

SELECTION OF STANDARD FREE ENERGIES
OF FORMATION FOR USE IN SOIL CHEMISTRY

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INTRODUCTION

Several authors have compiled thermodynamic data of Sr species. The most important references include Garrels and Christ (1965), Technical Notes of the U.S. National Bureau of Standards (NBS), Wagman et al. (1968, 1969, and 1982), Smith and Martell (1976), Parker et al. (1971), Stull et al. (1971), Naumov et al. (1971), and Karapet'yants and Karapet'yants (1970).

Often large differences are found in the free energy of formation (ΔG°_f) values of Sr reported by the various compilers. Users of these data are faced with the frustration of trying to select the best value for their use. In this report, we have attempted to review the available literature on thermodynamic, electrochemical, and solubility data of various Sr compounds to obtain the most reliable values. Attempts have also been made to compare thermodynamic equilibrium constants of Sr reactions used by different geochemical models.

Selection Criteria:

The free energies of formation (ΔG°_f) values showing wide scatter have been eliminated. In cases where the agreement of ΔG°_f values is poor, the original sources of the compilers were traced and compared with other available data to obtain the most reliable values. When solubility data was available, the ΔG°_f value for the species in question was calculated using other selected ΔG°_f values of the products and reactants involved in the equilibrium expression.

Methods of calculating standard free energies of formation (ΔG°_f):

The standard free energies of formation of different Sr compounds (solid phases, solution complexes, and ion pairs) compiled in this report were calculated from calorimetric, electrochemical, or solubility data. In cases where ΔG°_f was derived from calorimetric data, the standard heat of reaction and entropy of reaction ΔH°_r and ΔS°_r , were evaluated. The standard heat of formation (ΔH°_f) and standard entropy of reaction (S°_r) were calculated from equations:

$$\Delta H^\circ_r = \Sigma \Delta H^\circ_f \text{ (products)} - \Sigma \Delta H^\circ_f \text{ (reactants)} \quad (1)$$

$$\Delta S^\circ_r = \Sigma \Delta S^\circ \text{ (products)} - \Sigma \Delta S^\circ \text{ (reactants)} \quad (2)$$

The Gibbs free energy of reaction (ΔG°_r) was calculated from the equations:

$$\Delta G_r^\circ = \Delta H_r^\circ - T\Delta S_r^\circ \quad (3)$$

$$\Delta G_r^\circ = \sum \Delta G_f^\circ (\text{products}) - \sum \Delta G_f^\circ (\text{reactants}) \quad (4)$$

where ΔG_f° is the standard free energy of formation at 298.15°K (25°C).

Whenever electrochemical data were available, ΔG_r° was calculated from the equation:

$$\Delta G_r^\circ = -nFE^\circ \quad (5)$$

where

n = number of moles of electrons participating in the reaction

F = Faraday constant (96.487 kJ volts⁻¹ or 23.061 kcal volt⁻¹)

E° = standard cell potential.

When ΔG_f° values are available, ΔG_r° was calculated using Equation (4). Once ΔG_r° was known, the equilibrium constant (K°) was calculated from the equation:

$$\Delta G_r^\circ = -RT \ln K^\circ \quad (6)$$

where

K° = activity equilibrium constant

R = universal gas constant (0.00831 kJ mole⁻¹
or 0.001987 kcal mole⁻¹)

T = absolute temperature

At standard conditions (25°C and 1 atm) Equation (6) becomes

$$\log K^\circ = - \frac{\Delta G_r^\circ}{1.364} \quad (7)$$

(ΔG_f° expressed in kcal mole⁻¹), or

$$\log K^\circ = - \frac{\Delta G_r^\circ}{5.707} \quad (8)$$

(ΔG_f° expressed in kJ mole⁻¹). Substituting

$$\Delta G_r^\circ = \Delta G_f^\circ (\text{products}) - \Delta G_f^\circ (\text{reactants}).$$

into Equations (7) and (8) gives

$$\log K^{\circ} = - \frac{1}{1.364} [\Delta G^{\circ}_f (\text{products}) - \Delta G^{\circ}_f (\text{reactants})] \quad (9)$$

(ΔG°_f expressed in kcal mole⁻¹), or

$$\log K^{\circ} = - \frac{1}{5.707} [\Delta G^{\circ}_f (\text{products}) - G^{\circ}_f (\text{reactants})] \quad (10)$$

(ΔG°_f expressed in kJ mole⁻¹).

Standard Free Energies of Formation for Sr:

The results of this study are summarized in three tables. Table 1 summarizes the collected ΔG°_f value for various strontium species taken for the literature with no attempt to make them internally consistent or to compare one value against another.

Table 2 is a list of the selected ΔG°_f values of the various Sr species which resulted from this study and which are discussed in the section that follows.

Finally, Table 3 lists important equilibrium reactions of Sr along with the $\log K^{\circ}$ values which were calculated from the selected ΔG°_f values listed in Table 2. The ΔG°_f values for chemical species included in Table 3 that are not listed in Table 2 were taken from Lindsay (1979), and are internally consistent with values given in Table 2. A discussion of each Sr species and the factors involved in each ΔG°_f value follows.

Table 1. Summary of Collected ΔG_f^0 (kJ mole⁻¹) values for strontium species.
Values in parentheses are kcal mole⁻¹.

No.	Species	Source*									
		1	2	3	4	5	6	7	8	9	10
1.	Sr ²⁺	-599.47 (-133.72)	-559.44 (-133.71)	---	-571.44 (-136.58)	---	---	-563.83 (-134.76)	-559.43 (-133.70)	---	---
2.	SrSO ₄ (c)	-1340.89 (-320.48)	---	-1334.44 (-318.94)	-1353.35 (-323.46)	---	---	---	-1340.97 (-320.50)	---	-1340.68 (-320.43)
3.	SrO(c)	-561.87 (-134.29)	---	-573.00 (-137.07)	-574.13 (-137.22)	-559.82 (-133.80)	---	-559.95 (-133.83)	-560.32 (-133.92)	-560.57 (-133.98)	---
4.	Sr(NO ₃) ₂ (c)	-780.02 (-186.43)	---	-778.22 (-186.00)	-790.40 (-188.91)	---	---	-783.28 (-187.21)	-779.06 (-186.20)	---	---
5.	SrBr ₂ (c)	-697.10 (-166.61)	---	-695.80 (-166.30)	---	---	---	---	-695.89 (-166.32)	-699.77 (-167.25)	---
6.	SrHPO ₄ (c)	-1688.60 (-403.58)	---	-1681.31 (-401.80)	---	-1672.34 (-399.70)	---	---	---	---	---
7.	SrF ₂ (c)	-1164.57 (-278.34)	---	-1162.31 (-277.80)	-1180.56 (-282.16)	-1162.31 (-277.80)	---	---	---	-1164.74 (-278.38)	---
8.	SrCrO ₄ (c)	---	---	---	-1318.37 (-315.10)	---	-1319.21 (-315.30)	---	---	---	---
9.	SrSeO ₃ (c)	---	---	-965.83 (-230.84)	-969.43 (-231.70)	---	---	---	---	---	---
10.	Sr ₂ TiO ₄ (c)	-2172.30 (-519.19)	-2178.60 (-520.70)	---	-2196.01 (-524.86)	---	---	---	---	---	---
11.	SrOH ⁺	-721.32 (-172.40)	-721.32 (-172.40)	---	-733.45 (-175.30)	---	---	---	---	---	---
12.	SrSO ₄ ⁰	-1304.03 (-311.67)	---	---	---	---	---	---	---	---	---
13.	SrCO ₃ (c)	-1140.10 (-272.49)	---	-1138.13 (-272.02)	-1152.31 (-275.40)	---	---	---	-1137.63 (-271.90)	---	---
14.	SrSiO ₃ (c)	-1549.70 (-370.39)	---	-1467.75 (-350.80)	-1561.64 (-373.24)	---	---	---	---	---	---

Table 1, cont.

No.	Species	Source*									
		1	2	3	4	5	6	7	8	9	10
15.	$\text{Sr}_2\text{SiO}_4(\text{c})$	-2191.10 (-523.68)	---	-2074.00 (-495.70)	-2215.09 (-529.68)	-2074.00 (-495.70)	---	---	---	---	---
16.	$\text{Sr}_3(\text{PO}_4)_2(\text{c})$	---	---	---	---	-3899.90 (-932.10)	---	---	---	---	---
17.	$\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}(\text{c})$	---	---	-1725.48 (-412.40)	---	---	---	-1734.19 (-414.48)	---	---	---
18.	$\text{SrCl}_2(\text{c})$	-781.10 (-186.69)	---	---	---	-781.15 (-186.70)	-781.15 (-186.70)	-785.00 (-187.62)	---	-781.02 (-186.67)	---
19.	$\text{SrCl}_2 \cdot \text{H}_2\text{O}(\text{c})$	-1036.30 (-247.68)	---	-1038.47 (-248.20)	---	---	---	---	---	---	---
20.	$\text{SrBr}_2 \cdot \text{H}_2\text{O}(\text{c})$	-954.30 (-228.08)	---	---	---	---	---	---	---	---	---
21.	$\text{Sr}_3(\text{AsO}_4)_2(\text{c})$	-3080.10 (-736.16)	---	---	---	-3222.10 (-770.10)	---	---	---	---	---
22.	$\text{SrSeO}_4(\text{c})$	---	---	-1023.87 (-244.71)	-1039.14 (-248.36)	---	---	---	---	---	---
23.	$\text{SrMoO}_4(\text{c})$	---	---	-1448.50 (-346.20)	-1454.36 (-347.60)	---	---	---	---	---	---
24.	$\text{Sr}(\text{OH})_2(\text{c})$	---	---	-870.27 (-208.00)	-869.43 (-207.80)	---	---	---	---	---	---
25.	$\text{SrI}_2(\text{c})$	---	---	-562.33 (-134.40)	---	---	---	---	---	-558.71 (-133.53)	---
26.	$\text{SrTiO}_3(\text{c})$	-1588.36 (-379.62)	-1588.41 (-379.64)	---	-1600.38 (-382.50)	---	---	---	---	---	---
27.	$\text{SrZrO}_3(\text{c})$	-1682.80 (-402.20)	-1682.80 (-402.20)	---	-2548.89 (-609.20)	---	---	---	---	---	---
28.	SrHCO_3^+	---	---	---	---	---	---	-1157.50 (-276.65)	---	---	---

Table 1, cont.

No.	Species	Source*									
		1	2	3	4	5	6	7	8	9	10
29.	SrCO_3^0	-1087.30 (-259.87)	-1087.33 (-259.88)	---	---	---	---	-1175.50 (-280.95)	---	---	---
30.	$\text{Sr(NO}_3)_2^0$	-781.99 (-186.90)	---	---	---	---	---	---	---	---	---
31.	SrCl_2^0	-821.90 (-196.44)	---	---	---	---	---	---	---	---	---
32.	SrI_2^0	-662.62 (-158.37)	---	---	---	---	---	---	---	---	---
33.	SrBr_2^0	---	-767.38 (-183.41)	---	---	---	---	---	---	---	---

* Source

1. Wagman et al. (1982)
2. Parker et al. (1971)
3. Karapet'yants and Karapet'yants (1970)
4. Naumov et al. (1971)
5. Garrels and Christ (1968)
6. Latimer (1952)
7. Busenberg et al. (1984)
8. Robie et al. (1978)
9. Pankratz (1984)
10. Helgeson et al. (1978)

Table 2. Summary of Selected ΔG_f° of Strontium Species.

No.	Species	ΔG_f°		Source	Remarks
		(kJ mole ⁻¹)	(kcal mole ⁻¹)		
1.	Sr ²⁺	-563.83	-134.76	Busenberg et al. (1984)	K ^o
2.	SrSO ₄ (c)	-1346.16	-321.74	Reardon and Armstrong (1987)	K ^o
3.	SrO(c)	-559.95	-133.83	Busenberg et al. (1984)	K ^o
4.	Sr(NO ₃) ₂ (c)	-783.28	-187.21	Busenberg et al. (1984)	K ^o
5.	SrBr ₂ (c)	-699.77	-167.25	Pankratz (1984)	ΔH_f° and S ^o
6.	SrHPO ₄ (c)	-1688.60	-403.58	Wagman et al. (1982)	ΔH_f° and S ^o
7.	SrF ₂ (c)	-1180.56	-282.16	Naumov et al. (1971)	ΔH_f° and S ^o
8.	SrCrO ₄ (c)	-1318.37	-315.10	Naumov et al. (1971)	ΔH_f° and S ^o
9.	SrSeO ₃ (c)	-969.43	-231.70	Naumov et al. (1971)	ΔH_f° and S ^o
10.	Sr ₂ TiO ₄ (c)	-2196.01	-524.86	Naumov et al. (1971)	ΔH_f° and S ^o
11.	SrOH ⁺	-733.46	-175.30	Naumov et al. (1971)	ΔH_f° and S ^o
12.	SrSO ₄ ^o	-1321.39	-315.82	Reardon (1983)	K ^o
13.	SrCO ₃ (c)	-1144.64	-273.58	Busenberg et al. (1984)	K ^o
14.	SrSiO ₃ (c)	-1561.64	-373.24	Naumov et al. (1971)	ΔH_f° and S ^o
15.	Sr ₂ SiO ₄ (c)	-2191.10	-523.68	Wagman et al. (1982)	ΔH_f° and S ^o
16.	Sr ₃ (PO ₄) ₂ (c)	-3899.90	-932.10	Garrels and Christ (1968)	ΔH_f° and S ^o
17.	Sr(NO ₃) ₂ ·4H ₂ O(c)	-1734.19	-414.48	Busenberg et al. (1984)	K ^o
18.	SrCl ₂ (c)	-785.00	-187.62	Busenberg et al. (1984)	K ^o
19.	SrCl ₂ ·H ₂ O(c)	-1036.30	-247.68	Wagman et al. (1982)	ΔH_f° and S ^o
20.	SrBr ₂ ·H ₂ O(c)	-954.30	-228.08	Wagman et al. (1982)	ΔH_f° and S ^o

Table 2, cont.

No.	Species	ΔG_f°		Source	Remarks
		(kJ mole ⁻¹)	(kcal mole ⁻¹)		
21.	Sr ₃ (AsO ₄) ₂ (c)	-3080.10	-736.16	Wagman et al. (1982)	ΔH_f° and S°
22.	SrSeO ₄ (c)	-1039.14	-248.36	Naumov et al. (1971)	K°
23.	SrMoO ₄ (c)	-1454.36	-347.60	Naumov et al. (1971)	K°
24.	Sr(OH) ₂ (c)	-870.27	-208.00	Karapet'yants and Karapet'yants (1970)	ΔH_f° and S°
25.	SrI ₂ (c)	-558.71	-133.53	Pankratz (1984)	ΔH_f° and S°
26.	SrTiO ₃ (c)	-1600.38	-382.50	Naumov et al. (1971)	ΔH_f° and S°
27.	SrZrO ₃ (c)	-1682.77	-402.20	Wagman et al. (1982)	ΔH_f° and S°
28.	SrHCO ₃ ⁺	-1157.50	-276.65	Busenberg et al. (1984)	K°
29.	SrCO ₃ ^o	-1107.84	-264.78	Busenberg et al. (1984)	K°
30.	Sr(NO ₃) ₂ ^o	-781.99	-186.90	Wagman et al. (1982)	ΔH_f° and S°
31.	SrCl ₂ ^o	-821.90	-196.44	Wagman et al. (1982)	ΔH_f° and S°
32.	SrI ₂ ^o	-662.62	-158.37	Wagman et al. (1982)	ΔH_f° and S°
33.	SrBr ₂ ^o	-767.38	-183.41	Parker et al. (1971)	ΔH_f° and S°

Table 3. Equilibrium Reactions of Strontium

No.	Reaction	log K°
I. Solid Phases		
1.	$\text{SrO(c)} + 2\text{H}^+ \rightleftharpoons \text{Sr}^{2+} + \text{H}_2\text{O}$	42.23
2.	$\text{Sr(OH)}_2\text{(c)} + 2\text{H}^+ \rightleftharpoons \text{Sr}^{2+} + 2\text{H}_2\text{O}$	29.42
3.	$\text{SrSiO}_3\text{(c)} + 2\text{H}^+ + \text{H}_2\text{O} \rightleftharpoons \text{Sr}^{2+} + \text{H}_4\text{SiO}_4^0$	12.82
4.	$\text{Sr}_2\text{SiO}_4\text{(c)} + 4\text{H}^+ \rightleftharpoons 2\text{Sr}^{2+} + \text{H}_4\text{SiO}_4^0$	42.88
5.	$\text{SrCO}_3\text{(c)} \rightleftharpoons \text{Sr}^{2+} + \text{CO}_3^{2-}$	-9.27
6.	$\text{SrSO}_4\text{(c)} \rightleftharpoons \text{Sr}^{2+} + \text{SO}_4^{2-}$	-6.63
7.	$\text{Sr(NO}_3)_2\text{(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{NO}_3^-$	0.61
8.	$\text{SrBr}_2\text{(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{Br}^-$	12.64
9.	$\text{SrHPO}_4\text{(c)} + \text{H}^+ \rightleftharpoons \text{Sr}^{2+} + \text{H}_2\text{PO}_4^-$	2.22
10.	$\text{Sr}_3(\text{PO}_4)_2\text{(c)} + 4\text{H}^+ \rightleftharpoons 3\text{Sr}^{2+} + 2\text{H}_2\text{PO}_4^-$	11.64
11.	$\text{Sr(NO}_3)_2 \cdot 4\text{H}_2\text{O(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{NO}_3^- + 4\text{H}_2\text{O}$	0.22
12.	$\text{SrF}_2\text{(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{F}^-$	-8.46
13.	$\text{SrCl}_2\text{(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{Cl}^-$	7.24
14.	$\text{SrCl}_2 \cdot \text{H}_2\text{O(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{Cl}^- + \text{H}_2\text{O}$	4.77
15.	$\text{SrBr}_2 \cdot \text{H}_2\text{O(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{Br}^- + \text{H}_2\text{O}$	9.60
16.	$\text{Sr}_3(\text{AsO}_4)_2\text{(c)} + 2\text{H}^+ \rightleftharpoons 3\text{Sr}^{2+} + 2\text{HAsO}_4^{2-}$	5.46
17.	$\text{SrCrO}_4\text{(c)} \rightleftharpoons \text{Sr}^{2+} + \text{CrO}_4^{2-*}$	-4.70
18.	$\text{SrSeO}_3\text{(c)} \rightleftharpoons \text{Sr}^{2+} + \text{SeO}_3^{2-*}$	-6.27
19.	$\text{SrSeO}_4\text{(c)} \rightleftharpoons \text{Sr}^{2+} + \text{SeO}_4^{2-}$	-5.96
20.	$\text{SrMoO}_4\text{(c)} \rightleftharpoons \text{Sr}^{2+} + \text{MoO}_4^{2-}$	-9.53
21.	$\text{SrI}_2\text{(c)} \rightleftharpoons \text{Sr}^{2+} + 2\text{I}^-$	19.14

Table 3. cont.

No.	Reaction	log K°
I. Solution Phases		
22.	$\text{Sr}^{2+} + \text{H}_2\text{O} \rightleftharpoons \text{SrOH}^+ + \text{H}^+$	-11.83
23.	$\text{Sr}^{2+} + \text{HCO}_3^- \rightleftharpoons \text{SrHCO}_3^+$	1.18
24.	$\text{Sr}^{2+} + \text{CO}_3^{2-} \rightleftharpoons \text{SrCO}_3^0$	2.83
25.	$\text{Sr}^{2+} + \text{SO}_4^{2-} \rightleftharpoons \text{SrSO}_4^0$	2.29
26.	$\text{Sr}^{2+} + 2\text{NO}_3^- \rightleftharpoons \text{Sr}(\text{NO}_3)_2^0$	-0.84
27.	$\text{Sr}^{2+} + 2\text{Cl}^- \rightleftharpoons \text{SrCl}_2^0$	-0.78
28.	$\text{Sr}^{2+} + 2\text{I}^- \rightleftharpoons \text{SrI}_2^0$	-0.84
29.	$\text{Sr}^{2+} + 2\text{Br}^- \rightleftharpoons \text{SrBr}_2^0$	-0.80

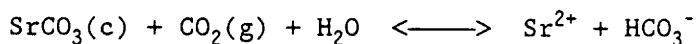
* ΔG_f° values for CrO_4^{2-} , SeO_3^{2-} , and SeO_4^{2-} , were selected from Wagman et al. (1982).

Sr²⁺

Recommended standard free energies of formation (ΔG_f°) of Sr²⁺ ion are summarized below:

Investigator	ΔG_f°	
	kJ mole ⁻¹	kcal mole ⁻¹
Wagman et al. (1982)	-559.47	-133.72
Busenberg et al. (1984)	-563.83	-134.76
Robie et al. (1978)	-559.43	-133.70
Parker et al. (1971)	-559.44	-133.71
Naumov et al. (1971)	-571.44	-136.58

Wagman et al. (1982) reported $\Delta G_f^\circ = -559.47$ kJ mole⁻¹ (-133.72 kcal mole⁻¹) from $\Delta H_f^\circ = -545.80$ kJ mole⁻¹ (-130.45 kcal mole⁻¹) and $S^\circ = -32.6$ J mole⁻¹ (-7.80 cal mole⁻¹). Parker et al. (1971) listed a similar value (-559.44 kJ mole⁻¹) for Sr²⁺. Robie et al. (1978) reported $\Delta G_f^\circ = -559.43$ kJ mole⁻¹ (-133.70 kcal mole⁻¹) from Parker et al. (1971). Naumov et al. (1971) recommended $\Delta G_f^\circ = -571.44$ kJ mole⁻¹ (-136.58 kcal mole⁻¹) from pK = 6.78 for the reaction:



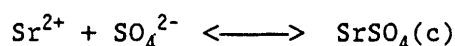
Busenberg et al. (1984) recommended $\Delta G_f^\circ = -563.83$ kJ mole⁻¹ (-134.76 kcal mole⁻¹). Khodakovskiy et al. (1981) calculated this ΔG_f° of Sr²⁺ from $\Delta H_f^\circ = -551.45 \pm 0.59$ kJ mole⁻¹ (-131.80 kcal mole⁻¹) and $S^\circ = -33.1 \pm 2.9$ J mole⁻¹ (7.91 cal mole⁻¹) based on their vapor pressure measurements of Sr(NO₃)₂·4H₂O. The listed ΔG_f° value for Sr²⁺ by Busenberg et al. (1984) is reasonably in agreement with Wagman et al. (1982), Robie et al. (1978), and Parker et al. (1971). Therefore, we adopted $\Delta G_f^\circ = -563.83$ kJ mole⁻¹ (-134.76 kcal mole⁻¹) for Sr²⁺ after Busenberg et al. (1984).

SrSO₄(c)

Robie et al. (1978) listed $\Delta G_f^\circ = -1340.97$ kJ mole⁻¹ (-320.50 kcal mole⁻¹) from Kelley (1937), Kelley and King (1961), and Parker et al. (1971). Wagman et al. (1982) recommended $\Delta G_f^\circ = -1340.89$ kJ mole⁻¹ (-320.48 kcal

mole⁻¹) from $\Delta H_f^\circ = -1453.10$ kJ mole⁻¹ (-347.30 kcal mole⁻¹) and $S^\circ = 116.98$ J mole⁻¹ (27.96 cal mole⁻¹). Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -1334.44$ kJ mole⁻¹ (-318.94 kcal mole⁻¹) from $\Delta H_f^\circ = -529.70$ kJ mole⁻¹ (-126.60 kcal mole⁻¹).

Helgeson et al. (1978) reported $\Delta G_f^\circ = -1340.68$ kJ mole⁻¹ (-320.43 kcal mole⁻¹) for SrSO₄(c) from $\Delta G_f^\circ = \Delta H_f^\circ - T\Delta S^\circ$. The authors adopted $\Delta H_f^\circ = -1453.10$ kJ mole⁻¹ (-347.30 kcal mole⁻¹) and $S^\circ = 117.15$ J mole⁻¹ (-1353.35 cal mole⁻¹) from Wagman et al. (1968, 1969). Naumov et al. (1971) listed $\Delta G_f^\circ = -1353.35$ kJ mole⁻¹ (-323.46 kcal mole⁻¹) from ΔH_f° values for the reaction:



Recently, Reardon and Armstrong (1987) made reliable solubility measurements of SrSO₄(c) and reported pK = -6.63 for this reaction. We adopted the calculated $\Delta G_f^\circ = -1346.16$ kJ mole⁻¹ (-321.74 kcal mole⁻¹) for SrSO₄(c) using selected ΔG_f° values for Sr²⁺ and SO₄²⁻.

SrO(c)

The standard free energy of formation of SrO(c) ranges from -559.82 kJ mole⁻¹ (-133.80 kcal mole⁻¹) to -574.13 kJ mole⁻¹ (-137.22 kcal mole⁻¹). Recommended ΔG_f° values for SrO(c) by various investigators are summarized below:

Investigator	ΔG_f° kJ mole ⁻¹	kcal mole ⁻¹
Garrels and Christ (1965)	-559.82	-133.80
Robie et al. (1978)	-560.32	-133.92
Wagman et al. (1982)	-561.87	-134.29
Pankratz (1984)	-560.57	-133.98
Busenberg et al. (1984)	-559.95	-133.83
Karapet'yants and Karapet'yants (1970)	-573.00	-137.07
Naumov et al. (1971)	-574.13	-137.22

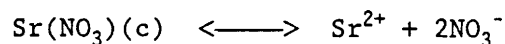
Reported ΔG_f° values for SrO(c) agree very well except Karapet'yants and Karapet'yants (1970) and Naumov et al. (1971). Recently Busenberg et al.

(1984) critically evaluated ΔG_f° for SrO(c) and recommended $-559.95 \text{ kJ mole}^{-1}$ ($-133.83 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -590.57 \text{ kJ mole}^{-1}$ ($-141.15 \text{ kcal mole}^{-1}$) and $S^\circ = 55.44 \text{ J mole}^{-1}$ ($13.25 \text{ kcal mole}^{-1}$).

In this report we selected the $\Delta G_f^\circ = -559.95 \text{ kJ mole}^{-1}$ ($-133.83 \text{ kcal mole}^{-1}$) of Busenberg et al. (1984).

$\text{Sr(NO}_3)_2(\text{c})$

Robie et al. (1978) reported $\Delta G_f^\circ = -779.06 \text{ kJ mole}^{-1}$ ($-186.20 \text{ kcal mole}^{-1}$). Wagman et al. (1982) listed $\Delta G_f^\circ = -780.02 \text{ kJ mole}^{-1}$ ($-186.43 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -978.22 \text{ kJ mole}^{-1}$ ($-233.80 \text{ kcal mole}^{-1}$) and $S^\circ = -194.55 \text{ J mole}^{-1}$ ($-46.50 \text{ cal mole}^{-1}$). Naumov et al. (1971) recommended $\Delta G_f^\circ = -790.40 \text{ kJ mole}^{-1}$ ($-188.91 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = 17.53 \text{ kJ mole}^{-1}$ ($4.19 \text{ kcal mole}^{-1}$) for the reaction:



Busenberg et al. (1984) calculated $\Delta G_f^\circ = -783.28 \text{ kJ mole}^{-1}$ ($-187.21 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -982.36 \text{ kJ mole}^{-1}$ ($-234.79 \text{ kcal mole}^{-1}$) and $S^\circ = 194.60 \text{ J mole}^{-1}$ ($46.51 \text{ cal mole}^{-1}$). Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -778.22 \text{ kJ mole}^{-1}$ ($-186.00 \text{ kcal mole}^{-1}$) from approximate calculations of ΔH_f° and S° . We adopted $\Delta G_f^\circ = -783.28 \text{ kJ mole}^{-1}$ ($-187.21 \text{ kcal mole}^{-1}$) for $\text{Sr(NO}_3)_2(\text{c})$ after Busenberg et al. (1984).

$\text{SrBr}_2(\text{c})$

Robie et al. (1978) reported $\Delta G_f^\circ = -695.89 \text{ kJ mole}^{-1}$ ($-166.32 \text{ kcal mole}^{-1}$) from ΔH_f° and S° calculations. Wagman et al. (1982) listed $\Delta G_f^\circ = -697.10 \text{ kJ mole}^{-1}$ ($-166.61 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -717.60 \text{ kJ mole}^{-1}$ ($-171.51 \text{ kcal mole}^{-1}$) and $S^\circ = 135.10 \text{ J mole}^{-1}$ ($32.29 \text{ cal mole}^{-1}$). Karapet'yants and Karapet'yants (1970) recommended $\Delta G_f^\circ = -695.80 \text{ kJ mole}^{-1}$ ($-166.30 \text{ kcal mole}^{-1}$) from approximate calculations of ΔH_f° and S° values. Pankratz (1984) listed $\Delta G_f^\circ = -699.77 \text{ kJ mole}^{-1}$ ($-167.25 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -717.97 \text{ kJ mole}^{-1}$ ($-171.60 \text{ kcal mole}^{-1}$) and $S^\circ = 143.42 \text{ J mole}^{-1}$ ($34.28 \text{ cal mole}^{-1}$).

The standard free energy of formation (ΔG_f°) for $\text{SrBr}_2(\text{c})$ reported by Pankratz (1984) agrees well with the values reported by Robie et al. (1978) and Wagman et al. (1982). Therefore, we selected $\Delta G_f^\circ = -699.77 \text{ kJ mole}^{-1}$ ($-167.25 \text{ kcal mole}^{-1}$) of Pankratz (1984).

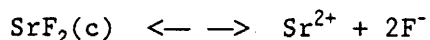
SrHPO₄(c)

Garrels and Christ (1965) reported $\Delta G_f^\circ = -1672.34 \text{ kJ mole}^{-1}$ ($-399.70 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1804.56 \text{ kJ mole}^{-1}$ ($-431.30 \text{ kcal mole}^{-1}$) and $S^\circ = 130.54 \text{ J mole}^{-1}$ ($31.2 \text{ cal mole}^{-1}$) from Latimer (1952). However, Latimer (1952) calculated the ΔG_f° value for SrHPO₄(c) compound from estimated S° values. Wagman et al. (1982) listed $\Delta G_f^\circ = -1688.60 \text{ kJ mole}^{-1}$ ($-403.58 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1821.67 \text{ kJ mole}^{-1}$ ($-435.39 \text{ kcal mole}^{-1}$) and $S^\circ = 120.96 \text{ J mole}^{-1}$ ($28.91 \text{ cal mole}^{-1}$).

Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -1681.13 \text{ kJ mole}^{-1}$ ($-408.80 \text{ kcal mole}^{-1}$) from approximate ΔH_f° and S° values. In this report we adopted $\Delta G_f^\circ = -1688.60 \text{ kJ mole}^{-1}$ ($-403.58 \text{ kcal mole}^{-1}$) after Wagman et al. (1982).

SrF₂(c)

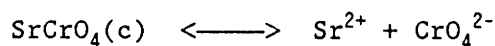
Garrels and Christ (1965) reported $\Delta G_f^\circ = -1162.31 \text{ kJ mole}^{-1}$ ($-277.80 \text{ kcal mole}^{-1}$) from Latimer (1952). However, Latimer (1952) calculated this value from $\Delta H_f^\circ = -1214.61 \text{ kJ mole}^{-1}$ ($-290.30 \text{ kcal mole}^{-1}$) and estimated S° of $89.53 \text{ J mole}^{-1}$ ($21.40 \text{ cal mole}^{-1}$). Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -1162.31 \text{ kJ mole}^{-1}$ ($-277.80 \text{ kcal mole}^{-1}$) for SrF₂(c). Pankratz (1984) reported $\Delta G_f^\circ = -1164.74 \text{ kJ mole}^{-1}$ ($-278.38 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1216.28 \text{ kJ mole}^{-1}$ ($-290.70 \text{ kcal mole}^{-1}$) and $S^\circ = -82.13 \text{ J mole}^{-1}$ ($-19.63 \text{ cal mole}^{-1}$) from Parker et al. (1971). Naumov et al. (1971) reported $\Delta G_f^\circ = -1180.56 \text{ kJ mole}^{-1}$ ($-282.16 \text{ kcal mole}^{-1}$) from $pK = 8.61$ for the reaction:



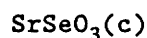
Wagman et al. (1982) recommended $\Delta G_f^\circ = -1164.57 \text{ kJ mole}^{-1}$ ($-278.34 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1216.28 \text{ kJ mole}^{-1}$ ($-290.70 \text{ kcal mole}^{-1}$) and $S^\circ = 82.13 \text{ J mole}^{-1}$ ($19.63 \text{ cal mole}^{-1}$). No other information is available to evaluate ΔG_f° for this compound. In this report we selected $\Delta G_f^\circ = -1180.56 \text{ kJ mole}^{-1}$ ($-282.16 \text{ kcal mole}^{-1}$) of Naumov et al. (1971).

SrCrO₄(c)

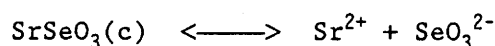
Latimer (1952) reported $\Delta G_f^\circ = -1319.21 \text{ kJ mole}^{-1}$ ($-315.30 \text{ kcal mole}^{-1}$) for SrCrO₄(c). No other information is available. Naumov et al. (1971) listed $\Delta G_f^\circ = -1318.37 \text{ kJ mole}^{-1}$ ($-315.10 \text{ kcal mole}^{-1}$) from $pK = 4.65 \pm 0.1$ for the reaction:



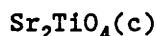
Reported ΔG_f° values for $\text{SrCrO}_4(\text{c})$ agree well. Therefore, we adopted $\Delta G_f^\circ = -1318.37 \text{ kJ mole}^{-1}$ ($-315.10 \text{ kcal mole}^{-1}$) after Naumov et al. (1971).



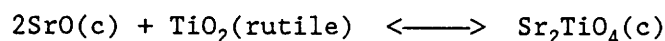
Naumov et al. (1971) reported $\Delta G_f^\circ = -969.43 \text{ kJ mole}^{-1}$ ($-231.70 \text{ kcal mole}^{-1}$) from $\text{pK} = 6.10$ for the reaction:



Karapet'yants and Karapet'yants (1970) listed $\Delta G_f^\circ = -965.83 \text{ kJ mole}^{-1}$ ($-230.84 \text{ kcal mole}^{-1}$) from approximate ΔH_f° and S° values. No further information is available. Therefore, we selected $\Delta G_f^\circ = -969.43 \text{ kJ mole}^{-1}$ ($-231.70 \text{ kcal mole}^{-1}$) after Naumov et al. (1971).



Naumov et al. (1971) listed $\Delta G_f^\circ = -2196.01 \text{ kJ mole}^{-1}$ ($-524.86 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -158.36 \text{ kJ mole}^{-1}$ ($-37.85 \text{ kcal mole}^{-1}$) for the reaction:



Parker et al. (1971) reported $\Delta G_f^\circ = -2178.60 \text{ kJ mole}^{-1}$ ($-520.70 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -2287.40 \text{ kJ mole}^{-1}$ ($-546.70 \text{ kcal mole}^{-1}$) and $S^\circ = 159.00 \text{ J mole}^{-1}$ ($38.00 \text{ cal mole}^{-1}$). Wagman et al. (1982) reported $\Delta G_f^\circ = -2172.30 \text{ kJ mole}^{-1}$ ($-519.19 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -2287.40 \text{ kJ mole}^{-1}$ ($-546.70 \text{ kcal mole}^{-1}$) and $S^\circ = 159.00 \text{ J mole}^{-1}$ ($38.00 \text{ cal mole}^{-1}$). Therefore, we selected $\Delta G_f^\circ = -2196.01 \text{ kJ mole}^{-1}$ ($-524.86 \text{ kcal mole}^{-1}$) after Naumov et al. (1971).



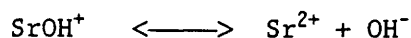
Recommended ΔG_f° values for SrOH^+ species are listed below:

Investigator	ΔG_f°	
	kJ mole^{-1}	kcal mole^{-1}
Parker et al. (1971)	-721.32	-172.40
Wagman et al. (1982)	-721.32	-172.40
Naumov et al. (1971)	-733.46	-175.30

Parker et al. (1971) recommended $\Delta G_f^\circ = -721.32 \text{ kJ mole}^{-1}$ (-172.40 kcal

mole⁻¹). No further information is available to evaluate this value. Wagman et al. (1982) also reported similar (-721.32 kJ mole⁻¹) value for SrOH⁺ species. The source was not documented.

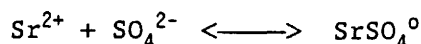
Naumov et al. (1971) listed $\Delta G_f^\circ = -733.46$ kJ mole⁻¹ (-175.30 kcal mole⁻¹) from $pK = 0.82$ and $S^\circ = -4.81$ J mole⁻¹ (-1.15 cal mole⁻¹) for the reaction:



We selected $\Delta G_f^\circ = -733.46$ kJ mole⁻¹ (-175.30 kcal mole⁻¹) for SrOH⁺ after Naumov et al. (1971).

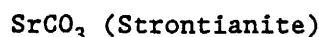


Wagman et al. (1982) recommended $\Delta G_f^\circ = -1304.03$ kJ mole⁻¹ (-311.67 kcal mole⁻¹) from ΔH_f° and S° values. Sposito and Mattigod (1980) estimated the equilibrium constant for the following equation:

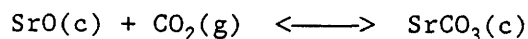


as $10^{2.20}$ whereas Smith and Martell (1976) reported $10^{2.55}$ for the same reaction.

Reardon (1983) determined the formation constant for the above reaction as $10^{2.29}$. We selected Reardon's (1983) equilibrium constant for the above reaction and calculated $\Delta G_f^\circ = -1321.39$ kJ mole⁻¹ (-315.82 kcal mole⁻¹) for SrSO₄[°] species.



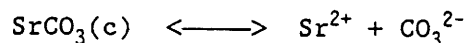
The reported ΔG_f° values range from -1137.64 to -1152.31 kJ mole⁻¹ (-271.90 to -275.40 kcal mole⁻¹). Naumov et al. (1971) listed $\Delta G_f^\circ = -1152.31$ kJ mole⁻¹ (-275.40 kcal mole⁻¹) for SrCO₃(c). This value was calculated from $\Delta H_f^\circ = -982.02$ kJ mole⁻¹ (-234.71 kcal mole⁻¹) for the reaction:



Khodakovsky et al. (1981) reported $\Delta G_f^\circ = -114.72$ kJ mole⁻¹ (-273.60 kcal mole⁻¹), based on their vapor pressure measurements of Sr(NO₃)₂·4H₂O(c) and ΔH_f° and S° values. Wagman et al. (1982) listed $\Delta G_f^\circ = -1140.10$ kJ mole⁻¹ (-272.49 kcal mole⁻¹). Karapet'yants and Karapet'yants (1970) listed $\Delta G_f^\circ = -1138.13$ kJ mole⁻¹ (-272.02 kcal mole⁻¹) from approximate calculations of

ΔH_f° and S° values. Robie et al. (1978) reported $\Delta G_f^\circ = -1137.63 \text{ kJ mole}^{-1}$ ($-271.90 \text{ kcal mole}^{-1}$).

The reported ΔG_f° values for $\text{SrCO}_3(\text{c})$ in literature differ significantly. Therefore, further investigation was done to obtain a reliable value for $\text{SrCO}_3(\text{c})$. The equilibrium constants ($\log K^\circ$) for the following reaction:

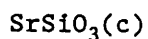


reported by the various investigators and geochemical models are listed below:

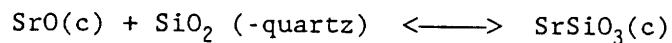
Investigator/Geochemical Model	$\log K^\circ$
Naumov et al. (1971)	-9.28
Busenberg et al. (1984)	-9.27
WATEQ-2, Ball et al. (1981)	-9.25
PHREEQE, Parkhurst et al. (1980)	-9.25
Smith and Martell (1976)	-9.03
GEOCHEM, Sposito and Mattigod (1980)	-9.00

Naumov et al. (1971) reported a value of -9.28 from products of activities of substances involved in the reaction. However, further information was not available to evaluate this value. Equilibrium constants reported by WATEQ-2, PHREEQE, and Busenberg et al. (1984) agree fairly well, except Smith and Martell (1976) and GEOCHEM.

Recently, Busenberg et al. (1984) made reliable solubility measurements for SrCO_3 (strontianite) in $\text{CO}_2\text{-H}_2\text{O}$ system from 2 to 91°C . These authors also made corrections for temperature, ionic strength, and solution complexes. Therefore, we selected $\log K^\circ$ of -9.271 after Busenberg et al. (1984). The ΔG_f° value for $\text{SrCO}_3(\text{c})$ was then calculated to be $-1144.64 \text{ kJ mole}^{-1}$ ($-273.58 \text{ kcal mole}^{-1}$) with selected ΔG_f° values of Sr^{2+} and CO_3^{2-} .



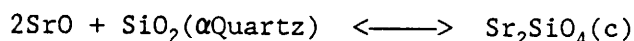
Naumov et al. (1971) listed $\Delta G_f^\circ = -1561.64 \text{ kJ mole}^{-1}$ ($-373.24 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -546.85 \text{ kJ mole}^{-1}$ ($-130.70 \text{ kcal mole}^{-1}$) for the reaction:



Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -1467.75 \text{ kJ mole}^{-1}$ ($-350.80 \text{ kcal mole}^{-1}$). Whereas Wagman et al. (1982) listed $\Delta G_f^\circ = -1549.70 \text{ kJ mole}^{-1}$ ($-370.39 \text{ kcal mole}^{-1}$). The source of information was not documented. Therefore, at present we adopted $\Delta G_f^\circ = -1561.64 \text{ kJ mole}^{-1}$ ($-373.24 \text{ kcal mole}^{-1}$) after Naumov et al. (1971).

$\text{Sr}_2\text{SiO}_4(\text{c})$

Wagman et al. (1982) listed $\Delta G_f^\circ = -2191.10 \text{ kJ mole}^{-1}$ ($-523.68 \text{ kcal mole}^{-1}$). Naumov et al. (1971) reported $\Delta G_f^\circ = -2215.09 \text{ kJ mole}^{-1}$ ($-529.42 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -876.00 \text{ kJ mole}^{-1}$ ($-209.37 \text{ kcal mole}^{-1}$) for the reaction:



Garrels and Christ (1965) and Karapet'yants and Karapet'yants (1970) listed $\Delta G_f^\circ = -2074.00 \text{ kJ mole}^{-1}$ ($-495.70 \text{ kcal mole}^{-1}$) from Latimer (1952). No further information is available for this compound. We tentatively adopted $\Delta G_f^\circ = -2191.10 \text{ kJ mole}^{-1}$ ($-523.68 \text{ kcal mole}^{-1}$) after Wagman et al. (1982).

$\text{Sr}_3(\text{PO}_4)_2(\text{c})$

Garrels and Christ (1965) reported $\Delta G_f^\circ = -3899.90 \text{ kJ mole}^{-1}$ ($-932.10 \text{ kcal mole}^{-1}$) for this compound. Authors listed this value from Latimer (1952).

No further information is available on ΔG_f° of $\text{Sr}_3(\text{PO}_4)_2(\text{c})$ in the literature. We adopted the value reported by Garrels and Christ (1965).

$\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}(\text{c})$

Busenberg et al. (1984) critically evaluated ΔG_f° of $\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}(\text{c})$ and recommended $-1734.19 \text{ kJ mole}^{-1}$ ($-414.48 \text{ kcal mole}^{-1}$). Karapet'yants and Karapet'yants (1970) listed $\Delta G_f^\circ = -1725.48 \text{ kJ mole}^{-1}$ ($-412.40 \text{ kcal mole}^{-1}$) from ΔH_f° and S° calculations. We adopted $\Delta G_f^\circ = -1734.19 \text{ kJ mole}^{-1}$ ($-414.48 \text{ kcal mole}^{-1}$) after Busenberg et al. (1984) for this compound.

$\text{SrCl}_2(\text{c})$

Garrels and Christ (1956) listed $\Delta G_f^\circ = -781.15 \text{ kJ mole}^{-1}$ ($-186.70 \text{ kcal mole}^{-1}$) from Rossini et al. (1952). Latimer (1952) reported $\Delta G_f^\circ = -781.15 \text{ kJ mole}^{-1}$ ($-186.70 \text{ kcal mole}^{-1}$) value calculated from $\Delta H_f^\circ = -828.43 \text{ kJ mole}^{-1}$ ($-198.00 \text{ kcal mole}^{-1}$) and $S^\circ = 117.15 \text{ J mole}^{-1}$ ($28.00 \text{ cal mole}^{-1}$). Wagman et al. (1982) listed $\Delta G_f^\circ = -781.10 \text{ J mole}^{-1}$ ($-186.69 \text{ kcal mole}^{-1}$). Pankratz

(1984) reported $\Delta G_f^\circ = -781.02 \text{ kJ mole}^{-1}$ ($-186.67 \text{ kcal mole}^{-1}$) from ΔH_f° and S° values. Busenberg et al. (1984) recommended $\Delta G_f^\circ = -785.00 \text{ kJ mole}^{-1}$ ($-187.62 \text{ kcal mole}^{-1}$). This value calculated from $\Delta H_f^\circ = -833.85 \text{ kJ mole}^{-1}$ ($-199.30 \text{ kcal mole}^{-1}$) and $S^\circ = 114.85 \text{ J mole}^{-1}$ ($27.50 \text{ cal mole}^{-1}$). ΔG_f° value reported by Busenberg et al. (1984) agree very well with the other values. Therefore, we adopted Busenberg et al. (1984) recommended value $-785.00 \text{ kJ mole}^{-1}$ ($-187.62 \text{ kcal mole}^{-1}$) for this compound.

$\text{SrCl}_2 \cdot \text{H}_2\text{O}(\text{c})$

Wagman et al. (1982) reported $\Delta G_f^\circ = -1036.30 \text{ kJ mole}^{-1}$ ($-247.68 \text{ kcal mole}^{-1}$). Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -1038.47 \text{ kJ mole}^{-1}$ ($-248.20 \text{ kcal mole}^{-1}$) from approximate calculations of ΔH_f° and S° values. This value is questionable. At present, we adopted $\Delta G_f^\circ = -1036.30 \text{ kJ mole}^{-1}$ ($-247.68 \text{ kcal mole}^{-1}$) reported by Wagman et al. (1982) for this compound.

$\text{SrBr}_2 \cdot \text{H}_2\text{O}(\text{c})$

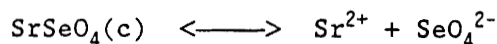
Wagman et al. (1982) reported $\Delta G_f^\circ = -954.30 \text{ kJ mole}^{-1}$ ($-228.08 \text{ kcal mole}^{-1}$). No further information is available. We adopted $\Delta G_f^\circ = -954.30 \text{ kJ mole}^{-1}$ ($-228.08 \text{ kcal mole}^{-1}$) after Wagman et al. (1982).

$\text{Sr}_3(\text{AsO}_4)_2(\text{c})$

Latimer (1952) reported $\Delta G_f^\circ = -3222.10 \text{ kJ mole}^{-1}$ ($-770.10 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -3350.13 \text{ kJ mole}^{-1}$ ($-800.70 \text{ kcal mole}^{-1}$) and $S^\circ = 312.12 \text{ kJ mole}^{-1}$ ($-74.60 \text{ cal mole}^{-1}$) values. However, S° value was estimated. Recently, Wagman et al. (1982) recommended $\Delta G_f^\circ = -3080.10 \text{ kJ mole}^{-1}$ ($-736.16 \text{ kcal mole}^{-1}$) from ΔH_f° and S° values. Therefore, we adopted the Wagman et al. (1982) value.

$\text{SrSeO}_4(\text{c})$

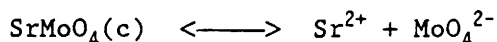
Naumov et al. (1971) reported $\Delta G_f^\circ = -1039.14 \text{ kJ mole}^{-1}$ ($-248.36 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = 2.42 \text{ kJ mole}^{-1}$ ($0.58 \text{ kcal mole}^{-1}$) and from $\text{pK} = 4.60$ for the reaction:



Karapet'yants and Karapet'yants (1970) listed $\Delta G_f^\circ = -1023.87 \text{ kJ mole}^{-1}$ ($-244.71 \text{ kcal mole}^{-1}$) from ΔH_f° and S° values. Since Naumov et al. (1971) reported ΔG_f° from pK values, we adopted their value.

SrMoO₄(c)

Naumov et al. (1971) listed $\Delta G_f^\circ = -1454.36 \text{ kJ mole}^{-1}$ ($-347.60 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = 19.24 \text{ kJ mole}^{-1}$ ($-4.60 \text{ kcal mole}^{-1}$) and $pK = 7.89$ for the reaction:



Karapet'yants and Karapet'yants (1970) reported $-1448.50 \text{ kJ mole}^{-1}$ ($-346.20 \text{ kcal mole}^{-1}$) from ΔH_f° and S° values. No further information is available. Therefore, we adopted $\Delta G_f^\circ = -1454.36 \text{ kJ mole}^{-1}$ ($-347.60 \text{ kcal mole}^{-1}$) for SrMoO₄(c) after Naumov et al. (1971).

Sr(OH)₂(c)

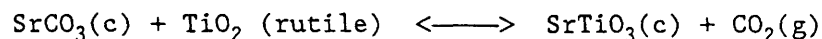
Garrels and Christ (1965) reported $\Delta G_f^\circ = -869.43 \text{ kJ mole}^{-1}$ ($-207.80 \text{ kcal mole}^{-1}$) from Latimer (1952). Latimer (1952) calculated this value from $\Delta H_f^\circ = -959.39 \text{ kJ mole}^{-1}$ ($-229.30 \text{ kcal mole}^{-1}$) and S° value of $87.86 \text{ J mole}^{-1}$ ($-21.00 \text{ kcal mole}^{-1}$). Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -870.27 \text{ kJ mole}^{-1}$ ($-208.00 \text{ kcal mole}^{-1}$). Both ΔG_f° values for Sr(OH)₂(c) agree very well. Therefore, we adopted $\Delta G_f^\circ = -870.27 \text{ kJ mole}^{-1}$ ($-208.00 \text{ kcal mole}^{-1}$) for this compound after Karapet'yants and Karapet'yants (1970).

SrI₂(c)

Karapet'yants and Karapet'yants (1970) reported $\Delta G_f^\circ = -562.33 \text{ kJ mole}^{-1}$ ($-134.40 \text{ kcal mole}^{-1}$) from approximate ΔH_f° and S° values. Pankratz (1984) recommended $\Delta G_f^\circ = -558.71 \text{ kJ mole}^{-1}$ ($-133.53 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -561.69 \text{ kJ mole}^{-1}$ ($-134.24 \text{ kcal mole}^{-1}$) and $S^\circ = 159.12 \text{ J mole}^{-1}$ ($-38.03 \text{ cal mole}^{-1}$). We adopted $\Delta G_f^\circ = -558.71 \text{ kJ mole}^{-1}$ ($-133.53 \text{ kcal mole}^{-1}$) after Pankratz (1984) for this compound.

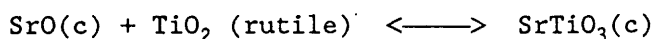
SrTiO₃(c)

Naumov et al. (1971) reported $\Delta G_f^\circ = -1600.38 \text{ kJ mole}^{-1}$ ($-382.50 \text{ kcal mole}^{-1}$). The enthalpy of formation is determined from average of ΔH_f° (298.18) $= -1684.48 \pm 4.184 \text{ kJ mole}^{-1}$ ($-402.60 \text{ kcal mole}^{-1}$). The $\Delta H_f^\circ = 99.16 \pm 0.83 \text{ J mole}^{-1}$ ($-23.70 \text{ cal mole}^{-1}$) for the reaction:

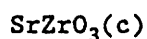


A similar $\Delta H_f^\circ = -1684.64 \pm 4.184 \text{ kJ mole}^{-1}$ ($-402.64 \text{ kcal mole}^{-1}$) was calculated from $\Delta H_f^\circ = -135.770 \pm 1.04 \text{ kJ mole}^{-1}$ ($-32.45 \text{ kcal mole}^{-1}$) from the

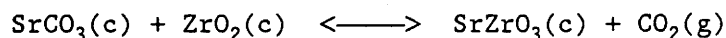
reaction:



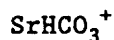
Parker et al. (1971) reported $\Delta G_f^\circ = -1588.41 \text{ kJ mole}^{-1}$ ($-379.64 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1672.38 \text{ kJ mole}^{-1}$ ($-399.70 \text{ kcal mole}^{-1}$) and $S^\circ = 108.78 \text{ kJ mole}^{-1}$ ($25.00 \text{ kcal mole}^{-1}$). Wagman et al. (1982) reported $\Delta G_f^\circ = -1588.36 \text{ kJ mole}^{-1}$ ($-379.62 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1672.38 \text{ kJ mole}^{-1}$ ($-399.70 \text{ kcal mole}^{-1}$) and $S^\circ = 108.87 \text{ J mole}^{-1}$ ($26.02 \text{ cal mole}^{-1}$). We selected $\Delta G_f^\circ = -1600.38 \text{ kJ mole}^{-1}$ ($-382.50 \text{ kcal mole}^{-1}$) after Naumov et al. (1971).



Naumov et al. (1971) reported $\Delta G_f^\circ = -2548.89 \text{ kJ mole}^{-1}$ ($-609.20 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -2904.20 \text{ kJ mole}^{-1}$ ($-694.12 \text{ kcal mole}^{-1}$) for the reaction:



Parker et al. (1971) listed $\Delta G_f^\circ = -1682.80 \text{ kJ mole}^{-1}$ ($-402.20 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1767.32 \text{ kJ mole}^{-1}$ ($-422.40 \text{ kcal mole}^{-1}$) and $S^\circ = 115.06 \text{ J mole}^{-1}$ ($27.50 \text{ cal mole}^{-1}$). Wagman et al. (1982) reported $\Delta G_f^\circ = -1682.80 \text{ kJ mole}^{-1}$ ($-402.20 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1767.30 \text{ kJ mole}^{-1}$ and $S^\circ = 115.10 \text{ J mole}^{-1}$ ($27.51 \text{ cal mole}^{-1}$). We adopted $\Delta G_f^\circ = -1682.79 \text{ kJ mole}^{-1}$ ($-402.20 \text{ kcal mole}^{-1}$) after Wagman et al. (1982).

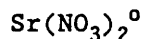


Busenberg et al. (1984) recommended $\Delta G_f^\circ = -1157.50 \text{ kJ mole}^{-1}$ ($-276.65 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1215.53 \text{ kJ mole}^{-1}$ ($-290.52 \text{ kcal mole}^{-1}$) and $S^\circ = 174.39 \text{ J mole}^{-1}$ ($41.68 \text{ cal mole}^{-1}$). No other information is available. Therefore, we adopted $\Delta G_f^\circ = -1157.50 \text{ kJ mole}^{-1}$ ($-276.65 \text{ kcal mole}^{-1}$) after Busenberg et al. (1984).

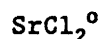


Wagman et al. (1982) reported $\Delta G_f^\circ = -1087.30 \text{ kJ mole}^{-1}$ ($-259.87 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1222.94 \text{ kJ mole}^{-1}$ ($-292.29 \text{ kcal mole}^{-1}$) and $S^\circ = -87.50 \text{ J mole}^{-1}$ ($-21.39 \text{ cal mole}^{-1}$). Parker et al. (1971) reported $\Delta G_f^\circ = -1087.33 \text{ kJ mole}^{-1}$ ($-259.88 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1222.94 \text{ kJ mole}^{-1}$ ($-292.29 \text{ kcal mole}^{-1}$) and $S^\circ = 89.53 \text{ J mole}^{-1}$ ($-21.40 \text{ cal mole}^{-1}$). Busenberg et al. (1984) reported $\Delta G_f^\circ = -1107.84 \text{ kJ mole}^{-1}$ ($-264.78 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -1226.12 \text{ kJ mole}^{-1}$ ($-293.05 \text{ kcal mole}^{-1}$) and $S^\circ = -81.46 \text{ J mole}^{-1}$ ($-19.47 \text{ cal mole}^{-1}$).

Since reported ΔG_f° values for SrCO_3 agree very well, we selected $\Delta G_f^\circ = -1107.84 \text{ kJ mole}^{-1}$ ($-264.78 \text{ kcal mole}^{-1}$) for SrCO_3 species after Busenberg et al. (1984).



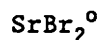
Wagman et al. (1982) reported $\Delta G_f^\circ = -781.99 \text{ kJ mole}^{-1}$ ($-186.90 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -960.52 \text{ kJ mole}^{-1}$ ($-229.57 \text{ kcal mole}^{-1}$) and $S^\circ = 260.20 \text{ J mole}^{-1}$ ($-62.19 \text{ cal mole}^{-1}$). No other information is available. Therefore, we adopted $\Delta G_f^\circ = -781.99 \text{ kJ mole}^{-1}$ ($-186.90 \text{ kcal mole}^{-1}$) after Wagman et al. (1982).



Wagman et al. (1982) listed $\Delta G_f^\circ = -821.90 \text{ kJ mole}^{-1}$ ($-196.44 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -880.10 \text{ kJ mole}^{-1}$ ($-210.35 \text{ kcal mole}^{-1}$) and $S^\circ = 80.29 \text{ J mole}^{-1}$ ($-19.19 \text{ cal mole}^{-1}$). We adopted $\Delta G_f^\circ = -821.90 \text{ kJ mole}^{-1}$ ($-196.44 \text{ kcal mole}^{-1}$) after Wagman et al. (1982).



Only Wagman et al. (1982) reported $\Delta G_f^\circ = -662.62 \text{ kJ mole}^{-1}$ ($-158.37 \text{ kcal mole}^{-1}$). No other information is available. Therefore, we adopted ΔG_f° value from Wagman et al. (1982) for this species.



Parker et al. (1971) reported $\Delta G_f^\circ = -767.38 \text{ kJ mole}^{-1}$ ($-183.41 \text{ kcal mole}^{-1}$) from $\Delta H_f^\circ = -788.89 \text{ kJ mole}^{-1}$ ($-188.55 \text{ kcal mole}^{-1}$) and $S^\circ = 132.21 \text{ J mole}^{-1}$ ($-1.60 \text{ cal mole}^{-1}$). No other information is available. Therefore, we adopted $\Delta G_f^\circ = -763.38 \text{ kJ mole}^{-1}$ ($-183.41 \text{ kcal mole}^{-1}$) after Parker et al. (1971) for this species.

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Strontium Supplement to Technical Bulletin 134: Selection of Standard Free Energies of Formation for Use in Soil Chemistry

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