

# Glottalization in Southern Wakashan: a comparative study\*

Eun-Sook Kim  
University of British Columbia

Southern Wakashan has a unique phonological phenomenon known as glottalization, which is manifested in different ways in the three sister languages, Nuu-chah-nulth, Ditidaht, and Makah. In addition, the process of glottalization itself interacts with phonetic and morphological factors to determine an output form. This study illustrates the distribution of glottalized sounds and the complex properties of the glottalization patterns observed in Southern Wakashan, concentrating on linguistic variation as well as phonetic and morphological variation.

## 1 Introduction

The Southern Wakashan languages, Nuu-chah-nulth, Ditidaht, and Makah, have a pervasive, though rare cross-linguistically, phonological process known as “glottalization”, where a plain consonant becomes its glottalized counterpart.<sup>1</sup> Phonetically, a glottalized/glottalic sound involves a constriction of the glottis, the aperture between the vocal folds. Some previous studies (Sapir 1938, Rose 1976) claim that the triggering factor is an adjacent glottal stop /ʔ/.

This study illustrates the distribution of glottalized sounds and the unique properties of the glottalization patterns observed in Southern Wakashan, concentrating on variation between the three sister languages, Nuu-chah-nulth, Ditidaht, and Makah.

Section 2 provides the phonemic inventory of each language. Section 3 illustrates examples according to language, phonetic and morphological categories, and section 4 discusses phonetic, phonological, and morphological properties exhibited by the glottalization process, and variation between these three languages. Section 5 summarizes the key ideas of this study.

## 2 Phonemic consonant inventories

The inventories of phonemic consonants in each language exhibit not only

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<sup>1</sup> I use the name Nuu-chah-nulth in this paper rather than Nootka, which the people dislike. Because Nootka and Ditidaht people both call themselves Nuu-chah-nulth, the name Nuu-chah-nulth is used only for linguistic distinction in this paper. Nuu-chah-nulth is spoken on the west coast of Vancouver Island from Barkley Sound north to Quatsino Sound, Ditidaht on the southwest coast of Vancouver Island south of Barkley Sound and Makah on Cape Flattery, the northwest tip of the Olympic Peninsula. The Nuu-chah-nulth data are from Ahousaht, one of its 13 dialects.

the fact that glottalized consonants are independently phonemic but also which kinds of consonants are affected in glottalization. (Here, shaded cells indicate that there are differences between the three languages with respect to relevant consonants).

(1) The phonemic consonant inventory of Nuu-chah-nulth

	Labial	Alveolar	Palatal	Lateral	Velar	Labio-Velar	Uvular	Labio-Uvular	Pharyngeal	Glottal
Stops	p	t			k	k <sup>w</sup>	q	q <sup>w</sup>		
Glottalized	p̚	t̚			k̚	k̚ <sup>w</sup>			ʕ	ʔ
Affricates		c	č	ʎ						
Glottalized		c̚	č̚	ʎ̚						
Fricatives		s	š	ʦ	x	x <sup>w</sup>	χ	χ <sup>w</sup>	ħ	h
Sonorants	m	n	y			w				
Glottalized	m̚	n̚	y̚			w̚				

(2) The phonemic consonant inventory of Ditidaht

	Labial	Alveolar	Palatal	Lateral	Velar	Labio-Velar	Uvular	Labio-Uvular	Pharyngeal	Glottal
Stops	p b	t d			k	k <sup>w</sup>	q	q <sup>w</sup>		
Glottalized	p̚	t̚			k̚	k̚ <sup>w</sup>			ʕ	ʔ
Affricates		c	č	ʎ						
Glottalized		c̚	č̚	ʎ̚						
Fricatives		s	š	ʦ	x	x <sup>w</sup>	χ	χ <sup>w</sup>	ħ	h
Sonorants	(m)	(n)	y	l		w				
Glottalized			y̚			w̚				

(3) The phonemic consonant inventory of Makah (Jacobsen 1999)

	Labial	Alveolar	Palatal	Lateral	Velar	Labio-Velar	Uvular	Labio-Uvular	Pharyngeal	Glottal
Stops	p b	t d			k	k <sup>w</sup>	q	q <sup>w</sup>		
Glottalized	p̚	t̚			k̚	k̚ <sup>w</sup>	q̚	q̚ <sup>w</sup>		ʔ
Affricates		c	č	ʎ						
Glottalized		c̚	č̚	ʎ̚						
Fricatives		s	š	ʦ	x	x <sup>w</sup>	χ	χ <sup>w</sup>	ħ	h
Sonorants	(m)	(n)	y	l		w				
Glottalized			y̚			w̚				

Consonants in Southern Wakashan exhibit an extensive range of contrasts in place of articulation as the charts (1-3) show. This property is typical of indigenous languages spoken on the northwest coast of North America.

Most stops, affricates, and sonorants have a glottalized counterpart. In both Nuuchahnulth and Ditidaht, stops do not have glottalized counterparts in the uvular and labio-uvular areas, and both Ditidaht and Makah do not have glottalized counterparts of each voiced stop. On the other hand, each language lacks glottalized fricatives, showing an asymmetry in the distribution of plain-glottalized pairs between obstruents.

Ditidaht and Makah both have voiced stops and a lateral, but Nuuchahnulth does not. In addition, whereas Ditidaht and Makah do not have glottalized nasals and even plain nasals are very rare (present only in loan words from neighbouring languages), Nuuchahnulth has both.

Variation between these three languages can be explained as follows.

First, Proto-Southern-Wakashan nasals *\*m* and *\*n* changed into voiced stops /b/ and /d/ respectively in Ditidaht and Makah. This is an areal feature of the Northwest coast, affecting languages in three different linguistic families, Wakashan, Chemakuan, and Salishan, and in Wakashan, only Ditidaht and Makah underwent this change (Haas 1969, Jacobsen 1969). This may have led to the absence of glottalized nasals in these two languages.

Second, a Proto-Southern-Wakashan lateral *\*l* changed into an alveolar nasal /n/ in Nuuchahnulth (Haas 1969).

Third, in Nuuchahnulth and Ditidaht, Proto-Southern Wakashan glottalized uvular and labio-uvular stops *\*q̣* and *\*q̣ʷ* were merged into a pharyngeal stop /ʕ/, but Makah preserves these two sounds. The following chart shows the correspondences in pharyngeal stops in Southern Wakashan:

#### (4) Correspondences in pharyngeal stops in Southern Wakashan

(Data from Jacobsen 1969)

Proto-Southern Wakashan	Nuuchahnulth	Ditidaht	Makah
*q̣	ʕ ʕakʷ- 'to cut with a knife'	ʕ ʕakʷ- 'to cut with a knife'	q̣ q̣akʷ- 'to cut sideways with a knife'
*q̣ʷ	ʕ ʕaçaq 'white and wrinkled of body from soaking in water'	ʕ ʕaçaqk 'fresh fish'	q̣ʷ q̣ʷaçaq 'soft or partly dried fish'

### 3 Glottalization in Southern Wakashan

In Southern Wakashan, some suffixes trigger glottalization of an immediately preceding sound. The examples in (5-6) show both glottalizing and non-glottalizing suffixes: *-ʔap* 'CAUS' in Nuuchahnulth and *-ʔaqʕ* 'inside' in Ditidaht are examples of glottalizing suffixes and *-ʔiṣ* '3sg/IND' and *ʔasʕa* 'front'

are not:<sup>2,3</sup>

(5) Nuu-chah-nulth

yaaʔak-ʔap-ʔiš      John      →      yaaʔakapʔiš    John.  
care-CAUS-3sg/IND      'She likes John'

(6) Ditidaht

ʔu-ʔuʔt-ʔaqʔ-ʔasʔa-ʔa      →      ʔuʔuʔtʔaqʔʔasʔaʔa  
RED-stay-inside-front-3sg      '(Something) staying in the front inside'

When a glottalizing suffix attaches to a stem, an immediately preceding plain consonant becomes its glottalized counterpart. However, the triggering aspects of a glottalizing suffix are different according to the morphological category of the suffix. In Southern Wakashan, suffixes are classified into derivational (lexical) or inflectional (grammatical) ones. Derivational suffixes either provide an independent part of the word's meaning or a dependent meaning which is completed only in conjunction with the total meaning of the root-suffix combination (Rose 1976). They are ordered between the root and inflectional suffixes. On the other hand, inflectional suffixes consist of elements which provide Tense, Mode, Modal, and person marking. While derivational suffixes glottalize all immediately preceding obstruents, inflectional ones do not affect fricatives. In addition to the morphological factor, there are phonetic factors to consider in order to completely understand glottalization in the Southern Wakashan languages. Not every preceding consonant is affected: stops/affricates are consistently glottalized, but fricatives and sonorants/voiced stops are not always glottalized. Finally, there is variation between the three sister languages with respect to glottalization. In the following sections, I will provide data according to language, manner of articulation and morphological category of glottalizing suffixes.

### 3.1 Nuu-chah-nulth

#### 3.1.1 Glottalization triggered by a derivational suffix

In Nuu-chah-nulth, the glottal element of a derivational glottalizing suffix always causes a preceding stop/affricate to be glottalized as shown in (7), but preceding fricatives are only glottalized in certain lexical items as in (8); however, note that they become a glottalized glide, either /w̥/ as in (8a) or /y̥/ as in (8c), depending upon place of articulation of each fricative. As shown in (9a-d), nasals are rarely glottalized by a glottalizing suffix, although there are some cases of glottalization as in (9e).

#### I. Stops/affricates

(7) a. tupk-ʔaqʔ      →      tupkʔaqʔ  
black-inside/consuming      '(something) black inside'

<sup>2</sup> I do not have Makah data for this.

<sup>3</sup> Abbreviations used in this paper are: CAUS=causative, sg=singular, IND=indicative, RED=reduplication, SEQ=sequential, POSS=possessive, NEG=negative, NEU=neutral, DEF=definite, MOM=momentaneous.

b. wik-stup-ʔaqʔ	→	wikstupaqʔ
not-thing-inside		‘nothing inside’
c. maʔ-ʔaaʔa	→	maʔaaʔa
tied-on the rock		‘being tied to the rock’
d. haskaamac-ʔic	→	haskaamaʔic
crab-eating		‘eating crabs’

## II. Fricatives

(8) a. tʰuh-ʔaqʔ	→	tʰuʔaqʔ
head-inside/consuming		‘eating (fish) head’
b. ʔih-ʔaqʔ-ʔak	→	ʔihʔaqʔʔak
driving-inside/consuming-instrument		‘shirt’
c. kʷis-ʔic	→	kʷiyic
snow-eating		‘eating snow’
d. ciyapuxs-ʔic	→	ciyapuxsʔic
hat-eating		‘biting a hat’

## III. Sonorants (nasals)<sup>4</sup>

(9) a. haʔum-ʔaqʔ	→	haʔumʔaqʔ
food-inside		‘food inside (of something)’
b. siicmin-ʔaqʔ	→	siicminʔaqʔ
maggot-inside		‘maggot inside (of something)’
c. huqsum-ʔaaʔa	→	huqsumʔaaʔa
goose-on the rock		‘geese on the rock’
d. hičin-ʔaaʔa	→	hičinʔaaʔa
little-neck clam-on the rock		‘little-neck clams on the rock’
e. ʕam-ʔaqʔ	→	ʕamaʔaqʔ
? -inside		‘the oven/bread pan’

### 3.1.2 Glottalization triggered by an inflectional suffix

An inflectional glottalizing suffix causes a plain stop/affricate to be glottalized as shown in (10), while it never affects a fricative and a nasal as shown in (11) and (12).

<sup>4</sup> Nuu-chah-nulth has no morphemes ending with a glide, /y/ or /w/, so it is not possible to test their behaviour in the process of glottalization.

I. Stops/affricates

- (10) a. kúupup-ʔaʔ hanging-SEQ → kúupupaʔ 'to hang (something)'  
 b. ʔuuc-ʔaʔ belonging to-SEQ → ʔuucáʔ 'to belong to (someone)'

II. Fricatives

- (11) a. kʷis-ʔaʔ-uk-ʔick snow-SEQ-POSS-2sg → kʷisʔaʔukʔick 'You have snow.'  
 b. wik-paʔ-ʔaʔ NEG-around-SEQ → wikpaʔʔaʔ 'None around now'

III. Nasals

- (12) a. waa-cum-ʔaʔ-sa say-would-SEQ-1sg/NEU → waacumʔaʔsa 'I would say...'  
 b. hinin-ʔaʔ-ʔiš arrive-SEQ-3sg/IND → hininʔaʔʔiš 'S/he arrived finally.'

The following chart summarizes the aspects of glottalization in Nuu-chah-nulth:

(13) The aspects of glottalization in Nuu-chah-nulth

(A: always glottalized, S: sometimes, N: never, R: rare)

Manner of Articulation	Suffix	
	Derivational	Inflectional
Stops/affricates	A	A
Fricatives	S	N
Nasals	R	N

3.2 Ditidaht

3.2.1 Glottalization triggered by a derivational suffix

In Ditidaht, glottalization of stops/affricates is the same as in Nuu-chah-nulth: an immediately preceding plain stop/affricate becomes its glottalized counterpart as shown in (14). However, while an immediately preceding fricative is only affected in certain lexical items (15a-c vs. 15b-d), as in Nuu-chah-nulth, the affected fricative, as shown in (15a-c), does not become a glottalized glide; it becomes a plain glide, unlike Nuu-chah-nulth. That is, the glottal element is deleted

when changing a preceding fricative to a glide. Ditidaht has variable stops, which appear in root-final position and whose voicing value is determined by the first segment of a following suffix. As shown in (16a), a variable stop becomes voiceless when a suffix starting with a vowel is attached. It becomes voiced when a derivational glottalizing suffix, whose initial part is always a glottal element, is attached, as in (16b). When a derivational glottalizing suffix is attached to a stem ending with a voiced stop or a liquid, the glottal element is deleted and the vowel of an immediately preceding syllable is lengthened as shown in (17).

### I. Stops/affricates

- (14) a.  $\text{ʔu-stuup-ʔaas-ʔa}$  →  $\text{ʔustuupʔaasa}$   
 It-thing-on the ground-3sg/IND 'There is something on the ground'
- b.  $\text{wik-ʔeet-ʔa}$  →  $\text{wikeeʔa}$   
 NEG-existing-3sg/IND 'there is nothing'
- c.  $\text{weʔic-ʔaas}$  →  $\text{weʔiʔaas}$   
 sleeping-on the ground 'sleeping on the ground'
- d.  $\text{ʔu-ʔiʔ-ʔaas-ʔa}$  →  $\text{ʔuʔiʔʔaasa}$   
 It-take-going to... -3sg/IND 'S/he is going somewhere to get something'

### II. Fricatives

- (15) a.  $\text{kʷiis-ʔaaʔs}$  →  $\text{kʷiiaaʔs}$   
 snow-vessel 'snow in a boat'
- b.  $\text{ʔis-ʔaaʔs}$  →  $\text{ʔisʔaaʔs}$   
 white-vessel '(something) white inside of a boat'
- c.  $\text{quuʔ-ʔaaqʔ}$  →  $\text{quuwaaqʔ}$   
 frozen-inside '(something) frozen inside'
- d.  $\text{haaʔub-ataʔ-ʔaas}$  →  $\text{haaʔubataʔʔaas}$   
 food-going after-going to... 'going somewhere to go fishing'

### III. Variable stop

- (16)  $\text{ʔuP-}$  'hot, warm'
- a.  $\text{ʔuP-aaʔ}$  →  $\text{ʔupaʔ}$   
 hot,warm-surface 'hot'
- b.  $\text{ʔuP-ʔaaʔs}$  →  $\text{ʔubaʔs}$   
 hot,warm-liquid 'hot water'

#### IV. Voiced stops/lateral

- (17) a. haʔad-ʔaas → haʔaadaas  
 LOC-inside 'there is (something) inside'
- b. ʕub-ʔaaʁs → ʕuubaʁs  
 washing-vessel 'washing (inside of) a canoe'
- c. sapliil-ʔaaqʔ → sapliilaaqʔ  
 bread-inside '(there is) bread inside'

#### 3.2.2 Glottalization triggered by an inflectional suffix

Ditidaht inflectional glottalizing suffixes cause a plain stop/affricate to be its glottalized counterpart as in (18). This is the same effect as that observed in Nuuchah-nulth. In the case of a fricative, on the other hand, the glottal element of an inflectional glottalizing suffix is deleted (as it is in a derivational glottalizing suffix), but an immediately preceding fricative is never affected, as in (19). Finally, the glottal element of an inflectional glottalizing suffix immediately following a voiced stop/liquid disappears, but it does not cause compensatory lengthening of a preceding vowel. This is shown in (20).

##### I. Stops/affricates

- (18) a. wik-ʔaq → wikaq  
 NEG-DEF 'the one (who is) not...'
- b. wik-stuup-ʔa → wikstuupa  
 NEG-thing-3sg/IND 'it is nothing'
- c. qaʁ-ʃiʔ-ʔaq → qaʁʃiʔaq  
 dying-MOM-DEF 'the dead (one)'

##### II. Fricatives

- (19) a. baʔas-ʔaq → baʔasaq  
 house-DEF 'the house'
- b. ʕupaaʔ-ʔa → ʕupaaʔa  
 warm-3sg/IND 'it is warm'

##### III. Voiced stops/liquid

- (20) a. ʔawatiid-ʔaq → ʔawatiidaq  
 eagle-DEF 'the eagle'
- b. haʔub-ʔaq → haʔubaq  
 food-DEF 'the food'
- c. sapliil-ʔaq → sapliilaq  
 bread-DEF 'the bread'



The following chart summarizes the aspects of glottalization in Ditidaht:

(21) The aspects of glottalization in Ditidaht

(A: always glottalized, S: sometimes, N: never, R: rare)

Manner of Articulation	Suffix	
	Derivational	Inflectional
Stops/affricates	A	A
Fricatives	N; becoming a glide	N; deleting the glottal element
Variable stop	N; voicing	Not applicable
Voiced stop/lateral	N; deleting the glottal element & lengthening a preceding vowel	N; deleting the glottal element but no lengthening

### 3.3 Makah<sup>5</sup>

#### 3.3.1 Hardening (glottalization) triggered by a formative (derivational) suffix

As in Nuu-chah-nulth and Ditidaht, a formative hardening (derivational glottalizing) suffix causes a preceding stop/affricate to become its glottalized counterpart as (22) shows. On the other hand, in the case of a fricative, the glottal element of a hardening suffix disappears, lengthening a preceding vowel and changing the fricative to a plain glide. Fricatives in Makah behave similarly to Ditidaht, except that glottalizing suffixes in Ditidaht do not cause the lengthening of a preceding vowel.<sup>6</sup> When a fricative is not affected by a glottalizing suffix, however, there is always a vowel inserted between a preceding fricative and a glottalizing suffix as shown in (23b) and (d). The value of the inserted vowel seems to be determined by the vowel of the preceding syllable. Furthermore, the inserted vowel is always long. As in Ditidaht, variable stops/liquids become voiced when preceding a formative hardening suffix, lengthening a preceding vowel and deleting the glottal element as shown in (24).

<sup>5</sup> Compared to Nuu-chah-nulth and Ditidaht, Makah seems to be more complex with respect to glottalization. (For more detail, I refer the reader to Jacobsen (1996), which provides a comprehensive description of glottalization in Makah.) I only cite the part of the Makah data which is relevant for my discussion. All the Makah data are from Jacobsen (1996); I cite examples intact and use his terminology in this section, along with mine. In the data, V' indicates a variable-length vowel, which is short in the third or a later syllable of a word, but long in the first two syllables and <'> represents an element causing a glottalization effect. Also, Jacobsen distinguishes suffixes as 'formative' or 'incremental' adopting Sapir & Swadesh (1939). The former is equivalent to 'derivational' and the latter 'inflectional'. The term 'hardening' for glottalization, first introduced in Boas (1911, 1947 cited in Jacobsen 1996), is used in Jacobsen (1996).

<sup>6</sup> According to Jacobsen (1996), a uvular fricative /x/ resists the change always yielding a sequence of a uvular fricative and a glottal stop (and there is always an inserted vowel between them): e.g. ʔapx 'to flap, fly' - 'aʔatu 'down' → ʔapxaʔaʔat.

### I. Stops/affricates

- (22) a. tɪtʉp-ʼiks → tɪtʉupɪks  
octopus-consume 'consuming octopus'
- b. hɪkʷat-ʼas → hɪkʷatʰas  
to stumble-on the ground 'to stumble on the ground'
- c. ɕʷiʰ-ʼaɕatu → ɕʷiʰʰaɕat  
landslide-down 'landslide to come down'
- d. tɪc-ʼa → tɪcʰa  
cloth spread out-on the rock 'cloth spread on rocks'

### II. Fricatives

- (23) a. ɕus-ʼas → ɕuyas  
to dig-in the ground 'hole dug in the ground'
- b. hus-ʼiʰta → husuʰiʰt  
wrinkled-nose 'wrinkled nose'
- c. kaxʷ-ʼaɕatu → ka waɕat  
to fall-down 'to fall down (from something)'
- d. sixʷ-ʼiʰta → sixʷiʰiʰt  
scabby-nose 'scabby nose'

### III. Variable stops/lateral

- (24) a. ʰuP-ʼaxs → ʰuʰbaxs  
hot,warm-in a vessel 'hot water'
- b. kʷiT-ʼa → kʷiʰda  
stuck on-on a rock 'stuck on a rock'
- c. baL-ʼiʰta → baʰiʰt  
cold-nose 'cold nose'

#### 3.3.2 Hardening (glottalization) triggered by an incremental (inflectional) suffix

As far as a stop/affricate is concerned, the glottalization effect triggered by an incremental suffix is the same as that triggered by a formative suffix. Each stop/affricate becomes its glottalized counterpart as shown in (25). This is exactly what occurs in both Nuu-chah-nulth and Ditidaht. On the other hand, an incremental suffix does not affect fricatives with the deletion of the glottal element, as shown in (26). Variable stops/liquid cannot be tested, according to Jacobsen

(1996), since “they do not end free forms which can take incremental suffixes.”

### I. Stops/affricates

- (25) a. čakup-’uuc → čakupuc  
 husband-3sg/POSS ‘her husband’
- b. tupa t-’uuc → tupaʔuc  
 family’s privileges’-3sg/POSS ‘his family’s privileges’
- c. ɕidiʔ-’uuc → ɕidiʔuc  
 dog-3sg/POSS ‘his dog’
- d. čapac-’uuc → čapauc  
 canoe-3sg/POSS ‘his canoe’

### II. Fricatives

- (26) a. baʔas-’uuc → baʔasuc  
 house-3sg/POSS ‘his house’
- b. laʔlačx-’uuc → laʔlačxuc  
 flower-3sg/POSS ‘her flower’

The following chart summarizes the aspects of glottalization in Makah:

#### (27) The aspects of glottalization in Makah

(A: always glottalized, S: sometimes, N: never, R: rare)

Manner of Articulation	Suffix	
	Derivational	Inflectional
Stops/affricates	A	A
Fricatives	N; becoming a glide & lengthening a preceding vowel; inserting a vowel for no glottalization	N; deleting the glottal element
Variable stops	N; voicing & lengthening a preceding vowel	Not applicable

## 4 Discussion<sup>7</sup>

As we saw in section 3, the Southern Wakashan languages exhibit very unique and complex properties in terms of glottalized consonants and glottalization. In this section, I will discuss phonetic, phonological and morphological properties of

<sup>7</sup> The goal of this study is to compare the three sister languages with respect to glottalization, without applying any theoretical perspective; see Kim (2001) for a theoretical analysis.

the process of glottalization and variation between the languages.

Consider the following chart summarizing similarities and differences between the three languages; here, I exclude voicing and the fact that a fricative becomes a plain glide when preceding a derivational glottalizing suffix, focusing on glottalization itself only:

(28) Aspects of glottalization in Southern Wakashan

(A: always glottalized, S: sometimes, N: never, R: rare)

Aspects of Glottalization	Languages					
	Nuu-chah-nulth		Ditidaht		Makah	
	Der.	Suf. Inf. Suf.	Der.	Suf. Inf. Suf.	Der.	Suf. Inf. Suf.
Stops/affricates	A	A	A	A	A	A
Voiced stops	Not applicable		N	N	Not applicable	
Fricatives	S	N	N	N	N	N
Sonorants	R	N	Not applicable		Not applicable	

First, in these languages only some suffixes cause glottalization. This morphological property raises a question: how does one distinguish the glottal element of a glottalizing suffix and that of a non-glottalizing suffix. Kim (2001) suggests that a glottalizing suffix includes a floating [C.G.] feature in the initial position of the suffix, whereas a non-glottalizing suffix has a glottal stop /ʔ/. (See Kim 2001 for more detailed discussion)

Second, phonetic properties determine the surface form of an input consonant. Stops and affricates never fail to be glottalized in Southern Wakashan. However, fricatives in the three languages are never glottalized; sometimes a glide appears on the surface, whether it is plain or glottalized. In the case of Makah, concomitant vowel lengthening occurs. Voiced consonants, particularly nasals in Nuu-chah-nulth, and voiced stops and a liquid in Ditidaht, are not glottalized by a glottalizing suffix. In Nuu-chah-nulth, a nasal is rarely glottalized, and in Ditidaht, voiced stops and a liquid are never glottalized; instead, the glottal element is deleted, lengthening a preceding vowel.<sup>8</sup> Finally, in both Ditidaht and Makah, variable stops (and a variable liquid in Makah) appear as voiced stops (and as a voiced liquid) when preceding a derivational glottalizing suffix. In the case of Makah, a preceding vowel also becomes long.

According to Sapir (1938), a very large number of American indigenous languages have glottalized stops/affricates (ejectives) but glottalized fricatives are very rare. Also, glottalized sonorants are more frequent than glottalized fricatives. The rarity of glottalized fricatives and the lack of glottalization of fricatives can be explained by articulatory mechanisms in sound production. When a fricative is

186 <sup>8</sup> The glottalization of voiced stops is not discussed in Jacobsen (1969).

produced, an air tunnel is formed, by which friction of air energy is made. On the other hand, a glottalic sound is produced by a combination of constriction and rapid vertical movement of the glottis and air compression in a small chamber in the mouth. Consequently, if a fricative is produced accompanied with a constriction of the glottis, there is not enough air movement for a fricative, which makes it difficult to make a glottalized fricative (Wang 1968, Greenberg 1970, Lindau 1984, and Vaux 1998). When it comes to glottalization of a sonorant or a voiced stop, the rarity of glottalization of sonorants or voiced stops is also associated with articulatory disharmony: the vibration of vocal folds for voiced sounds contradicts a glottal constriction. Kim (2001) suggests that even if Nuu-chah-nulth has glottalized sonorants, which are significantly devoiced compared to their plain counterparts, sonorants are rarely glottalized by a glottalizing suffix because of this phonetic factor.

Third, there are differences between glottalizing suffixes in terms of triggering power. In Nuu-chah-nulth, glottalizing suffixes, whether derivational or inflectional, consistently cause glottalization of stops/affricates. On the other hand, fricatives and nasals exhibit variation depending on morphological category. Derivational suffixes only affect some stem-final fricatives, whereas inflectional suffixes never do. In nasals, there are three cases of glottalization triggered by derivational suffixes, although they do not generally affect nasals, while inflectional suffixes do not cause a nasal to become glottalized.

In Ditidaht, a stem-final fricative becomes a glide when preceding a derivational glottalizing suffix, but the glottal element of an inflectional suffix is deleted when following a fricative. In voiced consonants, a derivational suffix triggers the lengthening of a preceding vowel, even if its glottal element is deleted, while there is no lengthening triggered by an inflectional suffix.

In Makah, derivational suffixes cause a stem-final fricative to become a glide, lengthening a preceding vowel along with the deletion of the glottal element, while inflectional suffixes only delete their glottal element.

Fourth, there are various phonetic/phonological aspects driven by glottalizing suffixes. The glottal element of a glottalizing suffix not only glottalizes an immediately preceding consonant but also causes various phonological phenomena, triggering the emergence of a plain glide, lengthening a preceding vowel, or determining a voicing value of a variable stop. In Nuu-chah-nulth, a glottalized glide surfaces as the glottalized counterpart of an input plain fricative when preceding a derivational glottalizing suffix. In Ditidaht and Makah, although the glottal element of a glottalizing suffix disappears on the surface when following a fricative, the suffix causes a fricative to become a glide, and furthermore, in Makah, triggers the lengthening of a preceding vowel. These phonological properties of a glottalizing suffix are rare cross-linguistically.

Finally, of the three languages, Ditidaht and Makah have more commonalities in terms of the phonemic inventory and the process of glottalization, while Nuu-chah-nulth and Ditidaht have a geographically closer relationship. Both Ditidaht and Makah have voiced stops and a liquid, and lack their glottalized counterparts. Besides, in the process of glottalization, both languages exhibit the same results especially in fricatives: the emergence of a plain glide when preceding a derivational glottalizing suffix. Also only in Ditidaht and Makah, vowel lengthening triggered by a glottalizing suffix is observed. On the other hand, all the three sister languages show the common property that voiced consonants are not

glottalized by a glottalizing suffix, while voiceless stops/ affricates never fail to be glottalized.

## 5 Conclusion

We have seen the distribution of glottalized consonants and glottalization in Southern Wakashan, Nuu-chah-nulth, Ditidaht, and Makah. It is noted that to completely understand the process of glottalization, we should consider phonetic, phonological, and morphological properties of the languages.

Although the three languages exhibit the same characteristics in the glottalization of stops/affricates, there is variation between them in terms of the glottalization of fricatives: some stem-final fricatives are glottalized, surfacing as a glottalized glide in Nuu-chah-nulth, but in Ditidaht and Makah, a fricative is never glottalized although there are some effects driven by a glottalizing suffix, such as the emergence of a plain glide with the deletion of the glottal element and lengthening of a preceding vowel.

This study shows that Ditidaht and Makah have more commonalities in their phonologies: the phonemic inventory and glottalization.

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