o/. In the tableau above, IDENT-ATR is usually not listed unless it is relevant to the analysis, for it is ranked low. Now let us propose a similar OT analysis on the assumption that the underlying vowel of the nasalized vowel [ɛ̃] is /a/, as shown in (26):

(26)

Input /a/	IDENT-HIGH	IDENT-BACK	IDENT-ROUND	IDENT-ATR
a. [ɵ̃]	*		*!	*
b. [ẽ]	*			*!
c. ☞ [ɛ̃]	*			

Since /a/ is unspecified for [back], IDENT-BACK is irrelevant to the analysis in (26). The tableau in (26) shows that the three candidates (a), (b) and (c) all violate IDENT-HIGH; candidate (a) violates IDENT-ROUND and is first to be ruled out; [ẽ] violates IDENT-ATR and is also ruled out; candidate (c) is the winner for the surface nasalized vowel of the underlying phonemic vowel /a/.

The nasalized [ẽ] has the oral counterpart /e/. Since all the constraints concerning the relations between the underlying representation and surface representation of the nasalized vowels are faithfulness constraints, the oral counterpart /e/ certainly best satisfies FAITHFULNESS and is the optimal candidate. This can be expressed through the following OT analysis:

(27)

Input /e/	IDENT-HIGH	IDENT-BACK	IDENT-ROUND	IDENT-ATR
a. [ɵ̃]			*!	
b. ☞ [ẽ]				
c. [ɛ̃]				*!

The tableau in (27) shows that candidates (a) is ruled out because it violates IDENT-ROUND; [ɛ̃] is also ruled out because it violates IDENT-ATR; candidate (b) is the winner because it has all the identical features its oral counterpart has. Thus, I conclude that in SX the underlying form of the nasalized [ẽ] is its oral counterpart [e]. Through the analysis of the three OT tableaus, we can conclude that the three nasalized vowels, [ẽ], [ɵ̃] and [ɛ̃], are the surface allophones of the underlying phonemic /e/, /o/ and /a/, respectively. This suggests that a fronting process takes place in some way in vowel nasaliztion, as shown in (28):

(28) /e/ → [ẽ]
/o/ → [ɵ̃]
/a/[10] → [ɛ̃]

The illustration in (28) shows that the two phonemic vowels (/o/ and /a/) get fronted when nasalized in surface representation in SX. I assume that such a fronting process in the SX vowel nasalization is place assimilation of the underlying final nasal [n], which I will be discussing in next subsection.

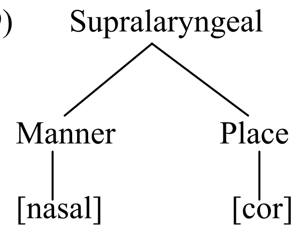
3.3.3.5 Phonological motivation

At this point, some questions may arise: Why should the underlying phonemes /o/ and /a/ become [ɵ̃] and [ɛ̃] in surface representation when nasalized, rather than [õ] and [ã], respectively, just like [ẽ]? What is the (phonological or phonetic) motivation for this change? Why can [ẽ], [ɵ̃] and [ɛ̃] not be phonemic vowels? Cross-linguistically, assimilation or dissimilation is frequently involved in diachronic or synchronic phonological changes. The processes of assimilation or dissimilation are a

[10] /a/ in SX is unspecified for [back]. However, it is obviously fronted when nasalized.

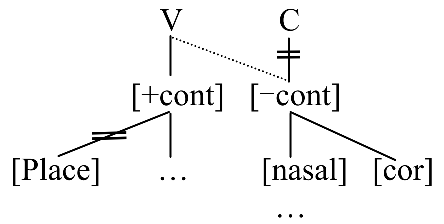
matter of feature spreading, progressive or regressive (Hall 2001). Vowel nasalization in SX is a diachronic process, which came about by debuccalization of final nasals through historical attrition (which will be discussed in detail in chapter 4). It is well known that SX had final [m], [n] and [ŋ] in Middle Chinese times. But in Modern SX only [ŋ] remains and [m] and [n] disappeared, both of which are specified for [−back] (or [+ant]) (see *SPE* 1968: 177). However, in nasal debuccalization, the Place component is lost and what remains is nasality which receives the default Place specification of [cor] (or the element [I] in a Dependency approach). When nasalization occurs, the feature of nasality ([N]) spreads leftward to the preceding vowel, involving [+nasal] and [cor]. The former is a feature of manner and the latter is a feature of place. According to feature geometry (McCarthy 1988), [nasal] and [cor] are in two feature domains under the Supralaryngeal Node, as shown in (29):

(29)



The feature geometry in (29) shows that [nasal] is under the manner domain and [cor] under the place domain and that [nasal] and [cor] are in sister relationship and under the same Supralaryngeal Node, which enables the spreading of both the features of manner and that of place. Van de Weijer (1994, 1996) actually claims that the feature of manner dominates that of place and both features can spread, which is well-attested cross-linguistically (also see Clements 1985; McCarthy 1988). For example, the underlying English prefix 'in-' should be 'ir-', 'il-' or 'im-' according to the manner and place features of the following cross-morpheme consonant. The feature spreading in vowel nasalization in SX can be captured by the feature geometry, as shown in (30):

(30)



The feature geometry in (30) shows that when the feature [nasal] spreads to the preceding vowel, the Place feature which is dominated by Manner feature spreads together with it and the original Place feature gets disassociated from the vowel, making the nasalized vowel fronted, which is the phonological and phonetic processes taking place in vowel nasalization in SX. Since [+cont] is the default value of a vowel, it does not get disassociated from the vowel, so that [−cont] has no effect on the vowel. I assume that in SX vowel nasalization, the Place component of the final nasal is lost by debuccalization so that the default Place feature spreads to the preceding vowel while in the English vowel nasalization (e.g. [θæ̃ŋk] 'thank') the following nasal is not lost and the Place feature does not spread. In SX vowel nasalization, the spreading of [I] element changes the vowel quality from /a/ and /o/ to [ɛ̃] and [ə̃], respectively, when /e/ did not change to a different vowel because /e/ is already a front vowel, both /e/ and [ẽ] having [I] element.

The cross-linguistic evidence strongly suggests that nasal deletion in vowel nasalization may occur diachronically or synchronically for different phonological reasons. In SX vowel nasalization, the syllable-final nasal is debuccalized and the contrastive property of a nasal is now carried by the vowel so that the nasalized vowels are long enough to bear full tones of the lexical syllables, as Halle (1995: 214) explains that since debuccalization does not affect the timing slot of the phoneme, deletion is accompanied by lengthening of the preceding vowel.

The nasalized vowels in SX, [ẽ], [ə̃] and [ɛ̃], need not be phonemic vowels underlyingly, though there are some languages in which nasalized vowels are in full contrastive distribution with their oral counterparts and thus are phonemic vowels such as Dan, Zande, Sara and Burmese (Maddieson 1984a). In the world's languages, the most frequent nasalized vowels are [ĩ ã ũ] also the counterparts of the most frequent oral vowels [i a u] (Ladefoged & Maddieson 1996). In SX, the nasalized [ẽ] has an oral counterpart /e/ which is the underlying form of the nasalized vowel because the surface [ẽ] is derived from the underlying /eN/.

The assumption that the underlying form of the nasalized vowels in SX is /VN/ is also well supported by the fact that there are no ṼC combinations such as *[ẽʔ], *[ɛ̃ʔ] or *[ɵ̃ŋ] in that Ṽ has a final nasal in the coda underlyingly. In short, /e/, /a/ and /o/ are the underlying phonemic vowels of the nasalized [ẽ], [ɛ̃] and [ɵ̃] in the SX surface representation, respectively.

3.3.3.6 Schwa in Shaoxing

Of the six mid vowels in the SX surface representation, one is schwa [ə], which is a common vowel in many other languages (Maddieson 1984a) and the most commonly used vowel in English (Wikipedia 2001).[11] However, [ə] in SX is not as frequent as other vowels. Schwa is usually specified as having many minus specifications in its feature matrix,[12] as shown below:

(31)

	ə
high	−
low	−
front	−
back	+
rounded	−

Perhaps, due to its remarkably negative feature specification, [ə] can be easily assimilated in certain phonetic or phonological environment. In SX, [ə] only occurs in VC structure, either [əŋ] or [əʔ]. It can never constitute a rhyme when standing on its own after the onset so that it can never contrast with the proposed six phonemic vowels. Thus, [ə] is not a phonemic vowel in SX. It is not easy to decide of which phonemic vowel [ə] is an allophone. Consider the distribution of all the VC syllables in SX, as shown in (32):

[11] Wikipedia (www.wikipedia.org) is a multilingual encyclopedia designed to be read and edited by anyone.

[12] Schwa [ə] is phonetically a central mid vowel, although it is phonologically specified as [+back], as shown in (23) and (31).

(32)

Vŋ		Vʔ	
[dɪŋ^{31}]	'stop'	[tɪʔ^{5}]	'fall down'
[dəŋ^{13}]	'wait'	[təʔ^{5}]	'get'
[daŋ^{22}]	'stroll'	[taʔ^{5}]	'build up'
[doŋ^{22}]	'cave'	[toʔ^{5}]	'inspect'
[dɒŋ^{31}]	'sugar'	[tɛʔ^{5}]	'correct'

From the distribution shown in the data in (32), I assume that the most likely underlying vowel(s) of [ə] would be /e/ or /ɤ/, because they do not occur in VC combinations. However, let us first make a reverse OT analysis (from the surface vowel to identify its possible underlying form), to see which candidate is the optimal output as its underlying phoneme, according to the constraint ranking discussed earlier, as shown in (33):

(33)

Input [ə]	IDENT-HIGH	IDENT-BACK	IDENT-ROUND
a. /i/	*!	*	
b. /u/	*!		*
c. /e/		*!	
d. ☞ /ɤ/			
e. /o/			*!
f. /a/	*!		

The tableau in (33) shows that candidates (a), (b) and (f) all violate the first constraint and are ruled out; the candidate /e/ is [−back], so that it is ruled out for violating IDENT-BACK; the candidate /ɤ/ is the optimal output as the underlying phoneme of schwa [ə] in SX. Now let us make a similar OT analysis of the five surface vowels in the 'Vʔ' column in (32) with /ɤ/ as the input, to see if the result is the same, as shown in (34):

(34)

Input /ɤ/	IDENT-HIGH	IDENT-BACK	IDENT-ROUND
a. [ɪ]	*!	*	
b. ☞ [ə]			
c. [a]	*!		
d. [o]			*!
e. [ɒ]	*!		*

The tableau in (34) presents the same result as that in (33) so that it is self-evident that the underlying vowel in the surface [əʔ] combination is /ɤ/. This can also be heuristically supported by data from other Wu dialects. Here are some examples from Qingyuan[13] (Cao 2001) as shown in (35):

(35)	Qingyuan	SX	
	[kʰuɤʔ⁵]	[kʰəʔ⁵]	'thirsty'
	[ʔdɤʔ⁵]	[təʔ⁵]	'obtain'
	[tɤʔ³⁴]	[dəʔ³]	'special'
	[kʰɤʔ⁵]	[kʰəʔ⁵]	'carve'
	[sɤʔ⁵]	[səʔ⁵]	'block'

The OT analysis in (33) and (34) can also be formulated in a rule as follows:

(36) /ɤ/ → [ə] / __ ʔ

There is another strong piece of evidence that /ɤ/ and schwa [ə] have close relations and show similar phonetic and phonological behaviour in SX. For example, schwa is used as an insertion vowel in many languages while in SX /ɤ/ is always used as an insertion vowel, e.g. in loanwords. As was discussed in chapter 2, there is no onset complex in SX so that any CC or CCC cluster in a source language always has /ɤ/ inserted between the consonant cluster when borrowed into SX. For example:

(37)	English	Loanwords in SX	
	a. [kloun]	[kʰɤloŋ]	'clone'
	b. [gri:n]	[kɤlɪŋ]	'Green (name)'

As for the other vowels in 'Vʔ' column, as shown in (32), I assume that the surface vowel of the underlying /e/ is [ɛ] because they share most similarities in features and are always regarded as a pair of mid vowels which only differ in ATR cross-linguistically. I present an OT analysis of the relations between the five surface vowels in 'Vʔ' column in (32) and the underlying phonemic /e/, as shown in (38):

[13] Qingyuan is also one of the Wu dialects which has eight tones, including [334], [52], [33], [221], [11], [31], [5] and [34] (Cao 2002).

(38)

Input /e/	IDENT-HIGH	IDENT-BACK	IDENT-ROUND
a. [ɪ]	*!		
b. [ə]		*!	
c. [a]	*!		
d. [o]		*!	*
e. ☞ [ɛ]			

The tableau in (38) shows that the candidates [ɪ] and [a] violate the constraint for height and are therefore ruled out; candidate [ə] and [o] violate IDENT-BACK because both candidates are [+back]; candidate [ɛ] does not violate any of the three major-feature constraints. Thus, it is the optimal output as the surface allophone of the phonemic /e/. Of the five surface vowels in 'Vʔ' combinations, two have the identical forms with the phonemic vowels. The derivation of all the five surface combinations can be formalized in the following rules:

(39)

$$\left.\begin{array}{lll} /i/ & \rightarrow & [ɪ] \\ /a/ & \rightarrow & [a] \\ /o/ & \rightarrow & [o] \\ /e/ & \rightarrow & [ɛ] \\ /ɤ/ & \rightarrow & [ə] \end{array}\right\} \_\_ʔ$$

The rules in (39) show that [ɪ], [a], [o], [ɛ] and [ə] are the surface variants of underlying /i/, /a/, /o/, /e/ and /ɤ/, respectively, in 'Vʔ' combinations. The examples in (32) also show that vowels between 'Vŋ' column and 'Vʔ' column are all the same except [ɒ] in [ɒŋ] and [ɛ] and [ɛʔ]. The possible underlying vowel for the surface [ɒ] in [ɒŋ] combination will be discussed in the next subsection of low vowels. Of the five rules in (39), three underlying [+tense] vowels become [−tense] when followed by a consonant. This can also be formulated as follows:

(40)

$$\left.\begin{array}{l} [-\text{low}] \\ \textit{or} \\ [-\text{round}] \end{array}\right\} \rightarrow [-\text{tense}] \; / \; \_\_ \text{C} \; \$$$

Rule (40) says that any [−low] or [−round] vowel will become [−tense] when followed by a syllable-final consonant. The rule in (40) is supported by the data of SX and also coincides with the syllable structure and tonal structure in SX because, phonetically, [+tense] vowels are articulated longer than [−tense] vowels and the rhymes of V and VC, as the weight unit, are phonetically equal in length and phonologically bimoraic when stressed. The examples in (32) also show that there are such vowels as [ɪ], [ɛ], [ə], [ɒ], [a] and [o] in surface VC combinations. Among them, [ɪ], [ɛ], [ə] and [ɒ] are [−tense]. However, articulatorily and acoustically speaking, the [+tense] rounded vowel [o] and low vowel [a] also sound much shorter when followed by a syllable-final consonant than when in an open syllable. Such an acoustic difference can be clearly manifested in the following syllables when spoken:

(41)	[toŋ^{52}]	‘east’	[to^{52}]	‘many’
	[dzoŋ^{31}]	‘worm’	[dzo^{31}]	‘tea’
	[ŋaŋ^{22}]	‘hard’	[ŋa^{22}]	‘stay’
	[saŋ^{35}]	‘save’	[sa^{35}]	‘sprinkle’

From all the phonetic and phonological evidence of SX discussed above, especially with regard to the surface realization of vowels in terms of syllable structure, I propose a mora-deletion rule in (42):

(42)
$$\begin{array}{ccccc} V & \rightarrow & V & / & \_\_\_\ C\ \$ \\ | & & | & & \\ \mu\mu & & \mu & & \end{array}$$

The rule in (42) says that a bimoraic vowel becomes a monomoraic vowel when it is followed by a syllable-final consonant, so that the mora-deletion rule is only realized in syllable structure rather than in feature because [long] is not a distinctive feature in SX. Rule (42) is made possible because the syllable-final consonant is also moraic in SX, which will be discussed in chapter 4. However, the rule in (42) captures all the phonetic facts of vowels in SX.

In short, through the analysis above, I conclude that among the six surface mid vowels, only /e/, /ɤ/ and /o/ exist underlyingly in SX, and [ɛ], [ə] and [ɵ] are allophonic vowels of these three phonemic vowels, respectively (except when [ɛ̃] is in nasalized form, its underlying vowel is /a/) in surface representation.

3.3.4 Low vowels

There are three low vowels in SX, viz. [a], [ɑ] and [ɒ]. Among the three surface low vowels, [a] can stand alone as the rhyme after an onset consonant and contrast with other phonemic vowels, so it is undoubtedly a phonemic vowel in SX. However, [ɑ] and [ɒ] remain questionable because there is disagreement about the existence of [ɑ] in the SX surface vowel inventory, as was discussed in chapter 2. According to the two versions of the Final inventory (see "Yang & Yang's Finals in SX" (40) and "Zhang's Finals in SX" (41) in chapter 2), the following syllables can be transcribed differently, as shown in (43):

(43)	Yang	Zhang	
	a. [pɒ^{52}]	d. [pɑɒ^{52}]	'wrap'
	b. [dʑjɒ^{31}]	e. [dʑjɑɒ^{31}]	'bridge'
	c. [k^{h}ɒ^{52}]	f. [k^{h}ɑɒ^{52}]	'knock'

The reason I claim that [ɒ] only occurs in the combination [ɑɒ] in open syllables in the SX surface representation, as shown in (43d, e, f) above and as discussed in chapter 2, is that the tonal structure of SX requires the syllable rhyme to be long enough for the purpose of realizing full tones when stressed. Thus, phonetically, every nuclear vowel in an open syllable must be [+tense] so that it is phonetically heavy enough to be bimoraic. This is supported by the fact that all vowels are [+tense] in open syllables and all [−tense] vowels are followed by a consonant, as discussed previously.

As was mentioned above, [ɒ] is specified as [−tense]. [tense] is a very important feature in determining the vowel system of SX. There is cross-linguistic evidence that [−tense] vowels have different phonological behaviour. For example, in English, [−tense] vowels cannot occur in syllable-final position, while [+tense] vowels can (cf. /biː/ 'bee' vs. */bɪ/, for example) (Ewen & van der Hulst 2001). I observe that, like English, a simple [−tense] vowel cannot be the syllable final in SX, which will crucially exclude [ɒ] as a phonemic vowel. However, there are more than enough reasons to make this assumption. As was discussed in chapter 2 and previously in this chapter, the length of a vowel is underspecified so that there is no contrast between [+long] and [−long] vowels. As a monosyllabic language, almost every syllable is stressed in SX, except some syllables which are grammatical particles or affixes, and only a stressed syllable is a full-tone TBU. Articulatorily speaking, a [−tense] vowel is pronounced shorter than a [+tense] vowel. Thus to make the rhyme of a syllable phonetically long enough to be a full-tone TBU, the SX syllable structure phonologically requires its syllable final (all that is left after the onset consonant) to be either a [+tense] vowel or a combination of VC or VV. Let us see how vowels of [+tense] and [−tense] are distributed in the syllable structure. Consider the following data in SX:

(44)	[+tense]		[−tense]	
	[mi^{13}]	‘rice’	[nəŋ^{31}]	‘able’
	[tsɿ^{35}]	‘paper’	[zɪʔ^{3}]	‘enter’
	[so^{52}]	‘sand’	[pɛʔ^{5}]	‘eight’
	[ku^{35}]	‘ancient’	[ɕɪŋ^{52}]	‘new’
	[he^{35}]	‘sea’	[pɵ̃^{33}]	‘half’
	[fɤ^{35}]	‘deny’	[zɒŋ^{31}]	‘taste’
	[ŋa^{13}]	‘we/us’	[ȵiɛ̃^{22}]	‘check’

The data in (44) show that simple vowels are all [+tense] vowels when they make up the whole syllable final. When a [−tense] vowel is in the rhyme, it is never alone, but either it is followed by a coda consonant, or it is nasalized (recall that nasalized vowels are phonetically longer than their oral counterparts (Rosner 1994)); phonologically, nasalized vowels are underlying vowel + nasal sequences in SX, as was discussed in chapter 2 and previously in this chapter. The data in (44) strongly suggest that a simple [−tense] vowel cannot be the final of a syllable. Thus, I assume that there is a segment filter in SX syllable structure to make sure every syllable is properly structured in terms of segments, as shown in (45):

(45) $$\mathrm{C} \; {}^{*}\begin{bmatrix} \mathrm{V} \\ -\mathrm{tense} \end{bmatrix} \; \$$$

The segment filter in (45) stipulates that a simple [−tense] vowel is not acceptable in an open syllable in SX. This segment filter will naturally filter out [ɒ] as the whole syllable final, so that the syllables in (43a, b, c) are ill-formed. Only syllables like (43d), (43e) and (43f) are acceptable, as was also presented in the Final inventory of Chao’s ((38), ch.2) and Campbell’s ((39), ch.2). The phonetic and phonological motivation why [ɒ] never occurs alone but in combinations of [ɑɒ] or [ɒŋ] in the SX surface representation is to satisfy the segment filter so as to be heavy enough for bimoraic status. Acoustically, the rhymes of the syllables in (43d, e, f) are factually as long as [ɑɒ], not as short as [ɒ]. However, both [ɑ] and [ɒ] are allophonic vowels in surface representation. The underlying phonemes of these two allophonic vowels can also be worked out through an OT analysis, with the same constraint ranking as shown in (46):

(46)

Input [ɑ]	IDENT-HIGH	IDENT-BACK	IDENT-ROUND
a. /i/	*!*	*	
b. /u/	*!*		*
c. /e/	*!	*	
d. /ɤ/	*!		
e. /o/	*!		*
f. ☞ /a/			

The tableau in (46) shows that candidates (a), (b), (c), (d) and (e) all violate IDENT-HIGH once or twice[14] and are ruled out together while candidate (f) does not violate any of the three constraints and is surely the winner. Thus /a/ is the optimal underlying phoneme for the allophonic vowel [ɑ], which is also phonetically satisfying because of the articulatory similarities between [a] and [ɑ]. Then we come to the analysis of [ɒ] in the same approach. But since [ɒ] only occurs in the combination [ɑɒ], we should also apply the OCP to the analysis to eliminate any possible sequence of the two exact same segments. This is not acceptable underlyingly in SX phonology. The OCP is inviolable in SX, so that it dominates the other faithfulness constraints. In the following analysis I propose [ɑɒ] as the input and /a/ as the first V of the combination for the output because /a/ is already decided as an underlying vowel for the allophonic [ɑ] through the analysis in (46). The violation of the output candidates only refers to those by the second V of the combination, as shown in (47):

[14] As is shown in (23), [ɑ] is specifies as [−high, +low] and [i] and [u] are specified as [+high, −low], so that candidates (a) and (b) violate IDENT-HIGH twice for the specifications of [high] and [low].

(47)

Input [ɑɒ]	OCP	IDENT-HIGH	IDENT-BACK	IDENT-ROUND
a. /ai/		**!	*	*
b. /au/		**!		
c. /ae/		*	*!	*
d. /aɤ/		*		*!
e. ☞ /ao/		*		
f. /aa/	*!		*	*

The tableau in (47) shows that candidate (f) violates the OCP and is the worst candidate, so it is ruled out; candidates (a) and (b) violate IDENT-HIGH one once more than (c), (d) and (e) so that they are also ruled out; candidate (c) is also ruled out by violating IDENT-BACK; candidate (d) finally is ruled out because it violates IDENT-ROUND; candidate (e) is the winner. Thus, /ao/ is the optimal underlying form of the surface combination [ɑɒ]. This result is also satisfying for the acoustic similarity between the input and output. However, according to my analysis in chapter 2, /ao/ is the only diphthong in SX underlyingly, which is not acceptable in surface representation because of the surface constraint *DIPH,[15] having the surface form [ɑɒ] consequently. The reason why there is no diphthong in the SX surface representation is not clear so far. However, it was widely accepted that diachronically the nucleus of the SX syllables have become shorter than that in Middle Chinese times, having lost the Middle Chinese diphthongs such as [əu], [ou], [ai] and [au], some of which are still retained in some other Wu dialects (Chao 1928; Cao 2002). One hypothesis would be that during the shortening of the nucleus, all diphthongs were missing and became monophthongs, but [ɒ] was ruled out by the segment filter in (45). Thus, SX has [ɑɒ] not only to satisfy the segment filter but also follow the tendency of losing diphthongs. The change from /ao/ into [ɑɒ] can be formalized as follows:

(48) $$/\text{ao}/ \rightarrow \begin{bmatrix}+\text{back}\\+\text{low}\end{bmatrix} \Big/ \ [+\underline{\text{low}}]\ [+\underline{\text{back}}]$$

The rule in (48) shows that when VV is a [+low]+[+back] combination, both VV will become [+low, +back] in surface representation. As

[15] I claim that there is no diphthong (*DIPH) in the SX surface representation and that [ɑɒ] is not a diphthong, as was discussed in chapter 2.

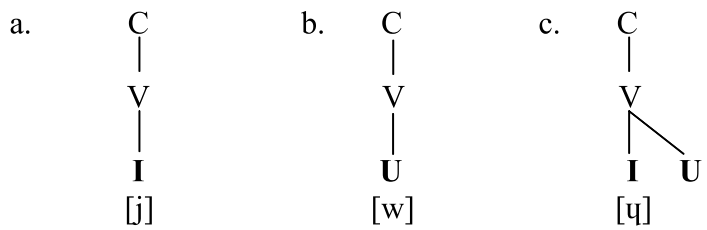
presented in (23), both [ɑ] and [ɒ] are specified as [+low] and [+back]. It is an interesting linguistic phenomenon in SX that in GV there is constraint OCP(H) (*[+high][+high]) so that /ju/ merges into [y] while in VV [+low][+low] is preferred so that /ao/ changes into [ɑɒ], which suggests that *DIPH dominates OCP(H) in SX. In fact, the two phonological changes both involve merger. In /ju/, the two segments merge into a [−back, +round] segment [y] and in /ao/ the two segments merge into a [+low, +back] combination rather than a single segment because the feature [+round] does not merge. Otherwise, the merged segment would be [ɒ] which is ruled out by the segment filter in (45). The only difference is that the high vowels merge into a front vowel and low vowels merge into (a) back vowel(s), which just fits in with the general vowel inventory that high vowels are more likely to be in front and low vowels are more likely to be in back (Maddieson 1984a).

In the data of SX, there are also such syllables as [zɒŋ^{31}] 'taste' and [fɒŋ^{52}] 'square', in which [ɒ] does not occur as a combination of [ɑɒ]. This phenomenon gives rise to the question if the underlying form of [ɒŋ] is /oŋ/. The problem is that in fact there are well-formed syllables such as [kɒŋ^{52}] 'steel' and [koŋ^{52}] 'male' in the SX surface representation. The reason that [ɒ] only occurs in combinations of [ɑɒ] and [ɒŋ] is that both [ɑɒ] and [ɒŋ] satisfy the segment filter in (45). If /oŋ/ is also the underlying form of [ɒŋ], how we could have both [ɒŋ] and [oŋ] as surface representation for the same underlying /oŋ/? I assume that [ɒŋ] is a derived form from [ɑɒŋ] so that the underlying form of [ɒŋ] is /aoŋ/, rather than /oŋ/, since /joŋ/, /woŋ/, /waŋ/, and /jaŋ/ are all well-formed underlyingly in SX. As was discussed above, [ɒ] cannot occur alone as the syllable final for its [−tense] or phonetically short duration. A [ɑɒ] combination is just like a long vowel in terms of time duration, so that [ɑɒ] is long enough to satisfy the segment filter but too long to be followed by the final nasal [ŋ]. As a result, [ɑ] is dropped when the syllable ends in [ŋ] in surface representation because the syllable-final nasal is also moraic, while such syllables as [dʑjoŋ^{31}] 'poor' and [ɦwoŋ^{31}] 'red' are also well-formed because the prenuclear glides are weightless. Accordingly, the underlying form of [ɒŋ] is /aoŋ/, not /oŋ/. In short, among the three low vowels, only /a/ is a phonemic vowel; [ɑ] and [ɒ] are allophonic vowels of /a/ and /o/, respectively.

3.3.5 The distribution of glides

3.3.5.1 What is a glide?

Perhaps the most problematic segment type for all theories of phonology is the class of glides (Hyman 2003:77). There have been controversial definitions of what a glide is. According to Trask (1996), a glide is a very brief phonetic vowel which functions in some languages as a phonological consonant; the English glides /j/ and /w/ (as in *yes* and *win*) are brief versions of [i] and [u]. Conventionally, glides are also known as semivowels. Jakobson, Fant and Halle (1963) think that there is only an allophonic difference between semivowels and vowels, which, however, has been challenged in later studies (Rosenthall 1997). Ladefoged and Maddieson (1996) call glides vowel-like consonants. Phonetically speaking, glides are sounds produced with a relatively unimpeded flow of air through the mouth. The constriction is not narrow enough to produce local turbulence, though cavity friction may be heard (Maddieson 1984a). In the *SPE* feature system, glides are [−cons, −voc] segments, which is not really insightful in that in some languages [−cons, −voc] segments also include [r], [h], [ʔ], etc. (Trask 1996). There are two kinds of glides, on-glides and off-glides. The former is a glide occurring at the beginning of a diphthong, such as [j] in [ja] and the latter is one occurring at the end of a diphthong such as [j] in [aj]. In Mandarin, all on-glides are [−voc] but off-glides can be [+voc] like [i] in [xwai^{35}] 'chest' and [u] in [t^{h}jau^{55}] 'choose', in which [ai] and [au] are treated as falling diphthongs. I would say, a glide is [−cons] and [−peak] in a syllabic aspect. However, a real glide should be both phonetically and phonologically a glide. In a CV approach, a glide is a C-dominated V, different from the corresponding high vowels which are V-dominated V. In van de Weijer's (1994, 1996) element-based segmental structure, the three glides [j], [w] and [ɥ] can be formalized as in (49):

(49)


The segmental structures in (49) capture what a glide is by nature, free of ambiguity whether they are [+voc] or [−voc], or whether they should be symbolized as [i] or [j], [u] or [w] and [y] or [ɥ].

3.3.5.2 Glides in Shaoxing

The majority of the world's languages (65.2%, Maddieson 1984a) have both /j/ and /w/ as glides, which are closely related to the high vowels /i/ and /u/, respectively, or in complementary distribution with /i/ and /u/, respectively, in many languages (Casali 1996). In SX, there are three glides in surface representation, viz. [j], [w] and [ɥ], which are all on-glides. SX has no off-glide: VG structure is not acceptable in SX. Thus glides in SX are all [−voc]. The three glides can be specified with the following features and thus be distinguished from the identical vowels as in (50):

(50) The glide feature specification[16]:

	Glides			Vowels		
	j	w	ɥ	i	u	y
[voc]	−	−	−	+	+	+
[back]	−	+	−	−	+	−
[round]	−	+	+	−	+	+

The feature specifications in (50) show that the only difference between glides and vowels in SX is [±voc], which is also true with the on-glides in other Chinese dialects. The syllable structure in SX will be discussed in detail in the next chapter. In this subsection I will present my analysis of the distribution of the three glides in SX. Glides in SX occur in two structures, GV and GVC.[17] Consider the following examples:

[16] For convenience, the glides are specified here with the features according to *SPE* (Chomsky & Halle 1968). However, I don't mean that all [−cons] and [−voc] segments are glides, which is of course not true. To distinguish between off-glides and their identical vowels, I would propose the feature [±peak].

[17] Either GV or GVC, excluding the onset C, is a sub-syllabic constituent in SX, which will be discussed in chapter 4.

(51) GV

[ɕja^{35}]	'write'	[kwa^{35}]	'strange'
[ȵjɛ̃^{31}]	'inspect'	[kwɛ̃^{52}]	'close'
[ɦje^{13}]	'too'[18]	[kwe^{33}]	'piece'
[ʔjo^{35}]	'graceful'[19]	[hwo^{52}]	'flower'
[tɕɥə̃^{33}]	'donate'	[hwə̃^{52}]	'happy'

GVC

[dʑʰjoŋ^{31}]	'poor'	[ɦwoŋ^{31}]	'red'
[ɕjaŋ^{35}]	'think'	[ɦwaŋ^{31}]	'horizontal'
[tɕʰjoʔ^{5}]	'lack'	[kʰwoʔ^{5}]	'wide'
[tɕjaʔ^{5}]	'foot'	[kwɛʔ^{5}]	'scratch'

The examples in (51) show that the glides [j] and [w] in SX seem to be in contrastive distribution with each other in both GV and GVC structures (in spite of the fact that the preceding consonants are in complementary distribution when preceding [j] and [w]. This will be discussed in chapter 4). However, there is one case in which [j] and [w] contrast with each other after the same onset consonants, which involve only alveolar stops and the lateral [l]. For example:

(52)

[ljɤ^{31}]	'flow'	[lwə̃^{22}]	'mess up'
[tja^{52}]	'dad'	[twə̃^{33}]	'stew'
[tʰjẽ^{52}]	'sky'	[tʰwə̃^{33}]	'swallow'
[djɑɒ^{22}]	'exchange'	[dwə̃^{31}]	'unite'

The examples in (52) show that [j] and [w] do contrast after the same consonants, though in most cases the onset consonants are in complementary distribution with others when preceding [j] and [w] (see the details of the distribution of consonants and vowels in §4.6.2, ch.4). However, it is true that there are no exact minimal pairs of [j] and [w], differing in either the preceding onset consonant or the following nucleus vowel, as shown in (52). I assume that the different distribution of [j] and [w] is decided by the phonotactics by their different phonological properties, e.g. [±back] and [±round]. Both [j] and [w] are phonologically different glides. The segment [ɥ] is an allophonic glide of [j] when

[18] [je] only occurs in literary style for some syllables borrowed from Mandarin, so it is not the real native SX pronunciation.
[19] [jo] also mostly occurs in literary style for some syllables borrowed from Mandarin.

followed by a [−back] rounded vowel, which can be formalized in a rule as follows:

(53) $$/j/ \rightarrow [ɥ] \; / \; \_\_ \begin{bmatrix} -\text{back} \\ +\text{round} \end{bmatrix}$$

The rule in (53) says /j/ becomes rounded when followed by a [−back] rounded segment, which actually involves labial assimilation triggered by the spreading of the [+round] feature of a [−back] vowel, rendering [jo] acceptable because [o] is [+back]. This phenomenon gives rise to the question why a [+back] vowel does not trigger labial assimilation in this case. As was discussed in chapter 2, [–back] roundedness is marked and [+back] roundedness is unmarked. Cross-linguistic evidence shows that marked features can trigger assimilation more strongly than unmarked ones. Underlyingly, there are only two glides in SX, viz [j] and [w].

Glides in SX have very remarkable characteristics in terms of syllabic position and phonological behaviour. Generally speaking, if there is a sequence CGV[20] in a language, usually G is either in the Nucleus so that GV is a diphthong, like [ja] in [ljato] 'boat' in Luganda (Clements 1986), or G is in the Onset so that CG is an onset cluster like [tj] in [etjo] 'to pull' in Okpe[21] which has no diphthong (Casali 1996). However, as was discussed previously, we agree that there is no diphthong or onset cluster in SX. Thus, G in CGV sequence is neither in the Nucleus nor the Onset. This topic will be discussed in detail in chapter 4.

Within one syllable, most VV-like sequences are diphthongs, either rising or falling. But some languages have no diphthongs, like SX and Okpe (Casali 1996), in which V_1 in V_1V_2 sequences is always a glide. Casali (1996: 18, 46) proposes a constraint GLIDEHOOD, saying (i) a glide must be [+high]; (ii) a glide must be [+front] or [+round]. Accordingly, in any VV-like sequences in SX, the first V-like segment must be a glide if it satisfies GLIDEHOOD because there is no diphthong in SX, so there is no VG sequence. The fact that V_1 in V_1V_2 sequences becomes a glide is a cross-linguistic commonality.

What is different between CGV in SX and CGV in many other world's languages is that in other languages when V_1 becomes G it is either in CG sequences as an onset cluster, like in Okpe, or in a GV

[20] C refers consonant; G refers to glide; V refers to vowel.

[21] Okpe is a Benue-Congo language spoken in Nigeria, which is discussed in Hoffman (1973), Pulleyblank (1986), and Omamor (1988) (see Casali 1996).

sequence as a diphthong as in Luganda, while in SX when V_1 becomes G it is neither an onset cluster nor a diphthong, because of the *COMPLEX-ONSET and *DIPH constraints in SX, which brings up a controversial issue of the syllable structure not only in SX but also in all other Chinese languages. The syllabic status of the prenuclear glides is a highly remarkable characteristic in SX. However, glides in SX are predictable because V_1 in V_1V_2 sequences is unexceptionally a glide if V_1 is [+high]. Glides are position-sensitive in SX. There is also cross-linguistic evidence that an underlying distinction between glides and high vowels is not based on a difference in feature content. Rather, it is shown that the difference is structural (Levin 1985).

3.4 The Six-vowel System

From the analyses I have presented in the previous sections, it clearly emerges that the underlying vowel inventory of SX consists of six phonemic vowels, which can be displayed as in (54):

(54)	i		u
	e	ɤ	o
		a	

The underlying vowel inventory of SX in (54) shows that SX has a symmetrical six-vowel system with two high vowels, three mid vowels and one low vowel. This symmetrical six-vowel system fits in with the general pattern of vowel systems of the world's languages. Vowels in the mid range are a little more common than high vowels and low vowels are substantially less common (Maddieson 1984a), while the number of height distinctions in a system is typically equal to or greater than the number of backness distinctions (Crothers 1978). Among the six phonemic vowels, five are the most preferred vowels in the world's vowel system, with /ɤ/ as a remarkable extra phonemic vowel in SX.

Crothers (1978) proposes that 55% of the languages with six-vowel system have /i u e ə o a/. This vowel inventory has only one vowel /ə/, which is different from that of SX. It is true that /ə/ is much more common than /ɤ/ in the world's languages (Maddieson 1984a). However, there is a strong phonological motivation to assume that SX has /ɤ/ instead of /ə/ as one of the six phonemic vowels. In this section I will briefly analyze the phonetic and phonological similarities and differences between /ɤ/ and /ə/ and discuss the phonological mechanism of SX which supports the six-vowel system, as I have presented above. I assume that the present six-vowel system has close relations with the syllable structure of SX, which bears on two main issues: stress and tenseness. These two issues give the answer to why schwa /ə/ is not in the six-vowel system of SX.

3.4.1 Stress

According to Maddieson's (1984a) UPSID analysis, about 21.1% of the languages have schwa /ə/. Phonologically speaking, the schwa is the vowel sound in many unaccented syllables in words of more than one syllable in many languages. It is almost always unstressed. For example, in English this vowel is related to rhythmic factors, which makes a contrast between stressed syllables and unstressed syllables. However, as was discussed in chapter 2, almost every syllable is a lexical word in SX and every syllable can be stressed so as to realize the full tone(s) of the syllable, except when a grammatical particle or an affix is involved. Thus, stress in SX is a realization of full tones which have to be carried by two moras of the rhyme (weight unit) so that the nuclear vowel (if it is all that the rhyme has) in the syllable of SX should be phonetically and phonologically bimoraic (the tonal structure in SX will be discussed in detail in chapter 5). Schwa /ə/ is too lightly pronounced to play such a phonological role in a syllable of SX. Phonetically speaking, /ɤ/ is the most similar to /ə/, which is strongly supported by some SX loanwords as shown in (55):

(55)	English	SX	
	['maikr**ə**foun]	[maʔ^{22}k**ɤ**^{33}fuŋ^{52}]	'microphone'
	['tʃɔk**ə**lɪt]	[tɕ^{h}jɑɒ^{35}k**ɤ**^{33}lɪʔ^{31}]	'chocolate'

The examples in (55) show that the schwa /ə/ in unstressed syllables in English becomes /ɤ/ in SX loanwords because every syllable in [maʔ^{22}k**ɤ**^{33}fuŋ^{52}] and [tɕ^{h}jɑɒ^{35}k**ɤ**^{33}lɪʔ^{31}] has to be stressed to realize full tones and [ə] and [ɤ] share many phonetic and phonological similarities, as was shown in the OT tableau in (34) and in the examples in (37). However, [ə] only occurs in CV combinations when [ɤ] can occur in an open syllable (or syllable final) in SX. As a result, /ɤ/ is assumed instead of /ə/ in the phonemic vowel system of SX to have phonetic and phonological reality of being stressed in an open syllable.

3.4.2 Tenseness

Specification of [tense] also plays an important role in the six-vowel system of SX and its syllable structure. As was discussed previously, there is a segment filter (45) in the SX syllable structure, which eliminates a [−tense] vowel alone as the syllable final of SX. Schwa [ə] is a [−tense] short vowel so that it is not accepted as a final phonemic vowel in SX because the segment filter requires that all phonemic vowels in open syllables must be [+tense] for the sake of weight. De Boer (2001) proposes that [±tense] is not a phonemic feature but an allophonic feature. This is also true for SX because all [−tense] vowels in SX are in fact allophones of phonemic vowels, and [±tense] is a redundant feature among the phonemic vowels in SX. However, not all languages divide the set of vowels into a tense and a lax subset. Many have two subsets according to tongue-root position, i.e. one [+ATR] set and one [−ATR] set, e.g. /i u e o ə/ are grouped for [+ATR] and /ɪ ʊ ɛ ɔ ɑ/ are grouped for [−ATR]. [ATR] plays an important role in some phonological systems, e.g. vowel harmony in Akan (see Ewen & van der Hulst 2001). Usually, [+ATR] vowels are tensed vowels, so that [ATR] also plays a role in deriving some surface representations from abstract underlying representations, as analysed above. However, in SX, of the 14 surface vowels, only /i u e ɤ o a/ constitute its underlying vowel system because these vowels are in natural class with specification of [tense].

In short, both for the segment filter of the syllable structure and the weight of syllables, specification of [tense] is one of the most important phonetic and phonological factors which make /i u e ɤ o a/ the underlying vowel system of SX. This not only satisfies the tendency of vowel systems of the world's languages to be symmetrical, but also satisfies the phonological demands of SX.

3.5 Summary

In this chapter I have attempted four things. First, I have worked out the constraint ranking for the analysis of the relations between the underlying phonemes and the surface vowels, proposing some constraints and rules which express certain phonological principle in general. Second, I have proposed a segment filter on SX syllable structure, which explains the phonological motivation for the alternation of some underlying phonemes into different variants in surface representation. I claim that a phonemic vowel in SX must be [+tense] to occur in open syllables. Third, I have presented a clear picture of the distribution of all the 14 surface vowels and three surface medial glides of SX, proposing some constraints and rules for either complementary or contrastive distribution. Last but not least, I have worked out an underlying vowel inventory of SX, a symmetrical six-vowel system, including /i u e ɤ o a/, which fits in the general pattern of vowel systems of the world's languages.