4), 4.50 (s, 2), 6.80–6.89 (m, 6), 7.14–7.21 (m, 6). ^{13}C NMR: δ 27.0, 28.0, 48.7, 49.2, 51.0, 52.2, 55.3, 65.7, 82.4, 114.1, 115.0, 127.6, 129.0, 130.0, 130.3, 157.5, 159.3, 167.9, 173.4. IR: 1746, 1731, 1612, 1513, 1317, 1185 cm^{-1}. Anal. Calcd for $C_{33}H_{41}NO_9S$: C, 63.14; H, 6.58; N, 2.23; S, 5.11. Found: C, 63.52; H, 6.64; N, 2.43; S, 4.89.

Methyl α-[2-(aminosulfonyl)ethyl]-4-(carboxymethoxy)-benzeneacetate (24) was prepared by the alternate procedure given previously for **15c**. Yield was 9.2 g (85%) after silica gel chromatography (6% MeOH/CH_2Cl_2/0.5% acetic acid). Mp: 115–117 °C dec. ^{1}H NMR (MeOH-d_4): δ 2.16–2.32 (m, 1), 2.42–2.57 (m, 1), 2.87–3.10 (m, 2), 3.62 (s, 3), 3.78 (dd, J = 7.7 Hz, 1), 4.63 (s, 2), 6.90 (d, 2), 7.21 (d, 2). ^{13}C NMR (MeOH-d_4): δ 28.7, 49.7, 52.8, 53.5, 65.9, 116.0, 130.2, 132.1, 158.9, 172.8, 175.3. IR: 3331, 1758, 1713, 1514, 1329, 1163 cm^{-1}. Anal. Calcd for $C_{13}H_{17}NO_7S$: C, 47.12; H, 5.23; N, 4.17; S, 9.68. Found: C, 46.73; H, 5.32; N, 4.11; S, 9.35.

Disodium [4-(tetrahydro-3-oxo-2*H*-1,2-thiazin-4-yl)phenoxy]acetate *S*,*S*-dioxide (25) was prepared by the procedure given previously for **8c**. Yield 6.4 g (80%). Mp >300 °C. ^{1}H NMR (D_2O): δ 2.21–2.35 (m, 1), 2.41–2.54 (m, 1), 3.20–3.30 (m, 2), 3.70 (dd, J = 5.6, 8.3 Hz, 1), 4.49 (s, 2), 6.95 (d, 2), 7.18 (d, 2). ^{13}C NMR (D_2O): δ 5.6, 22.7, 24.7, 45.2, 93.2, 107.9, 111.7, 135.0, 155.2, 157.6. IR: 1611, 1532, 1300, 1125 cm^{-1}. MS (HR): calcd for $C_{12}H_{11}NO_6SNa_2$ 300.0532, found 300.0542.

2-[4-(Tetrahydro-2*H*-1,2-thiazin-4-yl)phenoxy]ethanol *S*,*S*-dioxide (26) was prepared by the procedure given previously for **9a**. Yield: 127 mg (82%). Mp 130–133 °C, dec. ^{1}H NMR: δ 2.14–2.28 (m, 1), 2.30–4.49 (m, 1), 2.69–2.93 (m, 1), 3.04–3.47 (m, 4), 3.85 (t, J = 2 Hz, 2), 4.00 (t, J = 2 Hz, 2), 6.90 (d, 2), 7.15 (d, 2). ^{13}C NMR: δ 32.1, 42.0, 50.6, 52.2, 61.8, 68.2, 70.6, 116.0, 129.2, 134.9, 159.5. IR: 3506, 3248, 1515, 1317, 1298, 1148 cm^{-1}. Anal. Calcd for $C_{12}H_{17}NO_4S$: C, 53.12; H, 6.32; N, 5.16; S, 11.82. Found: C, 53.24; H, 6.40; N, 5.18; S, 11.79.

[4-(Tetrahydro-2*H*-1,2-thiazin-4-yl)phenoxy]acetic Acid *S*,*S*-Dioxide (27). A vigorously stirred solution of alcohol **26** (210 mg, 0.77 mmol) and 4 mL of H_2O in 4 mL of 50% CH_3CN/CH_2Cl_2 under N_2 at 0 °C was treated successively with $NaHCO_3$ (332 mg, 3.95 mmol), $NaIO_4$ (508 mg, 2.38 mmol), and $RuCl_3$ (17 mg, 0.08 mmol) and stirred for 3 h as the cooling bath expired. The organics were removed in vacuo, and the aqueous residue was diluted with 10 mL of 2 N NaOH. The mixture was extracted with 2 × 10 mL of Et_2O, and aqueous layer was adjusted to pH 2.5 with 5% HCl and extracted with 4 × 15 mL of EtOAc. The combined organics were dried over $MgSO_4$ and concentrated in vacuo (208 mg). Purification by chromatography over 12 g of silica gel, eluting with 10% acetone/EtOAc containing 3% acetic acid, afforded 102 mg (47%) of **27** as a white solid. Mp: 186–188 °C. ^{1}H NMR (MeOH-d_4): δ 2.20–2.30 (m, 1), 2.34–2.51 (m, 1), 2.78–2.91 (m, 1), 3.09–3.50 (m, 4), 4.63 (s, 2), 6.89 (d, 2), 7.19 (d, 2). ^{13}C NMR: δ 32.0, 42.0, 50.6, 52.1, 66.0, 116.0, 129.2, 136.0, 158.6, 173.0. IR: 3217, 1739, 1513, 1318, 1135 cm^{-1}. MS (HR): calcd for $C_{12}H_{15}NO_5S$ 285.0671, found 285.0694.

Supplementary Material Available: ^{1}H and ^{13}C NMR spectra for compounds **5c, 8c, 8d, 9b, 9c, 10c, 13b, 15a, 15b, 15d, 16, 25,** and **27** and spectral and analytical data for compounds **8d, 9c, 9d, 10b, 11b, 11c, 13d, 15c, 15d, 17,** and **19** (29 pages). Ordering information is given on any current masthead page.

Alkylation of 2-Oxy-Substituted 1-Sulfonylallyl and 1-Sulfonylvinyl Anions. New Routes to Functionalized Carbocycles and Dihydrofurans

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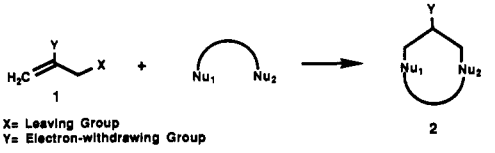
Alkylation of the anion derived from 2-phenoxy-3-(phenylsulfonyl)-1-propene proceeds α to the phenylsulfonyl group and affords cyclic products from 1,ω-dihalides. Reaction of the monoalkylated products, in which a suitably positioned olefinic or acetylenic unit is present, with sodium benzenesulfinate–acetic acid gives functionalized acetylcyclopentenes and cyclohexenes via C–C bond formation from the allyl cation–sulfinate ion pair. In the vinyl sulfone series, deprotonation of (*E*)- or (*Z*)-2-alkoxyvinyl phenyl sulfones rapidly affords the more stable (*E*)-lithio derivative, an acetaldehyde anion equivalent which reacts normally with aldehydes, ketones, alkyl halides, and epoxides. The latter process may be effected in an intramolecular fashion. Thus, (*E*)-(2-phenylsulfonyl) vinyl ethers of 2,3-epoxy alcohols cyclize on treatment with amide bases to afford dihydrofurans whose stereochemistry is fully defined by that of the starting epoxy alcohol.

For some time, synthetic chemists have sought efficient and stereospecific methods for carbocyclic annulations. Useful annulating reagents should be capable of acting sequentially as an alkylating agent and Michael acceptor.[1] In this context, functionalized allylic reagents of type 1, wherein X is some leaving group and Y is an electron-withdrawing substituent, have been extensively utilized in organic synthesis.[1-11] These substituted 1-propenes have been referred to as multicoupling reagents.[5,12] Recently, we have demonstrated that the closely related 2-



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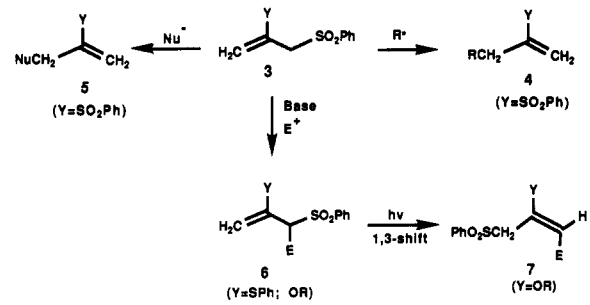
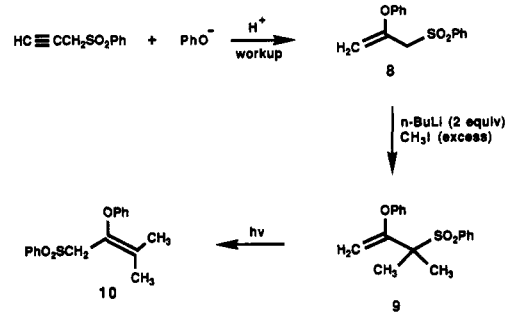
thio-substituted 3-(phenylsulfonyl)-1-propenes[13] (Y = SPh or SO_2Ph) are also versatile synthetic reagents.[14-16] They react with various nucleophiles[14] and radicals[15] or with electrophiles[16] leading to functionalized unsaturated sulfones, which can undergo further useful transformations.[17,18] In connection with our program dealing with the chemistry of unsaturated sulfones,[19,20] we became interested in effecting the 1,3-rearrangement of allylic sulfones[21-31] of the general type **6** (Y = OR). Our objective was to perform a metalation–alkylation on **3**, followed by a 1,3-rearrangement of the sulfonyl group. Hydrolysis of the vinyl ether (Y = OR) followed by reduction of the phenyl sulfonyl group would correspond to using **3** as an acetone dianion equivalent. At the outset of our investigations, we were aware of Whitham's work dealing with 1,3-sulfonyl shifts of simple allylic sulfones[28] and had ourselves made similar observations with phenylthio-substituted sulfones.[16] These encouraging results prompted us to embark on a systematic investigation of the chemistry of a series of substituted alkoxy(phenylsulfonyl)alkenes since we felt that these compounds would prove to be useful synthetic reagents. During the course of our studies, we found that the isomeric (*E*)-2-alkoxy-1-(phenylsulfonyl)ethene system reacts efficiently with a variety of electrophiles to give synthetically useful products. In this paper, we document the results of these studies.[32]

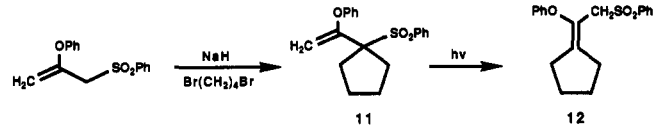


Results and Discussion

Reaction of propargyl phenyl sulfone[33] with lithium phenoxide according to the general procedure of Stirling[13] gave 2-phenoxy-3-(phenylsulfonyl)-1-propene (**8**) in 80% yield. Exposure of **8** to 2.2 equiv of *n*-butyllithium (THF, −78 °C to 25 °C) followed by reaction with excess methyl iodide produced the dialkylated sulfone **9** in 90% yield. A 1,3-sulfonyl shift occurred in quantitative yield when **9** was irradiated in benzene with 300-nm light. Photolysis initiates the reaction by bringing about cleavage of the allyl sulfone bond. The phenylsulfonyl radical so produced adds to the double bond of another molecule, leading to a new radical which loses the resident phenylsulfonyl group to generate the rearranged isomer.



Similarly, treatment of **8** with 1,4-dibromobutane in the presence of 2.2 equiv of sodium hydride lead to the cyclization product **11** in 80% yield. Irradiation of this compound in benzene for 4 h produced ethylidenecyclopentane **12** in 93% yield.



Within the last decade, new methods for the controlled production of carbon-centered free radicals have been coupled with intramolecular cyclization reactions of predictable regio- and stereoselectivity to provide a powerful technique for carbon–carbon bond formation in organic synthesis.[34-36] These reactions often involve a variety of well-known precursors to a carbon-centered radical, such as halides, thioacyl moieties, olefins, selenides, and sulfides which can be used to produce substituted cyclopentane derivatives when treated with *n*-tributyltin hydride.[37-40]

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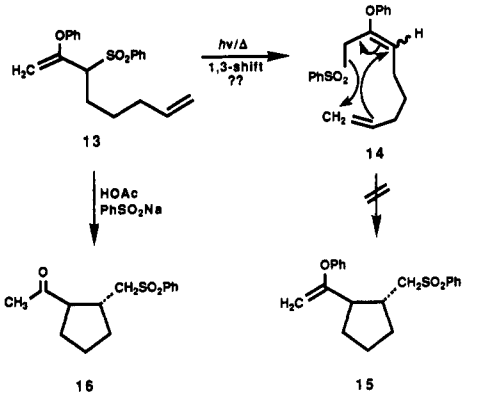
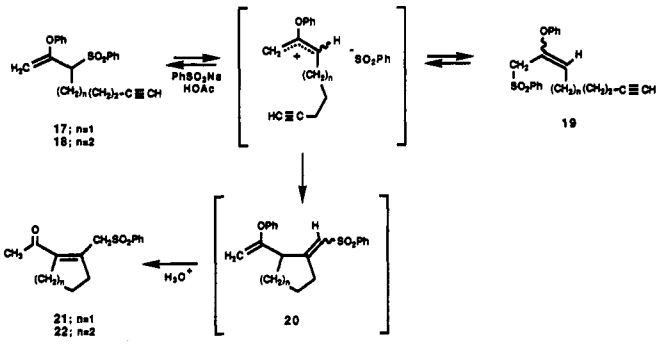
During the course of our studies, it occurred to us that the radical-induced 1,3-shift of a 2-phenoxy-substituted allylic sulfone might be used to promote the intramolecular 5-*exo* cyclization reaction.[34] Our initial attempts centered on sulfone **13**, which we expected to undergo cyclization to **15** via the rearranged isomer **14**. Ring closure would

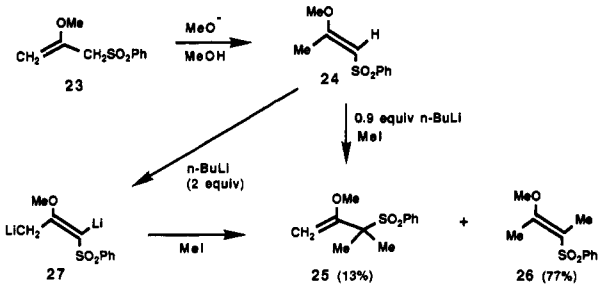


correspond to the formation of a five-membered ring from a hex-5-enyl radical.[41] Unfortunately, all of our attempts to effect cyclization of **13** under a variety of typical radical conditions were unsuccessful. However, sulfone **13** was found to undergo cyclization to the known keto sulfone **16** when heated with sodium phenylsulfinate in 60% aqueous acetic acid at 100 °C for 12 h in 63% yield.[16b,43] Related cyclizations also occurred with the acetylenic allylic phenoxy-substituted sulfones **17** and **18**. Use of the aqueous acetic acid–sodium phenylsulfinate procedure gave both the five- (**21**) and six-membered (**22**) α,β-unsaturated ketones in 75% and 68% yield, respectively. More than likely, the reaction proceeds via a tight ion pair which ultimately produces the acetylcycloalkene under the reaction conditions. Similar reactions were carried out previously with the corresponding vinyl sulfides.[16]



A number of substituted acyclic allylic sulfones have been found to undergo 1,3-rearrangement when heated in acetic acid–water.[22,27,28] Evidence was presented by Whitham in favor of an ion pair dissociation–recombination mechanism in these cases.[28] The ion pair was presumed to be fairly "intimate" since solvolysis products were not found. It should be noted that the above allylic sulfones do not cyclize by heating in acetic acid–water in the absence of added sodium phenyl sulfinate but rather undergo hydrolysis to an α-keto sulfone. One possibility to account for the role of phenylsulfinate is to invoke some sort of nucleophilic-assisted ion pair process.[44]

We also studied the alkylation–rearrangement behavior of 2-methoxy-3-(phenylsulfonyl)-1-propene (**23**), and this compound was found to behave in an analogous fashion. During the course of our studies with **23**, we noted that the isomeric (*E*)-2-methoxy-2-(phenylsulfonyl)propene (**24**), readily obtained from **23**, exhibited interesting behavior on deprotonation. The high kinetic acidity of the α-sulfonylvinyl proton results in preferential abstraction at this position rather than the allylic methyl group. However, a second deprotonation to give a dianion (**27**) occurred quite readily.[45,46] In fact, some dianion formation



took place even with a deficiency (0.9 equiv) of *n*-butyllithium. Quenching with methyl iodide gave the expected alkylation product **26**, recovered **24** and the gem-dimethylated compound **25**. This latter substance was obtained in excellent yield from **24** with two equivalents of *n*-butyllithium followed by reaction with methyl iodide, via dianion **27**.

The configurational properties and chemical reactivity of several 2-alkoxy-1-(phenylsulfonyl)vinyl anions was also examined.[47] Thus, treatment of the (*E*)-sulfone **28** or **29** with *n*-butyllithium or LDA[50] (THF–hexane, −70 °C) rapidly gave the yellow, soluble lithio compound, which reacted with a variety of electrophiles to give good yields of product. These reactions are outlined below. The products could be processed further to useful synthetic intermediates, exemplified by the desulfonylation of **31** (Na/Hg, K_2HPO_4, CH_3OH) to give 80% of enol ether **32** as a 1:1 E/Z mixture, which, in turn, could be converted to bromo acetal **33** by reaction with NBS and ethanol or to acetal **34** with *p*-toluenesulfonic acid in ethanol. Alkylations of the anion derived from **29** with primary halides were efficient, but bromocyclohexane underwent elimination. Reactions with aldehydes and ketones were general and high yielding. An intramolecular version of this process results in an efficient furan synthesis.[51]

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(44) This interpretation should be treated with some caution, however, in light of the earlier results of Whitham[28] who suggested that the role of sulfinic acid is to behave as a source of $ArSO_2$ radicals.

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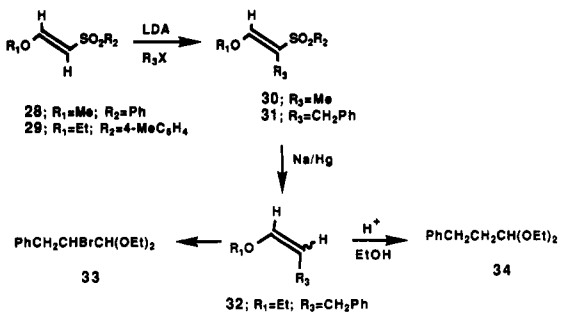
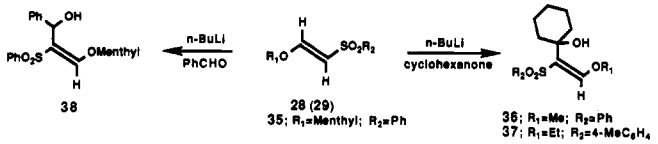
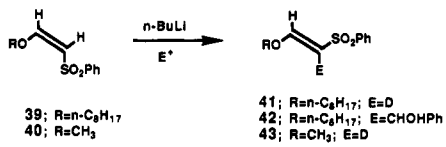
(50) We estimate the p*K* of **32** to lie between 22 and 25 p*K* units; the anion may be generated with $LiN(Si(CH_3)_3)_2$ and is completely reprotonated by Ph_2NH (no significant deuterium incorporation into **32** after sequential treatment with *n*-BuLi (1 equiv), Ph_2NH (1 equiv), and D_2O).



In an effort to induce chirality in the hydroxyalkylation products, ((*l*)-menthyloxy)vinyl sulfone anion (**35**) (*n*-butyllithium, −78 °C), was treated with benzaldehyde. However, NMR analysis of the product indicated a 1:1 mixture of diastereomers. Seemingly, the chiral centers in the anion were too distant to influence the stereochemistry in the addition step.

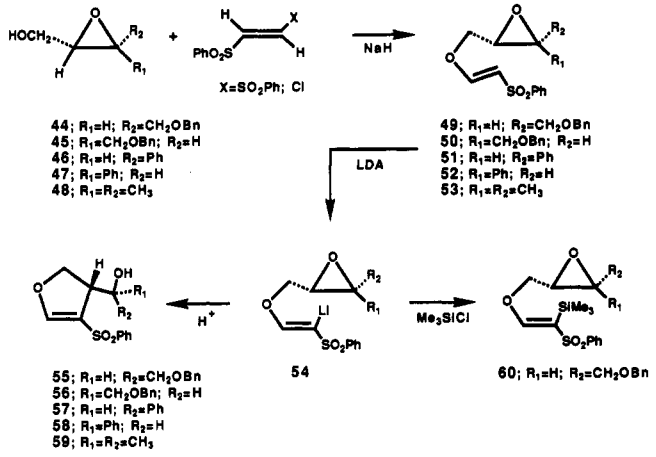


The structure of carbanions stabilized by an α-sulfonyl group have received considerable scrutiny from both theoretical and experimental standpoints.[17,18,52] In order to probe the configurational stability of ((*Z*)-2-alkoxy-1-(phenylsulfonyl)vinyl)lithium compounds, the (*Z*)-sulfones **39** and **40** were prepared and treated with *n*-butyllithium followed by electrophiles at −70 °C. In marked contrast to alkyl substituted ((*Z*)-1-(phenylsulfonyl)vinyl)lithium species,[49] which isomerize quite slowly at −70 °C, the alkoxy analogues isomerized rapidly and completely to the *E* isomers, even at −90 °C. Thus, reaction of **39** with *n*-BuLi (1 min, −70 °C) followed by D_2O or benzaldehyde quench gave **41** and **42**. Similarly, **40**–Li reacted with



CH_3OD and CH_3I to give products identical with samples prepared from the *E* olefin **28**. This rapid $Z \rightarrow E$ isomerization may be facilitated by reduced double bond order in a "push–pull" olefin such as **28** and is analogous to the situation found for 2-methoxy-1-(*p*-toluenesulfonyl)-cyclopropyl carbanions where stabilization of the *E* isomer is ascribed to lithium chelation by the β-alkoxy substituent,[53] or to an anomeric effect involving the carbanion lone pair with the σ^* orbital of the adjacent, heteroatom-bearing carbon.[54] In the olefinic system, the reduced π-bond may also lower the inversion barrier.

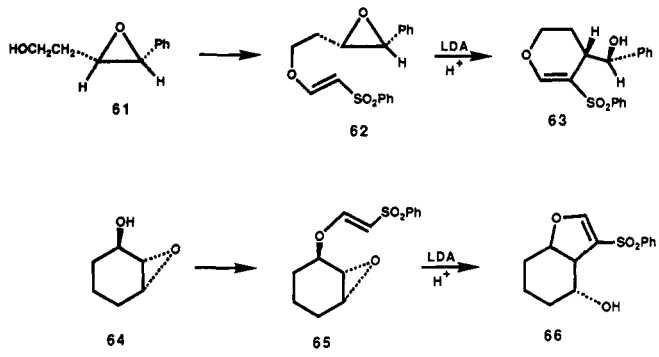
We next focused our efforts on the intramolecular S_N2 ring opening of a series of (*E*)-2-(phenylsulfonyl)vinyl ethers derived from 2,3-epoxy alcohols.[20] The sodium alkoxides of 2,3-epoxy alcohols **44**–**48** (NaH, THF, 0 °C) reacted with (*E*)-1,2-bis(phenylsulfonyl)ethene to stereospecifically produce the corresponding (*E*)-vinyl ethers.



The formation of these vinyl ethers proceeds in a stereoselective fashion and requires both formation of the intermediate carbanion and subsequent expulsion of the sulfinate anion to be stereoelectronically controlled. The results obtained suggest that elimination from the kinetically formed α-sulfonyl carbanion occurs in an anti fashion leading to the thermodynamically more stable *E* isomer. Highly stereoselective formation of the *Z* isomers **39**/**40** from (*Z*)-1,2-bis(phenylsulfonyl)ethene and the appropriate alkoxide is presumably a consequence of initial elimination to phenylsulfonyl acetylene, followed by anti addition–protonation.[55,56] Upon generation of the vinylsulfonyl carbanion in THF with LDA at −78 °C followed by warming to 0 °C over a period of 30 min, cyclization with C_2 inversion occurred, in agreement with Baldwin's guidelines,[57] to produce dihydrofurans **55**–**59**. Confirmation of anion production at −70 °C was secured by trapping with D_2O and trimethylsilyl chloride. Analogous LDA treatment of the corresponding (*Z*)-sulfonylvinyl ethers was capricious, leading to the suggestion of configurational stability for the derived anion;[20] this was shown not to be so by the experiments described in this paper. The 3,4-epoxy alcohol **61** and bicyclic alcohol **64** were similarly converted to dihydropyran **63** and bicyclic dihydrofuran **66**, respectively. Yields were generally in the 55–70% range for the cyclization step, with material balance being mostly polar, unidentified material. Addition of HMPA or mild Lewis acids ($MgCl_2$, BF_3·OEt_2) did not significantly improve the yield. The vinyl anion **54** can be easily aligned so that requirements for S_N2 attack at C_2 are satisfied. The products, retaining both sulfone and C–C π-bond functional groups are easily subject to further synthetic manipulations.[51]

An alternative procedure for intramolecular (S_N2) delivery of a sulfonyl-substituted carbon unit to C-2 of 2,3-epoxy alcohol derivatives involves the corresponding dianions derived from (arylsulfonyl)acetate esters.[58] This process is complementary to the dihydrofuran synthesis

(51) McCombie, S. W.; Shankar, B. B.; Ganguly, A. K. *Tetrahedron Lett.* **1987**, *28*, 4123.
(52) Block, E. *Reactions of Organosulfur Compounds*; Academic Press: New York, 1978.
(53) Padwa, A.; Wannamaker, M. W. *Tetrahedron Lett.* **1986**, *27*, 2555. Padwa, A.; Wannamaker, M. W.; Dyszlewski, A. D. *J. Org. Chem.* **1987**, *52*, 4760.
(54) Kirby, A. J. *The Anomeric Effect and Related Stereoelectronic Effects in Organic Chemistry*; Pergamon Press: London, 1983; Chapter 2. Romers, C.; Altona, C.; Buys, H. R.; Havinga, E. *Topics in Stereochemistry*; Eliel, E. L., Allinger, N. L., Eds.; Wiley Interscience: New York, 1969; Vol. 4, p 39.
(55) The addition–elimination reaction of β-oxygenated vinyl sulfones has been reported by Giblin, G. M.; Simpkins, N. S. *J. Chem. Soc., Chem. Commun.* **1987**, 207.
(56) For some related addition–elimination sequences with α,β-unsaturated carbonyl compounds, see: Sum, F. W.; Weiler, L. *Can. J. Chem.* **1979**, *57*, 1431. Casey, C. P.; Marten, D. F.; Boggs, R. A. *Tetrahedron Lett.* **1973**, 2071. Casey, C. P.; Marten, D. F. *Ibid.* **1974**, 925.
(57) Baldwin, J. E. *J. Chem. Soc., Chem. Commun.* **1976**, 734. Baldwin, J. E.; Cutting, J.; Dupont, W.; Kruse, L.; Silberman, L.; Thomas, R. C. *J. Chem. Soc., Chem. Commun.* **1976**, 736.
(58) McCombie, S. W.; Shankar, B. B.; Ganguly, A. K. *Tetrahedron Lett.* **1989**, *30*, 7029.



described herein, in that it is preferred for delivery of a two-carbon unit when a *cis*-2,3-epoxy alcohol is the precursor, but is less satisfactory for *trans*-epoxy alcohols, where a competing fragmentation of the dianion is problematic. The vinyl anion/dihydrofuran route is thus preferred for trans cases, and where cleavage (O_3) to a one-carbon unit is desired.

Experimental Section

Melting points are uncorrected. Mass spectra were determined at an ionizing voltage of 70 eV. Solutions were evaporated under reduced pressure with a rotary evaporator, and the residue was chromatographed on a silica gel column using an ethyl acetate–hexane mixture as the eluent unless specified otherwise.

2-Phenoxy-3-(phenylsulfonyl)-1-propene (8). To a solution containing 5.0 g of 3-(phenylsulfonyl)propyne[33] and 2.9 g of phenol (1.1 equiv) in 70 mL of dry THF was added 0.1 mL of a 1.54 M *n*-BuLi solution in hexane. The reaction was stirred for 8 h at rt under N_2. Evaporation of the solvent under reduced pressure left a brown oil that was dissolved in $CHCl_3$. The organic layer was washed twice with a saturated K_2CO_3 solution and was then dried (Na_2SO_4). Concentration of solvent left a yellow oil that was recrystallized from diisopropyl ether to give 6.1 g (80%) of **8** as white crystals: mp 53–54 °C; IR (KBr) 1650, 1600, 1450, 1310, 1150, 970, and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 4.00 (s, 2 H), 4.16 (d, 1 H, J = 2.5 Hz), 4.36 (d, 1 H, J = 2.5 Hz), 6.83 (d, 2 H, J = 7.5 Hz), 7.11 (t, 1 H, J = 7.5 Hz), 7.29 (t, 2 H, J = 7.5 Hz), 7.55 (t, 2 H, J = 7.5 Hz), 7.65 (t, 1 H, J = 7.5 Hz), and 7.98 (d, 2 H, J = 7.5 Hz); ^{13}C-NMR ($CDCl_3$, 75 MHz) δ 61.3, 95.6, 120.8, 124.8, 128.5, 128.9, 129.6, 133.8, 138.7, 151.5, and 153.8. Anal. Calcd for $C_{15}H_{14}O_3S$: C, 65.57; H, 5.14; S, 11.69. Found: C, 65.77; H, 5.17; S, 11.78.

3-Methyl-2-phenoxy-1-(phenylsulfonyl)-2-butene (10). A solution containing 0.33 g of **8** in 10 mL of dry THF was cooled to −78 °C under N_2. To this solution was added 1.53 mL of a 1.55 M *n*-BuLi solution in hexane (2.2 equiv). The resulting yellow solution was stirred at −78 °C for 10 min, and then 0.15 mL of CH_3I was added by syringe. The reaction was warmed to rt and was quenched with a saturated NH_4Cl solution. Evaporation of the solvent under reduced pressure left an oil that was extracted with ether. The combined organic extracts were washed with a saturated $NaHCO_3$ solution and a 10% $Na_2S_2O_5$ solution and then dried (Na_2SO_4). Concentration of the solvent under reduced pressure left 0.33 g (90%) of **9** as a clear oil: IR (neat) 1640, 1590, 1490, 1310, 1220, 1150, 1080, 760, and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 1.60 (s, 6 H), 4.13 (d, 1 H, J = 2.5 Hz), 4.43 (d, 1 H, J = 2.5 Hz), 6.75–6.85 (m, 2 H), 7.00–7.05 (m, 1 H), 7.15–7.25 (m, 2 H), 7.35–7.45 (m, 2 H), 7.50–7.55 (m, 1 H), and 7.86–7.91 (m, 2 H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 24.4, 67.3, 93.1, 121.1, 124.6, 128.4, 129.6, 130.6, 133.5, 136.4, 154.6 and 160.2; UV (acetonitrile) 266 nm (ϵ 1300); m/e 302 (M^+), 161, 149, 107, 95, 86, 84 (base) and 77; HRMS calcd for $C_{17}H_{18}O_3S$ 302.0976, found 302.0987.

A sample containing 0.11 g of sulfone **9** was placed in a quartz tube with 15 mL of dry benzene. A small amount of anhydrous K_2CO_3 (0.1 g) was added, and the solution was degassed with Ar for 10 min. The solution was then irradiated in a Rayonet photochemical reactor using a 8-W RPR-3000A (300 nm) lamp for 2 h. Concentration of the solvent under reduced pressure afforded a quantitative yield of sulfone **10** as a clear oil: IR (neat) 1600, 1490, 1310, 1150, 755, and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 1.60 (s, 3 H), 1.68 (s, 3 H), 3.98 (s, 2 H), 6.54 (m, 2 H, J = 7.5 Hz), 6.80–7.72 (m, 6 H), and 7.89 (d, 2 H, J = 7.5 Hz); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 17.9, 19.1, 56.4, 115.8, 116.0, 122.1, 128.6, 129.0, 129.2, 129.6, 129.7, 133.7, 139.2, and 155.3. Anal. Calcd for $C_{17}H_{18}O_3S$: C, 67.53; H, 6.01; S, 10.58. Found: C, 67.29; H, 5.97; S, 10.72.

1-[1-Phenoxy-2-(phenylsulfonyl)ethylidene]cyclopentane (12). A solution containing 60 mg of oil-free NaH (2.2 equiv) in 6 mL of dry DMF was cooled in an ice bath under N_2. To this solution was added 0.3 g of sulfone **8**, the resulting red-orange solution was stirred for 10 min at 0 °C, and then 0.13 mL of 1,4-dibromobutane (1 equiv) was added by syringe. The mixture was stirred at 0 °C for 1 h and was then warmed to rt and stirred for an additional 4 h. The reaction was quenched with 10% aqueous HCl and then poured into ether. The organic layer was separated and washed with another portion of 10% aqueous HCl followed by a saturated $NaHCO_3$ solution and was then dried (Na_2SO_4). Concentration of the solvent under reduced pressure afforded an oil that was chromatographed on a silica gel column using $CHCl_3$ as the eluent to give 0.29 g (80%) of sulfone **11** as a clear oil: IR (neat) 1630, 1590, 1450, 1310, 1140, 970, and 690 cm^{-1}; NMR ($CDCl_3$, 90 MHz) δ 1.60–2.25 (m, 4 H), 2.30–2.75 (m, 4 H), 4.16 (d, 1 H, J = 2.5 Hz), 4.53 (d, 1 H, J = 2.5 Hz), 6.72–7.65 (m, 8 H), and 8.05 (d, 2 H, J = 7.5 Hz).

Irradiation of 0.15 g of **11** was carried out as described above for **9** (4 h irradiation time). Purification by chromatography gave sulfone **12** in 93% yield as a colorless oil: IR (neat) 1590, 1490, 1310, 1220, 1150, 760, and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 1.55–1.63 (m, 4 H), 2.16–2.24 (m, 4 H), 3.93 (s, 2 H), 6.59 (d, 2 H, J = 7.8 Hz), 6.92 (t, 1 H, J = 7.8 Hz), 7.17 (t, 2 H, J = 7.8 Hz), 7.52 (t, 2 H, J = 7.5 Hz), 7.64 (t, 1 H, J = 7.5 Hz), and 7.90 (d, 2 H, J = 7.5 Hz); HRMS calcd for $C_{19}H_{20}O_3S$ 328.1133, found 328.1130.

2-[(Phenylsulfonyl)methyl]-1-cyclopentyl Methyl Ketone (16). A solution containing 250 mg of sulfone **8** and 0.75 mL of HMPA in 10 mL of dry THF was cooled to −78 °C under N_2. To this mixture was added 0.65 mL of a 1.6 M *n*-BuLi solution in hexane. The resulting yellow solution was stirred at −78 °C for 10 min, and then 0.11 mL of 5-bromo-1-pentene was added in one portion. The reaction mixture was allowed to warm to rt and was quenched with a saturated NH_4Cl solution. Evaporation of the solvent under reduced pressure left a yellow oil, which was extracted with ether. The combined ether extracts were washed with water and brine. Removal of the solvent under reduced pressure left a pale yellow oil in 87% yield whose structure was assigned as **2-phenoxy-3-(phenylsulfonyl)-1,7-octadiene (13)**: IR (neat) 1650, 1490, 1220, 1090, and 700 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 1.46–1.70 (m, 2 H), 2.01–2.25 (m, 4 H), 3.80 (dd, 1 H, J = 11.6 and 3.7 Hz), 4.08 (d, 1 H, J = 5.4 Hz), 4.33 (d, 1 H, J = 5.4 Hz), 4.95–5.11 (m, 2 H), 5.70–5.90 (m, 1 H), 6.76 (d, 2 H, J = 7.7 Hz), 7.14 (t, 1 H, J = 7.7 Hz), 7.28 (t, 2 H, J = 7.7 Hz), 7.55 (t, 2 H, J = 7.6 Hz), 7.66 (t, 1 H, J = 7.6 Hz), and 7.95 (d, 2 H, J = 7.6 Hz); HRCIMS (CH_4) calcd for (M + H) $C_{20}H_{23}O_3S$ 343.1368, found 343.1371.

A 200-mg sample of **13** was treated with 700 mg of $NaSO_2Ph$ in 25 mL of a 60% aqueous acetic acid solution, and the mixture was heated at 100 °C for 16 h. The solution was cooled to 25 °C and extracted with ether. The combined ether extracts were washed with dilute NaOH and water and dried (Na_2SO_4). Removal of the solvent under reduced pressure left a yellow oil, which was chromatographed to give **16** having spectral properties identical with those given earlier.[16b]

2-[(Phenylsulfonyl)methyl]-1-cyclopentenyl Methyl Ketone (21). This material was prepared from 250 mg of sulfone **8** and 0.11 mL of 5-iodo-1-pentyne[59] as described above for **13**. The remaining yellow oil was taken up in 50 mL of a 60% aqueous acetic acid solution. The mixture was treated with 640 mg of $NaSO_2Ph$ and was heated at 100 °C for 16 h. The reaction mixture was cooled to 25 °C and was extracted with ether. The combined ether extracts were washed with dilute NaOH and water and dried (Na_2SO_4). Removal of the solvent under reduced pressure left a yellow oil, which was chromatographed to give **21** as a pale yellow oil in 75% yield: IR (neat) 1680, 1610, 1150, 740, and 690 cm^{-1};

(59) Büchi, G.; Wüest, H. *J. Org. Chem.* **1979**, *44*, 546.

NMR ($CDCl_3$, 300 MHz) δ 1.78–1.95 (m, 2 H), 1.92 (s, 3 H), 2.58–2.65 (m, 2 H), 2.72–2.79 (m, 2 H), 4.53 (s, 2 H), 7.48–7.64 (m, 3 H), and 7.83–7.87 (m, 2 H); HRMS calcd for $C_{14}H_{16}O_2S$ 264.0820, found 264.0829.

2-[(Phenylsulfonyl)methyl]-1-cyclohexenyl Methyl Ketone (22). Using a similar procedure as that described above, 250 mg of sulfone **8**, 0.75 mL of HMPA, 10 mL of dry THF, 0.65 mL of a 1.6 M *n*-BuLi solution in hexane, and 0.11 mL of 5-iodo-1-hexyne[60] afforded sulfone **22** in 68% yield as a pale yellow oil: IR (neat) 1685, 1450, 1235, 1160, 750, and 700 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 1.64–1.68 (m, 4 H), 2.01 (s, 3 H), 2.27–2.29 (m, 2 H), 2.35–2.37 (m, 2 H), 4.29 (s, 2 H), 7.52–7.57 (m, 2 H), 7.61–7.66 (m, 1 H), and 7.84–7.88 (m, 2 H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 21.02, 21.30, 27.00, 27.94, 30.74, 58.24, 127.70, 128.44, 128.82, 133.01, 138.56, 140.63, and 202.93; HRMS calcd for $C_{15}H_{18}O_3S$ 278.0977, found 278.0986.

(*E*)-3-Methoxy-2-(phenylsulfonyl)-2-butene (26). A solution containing 0.26 mL of a 1.55 M *n*-BuLi solution in hexane (0.9 equiv) and 3 mL of dry THF was cooled to −78 °C under N_2. To this solution was added 100 mg of **24**[48] dissolved in 1 mL of dry THF over 4 min. The reaction was stirred for 6 min, and then 0.11 mL of CH_3I (4 equiv) was added and the reaction was stirred for another 5 min at −78 °C. The solution was warmed to −60 °C followed by the removal of the solvent under reduced pressure. Standard chromatographic workup afforded **26** as the major product in 77% yield: NMR ($CDCl_3$, 90 MHz) δ 1.83 (s, 3 H), 2.43 (s, 3 H), 3.73 (s, 3 H), 7.5–7.70 (m, 3 H), and 7.8–8.10 (m, 2 H). Anal. Calcd for $C_{11}H_{14}O_3S$: C, 58.39; H, 6.24; S, 14.14. Found: C, 58.22; H, 6.17; S, 14.12.

The reaction with *n*-BuLi was also carried out using a 2.2-fold excess of base. Standard workup afforded 0.35 g (99%) of **2-methoxy-3-methyl-3-(phenylsulfonyl)-1-butene (25)** as a light yellow oil: IR (neat) 1620, 1450, 1160, 1130, 770, 730, and 690 cm^{-1}; NMR ($CDCl_3$, 90 MHz) δ 1.47 (s, 6 H), 3.23 (s, 3 H), 4.10 (d, 1 H, *J* = 2.5 Hz), 4.24 (d, 1 H, *J* = 2.5 Hz), 7.40–7.66 (m, 3 H), and 7.73–7.87 (m, 2 H); UV (95% ethanol) 260 nm (ε 1140), 268 (ε 1210), and 274 nm (ε 1050). Anal. Calcd for $C_{12}H_{16}O_3S$: C, 59.98; H, 6.72; S, 13.32. Found: C, 60.13; H, 7.03; S, 13.18.

Reaction of the Lithiate of (*E*)-2-Methoxy-1-(phenylsulfonyl)ethene (28) with Various Electrophiles. To a solution containing 1.1 g of (*E*)-1-chloro-2-(phenylsulfonyl)ethylene[61] in 30 mL of methanol was added 0.35 g of $NaOCH_3$. The reaction was stirred at rt overnight under N_2. Evaporation of the solvent under reduced pressure left a clear oil that was dissolved in $CHCl_3$. The organic layer was washed with water followed by a saturated $NaHCO_3$ solution and then dried (Na_2SO_4). Concentration of the solvent under reduced pressure left 0.99 g (90%) of (*E*)-2-methoxy-1-(phenylsulfonyl)ethene (**28**)[62] as a clear oil: NMR ($CDCl_3$, 90 MHz) δ 3.70 (s, 3 H), 5.70 (d, 1 H, *J* = 12.1 Hz), 7.40–7.63 (m, 4 H), and 7.70–7.95 (m, 2 H).

A solution containing 0.16 g of sulfone **28** in 5 mL of dry THF was cooled to −78 °C under N_2. To this solution was added 0.73 mL of a 1.55 M *n*-BuLi solution in hexane (1.2 equiv). The yellow solution was stirred for 10 min at −78 °C and then 0.07 mL of CH_3I was added by syringe. The reaction was warmed to rt and was quenched with a saturated NH_4Cl solution. The solvent was removed under reduced pressure and the resulting oil that formed was dissolved in $CHCl_3$. The organic layer was washed with a saturated $NaHCO_3$ solution followed by a 10% $Na_2S_2O_5$ solution and dried (Na_2SO_4). Evaporation of the solvent under reduced pressure left a light yellow oil that was chromatographed to give 0.14 g (70%) of **(*E*)-2-methoxy-1-methyl-1-(phenylsulfonyl)ethylene (30)** as a clear oil: IR (neat) 1650, 1445, 1245, 1080, 780, and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 1.71 (s, 3 H), 3.87 (s, 3 H), 7.35 (s, 1 H), 7.40–7.65 (m, 3 H), and 7.80–7.90 (m, 2 H); *m/e* 212 (M^+), 125, 88, 87, 86, 84 (base), and 77; HRMS calcd for $C_{10}H_{12}O_3S$ 212.0507, found 212.0481. Anal. Calcd for $C_{10}H_{12}O_3S$: C, 56.59; H, 5.70. Found: C, 56.43; H, 5.65.

A solution containing 0.11 g of sulfone **28** in 5 mL of dry THF was cooled to −78 °C under N_2. To this solution was added 0.54 mL of a 1.55 M *n*-BuLi solution in hexane (1.2 equiv). The yellow solution was stirred for 10 min at −78 °C and 0.074 mL of cyclohexanone was added by syringe. The reaction was warmed to rt and was quenched with a saturated NH_4Cl solution. The solvent was removed under reduced pressure, and the oil that remained was dissolved in $CHCl_3$. The organic layer was washed with water followed by a saturated $NaHCO_3$ solution and was then dried (Na_2SO_4). Evaporation of the solvent under reduced pressure left an oil that was chromatographed to give 0.18 g (75%) of **1-[(*E*)-2-methoxy-1-(phenylsulfonyl)ethylene]cyclohexanol (36)**: IR (neat) 1620, 1450, 1140, 880, 760, and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 1.30–1.70 (m, 8 H), 1.80–2.00 (m, 2 H), 2.79 (br s, 1 H, D_2O exchangeable), 396 (s, 3 H), 7.45 (s, 1 H), 7.50–7.60 (m, 3 H), and 7.80–8.00 (m, 2 H); *m/e* 296 (M^+), 265, 253, 214, 200, 175, 162, 155, 139, 123, 111, 105, 91, 85, and 77 (base); HRMS calcd for $C_{15}H_{20}O_4S$ 296.1082, found 296.1081. Anal. Calcd for $C_{15}H_{20}O_4S$: C, 60.79; H, 6.81. Found: C, 60.72; H, 6.63.

Base-Induced Reaction of (*E*)-2-Ethoxy-1-(*p*-tolylsulfonyl)ethylene (29) with Benzaldehyde. To a stirred solution containing 44.0 g of sodium *p*-toluenesulfinate in 200 mL of DMF was added dropwise 40.5 g of α-bromoacetaldehyde diethyl acetal. The mixture was heated at reflux under N_2 for 3 h. After cooling, the reaction mixture was diluted with ether and the mixture was washed with brine, dried ($MgSO_4$), and concentrated under reduced pressure. The resulting crude solid was recrystallized from a 1:1 ether–hexane mixture to give 46.8 g (82%) of **1,1-diethoxy-2-(*p*-tolylsulfonyl)ethane**: ^1H NMR (90 MHz, $CDCl_3$) δ 1.06 (overlapping 2 t, 6 H), 2.43 (s, 3 H), 3.45 (m, 6 H), 4.90 (t, 1 H, *J* = 6 Hz), 7.28 (d, 2 H, *J* = 8 Hz), and 7.74 (d, 2 H, *J* = 8 Hz).

A stirred solution containing 10.2 g of the above compound in 200 mL of anhydrous THF at −78 °C was treated with 16.4 mL of a 2.5 M *n*-BuLi solution in hexane. The reaction mixture was allowed to warm to 0 °C over a period of 1 h and was then quenched with an aqueous NH_4Cl solution. The resulting mixture was diluted with ether, washed with brine, and dried ($MgSO_4$). Concentration of the solvent under reduced pressure left a solid, which was recrystallized from ether, giving 7.5 g (88%) of **29**: mp 57–58 °C; ^1H NMR (90 MHz, $CDCl_3$) δ 1.30 (t, 3 H, *J* = 7.5 Hz), 2.43 (s, 3 H), 3.84 (q, 2 H, *J* = 7.5 Hz), 5.68 (d, 1 H, *J* = 12 Hz), 7.31 (d, 2 H, *J* = 9 Hz), 7.55 (d, 1 H, *J* = 12 Hz), and 7.75 (d, 2 H, *J* = 9 Hz). Anal. Calcd for $C_{11}H_{14}SO_3$: C, 58.40; H, 6.19; S, 14.11. Found: C, 58.10; H, 5.96; S, 14.10.

A 0.45-g sample of **29** was treated with *n*-BuLi (2.4 mmol), and then 0.29 mL of benzyl bromide was introduced. The reaction was quenched with an NH_4Cl solution, and the resulting mixture was diluted with ether. The ether phase was washed with brine and dried ($MgSO_4$). Concentration under reduced pressure followed by purification of the crude mixture by chromatography produced 0.39 g (60%) of **(*E*)-1-benzyl-2-ethoxy-1-(*p*-tolylsulfonyl)ethylene (31)**: mp 62–63 °C; IR (film) ν 1730, 1640, 1495, 1300, 1210, and 1146 cm^{-1}; ^1H NMR (90 MHz, $CDCl_3$) δ 1.25 (t, 3 H, *J* = 7 Hz), 2.30 (s, 3 H), 3.53 (s, 2 H), 4.06 (q, 2 H, *J* = 7 Hz), and 7.04–7.64 (m, 10 H). Anal. Calcd for $C_{18}H_{20}SO_3$: C, 68.32; H, 6.31; S, 10.12. Found: C, 68.91; H, 5.90; S, 10.07.

Sodium Amalgam Reduction of Sulfone 29. A slurry containing 0.32 g of **29** and 0.56 g of anhydrous disodium hydrogen phosphate in 10 mL of dry methanol was purged with nitrogen and cooled to −20 °C. To this stirring mixture was added in portions 1.5 g of freshly prepared sodium amalgam (6%), and stirring was continued for 2 h with concurrent warming of the reaction to rt. The mixture was poured into brine, and then the product was extracted into ether. The extracts were dried ($MgSO_4$) and concentrated under reduced pressure, and the residue was purified by chromatography to give 0.13 g (80%) of **2-benzyl-1-ethoxyethylene (32)** as an oil (1:1 *E*:*Z* mixture by NMR): IR (film) ν 2940, 1642, 1245, 1148, and 1090 cm^{-1}; ^1H NMR (90 MHz, $CDCl_3$) δ 1.16 (overlapping t, 3 H), 3.51 (m, 4 H), 4.48 (m, $^1/_2$ H), 4.80 (m, $^1/_2$ H), 5.98 (d, $^1/_2$ H, *J* = 4 Hz), 6.25 (d, $^1/_2$ H, *J* = 13 Hz), and 7.18 (s, 5 H); *m/e* 163 (MH^+), 162, 133, 105, 91, and 77.

2-Bromo-3-phenylpropionaldehyde Diethyl Acetal (33). A 0.2-g sample of **32** and 0.26 g of NBS were dissolved in 5 mL of anhydrous ethanol, and the resulting mixture was stirred for 1 h at rt. The solvent was removed under reduced pressure, and the residue was purified by preparative TLC to give 0.31 g (87%) of **33**: IR (film) ν 2980, 1608, 1500, 1458, and 1375 cm^{-1}; ^1H NMR

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(79.5 MHz, $CDCl_3$) δ 1.27 (t, 6 H, J = 9 Hz), 2.65–3.87 (series of m, 6 H), 4.13 (m, 1 H), 4.5 (d, 1 H, J = 6 Hz), and 7.27 (s, 5 H); m/e 243, 161, 133, 103, 91, and 75.

3-Phenylpropionaldehyde Diethyl Acetal (34). A 0.2-g sample of **32** was dissolved in 5 mL of anhydrous ethanol and was treated with 0.01 g of *p*-toluenesulfonic acid. After the mixture was stirred for 2 h, the solvent was removed under reduced pressure and the crude residue was purified by preparative TLC to give 0.17 g (95%) of **34**: IR (film) ν 2975, 1605, 1498, 1455, and 1375 cm^{-1}; ^1H NMR (79.5 MHz, $CDCl_3$) δ 1.25 (t, 6 H, J = 10 Hz), 1.95 (m, 2 H), 2.59 (m, 2 H), 3.57 (m, 4 H), 4.47 (t, 1 H, J = 6 Hz), and 7.22 (s, 5 H); m/e 208, 163, 162, 117, 103, 91, and 75.

Base-Induced Reaction of 29 with Cyclohexanone. A 2-mmol sample of **29** was treated with *n*-BuLi (2.4 mmol) and 0.22 g of cyclohexanone in a fashion similar to that described above. Standard workup followed by preparative TLC (silica gel, 2% ether–methylene chloride) furnished 0.47 g (72%) of **(*E*)-2-ethoxy-1-(1-hydroxycyclohexyl)-1-(*p*-tolylsulfonyl)ethylene (37)** as a white solid: mp 96–98 °C; IR (film) ν 3490 (br), 2875, 1602, 1450, and 1135 cm^{-1}; ^1H NMR (200 MHz, $CDCl_3$) δ 1.60–1.71 (overlapping t and series of m, 11 H), 1.98 (m, 2 H), 2.40 (s, 3 H), 2.83 (m, 1 H, exchanged D_2O), 4.16 (q, 2 H, J = 8 Hz), 7.26 (d, 2 H, J = 9 Hz), 7.49 (s, 1 H), and 7.71 (d, 2 H, J = 9 Hz). Anal. Calcd for $C_{17}H_{24}SO_4$: C, 62.94; H, 7.46; S, 9.86. Found: C, 62.92; H, 6.96; S, 10.17.

Base-Induced Reaction of (*E*)-2-(Menthyloxy)-1-(phenylsulfonyl)ethylene (35) with Benzaldehyde. To a stirred mixture containing 1.56 g of (−)-menthol and 3.08 g of (*E*)-1,2-bis(phenylsulfonyl)ethylene in 40 mL of anhydrous THF was added in portions NaH (10 mmol). After the mixture was stirred for 3 h at 0 °C, standard workup and flash chromatography (silica gel, 10% ether–hexane) of the crude reaction mixture gave **35** as a white solid (67%): mp 94–95 °C; IR (film) ν 1605, 1438, 1293, 1124, 824, and 708 cm^{-1}; ^1H NMR (200 MHz, $CDCl_3$) δ 0.75–2.12 (series of m, 19 H), 3.80 (dt, 1 H, J = 10 and 5 Hz), 5.78 (d, 1 H, J = 12 Hz), and 7.5–7.94 (m, 6 H); m/e 323, 185, 139, 83, 69, 55. Anal. Calcd for $C_{18}H_{26}SO_3$: C, 67.08; H, 8.07; S, 9.93. Found: C, 67.18; H, 8.18; S, 9.64.

Treatment of a 0.64-g sample of **35** in 15 mL of anhydrous THF with 1.5 mL of a 1.6 M *n*-BuLi solution, followed by quenching with 0.25 g of benzaldehyde gave, after usual workup and preparative TLC (30% ethyl acetate–hexane), 0.58 g (67%) of **(*E*)-2-(menthyloxy)-1-(1-hydroxy-1-phenylmethyl)-1-(phenylsulfonyl)ethylene (38)**: mp 129–131 °C; IR (film) ν 3490 (br), 3040, 2940, 2900, 1620, 1486, 1378, 1208, 1140, 835, 768, and 690 cm^{-1}; ^1H NMR (200 MHz, $CDCl_3$) (peaks at δ 5.72 and 5.79 indicate that the product is a 1:1 diastereomeric mixture), δ 0.75–2.12 (series of m, 19 H), 3.39 (br hump, 1 H, exchanged D_2O), 3.80 (dt, 1 H, J = 10 and 5 Hz), 5.72 (s, $^1/_2$ H), 5.79 (s, $^1/_2$ H), and 7.03–7.72 (m, 11 H); m/e 291, 289, 138, 83, 69. Anal. Calcd for $C_{25}H_{32}O_4S$: C, 70.06; H, 7.53; S, 7.47. Found: C, 69.73; H, 7.45; S, 7.55.

Reaction of the Lithiate of (*Z*)-2-(*n*-Octyloxy)-1-(phenylsulfonyl)ethylene (39) with Methanol-*O*-*d*. A solution containing 1.6 g of 1-octanol and 3.7 g of (*Z*)-1,2-(diphenylsulfonyl)ethylene[63] in 50 mL of anhydrous THF was cooled to −20 °C and was then treated with 0.288 g of NaH in portions. The reaction mixture was stirred for 2 h, and warming to rt was allowed to occur. After decomposing the excess NaH by cautious addition of water, the resulting mixture was diluted with ether. The organic phase was sequentially washed with aqueous tartaric acid and brine and dried ($MgSO_4$), and the solvent was removed under reduced pressure. The residue was subjected to flash silica gel chromatography (5% ether–CH_2Cl_2) to give 1.9 g (55%) of **39** as an oil: ^1H NMR (200 MHz, $CDCl_3$) δ 0.90 (t, 3 H, J = 7.5 Hz), 1.25 (br s, 10 H), 1.56 (m, 2 H), 3.95 (t, 2 H, J = 7 Hz), 5.55 (d, 1 H, J = 7 Hz), 6.51 (d, 1 H, J = 7 Hz), and 7.45–8.32 (m, 5 H); m/e (CI, CH_3OH, NH_4OAc) 314 (MNH_4^+, 100).

To 10 mL of an anhydrous THF solution containing 0.12 g of **39** at −78 °C was added 0.3 mL of a 1.55 M *n*-BuLi solution. After 10 min of stirring, the reaction was quenched with 1 mL of D_2O. Removal of the solvent under vacuum followed by preparative TLC of the residue gave 0.09 g (75%) of **(*E*)-1-deuterio-2-(*n*-octyloxy)-1-(phenylsulfonyl)ethylene (41)** (>90% incorporation by NMR): ^1H NMR (200 MHz, $CDCl_3$) δ 0.85 (t, 3 H, J = 7.5 Hz), 1.26 (br s, 10 H), 1.60 (m, 2 H), 3.80 (t, 2 H, J = 7 Hz), and 7.44–7.90 (m, 6 H).

A sample of (*E*)-2-(*n*-octyloxy)-1-(phenylsulfonyl)ethylene was prepared in the following manner. A mixture containing 1.6 g of 1-octanol and 3.7 g of (*E*)-1,2-bis(phenylsulfonyl)ethylene[63] in 20 mL of anhydrous THF was treated with NaOH as described above for **39**. Similar workup and flash silica gel chromatography (5% ether–methylene chloride) of the crude furnished 2.2 g (61%) of the *E* isomer: ^1H NMR (200 MHz, $CDCl_3$) δ 0.85 (t, 3 H, J = 7.5 Hz), 1.26 (br s, 10 H), 1.65 (m, 2 H), 3.81 (t, 2 H, J = 7 Hz), 5.70 (d, 1 H, J = 12 Hz), and 7.44–7.90 (m, 6 H).

A cold (−78 °C) stirred solution containing 0.29 g of **39** in 10 mL of anhydrous THF was treated with 0.56 mL of a 2.5 M *n*-BuLI solution. After stirring for 5 min, 0.15 g of benzaldehyde was introduced. The reaction mixture was stirred for 0.5 h, and warming to 0 °C was allowed to occur. Following quenching with NH_4Cl, the mixture was diluted with ether and the organic phase was washed with brine, dried ($MgSO_4$), and concentrated under vacuum. Preparative TLC of the crude furnished 0.2 g (72%) of **(*E*)-2-(*n*-octyloxy)-1-(1-hydroxy-1-phenylmethyl)-1-(phenylsulfulfonyl)ethylene (42)**: ^1H NMR (200 MHz, $CDCl_3$) δ 0.88 (t, 3 H, J = 7.5 Hz), 1.25 (Br s, 10 H), 1.63 (m, 2 H), 3.3 (br hump, 1 H, exchanged D_2O), 4.10 (M, 2 H), 5.76 (s, 1 H), and 7.05–7.65 (m, 11 H): m/e (CI, CH_3OH/NH_4OAc) 420 (MNH_4^+, 74).

Reaction of the Lithiate of (*Z*)-2-Methoxy-1-(phenylsulfonyl)ethene (40) with Methanol-*O*-*d*. To a solution containing 0.5 g of (*Z*)-1,2-bis(phenylsulfonyl)ethylene in 20 mL of methanol was added 0.1 g of $NaOCH_3$. The reaction was stirred at rt overnight under N_2. Evaporation of the solvent under reduced pressure left a clear oil that was dissolved in ether. The organic layer was washed with water followed by a saturated K_2CO_3 solution and was then dried (Na_2SO_4). Concentration of the solvent under reduced pressure left 0.26 g (95%) of a clear oil whose structure was assigned as **40**:[62] IR 3060, 3040, 2940, 1630, 1575, 1450, 1300, 1140, 1190, 980, 790, 760, 720 and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) (*Z* isomer) δ 3.86 (s, 3 H), 5.53 (d, 1 H, J = 6.5 Hz), 6.46 (d, 1 H, J = 6.5 Hz), and 7.4–8.0 (m, 5 H); m/e 198 (M^+), 186, 162, 151, 125, 113, 105, 86, 84 (base), and 77.

To 10 mL of an anhydrous THF solution containing 0.10 g of **40** at −78 °C was added 0.3 mL of a 1.55 M *n*-BuLi solution. After 10 min of stirring, the reaction was quenched with 1 mL of D_2O. Removal of the solvent under vacuum followed by preparative TLC of the residue gave 0.08 g (80%) of **(*E*)-1-deuterio-2-methoxy-1-(phenylsulfonyl)ethylene (43)**: IR (neat) 1600, 1300, 1140, 790, 720, and 690 cm^{-1}; NMR ($CDCl_3$, 300 MHz) δ 3.67 (s, 3 H), 7.40–7.75 (m, 4 H), and 7.8–8.0 (m, 2 H).

General Procedure for the Epoxidation of Allylic Alcohols with *m*-Chloroperoxybenzoic Acid. To a biphasic mixture of CH_2Cl_2 and a saturated solution of $NaHCO_3$ (200 mL) containing the allylic alcohol (0.1 mmol) at 0 °C was added in portions *m*-CPBA (0.12 mol). The mixture was stirred for 4–8 h at rt before destroying the excess peroxy acid with dimethyl sulfide (5–10 mL or until starch iodide paper test was negative). The organic layer was washed successively with aqueous $NaHCO_3$ (2 × 100 mL) and brine (100 mL), dried ($MgSO_4$), and concentrated under vacuum. The resulting oil was purified by flash column chromatography to furnish the 2,3-epoxy alcohol in 70–80% yield.

LDA-Induced Cyclization of (2*R,3*S**)-2-[(Benzyloxy)methyl]-3-[[[(*E*)-2-(phenylsulfonyl)ethenyl]oxy]methyl]-oxirane (49).** To a stirred solution of containing 3.9 g of epoxy alcohol **44** and 7.4 g of (*E*)-1,2 bis(phenylsulfonyl)ethylene[63] in 100 mL of anhydrous THF at −20 °C was added in portions 1.15 g (50% oil dispersion) of NaH. The resulting mixture was warmed to rt over the course of 1 h. After the mixture was stirred for an additional 2 h, the excess NaH was destroyed with the dropwise addition of ethanol (5 mL). The mixture was diluted with ether (200 mL) and washed with saturated $NaHCO_3$ and brine. The organic layer was separated, dried ($MgSO_4$), and evaporated under reduced pressure. Purification of the residue by flash silica gel chromatography (3% ether–CH_2Cl_2) led to 5.5 g (77%) of **49** as a white solid: mp 54–55 °C; IR (film) 1600, 1298, 1134, 1075, and 710 cm^{-1}; ^1H NMR (200 MHz, $CDCl_3$) δ 3.28 (m, 2 H), 3.63 (d, 2 H, J = 4 Hz), 3.80 ($^1/_2$ ABX, 1 H, dd, J = 12 and 8 Hz), 4.10

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($^1/_2$ ABX, dd, 1 H, J = 8 and 2 Hz), 4.53 (AB q, 2 H, $\Delta\delta$ = 0.5, J = 12 Hz), 5.72 (d, 1 H, J = 12 Hz), and 7.34–7.9 (M, 11 H); m/e 360, 254, and 206 (base). Anal. Calcd for $C_{19}H_{20}SO_5$: C, 63.32; H, 5.60; S, 8.88. Found: C, 63.41; H, 5.58; S, 8.80.

To a 4.8-g sample of **49** in 50 mL of THF at −78 °C was added via syringe 16 mL of 1.0 M LDA solution. The resulting red solution was allowed to warm to 0 °C over a period of 0.5 h and was then quenched with 5 mL of an NH_4Cl solution. After the mixture was diluted with 150 mL of ethyl acetate, the organic layer was washed successively with aqueous tararic acid, $NaHCO_3$, and brine, dried ($MgSO_4$), and concentrated under vacuum. The crude product was subjected to flash silica gel column chromatography using an ether–CH_2Cl_2 mixture as the eluent to give 2.4 g (51%) of **(3*R**)-3-[(*S**)-1-hydroxy-2-(phenylmethoxy)ethyl]-4-(phenylsulfonyl)-2,3-dihydrofuran (55)** as a white solid: mp 99–101 °C; IR (film) 3460 (br), 1590, 1298, 1135, and 712 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 3.36 (m, 1 H), 3.52 (m, 3 H, 1 H exchanged D_2O), 4.12 (m, 1 H), 4.42–4.71 (overlapping m, 4 H), and 7.28–8.05 (m, 11 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 140.8, 137.7, 133.2, 129.3, 128.4, 127.8, 127.3, 118.6, 78.3, 77.0, 76.37, 75.8, 73.5, 70.9, 70.5, and 45.2; m/e 361 and 253 (base). Anal. Calcd for $C_{19}H_{20}SO_5$: C, 63.32; H, 5.60; S, 8.88. Found: C, 63.40; H, 5.49; S, 9.05.

LDA-Induced Cyclization of (2*R,3*R**)-2-[(Benzyloxy)methyl]-3-[[[(*E*)-2-(phenylsulfonyl)ethenyl]oxy]methyl]oxirane (50).** A 1.8-g sample of epoxy alcohol **45** and 2.3 g of 1-chloro-2-(phenylsulfonyl)ethylene[61] were dissolved in 50 mL of anhydrous THF, and the cooled (**20** °C) mixture was treated with NaH (11 mmol), in accordance with the procedure described above. After decom-posing the excess NaH with ethanol, similar workup and purification by flash silica gel chromatography (3% ether–CH_2Cl_2) furnished 1.6 g (50%) of **50**: mp 41–43 °C; IR (film) 1595, 1295, 1130, and 1072 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 3.17 (m, 2 H), 3.56 ($^1/_2$ ABX, 1 H, dd, J = 12 and 4 Hz), 3.71 (d, 1 H, J = 4 Hz), 3.80 ($^1/_2$ ABX, 1 H, dd, J = 10 and 4 Hz), 4.16 (d, 1 H, J = 12 Hz), 4.58 (s, 2 H), 5.79 (d, 1 H, J = 12 Hz), and 7.26–7.96 (m, 11 H); m/e 359, 181, and 141 (base). Anal. Calcd for $C_{19}H_{20}SO_5$: 63.32; H, 5.60; S, 8.88. Found: C, 63.35; H, 5.73; S, 8.84.

Treatment of a 1.5-g sample of **50** in 30 mL of dry THF with 5 mL of 1 M LDA solution under the reaction conditions described above, gave, after usual workup and preparative TLC (silica gel, 5% ether–CH_2Cl_2), 0.72 g (48%) of **(3*R**)-3-[(*R**)-1-hydroxy-2-(phenylmethoxy)ethyl]-4-(phenylsulfonyl)-2,3-dihydrofuran (56)**: IR (film) 3470 (Br), 1590, 1440, 1298, and 1135 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 2.78 (br s, 1 H, exchanged D_2O), 3.21 (m, 1 H), 3.40 (m, 2 H), 4.25 (m, 1 H), 4.51 (s, 2 H), 4.52 ($^1/_2$ ABX, 1 H, t, J = 8 Hz), 4.72 ($^1/_2$ ABX, 1 H, t, J = 8 Hz), and 7.18–7.93 (m, 11 H); m/e 361, 253, 209 (base), 159, and 141.

LDA-Induced Cyclization of (2*R,3*S**)-2-Phenyl-3-[[[(*E*)-2-(phenylsulfonyl)ethenyl]oxy]methyl]oxirane (51).** A solution containing 3.7 g of epoxy alcohol **46** and 9.3 g of (*E*)-1,2-bis(phenylsulfonyl)ethylene[63] in 100 mL of anhdryous THF was treated with NaH (30 mmol) according to the procedure described above. Analogous reaction conditions, workup, and flash silica gel chromatography (3% ether–CH_2Cl_2) furnished 5.87 g (74%) of **51**: IR (film) 1610, 1450, 1310, 1220, 1145, 1085, and 855 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 3.41–3.80 (m, 3 H), 4.20 (d, 1 H, J = 4 Hz), 5.58 (d, 1 H, J = 12 Hz), and 7.20–7.95 (m, 11 H); m/e 317 (base), 273, 223, and 213.

To a solution containing 2.2 g of **51** in 50 mL of THF at −78 °C was added dropwise 8.4 mL of a 1.0 M LDA solution. After the mixture was stirred for 0.5 h (−78 °C to 0 °C), the reaction was quenched with aqueous NH_4Cl and worked up in the usual manner. The resulting crude mixture was purified by flash silica gel chromatography (3% ether–CH_2Cl_2) to give 1.6 g (72%) of **(3*R**)-3-[(*S**)-1-hydroxy-1-phenylmethyl]-4-(phenylsulfonyl)-2,3-dihydrofuran (57)**: mp 120–122 °C; IR (film) 3570 (br), 1600, 1442, 1305, and 1135 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 3.28 (m, 1 H), 4.10–4.30 (m, 3 H, 1 H exchanged D_2O), 4.83 (dd, J = 8 and 3 Hz, 1 H, collapsed to d, J = 8 Hz, after D_2O exchange), and 7.12–8.05 (m, 11 H); m/e 316, 210 (base), 192, and 107. Anal. Calcd for $C_{17}H_{16}SO_4$: C, 64.54; H, 5.10; S, 10.12. Found: C, 64.21; H, 5.09; S, 10.10.

LDA-Induced Cyclization of (2*R,3*S**)-2-Phenyl-3-[[[(*E*)-2-(phenylsulfonyl)ethenyl]oxy]methyl]oxirane (52).** A stirred mixture containing 3.0 g of epoxy alcohol **47** and 6.78 g of (*E*)-1,2-bis(phenylsulfonyl)ethylene[63] in 100 mL of dry THF was cooled to −20 °C and was treated with NaH (22 mmol) in a manner analogus to as described above. After standard workup, the residue was subjected to flash silica gel chromatography (3% ether–CH_2Cl_2) to give 4.8 g (76%) of **52**: IR (film) 1610, 1299, 1134, 1075, and 610 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 3.24 (m, 1 H), 3.77 (d, 1 H, J = 2.5 Hz), 4.12 (ABX, 2 H, J = 12, 5.5, and 3 Hz), 5.82 (d, 1 H, J = 13 Hz), 7.2–8.0 (m, 11 H); m/e 317 (base), 239, and 222.

A solution containing 3.5 g of **52** in 50 mL of anhydrous THF was treated with 13.5 mL of a 1.0 M LDA solution at −78 °C, in a manner analogous to the procedure described above. Similar reaction conditions, workup, and flash column chromatography of the crude product (silica gel, ethyl acetate–CH_2Cl_2) furnished 2.1 g (62%) of **(3*R**)-3-[(*R**)-1-hydroxy-1-phenylmethyl]-4-(phenylsulfonyl)-2,3-dihydrofuran (58)**: mp 140–142 °C; IR (film) 3570, 1600, 145, 1305, 1140, and 604 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 2.74 (d, 1 H, J = 4.5 Hz, exchanged D_2O), 3.37 (m, 1 H), 4.10 (t, 1 H, J = 10 Hz), 4.54 (dd, 1 H, J = 10 and 7.5 Hz), 5.18 (m, 1 H, collapsed to d, J = 2.5 Hz after D_2O exchange), and 7.2–8.10 (m, 11 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 140.8, 140.7, 133.4, 129.4, 128.5, 128.3, 127.6, 127.4, 127.3, 125.4, 116.9, 78.3, 77.0, 75.8, 74.6, 69.6, and 49.1; m/e 316 and 300 (base). Anal. Calcd for $C_{17}H_{16}SO_4$: C, 64.54; H, 5.06; S, 10.12. Found: C, 64.60; H, 5.00; S, 9.79.

LDA-Induced Cyclization of 2,2-Dimethyl-3-[[[(*E*)-2-(phenylsulfonyl)ethenyl]oxy]methyl]oxirane (53). A solution containing 1.1 g of epoxy alcohol **48** and 2.48 g of 1-chloro-2-(phenylsulfonyl)ethylene in 40 mL of dry THF at −20 °C was treated with NaH (13.2 mmol). Similar reaction conditions and workup as described above afforded the crude product which was purified by flash silica gel chromatography (3% ether–CH_2Cl_2) to give 1.6 g (55%) of **53**: IR (film) 1600, 1295, 1134, 1075, and 710 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 1.27 (s, 3 H), 1.36 (s, 3 H), 3.03 (dd, 1 H, J = 6 and 4 Hz), 3.85 ($^1/_2$ ABX, 1 H, dd, J = 12 and 6 Hz), 4.13 ($^1/_2$ ABX, 1 H, dd, J = 12 and 4 Hz), 5.83 (d, 1 H, J = 12 Hz), 7.55–7.93 (m, 6 H); m/e 269, 185 (base), 140, and 111.

Treatment of 0.44-g sample of **53** in 10 mL of THF with 1.9 mL of a 1.0 M LDA solution following the general procedure, furnished, after standard workup and preparative TLC of the crude (3% ether–CH_2Cl_2), 0.26 g (59%) of **(+)-3-[1-hydroxy-1-methylethyl]-4-(phenylsulfonyl)-2,3-dihydrofuran (59)**: IR (film) 3440 (br), 1600, 1305, and 1155 cm^{-1}; ^{1}H NMR (200 MHz, $CDCl_3$) δ 1.15 (s, 3 H), 1.33 (s, 3 H), 3.10 (dd, 1 H, J = 12 and 6 Hz), 4.24 (s, 1 H, exchanged D_2O), 4.36 ($^1/_2$ ABX, 1 H, dd, J = 12 and 6 Hz), 4.61 ($^1/_2$ ABX, 1 H, t, J = 12 Hz), and 7.46–8.05 (m, 6 H); m/e 270, 251, and 209 (base). Anal. Calcd for $C_{13}H_{16}SO_4$: C, 58.19; H, 6.02. Found: C, 58.32; H, 5.86.

(2*R,3*S**)-2-[(Benzyloxy)methyl]-3-[[[(*E*)-2-(phenylsulfonyl)-2-(trimethylsilyl)ethenyl]oxy]methyl]oxirane (60).** A solution containing 1.2 g of **49** in 50 mL of anhydrous THF was treated with 4 mL of a 1.0 M LDA solution at −78 °C. After the mixture was stirred for 10 min, 0.25 mL of chlorotrimethylsilane was added as a 5-mL THF solution. The reaction was warmed to 0 °C (0.5 h) and was then quenched with aqueous NH_4Cl. Usual workup yielded 0.8 g of crude C-silylated product **60** (no further purification was attempted): ^{1}H NMR (200 MHz, $CDCl_3$) δ 1.05 (s, 9 H), 3.28 (m, 2 H), 3.63 (d, 2 H, J = 4 Hz), 3.80 ($^1/_2$ ABX, 1 H, dd, J = 12 and 8 Hz), 4.10 ($^1/_2$ ABX, 1 H, dd, J = 8 and 2 Hz), 4.53 (AB q, 2 H, $\Delta\delta$ = 0.5, J = 12 Hz), and 7.34–7.95 (m, 11 H).

LDA-Induced Cyclization of (2*R,3*S**)-2-Phenyl-3-[2-[[2(*E*)-(phenylsulfonyl)ethenyl]oxy]ethyl]oxirane (62).** Treatment of a cooled (−20 °C) mixture containing 1.85 g of epoxy alcohol **61** and 2.51 g of 1-chloro-2-(phenylsulfonyl)ethylene in 30 mL of dry THF with NaH (12.3 mmol) according to the general procedure, followed by usual workup and flash column chromatography of the crude residue (silica gel, 3% ether–CH_2Cl_2), gave 1.78 g (46%) of **62**: IR (film) 1615, 1400, 1310, 1090, 840, and 610 cm^{-1}; ^{1}H NMR (90 MHz, $CDCl_3$) δ 1.68 (q, 2 H), 3.32 (m, 1 H), 3.93 (m, 2 H), 4.12 (d, 1 H, J = 4.5 Hz), 5.74 (d, 1 H, J = 12 Hz), and 7.24–8.0 (m, 11 H).

Treatment of 1.3 g of **62** in 30 mL of THF with 4.7 mL of a 1.0 M LDA solution under the reaction conditions described above

resulted in, following standard workup and preparative TLC (3% ether–CH_2Cl_2), 0.58 g (45%) of **(4R*)-4-[(S*)-1-hydroxy-1-phenylmethyl]-5-(phenylsulfonyl)-2,3-dihydro-4H-pyran (63)** as a white solid: mp 150–152 °C; ^1H NMR (79.5 MHz, $CDCl_3$) δ 1.55 (m, 2 H), 2.52 (dt, 1 H, J = 6 and 1 Hz), 3.3 (dt, 1 H, J = 12 and 4 Hz), 3.9 (m, 3 H, 1 H exchanged D_2O), 4.94 (dd, 1 H, J = 7 and 2.5 Hz, collapsed to d, J = 7 Hz, on D_2O exchange), and 7.12–7.9 (M, 11 H); m/e 330, 225, 224 (base), 107, 99, 83, and 77. Anal. Calcd for $C_{18}H_{18}SO_4$: C, 65.44; H, 5.50; S, 9.69. Found: C, 65.30; H, 5.52; S, 9.79.

LDA-Induced Cyclization of (1R*,2R*,6R*)-2-[[2-(Phenylsulfonyl)ethenyl]oxy]-7-oxabicyclo[4.1.0]heptane (65). A solution containing 0.5 g of epoxy alcohol **64** and 1.0 g of 1-chloro-2-(phenylsulfonyl)ethylene in 20 mL of dry THF was cooled to −20 °C and was treated with NaH (5.2 mmol). Standard reaction conditions, workup, and preparative TLC of the residue afforded 0.48 g (40%) of **65**: mp 77–79 °C; ^1H NMR (90 MHz, $CDCl_3$) δ 1.13–2.16 (m, 6 H), 3.13 (m, 2 H), 4.21 (t, 1 H, J = 6 Hz), 5.80 (d, 1 H, J = 12 Hz), 7.42–8.05 (m, 6 H); m/e 281, 185, 125, 97 (base), and 79. Anal. Calcd for $C_{14}H_{16}SO_4$: C, 59.98; H, 5.76; S, 11.42. Found: C, 59.98; H, 5.81; S, 11.43.

Treatment of a 0.48-g sample of **65** in 15 mL of THF with 2 mL of a 1.0 M LDA solution, under the reaction conditions outlined above, gave, after standard workup and preparative TLC, 0.2 g (44%) of **(3aR*,4R*,7aR*)-3a,4,5,6,7,7a-hexahydro-3-(phenylsulfonyl)-4-benzofuranol (66)**: mp 59–61 °C; ^1H NMR (79.5 MHz, $CDCl_3$) δ 1.10–2.13 (m, 6 H), 2.43 (t, 1 H, J = 5 Hz), 3.67 (m, 1 H), 4.22 (d, 1 H, J = 2.5 Hz), 4.60 (m, 1 H, exchanged D_2O), and 7.36–8.05 (m, 6 H); m/e 281, 280, 236, 143, 125, 95 (base), and 77. Anal. Calcd for $C_{14}H_{16}SO_4$: C, 59.98; H, 5.76; S, 11.42. Found: C, 60.39; H, 5.89; S, 11.60.

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Supplementary Material Available: ^1H NMR and ^{13}C NMR spectra (75 MHz) for all compounds with high-resolution mass spectra (7 pages). Ordering information is given on any current masthead.

Novel Synthesis of Mevinolin-Related Compounds. Large-Scale Preparation of HMG-CoA Reductase Inhibitor L-679,336

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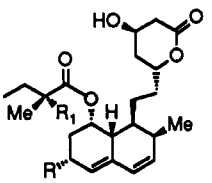
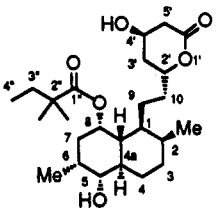
A novel synthetic route to a mevinolin-related HMG-CoA reductase inhibitor L-679,336 is described. The key features of the synthesis are a diastereoselective osmium tetraoxide catalyzed dihydroxylation reaction and a highly selective, phosphorus-mediated, pinacol-type rearrangement to give ketone **6**. In situ multinuclear NMR experiments were used to gain a detailed understanding of the pinacol step. The above route was used for multikilogram preparation of the title compound. Also described are Lewis acid catalyzed rearrangement reactions of epoxide intermediates **4** and **5**, as well as the intramolecular hydrosilylation reaction of deacylated olefinic substrates **17** and **18**.

Introduction

Recently, there has been strong interest in the chemistry and biology of the mevinic acid family of compounds.[1] Members of this class, which include Mevacor (**1a**), Zocor (**1b**), compactin (**1c**), and others, are useful in the treatment of elevated bloodserum cholesterol in humans. They function as potent inhibitors of hydroxymethylglutaryl coenzyme A (HMG-CoA) reductase, the enzyme which governs the rate-determining step in cholesterol biosynthesis.[2] The parent natural products **1a** and **1c** are obtained as fermentation products of *Streptomyces* fungi.[3]



1a R = Me, R_1 = H
1b R = R_1 = Me
1c R = R_1 = H



2
L-679,336

In an effort to improve pharmacological properties, semisynthetic derivatives of Mevacor (**1a**), including Zocor (**1b**) and many others have been prepared.[4] We wish to describe some novel and very interesting chemistry that has been revealed in our synthetic studies of an important new analogue L-679,336 (**2**).

Discussion

The original synthesis of **2** from **1b** was reported by medicinal chemists at Merck.[5] In order to facilitate larger

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