

Letter Section

A treatment of complex ions in sea water

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(Received April 26, 1971)

ABSTRACT

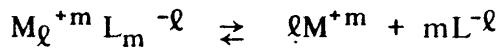
Mangel, M.S., 1971. A treatment of complex ions in sea water. *Marine Geol.*, 11: M24–M26.

The use of equilibria constants and ligand concentrations to evaluate complex ion concentrations in sea water has been employed. The concentrations of complex ions of 26 metals are included.

METHOD AND RESULTS

In order to evaluate complex ion concentrations in sea water a different approach has been taken. Ligand concentrations (Goldberg, 1965) and complex equilibria constants (Yatsimirski and Vasil'ev, 1960) have been employed.

For a general complex ion $M_\ell^{+m} L_m^{-\ell}$ (designated ML : M is the metal, L is the ligand) an equilibrium is defined:



and a corresponding constant:

$$K_\ell = \frac{[M^{+m}]^\ell [L^{-\ell}]^m}{[M_\ell^{+m} L_m^{-\ell}]}$$

Given two complexes, MA, MB; MA will predominate over MB if:

$$\log K_b - \log K_a > \log [B^{-b}] - \log [A^{-a}] \quad (\text{Sillen, 1964})$$

Finally, the ratio of concentrations of the two complexes is:

$$\frac{[MA]}{[MB]} = \frac{[A^{-a}]}{[B^{-b}]} \frac{K_b}{K_a}$$

The results of such calculations are given in the accompanying table (Table I).

TABLE I

COMPLEX IONS IN SEA WATER¹

Major species (> 30%)	Existing species (1-30%)	Minor species (0.05-1%)	Negligible species (< 0.05%)
MgSO ₄	--	MgGly ⁺	MgOH ⁺ , MgAsp, MgCit ⁻ MgAl ⁺ , MgMal, MgF ⁺ , MgAc ⁺ CaMal, CaAsp, CaGly ⁺ , CaOH ⁺ , CaAl ⁺ , CaCit ⁻ , CaAc ⁺
CaSO ₄	--	--	--
SrMal	SrOH ⁺ , SrAc ⁺ , SrGly ⁺ SrAsp, SrCit ⁻	--	--
BaMal	BaAc ⁺ , BaAsp	BaAl ⁺ , BaGly ⁺ , BaOH ⁺	--
AlF ₆ ³⁻ , AlF ₅ ²⁻	AlF ₄ ⁻	AlF ₂ ⁺	AlOH ²⁺ , Al(H ₂ O) ₆ ³⁺
In(OH) ₄ ⁻	--	--	In(Ac) ₆ ³⁻ , InF ₄ ⁻ , InBr ₃ InI ²⁺ , InCl ₃ , In(SO ₄) ₃ ³⁻
TlBr ₆ ³⁻	TlBr ₅ ²⁻	--	TlOH ⁺ , TlCl ₄ ²⁻ , TlF ⁺
SnOH ⁺	SnCl ₂ , SnCl ₃ ⁻	SnCl ⁺ , SnBr ₃ ⁻ , SnBr ₂	SnBr ⁺
Pb ₂ OH ³⁺	--	--	Pb(Al) ₂ , Pb(Gly) ₂ , PbCit ⁻ PbAc ₃ ⁻ , PbI ₃ ⁻ , PbBr ₄ , PbCl ₃ ⁺ BiBr ₂ ⁺ , BrBr ₃ , BiBr ₄ ⁻
BiBr ₆ ³⁻	BiCl ₆ ³⁻ , BiI ₆ ³⁻	--	--
VOH ²⁺	--	--	CrCl ₂ ⁺
CrF ⁺	--	CrF ₂ ⁺ , CrOH ²⁺	MnGly ⁺ , MnAl ⁺ , MnCl ⁺
MnF ³⁺	MnSO ₄ , MnAl ₂	Mn(Gly) ₂ , MnAsp	Fe(OH) ₂ ⁺ , FeF ₂ ⁺ , FeCl ₂ ⁺ Fe(SO ₄) ₂ ⁻ , FeCl ₃ , FeBr ₃ CoOH ⁺ , CoSO ₄ NiAc ⁺ , NiSO ₄
Fe(OH) ₄ ⁻	--	--	CuBr ₂ ⁻ , CuI ₂ ⁻ , CuSO ₄ , CuCl ₃ ²⁻ Cu(Ac) ₂ ZnMal, Zn(Gly) ₂ , ZnAl ⁺
Co(Gly) ₃ ⁻	Co(Asp) ₂ , Co(Gly) ₂	Co(Al) ₂	Zn(Asp) ₂ ²⁻ , ZnAc ⁺ , ZnSO ₄
Ni(Asp) ₂	Ni(Gly) ₂	Ni(Al) ₂ , NiOH ⁺	ZnOH ⁺ , ZnCl ₃ ⁻ , ZnCl ₂ , ZnCl ⁺
Cu(OH) ₂ (Cit) ₂ ⁶⁻	Cu(Gly) ₂	Cu(Asp) ₂ ²⁻ , Cu(Al) ₂	ZnI ⁺ , ZnBr ⁺
Cu(OH) ₄ ²⁻ , Cu(Gly) ₃ ⁻	Zn(OH) ₃ ⁻	--	--
Zn(OH) ₄ ²⁻	--	--	--
MoO ₄ ²⁻	--	--	--
PdCl ₄ ²⁻	--	PdBr ₄ ²⁻	--
Ag ₃ I ²⁺ , AgI ₃ ²⁻	--	Ag ₂ Br ⁺ , AgBr ₄ ³⁻ , Ag ₂ Cl ⁺ , AgCl ³⁻	AgOH, AgSO ₄ ⁻ , Ag(SO ₄) ₂ ³⁻
CdCl ₃ ⁻ , Cd(Gly) ₂	Cd(Asp) ₂ ²⁻	CdSO ₄ , CdBr ₄ ²⁻ CdI ₄ ²⁻	AgAc, Ag(Al) ₂ ⁻ , Ag(Gly) ₂ ⁻ Cd(Ac) ₂ , CdOH ⁺ , CdCit ⁻
PtBr ₄ ²⁻	PtCl ₄ ²⁻	--	--
AuCl ₄ ⁻	--	--	AuBr ₂ ⁻
HgI ₄ ²⁻	--	--	HgBr ⁺ , HgBr ₂ , HgBr ₃ ⁻ HgBr ₄ ²⁻ , HgOH ⁺ , Hg(OH) ₂ HgI ⁺ , HgI ₃ ⁻ , HgI ₂ , HgCl ₄ ²⁻ HgCl ₃ ⁻ , HgCl ₂ , HgCl ⁺ , Hg(Ac) ₂ CeBr ²⁺ , CeF ²⁺ , CeCl ²⁺ Ce(Ac) ₃ , Ce(H ₂ Cit) ₃ UBr ³⁺ , U(SO ₄) ₂
CeOH ²⁺	--	--	--
UO ₂ F ₄	UOH ³⁺	UO ₂ F ₃ ⁻	--

¹ (Per cent of metal tied up in the complex)

Abbreviations used: Cit = citrate ion; Mal = malate ion; Ac = acetate ion; Gly = glycine; Al = alanine; Asp = aspartate ion.

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