Polycyclic Indoline-Benzodiazepines through Electrophilic Additions of α-Imino Carbenes to Tröger Bases

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Supporting Information

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1. General remarks

Unless otherwise stated, reagents were purchased from commercial sources and used without further purification. NMR spectra were recorded on 400 or 500 MHz spectrometer at 20 °C. $^1$H-NMR: chemical shifts are given in ppm relative to Me$_4$Si with solvent resonances used as internal standards (CDCl$_3$ δ = 7.26 ppm or acetone-δ$_6$ δ = 2.05 ppm). Data were reported as follows: chemical shift (δ) in ppm on the δ scale, multiplicity (s = singlet, d = doublet, t = triplet, dd = doublet of doublets, td = triplet of doublets, sep = septet and m = multiplet), coupling constant (Hz) and integration. $^{13}$C-NMR: chemical shifts were given in ppm relative to Me$_4$Si with solvent resonances used as internal standards (CDCl$_3$ δ = 77.16 ppm or acetone-δ$_6$ δ = 29.84 and 206.26 ppm). IR spectra were recorded using an ATR sampler and are reported in wave numbers (cm$^{-1}$). Melting points (Mp) were measured in open capillary tubes and were uncorrected. Electrospray mass spectra (ESI) were obtained by the department of Mass Spectrometry of the University of Geneva. Flash column chromatography was performed with silica gel 40 - 63 μm or alumina (neutral Brockmann I, 50 - 200 μm). Tröger bases 2a-2k were synthesized starting from their respective anilines$^{[1]}$ and unsymmetrical Tröger bases 2l and 2m were prepared according to reported procedures.$^{[2]}$ Ethyl 2-diazo-3-oxopropanoate was synthesized as described in the literature.$^{[3]}$
2. Optimization of the reaction conditions

![Reaction Conditions Diagram]

Table S1. Optimization of the reaction conditions.

| Entry | Solvent | Catalyst | Cat. Loading | T (°C) | Time (h) | Yield[a] |
|-------|---------|----------|--------------|--------|----------|----------|
| 1     | CH₂Cl₂  | Rh₂(oct)₄ | 1 mol%       | 80 °C  | 48 h     | 8%       |
| 2     | CH₂Cl₂  | Rh₂(esp)₄ | 1 mol%       | 80 °C  | 48 h     | 16%      |
| 3     | CH₂Cl₂  | Rh₂(S-TCP TTL)₄ | 1 mol% | 80 °C  | 48 h     | -        |
| 4     | CH₂Cl₂  | Rh₂(Piv)₄ | 1 mol%       | 80 °C  | 48 h     | 14%      |
| 5     | DCE     | Rh₂(Piv)₄ | 1 mol%       | 80 °C  | 48 h     | 24%      |
| 6     | DCE     | Rh₂(esp)₂ | 1 mol%       | 80 °C  | 48 h     | 23%      |
| 7     | Toluene | Rh₂(S-TCP TTL)₄ | 1 mol% | 80 °C  | 48 h     | -        |
| 8     | Toluene | Rh₂(esp)₂ | 1 mol%       | 80 °C  | 48 h     | 14%      |
| 9     | Toluene | Rh₂(Piv)₄ | 1 mol%       | 80 °C  | 48h      | 23%      |
| 10    | CHCl₃   | Rh₂(oct)₄ | 1 mol%       | 80 °C  | 48 h     | 39%      |
| 11    | CHCl₃   | Rh₂(S-TCP TTL)₄ | 1 mol% | 80 °C  | 48 h     | -        |
| 12    | CHCl₃   | Rh₂(Piv)₄ | 1 mol%       | 80 °C  | 48 h     | 23%      |
| 13    | CHCl₃   | Rh₂(Piv)₄ | 1 mol%       | 80 °C  | 48 h     | 55%      |
| 14    | CHCl₃   | Rh₂(Piv)₄ | 2 mol%       | 80 °C  | 48 h     | 70%[b]  |
| 15    | CHCl₃   | Rh₂(Piv)₄ | 2 mol%       | 60 °C  | 48 h     | 5%       |
| 16    | CHCl₃   | Rh₂(Piv)₄ | 2 mol%       | 60 °C  | 7 days   | 33%      |
| 17    | CHCl₃   | Rh₂(Piv)₄ | 2 mol%       | 100 °C | 48 h     | 27%      |
| 18    | CHCl₃   | Rh₂(OAc)₄ | 2 mol%       | 80 °C  | 48 h     | 32%      |
| 19    | CHCl₃   | Rh₂(esp)₂ | 2 mol%       | 80 °C  | 48 h     | 30%      |
| 20    | CHCl₃   | Rh₂(oct)₄ | 2 mol%       | 80 °C  | 48 h     | 50%      |
| 21    | CHCl₃   | Rh₂(S-PTTL)₄ | 2 mol% | 80 °C  | 48 h     | -        |
| 22    | CHCl₃   | Rh₂(R-DOSP)₄ | 2 mol% | 80 °C  | 48 h     | -        |
| 23    | CHCl₃   | Rh₂(TFA)₄ | 2 mol%       | 80 °C  | 48 h     | -        |
| 24    | CHCl₃   | Rh₂(TPA)₄ | 2 mol%       | 80 °C  | 48 h     | -        |
| 25    | CHCl₃   | Rh₂(Cap)₄ | 2 mol%       | 80 °C  | 48 h     | <10%     |
| 26    | CHCl₃   | Rh₂(PTCC)₄ | 2 mol% | 80 °C  | 48 h     | -        |
| 27    | CHCl₃   | Rh₂(TCPTCC)₄ | 2 mol% | 80 °C  | 48 h     | -        |

[a] Determined by 1H-NMR spectroscopy using 1,3,5-trimethoxybenzene as reference. [b] Optimized conditions. Isolated yield.
3. General procedure I: synthesis of N-sulfonyl-1,2,3-triazoles

**Important note:** Sulfonyl azides are potentially explosive materials and must be handled with caution.

**Azide synthesis:** Following the reported procedure,[4] to a stirred solution of sulfonyl chloride (1.0 equiv) in water/acetone mixture (1:2, 0.2 M), NaN₃ (1.3 equiv) was slowly added at 0 °C. The resulting solution was stirred at room temperature for 12 h. The residue was suspended in Et₂O, the layers were separated and the aqueous phase was extracted three times with Et₂O. The organic layers were combined, dried over MgSO₄, filtered and concentrated under reduced pressure. The desired azide was obtained sufficiently pure to be used without any further purification.

**Caution:** Care should be taken to protect the reaction mixture from light at each step of the synthesis of the triazoles.

**Triazole synthesis:** Following the reported procedure,[5] 0.05 equiv of copper(I) thiophene-2-carboxylate (CuTC) and 1 equiv of the corresponding sulfonyl azide were diluted in toluene (0.2 M). Then 1.3 equiv of the corresponding alkyne was added and the solution was stirred at room temperature overnight and protected from light. The mixture was diluted with saturated NH₄Cl and extracted three times with EtOAc. The combined organic layers were dried over MgSO₄ and concentrated under reduced pressure. The crude material was purified by column chromatography or by precipitations to afford the desired product. Products of type 1 were then stored at -20 °C.

**Analysis data for unreported triazoles**

4-(4-Fluoro-3-methylphenyl)-1-tosyl-1H-1,2,3-triazole (1E):

Following general procedure I, compound 1E is obtained as a white solid (987 mg, 99% yield) starting from tosyl azide (0.46 mL, 3 mmol) and 4-ethyl-1-fluoro-2-methylbenzene.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2)

**IR (neat)**: ν 2128, 1593, 1495, 1385, 1339, 1124, 1170, 1120, 1087, 992, 972, 897, 804, 760, 702, 675 cm⁻¹; **¹H NMR (400 MHz, CDCl₃)**: δ 8.25 (s, 1H), 8.02 (d, J = 8.4 Hz, 2H), 7.72-7.65 (m, 1H), 7.61-7.57 (m, 1H), 7.39 (d, J = 8.2 Hz, 2H), 7.05 (t, J = 8.9 Hz, 1H), 2.45 (s, 3H), 2.31 (d, J = 1.9 Hz, 3H) ppm; **¹³C NMR (100 MHz, CDCl₃)**: δ 161.9 (d, J = 247.6 Hz, CF), 147.5 (C), 146.8 (C), 133.2 (C), 130.6 (2xCH), 129.5 (d, J = 5.5 Hz, CH), 128.9 (2xCH), 125.9 (d, J = 17.9 Hz, C), 125.3 (d, J = 8.4 Hz, CH), 124.9 (d, J = 3.7 Hz, C), 118.7 (C), 115.8 (d, J = 23.1 Hz, CH), 22.0 (CH₃), 14.7 (d, J = 3.5 Hz, CH₃) ppm; **HRMS (ESI):** Calculated for C₁₆H₁₃F₃N₃O₅S [M+H]⁺: 332.0864 m/z; Found: 332.0868 m/z.

1-Tosyl-4-(3,4-dichlorophenyl)-1H-1,2,3-triazole (1H):

Following general procedure I, compound 1H is obtained as a yellowish solid (667 mg, 61% yield) starting from tosyl azide (0.46 mL, 3 mmol) and 3,4-dichlorophenylethynylacetylene.

Purification: precipitations with Et₂O

**IR (neat)**: ν 1741, 1593, 1455, 1387, 1339, 1196, 1181, 1105, 995, 963, 807, 799, 666 cm⁻¹; **¹H NMR (400 MHz, CDCl₃)**: δ 8.32 (s, 1H), 8.03 (d, J = 8.3 Hz, 2H), 7.93 (d, J = 2.0 Hz, 1H), 7.66 (dd, J = 8.3, 2.0 Hz, 1H), 7.51 (d, J = 8.4 Hz, 1H), 7.41 (d, J = 8.2 Hz, 2H), 2.46 (s, 3H) ppm; **¹³C NMR (100 MHz, CDCl₃)**: δ 147.8 (C), 145.3 (C), 133.5 (C), 133.3 (C), 132.9 (C), 131.2 (CH), 130.7 (2xCH), 129.1 (C), 129.0 (2xCH), 128.0 (CH), 125.3 (CH), 119.5 (CH), 22.0 (CH₃) ppm; **HRMS (ESI):** Calculated for C₁₆H₁₂Cl₂N₃O₅S [M+H]⁺: 368.0022 m/z; Found: 368.0025 m/z.
4. General procedure II: synthesis of compounds 3

In a 2 mL screw-cap vial equipped with a magnetic stirring bar, Rh₂(Piv)₄ (2.44 mg, 0.004 mmol, 2 mol%), Tröger’s base 2 (0.2 mmol, 1 equiv) and N-sulfonyltriazole 1 (0.3 mmol, 1.5 equiv) were dissolved in 0.8 mL of anhydrous CHCl₃ (0.25 M). The vial was capped and stirred at 80 °C for 48 h. The solution was concentrated under reduced pressure and the residue was purified by column chromatography.

Analysis data for compounds 3

**Compound 3aA:**

Following general procedure II, compound 3aA is obtained as a white solid (73 mg, 70% yield) starting from Tröger Base 2a (50 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1)

\[ R_f = 0.67 \text{ (pentane/EtOAc, 8:2); M.p.} = 208-210 ^\circ C; \text{IR (neat):} \nu 2915, 1615, 1597, 1496, 1400, 1329, 1289, 1247, 1153, 1136, 1087, 1048, 988, 944, 886, 827, 804, 795, 700, 678 \text{ cm}^{-1}; \text{^1H NMR (400 MHz, CDCl}_3): \delta 7.83 (d, \text{J} = 8.2 \text{ Hz, 2H}), 7.38 (d, \text{J} = 8.0 \text{ Hz, 2H}), 6.89 (s, 1H), 6.86-6.80 (m, 2H), 6.54 (d, \text{J} = 8.0 \text{ Hz, 1H}), 6.41-6.31 (m, 2H), 5.48 (dd, \text{J} = 9.7, 1.4 \text{ Hz, 1H}), 5.44 (s, 1H), 4.67 (d, \text{J} = 17.5 \text{ Hz, 1H}), 4.57 (d, \text{J} = 17.5 \text{ Hz, 1H}), 3.76 (d, \text{J} = 15.5 \text{ Hz, 1H}), 3.70 (d, \text{J} = 9.6 \text{ Hz, 1H}), 3.59 (d, \text{J} = 15.4 \text{ Hz, 1H}), 2.50 (s, 3H), 2.23 (s, 3H), 2.03 (s, 3H); \text{^13C NMR (100 MHz, CDCl}_3): \delta 149.0 (C), 146.4 (C), 143.9 (2xC), 138.7 (C), 131.9 (C), 130.9 (CH), 130.8 (CH), 130.1 (2xCH), 129.4 (C) 128.9 (2xCH), 128.5 (2xCH), 127.8 (C), 127.5 (CH), 127.5 (CH), 126.7 (CH), 125.5 (2xCH), 123.9 (CH), 122.5 (C), 108.2 (CH), 73.7 (C), 66.1 (CH), 61.5 (CH), 50.2 (CH), 43.1 (CH), 21.7 (CH), 20.73 (CH), 20.65 (CH); \text{HRMS (ESI)}: Calculated for C_{33}H_{32}N_3O_2S [M+H]^+: 522.2210 m/z; Found: 522.2214 m/z.

**Compound 3bA:**

Following general procedure II, compound 3bA is obtained as a yellow solid (34 mg, 30% yield) starting from Tröger base 2b (56 mg, 0.2 mol) and triazole 1A.

Purification: column chromatography (silica gel, pentane/EtOAc, 95:5)

\[ R_f = 0.50 \text{ (Silica gel, pentane/EtOAc, 9:1); M.p.} = 131-133 ^\circ C; \text{IR (neat)}: \nu 2928, 1618, 1511, 1402, 1400, 1266, 1139, 953, 913, 829, 734, 658 \text{ cm}^{-1}; \text{^1H NMR (500 MHz, CDCl}_3): \delta 7.87 (d, \text{J} = 8.3 \text{ Hz, 2H}), 7.37-7.31 (m, 6H), 7.30-7.26 (m, 1H), 6.60 (s, 1H), 6.41 (s, 1H), 6.22 (s, 1H), 6.01 (s, 1H), 5.63 (s, 1H), 5.34-5.30 (m, 1H), 4.86 (d, \text{J} = 17.7 \text{ Hz, 1H}), 4.28 (d, \text{J} = 17.8 \text{ Hz, 1H}), 3.77 (d, \text{J} = 11.0 \text{ Hz, 1H}), 3.73 (d, \text{J} = 15.5 \text{ Hz, 1H}), 3.49 (d, \text{J} = 15.4 \text{ Hz, 1H}), 2.47 (s, 3H) 2.33 (s, 3H), 2.16 (s, 3H), 2.16 (s, 3H), 2.02 (s, 3H) ppm; \text{^13C NMR (126 MHz, CDCl}_3): \delta 151.7 (C), 149.1 (C), 143.9 (C), 143.6 (C), 140.5 (C), 138.0 (C), 137.2 (C), 137.0 (C), 136.6 (C), 123.0 (2xCH), 128.9 (2xCH), 127.8 (2xCH), 127.6 (CH), 126.0 (CH), 125.6 (2xCH), 124.6 (C), 123.4 (CH), 121.0 (CH), 117.9 (C), 105.2 (CH), 73.1 (C), 66.1 (CH), 61.5 (CH), 49.4 (CH), 43.1 (CH), 21.9 (CH), 21.8 (CH), 20.9 (CH), 20.4 (CH), 18.3 (CH) ppm; \text{HRMS (ESI)}: Calculated for C_{34}H_{36}N_3O_2S [M+H]^+: 550.2523 m/z; Found: 550.2528 m/z
Compound 3cA:

Following general procedure II, compound 3cA is obtained as an orange solid (76 mg, 64% yield) starting from Tröger base 2c (64 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (silica gel, pentane/EtOAc, 95:5)

R_f = 0.46 (Silica gel, pentane/EtOAc, 9:1); M.p. = 175-177 °C; IR (neat): 3054, 1623, 1595, 1472, 1340, 1321, 1156, 1113, 1092, 951, 807, 732, 698, 660 cm⁻¹; ¹H NMR (500 MHz, CDCl₃): δ 7.95 (d, J = 8.5 Hz, 1H), 7.90 (d, J = 8.3 Hz, 2H), 7.72-7.67 (m, 2H), 7.60-7.52 (m, 2H), 7.49-7.31 (m, 10H), 7.40 (d, J = 10.7 Hz, 1H), 4.84 (d, J = 17.9 Hz, 1H), 4.02 (d, J = 15.6 Hz, 1H), 3.91 (dd, J = 13.2, 1.2 Hz, 2H), 2.49 (s, 3H) ppm; ¹³C NMR (126 MHz, CDCl₃): δ 150.2 (C), 147.0 (C), 144.2 (C), 143.5 (C), 137.5 (C), 133.6 (C), 131.9 (CH), 131.5 (C), 130.1 (2x CH), 130.0 (C), 129.1 (2x CH), 128.8 (CH), 128.7 (CH), 128.7 (C), 128.0 (CH), 127.9 (2x CH), 127.9 (CH), 127.2 (CH), 127.0 (CH), 125.6 (2x CH), 123.8 (CH), 123.4 (CH), 122.1 (2x CH), 121.7 (CH), 119.2 (C), 111.1 (C), 110.6 (CH), 74.1 (C), 66.8 (CH), 61.6 (CH₂), 49.6 (CH₂), 43.6 (CH₂), 21.8 (CH₃) ppm; HRMS (ESI): Calculated for C₃₈H₃₂N₃O₂S [M+H]+: 594.2210 m/z; Found: 594.2218 m/z.

Compound 3dA:

Following general procedure II, compound 3dA is obtained as an orange solid (97 mg, 75% yield) starting from Tröger base 2d (75 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (silica gel, toluene/EtOAc, 98:2)

R_f = 0.39 (Silica gel, pentane/EtOAc, 9:1); M.p. = 138-140 °C; IR (neat): 3030, 2928, 1611, 1483, 1339, 1139, 1111, 953, 761, 698 cm⁻¹; ¹H NMR (500 MHz, CDCl₃): δ 7.95-7.87 (m, 2H), 7.62-7.57 (m, 2H), 7.54-7.41 (m, 9H), 7.40-7.33 (m, 5H), 7.32-7.27 (m, 3H), 7.26-7.24 (m, 1H), 6.78 (d, J = 8.2 Hz, 1H), 6.70 (d, J = 1.6 Hz, 1H), 6.57 (d, J = 8.4 Hz, 1H), 5.71 (dd, J = 9.4, 1.2 Hz, 1H), 5.68 (s, 1H), 4.91 (d, J = 17.4 Hz, 1H), 4.82 (d, J = 17.5 Hz, 1H), 4.03 (d, J = 15.6 Hz, 1H), 3.93 (d, J = 9.4 Hz, 1H), 3.81 (d, J = 15.5 Hz, 1H), 2.51 (s, 3H) ppm; ¹³C NMR (126 MHz, CDCl₃): δ 150.6 (C), 148.3 (C), 144.1 (C), 143.4 (C), 140.8 (C), 140.5 (C), 138.7 (C), 135.1 (C), 131.8 (C), 130.2 (2x CH), 129.2 (CH), 129.1 (2x CH), 129.0 (CH), 128.9 (2x CH), 128.9 (C), 128.7 (2x CH), 127.8 (CH), 127.3 (2x CH), 127.1 (CH), 126.8 (2x CH), 126.5 (CH), 126.7 (CH), 126.2 (2x CH), 125.6 (2x CH), 124.5 (CH), 124.0 (CH), 123.4 (C), 108.9 (CH), 74.6 (C), 66.5 (CH), 62.1 (CH₂), 50.2 (CH₂), 49.0 (CH₂), 21.8 (CH₃) ppm; HRMS (ESI): Calculated for C₃₈H₃₆N₃O₂S [M+H]+: 646.2523 m/z; Found: 646.2523 m/z.
Compound 3eA:

Following general procedure II, compound 3eA is obtained as a yellow solid (83 mg, 72% yield) starting from Tröger base 2e (61 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (silica gel, pentane/EtOAc, 9:5)

R<sub>f</sub> = 0.64 (Silica gel, pentane/EtOAc, 9:1); IR (neat): $\tilde{\nu}$ 2958, 2869, 1615, 1495, 1340, 1321, 1159, 1109, 955, 933, 909, 811, 730, 701 cm<sup>-1</sup>; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): $\delta$ 7.82 (d, $J = 8.2$ Hz, 2H), 7.44-7.30 (m, 6H), 6.63 (d, $J = 8.0$ Hz, 1H), 6.37 (d, $J = 8.2$ Hz, 1H), 6.26 (s, 1H), 5.50 (d, $J = 9.6$ Hz, 1H), 5.48 (s, 1H), 4.71 (d, $J = 17.5$ Hz, 1H), 4.64 (d, $J = 17.5$ Hz, 1H), 3.88 (d, $J = 6.9$ Hz, 1H), 2.47 (s, 3H), 1.21 (d, $J = 2.8$ Hz, 3H), 0.99 (d, $J = 6.9$ Hz, 3H), 0.96 (d, $J = 6.9$ Hz, 3H) ppm; <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>): $\delta$ 149.2 (C), 146.8 (C), 143.9 (C), 143.9 (C), 143.2 (C), 139.0 (C), 138.9 (C), 130.1 (2x CH), 129.4 (C), 128.9 (2x CH), 128.5 (CH), 128.2 (CH), 127.5 (CH), 127.3 (2x CH), 125.7 (2x CH), 125.6 (CH), 124.4 (CH), 123.7 (CH), 122.3 (C), 107.9 (CH), 73.8 (C), 66.6 (CH), 61.8 (CH<sub>2</sub>), 50.7 (CH<sub>2</sub>), 48.7 (CH<sub>2</sub>), 33.4 (CH), 33.2 (CH), 24.3 (CH<sub>3</sub>), 24.2 (2x CH<sub>3</sub>), 23.9 (CH<sub>3</sub>), 21.7 (CH<sub>3</sub>) ppm; HRMS (ESI): Calculated for C<sub>36</sub>H<sub>40</sub>N<sub>3</sub>O<sub>2</sub>S [M+H]<sup>+</sup>: 578.2836 m/z; Found: 578.2834 m/z.

Compound 3fA:

Following general procedure II, compound 3fA is obtained as a yellow solid (75 mg, 68% yield) starting from Tröger base 2f (56 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (Silica gel, pentane/EtOAc, 8:2)

R<sub>f</sub> = 0.31 (pentane/EtOAc, 8:2); M.p. = 184-186 °C; IR (neat): $\tilde{\nu}$ 1598, 1493, 1336, 1302, 1273, 1235, 1218, 1160, 1137, 1097, 1030, 946, 928, 873, 812, 789, 763, 701 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 7.85 (d, $J = 7.9$ Hz, 2H), 7.38 (d, $J = 8.0$ Hz, 2H), 7.32-7.31 (m, 5H), 6.68-6.58 (m, 4H), 6.40 (d, $J = 8.7$ Hz, 1H), 6.20 (s, 1H), 5.48-5.46 (m, 2H), 4.69 (d, $J = 17.5$ Hz, 1H), 4.56 (d, $J = 17.6$ Hz, 1H), 3.80 (d, $J = 15.5$ Hz, 1H), 3.74 (s, 3H), 3.66 (d, $J = 10.0$ Hz, 1H), 3.58 (d, $J = 15.5$ Hz, 1H), 3.51 (s, 3H), 2.47 (s, 3H); <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>): $\delta$ 155.3 (C), 152.1 (C), 145.1 (C), 144.0 (C), 143.7 (C), 138.5 (C), 130.9 (C), 130.3 (C), 130.2 (2xCH), 128.6 (2xCH), 127.6 (CH), 127.5 (CH), 126.2 (C), 125.6 (2xCH), 125.3 (CH), 123.0 (C), 117.3 (CH), 113.0 (CH), 112.6 (CH), 111.0 (CH), 109.1 (CH), 77.1 (C), 66.7 (CH), 62.1 (CH<sub>2</sub>), 55.9 (CH<sub>2</sub>), 55.7 (CH<sub>2</sub>), 50.6 (CH<sub>2</sub>), 49.0 (CH<sub>2</sub>), 21.7 (CH<sub>3</sub>) ppm; HRMS (ESI): Calculated for C<sub>36</sub>H<sub>32</sub>N<sub>2</sub>O<sub>4</sub>S [M+H]<sup>+</sup>: 554.2108 m/z; Found: 554.2112 m/z.
Compound 3gA: Following general procedure II, compound 3gA is obtained as a white solid (72 mg, 49% yield) starting from Tröger Base 2g (94 mg, 0.2 mmol) and triazole 1A.
Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1) R$_f$ = 0.75 (pentane/EtOAc, 8:2); M.p. = 205-207 °C; IR (neat): ν 1592, 1476, 1402, 1330, 1284, 1230, 1158, 1092, 949, 809, 760, 700, 674 cm$^{-1}$; 1H NMR (400 MHz, CDCl$_3$): 7.79-7.77 (m, 2H), 7.42-7.37 (m, 3H), 7.36-7.27 (m, 7H), 6.89 (s, 1H), 6.47 (s, 1H), 6.37 (d, J = 8.3 Hz, 1H), 6.23 (d, J = 8.4 Hz, 1H), 5.55 (dd, J = 9.4, 1.3 Hz, 1H), 5.45 (s, 1H), 4.67 (d, J = 17.6 Hz, 1H), 4.51 (d, J = 17.6 Hz, 1H), 3.85 (d, J = 15.6 Hz, 1H), 3.73 (d, J = 9.4 Hz, 1H), 3.61 (d, J = 15.5 Hz, 1H), 2.52 (s, 3H); 13C NMR (100 MHz, CDCl$_3$): δ 150.5 (C), 148.5 (C), 144.5 (C), 142.7 (C), 138.8 (CH), 138.7 (CH), 138.2 (CH), 136.9 (CH), 134.8 (CH), 134.8 (CH), 130.4 (2XCH), 130.4 (CH), 129.1 (2XCH) 128.0 (CH), 127.2 (2XCH), 125.4 (CH), 125.4 (CH), 125.3 (2XCH), 110.9 (CH), 85.0 (C), 79.4 (C), 74.5 (C), 65.8 (CH), 62.0 (CH$_2$), 49.8 (CH$_2$), 48.1 (CH$_2$), 21.9 (CH$_3$); HRMS (ESI): Calculated for C$_{30}$H$_{26}$I$_2$N$_3$O$_2$S [M+H]$^+$: 745.9830 m/z; Found: 745.9834 m/z.

Compound 3hA: Following general procedure II, compound 3hA is obtained as a yellow solid (63 mg, 48% yield) starting from Tröger Base 2h (76 mg, 0.2 mmol) and triazole 1A.
Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1) R$_f$ = 0.57 (pentane/EtOAc, 8:2); M.p. = 208-210 °C; IR (neat): ν 1595, 1478, 1407, 1329, 1287, 1155, 1089, 946, 815, 800, 760, 700, 680 cm$^{-1}$; 1H NMR (500 MHz, CDCl$_3$): 7.79 (d, J = 8.4 Hz, 2H), 7.40 (d, J = 8.2 Hz, 2H), 7.36-7.31 (m, 2H), 7.30-7.27 (m, 3H), 7.21 (d, J = 2.4 Hz, 1H), 7.15 (dd, J = 8.5, 2.3 Hz, 1H), 7.10 (dd, J = 8.5, 2.1 Hz, 1H), 6.48 (d, J = 8.4 Hz, 1H), 6.43-6.40 (m, 1H), 6.32 (d, J = 8.5 Hz, 1H), 5.54 (dd, J = 9.5, 1.4 Hz, 1H), 5.47 (s, 1H), 4.69 (d, J = 17.6 Hz, 1H), 4.53 (d, J = 17.6 Hz, 1H), 3.82 (d, J = 15.5 Hz, 1H), 3.74 (d, J = 9.5 Hz, 1H), 3.61 (d, J = 15.6 Hz, 1H), 2.51 (s, 3H); 13C NMR (126 MHz, CDCl$_3$): δ 149.9 (C), 147.7 (C), 144.5 (C), 142.7 (C), 138.1 (C), 133.0 (CH), 132.8 (CH), 130.9 (CH), 130.4 (2XCH), 130.0 (C), 129.1 (2XCH), 129.0 (CH), 128.0 (CH), 127.3 (2XCH), 125.3 (2XCH), 125.0 (CH), 124.8 (C), 114.6 (C), 110.4 (C), 110.1 (CH), 74.6 (C), 65.9 (CH), 62.0 (CH$_2$), 49.7 (CH$_2$), 48.3 (CH$_2$), 21.8 (CH$_3$); HRMS (ESI): Calculated for C$_{30}$H$_{25}$Br$_2$N$_3$O$_2$S [M+H]$^+$: 650.0107 m/z; Found: 650.0126 m/z.
Compound 3iA:
Following general procedure II, compound 3iA is obtained as a white solid (54 mg, 51% yield) starting from Tröger base 2i (52 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (silica gel, pentane/EtOAc, 95:5) Rf = 0.42 (Silica gel, pentane/EtOAc, 9:1); M.p. = 213-215 °C; IR (neat): ν 2934, 1490, 1340, 1263, 1136, 962, 871, 813, 763, 702, 657 cm⁻¹; ¹H NMR (500 MHz, CDCl₃): δ 7.87-7.73 (m, 2H), 7.39 (d, J = 8.0 Hz, 2H), 7.35-7.23 (m, 5H), 6.82 (dd, J = 8.7, 2.9 Hz, 1H), 6.76 (dd, J = 8.6, 2.7 Hz, 1H), 6.75 (dd, J = 8.6, 2.7 Hz, 1H), 6.58 (dd, J = 8.7, 5.0 Hz, 1H), 6.37 (dd, J = 8.7, 4.0 Hz, 1H), 6.33 (dd, J = 8.1, 2.5 Hz, 1H), 5.50 - 5.48 (m, 2H), 4.71 (d, J = 17.6 Hz, 1H), 4.55 (d, J = 17.7 Hz, 1H), 3.81 (d, J = 15.6 Hz, 1H), 3.69 (d, J = 10.0 Hz, 1H), 3.61 (d, J = 15.6 Hz, 1H), 2.50 (s, 3H).ppm; ¹³C NMR (126 MHz, CDCl₃): δ 158.3 (C, d, J = 187.4 Hz), 156.4 (C, d, J = 181.3 Hz), 147.1 (C), 144.8 (C, J = 2.5 Hz), 144.3 (C), 143.2 (C), 138.2 (C), 130.3 (2x CH), 130.2 (C), 129.0 (2x CH), 127.8 (CH), 127.3 (2x CH), 125.4 (2x CH), 124.9 (CH, J = 8.1 Hz), 123.8 (C, J = 7.7 Hz), 117.0 (CH, J = 23.7 Hz), 116.7 (CH, J = 22.1 Hz), 114.6 (CH, J = 22.2 Hz), 113.1 (CH, J = 24.0 Hz), 108.8 (CH, J = 8.0 Hz), 74.5 (C), 66.2 (CH, J = 1.4 Hz), 62.1 (CH₂), 50.0 (CH₂), 48.8 (CH₂), 21.8 (CH₃) ppm; HRMS (ESI): Calculated for C₃₀H₂₈F₂N₂O₂S [M+H]^+: 530.1708 m/z; Found: 530.1706 m/z.

Compound 3jA:
Following general procedure II, compound 3jA is obtained as a yellow solid (70 mg, 55% yield) starting from Tröger Base 2j (73 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (Silica gel, pentane/EtOAc, 8:2) Rf = 0.36 (pentane/EtOAc, 8:2); M.p. = 113-115 °C; IR (neat): ν 1703, 1606 1498, 1366, 1340, 1285, 1256, 1161, 1099, 1020, 953, 761, 656 cm⁻¹; ¹H NMR (500 MHz, CDCl₃): 7.86-7.80 (m, 3H), 7.73 (dd, J = 8.5, 1.8, Hz, 1H), 7.70 (dd, J = 8.4, 2.0, Hz, 1H), 7.39 (d, J = 7.7 Hz, 2H), 7.37-7.28 (m, 6H), 6.53 (d, J = 8.3 Hz, 1H), 6.40 (d, J = 8.5 Hz, 1H), 5.58 (s, 1H), 5.57 (dd, J = 9.8, 1.2 Hz, 1H), 4.78 (d, J = 17.5 Hz, 1H), 4.71 (d, J = 17.5 Hz, 1H), 4.37-4.30 (m, 2H), 4.26-4.19 (m, 2H), 3.92 (d, J = 15.5 Hz, 1H), 3.80 (d, J = 9.4 Hz, 1H), 3.75 (d, J = 15.6 Hz, 1H), 2.50 (s, 3H), 1.38 (t, J = 7.1, 3H), 1.29 (t, J = 7.1, 3H); ¹³C NMR (126 MHz, CDCl₃): δ 166.3 (C), 166.2 (C), 154.8 (C), 152.8 (C), 144.5 (C), 142.3 (C), 137.9 (C), 132.9 (CH), 132.3 (CH), 130.3 (2xCH), 129.6 (CH), 129.2 (2xCH) 128.1 (2xCH), 127.4 (2xCH), 126.7 (C), 125.4 (2xCH), 123.7 (C), 123.0 (C), 122.0 (CH), 121.4 (C), 108.0 (CH), 75.4 (C), 65.9 (CH), 61.9 (CH₂), 61.0 (CH₂), 60.5 (CH₂), 49.2 (CH₂), 48.5 (CH₂), 21.8 (CH₃), 14.6 (CH₃), 14.5 (CH₃); HRMS (ESI): Calculated for C₃₃H₃₄N₃O₇ [M+H]^+: 638.2319 m/z; Found: 638.2336 m/z.
Compound 3kA: Following general procedure II, compound 3kA is obtained as a yellow solid (57 mg, 45% yield) starting from Tröger base 2k (72 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (silica gel, pentane/EtOAc, 95:5)

R_f = 0.47 (Silica gel, pentane/EtOAc, 9:1); M.p. = 193-195 °C; IR (neat): ν 2846, 1598, 1452, 1339, 1261, 1233, 951, 938, 813, 702 cm⁻¹; ¹H NMR (500 MHz, CDCl₃): δ 7.79 (d, J = 8.3 Hz, 2H), 7.44-7.30 (m, 9H), 7.24 (dd, J = 8.5, 1.8 Hz, 1H), 5.65 (dd, J = 9.3, 1.3 Hz, 1H), 4.81 (d, J = 17.6 Hz, 1H), 4.70 (d, J = 17.6 Hz, 1H), 3.96 (d, J = 15.6 Hz, 1H), 3.77 (d, J = 9.3 Hz, 1H), 3.73 (d, J = 15.6 Hz, 1H), 2.49 (s, 3H). ppm; ¹³C NMR (126 MHz, CDCl₃): δ 153.4 (C), 151.6 (C), 144.8 (C), 142.2 (C), 138.1 (C), 130.4 (2x CH), 129.3 (2x CH), 128.0 (CH, q, J = 3.4 Hz), 127.5 (C, q, J = 3.4 Hz), 127.1 (2x CH), 126.0 (CF₃, q, J = 23.5 Hz), 125.4 (CH, q, J = 3.6 Hz), 125.3 (2x CH), 124.1 (C, q, J = 32.9 Hz), 123.5 (CH, q, J = 3.6 Hz), 123.1 (C), 121.90 (CF₃, q, J = 221.7 Hz), 121.1 (C, q, J = 33.0 Hz), 108.1 (CH), 75.2 (C), 65.7 (CH), 62.0 (CH₂), 49.5 (CH₂), 48.5 (CH₂), 21.7 (CH₃) ppm; HRMS (ESI): Calculated for C₃₂H₂₆F₆N₃O₂S [M+H]⁺: 630.1645 m/z; Found: 630.1640 m/z.

Compound 3aB: Following general procedure II, compound 3aB is obtained as a yellow solid (37 mg, 34% yield) starting from Tröger base 2a (50 mg, 0.20 mmol) and triazole 1B.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2)

R_f = 0.43 (Silica gel, pentane/EtOAc, 9:2); M.p. = 207-209 °C; IR (neat): ν 1534.3 (C), 151.6 (C), 144.8 (C), 142.2 (C), 138.1 (C), 130.4 (2x CH), 129.3 (2x CH), 128.0 (CH, q, J = 3.4 Hz), 127.5 (C, q, J = 3.4 Hz), 127.1 (2x CH), 126.0 (CF₃, q, J = 23.5 Hz), 125.4 (CH, q, J = 3.6 Hz), 125.3 (2x CH), 124.1 (C, q, J = 32.9 Hz), 123.5 (CH, q, J = 3.6 Hz), 123.1 (C), 123.1 (CH), 121.90 (CF₃, q, J = 221.7 Hz), 121.1 (C, q, J = 33.0 Hz), 108.1 (CH), 75.2 (C), 65.7 (CH), 62.0 (CH₂), 49.5 (CH₂), 48.5 (CH₂), 21.7 (CH₃) ppm; HRMS (ESI): Calculated for C₃₃H₃₄F₆N₃O₃S [M+H]⁺: 630.1645 m/z; Found: 630.1640 m/z.
Compound 3aC: Following general procedure II, compound 3aC is obtained as a yellow solid (60 mg, 54% yield) starting from Tröger base 2a (50 mg, 0.2 mmol) and triazole 1C.

Purification: column chromatography (silica gel, pentane/EtOAc, 9:1)

\[ R_f = 0.32 \text{ (Silica gel, pentane/EtOAc, 9:1); IR (neat): } \nu \text{ 2988, 1650, 1418, 1400, 1378, 1294, 1258, 1207, 1132, 940, 871, 813, 702 cm}^{-1}; \]

\[ ^1H \text{ NMR (500 MHz, CDCl}_3\text{): } \delta 7.83 (d, J = 8.3 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.23 (t, J = 8 Hz, 1H), 6.97 (d, J = 2.0 Hz, 1H), 6.91-6.76 (m, 5H), 6.54 (d, J = 8.0 Hz, 1H), 6.36 (d, J = 8.1 Hz, 1H), 6.29 (s, 1H), 5.51-5.43 (m, 2H), 4.68 (d, J = 17.5 Hz, 1H), 4.58 (d, J = 17.5 Hz, 1H), 3.83 (s, 3H), 3.79 (d, J = 15.5 Hz, 1H), 3.70 (d, J = 15.5 Hz, 1H), 3.70 (d, J = 9.8 Hz, 1H), 3.60 (d, J = 15.5 Hz, 1H), 2.50 (s, 3H), 2.24 (s, 3H), 2.02 (s, 3H) ppm; \]

\[ ^13C \text{ NMR (126 MHz, CDCl}_3\text{): } \delta 160.1 (C), 149.0 (C), 146.4 (C), 145.7 (C), 143.9 (C), 138.6 (C), 131.8 (C), 130.9 (CH), 130.7 (CH), 130.1 (2x CH), 129.9 (CH), 128.8 (C), 128.4 (CH), 127.7 (C), 127.4 (2x CH), 126.6 (CH), 123.8 (CH), 122.6 (C), 117.8 (CH), 112.5 (CH), 111.7 (CH), 108.3 (CH), 73.8 (C), 66.5 (CH), 62.0 (CH\text{2}), 55.4 (CH\text{3}), 50.2 (CH\text{2}), 48.7 (CH\text{3}), 21.7 (CH\text{3}), 20.7 (CH\text{3}), 20.6 (CH\text{3}) ppm; \]

\[ \text{HRMS (ESI): Calculated for } C_{33}H_{34}N_3O_3S \text{ [M+H]}^+: 552.2315 m/z; \text{ Found: 552.2315 m/z}. \]

Compound 3aD: Following general procedure II, compound 3aD is obtained as a white solid (59 mg, 55% yield) starting from Tröger Base 2a (50 mg, 0.2 mmol) and triazole 1D.

Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1)

\[ R_f = 0.45 \text{ (pentane/EtOAc, 8:2); M.p. = 206-208 °C; IR (neat): } \nu \text{ 1737, 1619, 1594 1343, 1319, 1159, 964, 948, 930, 877, 810, 795, 703, 664, 654 cm}^{-1}; \]

\[ ^1H \text{ NMR (400 MHz, CDCl}_3\text{): } \delta 7.84 (d, J = 8.0 Hz, 1H), 7.38 (d, J = 8.0 Hz, 1H), 7.15-7.09 (m, 4H), 6.90 (s, 1H), 6.86-6.81 (m, 2H), 6.57 (d, J = 7.9 Hz, 1H), 6.38 (s, 1H), 6.36 (d, J = 8.1 Hz, 1H), 5.48 (d, J = 9.7, 1.4 Hz, 1H), 5.42 (s, 1H), 4.65 (d, J = 17.5 Hz, 1H), 4.57 (d, J = 17.6 Hz, 1H), 3.74 (d, J = 15.5 Hz, 1H), 3.70 (d, J = 9.7 Hz, 1H), 3.57 (d, J = 15.5 Hz, 1H), 2.50 (s, 3H), 2.33 (s, 3H), 2.24 (s, 3H), 2.04 (s, 3H) ppm; \]

\[ ^13C \text{ NMR (100 MHz, CDCl}_3\text{): } \delta 149.0 (C), 146.3 (C), 143.9 (C), 140.8 (C), 138.6 (C), 137.2 (C), 132.0 (C), 130.9 (CH), 130.7 (CH) 130.1 (2x CH), 129.5 (2x CH), 129.0 (C), 128.5 (CH), 127.7 (C), 127.5 (2x CH), 126.8 (CH), 125.4 (2x CH), 124.0 (CH), 122.5 (C), 108.1 (CH), 73.3 (C), 66.7 (CH), 62.0 (CH\text{2}), 50.2 (CH\text{2}), 48.6 (CH\text{3}), 21.7 (CH\text{3}), 21.2 (CH\text{3}), 20.74 (CH\text{3}), 20.66 (CH\text{3}) ppm; \]

\[ \text{HRMS (ESI): Calculated for } C_{33}H_{34}N_3O_3S \text{ [M+H]}^+: 536.2366 m/z; \text{ Found: 536.2367 m/z}. \]
Compound 3aE:

Following general procedure II compound 3aE is obtained as a yellow solid (71 mg, 64% yield) starting from Tröger base 2a (50 mg, 0.2 mmol) and triazole 1E.

Purification: column chromatography (silica gel, pentane/EtOAc, 95:5)

\( R_f = 0.43 \) (Silica gel, pentane/EtOAc, 9:1); \( \nu \) 3002, 2850, 1516, 1397, 1200, 972, 963, 809, 732, 689 cm\(^{-1}\); \(^1\)H NMR (500 MHz, CDCl\(_3\)): \( \delta \) 7.91-7.77 (m, 2H), 7.45-7.34 (m, 2H), 7.14-7.01 (m, 2H), 6.94-6.87 (m, 2H), 6.87-6.79 (m, 2H), 6.54 (d, \( J = 8.0 \) Hz, 1H), 6.39 (s, 1H), 6.37 (d, \( J = 8.1 \) Hz, 1H), 5.48 (dd, \( J = 9.7, 1.4 \) Hz, 1H), 5.41 (s, 1H), 4.64 (d, \( J = 17.5 \) Hz, 1H), 4.57 (d, \( J = 17.5 \) Hz, 1H), 3.75-3.66 (m, 2H), 3.56 (d, \( J = 15.5 \) Hz, 1H), 2.50 (s, 3H), 2.24 (s, 3H), 2.23 (s, 3H), 2.05 (s, 3H).ppm; \(^{13}\)C NMR (126 MHz, CDCl\(_3\)): \( \delta \) 160.7 (C, d, \( J = 244.9 \) Hz), 148.9 (C), 146.4 (C), 143.9 (C), 139.35 (C, d, \( J = 244.9 \) Hz), 138.7 (C), 131.8 (C), 130.9 (CH), 130.1 (2xCH), 128.7 (C), 128.6 (CH, d, \( J = 5.1 \) Hz), 128.5 (CH). 127.9 (C), 127.4 (2x CH), 126.7 (CH), 125.1 (C, d, \( J = 17.3 \) Hz), 124.5 (CH, d, \( J = 8.0 \) Hz), 123.8 (CH), 122.4 (C), 115.2 (CH, d, \( J = 22.2 \) Hz), 108.3 (CH), 73.3 (C), 66.7 (CH), 62.0 (CH\(_2\)), 50.1 (CH\(_2\)), 21.7 (CH\(_3\)), 20.7 (CH\(_3\)), 20.6 (CH\(_3\)), 14.9 (CH\(_3\), d, \( J = 3.3 \) Hz) ppm; HRMS (ESI): Calculated for C\(_{33}\)H\(_{33}\)FN\(_3\)O\(_2\)S [M+H]\(^+\): 554.2272 m/z; Found: 554.2276 m/z

Compound 3aF:

Following general procedure II, compound 3aF is obtained as a white solid (89 mg, 74% yield) starting from Tröger base 2a (51 mg, 0.20 mmol) and triazole 1F.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2)

\( R_f = 0.64 \) (Silica gel, pentane/EtOAc, 8:2); m.p. = 195-197 °C; IR (neat): \( \nu \) 1617, 1496, 1355, 1324, 1156, 1112, 1066, 955, 812, 800, 792, 658 cm\(^{-1}\); \(^1\)H NMR (500 MHz, CDCl\(_3\)): \( \delta \) 7.83 (d, \( J = 8.3 \) Hz, 2H), 7.56 (d, \( J = 8.2 \) Hz, 2H), 7.46 (d, \( J = 8.2 \) Hz, 2H), 7.39 (d, \( J = 8.0 \) Hz, 2H), 6.90 (d, \( J = 2.0 \) Hz, 1H), 6.88-6.81 (m, 2H), 6.55 (d, \( J = 8.0 \) Hz, 1H), 6.39 (d, \( J = 8.1 \) Hz, 1H), 6.27 (s, 1H), 5.50 (dd, \( J = 9.7, 1.4 \) Hz, 1H), 5.42 (s, 1H), 4.68 (d, \( J = 17.6 \) Hz, 1H), 4.60 (d, \( J = 17.6 \) Hz, 1H), 3.84 (d, \( J = 15.4 \) Hz, 1H), 3.69 (d, \( J = 9.7 \) Hz, 1H), 3.61 (d, \( J = 15.4 \) Hz, 1H), 2.50 (s, 3H), 2.24 (s, 3H), 2.02 (s, 3H) ppm; \(^{13}\)C NMR (126 MHz, CDCl\(_3\)): \( \delta \) 148.8 (C), 147.9 (C), 146.2 (C), 144.1 (C), 138.5 (C), 132.1 (C), 131.0 (CH), 130.9 (CH), 130.2 (2xCH), 123.9 (q, \( J = 32.3 \) Hz, C), 128.6 (CH), 128.5 (C), 128.2 (C), 127.4 (2xCH), 126.6 (CH), 126.1 (2xCH), 125.9 (q, \( J = 3.7 \) Hz, 2xCH), 124.2 (q, \( J = 272.0 \) Hz, CF\(_3\)), 123.9 (CH), 122.2 (C), 108.6 (CH), 73.7 (C), 66.4 (CH), 62.0 (CH\(_2\)), 50.1 (CH\(_2\)), 48.8 (CH\(_2\)), 21.7 (CH\(_3\)), 20.74 (CH\(_3\)), 20.66 (CH\(_3\)) ppm; HR-MS (ESI): Calculated for C\(_{33}\)H\(_{31}\)F\(_3\)N\(_3\)O\(_2\)S [M+H]\(^+\): 590.2084 m/z; Found: 590.2092 m/z.
Compound 3aG:

Following general procedure II, compound 3aG is obtained as a yellow solid (99 mg, 83% yield) starting from Tröger Base 2a (50 mg, 0.2 mmol) and triazole 1G.

Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1) Rf = 0.42 (pentane/EtOAc, 8:2); M.p. = 208-210 °C; IR (neat): ṽ 1618, 1593, 1495, 1391, 1321, 1161, 1126, 1110, 1092, 959, 932, 810, 795, 703, 658 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.85 (d, J = 8.2 Hz, 2H), 7.44-7.36 (m, 4H), 7.18-7.10 (m, 2H), 6.90 (s, 1H), 6.90-6.83 (m, 2H), 6.61 (d, J = 15.4 Hz, 1H), 3.76 (d, J = 15.4 Hz, 1H), 3.66 (d, J = 9.8 Hz, 1H), 3.57 (d, J = 15.4 Hz, 1H), 2.50 (s, 3H), 2.24 (s, 3H), 2.03 (s, 3H) ppm; ¹³C NMR (100 MHz, CDCl₃): δ 148.7 (C), 145.7 (C), 144.1 (C), 142.8 (C), 138.4 (C), 132.4 (C), 132.0 (2xCH), 130.95 (CH), 130.93 (CH), 130.2 (2xCH), 128.71 (C) 128.65 (CH), 128.2 (C), 127.52 (2xCH), 127.46 (2xCH), 126.7 (CH), 124.0 (CH), 122.2 (C), 121.6 (C), 108.4 (CH), 73.1 (C), 66.4 (CH), 62.0 (CH₂), 50.1 (CH₂), 48.6 (CH₂), 21.8 (CH₃), 20.8 (CH₃), 20.7 (CH₃); HRMS (ESI): Calculated for C₃₂H₃₁BrN₃O₂S [M+H]⁺: 600.1315 m/z; Found: 600.1312 m/z.

Compound 3aH:

Following general procedure II, compound 3aH is obtained as an orange solid (93 mg, 79% yield) starting from Tröger base 2a (50 mg, 0.20 mmol) and triazole 1H.

Purification: column chromatography (silica gel, pentane/EtOAc, 9:1) Rf = 0.60 (Silica gel, pentane/EtOAc, 8:2); M.p. = 196-198 °C; IR (neat): ṽ 1615, 1594, 1496, 1468, 1408, 1340, 1290, 1158, 1140, 1093, 964, 809, 662 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.83 (d, J = 8.1 Hz, 2H), 7.40 (d, J = 8.3 Hz, 2H), 7.30 (d, J = 2.1 Hz, 1H), 7.18 (dd, J = 8.4, 2.2 Hz, 1H), 6.89 (s, 1H), 6.85 (d, J = 8.3 Hz, 2H), 6.53 (d, J = 8.0 Hz, 1H), 6.42-6.34 (m, 2H), 5.49 (d, J = 9.7, 1H), 5.37 (s, 1H), 4.66-4.52 (m, 2H), 3.71 (d, J = 5.2 Hz, 1H), 3.68 (s, 1H), 3.56 (d, J = 15.4 Hz, 1H), 2.50 (s, 3H), 2.23 (s, 3H), 2.04 (s, 3H) ppm; ¹³C NMR (100 MHz, CDCl₃): δ 148.7 (C), 146.2 (C), 144.3 (C), 144.2 (C), 138.5 (C), 132.7 (C), 132.0 (C), 131.6 (C), 131.01 (CH), 130.98 (CH), 130.9 (CH), 130.3 (2xCH), 128.6 (CH), 128.4 (C), 128.3 (C), 127.6 (CH), 127.3 (2xCH), 126.7 (CH), 125.4 (CH), 123.8 (CH), 122.2 (C), 108.7 (CH), 73.1 (C), 66.4 (CH), 62.0 (CH₂), 49.8 (CH₂), 48.8 (CH₂), 21.8 (CH₃), 20.73 (CH₃), 20.67 (CH₃) ppm; HR-MS (ESI): Calculated for C₃₂H₃₀Cl₂N₂O₃S [M+H]⁺: 590.1430 m/z; Found: 590.1428 m/z.
Compound 3aI:

Following general procedure II, compound 3aI is obtained as a white solid (28 mg, 29% yield) starting from Tröger Base 2a (50 mg, 0.2 mmol) and triazole 1I.

Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1); Rf = 0.38 (pentane/EtOAc, 9:1); M.p. = 184-186 °C; IR (neat): ν 1615, 1597, 1493, 1397, 1336, 1286, 1162, 1132, 1089, 1062, 963, 809, 718, 657 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.85 (d, J = 8.2 Hz, 2H), 7.37 (d, J = 7.8 Hz, 2H), 6.83-6.77 (m, 3H), 6.60 (s, 1H), 6.52-6.40 (m, 1H), 6.24 (d, J = 8.1 Hz, 1H), 5.33 (dd, J = 9.9, 1.4 Hz, 1H), 5.24 (s, 1H), 4.61 (d, J = 17.4 Hz, 1H), 4.36 (d, J = 17.4 Hz, 1H), 3.63 (d, J = 10.0 Hz, 1H), 3.42 (d, J = 15.5 Hz, 1H), 2.95 (d, J = 15.5 Hz, 1H), 2.47 (s, 3H), 2.20 (s, 3H), 2.07 (s, 3H), 1.45-1.18 (m, 4H), 0.87 (t, J = 7.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ 149.6 (C), 146.5 (2xC), 143.8 (C), 138.6 (C), 131.0 (CH), 130.7 (CH), 128.7 (C), 128.4 (CH), 127.6 (2XCH), 126.5 (CH), 125.4 (C), 108.0 (CH), 62.9 (CH), 62.5 (CH₂), 48.94 (CH₂), 48.87 (CH₂), 40.4 (CH₂), 21.7 (CH₃), 20.70 (CH₃), 20.69 (CH₃), 16.1 (CH₂), 14.7 (CH₃); HRMS (ESI): Calculated for C₂₉H₃₄N₃O₂S [M+H]+: 488.2366 m/z; Found: 488.2366 m/z.

Compound 3aJ:

Following general procedure II, compound 3aJ is obtained as a yellowish solid (50 mg, 41% yield) starting from Tröger base 2a (51 mg, 0.20 mmol) and triazole 1J.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2); Rf = 0.49 (Silica gel, pentane/EtOAc, 8:2); M.p. = 123-125 °C; IR (neat): ν 1632, 1605, 1497, 1336, 1267, 1208, 1158, 1091, 1031, 954, 907, 852, 808, 727, 663 cm⁻¹; ¹H NMR (500 MHz, CDCl₃): δ 7.83 (d, J = 8.3 Hz, 2H), 7.68 (d, J = 8.6 Hz, 1H), 7.64 (d, J = 8.9 Hz, 1H), 7.56 (s, 1H), 7.36 (d, J = 8.0 Hz, 2H), 7.33 (dd, J = 8.6, 2.0 Hz, 1H), 7.17-7.13 (m, 1H), 7.12 (d, J = 2.4 Hz, 1H), 6.91 (s, 1H), 6.86 (d, J = 8.1 Hz, 2H), 6.56 (d, J = 8.0 Hz, 1H), 6.46 (s, 1H), 6.41 (d, J = 8.1 Hz, 1H), 5.57-5.47 (m, 2H), 4.70 (d, J = 17.5 Hz, 1H), 4.61 (d, J = 17.5 Hz, 1H), 3.93 (s, 3H), 3.82 (d, J = 15.5 Hz, 1H), 3.77 (d, J = 9.7 Hz, 1H), 3.65 (d, J = 15.3 Hz, 1H), 2.51 (s, 3H), 2.24 (s, 3H), 2.06 (d, J = 1.7 Hz, 3H) ppm; ¹³C NMR (126 MHz, CDCl₃): δ 157.9 (C), 149.2 (C), 146.5 (C), 143.8 (C), 138.9 (C), 138.7 (C), 133.9 (C), 131.7 (C), 130.9 (CH), 130.8 (CH), 130.1 (2xCH), 129.7 (CH), 128.8 (C), 128.7 (C), 128.5 (CH), 127.8 (C), 127.8 (CH), 127.4 (2xCH), 126.8 (CH), 124.5 (CH), 123.8 (CH), 123.6 (CH), 122.6 (C), 119.1 (CH), 108.3 (CH), 105.6 (CH), 73.5 (C), 66.6 (CH), 62.1 (CH₂), 55.5 (CH₃), 49.7 (CH₃), 48.7 (CH₂), 21.8 (CH₃), 20.73 (CH₃), 20.67 (CH₃) ppm; HR-MS (ESI): Calculated for C₃₇H₃₆N₃O₃S [M+H]+: 602.2472 m/z; Found: 602.2477 m/z.
Compound 3aK:

Following general procedure II, compound 3aK is obtained as a white solid (92 mg, 85% yield) starting from Tröger Base 2a (50 mg, 0.2 mmol) and triazole 1K.

Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1) 

R_f = 0.51 (pentane/EtOAc, 8:2); M.p. = 211-213 °C; IR (neat): \(\nu\) 1618, 1596, 1494, 1364, 1289, 1164, 1157, 1134, 1090, 1058, 980, 957, 809, 776, 705, 661 cm\(^{-1}\); \(^1\)H NMR (400 MHz, CDCl\(_3\)): δ 7.83 (d, \(J = 8.3\) Hz, 2H), 7.37 (d, \(J = 8.5\) Hz, 2H), 7.29 (dd, \(J = 5.0, 3.0\) Hz, 1H), 7.08 (dd, \(J = 3.0, 1.3\) Hz, 1H) 6.95 (dd, \(J = 5.0, 1.3\) Hz, 1H), 6.89-6.88 (m, 1H), 6.85-6.81 (m, 2H), 6.54 (d, \(J = 8.0\) Hz, 1H), 6.41 (s, 1H), 6.34 (d, \(J = 8.1\) Hz, 1H), 5.46 (dd, \(J = 9.9, 1.5\) Hz, 2H), 5.43 (s, 1H), 4.72 (d, \(J = 17.5\) Hz, 1H), 4.52 (d, \(J = 17.5\) Hz, 1H), 3.75-3.69 (m, 5H), 2.49 (s, 3H), 2.23 (s, 3H), 2.05 (s, 3H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)): δ 148.9 (C), 146.2 (C), 145.6 (C), 143.9 (C), 138.5 (C), 131.9 (C), 131.0 (CH), 130.8 (CH), 130.1 (2xCH), 128.8 (C) 128.5 (CH), 128.0 (C), 127.5 (2xCH), 126.9 (CH), 126.7 (CH), 125.8 (CH), 123.8 (CH), 122.6 (C), 120.6 (CH), 108.6 (CH), 71.8 (C), 65.9 (CH), 62.1 (CH\(_2\)), 49.7 (CH\(_3\)), 48.8 (CH\(_3\)), 21.7 (CH\(_3\)), 20.7 (CH\(_3\)), 20.7 (CH\(_3\)); HRMS (ESI): Calculated for C\(_{30}\)H\(_{30}\)N\(_3\)O\(_2\)S\(_2\) [M+H]\(^+\): 528.1774 m/z; Found: 528.1774 m/z.

Compound 3aL:

Following general procedure II, compound 3aL is obtained as a white solid (82 mg, 81% yield) starting from Tröger base 2a (51 mg, 0.20 mmol) and triazole 1L.

Purification: column chromatography (silica gel, pentane/EtOAc, 7:3) 

R_f = 0.56 (Silica gel, pentane/EtOAc, 7:3); M.p. = 186-188 °C; IR (neat): \(\nu\) 1743, 1496, 1346, 1267, 1212, 1163, 1090, 1038, 962, 812, 779, 660, 579 cm\(^{-1}\); \(^1\)H NMR (500 MHz, CDCl\(_3\)): δ 7.88 (d, \(J = 8.4\) Hz, 2H), 7.37 (d, \(J = 8.0\) Hz, 2H), 6.87-6.77 (m, 4H), 6.43 (d, \(J = 7.9\) Hz, 1H), 6.32 (d, \(J = 8.1\) Hz, 1H), 6.09 (s, 1H), 5.30 (dd, \(J = 10.4, 1.4\) Hz, 1H), 4.86 (d, \(J = 17.6\) Hz, 1H), 4.43 (d, \(J = 17.7\) Hz, 1H), 3.77-3.69 (m, 5H), 2.88 (d, \(J = 15.7\) Hz, 1H), 2.46 (s, 3H), 2.20 (s, 3H), 2.13 (s, 3H) ppm; \(^{13}\)C NMR (126 MHz, CDCl\(_3\)): δ 171.8 (C), 148.0 (C), 145.9 (C), 143.9 (C), 137.8 (C), 131.7 (C), 131.1 (CH), 130.9 (CH), 130.0 (2xCH), 129.1 (C), 128.5 (CH), 128.2 (C), 127.4 (2xCH), 126.4 (CH), 123.5 (C), 123.3 (CH), 109.8 (CH), 73.3 (C), 62.4 (CH\(_2\)), 60.6 (CH), 52.8 (CH\(_3\)), 49.9 (CH\(_2\)), 46.6 (CH\(_2\)), 21.8 (CH\(_3\)), 20.74 (CH\(_3\)), 20.66 (CH\(_3\)) ppm; HR-MS (ESI): Calculated for C\(_{28}\)H\(_{30}\)N\(_3\)O\(_4\)S [M+H]\(^+\): 504.1952 m/z; Found: 504.1960 m/z.
Compound 3aM:

Following general procedure II, compound 3aM is obtained as an orange solid (53 mg, 56% yield) starting from Tröger base 2a (50 mg, 0.20 mmol) and triazole 1M using 100 °C as temperature for the reaction.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2) 
\( R_f = 0.49 \) (Silica gel, pentane/EtOAc, 8:2); M.p. = 173-175 °C; IR (neat): \( \tilde{\nu} = 1619, 1496, 1338, 1137, 1096, 953, 925, 793, 721, 703 \) cm\(^{-1}\); \(^1\)H NMR (500 MHz, CDCl\(_3\)): \( \delta = 7.63-7.57 \) (m, 2H), 7.42-7.34 (m, 2H), 7.29-7.25 (m, 1H), 6.96-6.88 (m, 3H), 6.57 (d, \( J = 7.9 \) Hz, 1H), 6.44 (d, \( J = 8.0 \) Hz, 1H), 5.42 (s, 1H), 5.22 (dd, \( J = 10.2, 1.6 \) Hz, 1H), 4.73 (d, \( J = 17.5 \) Hz, 1H), 4.64 (d, \( J = 17.5 \) Hz, 1H), 4.16 (d, \( J = 15.7 \) Hz, 1H), 3.71-3.62 (m, 2H), 2.91 (s, 6H), 2.25 (s, 3H), 2.17 (s, 3H) ppm; \(^{13}\)C NMR (126 MHz, CDCl\(_3\)): \( 149.2 \) (C), 146.8 (C), 143.8 (C), 132.0 (C), 131.0 (CH), 130.8 (CH), 129.3 (C), 129.0 (2xCH), 128.4 (CH), 127.6 (CH), 127.5 (CH), 126.6 (CH), 125.8 (2xCH), 124.3 (CH), 122.8 (C), 108.2 (CH), 74.0 (C), 67.4 (CH), 62.6 (CH\(_2\)), 50.3 (CH\(_3\)), 48.6 (CH\(_2\)), 38.4 (2xCH\(_3\)), 20.9 (CH\(_3\)), 20.8 (CH\(_3\)) ppm; HR-MS (ESI): Calculated for C\(_{27}\)H\(_{31}\)N\(_4\)O\(_2\)S [M+H\(^+\)]: 475.2162 m/z; Found: 475.2167 m/z.

Compound 3aN:

Following general procedure II, compound 3aN is obtained as a yellow solid (54 mg, 61% yield) starting from Tröger base 2a (50 mg, 0.20 mmol) and triazole 1N.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2) 
\( R_f = 0.29 \) (Silica gel, pentane/EtOAc, 8:2); M.p. = 204-206 °C; IR (neat): \( \tilde{\nu} = 1619, 1497, 1319, 1143, 1099, 949, 928, 910, 702 \) cm\(^{-1}\); \(^1\)H NMR (500 MHz, CDCl\(_3\)): \( \delta = 7.56-7.51 \) (m, 2H), 7.42-7.34 (m, 2H), 7.31-7.27 (m, 1H), 6.94 (s, 1H), 6.93-6.84 (m, 3H), 6.59 (s, 1H), 6.44 (d, \( J = 8.0 \) Hz, 1H), 5.53 (s, 1H), 5.31 (dd, \( J = 9.9, 1.5 \) Hz, 1H), 4.73 (d, \( J = 17.5 \) Hz, 1H), 4.65 (d, \( J = 17.6 \) Hz, 1H), 4.03 (d, \( J = 15.6 \) Hz, 1H), 3.70 (d, \( J = 8.4 \) Hz, 1H), 3.68 (d, \( J = 2.6 \) Hz, 1H), 3.16 (s, 3H), 2.25 (s, 3H), 2.17 (s, 3H) ppm; \(^{13}\)C NMR (126 MHz, CDCl\(_3\)): \( 149.1 \) (C), 146.4 (C), 143.6 (C), 132.2 (C), 131.1 (CH), 130.8 (CH), 129.2 (C), 129.1 (2xCH), 128.5 (CH), 127.9 (C), 127.7 (CH), 126.4 (CH), 125.6 (2xCH), 124.3 (CH), 122.6 (C), 108.3 (CH), 73.7 (C), 66.9 (CH), 61.7 (CH\(_3\)), 50.4 (CH\(_2\)), 48.6 (CH\(_3\)), 42.5 (CH\(_3\)), 20.82 (CH\(_3\)), 20.78 (CH\(_3\)) ppm; HR-MS (ESI): Calculated for C\(_{26}\)H\(_{28}\)N\(_3\)O\(_2\)S [M+H\(^+\)]: 446.1897 m/z; Found: 446.1891 m/z.
Compound 3aO:
Following general procedure II, compound 3aO is obtained as a yellow solid (52 mg, 47% yield) starting from Tröger base 2a (50 mg, 0.2 mmol) and triazole 10.
Purification: column chromatography (silica gel, pentane/EtOAc, 9:1)  
\( R_f = 0.60 \) (Silica gel, pentane/EtOAc, 8:2);  
**M.p.** = 179-181 °C;  
**IR (neat):** \( \nu = 1621, 1604, 1529, 1496, 1343, 1311, 1166, 1127, 1086, 974, 942, 804, 736, 699 \ \text{cm}^{-1} \);  
**\( ^1H \) NMR (500 MHz, CDCl\(_3\)):** \( \delta = 8.43-8.38 \) (m, 2H), 8.12-8.07 (m, 2H), 7.35-7.25 (m, 5H), 6.93-6.89 (m, 1H), 6.89-6.83 (m, 2H), 6.56 (d, \( J = 8.0 \) Hz, 1H), 6.42 (s, 1H), 6.39 (d, \( J = 8.1 \) Hz, 1H), 5.49 (s, 1H), 5.43 (dd, \( J = 9.8, 1.5 \) Hz, 1H), 4.66 (d, \( J = 17.6 \) Hz, 1H), 4.58 (d, \( J = 17.6 \) Hz, 1H), 3.79 (d, \( J = 9.9 \) Hz, 1H), 3.71 (d, \( J = 15.5 \) Hz, 1H), 3.65 (d, \( J = 15.5 \) Hz, 1H), 2.24 (s, 3H), 2.03 (s, 3H) ppm;  
**\( ^{13}C \) NMR (126 MHz, CDCl\(_3\)):** \( \delta = 150.3 \) (C), 149.1 (C), 147.2 (C), 145.9 (C), 143.5 (C), 132.3 (C), 131.2 (CH), 131.0 (CH), 129.1 (2xCH), 128.9 (C), 128.60 (CH), 128.56 (2xCH), 128.0 (C), 127.9 (CH), 126.4 (CH), 125.4 (2xCH), 124.7 (2xCH), 124.0 (CH), 121.8 (C), 108.5 (CH), 73.4 (C), 67.3 (CH), 62.3 (CH\(_2\)), 50.0 (CH\(_2\)), 48.5 (CH\(_2\)), 20.75 (CH\(_3\)), 20.74 (CH\(_3\)) ppm;  
**HRMS (ESI):** Calculated for C\(_{31}\)H\(_{29}\)N\(_4\)O\(_4\)S [M+H]\(^+\): 553.1904 m/z; Found: 553.1909 m/z.

Compound 3aP:
Following general procedure II, compound 3aP is obtained as a yellow solid (38 mg, 31% yield) starting from Tröger base 2a (50 mg, 0.2 mmol) and triazole 1P.
Purification: column chromatography (silica gel, pentane/EtOAc, 8:2)  
\( R_f = 0.44 \) (Silica gel, pentane/EtOAc, 6:4);  
**M.p.** = 189-191 °C;  
**IR (neat):** \( \nu = 1776, 1711, 1595, 1497, 1311, 1260, 1148, 1089, 1057, 967, 799, 724 \ \text{cm}^{-1} \);  
**\( ^1H \) NMR (500 MHz, CDCl\(_3\)):** \( \delta = 7.85-7.80 \) (m, 2H), 7.80-7.71 (m, 4H), 6.87-6.83 (m, 2H), 6.83-6.76 (m, 4H), 6.33 (d, \( J = 8.0 \) Hz, 1H), 6.26 (d, \( J = 8.0 \) Hz, 1H), 6.13 (s, 1H), 5.44 (d, \( J = 9.7 \) Hz, 1H), 4.88 (d, \( J = 17.5 \) Hz, 1H), 4.83 (d, \( J = 16.2 \) Hz, 1H), 4.34 (d, \( J = 17.5 \) Hz, 1H), 3.84 (d, \( J = 9.6 \) Hz, 1H), 3.81 (s, 3H), 3.59 (d, \( J = 15.8 \) Hz, 1H), 2.19 (s, 3H), 2.15 (s, 3H) ppm;  
**\( ^{13}C \) NMR (126 MHz, CDCl\(_3\)):** \( \delta = 168.3 \) (2xC), 163.2 (C), 148.2 (C), 145.5 (C), 134.5 (2xCH), 132.7 (C), 131.9 (2xC), 131.2 (CH), 130.6 (C), 130.3 (CH), 129.4 (C), 129.3 (2xCH), 128.5 (CH), 126.1 (C), 125.1 (CH), 124.5 (C), 124.3 (2xCH), 121.3 (CH), 114.6 (2xCH), 109.7 (CH), 85.1 (C), 64.0 (CH), 62.5 (CH\(_2\)), 55.8 (CH\(_3\)), 49.9 (CH\(_3\)), 46.1 (CH\(_2\)), 20.9 (CH\(_3\)), 20.7 (CH\(_3\)) ppm;  
**HR-MS (ESI):** Calculated for C\(_{34}\)H\(_{33}\)N\(_4\)O\(_5\)S [M+H]\(^+\): 607.2014 m/z; Found: 607.2010 m/z.
Compound 3lA:

Following general procedure II, compound 3lA is obtained as an orange-yellow solid (63 mg, 55% yield) starting from Tröger Base 2l (59 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (Silica gel, pentane/EtOAc, 7:3)

R<sub>f</sub> = 0.52 (pentane/EtOAc, 6:4); M.p. = 158-160 °C; IR (neat): ν 1605, 1494, 1448, 1311, 1275, 1156, 1088, 1031, 811, 764, 699, 659 cm<sup>-1</sup>; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): 8.00 (dd, J = 8.9, 2.3 Hz, 1H), 7.80 (d, J = 8.3 Hz, 2H), 7.43-7.36 (m, 4H), 7.34-7.28 (m, 3H), 7.15-7.14 (m, 1H), 6.73 (d, J = 8.6 Hz, 1H), 6.70 (d, J = 2.8 Hz, 1H), 6.66 (dd, J = 8.6, 2.9 Hz, 1H), 6.47 (d, J = 8.9, 1H), 5.52 (dd, J = 10.1, 1.6 Hz, 1H), 5.45 (s, 1H), 4.78 (d, J = 17.4 Hz, 1H), 4.69 (d, J = 17.4 Hz, 1H), 4.00 (d, J = 15.6 Hz, 1H), 3.76 (s, 3H), 3.61-3.53 (m, 2H), 2.52 (s, 3H); <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>): δ 156.0 (C), 155.6 (C), 145.0 (C), 141.7 (C), 141.5 (C), 139.8 (C), 137.8 (C), 130.4 (2xCH), 129.5 (C) 129.4 (2xCH), 128.3 (CH), 128.0 (CH), 127.2 (2XCH), 126.5 (CH), 125.1 (2XCH), 123.4 (C), 123.3 (CH), 115.5 (CH), 113.1 (CH), 106.3 (CH), 75.6 (C), 64.6 (CH), 61.6 (CH<sub>2</sub>), 55.7 (CH), 50.2 (CH<sub>3</sub>), 48.1 (CH<sub>3</sub>), 21.8 (CH<sub>3</sub>); HRMS (ESI): Calculated for C<sub>31</sub>H<sub>29</sub>N<sub>4</sub>O<sub>5</sub>S [M+H]<sup>+</sup>: 569.1853 m/z; Found: 569.1860 m/z.

Compound 3mA:

Following general procedure II, compound 3mA is obtained as an orange-yellow solid (38 mg, 34% yield) starting from Tröger Base 2m (56 mg, 0.2 mmol) and triazole 1A.

Purification: column chromatography (Silica gel, pentane/EtOAc, 9:1)

R<sub>f</sub> = 0.36 (pentane/EtOAc, 8:2); M.p. = 198-200 °C; IR (neat): ν 1598, 1494, 1445, 1348, 1315, 1271, 1229, 1157, 1105, 1054, 951, 938, 831, 813, 765, 723, 703, 661 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 7.99 (dd, J = 8.9, 2.3 Hz, 1H), 7.81 (d, J = 8.3 Hz, 2H), 7.49-7.34 (m, 4H), 7.35-7.29 (m, 3H), 7.15-7.14 (m, 1H), 6.96-6.87 (m, 2H), 6.65 (dd, J = 8.0, 1H), 6.44 (d, J = 8.9, 1H), 5.57 (dd, J = 10.0, 1.5 Hz, 1H), 5.48 (s, 1H), 4.78 (d, J = 17.4 Hz, 1H), 4.67 (d, J = 17.3 Hz, 1H), 4.00 (d, J = 15.6 Hz, 1H), 3.67-3.56 (m, 2H), 2.52 (s, 3H), 2.26 (s, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>): δ 156.2 (C), 145.9 (C), 145.0 (C), 141.6 (C), 139.8 (C), 137.9 (C), 132.8 (C), 130.6 (CH), 130.5 (2xCH), 129.4 (2XCH), 129.2 (CH), 128.3 (CH), 128.0 (CH), 127.5 (C), 127.2 (2XCH), 125.1 (2XCH), 124.8 (CH), 123.5 (CH), 123.2 (C), 106.6 (CH), 75.7 (C), 64.7 (CH), 61.7 (CH<sub>2</sub>), 49.9 (CH<sub>3</sub>), 48.2 (CH<sub>3</sub>), 21.8 (CH<sub>3</sub>), 20.8 (CH<sub>3</sub>); HRMS (ESI): Calculated for C<sub>31</sub>H<sub>29</sub>N<sub>4</sub>O<sub>4</sub>S [M+H]<sup>+</sup>: 553.1904 m/z; Found: 553.1907 m/z.
5. General procedure III: synthesis of compounds 4

In a 2 mL screw-cap vial equipped with a magnetic stirring bar, Rh₂(Piv)₄ (1.22 mg, 0.002 mmol, 2 mol%), compound 3aO (0.1 mmol, 1 equiv) and N-sulfonyltriazole 1 (0.3 mmol, 3 equiv) were dissolved in 0.4 mL of anhydrous CHCl₃ (0.25 M). The vial was capped and stirred at 80 °C for 48 h. The solution was concentrated under reduced pressure and the residue was purified by column chromatography.

Analysis data for compounds 4

Compound 4A:

Following general procedure III, compound 4A is obtained as an orange solid (24 mg, 29% yield) starting from compound 3aO (55 mg, 0.10 mmol) and triazole 1A.

Purification: column chromatography (silica gel, pentane/EtOAc, 9:1)

Rf = 0.40 (Silica gel, pentane/EtOAc, 8:2); M.p. = 178-180 °C; IR (neat): ν 1618, 1531, 1347, 1314, 1240, 1164, 1090, 1009, 939, 809, 764, 665 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 5.80-5.85 (m, 2H), 5.35-5.45 (m, 2H), 4.96 (s, 1H), 4.58-4.64 (m, 1H), 4.51 (d, J = 2.8 Hz, 1H), 4.12 (d, J = 15.5 Hz, 1H), 2.37 (s, 3H), 2.15 (s, 3H), 1.91 (s, 3H) ppm; ¹³C NMR (100 MHz, CDCl₃): δ 150.6 (C), 147.7 (C), 144.9 (C), 144.0 (C), 143.9 (C), 137.9 (C), 135.6 (C), 131.6 (C), 131.4 (CH), 130.5 (CH), 129.8 (2xCH), 129.8 (2xCH), 129.3 (2xCH), 129.1 (CH), 129.0 (2xCH), 128.2 (CH), 128.0 (CH), 127.7 (C), 126.9 (2xCH), 126.6 (2xCH), 126.6 (C), 125.7 (CH), 125.4 (2xCH), 124.8 (2xCH), 122.5 (C), 120.4 (C), 119.1 (CH), 115.8 (CH), 105.7 (CH), 77.3 (C), 68.6 (CH), 59.6 (CH), 56.9 (CH₂), 46.7 (CH₂), 21.7 (CH₃), 20.8 (CH₃), 20.2 (CH₃) ppm; HR-MS (ESI): Calculated for C₆₆H₄₂N₂O₄S₂ [M+H]^+: 824.2556 m/z; Found: 824.2571 m/z.

Compound 4B:

Following general procedure III, compound 4B is obtained as an orange solid (29 mg, 34% yield) starting from compound 3aO (55 mg, 0.10 mmol) and triazole 1B.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2)

Rf = 0.39 (Silica gel, pentane/EtOAc, 8:2); M.p. = 181-183 °C; IR (neat): ν 1607, 1531, 1347, 1314, 1291, 1249, 1165, 1090, 1014, 940, 756, 662 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 8.47 (d, J = 8.8 Hz, 2H), 8.30 (d, J = 8.8 Hz, 2H), 7.39-7.26 (m, 6H), 7.26-7.20 (m, 1H), 7.11 (d, J = 8.7 Hz, 2H), 7.07 (d, J = 8.1 Hz, 2H), 6.93 (d, J = 8.1 Hz, 1H), 6.84-6.76 (m, 3H), 6.68 (s, 1H), 6.49 (d, J = 8.1 Hz, 1H), 6.19 (d, J = 8.5 Hz, 1H), 6.13 (d, J = 8.4 Hz, 1H), 5.33 (s, 2H), 4.99 (s, 1H), 4.95 (d, J = 4.1 Hz, 1H), 4.55 (d, J = 3.9 Hz, 1H), 4.51 (s, 1H), 4.08 (d, J = 15.5 Hz, 1H), 3.96 (d, J = 15.5 Hz, 1H), 3.79 (s, 3H), 2.37 (s, 3H), 2.15 (s, 3H), 1.92 (s, 3H) ppm; ¹³C NMR (100 MHz, CDCl₃): δ 159.8 (C), 150.6 (C), 147.7 (C), 145.0 (C), 144.1 (C), 143.8 (C), 137.9 (C), 131.7 (C), 131.4 (CH), 130.4 (CH), 129.8 (2xCH), 129.7 (2xCH), 129.3 (2xCH), 128.9 (CH), 128.2 (2xCH), 128.00 (C), 127.95 (CH), 127.6 (C), 126.6 (2xCH), 126.5 (C), 125.8 (CH), 125.4 (2xCH), 124.8 (2xCH), 122.5 (C), 120.4 (C), 117.3 (CH), 115.9 (CH), 114.4 (2xCH), 105.6 (CH), 77.3 (C), 68.6 (CH), 59.6 (CH₂), 56.9 (CH₃), 55.5 (CH₃), 46.6 (CH₂), 21.7 (CH₃), 20.8 (CH₃), 20.2 (CH₃) ppm; HR-MS (ESI): Calculated for C₆₆H₄₂N₂O₄S₂ [M+H]^+: 824.2569 m/z; Found: 854.2677 m/z.
Following general procedure III, compound 4O is obtained as an orange solid (27 mg, 32% yield) starting from compound 3aO (55 mg, 0.10 mmol) and triazole 1O.

Purification: column chromatography (silica gel, pentane/EtOAc, 9:1)

\[ R_f = 0.40 \] (Silica gel, pentane/EtOAc, 8:2); M. p. = 208-210 °C; IR (neat): \( \tilde{\nu} \) 1614, 1530, 1346, 1313, 1167, 1127, 1102, 1015, 942, 912, 853 cm\(^{-1}\);

\(^1\)H NMR (500 MHz, CDCl\(_3\)): \( \delta \) 8.53-8.46 (m, 2H), 8.32-8.25 (m, 2H), 8.10-8.03 (m, 2H), 7.61-7.55 (m, 5H), 7.36-7.27 (m, 5H), 7.25-7.19 (m, 5H), 6.96 (d, \( J = 8.0 \) Hz, 1H), 6.84 (s, 1H), 6.79 (s, 1H), 6.50 (d, \( J = 8.1 \) Hz, 1H), 6.19-6.12 (m, 2H), 5.22 (s, 1H), 5.20 (s, 1H), 4.99-4.88 (m, 2H), 4.59-4.55 (m, 1H), 4.53 (d, \( J = 6.0 \) Hz, 1H), 4.04 (d, \( J = 15.6 \) Hz, 1H), 3.99 (d, \( J = 15.6 \) Hz, 1H), 2.10 (s, 3H), 1.90 (s, 3H) ppm;

\(^{13}\)C NMR (126 MHz, CDCl\(_3\)): \( \delta \) 150.8 (C), 150.0 (C), 147.7 (C), 146.1 (C), 144.5 (C), 144.4 (C), 143.1 (C), 135.2 (C), 134.4 (C), 131.7 (CH), 130.4 (CH), 129.7 (2xCH), 129.4 (2xCH), 129.1 (2xCH), 128.8 (CH), 128.6 (CH), 128.6 (C), 128.1 (CH), 127.7 (2xCH), 127.2 (2xCH), 126.6 (C), 125.8 (CH), 125.4 (2xCH), 125.0 (2xCH), 124.6 (2xCH), 122.9 (C), 120.0 (C), 118.2 (CH), 105.4 (CH), 77.1 (C), 68.7 (CH), 59.8 (CH\(_2\)), 56.9 (CH\(_2\)), 46.3 (CH\(_2\)), 20.8 (CH\(_3\)), 19.9 (CH\(_3\)) ppm;

HR-MS (ESI): Calculated for C\(_{45}\)H\(_{39}\)N\(_6\)O\(_8\)S\(_2\) [M+H]\(^+\): 855.2265 m/z; Found: 855.2290 m/z.

6. Synthesis of compound 5

To a stirred solution of compound 3aO (110 mg, 0.2 mmol, 1 equiv) in a mixture of CH\(_3\)CN/DMSO (49:1, 10 mL) were added K\(_2\)CO\(_3\) (111 mg, 0.8 mmol, 4 equiv) and PhSH (0.1 mL, 1.0 mmol, 5 equiv). The reaction mixture was stirred at 50 °C for 2 h. After being cooled to 20 °C, solvent was evaporated and the residue was directly purified by column chromatography (silica gel, pentane/EtOAc 7:3) to afford compound 5 as a yellowish solid (54 mg, 74% yield).

\[ R_f = 0.28 \] (Silica gel, pentane/EtOAc, 1:1); M. p. = 158-160 °C; IR (neat): \( \tilde{\nu} \) 2919, 1616, 1494, 1357, 1292, 1244, 1152, 1129, 904, 873, 804, 751, 728, 698 cm\(^{-1}\);

\(^1\)H NMR (400 MHz, CDCl\(_3\)): \( \delta \) 7.53-7.41 (m, 2H), 7.38-7.29 (m, 2H), 7.25-7.20 (m, 1H), 6.98-6.97 (m, 4H), 6.65 (d, \( J = 8.0 \) Hz, 1H), 6.54 (d, \( J = 8.0 \) Hz, 1H), 4.91 (d, \( J = 17.3 \) Hz, 1H), 4.63 (d, \( J = 17.3 \) Hz, 1H), 4.51 (d, \( J = 11.9 \) Hz, 1H), 4.40 (s, 1H), 4.02-3.86 (m, 3H), 2.23 (s, 3H), 2.15 (s, 3H) ppm;

\(^{13}\)C NMR (100 MHz, CDCl\(_3\)): \( \delta \) 148.9 (C), 146.6 (C), 144.9 (C), 131.1 (C), 131.1 (C), 130.8 (CH), 129.9 (CH), 128.7 (2xCH), 128.7 (CH), 128.6 (C), 127.5 (C), 127.2 (CH), 126.6 (CH), 125.7 (2xCH), 124.4 (CH), 108.6 (CH), 70.4 (C), 65.7 (CH), 65.5 (CH\(_2\)), 51.5 (CH\(_2\)), 49.2 (CH\(_3\)), 20.8 (CH\(_3\)), 20.7 (CH\(_3\)) ppm;

HR-MS (ESI): Calculated for C\(_{25}\)H\(_{26}\)N\(_3\) [M+H]\(^+\): 368.2123 m/z; Found: 368.2121 m/z.
7. **NMR spectra of new compounds**

**Compound 1E.** $^1$H NMR (CDCl$_3$, 400 MHz)

![NMR spectrum of Compound 1E](image1)

**Compound 1E.** $^{13}$C NMR (CDCl$_3$, 100 MHz)

![NMR spectrum of Compound 1E](image2)
Compound 1H. $^1$H NMR (CDCl$_3$, 400 MHz)

Compound 1H. $^{13}$C NMR (CDCl$_3$, 100 MHz)
**Compound 3aA.** $^1$H NMR (CDCl$_3$, 400 MHz)

![$^1$H NMR spectrum of Compound 3aA.](image)

**Compound 3aA.** $^{13}$C NMR (CDCl$_3$, 100 MHz)

![$^{13}$C NMR spectrum of Compound 3aA.](image)
Compound 3bA. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3bA. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3cA. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3cA. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3dA. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3dA. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3eA. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3eA. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3fA. $^1$H NMR (CDCl$_3$, 400 MHz)

![NMR Spectroscopy Image]

Compound 3fA. $^{13}$C NMR (CDCl$_3$, 126 MHz)

![NMR Spectroscopy Image]
Compound 3gA. $^1$H NMR (CDCl$_3$, 400 MHz)

Compound 3gA. $^{13}$C NMR (CDCl$_3$, 100 MHz)
**Compound 3hA.** $^1$H NMR (CDCl$_3$, 500 MHz)

**Compound 3hA.** $^{13}$C NMR (CDCl$_3$, 126 MHz)
**Compound 3iA.** $^1$H NMR (CDCl$_3$, 500 MHz)

**Compound 3iA.** $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3JA. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3JA. $^{13}$C NMR (CDCl$_3$, 126 MHz)
**Compound 3kA.** $^1$H NMR (CDCl$_3$, 500 MHz)

**Compound 3kA.** $^{13}$C NMR (CDCl$_3$, 126 MHz)
**Compound 3aB.** $^1$H NMR (acetone-$d_6$, 500 MHz)

**Compound 3aB.** $^{13}$C NMR (acetone-$d_6$, 126 MHz)
Compound 3aC. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3aC. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3aD. $^1$H NMR (CDCl$_3$, 400 MHz)

Compound 3aD. $^{13}$C NMR (CDCl$_3$, 100 MHz)
**Compound 3aE.** $^1$H NMR (CDCl$_3$, 500 MHz)

![NMR spectrum of Compound 3aE](image)

**Compound 3aE.** $^{13}$C NMR (CDCl$_3$, 126 MHz)

![NMR spectrum of Compound 3aE](image)
Compound 3af. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3af. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3aG. $^1$H NMR (CDCl$_3$, 400 MHz)

Compound 3aG. $^{13}$C NMR (CDCl$_3$, 100 MHz)
Compound 3aH. $^1$H NMR (CDCl$_3$, 400 MHz)

Compound 3aH. $^{13}$C NMR (CDCl$_3$, 100 MHz)
Compound 3a. $^1$H NMR (CDCl$_3$, 400 MHz)

Compound 3a. $^{13}$C NMR (CDCl$_3$, 100 MHz)
Compound 3aJ. $^1$H NMR (CDCl$_3$, 500 MHz)

\[ R = \begin{array}{c}
\text{O} \\
\text{Me}
\end{array} \]

Compound 3aJ. $^{13}$C NMR (CDCl$_3$, 126 MHz)

\[ R = \begin{array}{c}
\text{O} \\
\text{Me}
\end{array} \]
**Compound 3aK.** $^1$H NMR (CDCl$_3$, 400 MHz)

**Compound 3aK.** $^{13}$C NMR (CDCl$_3$, 100 MHz)
**Compound 3aL**. $^1$H NMR (CDCl$_3$, 500 MHz)

![NMR spectrum for Compound 3aL](image)

**Compound 3aL**. $^{13}$C NMR (CDCl$_3$, 126 MHz)

![NMR spectrum for Compound 3aL](image)
**Compound 3aM.** $^1$H NMR (CDCl$_3$, 500 MHz)

[Chemical structure image]

**Compound 3aM.** $^{13}$C NMR (CDCl$_3$, 126 MHz)

[Chemical structure image]
Compound 3aN. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3aN. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3aO. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3aO. $^{13}$C NMR (CDCl$_3$, 126 MHz)
**Compound 3aP.** $^1$H NMR (CDCl$_3$, 500 MHz)

**Compound 3aP.** $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 3IA. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 3IA. $^{13}$C NMR (CDCl$_3$, 126 MHz)
**Compound 3mA.** \(^1\)H NMR (CDCl\(_3\), 400 MHz)

![NMR Spectrum of Compound 3mA (\(^1\)H)](image1)

**Compound 3mA.** \(^{13}\)C NMR (CDCl\(_3\), 100 MHz)

![NMR Spectrum of Compound 3mA (\(^{13}\)C)](image2)
Compound 4A. $^1$H NMR (CDCl$_3$, 400 MHz)

Compound 4A. $^{13}$C NMR (CDCl$_3$, 100 MHz)
**Compound 4B.** $^1$H NMR (CDCl$_3$, 400 MHz)

**Compound 4B.** $^{13}$C NMR (CDCl$_3$, 100 MHz)
Compound 40. $^1$H NMR (CDCl$_3$, 500 MHz)

Compound 40. $^{13}$C NMR (CDCl$_3$, 126 MHz)
Compound 5. $^1$H NMR (CDCl$_3$, 400 MHz)

\[
\text{Chemical Structure}
\]

Compound 5. $^{13}$C NMR (CDCl$_3$, 100 MHz)

\[
\text{Chemical Structure}
\]
8. Reactivity of 2l and 2m under thermal activation (metal-free) conditions

In a 2 mL screw-cap vial equipped with a magnetic stirring bar, Tröger’s base 2l (0.1 mmol, 1 equiv) and N-sulfonyltriazole 1Q (0.15 mmol, 1.5 equiv) were dissolved in 0.4 mL of anhydrous CHCl$_3$ (0.25 M). The vial was capped and stirred at 80 °C for 48 h. The solution was concentrated under reduced pressure and the $^1$H NMR of the crude mixture is recorded. As the separation/purification of both regioisomers was difficult by chromatography, the ratio is determined from the crude mixture.

Scheme S1. $^1$H NMR of the crude reaction mixture of 1Q with 2l: 1:1 ratio of the two regioisomers.
In a 2 mL screw-cap vial equipped with a magnetic stirring bar, Tröger’s base 2m (0.1 mmol, 1 equiv) and N-sulfonyltriazole 1Q (0.15 mmol, 1.5 equiv) were dissolved in 0.4 mL of anhydrous CHCl₃ (0.25 M). The vial was capped and stirred at 80 °C for 48 h. The solution was concentrated under reduced pressure and the residue was purified by column chromatography (Pentane/EtOAc 6:4). An inseparable mixture of the two regioisomers is obtained. As the purification was difficult to carry out, the yield is not reported.

Scheme S2. ¹H NMR of the isolated mixture from reaction of 1Q with 2m: 1:1 the two regioisomers.
9. Synthesis of compounds 2' and 3'

**Compound 2':**

In a screw cap vial, Tröger base 2a (125 mg, 0.5 mmol) and CuTc (5 mol%) were dissolved in 1.3 mL of toluene. Then ethyl 2-diazo-3-oxopropanoate (0.75 mmol, 1.5 equiv) was added slowly to the reaction mixture. The resulting solution was stirred at 90°C for 16 h. After being cooled to 20°C, solvent was evaporated and the residue was directly purified by column chromatography (silica gel, pentane/EtOAc 9:1) to afford compound 2' as a yellow solid (87 mg, 48% yield).

R_f = 0.63 (Silica gel, pentane/EtOAc, 8:2); **IR (neat):** ν 1743, 1720, 1495, 1435, 1218, 1182, 1099, 1070, 1011, 962, 890, 824 cm⁻¹; **Major diastereoisomer:** ¹H NMR (400 MHz, CDCl₃): δ 9.37 (d, J = 1.8 Hz, 1H), 7.31 (d, J = 8.0 Hz, 1H), 7.00 (d, J = 7.9 Hz, 1H), 6.94 (dd, J = 8.1, 2.1 Hz, 1H), 6.88 (dd, J = 8.1, 2.1 Hz, 1H), 6.71 (s, 1H), 6.58 (s, 1H), 4.77 (d, J = 17.9 Hz, 1H), 4.52 (d, J = 15.2 Hz, 1H), 4.42 (d, J = 18.0 Hz, 1H), 4.31 (d, J = 17.7 Hz, 1H), 4.26-4.15 (m, 3H), 3.84 (dt, J = 15.2, 1.5 Hz, 1H), 2.18 (s, 3H), 2.17 (s, 3H), 1.27 (t, J = 7.1 Hz, 3H) ppm; ¹³C NMR (100 MHz, CDCl₃): δ 193.9 (C), 167.6 (C), 146.7 (C), 142.3 (C), 136.6 (C), 136.0 (C), 135.0 (C), 133.9 (C), 130.6 (CH), 129.4 (CH), 128.82 (CH), 127.89 (CH), 128.4 (CH), 128.3 (CH), 82.3 (C), 62.4 (CH), 59.6 (CH₂), 57.3 (CH₃), 56.2 (CH₃), 21.0 (CH₃), 20.9 (CH₃), 14.2 (CH₃) ppm; **Minor diastereoisomer:** ¹H NMR (400 MHz, CDCl₃): δ 9.82 (s, 1H), 7.17 (d, J = 8.0 Hz, 1H), 7.04 (d, J = 8.0 Hz, 1H), 6.90 (d, J = 7.8, 2.1 Hz, 2H), 6.68 (s, 1H), 6.62 (s, 1H), 4.70 (d, J = 17.5 Hz, 1H), 4.59 (d, J = 15.4 Hz, 1H), 4.49 (d, J = 17.8 Hz, 1H), 4.42-4.25 (m, 2H), 3.99 (dq, J = 10.7, 7.1 Hz, 1H), 3.87 (dq, J = 10.7, 7.1 Hz, 1H), 3.65 (dd, J = 15.5, 1.4 Hz, 1H), 2.17 (s, 3H), 2.16 (s, 3H), 0.83 (t, J = 7.1 Hz, 3H) ppm; ¹³C NMR (100 MHz, CDCl₃): δ 198.6 (C), 167.2 (C), 146.9 (C), 143.1 (C), 136.5 (C), 136.0 (C), 135.9 (C), 135.8 (C), 134.8 (C), 130.6 (CH), 128.9 (CH), 128.6 (CH), 128.4 (CH), 128.3 (CH), 128.1 (CH), 82.5 (C), 62.4 (CH₂), 59.7 (CH₂), 57.5 (CH₃), 56.2 (CH₃), 20.94 (CH₃), 20.87 (CH₃), 13.6(CH₃) ppm; **HR-MS (ESI):** Calculated for C₂₉H₃₂N₂O₅S [M+H]+: 518.2108 m/z; Found: 518.2127 m/z.

**Compound 3':**

Following a procedure reported in the literature,[⁶] compound 3' is obtained as a white solid (10 mg, 32% yield) starting from tosyl amine (10 mg, 0.06 mmol) and Tröger base 2' (33 mg, 0.18 mmol, 3 equiv) with 10 mol% of antranilic acid.

Purification: column chromatography (silica gel, pentane/EtOAc, 8:2) R_f = 0.33 (Silica gel, pentane/EtOAc, 8:2); **IR (neat):** ν 1734, 1615, 1496, 1397, 1348, 1263, 1206, 1162, 1091, 1035, 960, 813, 660 cm⁻¹; **¹H NMR (500 MHz, CDCl₃):** δ 7.88 (d, J = 8.3 Hz, 2H), 7.36 (d, J = 7.7 Hz, 2H), 6.88-6.74 (m, 4H), 6.42 (d, J = 8.0 Hz, 1H), 6.32 (d, J = 8.1 Hz, 1H), 6.11 (s, 1H), 5.30 (dd, J = 10.4, 1.3 Hz, 1H), 4.88 (d, J = 17.6 Hz, 1H), 4.44 (d, J = 17.7 Hz, 1H), 4.19 (m, 2H), 3.79-3.65 (m, 2H), 2.85 (d, J = 15.7 Hz, 1H), 2.46 (s, 3H), 2.20 (s, 3H), 2.13 (s, 3H), 1.28 (t, J = 7.1 Hz, 3H) ppm; ¹³C NMR (126 MHz, CDCl₃): δ 171.2 (C), 148.0 (C), 146.0 (C), 143.9 (C), 137.9 (C), 131.7 (C), 131.1 (CH), 130.8 (CH), 130.1 (2xCH), 129.0 (C), 128.5 (CH), 128.3 (C), 127.4 (2xCH), 126.4 (CH), 123.5 (C), 123.3 (CH), 109.7 (CH), 73.3 (C), 62.3 (CH₂), 61.8 (CH₃), 60.4 (CH), 49.9 (CH₂), 46.7 (CH₂), 21.8 (CH₃), 20.8 (CH₃), 20.7 (CH₃), 14.4 (CH₃) ppm; **HR-MS (ESI):** Calculated for C₂₉H₃₂N₂O₅S [M+H]+: 518.2108 m/z; Found: 518.2127 m/z.
**Compound 2**. $^1$H NMR (CDCl$_3$, 400 MHz) Major diastereoisomer

$2' : X = \text{CHO}, Y = \text{CO}_2\text{Et}$

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**Compound 2**. $^{13}$C NMR (CDCl$_3$, 100 MHz) Major diastereoisomer

$2' : X = \text{CHO}, Y = \text{CO}_2\text{Et}$
**Compound 2'.** $^1$H NMR (CDCl$_3$, 400 MHz) Minor diastereoisomer

$2': X = \text{CHO}, Y = \text{CO}_2\text{Et}$

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**Compound 2'.** $^{13}$C NMR (CDCl$_3$, 100 MHz) Minor diastereoisomer

$2': X = \text{CHO}, Y = \text{CO}_2\text{Et}$
Compound 3'. $^1$H NMR (CDCl$_3$, 500 MHz)

$^1$H NMR spectrum

$^1$C NMR (CDCl$_3$, 126 MHz)

$^{13}$C NMR spectrum

Compound 3'. $^{13}$C NMR (CDCl$_3$, 126 MHz)
10. **Crystallographic data**

All data were collected on a Rigaku Supernova diffractometer using Cu Kα radiation. The crystal was mounted on a Mitegen cryoloop and held at 180K in the cold stream of a cryostream (Oxford Cryosystems). Structures were solved SIR2004\textsuperscript{[7]}, olex2\textsuperscript{[8]} or shelxt\textsuperscript{[9]} and refined in the SHELXL\textsuperscript{[10]} program within the Olex2 Software.

**Compound 3aA**

**Table S2.** Crystal data and structure refinement for compound 3aA.

| CCDC number | 1832810 |
|-------------|---------|
| Empirical formula | C32 H31 N3 O2 S |
| Formula weight | 521.66 |
| Temperature | 180.00(14) K |
| Wavelength | 1.5418 Å |
| Crystal system | Monoclinic |
| Space group | P 1 21/n 1 |
| Unit cell dimensions | a = 11.06311(19) Å, α = 90° |
| | b = 16.1063(4) Å, β = 93.3032(16)° |
| | c = 14.3748(3) Å, γ = 90° |
| Volume | 2557.14(9) Å³ |
| Z | 4 |
| Density (calculated) | 1.355 Mg/m³ |
| Absorption coefficient | 1.407 mm⁻¹ |
| F(000) | 1104 |
| Crystal size | 0.1788 x 0.133 x 0.028 mm³ |
| Theta range for data collection | 4.126 to 73.342° |
| Index ranges | -13≤h≤13, -17≤k≤19, -17≤l≤16 |
| Reflections collected | 20453 |
| Independent reflections | 5050 [R(int) = 0.0301] |
| Completeness to theta = 67.680° | 99.8 % |
| Absorption correction | Analytical |
| Max. and min. transmission | 0.962 and 0.835 |
| Refinement method | Full-matrix least-squares on F² |
| Data / restraints / parameters | 5050 / 0 / 346 |
| Goodness-of-fit on F² | 1.028 |
| Final R indices [I>2sigma(I)] | R1 = 0.0379, wR2 = 0.0959 |
| R indices (all data) | R1 = 0.0497, wR2 = 0.1028 |
| Extinction coefficient | n/a |
| Largest diff. peak and hole | 0.222 and -0.348 e.Å⁻³ |
**Figure S1.** View of the asymmetric unit (displacement ellipsoids are depicted at 50 percent probability level)

**Compound 3IA**

**Table S2.** Crystal data and structure refinement for compound 3IA.

| Parameter                        | Value                                      |
|----------------------------------|--------------------------------------------|
| **CCDC number**                  | 1832811                                    |
| **Empirical formula**            | C31H28N4O5S                                |
| **Formula weight**               | 568.63                                     |
| **Temperature**                  | 179.9(2) K                                 |
| **Wavelength**                   | 1.54184 Å                                  |
| **Crystal system**               | Monoclinic                                 |
| **Space group**                  | P 1 21/n 1                                 |
| **Unit cell dimensions**         | a = 11.23463(12) Å, b = 15.96591(15) Å, c = 14.91002(14) Å |
| **Volume**                       | 2648.37(5) Å³                             |
| **Z**                            | 4                                          |
| **Density (calculated)**         | 1.426 Mg/m³                                |
| **Absorption coefficient**       | 1.508 mm⁻¹                                 |
| **F(000)**                       | 1192                                       |
| **Crystal size**                 | 0.3559 x 0.2352 x 0.1567 mm³               |
| **Theta range for data collection** | 4.078 to 73.478°.                           |
| **Index ranges**                 | -13≤h≤10, -19≤k≤19, -18≤l≤18               |
| **Reflections collected**        | 22701                                      |
| **Independent reflections**      | 5282 [R(int) = 0.0332]                     |
Completeness to theta = 67.684° 100.0 %
Absorption correction Analytical
Max. and min. transmission 0.822 and 0.702
Refinement method Full-matrix least-squares on F^2
Data / restraints / parameters 5282 / 159 / 443
Goodness-of-fit on F^2 1.043
Final R indices [I>2sigma(I)] R1 = 0.0362, wR2 = 0.0910
R indices (all data) R1 = 0.0419, wR2 = 0.0959
Extinction coefficient n/a
Largest diff. peak and hole 0.246 and -0.421 e.Å\(^{-3}\)

**Figure S2.** View of the asymmetric unit (displacement ellipsoids are depicted at 50 percent probability level)

**COMMENTS:** One part of the molecule is disordered and was refined using two components. Restraints were applied on the bond lengths and on the anisotropic displacement parameters. Constraints were also applied on some displacement parameters:

*SADI O17A C15A O17B C15B*
Figure S3. Numbering of the disordered parts A (orange) and B (green)

**Compound 4O**

**Table S2.** Crystal data and structure refinement for compound 4O.

| Property                        | Value                  |
|---------------------------------|------------------------|
| CCDC number                     | 1832809                |
| Empirical formula               | C45 H38 N6 O8 S2       |
| Formula weight                  | 854.93                 |
| Temperature                     | 180.1(6) K             |
| Wavelength                      | 1.54184 Å              |
| Crystal system                  | Triclinic              |
| Space group                     | P-1                    |
| Unit cell dimensions            | a = 10.3882(9) Å       |
|                                | α= 83.792(7)°          |
|                                | b = 11.7539(10) Å      |
|                                | β= 85.494(7)°          |
|                                | c = 16.4258(13) Å      |
|                                | γ = 78.477(7)°         |
| Volume                          | 1950.3(3) Å³           |
| Z                               | 2                      |
| Density (calculated)            | 1.456 Mg/m³            |
| Absorption coefficient          | 1.793 mm⁻¹             |
F(000) 892
Crystal size 0.542 x 0.093 x 0.012 mm³
Theta range for data collection 3.855 to 73.759°
Index ranges -12<=h<=10, -14<=k<=12, -20<=l<=20
Reflections collected 12601
Independent reflections 7618 [R(int) = 0.0505]
Completeness to theta = 67.684° 99.6 %
Absorption correction Semi-empirical from equivalents
Max. and min. transmission 1.00000 and 0.68168
Refinement method Full-matrix least-squares on F²
Data / restraints / parameters 7618 / 0 / 552
Goodness-of-fit on F² 1.047
Final R indices [I>2sigma(I)] R1 = 0.0663, wR2 = 0.1646
R indices (all data) R1 = 0.1028, wR2 = 0.1880
Extinction coefficient n/a
Largest diff. peak and hole 1.152 and -0.459 e.Å⁻³

Figure S4. View of the asymmetric unit (displacement ellipsoids are depicted at 50 percent probability level)
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