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$(\mu_3\text{-Hydrido})[\mu_3\text{-2-(trimethylsilyl)ethylidyne-}\kappa^3\text{C}^1:\text{C}^1:\text{C}^1]\text{tetrakis}[(\eta^5\text{-cyclopentadienyl)cobalt(II)]$

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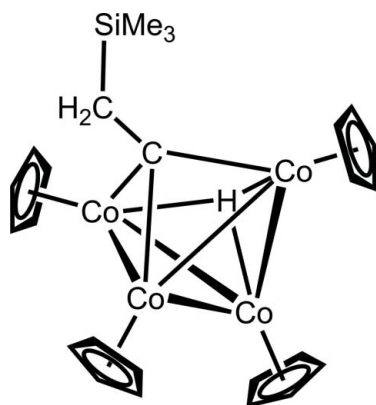
Received 28 October 2013; accepted 6 November 2013

 Key indicators: single-crystal X-ray study; $T = 150\text{ K}$; mean $\sigma(\text{C}-\text{C}) = 0.004\text{ \AA}$; R factor = 0.028; wR factor = 0.058; data-to-parameter ratio = 21.7.

In the title compound, $[\text{Co}_4(\text{C}_5\text{H}_5)_4(\mu_3\text{-CCH}_2\text{SiMe}_3)(\mu_3\text{-H})]$, the Co atoms form a distorted tetrahedron with the ethylidyne moiety bridging three of the Co atoms as well as the hydrido ligand also bridging three of the Co atoms. The Co—Co bond lengths in the Co_4 tetrahedron vary from 2.3844 (4) to 2.4608 (4) Å. Each Co atom is additionally η^5 -bonded to a cyclopentadienyl (Cp) anion.

Related literature

For other tetranuclear Co clusters with a tetrahedral Co_4 core featuring μ_3 -bridging hydrido ligands, see: Huttner & Lorenz (1975); Stella *et al.* (1988); Wadepohl & Pritzkow (1993); Schneider *et al.* (1997); Bau *et al.* (2004). $[\text{CpCo}]_4$ clusters with μ_3 -bridging carbonyl groups are described by Gambarotta *et al.* (1985) and Stella *et al.* (1988). For $[\text{CpCo}]_4$ clusters with μ_3 -bridging hydrido and μ_3 -bridging C—CH₃ ligands, see: Stella *et al.* (1988) and Wadepohl & Pritzkow (1993). The starting alkyne complex $\text{Cp}^*_2\text{Ti}(\eta^2\text{-Ph}_2\text{PC}_2\text{PPh}_2)$ is described by Haehnel *et al.* (2013). For the starting Co complex $\text{CpCo}(\text{H}_2\text{C}=\text{CHSiMe}_3)_2$, see: Hapke *et al.* (2010).



Experimental

Crystal data

 $[\text{Co}_4(\text{C}_5\text{H}_5)_4(\text{C}_5\text{H}_{11}\text{Si})\text{H}]$
 $M_r = 596.32$

 Monoclinic, $P2_1/n$
 $a = 9.3691(4)\text{ \AA}$
 $b = 17.7016(8)\text{ \AA}$
 $c = 14.2208(7)\text{ \AA}$
 $\beta = 92.779(3)^\circ$
 $V = 2355.72(19)\text{ \AA}^3$
 $Z = 4$

 Mo $K\alpha$ radiation

 $\mu = 2.83\text{ mm}^{-1}$
 $T = 150\text{ K}$
 $0.27 \times 0.14 \times 0.04\text{ mm}$

Data collection

Bruker Kappa APEXII DUO

diffractometer

Absorption correction: multi-scan

(SADABS; Bruker, 2008)

 $T_{\text{min}} = 0.891$, $T_{\text{max}} = 1.000$

62865 measured reflections

5682 independent reflections

 4481 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.066$

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.028$
 $wR(F^2) = 0.058$
 $S = 1.03$

5682 reflections

262 parameters

H atoms treated by a mixture of independent and constrained refinement

 $\Delta\rho_{\text{max}} = 0.52\text{ e \AA}^{-3}$
 $\Delta\rho_{\text{min}} = -0.32\text{ e \AA}^{-3}$

Data collection: APEX2 (Bruker, 2011); cell refinement: SAINT (Bruker, 2009); data reduction: SAINT; program(s) used to solve structure: SHELXS97 (Sheldrick, 2008); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: XP in SHELXTL (Sheldrick, 2008); software used to prepare material for publication: SHELXL97.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: PK2502).

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supporting information

Acta Cryst. (2013). E69, m651 [doi:10.1107/S1600536813030432]

(μ_3 -Hydrido)[μ_3 -2-(trimethylsilyl)ethylidyne- κ^3 C¹:C¹:C¹]tetrakis[(η^5 -cyclopentadienyl)cobalt(II)]****

Martin Haehnel, Anke Spannenberg and Uwe Rosenthal

S1. Comment

The reaction of the [CpCo] precursor CpCo(hexadiene) with the titanocene alkyne complex Cp*₂Ti(η^2 -Ph₂PC₂PPh₂) was investigated to synthesize a new heterobimetallic complex. However, only the degradation of the [CpCo] precursor complex was observed. The title compound consists of a tetrahedral Co₄ core. Two Co atoms (Co1 and Co2) feature a hexa-coordination by one Cp ligand, three Co atoms and the bridging hydrido- and ethylidyne unit. The other two Co atoms (Co3 and Co4) feature a penta-coordination mode. While the Co3 atom is surrounded by the Cp unit, three Co atoms and the hydrido ligand, the Co4 atom is coordinated by its Cp ligand, also three Co atoms and the ethylidyne unit. The Co—Co distances vary from 2.3844 (4) Å (Co3—Co4) to 2.4608 (4) Å (Co1—Co2). The vector C1-C2 is almost perpendicular to the Co1, Co2, Co4 plane and the Co—C distances are similar to those obtained for a Co₄ cluster described by Wadepohl *et al.* (1993). The μ_3 -bridging hydride was found in a difference Fourier map and Co—H distances of about 1.65 Å were found (Co1—H1 1.67 (3), Co2—H1 1.64 (3), Co3—H1 1.65 (3) Å).

S2. Experimental

To a stirred solution of Cp*₂Ti(η^2 -Ph₂PC₂PPh₂) (180 mg, 0.253 mmol) in 10 ml of THF was added a solution of crude CpCo(hexadiene) (0.81 M, 3.12 ml) (contaminated with a small amount of CpCo(H₂C=CHSiMe₃)₂) in THF. The reaction mixture was stirred for 16 h at 45 °C and then cooled to room temperature. After removing all the volatiles in vacuum, the dark brown residue was dissolved in 6 ml of a mixture of THF/*n*-hexane (1:2). Dark brown crystals of the title compound, suitable for X-ray analysis were grown after 14 days at -78 °C, being a degradation product of the small impurities mentioned above. Noteworthy, the μ_3 -(trimethylsilyl)ethylidyne unit results from this starting material CpCo(H₂C=CHSiMe₃)₂.

S3. Refinement

The hydride was found in a difference Fourier map and was refined freely. All other H atoms were placed at idealized positions with d(C—H) = 0.95 Å (CH), 0.99 Å (CH₂) and 0.98 Å (CH₃) and refined using a riding model with $U_{\text{iso}}(\text{H})$ fixed at 1.2 $U_{\text{eq}}(\text{C})$ for CH, CH₂ and 1.5 $U_{\text{eq}}(\text{C})$ for CH₃.

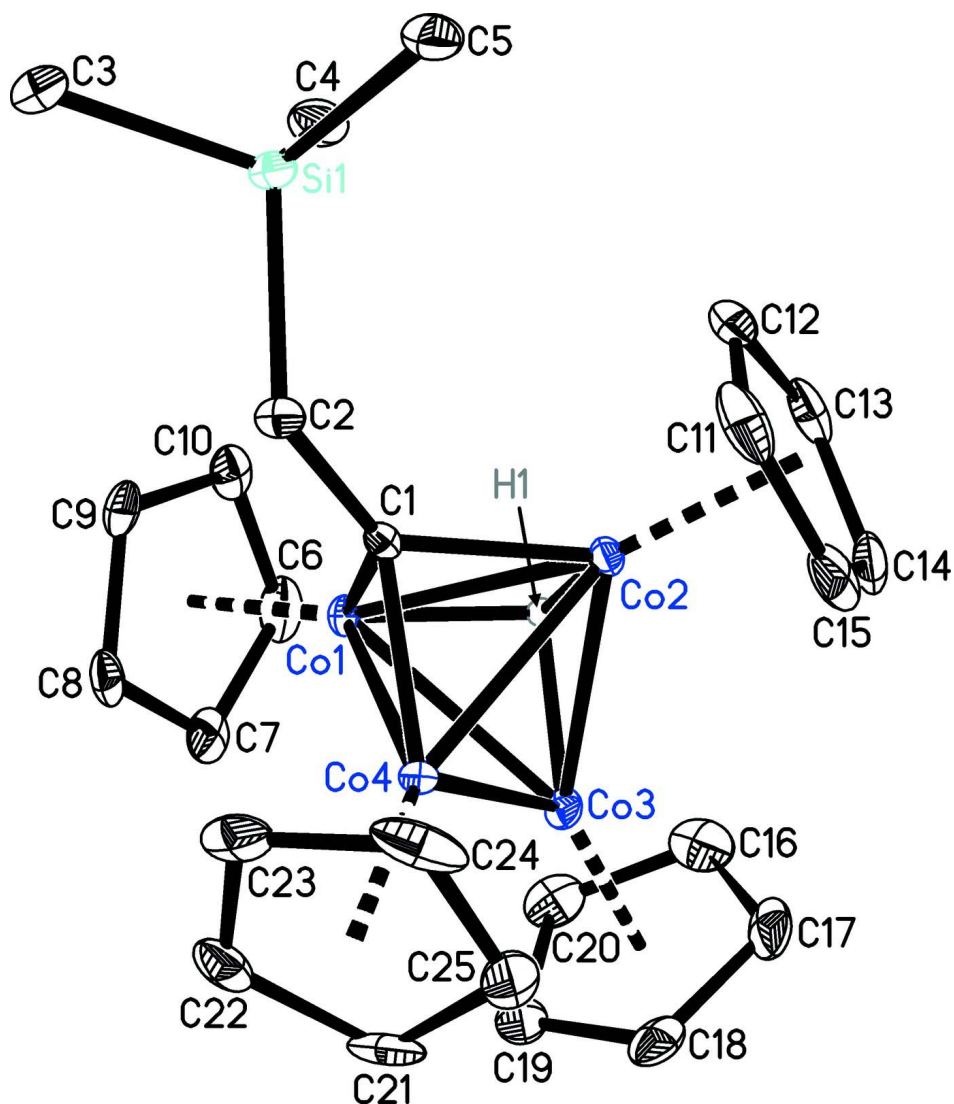


Figure 1

Molecular structure of the title compound in the crystal. Hydrogen atoms except H1 are omitted for clarity. Displacement ellipsoids are drawn at the 30% probability level.

(μ_3 -Hyrido)[μ_3 -2-(trimethylsilyl)ethylidyne- κ^3 C¹:C¹:C¹]tetrakis[(η^5 -cyclopentadienyl)cobalt(II)]

Crystal data

[Co₄(C₅H₅)₄(C₅H₁₁Si)H]

$M_r = 596.32$

Monoclinic, $P2_1/n$

$a = 9.3691$ (4) Å

$b = 17.7016$ (8) Å

$c = 14.2208$ (7) Å

$\beta = 92.779$ (3)°

$V = 2355.72$ (19) Å³

$Z = 4$

$F(000) = 1216$

$D_x = 1.681$ Mg m⁻³

Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å

Cell parameters from 9904 reflections

$\theta = 2.3$ – 27.2 °

$\mu = 2.83$ mm⁻¹

$T = 150$ K

Plate, brown

$0.27 \times 0.14 \times 0.04$ mm

Data collection

| | |
|----------------------------------------------------------------------|------------------------------------------------------------------------|
| Bruker Kappa APEXII DUO diffractometer | 62865 measured reflections 5682 independent reflections |
| Radiation source: fine-focus sealed tube | 4481 reflections with $I > 2\sigma(I)$ |
| Curved graphite monochromator | $R_{\text{int}} = 0.066$ |
| Detector resolution: 8.3333 pixels mm^{-1} | $\theta_{\text{max}} = 28.0^\circ$, $\theta_{\text{min}} = 1.8^\circ$ |
| φ and ω scans | $h = -12 \rightarrow 12$ |
| Absorption correction: multi-scan (<i>SADABS</i> ; Bruker, 2008) | $k = -23 \rightarrow 23$ |
| $T_{\text{min}} = 0.891$, $T_{\text{max}} = 1.000$ | $l = -18 \rightarrow 18$ |

Refinement

| | |
|-------------------------------------------------------------------|---------------------------------------------------------------------------|
| Refinement on F^2 | Secondary atom site location: difference Fourier map |
| Least-squares matrix: full | Hydrogen site location: inferred from neighbouring sites |
| $R[F^2 > 2\sigma(F^2)] = 0.028$ | H atoms treated by a mixture of independent and constrained refinement |
| $wR(F^2) = 0.058$ | $w = 1/[\sigma^2(F_o^2) + (0.0181P)^2 + 2.1633P]$ |
| $S = 1.03$ | where $P = (F_o^2 + 2F_c^2)/3$ |
| 5682 reflections | $(\Delta/\sigma)_{\text{max}} < 0.001$ |
| 262 parameters | $\Delta\rho_{\text{max}} = 0.52 \text{ e } \text{\AA}^{-3}$ |
| 0 restraints | $\Delta\rho_{\text{min}} = -0.32 \text{ e } \text{\AA}^{-3}$ |
| Primary atom site location: structure-invariant direct methods | |

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) *etc.* and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

| | <i>x</i> | <i>y</i> | <i>z</i> | $U_{\text{iso}}^*/U_{\text{eq}}$ |
|-----|------------|---------------|--------------|----------------------------------|
| C1 | 0.4449 (2) | 0.10065 (12) | 0.25656 (15) | 0.0144 (4) |
| C2 | 0.5227 (2) | 0.07279 (14) | 0.34492 (16) | 0.0200 (5) |
| H2A | 0.4492 | 0.0514 | 0.3850 | 0.024* |
| H2B | 0.5614 | 0.1181 | 0.3781 | 0.024* |
| C3 | 0.8023 (3) | 0.02862 (17) | 0.4434 (2) | 0.0358 (7) |
| H3A | 0.7523 | 0.0312 | 0.5022 | 0.054* |
| H3B | 0.8436 | 0.0781 | 0.4301 | 0.054* |
| H3C | 0.8788 | -0.0091 | 0.4495 | 0.054* |
| C4 | 0.7712 (3) | -0.00180 (16) | 0.2340 (2) | 0.0329 (6) |
| H4A | 0.8323 | -0.0467 | 0.2342 | 0.049* |
| H4B | 0.8303 | 0.0436 | 0.2295 | 0.049* |
| H4C | 0.7023 | -0.0040 | 0.1800 | 0.049* |
| C5 | 0.6069 (3) | -0.09495 (15) | 0.3726 (2) | 0.0328 (6) |
| H5A | 0.6882 | -0.1291 | 0.3843 | 0.049* |
| H5B | 0.5469 | -0.1138 | 0.3193 | 0.049* |

| | | | | |
|-----|--------------|---------------|---------------|--------------|
| H5C | 0.5504 | -0.0927 | 0.4288 | 0.049* |
| C6 | 0.6245 (3) | 0.22244 (16) | 0.06694 (18) | 0.0319 (6) |
| H6 | 0.6135 | 0.2184 | 0.0004 | 0.038* |
| C7 | 0.5565 (3) | 0.27580 (15) | 0.12302 (19) | 0.0303 (6) |
| H7 | 0.4925 | 0.3142 | 0.1010 | 0.036* |
| C8 | 0.6004 (3) | 0.26194 (15) | 0.21753 (19) | 0.0275 (6) |
| H8 | 0.5706 | 0.2892 | 0.2707 | 0.033* |
| C9 | 0.6966 (3) | 0.20041 (16) | 0.21950 (18) | 0.0265 (6) |
| H9 | 0.7431 | 0.1791 | 0.2741 | 0.032* |
| C10 | 0.7113 (3) | 0.17631 (16) | 0.12609 (18) | 0.0278 (6) |
| H10 | 0.7697 | 0.1359 | 0.1065 | 0.033* |
| C11 | 0.2899 (3) | -0.04602 (12) | 0.21512 (14) | 0.0433 (8) |
| H11 | 0.2953 | -0.0545 | 0.2812 | 0.052* |
| C12 | 0.3974 (2) | -0.06058 (11) | 0.15344 (15) | 0.0359 (7) |
| H12 | 0.4891 | -0.0808 | 0.1700 | 0.043* |
| C13 | 0.3469 (2) | -0.04038 (11) | 0.06330 (14) | 0.0374 (7) |
| H13 | 0.3981 | -0.0444 | 0.0075 | 0.045* |
| C14 | 0.2081 (2) | -0.01335 (12) | 0.06928 (17) | 0.0457 (8) |
| H14 | 0.1480 | 0.0044 | 0.0182 | 0.055* |
| C15 | 0.1729 (2) | -0.01683 (12) | 0.16311 (19) | 0.0533 (11) |
| H15 | 0.0845 | -0.0019 | 0.1874 | 0.064* |
| C16 | 0.2190 (4) | 0.17467 (19) | -0.0635 (2) | 0.0463 (8) |
| H16 | 0.2581 | 0.1415 | -0.1080 | 0.056* |
| C17 | 0.0924 (3) | 0.16256 (18) | -0.0154 (2) | 0.0438 (8) |
| H17 | 0.0313 | 0.1199 | -0.0221 | 0.053* |
| C18 | 0.0727 (3) | 0.22448 (17) | 0.0441 (2) | 0.0341 (6) |
| H18 | -0.0040 | 0.2311 | 0.0846 | 0.041* |
| C19 | 0.1864 (3) | 0.27501 (16) | 0.03311 (19) | 0.0321 (6) |
| H19 | 0.2004 | 0.3217 | 0.0652 | 0.038* |
| C20 | 0.2762 (3) | 0.24413 (18) | -0.03388 (19) | 0.0368 (7) |
| H20 | 0.3609 | 0.2666 | -0.0552 | 0.044* |
| C21 | 0.1300 (2) | 0.24468 (11) | 0.27716 (14) | 0.0361 (7) |
| H21 | 0.0887 | 0.2789 | 0.2321 | 0.043* |
| C22 | 0.2522 (2) | 0.25765 (11) | 0.33478 (14) | 0.0330 (6) |
| H22 | 0.3087 | 0.3022 | 0.3359 | 0.040* |
| C23 | 0.2769 (2) | 0.19371 (12) | 0.39046 (13) | 0.0368 (7) |
| H23 | 0.3532 | 0.1871 | 0.4362 | 0.044* |
| C24 | 0.1700 (2) | 0.14122 (11) | 0.36725 (14) | 0.0426 (8) |
| H24 | 0.1606 | 0.0925 | 0.3944 | 0.051* |
| C25 | 0.07921 (19) | 0.17272 (12) | 0.29723 (15) | 0.0404 (8) |
| H25 | -0.0029 | 0.1493 | 0.2683 | 0.049* |
| Co1 | 0.49716 (3) | 0.167531 (17) | 0.16344 (2) | 0.01454 (7) |
| Co2 | 0.34418 (3) | 0.054480 (17) | 0.15636 (2) | 0.01542 (7) |
| Co3 | 0.26521 (3) | 0.172517 (18) | 0.08131 (2) | 0.01868 (8) |
| Co4 | 0.28421 (3) | 0.162137 (17) | 0.24862 (2) | 0.01396 (7) |
| Si1 | 0.67352 (7) | 0.00134 (4) | 0.34501 (5) | 0.02116 (14) |
| H1 | 0.406 (3) | 0.1162 (16) | 0.0821 (19) | 0.034 (8)* |

Atomic displacement parameters (\AA^2)

| | U^{11} | U^{22} | U^{33} | U^{12} | U^{13} | U^{23} |
|-----|--------------|--------------|--------------|---------------|---------------|---------------|
| C1 | 0.0154 (11) | 0.0123 (11) | 0.0158 (10) | -0.0006 (9) | 0.0036 (9) | -0.0012 (8) |
| C2 | 0.0209 (12) | 0.0210 (12) | 0.0181 (11) | 0.0046 (10) | 0.0022 (9) | 0.0015 (9) |
| C3 | 0.0307 (15) | 0.0318 (15) | 0.0434 (17) | 0.0071 (13) | -0.0144 (13) | 0.0018 (13) |
| C4 | 0.0268 (14) | 0.0311 (15) | 0.0414 (16) | 0.0075 (12) | 0.0097 (12) | -0.0025 (13) |
| C5 | 0.0322 (15) | 0.0219 (13) | 0.0438 (16) | 0.0047 (12) | -0.0036 (13) | 0.0063 (12) |
| C6 | 0.0329 (15) | 0.0415 (17) | 0.0220 (13) | -0.0215 (13) | 0.0078 (11) | 0.0032 (12) |
| C7 | 0.0296 (14) | 0.0212 (13) | 0.0394 (15) | -0.0146 (11) | -0.0034 (12) | 0.0078 (12) |
| C8 | 0.0259 (13) | 0.0255 (14) | 0.0312 (14) | -0.0133 (11) | 0.0025 (11) | -0.0092 (11) |
| C9 | 0.0168 (12) | 0.0350 (15) | 0.0275 (13) | -0.0114 (11) | -0.0010 (10) | -0.0026 (11) |
| C10 | 0.0188 (12) | 0.0326 (15) | 0.0328 (14) | -0.0112 (11) | 0.0093 (11) | -0.0054 (12) |
| C11 | 0.071 (2) | 0.0227 (15) | 0.0366 (16) | -0.0214 (15) | 0.0100 (16) | 0.0003 (13) |
| C12 | 0.0317 (15) | 0.0153 (13) | 0.060 (2) | -0.0001 (11) | -0.0059 (14) | -0.0029 (13) |
| C13 | 0.0504 (18) | 0.0235 (15) | 0.0390 (16) | -0.0131 (13) | 0.0091 (14) | -0.0161 (12) |
| C14 | 0.0482 (19) | 0.0232 (15) | 0.063 (2) | -0.0102 (14) | -0.0300 (17) | -0.0059 (14) |
| C15 | 0.0242 (15) | 0.0275 (16) | 0.111 (3) | -0.0152 (13) | 0.0277 (18) | -0.0272 (19) |
| C16 | 0.069 (2) | 0.049 (2) | 0.0193 (13) | 0.0227 (18) | -0.0176 (14) | -0.0030 (13) |
| C17 | 0.0483 (19) | 0.0318 (16) | 0.0479 (18) | -0.0049 (14) | -0.0329 (15) | 0.0054 (14) |
| C18 | 0.0261 (14) | 0.0368 (16) | 0.0383 (16) | 0.0044 (12) | -0.0096 (12) | 0.0136 (13) |
| C19 | 0.0368 (15) | 0.0255 (14) | 0.0329 (14) | 0.0052 (12) | -0.0089 (12) | 0.0071 (12) |
| C20 | 0.0414 (16) | 0.0437 (18) | 0.0248 (14) | 0.0050 (14) | -0.0034 (12) | 0.0179 (13) |
| C21 | 0.0432 (17) | 0.0350 (16) | 0.0306 (15) | 0.0294 (14) | 0.0071 (13) | 0.0022 (12) |
| C22 | 0.0358 (15) | 0.0259 (14) | 0.0389 (16) | 0.0019 (12) | 0.0161 (13) | -0.0128 (12) |
| C23 | 0.0399 (16) | 0.0522 (19) | 0.0182 (13) | 0.0254 (15) | 0.0024 (12) | -0.0103 (12) |
| C24 | 0.061 (2) | 0.0259 (15) | 0.0446 (18) | 0.0168 (15) | 0.0406 (16) | 0.0113 (13) |
| C25 | 0.0162 (13) | 0.0483 (19) | 0.058 (2) | -0.0015 (13) | 0.0131 (13) | -0.0214 (16) |
| Co1 | 0.01496 (15) | 0.01619 (15) | 0.01250 (14) | -0.00413 (13) | 0.00114 (11) | -0.00058 (12) |
| Co2 | 0.01599 (15) | 0.01296 (15) | 0.01731 (15) | -0.00182 (12) | 0.00085 (11) | -0.00215 (12) |
| Co3 | 0.02114 (16) | 0.01829 (16) | 0.01602 (15) | -0.00056 (13) | -0.00513 (12) | 0.00215 (13) |
| Co4 | 0.01403 (15) | 0.01336 (15) | 0.01463 (14) | 0.00218 (12) | 0.00197 (11) | 0.00088 (12) |
| Si1 | 0.0183 (3) | 0.0192 (3) | 0.0257 (3) | 0.0042 (3) | -0.0019 (3) | 0.0018 (3) |

Geometric parameters (\AA , $^\circ$)

| | | | |
|--------|-----------|---------|-------------|
| C1—C2 | 1.505 (3) | C14—C15 | 1.3914 (15) |
| C1—Co4 | 1.857 (2) | C14—Co2 | 2.109 (2) |
| C1—Co1 | 1.860 (2) | C14—H14 | 0.9500 |
| C1—Co2 | 1.860 (2) | C15—Co2 | 2.047 (2) |
| C2—Si1 | 1.896 (2) | C15—H15 | 0.9500 |
| C2—H2A | 0.9900 | C16—C20 | 1.398 (4) |
| C2—H2B | 0.9900 | C16—C17 | 1.415 (5) |
| C3—Si1 | 1.866 (3) | C16—Co3 | 2.084 (3) |
| C3—H3A | 0.9800 | C16—H16 | 0.9500 |
| C3—H3B | 0.9800 | C17—C18 | 1.402 (4) |
| C3—H3C | 0.9800 | C17—Co3 | 2.080 (3) |
| C4—Si1 | 1.863 (3) | C17—H17 | 0.9500 |

| | | | |
|------------|-------------|-------------|-------------|
| C4—H4A | 0.9800 | C18—C19 | 1.406 (4) |
| C4—H4B | 0.9800 | C18—Co3 | 2.071 (3) |
| C4—H4C | 0.9800 | C18—H18 | 0.9500 |
| C5—Si1 | 1.864 (3) | C19—C20 | 1.411 (4) |
| C5—H5A | 0.9800 | C19—Co3 | 2.063 (3) |
| C5—H5B | 0.9800 | C19—H19 | 0.9500 |
| C5—H5C | 0.9800 | C20—Co3 | 2.078 (3) |
| C6—C10 | 1.403 (4) | C20—H20 | 0.9500 |
| C6—C7 | 1.408 (4) | C21—C22 | 1.3942 (14) |
| C6—Co1 | 2.100 (2) | C21—C25 | 1.3942 (14) |
| C6—H6 | 0.9500 | C21—Co4 | 2.1078 (18) |
| C7—C8 | 1.408 (4) | C21—H21 | 0.9500 |
| C7—Co1 | 2.084 (2) | C22—C23 | 1.3942 (14) |
| C7—H7 | 0.9500 | C22—Co4 | 2.1178 (19) |
| C8—C9 | 1.413 (4) | C22—H22 | 0.9500 |
| C8—Co1 | 2.061 (2) | C23—C24 | 1.3942 (14) |
| C8—H8 | 0.9500 | C23—Co4 | 2.0973 (19) |
| C9—C10 | 1.408 (4) | C23—H23 | 0.9500 |
| C9—Co1 | 2.079 (2) | C24—C25 | 1.3942 (14) |
| C9—H9 | 0.9500 | C24—Co4 | 2.0745 (18) |
| C10—Co1 | 2.106 (2) | C24—H24 | 0.9500 |
| C10—H10 | 0.9500 | C25—Co4 | 2.0810 (18) |
| C11—C12 | 1.3914 (15) | C25—H25 | 0.9500 |
| C11—C15 | 1.3914 (15) | Co1—Co4 | 2.3857 (4) |
| C11—Co2 | 2.040 (2) | Co1—Co3 | 2.4183 (4) |
| C11—H11 | 0.9500 | Co1—Co2 | 2.4608 (4) |
| C12—C13 | 1.3914 (15) | Co1—H1 | 1.67 (3) |
| C12—Co2 | 2.098 (2) | Co2—Co4 | 2.3959 (4) |
| C12—H12 | 0.9500 | Co2—Co3 | 2.4445 (4) |
| C13—C14 | 1.3914 (15) | Co2—H1 | 1.64 (3) |
| C13—Co2 | 2.139 (2) | Co3—Co4 | 2.3844 (4) |
| C13—H13 | 0.9500 | Co3—H1 | 1.65 (3) |
| | | | |
| C2—C1—Co4 | 126.97 (15) | C7—Co1—C6 | 39.33 (11) |
| C2—C1—Co1 | 132.04 (16) | C1—Co1—C10 | 120.90 (10) |
| Co4—C1—Co1 | 79.87 (9) | C8—Co1—C10 | 66.33 (10) |
| C2—C1—Co2 | 134.67 (17) | C9—Co1—C10 | 39.32 (10) |
| Co4—C1—Co2 | 80.28 (9) | C7—Co1—C10 | 65.94 (11) |
| Co1—C1—Co2 | 82.85 (9) | C6—Co1—C10 | 38.98 (11) |
| C1—C2—Si1 | 123.36 (16) | C1—Co1—Co4 | 50.01 (7) |
| C1—C2—H2A | 106.5 | C8—Co1—Co4 | 103.41 (7) |
| Si1—C2—H2A | 106.5 | C9—Co1—Co4 | 125.09 (7) |
| C1—C2—H2B | 106.5 | C7—Co1—Co4 | 114.70 (8) |
| Si1—C2—H2B | 106.5 | C6—Co1—Co4 | 149.99 (9) |
| H2A—C2—H2B | 106.5 | C10—Co1—Co4 | 164.04 (7) |
| Si1—C3—H3A | 109.5 | C1—Co1—Co3 | 96.07 (7) |
| Si1—C3—H3B | 109.5 | C8—Co1—Co3 | 123.04 (8) |
| H3A—C3—H3B | 109.5 | C9—Co1—Co3 | 160.91 (8) |

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| Si1—C3—H3C | 109.5 | C7—Co1—Co3 | 94.52 (8) |
| H3A—C3—H3C | 109.5 | C6—Co1—Co3 | 101.14 (8) |
| H3B—C3—H3C | 109.5 | C10—Co1—Co3 | 136.08 (8) |
| Si1—C4—H4A | 109.5 | Co4—Co1—Co3 | 59.510 (13) |
| Si1—C4—H4B | 109.5 | C1—Co1—Co2 | 48.58 (7) |
| H4A—C4—H4B | 109.5 | C8—Co1—Co2 | 159.48 (7) |
| Si1—C4—H4C | 109.5 | C9—Co1—Co2 | 138.96 (8) |
| H4A—C4—H4C | 109.5 | C7—Co1—Co2 | 154.06 (8) |
| H4B—C4—H4C | 109.5 | C6—Co1—Co2 | 134.26 (8) |
| Si1—C5—H5A | 109.5 | C10—Co1—Co2 | 127.58 (8) |
| Si1—C5—H5B | 109.5 | Co4—Co1—Co2 | 59.231 (12) |
| H5A—C5—H5B | 109.5 | Co3—Co1—Co2 | 60.127 (13) |
| Si1—C5—H5C | 109.5 | C1—Co1—H1 | 90.2 (9) |
| H5A—C5—H5C | 109.5 | C8—Co1—H1 | 156.0 (9) |
| H5B—C5—H5C | 109.5 | C9—Co1—H1 | 146.9 (9) |
| C10—C6—C7 | 108.4 (2) | C7—Co1—H1 | 116.3 (9) |
| C10—C6—Co1 | 70.73 (14) | C6—Co1—H1 | 95.0 (9) |
| C7—C6—Co1 | 69.73 (14) | C10—Co1—H1 | 109.2 (9) |
| C10—C6—H6 | 125.8 | Co4—Co1—H1 | 85.2 (9) |
| C7—C6—H6 | 125.8 | Co3—Co1—H1 | 42.9 (9) |
| Co1—C6—H6 | 125.3 | Co2—Co1—H1 | 41.6 (9) |
| C8—C7—C6 | 107.7 (2) | C1—Co2—C11 | 101.35 (9) |
| C8—C7—Co1 | 69.27 (14) | C1—Co2—C15 | 127.21 (10) |
| C6—C7—Co1 | 70.94 (15) | C11—Co2—C15 | 39.8 |
| C8—C7—H7 | 126.1 | C1—Co2—C12 | 109.25 (9) |
| C6—C7—H7 | 126.1 | C11—Co2—C12 | 39.3 |
| Co1—C7—H7 | 125.2 | C15—Co2—C12 | 65.78 (7) |
| C7—C8—C9 | 108.0 (2) | C1—Co2—C14 | 165.93 (9) |
| C7—C8—Co1 | 71.02 (14) | C11—Co2—C14 | 65.70 (7) |
| C9—C8—Co1 | 70.72 (14) | C15—Co2—C14 | 39.1 |
| C7—C8—H8 | 126.0 | C12—Co2—C14 | 64.72 (7) |
| C9—C8—H8 | 126.0 | C1—Co2—C13 | 142.97 (9) |
| Co1—C8—H8 | 123.9 | C11—Co2—C13 | 65.14 (7) |
| C10—C9—C8 | 107.8 (2) | C15—Co2—C13 | 65.02 (7) |
| C10—C9—Co1 | 71.37 (14) | C12—Co2—C13 | 38.3 |
| C8—C9—Co1 | 69.37 (14) | C14—Co2—C13 | 38.2 |
| C10—C9—H9 | 126.1 | C1—Co2—Co4 | 49.81 (7) |
| C8—C9—H9 | 126.1 | C11—Co2—Co4 | 113.54 (6) |
| Co1—C9—H9 | 124.8 | C15—Co2—Co4 | 105.05 (6) |
| C6—C10—C9 | 108.0 (2) | C12—Co2—Co4 | 147.71 (6) |
| C6—C10—Co1 | 70.28 (14) | C14—Co2—Co4 | 128.56 (6) |
| C9—C10—Co1 | 69.31 (13) | C13—Co2—Co4 | 166.75 (6) |
| C6—C10—H10 | 126.0 | C1—Co2—Co3 | 95.19 (7) |
| C9—C10—H10 | 126.0 | C11—Co2—Co3 | 147.98 (7) |
| Co1—C10—H10 | 126.0 | C15—Co2—Co3 | 109.04 (7) |
| C12—C11—C15 | 108.0 | C12—Co2—Co3 | 152.68 (6) |
| C12—C11—Co2 | 72.59 (8) | C14—Co2—Co3 | 93.94 (6) |
| C15—C11—Co2 | 70.37 (8) | C13—Co2—Co3 | 114.41 (6) |

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| C12—C11—H11 | 126.0 | Co4—Co2—Co3 | 59.012 (13) |
| C15—C11—H11 | 126.0 | C1—Co2—Co1 | 48.57 (7) |
| Co2—C11—H11 | 122.7 | C11—Co2—Co1 | 148.06 (7) |
| C11—C12—C13 | 108.0 | C15—Co2—Co1 | 162.88 (6) |
| C11—C12—Co2 | 68.15 (8) | C12—Co2—Co1 | 130.69 (6) |
| C13—C12—Co2 | 72.44 (8) | C14—Co2—Co1 | 145.22 (7) |
| C11—C12—H12 | 126.0 | C13—Co2—Co1 | 129.75 (6) |
| C13—C12—H12 | 126.0 | Co4—Co2—Co1 | 58.824 (12) |
| Co2—C12—H12 | 125.0 | Co3—Co2—Co1 | 59.076 (13) |
| C12—C13—C14 | 108.0 | C1—Co2—H1 | 91.1 (9) |
| C12—C13—Co2 | 69.23 (8) | C11—Co2—H1 | 160.9 (10) |
| C14—C13—Co2 | 69.70 (7) | C15—Co2—H1 | 137.7 (9) |
| C12—C13—H13 | 126.0 | C12—Co2—H1 | 122.8 (9) |
| C14—C13—H13 | 126.0 | C14—Co2—H1 | 102.8 (9) |
| Co2—C13—H13 | 126.6 | C13—Co2—H1 | 96.3 (10) |
| C15—C14—C13 | 108.0 | Co4—Co2—H1 | 85.5 (10) |
| C15—C14—Co2 | 68.08 (8) | Co3—Co2—H1 | 42.2 (9) |
| C13—C14—Co2 | 72.06 (7) | Co1—Co2—H1 | 42.6 (9) |
| C15—C14—H14 | 126.0 | C19—Co3—C18 | 39.76 (11) |
| C13—C14—H14 | 126.0 | C19—Co3—C20 | 39.85 (11) |
| Co2—C14—H14 | 125.4 | C18—Co3—C20 | 66.64 (11) |
| C14—C15—C11 | 108.0 | C19—Co3—C17 | 66.45 (12) |
| C14—C15—Co2 | 72.83 (8) | C18—Co3—C17 | 39.48 (12) |
| C11—C15—Co2 | 69.83 (8) | C20—Co3—C17 | 66.27 (12) |
| C14—C15—H15 | 126.0 | C19—Co3—C16 | 66.54 (12) |
| C11—C15—H15 | 126.0 | C18—Co3—C16 | 66.58 (12) |
| Co2—C15—H15 | 123.0 | C20—Co3—C16 | 39.26 (12) |
| C20—C16—C17 | 107.8 (3) | C17—Co3—C16 | 39.71 (13) |
| C20—C16—Co3 | 70.12 (16) | C19—Co3—Co4 | 114.04 (8) |
| C17—C16—Co3 | 69.99 (16) | C18—Co3—Co4 | 108.14 (8) |
| C20—C16—H16 | 126.1 | C20—Co3—Co4 | 146.05 (9) |
| C17—C16—H16 | 126.1 | C17—Co3—Co4 | 132.14 (10) |
| Co3—C16—H16 | 125.4 | C16—Co3—Co4 | 171.61 (11) |
| C18—C17—C16 | 108.1 (3) | C19—Co3—Co1 | 119.41 (8) |
| C18—C17—Co3 | 69.90 (15) | C18—Co3—Co1 | 153.00 (9) |
| C16—C17—Co3 | 70.30 (16) | C20—Co3—Co1 | 108.97 (9) |
| C18—C17—H17 | 125.9 | C17—Co3—Co1 | 165.60 (10) |
| C16—C17—H17 | 125.9 | C16—Co3—Co1 | 128.08 (10) |
| Co3—C17—H17 | 125.5 | Co4—Co3—Co1 | 59.565 (12) |
| C17—C18—C19 | 107.9 (3) | C19—Co3—Co2 | 172.96 (8) |
| C17—C18—Co3 | 70.63 (16) | C18—Co3—Co2 | 137.12 (8) |
| C19—C18—Co3 | 69.83 (15) | C20—Co3—Co2 | 147.15 (9) |
| C17—C18—H18 | 126.0 | C17—Co3—Co2 | 115.18 (9) |
| C19—C18—H18 | 126.0 | C16—Co3—Co2 | 119.41 (9) |
| Co3—C18—H18 | 125.1 | Co4—Co3—Co2 | 59.478 (12) |
| C18—C19—C20 | 108.0 (3) | Co1—Co3—Co2 | 60.797 (13) |
| C18—C19—Co3 | 70.41 (15) | C19—Co3—H1 | 143.7 (9) |
| C20—C19—Co3 | 70.63 (16) | C18—Co3—H1 | 162.6 (9) |

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| C18—C19—H19 | 126.0 | C20—Co3—H1 | 107.7 (9) |
| C20—C19—H19 | 126.0 | C17—Co3—H1 | 123.2 (9) |
| Co3—C19—H19 | 124.6 | C16—Co3—H1 | 98.3 (9) |
| C16—C20—C19 | 108.1 (3) | Co4—Co3—H1 | 85.8 (9) |
| C16—C20—Co3 | 70.62 (16) | Co1—Co3—H1 | 43.7 (9) |
| C19—C20—Co3 | 69.52 (15) | Co2—Co3—H1 | 42.0 (9) |
| C16—C20—H20 | 125.9 | C1—Co4—C24 | 107.14 (9) |
| C19—C20—H20 | 125.9 | C1—Co4—C25 | 142.31 (9) |
| Co3—C20—H20 | 125.5 | C24—Co4—C25 | 39.2 |
| C22—C21—C25 | 108.0 | C1—Co4—C23 | 99.32 (8) |
| C22—C21—Co4 | 71.12 (7) | C24—Co4—C23 | 39.0 |
| C25—C21—Co4 | 69.52 (7) | C25—Co4—C23 | 65.35 (6) |
| C22—C21—H21 | 126.0 | C1—Co4—C21 | 162.91 (9) |
| C25—C21—H21 | 126.0 | C24—Co4—C21 | 65.28 (6) |
| Co4—C21—H21 | 124.9 | C25—Co4—C21 | 38.9 |
| C21—C22—C23 | 108.0 | C23—Co4—C21 | 64.88 (6) |
| C21—C22—Co4 | 70.35 (7) | C1—Co4—C22 | 124.74 (9) |
| C23—C22—Co4 | 69.89 (7) | C24—Co4—C22 | 65.10 (6) |
| C21—C22—H22 | 126.0 | C25—Co4—C22 | 64.99 (6) |
| C23—C22—H22 | 126.0 | C23—Co4—C22 | 38.6 |
| Co4—C22—H22 | 125.3 | C21—Co4—C22 | 38.5 |
| C24—C23—C22 | 108.0 | C1—Co4—Co3 | 97.29 (7) |
| C24—C23—Co4 | 69.59 (7) | C24—Co4—Co3 | 143.97 (7) |
| C22—C23—Co4 | 71.48 (7) | C25—Co4—Co3 | 107.40 (6) |
| C24—C23—H23 | 126.0 | C23—Co4—Co3 | 159.19 (6) |
| C22—C23—H23 | 126.0 | C21—Co4—Co3 | 96.89 (5) |
| Co4—C23—H23 | 124.5 | C22—Co4—Co3 | 120.66 (6) |
| C23—C24—C25 | 108.0 | C1—Co4—Co1 | 50.11 (7) |
| C23—C24—Co4 | 71.37 (7) | C24—Co4—Co1 | 153.79 (6) |
| C25—C24—Co4 | 70.65 (7) | C25—Co4—Co1 | 166.68 (6) |
| C23—C24—H24 | 126.0 | C23—Co4—Co1 | 123.01 (6) |
| C25—C24—H24 | 126.0 | C21—Co4—Co1 | 131.90 (6) |
| Co4—C24—H24 | 123.6 | C22—Co4—Co1 | 114.02 (5) |
| C24—C25—C21 | 108.0 | Co3—Co4—Co1 | 60.926 (13) |
| C24—C25—Co4 | 70.14 (7) | C1—Co4—Co2 | 49.91 (7) |
| C21—C25—Co4 | 71.60 (7) | C24—Co4—Co2 | 116.57 (6) |
| C24—C25—H25 | 126.0 | C25—Co4—Co2 | 119.88 (6) |
| C21—C25—H25 | 126.0 | C23—Co4—Co2 | 139.29 (6) |
| Co4—C25—H25 | 123.9 | C21—Co4—Co2 | 146.92 (6) |
| C1—Co1—C8 | 112.67 (10) | C22—Co4—Co2 | 174.46 (6) |
| C1—Co1—C9 | 99.67 (10) | Co3—Co4—Co2 | 61.510 (13) |
| C8—Co1—C9 | 39.91 (10) | Co1—Co4—Co2 | 61.945 (12) |
| C1—Co1—C7 | 149.87 (10) | C4—Si1—C5 | 109.54 (13) |
| C8—Co1—C7 | 39.70 (10) | C4—Si1—C3 | 108.44 (14) |
| C9—Co1—C7 | 66.51 (11) | C5—Si1—C3 | 106.86 (13) |
| C1—Co1—C6 | 159.65 (11) | C4—Si1—C2 | 114.57 (12) |
| C8—Co1—C6 | 66.26 (10) | C5—Si1—C2 | 110.66 (12) |
| C9—Co1—C6 | 65.95 (10) | C3—Si1—C2 | 106.43 (12) |

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| Co4—C1—C2—Si1 | 172.95 (12) | Co4—Co1—Co3—C19 | 102.20 (9) |
| Co1—C1—C2—Si1 | -74.6 (3) | Co2—Co1—Co3—C19 | 171.93 (9) |
| Co2—C1—C2—Si1 | 56.4 (3) | C1—Co1—Co3—C18 | 104.69 (19) |
| C10—C6—C7—C8 | -0.7 (3) | C8—Co1—Co3—C18 | -17.4 (2) |
| Co1—C6—C7—C8 | 59.76 (17) | C9—Co1—Co3—C18 | -40.7 (3) |
| C10—C6—C7—Co1 | -60.43 (17) | C7—Co1—Co3—C18 | -47.05 (19) |
| C6—C7—C8—C9 | 0.5 (3) | C6—Co1—Co3—C18 | -86.2 (2) |
| Co1—C7—C8—C9 | 61.36 (17) | C10—Co1—Co3—C18 | -106.6 (2) |
| C6—C7—C8—Co1 | -60.82 (17) | Co4—Co1—Co3—C18 | 69.04 (18) |
| C7—C8—C9—C10 | -0.2 (3) | Co2—Co1—Co3—C18 | 138.77 (18) |
| Co1—C8—C9—C10 | 61.34 (17) | C1—Co1—Co3—C20 | -179.72 (11) |
| C7—C8—C9—Co1 | -61.56 (17) | C8—Co1—Co3—C20 | 58.17 (13) |
| C7—C6—C10—C9 | 0.5 (3) | C9—Co1—Co3—C20 | 34.9 (2) |
| Co1—C6—C10—C9 | -59.27 (17) | C7—Co1—Co3—C20 | 28.53 (12) |
| C7—C6—C10—Co1 | 59.80 (17) | C6—Co1—Co3—C20 | -10.64 (13) |
| C8—C9—C10—C6 | -0.2 (3) | C10—Co1—Co3—C20 | -30.97 (15) |
| Co1—C9—C10—C6 | 59.87 (17) | Co4—Co1—Co3—C20 | 144.62 (9) |
| C8—C9—C10—Co1 | -60.07 (16) | Co2—Co1—Co3—C20 | -145.64 (9) |
| C15—C11—C12—C13 | 0.0 | C1—Co1—Co3—C17 | -111.6 (4) |
| Co2—C11—C12—C13 | -61.83 (8) | C8—Co1—Co3—C17 | 126.3 (4) |
| C15—C11—C12—Co2 | 61.83 (8) | C9—Co1—Co3—C17 | 103.0 (4) |
| C11—C12—C13—C14 | 0.0 | C7—Co1—Co3—C17 | 96.7 (4) |
| Co2—C12—C13—C14 | -59.12 (8) | C6—Co1—Co3—C17 | 57.5 (4) |
| C11—C12—C13—Co2 | 59.12 (8) | C10—Co1—Co3—C17 | 37.2 (4) |
| C12—C13—C14—C15 | 0.0 | Co4—Co1—Co3—C17 | -147.2 (4) |
| Co2—C13—C14—C15 | -58.82 (8) | Co2—Co1—Co3—C17 | -77.5 (4) |
| C12—C13—C14—Co2 | 58.82 (8) | C1—Co1—Co3—C16 | -140.14 (14) |
| C13—C14—C15—C11 | 0.0 | C8—Co1—Co3—C16 | 97.75 (15) |
| Co2—C14—C15—C11 | -61.33 (8) | C9—Co1—Co3—C16 | 74.4 (2) |
| C13—C14—C15—Co2 | 61.33 (8) | C7—Co1—Co3—C16 | 68.12 (14) |
| C12—C11—C15—C14 | 0.0 | C6—Co1—Co3—C16 | 28.95 (15) |
| Co2—C11—C15—C14 | 63.26 (8) | C10—Co1—Co3—C16 | 8.61 (16) |
| C12—C11—C15—Co2 | -63.26 (8) | Co4—Co1—Co3—C16 | -175.79 (12) |
| C20—C16—C17—C18 | -0.3 (3) | Co2—Co1—Co3—C16 | -106.06 (12) |
| Co3—C16—C17—C18 | 59.89 (19) | C1—Co1—Co3—Co4 | 35.66 (7) |
| C20—C16—C17—Co3 | -60.20 (19) | C8—Co1—Co3—Co4 | -86.45 (9) |
| C16—C17—C18—C19 | 0.0 (3) | C9—Co1—Co3—Co4 | -109.8 (2) |
| Co3—C17—C18—C19 | 60.14 (18) | C7—Co1—Co3—Co4 | -116.09 (8) |
| C16—C17—C18—Co3 | -60.14 (19) | C6—Co1—Co3—Co4 | -155.26 (8) |
| C17—C18—C19—C20 | 0.3 (3) | C10—Co1—Co3—Co4 | -175.60 (11) |
| Co3—C18—C19—C20 | 60.95 (18) | Co2—Co1—Co3—Co4 | 69.732 (13) |
| C17—C18—C19—Co3 | -60.64 (19) | C1—Co1—Co3—Co2 | -34.08 (7) |
| C17—C16—C20—C19 | 0.5 (3) | C8—Co1—Co3—Co2 | -156.18 (9) |
| Co3—C16—C20—C19 | -59.62 (18) | C9—Co1—Co3—Co2 | -179.5 (2) |
| C17—C16—C20—Co3 | 60.12 (19) | C7—Co1—Co3—Co2 | 174.18 (8) |
| C18—C19—C20—C16 | -0.5 (3) | C6—Co1—Co3—Co2 | 135.01 (8) |
| Co3—C19—C20—C16 | 60.31 (19) | C10—Co1—Co3—Co2 | 114.67 (11) |

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| C18—C19—C20—Co3 | -60.81 (18) | Co4—Co1—Co3—Co2 | -69.732 (13) |
| C25—C21—C22—C23 | 0.0 | C1—Co2—Co3—C19 | -59.7 (7) |
| Co4—C21—C22—C23 | -60.01 (7) | C11—Co2—Co3—C19 | 61.5 (7) |
| C25—C21—C22—Co4 | 60.01 (7) | C15—Co2—Co3—C19 | 72.7 (7) |
| C21—C22—C23—C24 | 0.0 | C12—Co2—Co3—C19 | 146.6 (7) |
| Co4—C22—C23—C24 | -60.30 (7) | C14—Co2—Co3—C19 | 109.6 (7) |
| C21—C22—C23—Co4 | 60.30 (7) | C13—Co2—Co3—C19 | 143.2 (7) |
| C22—C23—C24—C25 | 0.0 | Co4—Co2—Co3—C19 | -23.8 (7) |
| Co4—C23—C24—C25 | -61.50 (7) | Co1—Co2—Co3—C19 | -93.7 (7) |
| C22—C23—C24—Co4 | 61.50 (7) | C1—Co2—Co3—C18 | -119.89 (14) |
| C23—C24—C25—C21 | 0.0 | C11—Co2—Co3—C18 | 1.29 (17) |
| Co4—C24—C25—C21 | -61.95 (7) | C15—Co2—Co3—C18 | 12.46 (15) |
| C23—C24—C25—Co4 | 61.95 (7) | C12—Co2—Co3—C18 | 86.34 (18) |
| C22—C21—C25—C24 | 0.0 | C14—Co2—Co3—C18 | 49.40 (15) |
| Co4—C21—C25—C24 | 61.02 (7) | C13—Co2—Co3—C18 | 82.95 (14) |
| C22—C21—C25—Co4 | -61.02 (7) | Co4—Co2—Co3—C18 | -84.04 (13) |
| C2—C1—Co1—C8 | -42.7 (2) | Co1—Co2—Co3—C18 | -153.91 (13) |
| Co4—C1—Co1—C8 | 88.72 (10) | C1—Co2—Co3—C20 | 113.70 (17) |
| Co2—C1—Co1—C8 | 170.07 (9) | C11—Co2—Co3—C20 | -125.1 (2) |
| C2—C1—Co1—C9 | -3.2 (2) | C15—Co2—Co3—C20 | -113.94 (18) |
| Co4—C1—Co1—C9 | 128.18 (9) | C12—Co2—Co3—C20 | -40.1 (2) |
| Co2—C1—Co1—C9 | -150.47 (9) | C14—Co2—Co3—C20 | -77.00 (18) |
| C2—C1—Co1—C7 | -62.4 (3) | C13—Co2—Co3—C20 | -43.45 (17) |
| Co4—C1—Co1—C7 | 69.0 (2) | Co4—Co2—Co3—C20 | 149.56 (16) |
| Co2—C1—Co1—C7 | 150.33 (17) | Co1—Co2—Co3—C20 | 79.69 (16) |
| C2—C1—Co1—C6 | 39.9 (4) | C1—Co2—Co3—C17 | -161.55 (13) |
| Co4—C1—Co1—C6 | 171.3 (3) | C11—Co2—Co3—C17 | -40.37 (16) |
| Co2—C1—Co1—C6 | -107.3 (3) | C15—Co2—Co3—C17 | -29.20 (13) |
| C2—C1—Co1—C10 | 32.4 (3) | C12—Co2—Co3—C17 | 44.68 (17) |
| Co4—C1—Co1—C10 | 163.83 (9) | C14—Co2—Co3—C17 | 7.74 (13) |
| Co2—C1—Co1—C10 | -114.82 (10) | C13—Co2—Co3—C17 | 41.29 (13) |
| C2—C1—Co1—Co4 | -131.4 (2) | Co4—Co2—Co3—C17 | -125.69 (11) |
| Co2—C1—Co1—Co4 | 81.35 (8) | Co1—Co2—Co3—C17 | 164.43 (11) |
| C2—C1—Co1—Co3 | -172.4 (2) | C1—Co2—Co3—C16 | 153.75 (14) |
| Co4—C1—Co1—Co3 | -40.97 (6) | C11—Co2—Co3—C16 | -85.07 (16) |
| Co2—C1—Co1—Co3 | 40.38 (6) | C15—Co2—Co3—C16 | -73.90 (14) |
| C2—C1—Co1—Co2 | 147.2 (3) | C12—Co2—Co3—C16 | -0.02 (17) |
| Co4—C1—Co1—Co2 | -81.35 (8) | C14—Co2—Co3—C16 | -36.96 (14) |
| C7—C8—Co1—C1 | -164.60 (15) | C13—Co2—Co3—C16 | -3.41 (13) |
| C9—C8—Co1—C1 | 77.54 (16) | Co4—Co2—Co3—C16 | -170.40 (12) |
| C7—C8—Co1—C9 | 117.9 (2) | Co1—Co2—Co3—C16 | 119.73 (12) |
| C9—C8—Co1—C7 | -117.9 (2) | C1—Co2—Co3—Co4 | -35.86 (6) |
| C7—C8—Co1—C6 | 37.53 (16) | C11—Co2—Co3—Co4 | 85.33 (11) |
| C9—C8—Co1—C6 | -80.33 (17) | C15—Co2—Co3—Co4 | 96.50 (7) |
| C7—C8—Co1—C10 | 80.27 (17) | C12—Co2—Co3—Co4 | 170.38 (13) |
| C9—C8—Co1—C10 | -37.58 (15) | C14—Co2—Co3—Co4 | 133.43 (7) |
| C7—C8—Co1—Co4 | -112.65 (15) | C13—Co2—Co3—Co4 | 166.99 (6) |
| C9—C8—Co1—Co4 | 129.49 (14) | Co1—Co2—Co3—Co4 | -69.871 (13) |

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| C7—C8—Co1—Co3 | -50.50 (18) | C1—Co2—Co3—Co1 | 34.01 (6) |
| C9—C8—Co1—Co3 | -168.36 (12) | C11—Co2—Co3—Co1 | 155.20 (11) |
| C7—C8—Co1—Co2 | -142.96 (19) | C15—Co2—Co3—Co1 | 166.37 (7) |
| C9—C8—Co1—Co2 | 99.2 (2) | C12—Co2—Co3—Co1 | -119.75 (13) |
| C10—C9—Co1—C1 | 127.89 (17) | C14—Co2—Co3—Co1 | -156.70 (7) |
| C8—C9—Co1—C1 | -113.94 (16) | C13—Co2—Co3—Co1 | -123.14 (6) |
| C10—C9—Co1—C8 | -118.2 (2) | Co4—Co2—Co3—Co1 | 69.871 (13) |
| C10—C9—Co1—C7 | -80.16 (18) | C2—C1—Co4—C24 | -29.2 (2) |
| C8—C9—Co1—C7 | 38.01 (16) | Co1—C1—Co4—C24 | -164.98 (8) |
| C10—C9—Co1—C6 | -37.01 (17) | Co2—C1—Co4—C24 | 110.63 (8) |
| C8—C9—Co1—C6 | 81.16 (17) | C2—C1—Co4—C25 | -51.2 (3) |
| C8—C9—Co1—C10 | 118.2 (2) | Co1—C1—Co4—C25 | 173.00 (10) |
| C10—C9—Co1—Co4 | 175.28 (13) | Co2—C1—Co4—C25 | 88.61 (14) |
| C8—C9—Co1—Co4 | -66.55 (17) | C2—C1—Co4—C23 | 10.2 (2) |
| C10—C9—Co1—Co3 | -87.0 (3) | Co1—C1—Co4—C23 | -125.61 (8) |
| C8—C9—Co1—Co3 | 31.1 (3) | Co2—C1—Co4—C23 | 150.00 (8) |
| C10—C9—Co1—Co2 | 93.63 (17) | C2—C1—Co4—C21 | 31.7 (4) |
| C8—C9—Co1—Co2 | -148.20 (13) | Co1—C1—Co4—C21 | -104.1 (3) |
| C8—C7—Co1—C1 | 29.2 (3) | Co2—C1—Co4—C21 | 171.5 (3) |
| C6—C7—Co1—C1 | 147.59 (19) | C2—C1—Co4—C22 | 42.0 (2) |
| C6—C7—Co1—C8 | 118.4 (2) | Co1—C1—Co4—C22 | -93.79 (10) |
| C8—C7—Co1—C9 | -38.21 (15) | Co2—C1—Co4—C22 | -178.18 (7) |
| C6—C7—Co1—C9 | 80.17 (17) | C2—C1—Co4—Co3 | 177.62 (19) |
| C8—C7—Co1—C6 | -118.4 (2) | Co1—C1—Co4—Co3 | 41.81 (6) |
| C8—C7—Co1—C10 | -81.35 (17) | Co2—C1—Co4—Co3 | -42.59 (6) |
| C6—C7—Co1—C10 | 37.03 (16) | C2—C1—Co4—Co1 | 135.8 (2) |
| C8—C7—Co1—Co4 | 81.13 (16) | Co2—C1—Co4—Co1 | -84.39 (8) |
| C6—C7—Co1—Co4 | -160.49 (13) | C2—C1—Co4—Co2 | -139.8 (2) |
| C8—C7—Co1—Co3 | 139.54 (15) | Co1—C1—Co4—Co2 | 84.39 (8) |
| C6—C7—Co1—Co3 | -102.08 (15) | C23—C24—Co4—C1 | 83.61 (10) |
| C8—C7—Co1—Co2 | 151.14 (15) | C25—C24—Co4—C1 | -158.74 (10) |
| C6—C7—Co1—Co2 | -90.5 (2) | C23—C24—Co4—C25 | -117.6 |
| C10—C6—Co1—C1 | -10.3 (4) | C25—C24—Co4—C23 | 117.6 |
| C7—C6—Co1—C1 | -129.3 (3) | C23—C24—Co4—C21 | -80.0 |
| C10—C6—Co1—C8 | 81.17 (17) | C25—C24—Co4—C21 | 37.7 |
| C7—C6—Co1—C8 | -37.88 (16) | C23—C24—Co4—C22 | -37.3 |
| C10—C6—Co1—C9 | 37.33 (16) | C25—C24—Co4—C22 | 80.3 |
| C7—C6—Co1—C9 | -81.72 (17) | C23—C24—Co4—Co3 | -145.86 (11) |
| C10—C6—Co1—C7 | 119.0 (2) | C25—C24—Co4—Co3 | -28.21 (10) |
| C7—C6—Co1—C10 | -119.0 (2) | C23—C24—Co4—Co1 | 56.86 (12) |
| C10—C6—Co1—Co4 | 156.40 (13) | C25—C24—Co4—Co1 | 174.51 (13) |
| C7—C6—Co1—Co4 | 37.3 (2) | C23—C24—Co4—Co2 | 136.79 (6) |
| C10—C6—Co1—Co3 | -157.47 (14) | C25—C24—Co4—Co2 | -105.56 (6) |
| C7—C6—Co1—Co3 | 83.48 (15) | C24—C25—Co4—C1 | 34.52 (15) |
| C10—C6—Co1—Co2 | -98.60 (16) | C21—C25—Co4—C1 | 152.31 (15) |
| C7—C6—Co1—Co2 | 142.36 (13) | C21—C25—Co4—C24 | 117.8 |
| C6—C10—Co1—C1 | 175.86 (15) | C24—C25—Co4—C23 | -37.9 |
| C9—C10—Co1—C1 | -65.05 (19) | C21—C25—Co4—C23 | 79.9 |

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| C6—C10—Co1—C8 | -80.95 (17) | C24—C25—Co4—C21 | -117.8 |
| C9—C10—Co1—C8 | 38.14 (17) | C24—C25—Co4—C22 | -80.6 |
| C6—C10—Co1—C9 | -119.1 (2) | C21—C25—Co4—C22 | 37.2 |
| C6—C10—Co1—C7 | -37.36 (16) | C24—C25—Co4—Co3 | 163.06 (7) |
| C9—C10—Co1—C7 | 81.73 (18) | C21—C25—Co4—Co3 | -79.14 (7) |
| C9—C10—Co1—C6 | 119.1 (2) | C24—C25—Co4—Co1 | -169.4 (3) |
| C6—C10—Co1—Co4 | -133.3 (3) | C21—C25—Co4—Co1 | -51.6 (2) |
| C9—C10—Co1—Co4 | -14.2 (4) | C24—C25—Co4—Co2 | 96.41 (6) |
| C6—C10—Co1—Co3 | 32.8 (2) | C21—C25—Co4—Co2 | -145.79 (6) |
| C9—C10—Co1—Co3 | 151.91 (13) | C24—C23—Co4—C1 | -105.77 (10) |
| C6—C10—Co1—Co2 | 116.68 (15) | C22—C23—Co4—C1 | 136.04 (10) |
| C9—C10—Co1—Co2 | -124.23 (15) | C22—C23—Co4—C24 | -118.2 |
| C2—C1—Co2—C11 | 22.2 (2) | C24—C23—Co4—C25 | 38.0 |
| Co4—C1—Co2—C11 | -111.34 (9) | C22—C23—Co4—C25 | -80.2 |
| Co1—C1—Co2—C11 | 167.77 (8) | C24—C23—Co4—C21 | 81.1 |
| C2—C1—Co2—C15 | 55.9 (3) | C22—C23—Co4—C21 | -37.1 |
| Co4—C1—Co2—C15 | -77.60 (12) | C24—C23—Co4—C22 | 118.2 |
| Co1—C1—Co2—C15 | -158.49 (8) | C24—C23—Co4—Co3 | 111.7 (2) |
| C2—C1—Co2—C12 | -17.8 (2) | C22—C23—Co4—Co3 | -6.5 (2) |
| Co4—C1—Co2—C12 | -151.31 (7) | C24—C23—Co4—Co1 | -153.83 (7) |
| Co1—C1—Co2—C12 | 127.80 (8) | C22—C23—Co4—Co1 | 87.98 (7) |
| C2—C1—Co2—C14 | 44.3 (5) | C24—C23—Co4—Co2 | -69.86 (8) |
| Co4—C1—Co2—C14 | -89.2 (4) | C22—C23—Co4—Co2 | 171.96 (8) |
| Co1—C1—Co2—C14 | -170.1 (3) | C22—C21—Co4—C1 | 13.6 (3) |
| C2—C1—Co2—C13 | -41.3 (3) | C25—C21—Co4—C1 | -104.8 (3) |
| Co4—C1—Co2—C13 | -174.84 (10) | C22—C21—Co4—C24 | 80.4 |
| Co1—C1—Co2—C13 | 104.26 (13) | C25—C21—Co4—C24 | -38.0 |
| C2—C1—Co2—Co4 | 133.5 (2) | C22—C21—Co4—C25 | 118.4 |
| Co1—C1—Co2—Co4 | -80.89 (8) | C22—C21—Co4—C23 | 37.2 |
| C2—C1—Co2—Co3 | 174.6 (2) | C25—C21—Co4—C23 | -81.2 |
| Co4—C1—Co2—Co3 | 41.10 (6) | C25—C21—Co4—C22 | -118.4 |
| Co1—C1—Co2—Co3 | -39.79 (6) | C22—C21—Co4—Co3 | -132.29 (7) |
| C2—C1—Co2—Co1 | -145.6 (3) | C25—C21—Co4—Co3 | 109.27 (8) |
| Co4—C1—Co2—Co1 | 80.89 (8) | C22—C21—Co4—Co1 | -75.60 (8) |
| C12—C11—Co2—C1 | -106.61 (10) | C25—C21—Co4—Co1 | 165.96 (8) |
| C15—C11—Co2—C1 | 136.28 (10) | C22—C21—Co4—Co2 | -178.29 (10) |
| C12—C11—Co2—C15 | 117.1 | C25—C21—Co4—Co2 | 63.27 (9) |
| C15—C11—Co2—C12 | -117.1 | C21—C22—Co4—C1 | -175.16 (11) |
| C12—C11—Co2—C14 | 79.2 | C23—C22—Co4—C1 | -56.47 (11) |
| C15—C11—Co2—C14 | -37.9 | C21—C22—Co4—C24 | -81.0 |
| C12—C11—Co2—C13 | 36.9 | C23—C22—Co4—C24 | 37.7 |
| C15—C11—Co2—C13 | -80.2 | C21—C22—Co4—C25 | -37.5 |
| C12—C11—Co2—Co4 | -157.51 (7) | C23—C22—Co4—C25 | 81.2 |
| C15—C11—Co2—Co4 | 85.38 (7) | C21—C22—Co4—C23 | -118.7 |
| C12—C11—Co2—Co3 | 133.74 (13) | C23—C22—Co4—C21 | 118.7 |
| C15—C11—Co2—Co3 | 16.63 (13) | C21—C22—Co4—Co3 | 58.63 (8) |
| C12—C11—Co2—Co1 | -89.13 (9) | C23—C22—Co4—Co3 | 177.32 (8) |
| C15—C11—Co2—Co1 | 153.76 (10) | C21—C22—Co4—Co1 | 127.88 (7) |

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| C14—C15—Co2—C1 | -175.56 (12) | C23—C22—Co4—Co1 | -113.43 (7) |
| C11—C15—Co2—C1 | -58.30 (11) | C21—C22—Co4—Co2 | 170.3 (6) |
| C14—C15—Co2—C11 | -117.3 | C23—C22—Co4—Co2 | -71.1 (6) |
| C14—C15—Co2—C12 | -79.1 | C19—Co3—Co4—C1 | -147.02 (11) |
| C11—C15—Co2—C12 | 38.2 | C18—Co3—Co4—C1 | 170.68 (11) |
| C11—C15—Co2—C14 | 117.3 | C20—Co3—Co4—C1 | -114.43 (16) |
| C14—C15—Co2—C13 | -36.8 | C17—Co3—Co4—C1 | 133.71 (14) |
| C11—C15—Co2—C13 | 80.5 | C16—Co3—Co4—C1 | 120.9 (6) |
| C14—C15—Co2—Co4 | 133.86 (7) | Co1—Co3—Co4—C1 | -35.82 (7) |
| C11—C15—Co2—Co4 | -108.88 (7) | Co2—Co3—Co4—C1 | 36.09 (7) |
| C14—C15—Co2—Co3 | 71.98 (7) | C19—Co3—Co4—C24 | 80.06 (13) |
| C11—C15—Co2—Co3 | -170.76 (8) | C18—Co3—Co4—C24 | 37.75 (13) |
| C14—C15—Co2—Co1 | 115.4 (2) | C20—Co3—Co4—C24 | 112.64 (18) |
| C11—C15—Co2—Co1 | -127.4 (2) | C17—Co3—Co4—C24 | 0.79 (15) |
| C11—C12—Co2—C1 | 84.38 (10) | C16—Co3—Co4—C24 | -12.1 (6) |
| C13—C12—Co2—C1 | -157.19 (10) | Co1—Co3—Co4—C24 | -168.74 (10) |
| C13—C12—Co2—C11 | 118.4 | Co2—Co3—Co4—C24 | -96.83 (9) |
| C11—C12—Co2—C15 | -38.7 | C19—Co3—Co4—C25 | 61.81 (11) |
| C13—C12—Co2—C15 | 79.77 (5) | C18—Co3—Co4—C25 | 19.50 (11) |
| C11—C12—Co2—C14 | -81.87 (5) | C20—Co3—Co4—C25 | 94.39 (16) |
| C13—C12—Co2—C14 | 36.6 | C17—Co3—Co4—C25 | -17.46 (13) |
| C11—C12—Co2—C13 | -118.4 | C16—Co3—Co4—C25 | -30.3 (6) |
| C11—C12—Co2—Co4 | 41.03 (11) | Co1—Co3—Co4—C25 | 173.01 (6) |
| C13—C12—Co2—Co4 | 159.46 (12) | Co2—Co3—Co4—C25 | -115.09 (6) |
| C11—C12—Co2—Co3 | -123.41 (17) | C19—Co3—Co4—C23 | -4.26 (19) |
| C13—C12—Co2—Co3 | -4.98 (16) | C18—Co3—Co4—C23 | -46.56 (19) |
| C11—C12—Co2—Co1 | 135.77 (8) | C20—Co3—Co4—C23 | 28.3 (2) |
| C13—C12—Co2—Co1 | -105.80 (8) | C17—Co3—Co4—C23 | -83.5 (2) |
| C15—C14—Co2—C1 | 14.7 (4) | C16—Co3—Co4—C23 | -96.4 (6) |
| C13—C14—Co2—C1 | -104.0 (4) | Co1—Co3—Co4—C23 | 106.94 (17) |
| C15—C14—Co2—C11 | 38.6 | Co2—Co3—Co4—C23 | 178.85 (17) |
| C13—C14—Co2—C11 | -80.08 (5) | C19—Co3—Co4—C21 | 23.43 (10) |
| C13—C14—Co2—C15 | -118.7 | C18—Co3—Co4—C21 | -18.88 (11) |
| C15—C14—Co2—C12 | 82.06 (5) | C20—Co3—Co4—C21 | 56.01 (16) |
| C13—C14—Co2—C12 | -36.6 | C17—Co3—Co4—C21 | -55.84 (13) |
| C15—C14—Co2—C13 | 118.7 | C16—Co3—Co4—C21 | -68.7 (6) |
| C15—C14—Co2—Co4 | -62.94 (8) | Co1—Co3—Co4—C21 | 134.62 (6) |
| C13—C14—Co2—Co4 | 178.35 (8) | Co2—Co3—Co4—C21 | -153.47 (6) |
| C15—C14—Co2—Co3 | -115.70 (8) | C19—Co3—Co4—C22 | -8.97 (11) |
| C13—C14—Co2—Co3 | 125.59 (8) | C18—Co3—Co4—C22 | -51.27 (11) |
| C15—C14—Co2—Co1 | -152.21 (9) | C20—Co3—Co4—C22 | 23.62 (16) |
| C13—C14—Co2—Co1 | 89.08 (9) | C17—Co3—Co4—C22 | -88.23 (13) |
| C12—C13—Co2—C1 | 37.43 (16) | C16—Co3—Co4—C22 | -101.1 (6) |
| C14—C13—Co2—C1 | 156.95 (16) | Co1—Co3—Co4—C22 | 102.23 (6) |
| C12—C13—Co2—C11 | -37.8 | Co2—Co3—Co4—C22 | 174.14 (6) |
| C14—C13—Co2—C11 | 81.68 (5) | C19—Co3—Co4—Co1 | -111.20 (9) |
| C12—C13—Co2—C15 | -81.92 (5) | C18—Co3—Co4—Co1 | -153.50 (9) |
| C14—C13—Co2—C15 | 37.6 | C20—Co3—Co4—Co1 | -78.61 (15) |

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| C14—C13—Co2—C12 | 119.5 | C17—Co3—Co4—Co1 | 169.54 (12) |
| C12—C13—Co2—C14 | -119.5 | C16—Co3—Co4—Co1 | 156.7 (6) |
| C12—C13—Co2—Co4 | -125.1 (3) | Co2—Co3—Co4—Co1 | 71.910 (14) |
| C14—C13—Co2—Co4 | -5.6 (3) | C19—Co3—Co4—Co2 | 176.89 (9) |
| C12—C13—Co2—Co3 | 177.49 (8) | C18—Co3—Co4—Co2 | 134.59 (9) |
| C14—C13—Co2—Co3 | -63.00 (8) | C20—Co3—Co4—Co2 | -150.52 (15) |
| C12—C13—Co2—Co1 | 108.38 (8) | C17—Co3—Co4—Co2 | 97.63 (12) |
| C14—C13—Co2—Co1 | -132.11 (8) | C16—Co3—Co4—Co2 | 84.8 (6) |
| C8—Co1—Co2—C1 | -27.0 (2) | Co1—Co3—Co4—Co2 | -71.910 (14) |
| C9—Co1—Co2—C1 | 47.74 (14) | C8—Co1—Co4—C1 | -108.49 (12) |
| C7—Co1—Co2—C1 | -145.4 (2) | C9—Co1—Co4—C1 | -71.26 (13) |
| C6—Co1—Co2—C1 | 152.38 (14) | C7—Co1—Co4—C1 | -148.95 (12) |
| C10—Co1—Co2—C1 | 100.67 (13) | C6—Co1—Co4—C1 | -173.99 (17) |
| Co4—Co1—Co2—C1 | -61.83 (9) | C10—Co1—Co4—C1 | -60.3 (3) |
| Co3—Co1—Co2—C1 | -132.01 (9) | Co3—Co1—Co4—C1 | 130.84 (9) |
| C1—Co1—Co2—C11 | -23.12 (15) | Co2—Co1—Co4—C1 | 59.63 (9) |
| C8—Co1—Co2—C11 | -50.1 (3) | C1—Co1—Co4—C24 | 34.09 (16) |
| C9—Co1—Co2—C11 | 24.62 (16) | C8—Co1—Co4—C24 | -74.40 (16) |
| C7—Co1—Co2—C11 | -168.5 (2) | C9—Co1—Co4—C24 | -37.16 (17) |
| C6—Co1—Co2—C11 | 129.26 (17) | C7—Co1—Co4—C24 | -114.86 (16) |
| C10—Co1—Co2—C11 | 77.55 (15) | C6—Co1—Co4—C24 | -139.9 (2) |
| Co4—Co1—Co2—C11 | -84.95 (12) | C10—Co1—Co4—C24 | -26.2 (3) |
| Co3—Co1—Co2—C11 | -155.13 (12) | Co3—Co1—Co4—C24 | 164.93 (13) |
| C1—Co1—Co2—C15 | 82.8 (3) | Co2—Co1—Co4—C24 | 93.73 (13) |
| C8—Co1—Co2—C15 | 55.8 (3) | C1—Co1—Co4—C25 | -161.1 (3) |
| C9—Co1—Co2—C15 | 130.5 (3) | C8—Co1—Co4—C25 | 90.4 (3) |
| C7—Co1—Co2—C15 | -62.6 (3) | C9—Co1—Co4—C25 | 127.6 (3) |
| C6—Co1—Co2—C15 | -124.8 (3) | C7—Co1—Co4—C25 | 49.9 (3) |
| C10—Co1—Co2—C15 | -176.5 (3) | C6—Co1—Co4—C25 | 24.9 (3) |
| Co4—Co1—Co2—C15 | 21.0 (3) | C10—Co1—Co4—C25 | 138.5 (4) |
| Co3—Co1—Co2—C15 | -49.2 (3) | Co3—Co1—Co4—C25 | -30.3 (2) |
| C1—Co1—Co2—C12 | -79.69 (12) | Co2—Co1—Co4—C25 | -101.5 (3) |
| C8—Co1—Co2—C12 | -106.7 (2) | C1—Co1—Co4—C23 | 73.06 (11) |
| C9—Co1—Co2—C12 | -31.96 (13) | C8—Co1—Co4—C23 | -35.43 (11) |
| C7—Co1—Co2—C12 | 134.9 (2) | C9—Co1—Co4—C23 | 1.81 (12) |
| C6—Co1—Co2—C12 | 72.69 (14) | C7—Co1—Co4—C23 | -75.89 (11) |
| C10—Co1—Co2—C12 | 20.98 (12) | C6—Co1—Co4—C23 | -100.92 (16) |
| Co4—Co1—Co2—C12 | -141.52 (8) | C10—Co1—Co4—C23 | 12.7 (3) |
| Co3—Co1—Co2—C12 | 148.29 (8) | Co3—Co1—Co4—C23 | -156.10 (7) |
| C1—Co1—Co2—C14 | 175.79 (14) | Co2—Co1—Co4—C23 | 132.70 (7) |
| C8—Co1—Co2—C14 | 148.8 (2) | C1—Co1—Co4—C21 | 157.48 (12) |
| C9—Co1—Co2—C14 | -136.47 (15) | C8—Co1—Co4—C21 | 48.99 (11) |
| C7—Co1—Co2—C14 | 30.4 (2) | C9—Co1—Co4—C21 | 86.23 (12) |
| C6—Co1—Co2—C14 | -31.83 (16) | C7—Co1—Co4—C21 | 8.53 (11) |
| C10—Co1—Co2—C14 | -83.53 (15) | C6—Co1—Co4—C21 | -16.50 (17) |
| Co4—Co1—Co2—C14 | 113.96 (11) | C10—Co1—Co4—C21 | 97.2 (3) |
| Co3—Co1—Co2—C14 | 43.78 (11) | Co3—Co1—Co4—C21 | -71.68 (8) |
| C1—Co1—Co2—C13 | -130.61 (12) | Co2—Co1—Co4—C21 | -142.88 (8) |

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| C8—Co1—Co2—C13 | -157.6 (2) | C1—Co1—Co4—C22 | 116.14 (11) |
| C9—Co1—Co2—C13 | -82.87 (13) | C8—Co1—Co4—C22 | 7.65 (10) |
| C7—Co1—Co2—C13 | 84.0 (2) | C9—Co1—Co4—C22 | 44.89 (11) |
| C6—Co1—Co2—C13 | 21.77 (14) | C7—Co1—Co4—C22 | -32.81 (10) |
| C10—Co1—Co2—C13 | -29.94 (12) | C6—Co1—Co4—C22 | -57.84 (16) |
| Co4—Co1—Co2—C13 | 167.56 (8) | C10—Co1—Co4—C22 | 55.8 (3) |
| Co3—Co1—Co2—C13 | 97.38 (8) | Co3—Co1—Co4—C22 | -113.02 (6) |
| C1—Co1—Co2—Co4 | 61.83 (9) | Co2—Co1—Co4—C22 | 175.77 (6) |
| C8—Co1—Co2—Co4 | 34.8 (2) | C1—Co1—Co4—Co3 | -130.84 (9) |
| C9—Co1—Co2—Co4 | 109.57 (11) | C8—Co1—Co4—Co3 | 120.67 (8) |
| C7—Co1—Co2—Co4 | -83.55 (18) | C9—Co1—Co4—Co3 | 157.91 (10) |
| C6—Co1—Co2—Co4 | -145.79 (12) | C7—Co1—Co4—Co3 | 80.21 (8) |
| C10—Co1—Co2—Co4 | 162.50 (10) | C6—Co1—Co4—Co3 | 55.17 (15) |
| Co3—Co1—Co2—Co4 | -70.183 (14) | C10—Co1—Co4—Co3 | 168.8 (3) |
| C1—Co1—Co2—Co3 | 132.01 (9) | Co2—Co1—Co4—Co3 | -71.208 (14) |
| C8—Co1—Co2—Co3 | 105.0 (2) | C1—Co1—Co4—Co2 | -59.63 (9) |
| C9—Co1—Co2—Co3 | 179.75 (11) | C8—Co1—Co4—Co2 | -168.12 (8) |
| C7—Co1—Co2—Co3 | -13.36 (18) | C9—Co1—Co4—Co2 | -130.89 (10) |
| C6—Co1—Co2—Co3 | -75.61 (12) | C7—Co1—Co4—Co2 | 151.42 (8) |
| C10—Co1—Co2—Co3 | -127.31 (10) | C6—Co1—Co4—Co2 | 126.38 (15) |
| Co4—Co1—Co2—Co3 | 70.183 (14) | C10—Co1—Co4—Co2 | -120.0 (3) |
| C20—C19—Co3—C18 | -118.2 (3) | Co3—Co1—Co4—Co2 | 71.208 (14) |
| C18—C19—Co3—C20 | 118.2 (3) | C11—Co2—Co4—C1 | 85.00 (11) |
| C18—C19—Co3—C17 | 37.56 (18) | C15—Co2—Co4—C1 | 126.35 (12) |
| C20—C19—Co3—C17 | -80.6 (2) | C12—Co2—Co4—C1 | 58.05 (14) |
| C18—C19—Co3—C16 | 81.0 (2) | C14—Co2—Co4—C1 | 161.89 (12) |
| C20—C19—Co3—C16 | -37.14 (18) | C13—Co2—Co4—C1 | 166.3 (3) |
| C18—C19—Co3—Co4 | -89.81 (17) | Co3—Co2—Co4—C1 | -130.21 (9) |
| C20—C19—Co3—Co4 | 152.01 (15) | Co1—Co2—Co4—C1 | -59.92 (9) |
| C18—C19—Co3—Co1 | -157.15 (15) | C1—Co2—Co4—C24 | -90.56 (11) |
| C20—C19—Co3—Co1 | 84.67 (18) | C11—Co2—Co4—C24 | -5.56 (11) |
| C18—C19—Co3—Co2 | -67.4 (7) | C15—Co2—Co4—C24 | 35.79 (11) |
| C20—C19—Co3—Co2 | 174.4 (6) | C12—Co2—Co4—C24 | -32.51 (13) |
| C17—C18—Co3—C19 | 118.5 (3) | C14—Co2—Co4—C24 | 71.34 (11) |
| C17—C18—Co3—C20 | 80.5 (2) | C13—Co2—Co4—C24 | 75.8 (3) |
| C19—C18—Co3—C20 | -37.97 (17) | Co3—Co2—Co4—C24 | 139.24 (7) |
| C19—C18—Co3—C17 | -118.5 (3) | Co1—Co2—Co4—C24 | -150.48 (7) |
| C17—C18—Co3—C16 | 37.55 (19) | C1—Co2—Co4—C25 | -135.17 (11) |
| C19—C18—Co3—C16 | -80.92 (19) | C11—Co2—Co4—C25 | -50.17 (11) |
| C17—C18—Co3—Co4 | -135.47 (17) | C15—Co2—Co4—C25 | -8.82 (11) |
| C19—C18—Co3—Co4 | 106.06 (16) | C12—Co2—Co4—C25 | -77.12 (13) |
| C17—C18—Co3—Co1 | 166.62 (17) | C14—Co2—Co4—C25 | 26.72 (11) |
| C19—C18—Co3—Co1 | 48.2 (3) | C13—Co2—Co4—C25 | 31.2 (3) |
| C17—C18—Co3—Co2 | -71.1 (2) | Co3—Co2—Co4—C25 | 94.62 (7) |
| C19—C18—Co3—Co2 | 170.43 (13) | Co1—Co2—Co4—C25 | 164.91 (7) |
| C16—C20—Co3—C19 | -118.9 (3) | C1—Co2—Co4—C23 | -49.17 (12) |
| C16—C20—Co3—C18 | -81.0 (2) | C11—Co2—Co4—C23 | 35.83 (12) |
| C19—C20—Co3—C18 | 37.89 (17) | C15—Co2—Co4—C23 | 77.18 (12) |

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| C16—C20—Co3—C17 | -37.82 (19) | C12—Co2—Co4—C23 | 8.88 (14) |
| C19—C20—Co3—C17 | 81.12 (19) | C14—Co2—Co4—C23 | 112.73 (12) |
| C19—C20—Co3—C16 | 118.9 (3) | C13—Co2—Co4—C23 | 117.2 (3) |
| C16—C20—Co3—Co4 | -169.07 (16) | Co3—Co2—Co4—C23 | -179.37 (9) |
| C19—C20—Co3—Co4 | -50.1 (2) | Co1—Co2—Co4—C23 | -109.09 (9) |
| C16—C20—Co3—Co1 | 127.57 (17) | C1—Co2—Co4—C21 | -175.45 (14) |
| C19—C20—Co3—Co1 | -113.49 (16) | C11—Co2—Co4—C21 | -90.45 (13) |
| C16—C20—Co3—Co2 | 62.3 (3) | C15—Co2—Co4—C21 | -49.10 (13) |
| C19—C20—Co3—Co2 | -178.74 (13) | C12—Co2—Co4—C21 | -117.40 (15) |
| C18—C17—Co3—C19 | -37.83 (17) | C14—Co2—Co4—C21 | -13.56 (14) |
| C16—C17—Co3—C19 | 81.08 (19) | C13—Co2—Co4—C21 | -9.1 (3) |
| C16—C17—Co3—C18 | 118.9 (3) | Co3—Co2—Co4—C21 | 54.34 (11) |
| C18—C17—Co3—C20 | -81.51 (19) | Co1—Co2—Co4—C21 | 124.63 (11) |
| C16—C17—Co3—C20 | 37.40 (18) | C1—Co2—Co4—C22 | 15.7 (6) |
| C18—C17—Co3—C16 | -118.9 (3) | C11—Co2—Co4—C22 | 100.7 (6) |
| C18—C17—Co3—Co4 | 64.0 (2) | C15—Co2—Co4—C22 | 142.0 (6) |
| C16—C17—Co3—Co4 | -177.09 (15) | C12—Co2—Co4—C22 | 73.7 (6) |
| C18—C17—Co3—Co1 | -155.0 (3) | C14—Co2—Co4—C22 | 177.6 (6) |
| C16—C17—Co3—Co1 | -36.1 (5) | C13—Co2—Co4—C22 | -178.0 (6) |
| C18—C17—Co3—Co2 | 134.65 (15) | Co3—Co2—Co4—C22 | -114.5 (6) |
| C16—C17—Co3—Co2 | -106.44 (17) | Co1—Co2—Co4—C22 | -44.2 (6) |
| C20—C16—Co3—C19 | 37.68 (18) | C1—Co2—Co4—Co3 | 130.21 (9) |
| C17—C16—Co3—C19 | -80.85 (19) | C11—Co2—Co4—Co3 | -144.80 (8) |
| C20—C16—Co3—C18 | 81.20 (19) | C15—Co2—Co4—Co3 | -103.45 (8) |
| C17—C16—Co3—C18 | -37.34 (18) | C12—Co2—Co4—Co3 | -171.74 (11) |
| C17—C16—Co3—C20 | -118.5 (3) | C14—Co2—Co4—Co3 | -67.90 (9) |
| C20—C16—Co3—C17 | 118.5 (3) | C13—Co2—Co4—Co3 | -63.5 (3) |
| C20—C16—Co3—Co4 | 133.5 (6) | Co1—Co2—Co4—Co3 | 70.289 (14) |
| C17—C16—Co3—Co4 | 15.0 (7) | C1—Co2—Co4—Co1 | 59.92 (9) |
| C20—C16—Co3—Co1 | -72.2 (2) | C11—Co2—Co4—Co1 | 144.92 (8) |
| C17—C16—Co3—Co1 | 169.27 (14) | C15—Co2—Co4—Co1 | -173.73 (8) |
| C20—C16—Co3—Co2 | -146.54 (15) | C12—Co2—Co4—Co1 | 117.97 (11) |
| C17—C16—Co3—Co2 | 94.93 (18) | C14—Co2—Co4—Co1 | -138.19 (9) |
| C1—Co1—Co3—C19 | 137.85 (11) | C13—Co2—Co4—Co1 | -133.7 (3) |
| C8—Co1—Co3—C19 | 15.74 (13) | Co3—Co2—Co4—Co1 | -70.289 (14) |
| C9—Co1—Co3—C19 | -7.6 (2) | C1—C2—Si1—C4 | 25.0 (2) |
| C7—Co1—Co3—C19 | -13.89 (12) | C1—C2—Si1—C5 | -99.4 (2) |
| C6—Co1—Co3—C19 | -53.07 (12) | C1—C2—Si1—C3 | 144.8 (2) |
| C10—Co1—Co3—C19 | -73.40 (14) | | |
