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# Diastereoselective $\beta$ -Hydroxy Vinylsulfone Isomerizations

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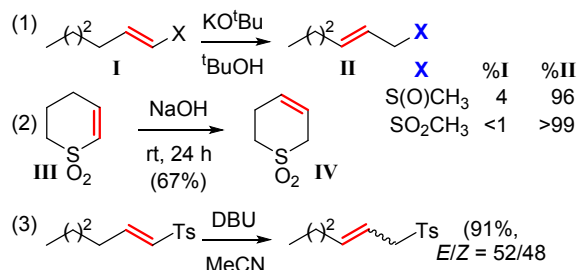
**Abstract.** Vinylic phenylsulfones containing a  $\beta$ -hydroxyl stereocenter undergo a diastereoselective isomerization to the corresponding allylic isomer upon treatment with 1,8-diazabicyclo(5.4.0)undec-7-ene (DBU). Diastereoselectivity of this reaction increases with increasing size of the group attached to the carbinol carbon (up to >20:1 d.r. with a *tert*-butyl). Isolated yields of the isomerized allylic 1,2-hydroxy phenylsulfone products were comparable among the different vinylsulfones tested (59-66%). The major competing pathway was a C-C bond cleavage process, proposed to occur after the initial isomerization event. The sense of diastereoselection was consistent among all substrates investigated, in favor of the *erythro*-isomer based on NMR analysis.

## Introduction

The positional isomerization of carbon-carbon double bonds continues to attract considerable attention as a synthetic tool,<sup>1</sup> owing to the wide availability of olefins as feedstock chemicals and the presence of C-C double bonds in final target structures. Additionally, this transformation benefits from positive atom economy,<sup>2</sup> in line with green chemistry principles.<sup>3</sup> Often, but not always,<sup>4-6</sup> these processes are driven by thermodynamic considerations, where a less-stable C-C double bond is selectively isomerized to a more stable position. Examples include the isomerization of  $\gamma,\beta$ -unsaturated esters<sup>7</sup> and allylbenzenes<sup>8</sup> to their conjugated isomers. Isomerization can also occur sequentially over longer distances in the presence of metal catalysts such as palladium<sup>9,10</sup> and ruthenium,<sup>11,12</sup> favoring formation of the most stable double bond positional isomer. Preventing this thermodynamically controlled chain walking isomerization, for example to select for a monoisomerization product, presents a challenge for these types of processes.<sup>13</sup>

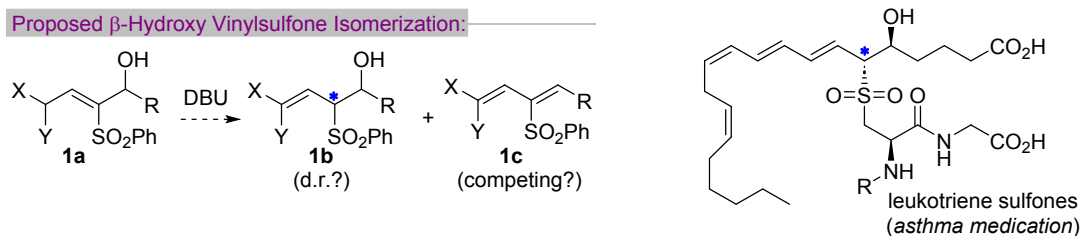
In 1964, O'Connor and Lyness reported a deconjugative monoisomerization of vinyl sulfoxides and sulfones to their allylic isomers upon treatment with potassium *tert*-butoxide (Scheme 1, eq. 1).<sup>14</sup> This was consistent with Fehnel's previous observation that cyclic vinylsulfone **III** readily tautomerizes to **IV** in the presence of sodium hydroxide (eq. 2).<sup>15</sup> Later, Inomata and coworkers showed that a weaker base DBU is similarly capable of vinylic- to allylic sulfone isomerizations, and also studied stereochemical aspects (e.g. *E:Z* ratios of the products) of this transformation (eq. 3).<sup>16-19</sup> Inomata's protocol was subsequently adopted for the total synthesis of the natural products ingenol<sup>20</sup> and avermectin B1a,<sup>21</sup> and has also featured in the synthesis of vinyl azides.<sup>22</sup> Theory supports a thermodynamic preference for the allylic isomer in these systems, explained in part by the destabilizing effect of a positively charged sulfur attached to an  $sp^2$  hybridized carbon, presumably due to shorter bond lengths and thus closer proximity to the positively charged carbon nucleus.<sup>23</sup>

**Scheme 1.** Previously reported isomerization of vinylsulfones to their allylic isomer.



Recently our group has been investigating reactions of allylic  $\beta$ -hydroxy phenyl sulfones of type **1b** (Scheme 2).<sup>24</sup> Among the different preparative approaches considered for these compounds, one option that surfaced was an isomerization from a vinyl precursor **1a**. This proposal, however, raised several important questions and concerns. Foremost, it was expected that dehydration and formation of the corresponding conjugated diene **1c** would compete. If successful, however, the reaction would produce a new sulfone-containing carbon stereocenter (\*). Sulfone stereocenters can be found in a number of medically relevant molecules,<sup>25</sup> with pertinent examples being the leukotriene sulfones.<sup>26</sup> New approaches to their synthesis could therefore be of value to drug discovery programs. Moreover, the presence of an existing hydroxyl stereocenter in **1a** might render the reaction diastereoselective, providing a handle to control the relative (or absolute if **1a** can be prepared enantioenriched) geometry of the final product.

**Scheme 2.** Proposed isomerization of **1a** for the preparation of allylic  $\beta$ -hydroxy phenylsulfones **1b**.

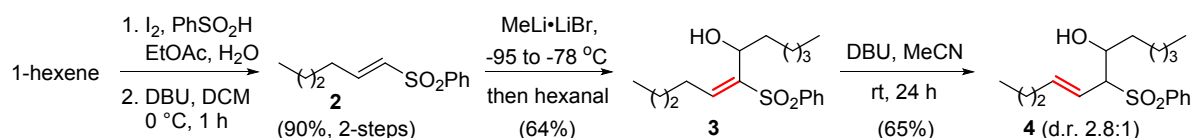


Herein we report results from studies on the diastereoselective isomerization of hydroxy vinylphenylsulfones to *E*-allylic sulfone products. Our results indicate that diastereoselectivity is affected by sterics associated with the group attached to the carbinol carbon ("R" in Scheme 2), and that the sense of diastereoselectivity was the same for all substrates tested in favor of the *erythro*-isomer. Rather than dehydration, the primary competing reaction was a C-C bond cleavage process. Nonetheless, good yields (59-66%) and excellent diastereoselectivity (up to >20:1) of the allylic sulfone product could be obtained.

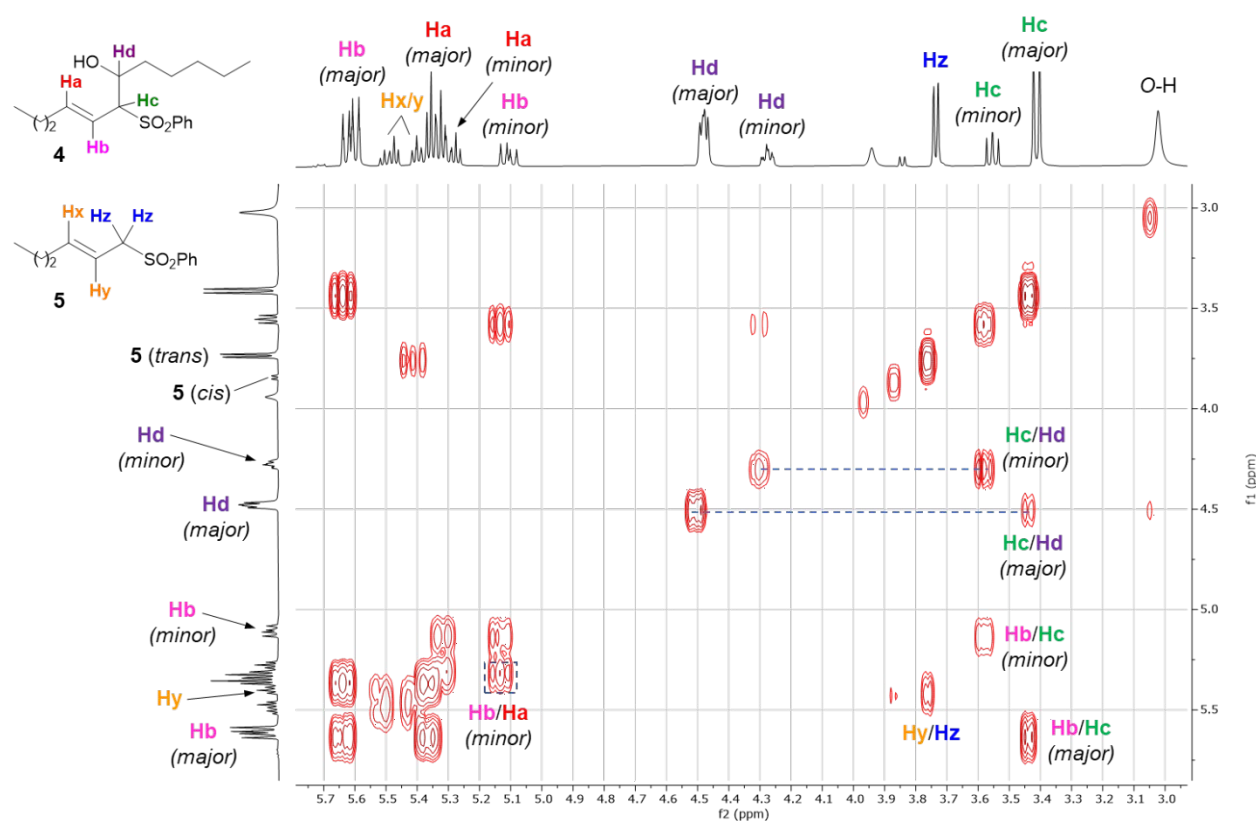
## Results and Discussion

Our studies began with the preparation of  $\beta$ -hydroxy vinylsulfone **3** (Scheme 3). This was accomplished through the union of 1-hexene and hexanal via intermediate vinylsulfone **2** according to the combined procedures of Inomata<sup>16,17</sup> (for vinylsulfone synthesis) and Eisch and Galle<sup>27</sup> (for aldehyde addition). Treatment of **3** with DBU in acetonitrile (MeCN) at room temperature for 24 h resulted in a mixture of products, where the major component was the double-bond isomerized allylic sulfone **4** that was isolated in 65% yield as an inseparable 2.8:1 mixture of diastereomers.

**Scheme 3.** Synthesis and DBU isomerization of  $\beta$ -hydroxy vinyl phenylsulfone **3**.



The use of COSY NMR allowed for the assignment of signals belonging to major- and minor diastereomers of **4** as well as identification of a single component giving rise to unexpected signals in the alkene region that were coupled to a doublet at 3.72 ppm (Figure 1). Further analysis led to the assignment of these signals belonging to allylic sulfone **5**, which was confirmed by comparison to reported NMR data<sup>28</sup> as well as its independent synthesis by the isomerization of **2** with DBU. Interestingly, a ~1:1 *cis:trans* mixture of **5** was obtained from **2** (consistent with Inomata's results<sup>16</sup>), whereas formation of **5** from **3** was highly *trans*-selective under the same conditions.<sup>29</sup> Similarly, only the *trans*-isomer of **4** was observed from the isomerization of **3** by  $^1\text{H}$  NMR analysis ( $J_{ab} = 15.5$  Hz).

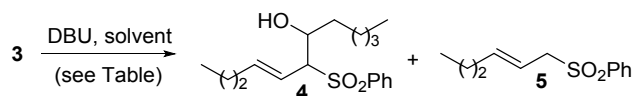


**Figure 1.** COSY NMR spectrum of the product mixture obtained upon treatment of vinylsulfone **3** with DBU in MeCN at room temperature for 24 h. Cross-peak analysis allowed for the assignment of signals  $\text{H}_a$ - $\text{H}_d$  belonging to major- and minor diastereomers of **4** (d.r. 2.8:1) as well as identification of compound **5** as the major side-product.

Other solvents besides MeCN were examined in the DBU isomerization of **3** (Table 1). In general, greater solvent polarity resulted in higher conversions but also increased amounts of side-product **5**. For instance, the reaction in DMSO proceeded with complete conversion but gave a 1.6:1 ratio of **4:5** (Entry 5). Conversely, the use of less polar chloroform ( $\text{CHCl}_3$ ) as solvent under otherwise identical conditions resulted in only 41% conversion, but far greater selectivity for the isomerized product **4** (19.4:1 **4:5**;

Entry 4). An outlier was toluene (PhMe), where lower conversion (31%) was accompanied by significant amounts of **5** (3.6:1 **4**:**5**; Entry 6), greater than what was obtained with MeCN and methanol (MeOH; 6.7-6.8:1 **4**:**5**; Entries 1 and 3). Heating the reaction increased conversion as well as compound **5** formation (Entries 7 and 8). Cooling the reaction (e.g. to 0 °C) or reducing the equivalents of DBU resulted in significantly lower conversion (Entries 9 and 10). Balancing conversion with the yield and d.r. of **4**, the use of MeCN and 4.0 equivalents of DBU at room temperature for 20 h was selected as optimal for this transformation.

**Table 1.** Results from solvent studies on the DBU isomerization of **3**.

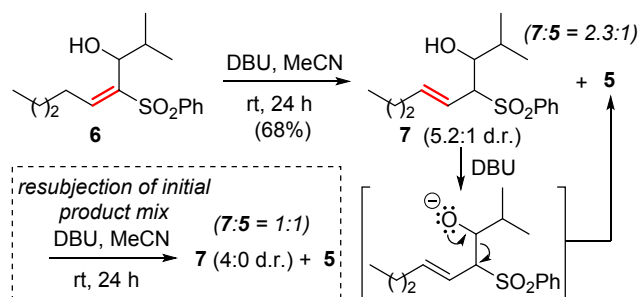


Entry	Solvent <sup>A</sup>	% Conv. <sup>B</sup>	<b>4</b> d.r. <sup>C</sup>	<b>4</b> : <b>5</b> <sup>C</sup>
1	MeCN	88	2.8 : 1	6.8 : 1
2	THF	57	1.6 : 1	20.0 : 1
3	MeOH	68	2.5 : 1	6.7 : 1
4	CHCl <sub>3</sub>	41	2.1 : 1	19.4 : 1
5	DMSO	100	3.3 : 1	1.6 : 1
6	PhMe	31	2.0 : 1	3.6 : 1
7	THF <sup>D</sup>	91	2.1 : 1	1 : 2.0
8	CHCl <sub>3</sub> <sup>D</sup>	52	2.1 : 1	7.2 : 1
9	MeCN <sup>E</sup>	11	ND <sup>F</sup>	ND <sup>F</sup>
10	MeCN <sup>G</sup>	32	2.9 : 1	9.0 : 1

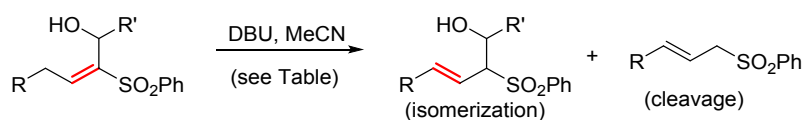
*Notes for Table:* <sup>A</sup>Reactions were performed by adding DBU (4.0 equiv.) to a 0.4 M solution of the vinylsulfone in MeCN and stirring at room temperature for 20 h. <sup>B</sup>Calculated by dividing the product <sup>1</sup>H NMR integration values (major + minor diastereomer) by the sum of product + starting material integrations. <sup>C</sup>From <sup>1</sup>H NMR integrations. <sup>D</sup>Performed at 50 °C. <sup>E</sup>Performed at 0 °C. <sup>F</sup>Not determined. <sup>G</sup>Performed with 2.0 equivalents of DBU.

Side-product **5** was also observed in the mixture obtained from isobutyraldehyde-derived hydroxy vinylsulfone **6** upon treatment with DBU in MeCN at rt for 24 h (Scheme 4). The isomerized product **7** was nonetheless the major component, obtained in 68% isolated yield as a 5.2:1 mixture of diastereomers. Formation of **5** from the reaction of **6** (and **3**) is proposed to proceed via a mechanism involving deprotonation of the hydroxyl group followed by a retro-sulfonyl anion aldehyde addition. In support of this mechanism, resubjection of the initially formed 2.3:1 mixture of **7** and **5** with DBU resulted in increased amounts of **5** relative to **7** (now ~1:1), supporting the intermediacy of **7** in the formation of **5**. There was also a slight erosion in the d.r. of **7** (from 5.2:1 to 4.0:1) upon resubjection, perhaps indicating differences in rate for this C-C bond cleavage process between the two diastereomers of **7**.

**Scheme 4.** Isomerization of **6** and resubjection of the initially formed product mixture. The increased amounts of **5** relative to **7** upon resubjection is consistent with a mechanism involving formation of **7** from **6** followed by the conversion of **7** to **5**.



A series of additional  $\beta$ -hydroxy vinyl sulfones were synthesized and examined in their isomerization with DBU to the corresponding allylic isomer (Table 2). A clear trend was observed with larger groups attached to the carbinol carbon resulting in isomerized products with higher d.r. For instance, a methyl group at this position as in compound **8** gave the isomerized hydroxy allylic sulfone with a d.r. of 1.8:1 (Entry 1), whereas an isopropyl resulted in a d.r. of 5.2:1 (Entry 4, *i*-Pr, **6**), and *tert*-butyl produced a single diastereomer by  $^1\text{H}$  NMR (Entries 7 and 10, *t*-Bu, **10**). Reducing the reaction time for **6** to 16 h (Entry 5) and 8 h (Entry 6) gave lower conversions (86% and 79% respectively) but higher ratios in favor of the isomerized product over C-C bond cleavage, again consistent with a mechanism involving first isomerization followed by retro-sulfonyl anion aldehyde addition (where the rate of isomerization is greater than cleavage). Comparing results for compounds **6** and **12** (Entries 5 and 9 respectively) and compounds **10** and **13** (Entries 5 and 9 respectively) indicate that the nature of the vinyl substituent had less of an effect on the reaction outcome (i.e. similar yields, d.r., and isomerization:cleavage ratios). However, for reasons that are not yet understood, substituting the terminal  $\text{CH}_3$  group in **6** with a phenyl as in compound **14** produced a highly reactive substrate that underwent complete conversion within 8 h (Entry 13). Consistent with our previous results, longer reaction times produced higher amounts of cleavage and a lower d.r. of the product (compare Entries 11-13). Introduction of a phenyl adjacent to the hydroxyl resulted in essentially complete C-C bond cleavage and formation of **5** (Entry 8),<sup>29</sup> perhaps as a result of conjugation afforded to the aldehyde coproduct by this group (i.e. benzaldehyde; *ref.* Scheme 4).

**Table 2.** Results from different  $\beta$ -hydroxy vinyl phenylsulfone reactions with DBU.

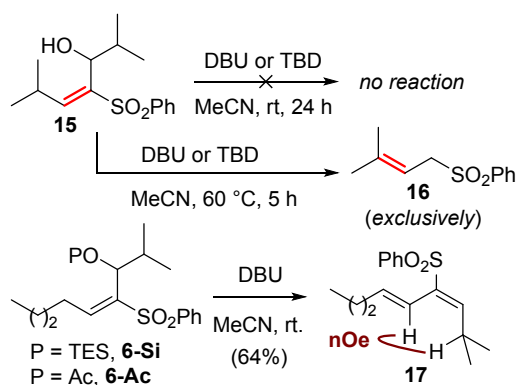
Entry	R	R' (compound #)	% Conversion <sup>A</sup> (% Yield <sup>B</sup> )	d.r. <sup>C</sup>	Isom : Cleav <sup>C</sup>
1	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	Me ( <b>8</b> )	92 (59)	1.8 : 1	2.6 : 1
2	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	<i>n</i> -pent ( <b>3</b> )	89 (65)	2.8 : 1	6.0 : 1
3	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	<i>i</i> -Bu ( <b>9</b> )	89 (61)	2.6 : 1	3.3 : 1
4	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	<i>i</i> -Pr ( <b>6</b> )	95 (60)	5.2 : 1	2.3 : 1
5	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	<i>i</i> -Pr ( <b>6</b> )	86 <sup>C</sup>	5.8 : 1	5.3 : 1
6	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	<i>i</i> -Pr ( <b>6</b> )	79 <sup>D</sup>	4.9 : 1	6.9 : 1
7	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	<i>t</i> -Bu ( <b>10</b> )	100 (64)	>20 : 1	3.2 : 1
8	(CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	Ph ( <b>11</b> )	100	--	1:>10
9	(CH <sub>2</sub> ) <sub>3</sub> OTIPS	<i>i</i> -Pr ( <b>12</b> )	94 (61)	6.1 : 1	3.1 : 1
10	(CH <sub>2</sub> ) <sub>3</sub> OTIPS	<i>t</i> -Bu ( <b>13</b> )	100 (66)	>20 : 1	3.2 : 1
11	(CH <sub>2</sub> ) <sub>2</sub> Ph	<i>i</i> -Pr ( <b>14</b> )	100	3.7 : 1	0.7 : 1
12	(CH <sub>2</sub> ) <sub>2</sub> Ph	<i>i</i> -Pr ( <b>14</b> )	100 <sup>C</sup>	4.0 : 1	0.8 : 1
13	(CH <sub>2</sub> ) <sub>2</sub> Ph	<i>i</i> -Pr ( <b>14</b> )	100 <sup>D</sup> (73)	4.6 : 1	2.0 : 1

Notes: <sup>A</sup>Reactions were performed by adding DBU (4.0 equiv.) to a 0.4 M solution of the vinylsulfone in MeCN and stirring at room temperature for 24 h. Percent conversions were calculated by dividing the product integration values (major + minor diastereomer) by the product + starting material integrations.

<sup>B</sup>Isolated yield after chromatography on silica. <sup>C</sup>Determined by <sup>1</sup>H NMR. <sup>C</sup>The reaction was run for 16 h.

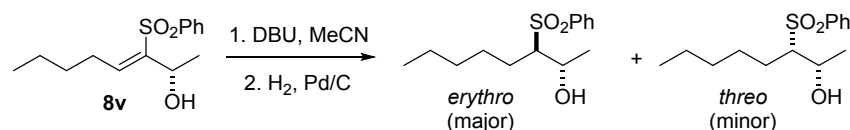
<sup>D</sup>The reaction was run for 8 h.

Attempts to prepare a trisubstituted double bond by isomerization of **15** failed (Scheme 5). Treatment of **15** with DBU or the more basic 1,5,7-triazabicyclo-[4.4.0]dec-5-ene (TBD)<sup>30</sup> in MeCN at room temperature for 24 h gave only unreacted starting material. Heating the reaction to 60 °C produced only the cleavage product **16** by <sup>1</sup>H NMR analysis. Attempted isomerization of silyl ether- and ester derivatives **6-Si** and **6-Ac** resulted primarily in elimination and formation of (*E,E*)-**17**.<sup>31</sup> No evidence for C-C bond cleavage in these reactions was seen by <sup>1</sup>H NMR analysis, consistent with the proposed mechanism for this process involving first deprotonation of the hydroxyl (see Scheme 4).

**Scheme 5.** Attempted isomerizations of **15**, **6-Si** and **6-Ac**.

Marcantoni and Cingolani noted an upfield shift in the  $^{13}\text{C}$  NMR spectrum for the carbinol carbons of  $\beta$ -hydroxy phenylsulfones in the *erythro*-isomer compared with those in the *threo*-isomer.<sup>32</sup> For all products listed in Table 2, the major diastereomer consistently displayed an upfield carbinol signal (as well as an upfield sulfonyl carbon signal) in their  $^{13}\text{C}$  NMR spectrum. Mase and coworkers noted a trend in coupling constants from the  $^1\text{H}$  NMR spectra of beta-hydroxy phenylsulfones that they used for stereochemical assignments.<sup>33</sup> Specifically, the authors state that the *threo*-isomer generally displays a larger coupling constant ( $\sim 6\text{--}8\text{ Hz}$ ) between the carbinol hydrogen and the alpha-sulfonyl hydrogen compared to the *erythro*-isomer ( $1\text{--}1.5\text{ Hz}$ ). The major isomer we obtained in each case displayed a smaller coupling constant ( $1\text{--}1.5\text{ Hz}$ ) between these two protons, consistent with the chemical shift correlations indicating that the *erythro*-isomer is major. To further confirm the *erythro*-isomer as the major stereoisomer from our reactions, the mixture of diastereomers we obtained by isomerization of **8v** was hydrogenated to produce a known compound<sup>33</sup> (Scheme 6). Comparing the  $^1\text{H}$  NMR data we obtained to that previously reported for the two diastereomers<sup>33</sup> again indicated that the major stereoisomer is the *erythro*-isomer.

**Scheme 6.** Hydrogenation of **8a** and comparison of  $^1\text{H}$  NMR data obtained to that previously reported.<sup>33</sup>



$^1\text{H}$  NMR data for the two stereoisomers obtained:

Major				Minor			
$\delta$ (ppm)	Splitting	$J$ (Hz)	# Protons	$\delta$ (ppm)	Splitting	$J$ (Hz)	# Protons
1.27	d	6.7	3	1.34	d	6.4	3
2.88	dt	1.5, 5.4	1	3.06	ddd	4.8, 6.2, 7.0	1
3.2	d	3.8	1	3.52	d	3.7	1
4.34-4.40	m	-	1	4.26-4.33	m	-	1

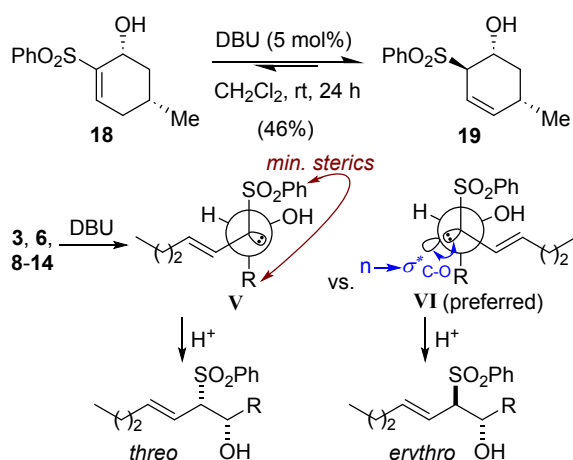
Previously reported  $^1\text{H}$  NMR data for the *erythro* and *threo* isomers:<sup>33</sup>

Erythro				Threo			
$\delta$ (ppm)	Splitting	$J$ (Hz)	# Protons	$\delta$ (ppm)	Splitting	$J$ (Hz)	# Protons
1.27	d	6.6	3	1.34	d	6.3	3
2.88	dt	1.4, 5.4	1	3.03	ddd	4.8, 5.9, 6.7	1
3.2	d	3.8	1	3.51	d	3.6	1
4.20-4.43	m	-	1	4.20-4.43	m	-	1

To our knowledge, only one diastereoselective vinylic to allylic sulfone isomerization has been reported, in this case from cyclic vinylsulfone **18** as part of a synthesis of the C21-C26 segment of apoptolidin



natural products<sup>34</sup> (Scheme 7). Treatment of **18** with DBU resulted in a 1:2.5 equilibrium mixture in favor of the allylic isomer from which **19** could be isolated in 46% yield. Compound **19** was described as a single diastereomer, yet in this case the stereochemical outcome is presumably controlled by the cyclohexene ring conformation energetics (i.e. all groups in **19** are equatorial). Other studies indicate that  $\alpha$ -phenylsulfonyl carbanions exist largely with the lone-pair of electrons in an  $sp^3$ -hybridized orbital.<sup>35,36</sup> The structure of the intermediate anion formed upon deprotonation of the  $\beta$ -hydroxy vinylsulfone with DBU might therefore be best represented by the two Newman projections **V** and **VI**. Sterics are minimized between the phenylsulfonyl- and R groups, which becomes increasingly influential as R becomes larger. Dipole-minimization and hyperconjugation<sup>37</sup> ( $n \rightarrow \sigma^*_{C-O}$ ) would then favor **VI** from which the *erythro*-isomer would be formed. **Scheme 7**. Previously reported diastereoselective  $\beta$ -hydroxy vinylsulfone isomerization of **18** to **19**<sup>34</sup> and proposed model for selective formation of the *erythro*-isomer from acyclic substrates **3**, **6**, and **8-14**.



## Conclusion

In summary,  $\beta$ -hydroxy vinyl phenylsulfones undergo diastereoselective isomerization to the corresponding allylic isomer upon treatment with DBU at room temperature. Diastereoselectivity increases with increasing sterics associated with the group attached to the carbinol carbon (e.g. 1.8:1 for Me vs 5.2:1 for *i*-Pr and >20:1 for *tert*-butyl). A competing C-C bond cleavage also occurs during the reaction, which appears to be promoted by higher polarity solvents like DMSO and higher temperature. When performed at room temperature in acetonitrile for 24 h, isolated yields of the isomerized allylic  $\beta$ -hydroxy sulfone products were consistently around 60%. Current efforts are directed at further optimizations and scope studies, as well as investigating strategic applications of the isomerization reaction (and C-C bond cleavage) to the preparation of valuable synthetic targets.

## Experimental Section

**General Information.** All reactions were carried out in vessels under a nitrogen atmosphere unless otherwise specified. Dry solvents were prepared by passing the solvent through a column of activated alumina under nitrogen immediately prior to use. All reagents were purchased and used as received

unless mentioned otherwise. TLC analysis used 0.25 mm silica layer fluorescence UV<sub>254</sub> plates. Column chromatography: silica gel (230-400 mesh). IR: FT-IR with single-bounce diamond ATR. NMR: Spectra were recorded on a 500 MHz spectrometer in CDCl<sub>3</sub>; chemical shifts ( $\delta$ ) are given in ppm, coupling constants ( $J$ ) in Hz. Solvent signals were used as references (CDCl<sub>3</sub>:  $\delta$  77.0 ppm; residual CHCl<sub>3</sub> in CDCl<sub>3</sub>:  $\delta$  7.26 ppm). HRMS: quadrupole time-of-flight LC-MS with electrospray ionization (ESI positive and negative).

### General Experimental Procedures.

**General Procedure A: Vinyl Phenylsulfone Synthesis.**<sup>18</sup> To a solution of sodium benzenesulfinate (1.08 g, 6 mmol) in ethyl acetate (EtOAc, 25 mL) and water (25 mL) open to air was added the 1-alkene (4 mmol) and iodine (1.02 g, 4 mmol) and the mixture was stirred vigorously at room temperature for 2 h. The reaction was quenched with aq. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> (25 mL) and extracted with EtOAc (2 x 25 mL). The combined organic extracts were dried over MgSO<sub>4</sub>, filtered, and concentrated on a rotary evaporator. The crude product was redissolved in DCM (25 mL) in a flask open to air and cooled to 0 °C. DBU (0.9 mL, 6 mmol) was then added, and the mixture was stirred for 1 h. The reaction was quenched with aq. HCl (1M, 25 mL), and extracted with DCM (2 x 25 mL). The combined organic extracts were dried over MgSO<sub>4</sub>, filtered, and concentrated on a rotary evaporator. Purification of the crude product by chromatography on silica (10:1 to 4:1 hexanes:EtOAc) gave the *E*-vinylsulfone as a colorless oil.

**General Procedure B: Vinylsulfone Aldehyde Additions.**<sup>27</sup> To a solution of (*E*)-(hex-1-en-1-ylsulfonyl)benzene (**2**) or (*E*)-triisopropyl((6-(phenylsulfonyl)hex-5-en-1-yl)oxy)silane in THF (to make a 0.5 M solution) at -95 °C was added a solution of MeLi•LiBr (1.5 M, 1.2 equiv.) and the resulting mixture was warmed to -78 °C and stirred for 30 min. The aldehyde (1.5 equiv.) was then added and the reaction was stirred for 2 h before quenching with aq. NH<sub>4</sub>Cl and extracting with EtOAc. The organic phase was dried over MgSO<sub>4</sub>, filtered, and concentrated on a rotary evaporator. Purification of the crude product by chromatography on silica (4:1 to 1:1 hexanes:EtOAc) gave the  $\beta$ -hydroxy vinylsulfone as a colorless oil.

**General Procedure C:  $\beta$ -Hydroxy Vinylsulfone Isomerizations.** To a solution of the  $\beta$ -hydroxy vinylsulfone in MeCN (to make a 0.4 M solution) at room temperature was added DBU (4 equiv.) and the mixture was stirred for 24 h. The reaction was quenched with 1M HCl and extracted with DCM (2x). The combined organic extracts were dried over MgSO<sub>4</sub>, filtered, and concentrated on a rotary evaporator. Purification of the crude product by chromatography on silica (4:1 to 1:1 hexanes:EtOAc) gave the  $\beta$ -hydroxy allylic phenylsulfone as a colorless oil.

**(*E*)-(Hex-1-en-1-ylsulfonyl)benzene (**2**).** Prepared according to procedure A. Compound **2** was obtained as a colorless oil (0.67 g, 75%). *Spectral data matched that previously reported:*<sup>38</sup> <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  7.88 – 7.78 (m, 2H), 7.64 – 7.52 (m, 1H), 7.53 – 7.43 (m, 2H), 6.95 (dt,  $J$  = 15.1, 6.9 Hz, 1H), 6.28 (dt,  $J$  = 15.1, 1.6 Hz, 1H), 2.19 (dtd,  $J$  = 8.3, 6.9, 1.6 Hz, 2H), 1.49 – 1.34 (m, 2H), 1.34 – 1.23 (m, 2H), 0.84 (t,  $J$  = 7.3 Hz, 3H).

**(*E*)-Triisopropyl((6-(phenylsulfonyl)hex-5-en-1-yl)oxy)silane.** Prepared according to procedure A. (*E*)-Triisopropyl((6-(phenylsulfonyl)hex-5-en-1-yl)oxy)silane was obtained as a colorless oil (1.2 g, 78%). IR

(ATR): 2972, 2929, 2867, 1470, 1445, 1285, 1183, 1121, 1079, 1045, 1009, 998, 854, 721, 687  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.86 (dd,  $J = 8.4, 1.4$  Hz, 2H), 7.66 – 7.56 (m, 1H), 7.55 – 7.49 (m, 2H), 6.99 (dt,  $J = 15.1, 6.8$  Hz, 1H), 6.31 (dt,  $J = 15.1, 1.6$  Hz, 1H), 3.65 (t,  $J = 5.9$  Hz, 2H), 2.26 (td,  $J = 6.9, 5.3$  Hz, 2H), 1.60 – 1.47 (m, 4H), 1.12 – 0.94 (m, 21H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  147.1, 140.7, 133.1, 130.4, 129.1, 127.5, 62.7, 32.1, 31.2, 24.0, 17.9, 11.9. HRMS (ESI+) calcd for  $\text{C}_{21}\text{H}_{36}\text{NaO}_3\text{SSi}$  ( $\text{M} + \text{Na}$ ): 419.2047. Found 419.2044.

**(E)-7-(Phenylsulfonyl)dodec-7-en-6-ol (3).** Prepared according to procedure B using vinyl sulfone **2** (0.20 g, 0.89 mmol) and hexanal. Compound **3** was obtained as a colorless oil (0.184 g, 64%). IR (ATR): 3600 – 3400, 2987, 2972, 2867, 1515, 1470, 1293, 1110, 1105, 1085, 1052, 1021, 998, 833, 709, 683  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 – 7.81 (m, 2H), 7.62 – 7.56 (m, 1H), 7.56 – 7.42 (m, 2H), 6.94 (t,  $J = 7.7$  Hz, 1H), 4.53 (dd,  $J = 8.8, 5.5$  Hz, 1H), 2.56 (bs, OH), 2.41 – 2.29 (m, 2H), 1.73 (dddd,  $J = 13.4, 9.6, 8.7, 4.8$  Hz, 1H), 1.52 – 1.40 (m, 3H), 1.40 – 1.32 (m, 2H), 1.32 – 1.23 (m, 2H), 1.23 – 1.00 (m, 4H), 0.91 (t,  $J = 7.3$  Hz, 3H), 0.81 (t,  $J = 7.2$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  145.5, 143.0, 141.2, 133.1, 129.1, 127.7, 69.0, 36.7, 31.3, 30.7, 28.2, 25.6, 22.40, 22.38, 13.9, 13.8. HRMS (ESI+) calcd for  $\text{C}_{18}\text{H}_{29}\text{O}_3\text{S}$  ( $\text{M} + \text{H}$ ): 325.1832. Found 325.1831.

**(E)-7-(Phenylsulfonyl)dodec-8-en-6-ol (4).** Prepared according to procedure C using  $\beta$ -hydroxy vinyl sulfone **3** (0.13 g, 0.40 mmol). Compound **4** was obtained as a colorless oil (0.085 g, 65%) and 2.8:1 mixture of diastereomers. *Spectral data for the mixture of diastereomers:* IR (ATR): 3600–3300, 2972, 2851, 1468, 1447, 1391, 1373, 1306, 1223, 1125, 1086, 1023, 987  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.85 – 7.78 (m, 4H), 7.65 – 7.60 (m, 2H), 7.55 – 7.50 (m, 4H), 5.61 (ddt,  $J = 15.5, 9.9, 1.5$  Hz, 1H), 5.34 (dt,  $J = 15.5, 6.8$  Hz, 1H), 5.30 – 5.25 (m, 1H), 5.11 (ddt,  $J = 15.3, 10.1, 1.4$  Hz, 1H), 4.48 (ddd,  $J = 8.4, 5.2, 1.4$  Hz, 1H), 4.28 (td,  $J = 8.3, 2.9$  Hz, 1H), 3.94 (s, OH), 3.55 (dd,  $J = 10.1, 8.7$  Hz, 1H), 3.41 (dd,  $J = 9.9, 1.4$  Hz, 1H), 3.02 (s, OH), 1.93 (dddd,  $J = 15.7, 13.9, 6.5, 1.3$  Hz, 4H), 1.62 – 1.50 (m, 2H), 1.49 – 1.34 (m, 2H), 1.33 – 1.15 (m, 12H), 0.85 (td,  $J = 7.0, 3.4$  Hz, 3H), 0.76 (dt,  $J = 9.2, 6.1$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  142.6, 141.6, 141.0, 137.5, 133.7, 129.1, 128.90, 128.87, 128.83, 128.77, 128.5, 119.3, 117.0, 116.0, 74.9, 73.0, 68.6, 68.1, 34.7, 34.5, 31.4, 25.0, 22.4, 21.8, 13.9, 13.5. HRMS (ESI+) calcd for  $\text{C}_{18}\text{H}_{29}\text{O}_3\text{S}$  ( $\text{M} + \text{H}$ ): 325.1832. Found 325.1832.

**(E/Z)-(Hex-2-en-1-ylsulfonyl)benzene (5).** Prepared according to procedure C using vinylsulfone **2** (0.05 g, 0.22 mmol). Compound **5** was obtained as a colorless oil (0.048 g, 96%) and ~1:1 *cis:trans* mixture. *Spectral data for the mixture matched that previously reported:*<sup>28</sup>  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 (dd,  $J = 8.3, 1.3$  Hz, 2H), 7.87 – 7.84 (m, 2H), 7.70 – 7.61 (m, 2H), 7.54 (dd,  $J = 8.4, 7.1$  Hz, 4H), 5.72 (dtt,  $J = 10.0, 7.4, 1.3$  Hz, 1H), 5.59 – 5.46 (m, 1H), 5.45 – 5.36 (m, 2H), 3.85 (dd,  $J = 7.9, 1.2$  Hz, 2H), 3.74 (dd,  $J = 7.3, 1.0$  Hz, 2H), 2.07 – 1.92 (m, 2H), 1.71 (qd,  $J = 7.4, 1.7$  Hz, 2H), 1.29 (h,  $J = 7.4$  Hz, 2H), 1.15 (h,  $J = 7.4$  Hz, 2H), 0.81 (t,  $J = 7.4$  Hz, 2H), 0.75 (t,  $J = 7.4$  Hz, 3H).

**(E)-2-Methyl-4-(phenylsulfonyl)non-4-en-3-ol (6).** Prepared according to procedure B using vinyl sulfone **2** (0.20 g, 0.89 mmol) and isobutyraldehyde. Compound **6** was obtained as a colorless oil (0.16 g, 62%).

IR (ATR): 3550-3300, 2989, 2974, 2881, 1510, 1476, 1283, 1181, 1110, 1055, 1032, 1010, 996, 830, 711, 685  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.91 – 7.82 (m, 2H), 7.62 – 7.55 (m, 1H), 7.54 – 7.45 (m, 2H), 6.93 (t,  $J$  = 7.6 Hz, 1H), 4.11 (dd,  $J$  = 10.1, 4.0 Hz, 1H), 2.75 (d,  $J$  = 6.7 Hz, OH), 2.32 (q,  $J$  = 7.7 Hz, 2H), 2.01 (dt,  $J$  = 9.6, 6.6 Hz, 1H), 1.49 – 1.40 (m, 2H), 1.33 (dq,  $J$  = 8.9, 7.2 Hz, 2H), 1.00 (d,  $J$  = 6.5 Hz, 3H), 0.89 (t,  $J$  = 7.3 Hz, 3H), 0.54 (d,  $J$  = 6.9 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  146.5, 142.4, 141.3, 133.1, 129.0, 127.7, 74.9, 33.2, 30.5, 28.4, 22.3, 19.4, 18.9, 13.7. HRMS (ESI+) calcd for  $\text{C}_{16}\text{H}_{25}\text{O}_3\text{S}$  ( $\text{M} + \text{H}$ ): 297.1519. Found 297.1521.

(*E*)-Triethyl((2-methyl-4-(phenylsulfonyl)non-4-en-3-yl)oxy)silane (**6-Si**). To a solution of **6** (0.2 g, 0.67 mmol) in DCM (3.4 mL) at 0 °C was added imidazole (0.092 g, 1.34 mmol) followed by chlorotriethylsilane (0.14 mL, 0.81 mmol) and the mixture was stirred and allowed to slowly warm to room temperature over 5 h. The reaction was quenched with aq.  $\text{NaHCO}_3$  (10 mL) and extracted with DCM (3 x 10 mL). The combined organic extracts were dried over  $\text{MgSO}_4$ , filtered, and concentrated on a rotary evaporator. Purification by flash column chromatography on silica (10:1 hexanes:ethyl acetate) gave **6-Si** (0.20 g, 73%) as a pale yellow oil. IR (ATR): 2947, 2865, 1520, 1473, 1447, 1303, 1084, 996, 972, 881  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 – 7.85 (m, 2H), 7.64 – 7.59 (m, 1H), 7.58 – 7.51 (m, 2H), 7.03 (t,  $J$  = 7.5 Hz, 1H), 4.30 (d,  $J$  = 5.9 Hz, 1H), -- 2.56 – 2.45 (m, 2H), 2.20 – 2.05 (m, 1H), 1.52 – 1.44 (m, 2H), 1.40 (ddd,  $J$  = 14.3, 7.2, 1.1 Hz, 2H), 0.95 (t,  $J$  = 7.1 Hz, 3H), 0.92 (d,  $J$  = 6.7 Hz, 3H), 0.81 (t,  $J$  = 7.9 Hz, 9H), 0.79 (d,  $J$  = 7.0 Hz, 3H), 0.32 (q,  $J$  = 7.7 Hz, 6H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  146.2, 143.0, 133.0, 129.0, 128.5, 74.7, 34.5, 30.9, 29.0, 22.7, 17.8, 13.9, 6.9, 4.5. HRMS (ESI+) calcd for  $\text{C}_{22}\text{H}_{38}\text{NaO}_3\text{SSi}$  ( $\text{M} + \text{Na}$ ): 433.2209. Found 433.2206.

(*E*)-2-Methyl-4-(phenylsulfonyl)non-4-en-3-yl acetate (**6-Ac**). To a solution of **6** (0.2 g, 0.67 mmol) in DCM (3.4 mL) at 0 °C was added *N,N*-dimethylaminopyridine (0.164 g, 1.34 mmol) followed by acetyl chloride (0.07 mL, 1.0 mmol) and the mixture was stirred and allowed to slowly warm to room temperature over 5 h. The reaction was quenched with aq.  $\text{NaHCO}_3$  (10 mL) and extracted with DCM (3 x 10 mL). The combined organic extracts were dried over  $\text{MgSO}_4$ , filtered, and concentrated on a rotary evaporator. Purification by flash column chromatography on silica (10:1 hexanes:ethyl acetate) gave **6-Ac** (0.13 g, 57%) as a colorless oil. IR (ATR): 2965, 1730, 1507, 1447, 1304, 1225, 1158, 1022, 912  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 – 7.83 (m, 2H), 7.63 – 7.56 (m, 1H), 7.53 (ddt,  $J$  = 8.2, 6.7, 1.4 Hz, 2H), 7.24 (dd,  $J$  = 7.9, 7.0 Hz, 1H), 5.35 (d,  $J$  = 10.0 Hz, 1H), 2.60 (ddt,  $J$  = 14.1, 7.4, 3.7 Hz, 1H), 2.56 – 2.48 (m, 1H), 2.39 (ddt,  $J$  = 15.2, 8.3, 6.7 Hz, 1H), 1.63 – 1.49 (m, 2H), 1.43 (s, 3H), 1.47 – 1.38 (m, 2H), 0.97 (t,  $J$  = 7.3 Hz, 3H), 0.94 (d,  $J$  = 6.6 Hz, 3H), 0.92 (d,  $J$  = 6.8 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  169.73, 149.38, 142.16, 137.60, 132.74, 128.92, 127.63, 75.13, 30.97, 30.60, 28.66, 22.52, 19.84, 19.38, 18.75, 13.83, - 0.02. HRMS (ESI+) calcd for  $\text{C}_{18}\text{H}_{26}\text{NaO}_4\text{S}$  ( $\text{M} + \text{Na}$ ): 361.1449. Found 361.1448.

(*E*)-2-Methyl-4-(phenylsulfonyl)non-5-en-3-ol (**7**). Prepared according to procedure C using  $\beta$ -hydroxy vinyl sulfone **6** (0.13 g, 0.44 mmol). Compound **7** was obtained as a colorless oil (0.88 g, 68%) and 5.2:1 mixture of diastereomers. IR (ATR): 3600-3200, 2962, 2897, 2865, 1464, 1444, 1372, 1363, 1306, 1223, 1125, 1085, 1022, 986  $\text{cm}^{-1}$ . *Spectral data for the major diastereomer*:  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.91 – 7.79 (m, 2H), 7.67 – 7.59 (m, 1H), 7.58 – 7.49 (m, 2H), 5.64 (ddt,  $J$  = 15.6, 9.9, 1.5 Hz, 1H), 5.45 – 5.30 (m,

1H), 4.08 (dd,  $J = 9.0, 1.4$  Hz, 1H), 3.60 (dd,  $J = 9.8, 1.2$  Hz, 1H), 2.01 – 1.88 (m, 2H), 1.67 (dp,  $J = 9.0, 6.7$  Hz, 1H), 1.35 – 1.12 (m, 4H), 1.02 (d,  $J = 6.6$  Hz, 3H), 0.80 – 0.74 (m, 6H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  142.4, 137.4, 133.7, 129.0, 128.8, 117.1, 73.3, 71.3, 34.7, 31.7, 21.8, 19.1, 18.3, 13.5. HRMS (ESI+) calcd for  $\text{C}_{16}\text{H}_{25}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 297.1519. Found 297.1519.

**(E)-3-(Phenylsulfonyl)oct-3-en-2-ol (8v).** Prepared according to procedure B using vinyl sulfone **2** (0.20 g, 0.89 mmol) and acetaldehyde. Compound **8v** was obtained as a colorless oil (0.13 g, 55%). IR (ATR): 3600-3300, 2972, 2928, 2876, 1485, 1443, 1287, 1181, 1152, 1079, 1033, 1011, 998, 832, 754, 691  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.92 – 7.86 (m, 2H), 7.66 – 7.59 (m, 1H), 7.55 (ddt,  $J = 8.2, 6.7, 1.2$  Hz, 2H), 6.95 (t,  $J = 7.7$  Hz, 1H), 4.79 (p,  $J = 6.7$  Hz, 1H), 2.46 (d,  $J = 6.5$  Hz, 1H), 2.41 (qd,  $J = 7.4, 2.3$  Hz, 2H), 1.55 – 1.46 (m, 2H), 1.43 – 1.36 (m, 2H), 1.34 (d,  $J = 6.7$  Hz, 3H), 0.95 (t,  $J = 7.3$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  144.9, 143.6, 141.1, 133.2, 129.2, 127.7, 65.0, 30.7, 28.2, 23.2, 22.4, 13.8. HRMS (ESI+) calcd for  $\text{C}_{14}\text{H}_{21}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 269.1206. Found 269.1211.

**(E)-3-(Phenylsulfonyl)oct-4-en-2-ol (8a).** Prepared according to procedure C using  $\beta$ -hydroxy vinyl sulfone **8v** (0.14 g, 0.51 mmol). Compound **8a** was obtained as a colorless oil (0.08 g, 59%) and 1.8:1 mixture of diastereomers. *Spectral data for the mixture of diastereomers:* IR (ATR): 3600-3300, 2967, 2851, 1468, 1447, 1391, 1373, 1306, 1223, 1125, 1086, 1023, 987  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.85 (ddd,  $J = 8.6, 3.9, 1.3$  Hz, 4H), 7.69 – 7.63 (m, 2H), 7.57 (dd,  $J = 8.5, 7.1$  Hz, 4H), 5.65 (ddt,  $J = 15.5, 10.0, 1.5$  Hz, 1H), 5.43-5.32 (m, 2H), 5.13 (ddt,  $J = 15.4, 10.1, 1.4$  Hz, 1H), 4.72 (qd,  $J = 6.5, 1.5$  Hz, 1H), 4.47 (dq,  $J = 8.6, 6.3$  Hz, 1H), 4.03 (bs, OH), 3.53 (dd,  $J = 10.1, 8.5$  Hz, 1H), 3.40 (dd,  $J = 9.9, 1.5$  Hz, 1H), 3.10 (bs, OH), 2.03 – 1.90 (m, 4H), 1.32 – 1.23 (m, 4H), 1.22 (d,  $J = 6.4$  Hz, 6H), 0.88 – 0.76 (m, 6H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  143.1, 141.2, 137.5, 137.2, 133.9, 133.8, 129.1, 128.90, 128.88, 128.8, 119.3, 116.8, 75.9, 74.0, 34.7, 34.5, 21.84, 21.76, 21.1, 20.6, 13.54, 13.49. HRMS (ESI+) calcd for  $\text{C}_{14}\text{H}_{21}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 269.1206. Found 269.1204.

**(E)-2-Methyl-5-(phenylsulfonyl)dec-5-en-4-ol (9v).** Prepared according to procedure B using vinyl sulfone **2** (0.50 g, 2.2 mmol) and isovaleraldehyde. Compound **9v** was obtained as a colorless oil (0.35 g, 51%). IR (ATR): 3600-3300, 2989, 2932, 2877, 1472, 1431, 1283, 1182, 1145, 1076, 1031, 1012, 994, 852, 709, 683  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 – 7.82 (m, 2H), 7.61 – 7.56 (m, 1H), 7.54 – 7.49 (m, 2H), 6.91 (t,  $J = 7.7$  Hz, 1H), 4.61 (dd,  $J = 10.2, 4.2$  Hz, 1H), 2.54 (s, 1H), 2.35 (td,  $J = 7.4, 3.1$  Hz, 2H), 1.72 (ddd,  $J = 13.9, 9.8, 5.2$  Hz, 1H), 1.60 (dpd,  $J = 8.7, 6.7, 5.2$  Hz, 1H), 1.51 – 1.43 (m, 2H), 1.39 – 1.30 (m, 2H), 1.14 (ddd,  $J = 14.0, 8.6, 4.3$  Hz, 1H), 0.91 (t,  $J = 7.3$  Hz, 3H), 0.82 (d,  $J = 6.7$  Hz, 3H), 0.73 (d,  $J = 6.6$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  145.2, 143.4, 141.2, 133.1, 129.1, 127.8, 67.1, 45.8, 30.7, 28.2, 24.6, 23.2, 22.4, 21.4, 13.8. HRMS (ESI+) calcd for  $\text{C}_{17}\text{H}_{27}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 311.1675. Found 311.1675.

**(E)-2-Methyl-5-(phenylsulfonyl)dec-6-en-4-ol (9a).** Prepared according to procedure C using  $\beta$ -hydroxy vinyl sulfone **9v** (0.10 g, 0.32 mmol). Compound **9a** was obtained as a colorless oil (0.061 g, 61%) and 2.6:1 mixture of diastereomers. IR (ATR): 2967, 2851, 1468, 1447, 1391, 1373, 1306, 1223, 1125, 1086, 1023, 987  $\text{cm}^{-1}$ . *Spectral data for the major diastereomer:*  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.88 – 7.79 (m,

2H), 7.67 – 7.60 (m, 1H), 7.58 – 7.50 (m, 2H), 5.63 (ddt,  $J$  = 15.4, 10.0, 1.5 Hz, 1H), 5.33 (dt,  $J$  = 15.4, 6.8 Hz, 1H), 4.61 (ddd,  $J$  = 9.0, 4.8, 1.3 Hz, 1H), 3.38 (dd,  $J$  = 10.5, 1.2 Hz, 1H), 2.97 (s, 1H), 2.01 – 1.87 (m, 2H), 1.73 (dh,  $J$  = 8.4, 6.6 Hz, 1H), 1.51 (ddd,  $J$  = 13.7, 9.0, 5.9 Hz, 1H), 1.28 – 1.16 (m, 2H), 1.09 (ddd,  $J$  = 13.8, 8.3, 4.8 Hz, 1H), 0.90 (d,  $J$  = 6.6 Hz, 3H), 0.88 (d,  $J$  = 6.7 Hz, 3H), 0.76 (t,  $J$  = 7.4 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  142.7, 137.5, 133.8, 128.93, 128.90, 117.1, 73.3, 66.2, 43.5, 34.7, 24.2, 23.0, 22.0, 21.9, 13.5. HRMS (ESI+) calcd for  $\text{C}_{17}\text{H}_{27}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 311.1675. Found 311.1673.

**(*E*)-2,2-Dimethyl-4-(phenylsulfonyl)non-4-en-3-ol (10v).** Prepared according to procedure B using vinyl sulfone **2** (0.20 g, 0.89 mmol) and pivaldehyde. Compound **10v** was obtained as a colorless oil (0.16 g, 72%). IR (ATR): 3600-3200, 2989, 2956, 2892, 1473, 1444, 1287, 1183, 1119, 1081, 1039, 1010, 997, 834, 719, 687  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 – 7.88 (m, 2H), 7.60 – 7.56 (m, 1H), 7.54 – 7.49 (m, 2H), 6.70 (s, 1H), 4.40 (d,  $J$  = 9.1 Hz, 1H), 2.26 (dq,  $J$  = 15.4, 8.0 Hz, 2H), 1.40 – 1.29 (m, 2H), 1.21 (h,  $J$  = 7.1 Hz, 2H), 1.02 (s, 9H), 0.83 (t,  $J$  = 7.3 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  148.8, 143.1, 142.6, 132.9, 129.0, 127.5, 77.6, 37.7, 30.6, 29.7, 26.9, 22.3, 13.7. HRMS (ESI+) calcd for  $\text{C}_{17}\text{H}_{27}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 311.1675. Found 311.1672.

**(*E*)-2,2-Dimethyl-4-(phenylsulfonyl)non-5-en-3-ol (10a).** Prepared according to procedure C using  $\beta$ -hydroxy vinyl sulfone **10a** (0.07 g, 0.24 mmol). Compound **10v** was obtained as a colorless oil (0.048 g, 64%) and >20:1 mixture of diastereomers. IR (ATR): 3500-3350, 2982, 2856, 1478, 1441, 1323, 1303, 1221, 1145, 1076, 1021, 985  $\text{cm}^{-1}$ . *Spectral data for the major diastereomer:*  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.84 – 7.77 (m, 2H), 7.68 – 7.59 (m, 1H), 7.56 – 7.49 (m, 2H), 5.69 (ddt,  $J$  = 15.7, 9.8, 1.5 Hz, 1H), 5.26 (dt,  $J$  = 15.7, 6.9 Hz, 1H), 4.26 (dd,  $J$  = 3.4, 0.9 Hz, 1H), 3.71 (dt,  $J$  = 9.8, 0.8 Hz, 1H), 2.78 (d,  $J$  = 3.3 Hz, 1H), 1.89 (dtdd,  $J$  = 8.0, 6.7, 5.6, 1.5 Hz, 2H), 1.25 – 1.15 (m, 2H), 0.91 (s, 9H), 0.77 (t,  $J$  = 7.4 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  141.7, 137.0, 133.6, 129.2, 128.8, 118.7, 74.0, 70.6, 35.9, 34.9, 26.6, 21.7, 13.7. HRMS (ESI+) calcd for  $\text{C}_{17}\text{H}_{27}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 311.1675. Found 311.1675.

**(*E*)-1-Phenyl-2-(phenylsulfonyl)hept-2-en-1-ol (11v).** Prepared according to procedure B using vinyl sulfone **2** (0.20 g, 0.89 mmol) and benzaldehyde. Compound **11v** was obtained as a colorless oil (0.21 g, 73%). IR (ATR): 2982, 2928, 2892, 1473, 1441, 1295, 1164, 1131, 1091, 1041, 1023, 998, 824, 731, 687  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.59 – 7.54 (m, 2H), 7.50 – 7.44 (m, 1H), 7.40 – 7.31 (m, 3H), 7.16 (t,  $J$  = 7.7 Hz, 1H), 7.12 (s, 5H), 5.80 (d,  $J$  = 5.7 Hz, 1H), 3.47 (d,  $J$  = 8.0 Hz, 1H), 2.27 (q,  $J$  = 7.6 Hz, 2H), 1.42 (m, 2H), 1.33 – 1.23 (m, 2H), 0.86 (t,  $J$  = 7.3 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  147.2, 142.7, 140.7, 139.8, 132.8, 128.9, 128.2, 127.6, 127.3, 125.5, 69.1, 30.4, 28.3, 22.4, 13.7. HRMS (ESI+) calcd for  $\text{C}_{19}\text{H}_{23}\text{O}_3\text{S}$  ( $M + \text{H}$ ): 331.1362. Found 331.1360.

**(*E*)-2-Methyl-4-(phenylsulfonyl)-9-((triisopropylsilyl)oxy)non-4-en-3-ol (12v).** Prepared according to procedure B using triisopropyl((6-(phenylsulfonyl)hex-5-en-1-yl)oxy)silane (0.20 g, 0.50 mmol) and isobutyraldehyde. Compound **12v** was obtained as a colorless oil (0.16 g, 68%). IR (ATR): 2998, 2943, 2876, 1487, 1463, 1285, 1184, 1119, 1081, 1039, 1012, 997, 834, 719, 687  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 – 7.84 (m, 2H), 7.61 – 7.55 (m, 1H), 7.55 – 7.47 (m, 2H), 6.94 (t,  $J$  = 7.6 Hz, 1H), 4.12 (d,  $J$  =

9.7 Hz, 1H), 3.71 – 3.65 (m, 2H), 2.73 (s, 1H), 2.36 (tdd,  $J = 7.3, 5.1, 2.2$  Hz, 2H), 2.02 (dh,  $J = 9.7, 6.6$  Hz, 1H), 1.62 – 1.49 (m, 4H), 1.11 – 1.02 (m, 21H), 1.01 (d,  $J = 6.5$  Hz, 3H), 0.55 (d,  $J = 6.8$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  146.4, 142.7, 141.4, 133.2, 129.1, 127.8, 75.0, 62.8, 33.4, 32.6, 28.6, 25.1, 19.4, 19.0, 18.0, 12.0. HRMS (ESI+) calcd for  $\text{C}_{25}\text{H}_{44}\text{NaO}_4\text{SSi}$  ( $\text{M} + \text{Na}$ ): 491.2622. Found 491.2621.

**(E)-2-Methyl-4-(phenylsulfonyl)-9-((triisopropylsilyl)oxy)non-5-en-3-ol (12a).** Prepared according to procedure C using  $\beta$ -hydroxy vinyl sulfone **12v** (0.08 g, 0.18 mmol). Compound **12a** was obtained as a colorless oil (0.048 g, 61%) and 6.1:1 mixture of diastereomers. IR (ATR): 3550-3300, 2983, 2877, 1505, 1451, 1384, 1372, 1301, 1227, 1145, 1074, 1027, 986  $\text{cm}^{-1}$ . *Spectral data for the major diastereomer:*  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 – 7.77 (m, 2H), 7.66 – 7.59 (m, 1H), 7.53 (ddt,  $J = 8.4, 6.5, 1.4$  Hz, 2H), 5.65 (ddt,  $J = 15.5, 9.9, 1.5$  Hz, 1H), 5.37 (dt,  $J = 15.6, 6.8$  Hz, 1H), 4.07 (dt,  $J = 9.0, 1.6$  Hz, 1H), 3.73 (dd,  $J = 7.3, 1.0$  Hz, 1H), 3.63 – 3.48 (m, 2H), 3.05 (d,  $J = 2.5$  Hz, 1H), 2.12 – 1.95 (m, 2H), 1.66 (dh,  $J = 9.0, 6.6$  Hz, 1H), 1.41 (dtd,  $J = 13.6, 6.5, 1.9$  Hz, 2H), 1.05 – 1.02 (m, 21H), 1.01 (d,  $J = 3.6$  Hz, 3H), 0.77 (d,  $J = 6.7$  Hz, 3H). *Spectral data for the mixture of diastereomers:*  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  142.2, 141.5, 138.4, 137.4, 133.7, 133.6, 129.04, 128.95, 128.9, 128.6, 117.1, 116.1, 73.3, 71.3, 62.6, 62.5, 60.2, 32.0, 31.8, 29.2, 29.0, 19.1, 18.4, 18.0, 12.0. HRMS (ESI+) calcd for  $\text{C}_{25}\text{H}_{44}\text{NaO}_4\text{SSi}$  ( $\text{M} + \text{Na}$ ): 491.2622. Found 491.2625.

**(E)-2,2-Dimethyl-4-(phenylsulfonyl)-9-((triisopropylsilyl)oxy)non-4-en-3-ol (13v).** Prepared according to procedure B using triisopropyl((6-(phenylsulfonyl)hex-5-en-1-yl)oxy)silane (0.20 g, 0.50 mmol) and pivaldehyde. Compound **13v** was obtained as a colorless oil (0.17 g, 70%). IR (ATR): 3450-3100, 2992, 2928, 2874, 1471, 1423, 1284, 1185, 1181, 1039, 1010, 984, 828, 754, 683  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 – 7.86 (m, 2H), 7.59 – 7.54 (m, 1H), 7.53 – 7.47 (m, 2H), 6.71 (s, 1H), 4.40 (d,  $J = 9.2$  Hz, 1H), 3.61 (t,  $J = 5.8$  Hz, 2H), 2.29 (ddd,  $J = 14.2, 7.9, 6.0$  Hz, 1H), 1.52 – 1.37 (m, 4H), 1.11 – 0.97 (m, 30H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  148.7, 143.2, 142.6, 132.9, 129.0, 127.4, 77.5, 62.8, 37.7, 32.4, 29.8, 27.0, 25.1, 18.0, 12.0. HRMS (ESI+) calcd for  $\text{C}_{26}\text{H}_{46}\text{NaO}_4\text{SSi}$  ( $\text{M} + \text{Na}$ ): 505.2778. Found 505.2775.

**(E)-2,2-Dimethyl-4-(phenylsulfonyl)-9-((triisopropylsilyl)oxy)non-5-en-3-ol (13a).** Prepared according to procedure C using  $\beta$ -hydroxy vinyl sulfone **13v** (0.08 g, 0.17 mmol). Compound **13a** was obtained as a colorless oil (0.053 g, 66%) and >20:1 mixture of diastereomers. IR (ATR): 3600-3300, 2972, 2868, 1451, 1437, 1388, 1363, 1301, 1235, 1181, 1084, 1023, 987  $\text{cm}^{-1}$ . *Spectral data for the major diastereomer:*  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 – 7.76 (m, 2H), 7.65 – 7.58 (m, 1H), 7.53 (dt,  $J = 8.6, 6.9$  Hz, 2H), 5.70 (ddt,  $J = 15.6, 9.7, 1.5$  Hz, 1H), 5.27 (dt,  $J = 15.7, 6.8$  Hz, 1H), 4.26 (s, 1H), 3.70 (d,  $J = 9.7$  Hz, 1H), 3.56 (td,  $J = 6.4, 3.5$  Hz, 2H), 2.85 – 2.73 (m, 1H), 1.99 (dddd,  $J = 14.7, 13.0, 10.6, 6.8$  Hz, 2H), 1.44 – 1.34 (m, 2H), 1.12 – 0.97 (m, 21H), 0.91 (s, 9H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  141.4, 136.9, 133.6, 129.2, 128.7, 118.7, 74.0, 70.6, 62.6, 35.9, 31.8, 29.2, 26.5, 18.0, 11.9. HRMS (ESI+) calcd for  $\text{C}_{26}\text{H}_{46}\text{NaO}_4\text{SSi}$  ( $\text{M} + \text{Na}$ ): 505.2778. Found 505.2778.

**(E)-2-Methyl-7-phenyl-4-(phenylsulfonyl)hept-4-en-3-ol (14v).** Prepared according to procedure B using ((4-phenylbut-1-en-1-yl)sulfonyl)benzene<sup>22</sup> (0.44 g, 0.16 mmol) and isobutyraldehyde. Compound **14v** was obtained as a colorless oil (0.053 g, 96%). IR (ATR): 2962, 2930, 2872, 1467, 1446, 1285, 1184, 1119,

1081, 1039, 1010, 997, 834, 719, 687  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.84 – 7.77 (m, 2H), 7.66 – 7.57 (m, 1H), 7.56 – 7.46 (m, 2H), 7.28 (tt,  $J$  = 6.7, 1.0 Hz, 2H), 7.25 – 7.20 (m, 1H), 7.19 – 7.11 (m, 2H), 6.99 (t,  $J$  = 7.5 Hz, 1H), 4.09 (dd,  $J$  = 10.1, 3.9 Hz, 1H), 2.83 (t,  $J$  = 6.9 Hz, 2H), 2.78 – 2.63 (m, 2H), 2.40 (d,  $J$  = 7.2 Hz, OH), 2.04 (ddt,  $J$  = 13.3, 9.5, 6.7 Hz, 1H), 1.01 (d,  $J$  = 6.5 Hz, 3H), 0.58 (d,  $J$  = 6.8 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  145.05, 143.32, 141.12, 140.04, 133.05, 128.97, 128.52, 128.37, 127.76, 126.36, 77.26, 77.00, 76.75, 74.83, 34.49, 33.25, 30.24, 19.19, 18.88. HRMS (ESI+) calcd for  $\text{C}_{20}\text{H}_{25}\text{O}_3\text{S}$  (M + H): 345.1519. Found 345.1519.

**(E)-2-Methyl-7-phenyl-4-(phenylsulfonyl)hept-5-en-3-ol (14a).** To a solution of the **14v** (0.043 g, 0.13 mmol) in MeCN (0.3 mL) at room temperature was added DBU (0.08 mL, 0.52 mmol) and the mixture was stirred for 8 h. The reaction was quenched with 1M HCl (10 mL) and extracted with DCM (2 x 10 mL). The combined organic extracts were dried over  $\text{MgSO}_4$ , filtered, and concentrated on a rotary evaporator. Purification of the crude product by chromatography on silica (4:1 to 1:1 hexanes:EtOAc) gave the **14a** (0.033 mg, 73%) as a colorless oil. IR (ATR): 3550-3400, 2967, 2851, 1468, 1447, 1391, 1373, 1306, 1223, 1125, 1086, 1023, 987  $\text{cm}^{-1}$ . *Spectral data for the major diastereomer:*  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.83 – 7.79 (m, 2H), 7.63 – 7.58 (m, 1H), 7.47 (t,  $J$  = 7.8 Hz, 2H), 7.31 – 7.19 (m, 4H), 7.00 – 6.94 (m, 1H), 5.80 (ddt,  $J$  = 15.6, 10.1, 1.5 Hz, 1H), 5.52 (dt,  $J$  = 15.3, 7.1 Hz, 1H), 4.16 (dd,  $J$  = 9.0, 1.3 Hz, 1H), 3.81 (dd,  $J$  = 7.4, 1.0 Hz, 1H), 3.68 (dd,  $J$  = 9.9, 1.3 Hz, 1H), 3.41 – 3.33 (m, 1H), 3.30 (ddd,  $J$  = 15.5, 7.3, 1.5 Hz, 1H), 1.73 (dp,  $J$  = 9.3, 6.7 Hz, 1H), 1.07 (d,  $J$  = 6.6 Hz, 3H), 0.82 (d,  $J$  = 6.8 Hz, 3H). *Spectral data for the mixture of diastereomers:*  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  140.48, 139.91, 138.88, 138.82, 138.17, 137.24, 133.65, 133.55, 128.96, 128.87, 128.50, 128.46, 128.44, 128.35, 126.31, 126.23, 118.57, 117.48, 73.28, 71.02, 59.93, 39.14, 38.82, 31.77, 19.09, 18.38. HRMS (ESI+) calcd for  $\text{C}_{20}\text{H}_{25}\text{O}_3\text{S}$  (M + H): 345.1519. Found 345.1518.

**(E)-2,6-Dimethyl-4-(phenylsulfonyl)hept-4-en-3-ol (15).** Prepared according to procedure B using (*E*)-((3-methylbut-1-en-1-yl)sulfonyl)benzene<sup>39</sup> (0.05 g, 0.29 mmol) and isobutyraldehyde. Compound **14v** was obtained as a colorless oil (0.07 g, 87%). IR (ATR): 3500-3300, 2962, 2930, 2872, 1467, 1446, 1285, 1184, 1119, 1081, 1039, 1010, 997, 834, 719, 687  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 – 7.86 (m, 2H), 7.64 – 7.57 (m, 1H), 7.55 – 7.50 (m, 2H), 6.75 (d,  $J$  = 10.8 Hz, 1H), 4.13 (d,  $J$  = 9.1 Hz, 1H), 2.87 (dp,  $J$  = 10.7, 6.6 Hz, 1H), 2.00 (dp,  $J$  = 9.7, 6.7 Hz, 1H), 1.07 (d,  $J$  = 6.6, 3H), 1.06 (d,  $J$  = 6.7 Hz, 3H), 1.02 (d,  $J$  = 6.5 Hz, 3H), 0.55 (d,  $J$  = 6.8 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  152.22, 141.33, 140.32, 133.14, 129.09, 127.77, 75.14, 33.21, 28.10, 21.83, 21.73, 19.44, 19.07. HRMS (ESI+) calcd for  $\text{C}_{15}\text{H}_{23}\text{O}_3\text{S}$  (M + H): 283.1362. Found 283.1362.

**((3Z,5E)-2-Methylnona-3,5-dien-4-yl)(phenylperoxy)sulfane (17).** Prepared according to procedure C using **6-Ac** (0.15 mmol). Compound **17** was obtained as a pale yellow oil (0.026 g, 64%) IR (ATR): 2962, 1507, 1446, 1304, 1288, 1086, 1070, 967  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.85 – 7.80 (m, 2H), 7.61 – 7.56 (m, 1H), 7.51 (ddt,  $J$  = 8.2, 6.7, 1.3 Hz, 2H), 6.77 (d,  $J$  = 10.2 Hz, 1H), 5.93 – 5.88 (m, 2H), 2.74 (dp,  $J$  = 10.1, 6.6 Hz, 1H), 2.04 (dtd,  $J$  = 7.3, 5.3, 2.8 Hz, 2H), 1.33 (q,  $J$  = 7.3 Hz, 2H), 1.10 (d,  $J$  = 6.7 Hz, 6H), 0.79 (t,  $J$  = 7.4 Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  147.6, 140.4, 137.4, 132.9, 128.8, 127.9, 118.3, 35.4, 28.0, 22.1, 22.0, 13.4. HRMS (ESI+) calcd for  $\text{C}_{16}\text{H}_{23}\text{O}_2\text{S}$  (M + H): 279.1419. Found 279.1418.



## Author Contributions

Conceptualization, G. O.; methodology, G.O., T.C.; investigation, G.O., T.C., D.C, H.C., C.W., and A.J.; resources, G.O.; data curation, G.O., T.C., D.C, H.C., C.W., and A.J.; writing—original draft preparation, G. O.; writing—review and editing, G.O., T.C., D.C, H.C., C.W., and A.J.; supervision, G.O.; project administration, G.O.; funding acquisition, G.O

## Conflicts of Interest

There are no conflicts of interest to declare.

## Data Availability

The data supporting this article have been included as part of the Supplementary Information.

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## Notes and References

1. For select recent examples see: (a) L. Wu, J. Qu, Y. Chen, Merging Alkene Isomerization Enables Difunctionalization of Cyclic Enamines toward Ring-Fused Amino Synthesis. *Org. Lett.* 2023, **25**, 992-997. (b) D. D. Youmans, H. N. Tran, L. M. Stanley, Nickel-Catalyzed Isomerization of Homoallylic Alcohols. *Org. Lett.* 2023, **25**, 3559-3563. (c) S. de Roo, F. Einsiedler, S. Mecking, Catalytic Biorefining of Natural Oils to Basic Olefinic Building Blocks of Proven Chemical Valorization Schemes. *Angew. Chem., Int. Ed.* 2023, **62**, e202219222. (d) Z. Wu, J. Meng, H. Liu, Y. Li, X. Zhang, W. Zhang, Multi-site programmable functionalization of alkenes via controllable alkene isomerization. *Nature Chem.* 2023, **15**, 988-997. (e) T. M. Saunders, S. B. Shepard, D. J. Hale, K. N. Robertson, L. Turculet, L. Highly Selective Nickel-Catalyzed Isomerization-Hydroboration of Alkenes Affords Terminal Functionalization at Remote C–H Position. *Chem-Eur. J.* 2023, **29**, e202301946.
2. J. J. Molloy, T. Morack, R. Gilmour, Positional and Geometrical Isomerisation of Alkenes: The Pinnacle of Atom Economy. *Angew. Chem., Int. Ed.* 2019, **58**, 13654– 13664.
3. P. T. Anastas, J. C. Warner, Green Chemistry: Theory and Practice, Oxford University Press: New York, 1998, p.30.
4. K. Zhao, R. R. Knowles, Contra-Thermodynamic Positional Isomerization of Olefins. *J. Am. Chem. Soc.* 2022, **144**, 137-144.
5. S. Hanna, T. Wills, T. W. Butcher, J. F. Hartwig, Palladium-Catalyzed Oxidative Dehydrosilylation for Contra-Thermodynamic Olefin Isomerization. *ACS Catal.* 2020, **10**, 8736– 8741.
6. S. Hanna, T. W. Butcher, J. F. Hartwig, Contra-thermodynamic Olefin Isomerization by Chain-Walking Hydrofunctionalization and Formal Retro-hydrofunctionalization. *Org. Lett.* 2019, **21**, 7129– 7133.
7. For select references see: (a) S. J. Rhoads, J. K. Chattopadhyay, E. E. Waali, Double bond isomerizations in unsaturated esters and enol ethers. I. Equilibrium studies in cyclic and acyclic systems. *J. Org. Chem.* 1970, **35**, 3352-3358. (b) J. Hine, N. W. Flachskam, Electronic Effects of

- Substituents on the Stabilities of Carbon-Carbon Double Bonds. *J. Am. Chem. Soc.* 1973, **95**, 1179-1185. (c) J. Hine, V. M. Kanagasabapathy, P. Ng, Structural effects on rates and equilibria. 24. Double bond-stabilizing abilities of formyl, carbo-tert-butoxy, and carbomethoxy substituents. *J. Org. Chem.* 1982, **47**, 2745-2748. (d) S. G. Alcock, J. E. Baldwin, R. Bohlmann, L. M. Harwood, J. I. Seeman, On the Conjugative Isomerizations of beta,gamma-Unsaturated Esters. Stereochemical Generalizations and Predictions for 1,3-Prototropic Shifts under Basic Conditions. *J. Org. Chem.* 1985, **50**, 3526-3535.
8. For a review see: M. Hassam, A. Taher, G. E. Arnott, I. R. Green, W. A. L. van Otterlo, Isomerization of Allylbenzenes. *Chem. Rev.* 2015, **115**, 5462-5569.
  9. E. Larionov, L. Lin, L. Guenee, C. Mazet, Scope and Mechanism in Palladium-Catalyzed Isomerizations of Highly Substituted Allylic, Homoallylic, and Alkenyl Alcohols. *J. Am. Chem. Soc.* 2014, **136**, 16882-16894.
  10. L. Lin, C. Romano, C. Mazet, Palladium-Catalyzed Long-Range Deconjugative Isomerization of Highly Substituted  $\alpha,\beta$ -Unsaturated Carbonyl Compounds. *J. Am. Chem. Soc.* 2016, **138**, 10344-10350.
  11. S. Sanz-Navarro, M. Mon, A. Domenech-Carbo, R. Greco, J. Sanchez-Quesada, E. Espinos-Ferri, A. Leyva-Perez, Parts-per-million of ruthenium catalyze the selective chain-walking reaction of terminal alkenes. *Nature Chem.* 2022, **13**, 2831.
  12. D. B. Grotjahn, C. R. Larsen, J. L. Gustafson, R. Nair, A. Sharma, A. Miled and Selective Deuteration and Isomerization of Alkenes by a Bifunctional Catalyst and Deuterium Oxide. *J. Am. Chem. Soc.* 2007, **129**, 9592-9593.
  13. For select examples of selective C-C double bond monoisomerization reactions see:  
(a) S. W. M. Crossley, F. Barabe, R. A. Shenvi, Simple, Chemoselective, Catalytic Olefin Isomerization. *J. Am. Chem. Soc.* 2014, **136**, 16788-16791; (b) A. L. Kocen, K. Klimovica, M.F. Weber, A. Schmidt, P. Rose, M. Fischer, O. Burghaus, G. Hilt, Double-Bond Isomerization: Highly Reactive Nickel Catalyst Applied in the Synthesis of the Pheromone (9Z,12Z)-Tetradeca-9,12-dienyl Acetate. *Org. Lett.* 2015, **17**, 2952-2955. (c) X. Liu, W. Zhang, Y. Wang, Z. Zhang, L. Jiao, Q. Liu, Cobalt-Catalyzed Regioselective Olefin Isomerization Under Kinetic Control. *J. Am. Chem. Soc.* 2018, **140**, 6873-6882. (d) Q.-Y. Meng, T. E. Schirmer, K. Katou, B. Konig, Controllable Isomerization of Alkenes by Dual Visible-Light-Cobalt Catalysis. *Angew. Chem. Int. Ed.* 2019, **58**, 5723-5728.
  14. D. E. O'Connor, W. I. Lyness, The Effect of Methylmercapto, Methylsulfinyl, and Methylsulfonyl Groups on the Equilibrium in Three-Carbon Prototropic Systems. *J. Am. Chem. Soc.* 1964, **86**, 3840-3846.
  15. E. A. Fehnel, Thiapyran Derivatives. III. The Preparation, Properties and Reactions of Delta2-Dihydrothiapyran 1,1-Dioxide. *J. Am. Chem. Soc.* 1952, **74**, 1569-1574.
  16. K. Inomata, T. Kobayashi, S.-i. Sasaoka, H. Kinoshita, H.; Kotake, H. Convenient Methods for the Preparation of Vinylic and Allylic Sulfones from Alkenes. *Chem. Lett.* 1986, **15**, 289-292.
  17. T. Kobayashi, Y. Tanaka, T. Ohtani, H. Kinoshita, K. Inomata, H. Kotake, Regio- and Stereoselective Synthesis of (E)- and (Z)-Vinylic Sulfones and Their Conversion to the Corresponding Allylic Sulfones. *Chem. Lett.* 1987, **16**, 1209-1212.
  18. K. Inomata, S.-i. Sasaoka, T. Kobayashi, Y. Tanaka, S. Igarashi, T. Ohtani, H. Kinoshita, H.; Kotake, Convenient Methods for the Preparation of Vinylic and Allylic Sulfones from Alkenes, Haloalkanes, and Aldehydes. Stereochemistry of the Conversion of Vinylic Sulfones to the Corresponding Allylic Sulfones. *Chem. Lett.* 1987, **60**, 1767-1779.
  19. S. K. Guha, Y. Ukaji, K. Inomata, "Syn Effect" in the Desilylation Reaction of gamma-Silylated Allylic and Vinyl Sulfones. *Chem. Lett.* 2003, **32**, 1158-1159.

20. A. Nickel, T. Maruyama, H. Tang, P. D. Murphy, B. Greene, N. Yusuff, N.; J. L. Wood, Total Synthesis of Ingenol. *J. Am. Chem. Soc.* 2004, **126**, 16300-16301.
21. S. V. Ley, A. Armstrong, D. Diez-Martin, M. J. Ford, P. Grice, J. G. Knight, H. C. Kolb, A. Madin, A.; C. A. Marby, S. Mukherjee, A. N. Shaw, A. M. Z. Slawin, S. Vile, A. D. White, D. J. Williams, D. J.; M. Woods, Total Synthesis of the Anthelmintic Macrolide Avermectin B1a. *J. Chem. Perkin Trans. 1*, 1991, 667-692.
22. N. Collins, R. Connon, G. Sanchez-Sanz, P. Evans, Isomerisation of Vinyl Sulfones for the Stereoselective Synthesis of Vinyl Azides. *Eur. J. Org. Chem.* 2020, 6228-6235.
23. P. S. Lee, W. Du, D. L. Boger, W. L. Jorgensen, Energetic Preferences for  $\alpha$ ,  $\beta$  versus  $\beta$ ,  $\gamma$  Unsaturation. *J. Org. Chem.* 2004, **69**, 5448-5453.
24. C. L. Schwans, T. D. Clark, G. W. O'Neil, Hydroxyl-Directed Regio- and Diastereoselective Allylic Sulfone Reductions with  $[\text{Sm}(\text{H}_2\text{O})_n]\text{I}_2$ . *J. Org. Chem.* 2024, **89**, 692-700.
25. M. Feng, B. Tang, S. H. Liang, X. Jiang, Sulfur Containing Scaffolds in Drugs: Synthesis and Application in Medicinal Chemistry. *Curr. Top. Med. Chem.* 2016, **16**, 1200-1216.
26. T. Jones, P. Masson, R. Hamel, G. Brunet, G. Holme, Y. Girard, M. Larue, J. Rokach, Biological activity of leukotriene sulfones on respiratory tissues. *Prostaglandins* 1982, **24**, 279-291.
27. J. J. Eisch, J. E. Galle, Generation of  $\alpha$ -Sulfonylvinylolithium Reagents by Lithiation of Vinylic Sulfones. *J. Org. Chem.* 1979, **44**, 3279-3280.
28. T. Kanai, Y. Kanagawa, Y. Ishii, Hydrogen iodide strategy for one-pot preparation of allylic azides, nitriles, and phenyl sulfones from allylic alcohols. *J. Org. Chem.* 1990, **55**, 3274-3277.
29. See Supporting Information.
30. T. R. Puleo, S. J. Sujansky, S. E. Wright, J. S. Bandar, Organic Superbases in Recent Synthetic Methodology. *Eur. J. Org. Chem.* 2021, **27**, 4216-4229.
31. E. Marcantoni, S. Cingolani, Efficient Diastereoselective Syntheses of *erythro*- or *threo*- $\alpha$ -Alkyl- $\beta$ -hydroxy Sulfones by Reductions of  $\alpha$ -Alkyl- $\beta$ -keto Sulfones with  $\text{TiCl}_4/\text{BH}_3$  or  $\text{LiEt}_3\text{BH}/\text{CeCl}_3$ , Respectively. *J. Org. Chem.* 1998, **63**, 3624-3630.
32. The stereochemistry of compound **17** was assigned as *E,E* based on NMR analysis. See Supporting Information for details.
33. N. Mase, Y. Watanabe, T. Toru, T. Hagiwara, Diastereoselective Radical Hydrogenation of  $\alpha$ -(1-Hydroxyalkyl)vinyl Sulfoxides and Sulfones Controlled by Intramolecular Hydrogen Bonding. *J. Org. Chem.* 2000, **65**, 7083-7090.
34. Y. Chen, J. B. Evarts, Jr., E. Torres, P. L. Fuchs, Synthesis of Termini-Differentiated 6-Carbon Stereotetrads: An Alkylative Oxidation Strategy for Preparation of the C21-C26 Segment of Apoptolidin. *Org. Lett.* 2002, **4**, 3571-3574.
35. H. E. Zimmerman, B. S. Thyagarajan, The Stereochemistry of Proton Transfer Reactions. VII. *J. Am. Chem. Soc.* 1958, **80**, 3060-3064.
36. H. E. Zimmerman, B. S. Thyagarajan, The Stereochemistry of Sulfone-stabilized Carbanions. *J. Am. Chem. Soc.* 1960, **82**, 2505-2511.
37. For a recent review see: I. V. Alabugin, L. Kuhn, N. V. Krivoshchapov, P. Mehaffy, M. G. Medvedev, Anomeric Effect, Hyperconjugation and Electrostatics: Lessons from Complexity in a Classic Stereoelectronic Phenomenon. *Chem. Soc. Rev.* 2021, **50**, 10212-10252.
38. D. Biswanth, M. Lingaiah, K. Damodar, N. Bhunia, An efficient synthesis of vinyl sulfones from alkenes and aryl sulfinates. Studies on novel synthetic methodologies. *Synthesis* 2011, 2941-2944.
39. P. Mauleón, A. A. Núñez, A. Inés, J. C. Carretero, Palladium-Catalyzed Cascade Reaction of  $\alpha,\beta$ -Unsaturated Sulfones with Aryl Iodides. *Chem-Eur. J.* 2003, **9**, 1511-1520.

**Data Availability Statement For: Diastereoselective  $\beta$ -Hydroxy Vinylsulfone Isomerizations**

The data supporting this article have been included as part of the Supplementary Information.