# **Dr. P. Chakraborty**

# **Associate Professor**

Centre For Oceans, Rivers, Atmosphere and Land Science Indian Institute of Technology, Kharagpur

# **Curriculum-vitae of Dr P. Chakraborty**

- 1. Name: DR. PARTHASARATHI CHAKRABORTY
- 2. Sex (M/F): M
- 3. Date of birth and Age (completed years): 24<sup>TH</sup> OF OCTOBER 1976 (42 YRS)
- 4. Educational qualifications: Ph.D., M-Tech, M.Sc.
- 5. Present occupation: ASSOCIATE PROFESSOR AT CORAL, IIT KHARAGPUR
- 6. a) Research and/or Academic Experience:

### **EDUCATION:**

Academic Qualifications (Bachelor's Degree onwards)

S No	Degree	Subject	Year	University	Additional Particulars
					- rd -
1	B Sc (H)	Chemistry (H)	1997	University of	3 <sup>rd</sup> Rank
		Physics Mathematics		North	In the University
		Mainematics		West	
				Bengal, India	
2	M Sc	Chemistry	2000	University of	1 <sup>st</sup> Rank in the
				North	University
				Bengal,	
				West	
-				Bengal, India	. et –
3	M-Tech	Industrial	2002	Cochin	1 <sup>st</sup> Rank in the
		Catalysis		University Of	University
				Science And	
				l echnology,	
2			2007	Kerala, India	
3	PhD	Analytical and	2007	Carleton	-
		Chomistry		Offiversity,	
		Onemisuy		Canada	
				Canada	

#### POSITIONS HELD EARLIER (IN CHRONOLOGICAL ORDER)

S No	Period	Place of Employment	Designation
1	Sep 03-Jul 07	Carleton University, Canada	Teaching Assistant
2	Sep 03-Jul 07	Carleton University, Canada	Research Assistant
3	Sep-07-Oct 08	Wageningen University, The Netherlands	Postdoctoral Research Associate
4	Dec 08-Dec 12	CSIR-NIO, Visakhapatnam	Scientist C

5	May 12-Aug 12	University of Saskatchewan, Canada	Visiting Scientist (on deputation)
6	Dec-12- Dec 18	CSIR-NIO, Goa	Senior Scientist
7	Dec-18-till date	CORAL, IIT KGP	Associate Professor

Field(s) of specialization:

## METAL GEOCHEMISTRY/ ENVIRONMENTAL GEOCHEMISTRY

# Complete list of publications in standard refereed journals

## No. of Papers Published: 57 Total Impact Factor = 167.48, h-index-20, i-index=33

S. No.	Authors	Title of the paper	Journal, volume, page no. & Year
1.	Saranya Jayachandran <sup>1</sup> , <b>Parthasarathi</b> <b>Chakraborty*</b> , Darwin Ramteke, , Kartheek Chennuri, and Sucharita Chakraborty <sup>1</sup> Ph.D student	Effect of pH on transport and transformation of Cu-sediment complexes in mangrove systems	Volume 133, August 2018, Pages 920- 929. https://doi.org/10.10 16/j.marpolbul.2018. 03.054
2.	Parthasarathi Chakraborty*, Saranya Jayachandran, Jyothi Lekshmy, Prasad Padalkar, Lamjahao Sitlhou, Kartheek Chennuri, Suhas Shetye, Areef Sardar, and Rakhee Khandeparker	Seawater intrusion and re- suspension of surface sediment control mercury (Hg) distribution and its bioavailability in water column of a monsoonal estuarine system during dry period	Science of the Total Environment MS No. STOTEN-D- 18-11114 (Minor revision)
3.	Prasad P. Padalkar, <b>Parthasarthi</b> <b>Chakraborty*</b> , Kartheek Chennuri, Saranya Jayachandran, Lamjahao Sitlhou, Mandar Nanajkar, Supriya Tilvi and Keisham Singh	Molecular characteristics of sedimentary organic matter in controlling elemental mercury distribution in tropical estuarine sediments	Science of the Total Environment MS No. STOTEN-D- 18-09871 (Moderate revision)
4.	Sucharita Chakraborty <sup>1</sup> , <b>Parthasarathi</b> <b>Chakraborty*,</b> Arindam Sarkar, Armoury Kazip, M.B.L. Mascarenhas-	Distribution and geochemical fractionation of lead in the continental shelf sediments around India	Geological Journal (First published: 09 May 2018) https://doi.org/10.10 02/gj.3218

	Pereira, B. Nagender Nath		
	<sup>1</sup> Ph.D student		
5.	Parthasarathi Chakraborty*, Saranya Jayachandran, Sucharita Chakraborty	Chromium speciation in the sediments across the oxygen minimum zone, western continental margin of India	Geological Journal (First published: 21 June 2018) https://doi.org/10.10 02/gj.3214
6.	S. Chakraborty <sup>1</sup> , <b>Parthasarathi</b> <b>Chakraborty</b> *, A. Sarkar, B. N. Nath <sup>1</sup> Ph.D student	Kinetic and equilibrium based fractionation study of Pb in continental shelf sediment of India	Marine pollution bulletin, 123(1-2), pp.188-196. (2017) DOI information: 10.1016/j.marpolbul. 2017.08.063
7.	K Vudamala <sup>1</sup> , <b>Parthasarathi</b> <b>Chakraborty*</b> , BBV Sailaja <sup>1</sup> Ph.D student	An insight into mercury reduction process by humic substances in aqueous medium under dark condition	Environmental Science and Pollution Research 24 (16), 14499- 14507 (2017)
8.	Parthasarathi Chakraborty	Oyster reef restoration in controlling coastal pollution around India: A viewpoint	Marine pollution bulletin, 115(1-2), pp.190-193 (2017).http://dx.doi.o rg/10.1016/j.marpolb ul.2016.11.059
9.	Parthasarathi Chakraborty	Mercury exposure and Alzheimer's disease in India-An imminent threat?	Science of The Total Environment Volume 589, 1 July 2017, Pages 232– 235
10.	Chakraborty, Parthasarathi., Ramteke, D., Chakraborty, S., Chennuri, K. and Bardhan, P.	Corrigendum to" Relationship between the lability of sediment- bound Cd and its bioaccumulation in edible oyster"[Mar. Pollut. Bull. 100 (2015) 344-351].	, <i>Marine pollution bulletin, 105</i> (1), p.437 (2016)
11.	Parthasarathi Chakraborty, Robert P. Mason, Saranya Jayachandran, Krushna Vudamala, Kazip Armoury, Arindam Sarkar, Sucharita Chakraborty, Pratirupa Bardhan, Richita Naik	Effects of bottom water oxygen concentrations on mercury distribution and speciation in sediments below the oxygen minimum zone of the Arabian Sea	Marine Chemistry, 186, pp.24-32. (2016)

12.	V Purnachandra Rao and Parthasarathi Chakraborty	Estuarine and Marine Geology (2011-2016)	Proc Indian Natn Sci Acad 82 No. 3 July Spl Issue (2016) (IUGS report, edited volume)
13.	Parthasarathi Chakraborty • Sucharita Chakraborty • Saranya Jayachandran • [] • B. Nagender Nath	Effects of bottom water dissolved oxygen variability on copper and lead fractionation in the sediments across the oxygen minimum zone, Western Continental margin of India	Science of the Total Environment Science of the Total Environment, 566, pp.1052- 1061.(2016)
14.	Krushna Vudamala, Parthasarathi Chakraborty*	Kinetic speciation of mercury- humic acid complexes in aqueous solutions by using competing ligand exchange method	Microchemical Journal, 126, pp.551-557. (2016) DOI: 10.1016/j.microc.20 16.01.012
15.	A. Prajith · V. Purnachandra Rao · <b>Parthasarathi</b> Chakraborty	Distribution, provenance and early diagenesis of major and trace metals in sediment cores from the Mandovi estuary, western India	Estuarine Coastal and Shelf Science; <u>Volume 170</u> , 5 (2016), Pages 173– 185
16.	Parthasarathi Chakraborty · Krushna Vudamala · Kartheek Chennuri · Kazip A · Linsy P. · Darwin Ramteke · Tyson Sebastian · Saranya Jayachandran · Chandan Naik · Richita Naik · B. Nagender Nath	Mercury profiles in sediment from the marginal high of Arabian Sea: An indicator of increasing anthropogenic Hg input in Sea	Environmental Science and Pollution Research, 23(9), pp.8529- 8538.(2016) DOI: 10.1007/s11356- 015-5925-1
17.	Arindam Sarkar · <b>Parthasarathi</b> <b>Chakraborty ·</b> Bejugam Nagender Nath	Distribution and nature of sedimentary organic matter in a tropical estuary: An indicator of human intervention on the environment	Marine Pollution Bulletin , Volume 102, Issue 1, 15 January 2016, Pages 176–186
18.	Simontini Sensarma · Parthasarathi Chakraborty · Ranadip Banerjee · Subir Mukhopadhyay	Geochemical fractionation of Ni, Cu and Pb in the deep sea sediments from the Central Indian Ocean Basin: An insight into the mechanism of metal enrichment in sediment	Chemie der Erde- Geochemistry, 76(1), pp.39- 48.(2015) DOI: 10.1016/j.chemer.20 15.10.002
19.	Parthasarathi Chakraborty · Sucharita Chakraborty · Krushna Vudamala · Arindam Sarkar · B. Nagnder Nath	Partitioning of metals in different binding phases of tropical estuarine sediments: Importance of metal chemistry	Environmental Science and Pollution Research, 23(4), pp.3450-3462 (2015) DOI: 10.1007/s11356-

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20.	Parthasarathi	Relationship between the lability of	Marine pollution
	<u>Ramteke</u> <u>Sucharita</u> <u>Chakraborty</u> <u>Kartheek</u>	sediment-bound Cd and its bioaccumulation in edible oyster	pp.344-351.(2015)
	<u>Chennuri</u> · <u>Pratirupa</u> <u>Bardhan</u>		
21.	Naqvi and CSIR-NIO Team	Understanding our seas: National Institute of Oceanography, Goa	Current Science, 108(8); 2015; 1454- 1460
22.	Parthasarathi Chakraborty • Darwin Ramteke • Subhadra Devi Gadi • Pratirupa Bardhan	Linkage between speciation of Cd in mangrove sediment and its bioaccumulation in total soft tissue of oyster from the west coast of India	Marine pollution bulletin, 106(1-2), pp.274-282. (2015) DOI: 10.1016/j.marpolbul. 2015.12.025
23.	Sucharita Chakraborty Parthasarathi Chakraborty, B.N. Nath	Lead distribution in coastal and estuarine sediments around India: A comprehensive literature review	Marine pollution bulletin, 97(1-2), pp.36-46.(2015)
24.	Parthasarathi Chakraborty, P.V. Raghunadh Babu	Environmental controls on the speciation and distribution of mercury in surface sediments of a tropical estuary, India	Marine pollution bulletin, 95(1), pp.350-357. (2015) <u>http://dx.doi.org/10.1</u> <u>016/j.marpolbul.201</u> <u>5.02.035</u> ,
25.	Parthasarathi Chakraborty, Darwin Ramteke, Sucharita Chakraborty	Geochemical partitioning of Cu and Ni in mangrove sediments: Relationships with their bioavailability	Marine pollution bulletin, 93(1-2), pp.194-201. (2015) <u>http://dx.doi.org/10.1</u> <u>016/j.marpolbul.201</u> <u>5.01.016</u> (2015)
26.	Parthasarathi Chakraborty, Sucharita Chakraborty, Darwin Ramteke, Kartheek Chennuri	Kinetic speciation and bioavailability of copper and nickel in mangrove sediments	Marine pollution bulletin 88 (1), 224- 230(2015)
27.	Parthasarathi Chakraborty, Krushna Vudamala, Mariame Coulibaly, Darwin Ramteke, Kartheek Chennuri, David Lean	Reduction of mercury (II) by humic substances—influence of pH, salinity of aquatic system	Environmental Science and Pollution Research, 22(14), pp.10529- 10538.(2015) DOI: 10.1007/s11356- 015-4258-4
28.	Brij Mohan Sharma, Shrest Tayal, <b>Parthasarthi</b>	Chemical Characterization of Meltwater from East Rathong	Book Chapter: Dynamics of Climate

	Chakraborty, GK Bharat	Glacier Vis-à-Vis Western Himalayan Glaciers	Change and Water Resources of Northwestern Himalaya, 181-190 Publisher: Springer International Publishing (2015)
29.	* <b>Parthasarathi</b> <b>Chakraborty</b> , Arindam Sarkar, Krushna Vudamala, B. Nagender Nath	Organic matter-A key factor in controlling mercury distribution in estuarine sediment	Marine Chemistry, 173, pp.302-309. (2015) http://dx.doi.org/10.1 016/j.marchem.2014 .10.005
30.	Parthasarathi Chakraborty, Sylvia G. Sander, Saranya Jayachandran, B. Nagender Nath, G. Nagaraju, Kartheek Chennuri1, Krushna Vudamala, N. Lathika, M B L. Mascarenhas-Pereira	Fate of copper complexes in hydrothermally altered deep sea sediments from the Central Indian Ocean Basin	Environmental Pollution, 194, 138- 144 (2014)
31.	Parthasarathi Chakraborty, P.V. Raghunadh Babu, Krushna Vudamala, Darwin Ramteke, Kartheek Chennuri	Mercury speciation in coastal sediments from the central east coast of India	Marine Pollution Bulletin, 81, 2014, 282-288 (2014)
32.	Parthasarathi Chakraborty, Darwin Ramteke, Sucharita Chakraborty, B. Nagender Nath	Changes in metal contamination levels in estuarine sediments around India-An assessment	Marine Pollution Bulletin, 78, 2014, 15-25 (2014)
33.	Parthasarathi Chakraborty, Brijmohan Sharma, P.V. Raghunath Babu, Koffi Marcellin Yao, Saranya Jaychandran	Impact of Total Organic Carbon (in sediments) and Dissolved Organic Carbon (in overlying water column) on Hg sequestration by coastal sediments from the central east coast of India	Marine Pollution Bulletin, 79, 2014, 342-347 (2014)
34.	Parthasarathi Chakraborty, Koffi Marcellin Yao, P.V. Raghunadh Babu, Krishna Vudamala, Kartheek Chennuri	Interactions of mercury with different molecular weight fractions of humic substances in aquatic environments	Environmental earth sciences, 72(3), pp.931-939. doi:10.1007/s12665- 013-3028-1 (2014)
35.	Parthasarathi Chakraborty, Aditya Manek, Som Niyogi, Jeff	Determination of dynamic metal complexes and their diffusion coefficients in the presence of different humic substances by	Analytical Letters 47 (7), 1224-1241 (2014)

	Hudson	combining two analytical techniques	
36.	Parthasarathi Chakraborty, Melodie Boissel, Alice Reuillon, P.V.R. Babu, G Parthiban,	Ultrafiltration technique in conjunction with competing ligand exchange method for Ni-humics speciation in aquatic	Microchemical Journal, 106, (2013) 263–269
37.	Parthasarathi Chakraborty	Some fundamental aspects of metal-sediment interactions in marine environment	CSIR Newsletter, September (2012), Vol-62 No. 17& 18
38.	Parthasarathi Chakraborty, P.V.R. Babu, and V.V. Sarma	A study of lead and cadmium speciation in some estuarine and coastal sediments	Chemical Geology, (2012), 294-295, 217-225
39.	Parthasarathi Chakraborty	Speciation of Co, Ni and Cu in the coastal and estuarine sediments: Some fundamental characteristics	Journal of Geochemical Exploration, (2012), 115, 13–23.
40.	Parthasarathi Chakraborty, P. V. R. Babu, V. V. Sarma	A new spectrofluorometric method for the determination of total arsenic in sediments and its application to kinetic speciation	International Journal of Environmental Analytical Chemistry, (2012), 92, 2, 133-147
41.	Parthasarathi Chakraborty	A multi-method approach for the study of lanthanum speciation in coastal and estuarine sediments	Journal of Geochemical Exploration, (2012), 114, 134-135
42.	Parthasarathi Chakraborty, Saranya Jayachandran, P.V. Raghunadh Babu, Shanta Karri, Priyadarshini Tyadi, K. M. Yao, B.M. Sharma	Intra-annual variations of arsenic totals and species in tropical estuary surface sediments	Chemical Geology, 322–323 (2012) 172–180
43.	Chakraborty, Parthasarathi	Corrigendum to "A multi-method approach for the study of lanthanum speciation in coastal and estuarine sediments"[J of Geochem Explor, 110 (2011) 225– 231].	Journal of Geochemical Exploration, 114, pp.134-135. (2012).
44.	Parthasarathi Chakraborty, T. Acharyya, P.V. R. Babu and D. Bandhyopadhyay	Impact of salinity and pH on phytoplankton community in a tropical freshwater system: An investigation with pigment analysis by HPLC.	Journal of Environmental Monitoring, (2011), 13, 614-620
45.	Parthasarathi Chakraborty, P.V.R. Babu, and V.V. Sarma	A multi-method approaches for the study of lanthanum speciation in coastal and estuarine sediments	Journal of Geochemical Exploration, (2011),

			110 (2) 225-231.
46.	Parthasarathi Chakraborty	Study of cadmium-humic interactions and determination of stability constants of cadmium- humate complexes from their diffusion coefficients obtained by scanned stripping voltammetry and dynamic light scattering techniques	Analytica Chimica Acta, 659(1-2); 137- 143, (2010).
47.	Parthasarathi Chakraborty, P. V. R. Babu, Tamoghna Acharyya and D. Bandyopadhyay	Stress and toxicity of biologically important transition metals (Co, Ni, Cu and Zn) on phytoplankton in a tropical freshwater system: An investigation with pigment analysis by HPLC	Chemosphere, 80 (2010) 548–553
48.	Pascal L. R. van der Veeken, <b>Parthasarathi</b> <b>Chakraborty</b> and Herman P. van Leeuwen	Accumulation of Humic Acid in DET/DGT Gels	Environmental Science and Technology., ( <b>2010)</b> , 44 (11), 4253–4257
49.	Parthasarathi Chakraborty, Jiujiang Zhao and C. L. Chakrabarti	Copper and nickel speciation in mine effluents by combination of two independent techniques	Analytica Chimica Acta 636 (2009) 70- 76.
50.	Jiujiang Zhao, Ismail I. Fasfous, John D. Murimboh, Tahir Yapici, <b>Parthasarathi</b> <b>Chakraborty</b> , Sheren Boca, Chuni L. Chakrabarti	Kinetic study of uranium speciation in model solutions and in natural waters using Competitive Ligand Exchange Method.	Talanta, 77(3), 1015-1020.(2009)
51.	Raewyn M. Town, <b>Parthasarathi</b> <b>Chakraborty</b> and H. P. van Leeuwen	Dynamic DGT speciation analysis and applicability to natural heterogeneous complexes	Environmental Chemistry, (2009), 6(2) 170.
52.	Parthasarathi Chakraborty and Chuni L. Chakrabarti	Competition from Cu(II), Zn(II) and Cd(II) in Pb(II) binding to Suwannee River Fulvic Acid	Water, air, and soil pollution,195,1-4, 63-71, (2008).
53.	Yamini Gopalapillai, Ismail I. Fasfous, John Murimboh , Tahir Yapici, <b>Parthasarathi</b> <b>Chakraborty</b> , Chuni L. Chakrabarti	Determination of free nickel ion concentrations using the ion exchange technique: Application to mining and municipal effluents	Aquatic Geochemistry ,14, 2, 99-116, (2008)
54.	Parthasarathi Chakraborty	Chemical heterogeneity of humic substances and its impact on metal complexation in natural waters	Carleton University, P210, 2007
55.	Parthasarathi Chakraborty, Ismail I.	Simultaneous determination of speciation parameters of Cu, Pb,	Analytical and Bioanalytical

	Fasfous, John Murimboh, and Chuni. L. Chakrabarti	Cd and Zn in model solutions of well-characterized Fulvic acid	Chemistry, 388, 2, 463-474, (2007)
56.	Parthasarathi Chakraborty and Chuni. L. Chakrabarti	Chemical speciation of Co (II), Ni (II), Cu (II) and Zn (II) in (Sudbury, Canada) Copper Cliff mine effluent and the effect of dilution of the effluent with the tap water on the lability of the metal-DOC complexes	Analytica Chimica Acta, ,571, 2, 261- 269, (2006)
57.	Parthasarathi Chakraborty, Y. Gopalapillai, John Murimboh, Ismail I. Fasfous and Chuni. L. Chakrabarti	Kinetic speciation of nickel in mining and municipal effluents.	Analytical and Bioanalytical Chemistry,386, 6, 1803-1813, (2006).

## **AWARDS /HONORS:**

- Shanti Swarup Bhatnagar Prize, 2018, CSIR-INDIA, September 2018
- Fellow of Indian Geophysical Union, Hyderabad, March 2018
- Appointed as an Associate Editor of Marine Pollution Bulletin, Elsevier, (Impact Factor-3.25) USA, 2017
- Selected for the IAGC-Kharaka Award -2017 by International Association of Geochemistry, USA.
- Identified as a potential reviewer of National Science Foundation (NSF), USA for the assessment and evaluation of NATIONAL SCIENCE FOUNDATION (NSF, USA) funded projects.
- Associate member of SCOR (Scientific Committee on Oceanic Research)-WG 145 (Chemical Speciation Modelling in Seawater to Meet 21st Century Needs)
- MS Krishnan Gold Medal-2015 from Geological Society of India
- National Geosciences Award-2013 in Oceanography and Marine Geology from Ministry of Mines
- Associate member of SCOR (Scientific Committee on Oceanic Research)-WG 139 (Organic Ligands A key Control on Trace Metal Biogeochemistry in the Ocean)
- **Outstanding Graduate Student Award** in Environmental/Analytical Chemistry (Varian Lecture Award, **\$2000, 2007**).
- Academic Excellence Award (\$5000/year, 2003-2007), Carleton University, Canada
- Academic Rank Certificate for securing First class First (2002) in M.Tech, Cochin University of Science and Technology, India.
- University Gold Medal for securing First class Firstposition in M. Sc. (2000) North Bengal University, India.
- SurendranathBhattyacharya Gold Medal for securing First class Firstposition in M. Sc. (2000) North Bengal University, India.
- Scholarship (\$2000/year, 2003-2007) Department of Chemistry, Carleton University
- GATE Scholarship (Rs 49500, 2000-2002), All India Council of Technical Education
- National Scholarship (Rs, 5000/year, 1998-2000), Govt. of India

### Membership in Academics/Societies/Professional bodies

- Life Member of Indian Geophysical Union, Hyderabad
- Associate Member of SCOR (Scientific Committee on Oceanic Research)-WG 145 (Chemical Speciation Modelling in Seawater to Meet 21st Century Needs)
- Associate Member of SCOR (Scientific Committee on Oceanic Research)-WG 139 (Organic Ligands A key Control on Trace Metal Biogeochemistry in the Ocean)
- Member of **Canadian Chemical Society**
- Member of International Association of Geochemists, USA
- Life member of Ocean Society of India
- Life member of the Indian Science Congress Association
- Recognized as a PhD supervisor in Andhra University/ Goa University/ Bharathidasan University.

#### SIGNIFICANT CONTRIBUTIONS TO SCIENCE AND/ OR TECHNOLOGY:

Metal Speciation is a multidisciplinary study of the occurrence, mobility and detection of metal species within different environments as well as their interaction with life. I initiated metal speciation study (after establishing the FIRST metal-speciation laboratory in India (at CSIR-National Institute of Oceanography) in 2008) to understand the role of metal-natural ligands interactions in controlling distribution, fate, mobility, and bioavailability of trace/heavy metals in marine environments (estuarine, coastal and open ocean).

My research succeeded in revealing one of the closely guarded secrets of nature: how the metalbuffering action of natural ligands (Fe/Mn-oxyhydroxide, dissolved organic carbon, humic substances etc) makes them a vital web in the complex fabric of homeostasis.

I discovered that metal (trace/heavy) loading in sediments; trace metal competitions, major cation's screening, quantity and quality of sedimentary natural ligands play key roles in controlling the concentration of labile metal-complexes and their dissociation rate constants (a good indicator of metal's bioavailability) in marine sediment system. Ligand Field Stabilization Energy, water exchange rate, Jahn-Teller distortion of transition metals has been used by me as useful tools to understand metal-natural ligands interactions in estuarine and coastal sediments. Results of his research offer a new way to explain metal–natural ligands interactions in marine environments.

My research provides a better description on the patterns of trace/heavy metals distribution and the processes that control metal speciation in the continental shelf sediments around India. An important research achievement of mine has been to advance the science of metal speciation by identifying the analytical timescale of measurement as the critical parameter for defining the chemical species in coastal and marine sediment system.

My research in perennial oxygen minimum zone shows that varying redox condition of the overlying water column can influence the stability and lability of metal-complexes in sediment. He proved that sediment-water exchange fluxes at low oxygen environment may alter bioavailability of some heavy metals in water column which may have tremendous impact on biological species in the overlying water column.

I have also been investigating the speciation and fate of different metal complexes in hydrothermally altered deep sea sediments and polymetallic nodules from the Central Indian Ocean Basin. His aim is to assess the probable impacts of deep sea mining on speciation and bioavailability of metal complexes in the Central Indian Basin and their impact on deep sea environments.

My research showed that low thermodynamic stability (with fast dissociation rate constants) and high concentration of labile metal complexes are responsible for their high bioaccumulation in sessile organisms. I succeeded in finding out a mechanistic linkage between trace/heavy metal

speciation, bioavailability in marine system. In view of the Arsenic/mercury posing health problems in our country; I also developed simple, reliable and inexpensive techniques for arsenic and mercury speciation in marine sediments/water systems.

My research greatly improved our understanding on metal-natural ligand interaction in marine environments and led to predictive models from the experimental and observational data on metal speciation around India, with particular emphasis on societal applications.

My research helped to understand the role of metal-natural ligands interactions in controlling distribution, fate, mobility, and bioavailability of trace/heavy metals in tropical marine environments (estuarine, coastal and open ocean).

(a) Impact of the contributions in the field concerned, basic or applied:

I made unique and outstanding contributions to the field of Environmental Geochemistry which has facilitated the understanding of the metals-natural ligands interaction in marine environment. My study always helps us to know different geochemical processes in the Indian Ocean region. The major contributions made by Dr Chakraborty in the field of Environmental Geochemistry (in the field of trace and heavy metal speciation in marine systems) are described below:

Since the marine systems are dynamic in nature and never at chemical equilibrium, I realized 1. that chemical-equilibrium-based approach to do metal speciation would give wrong estimates of labile metal concentrations (which are widely correlated with ecotoxicity) in marine sediments. I developed kinetics-based approaches to understand metals speciation and their bioavailability in estuarine/coastal and deep sea systems. My research focuses on developing and applying a wide range of kinetic methods for chemical speciation in marine/estuarine sediment systems, each with its own characteristic timescale of measurement. An important research achievement of mine has been to advance the science of metal speciation by identifying the analytical timescale of measurement as the critical parameter for defining the chemical species in coastal and marine sediment system. The ability of the speciation techniques (multi-method approach) to provide a chemically significant description of the kinetics of metal-natural ligands interaction in sediment suggests that the metal and ligand exchange reactions precede mainly by the disjunctive mechanism (complete dissociation of ML), a fundamental process in coastal marine systems. I showed that kinetics-based approach provides the actual metal speciation instead of the current practice of chemical equilibrium speciation. This kinetic based is expected to promote wider acceptance of the approach by regulatory agencies.

2. I have demonstrated the effects of Ligand Field Stabilization Energy, water exchange rate, Jahn Teller distortion of transition metals on their speciation and bioavailability in estuarine and coastal sediments. This is for the first time that these effects have been described in sediments. This research is directly relevant for researchers in geochemistry as it will help provide a better understanding of metal–natural ligand interactions in marine environments.

3. By realizing the global catastrophic risk in near future, many developing countries have already signed the treaty to reduce Hg use and its release to control environmental Hg pollution. However, how to reduce the impact of climate change on Hg pollution is not truly known. Climate change is anticipated to increase Earth's average temperature and influence overall patterns and amounts of precipitation. Climate change has been proclaimed to increase Hg pollution even if anthropogenic Hg emission remains constant. Therefore, increasing anthropogenic Hg release with climate change is expected to intensify the detrimental effects of Hg in the developing countries. I took the challenge to understand Hg-natural ligands interaction with an aim to reduce Hg pollution in marine systems. He showed that sedimentary Hg concentrations around India are low and not alarming. I identified that sedimentary organic matter can be an important factor to control Hg distribution and their bioavailability in coastal marine systems. I suggests that non-labile sedimentary organic matter (with high C: N molar ratio) reduces Hg(II) to Hg<sup>0</sup> and followed by the

release of Hg<sup>0</sup> from the sediment system decreases the total sedimentary Hg concentration in the sediments around India. I suggest that planting trees may holistically reduce the impacts of climate change on Hg pollution.

The outcomes of my research have been enormously contributing to the field of environmental geochemistry and oceanic biogeochemistry. Two of my research articles are the most cited articles in "Marine Chemistry" and "Chemical Geology" journals (the two most respected international journals in Chemical and geological oceanography) since 2012, (extracted from Scopus).

My pioneering works put me as an associate member of Scientific Committee on Ocean Research Working Groups (SCOR-WG 139 and SCIR-WG 145). I am the recipient of SHANTI SWARUP BHATNAGAR PRIZE-2018 (CSIR, India), NATIONAL GEOSCIENCE AWARD-2013 (Ministry of Mines, Govt of India) KRISHNAN MEDAL -2015 (Indian Geophysical Union), KHARAKA AWARD-2017 (International Association of Geochemistry, USA) and INDIAN SOCIETY OF APPLIED GEOCHEMISTS (ISAG)-MEDAL-2017 for my significant contributions to the field of Environmental Geochemistry. My international recognition includes serving as an associate member of Scientific Committees (SCOR-WG139 AND WG-145), Thesis reviewer and committee member in foreign university (Otago University, New Zealand) and working as a potential reviewer for the assessment and evaluation of NATIONAL SCIENCE FOUNDATION (NSF, USA) funded projects. I have been a visiting scientist/Professor to University of Saskatchewan, Canada. I have been appointed as an ASSOCIATE EDITOR of a very reputed journal MARINE POLLUTION BULLETIN (ELSEVIER, with IMPACT FACTOR 3.15).

### HUMAN RESOURCE DEVELOPMENT

I have been significantly contributing in developing quality students for PhD (completed-2, Thesis submitted-1, PhD undergoing-4, Post-doc-2 and MSc dissertation -14.

### SOCIETAL RELEVANCE OF MY RESEARCH WORK:

Scientific research is performed to elucidate how the world around us is functioning. One dimension of the acquired knowledge is that it can be used to develop various sectors of society such as industry, education, governmental practices, the health system or social cohesion. A main characteristic of the so-called societal relevance of research is therefore the quest towards answering questions that society asks or to solve problems it faces. Even though modern societies highly depend on scientific research it is highly disputable how the societal relevance of academic research can (A) be measured and (B) improved. I have been relentlessly working on this challenge. I started acquiring knowledge (from his academic research) and started educating people in Goa (by portraying his research outcome in the local news papers). Goa is famous for its beaches, and sea foods. However, industrialization and rapid economic growth have increasingly contaminated our estuarine sediments with heavy/trace metals which are among the serious pollutants due to their toxicity, persistence and bioaccumulation. My research of toxic metal accumulation in edible oyster or increasing concentration of Hg is gastropod took attention of the general public in Goa. The cut out of the few papers are appended below. I have been working to find out a simple mechanism to reduce toxic metal concentrations in soft tissues of oysters.