南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

课程详述
COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	**化学海洋学 Chemical Oceanography**
2.	**授课院系** **Originating Department**	海洋科学与工程系 Department of Ocean Science and Engineering
3.	**课程编号** **Course Code**	OCE307
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业核心课 Major Core Course
6.	**授课学期** **Semester**	春季 Spring
7.	**授课语言** **Teaching Language**	中英双语 English & Chinese
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）** **Instructor(s), Affiliation& Contact** **（For team teaching, please list all instructors）**	李芯芯 海洋科学与工程系 创园 9 栋 605 0755-88018796 Drs. Xinxin Li Department of Ocean Sciences and Engineering Chuang Yuan 9-605
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	赵昕 海洋科学与工程系 创园 9 栋 605 0755-88018796 zhaox@mail.sustech.edu.cn Xin Zhao Department of Ocean Sciences and Engineering Chuang Yuan 9-605
10.	**选课人数限额(可不填)** **Maximum Enrolment（Optional）**	

		讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
11.	授课方式 Delivery Method					
	学时数 Credit Hours	48	0	0	0	48

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	OCE302 海洋生态系统导论 Introduction to Marine Ecosystem
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	OCE471 海洋实习 Marine Cruises
14.	其它要求修读本课程的学系 Cross-listing Dept.	

教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

OCE307 是针对本科生学习化学海洋学的基础课程，学生将全面了解如何用化学方法解决海洋学问题。本课程会着重强调海洋碳循环与地球环境间的相互关系。

OCE307 is an introduction to chemical oceanography for undergraduate students. The class will provide you with a comprehensive overview of how the chemistry being applied in solving oceanographic questions. There will be an emphasis on the interaction of the marine carbon cycling with the environment.

16. **预达学习成果 Learning Outcomes**

能力方面：具有自主学习的能力和终身学习的意识；具有获取有关专业信息的能力，掌握中外文资料查询、文献检索及运用现代信息技术获取和表达信息的基本方法；具有不断学习和适应社会发展的能力。

知识方面：系统掌握化学海洋学基本理论、基本知识和基本技能，了解海洋科学的知识体系和发展趋势；了解化学海洋学的前沿发展现状和趋势。掌握一门外国语及基本的信息技术；具备一定的人文和社会科学知识。

The students will gain the ability of self-motivated study for their life-time; They are able to obtain the international scientific references, papers using modern information technology, and have the potential of continuous study and adaptation to the development of the society.

They master basic theories and skills of chemical oceanography, understand the knowledge, frontiers and development trends in chemical oceanography in different marine ecosystems. They master a foreign language, basic information and technology, and obtain certain background in humanities and social sciences.

17. **课程内容及教学日历（如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）**
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

Topic	hours
1. 课程及大纲简介 Syllabus and Class Introduction	3
2. 质量守恒 Mass Balance	3
3. 热力学 Thermodynamics	3
4. 碳酸盐化学 Carbonate Chemistry	3
5. 海洋硅循环 Silicate Cycle	3
6. 营养盐化学-1 Nutrients-1	3
7. 营养盐化学-2 Nutrients-2	3
8. 海洋富营养化及缺氧环境化学 Eutrophication and Hypoxia	3
9. 期中考试 Mid-Term	3
10. 同位素化学 Isotopes	3

11. 海洋有机地球化学 Organic Geochemistry-1	3
12. 海洋有机地球化学 Organic Geochemistry-2	3
13. 海洋沉积物化学 Marine Sediments	3
14. 河口海洋化学 Estuary Biogeochemistry	3
15. 海洋生命过程及碳循环 Life Processes and Marine Carbon Cycle	3
16. 期末考试 Final	3

1. 课程及大纲简介 Syllabus and Class Introduction

Chemical Oceanography is the most interdisciplinary of all the sub-disciplines of this interdisciplinary science. It is based on the distribution and dynamics of elements, isotopes, atoms and molecules. This ranges from fundamental physical, thermodynamic and kinetic chemistry to two-way interactions of ocean chemistry with biological, geological and physical processes. It encompasses both inorganic and organic chemistry. The cornerstones of progress are breakthroughs in analytical chemistry.

Readings:

Libes S. (1992), Marine Biogeochemistry. Wiley, New York, 734pp.

Ocean Studies Board (1999), Global Ocean Science: Toward an Integrated Approach. National Academy Press, Washington, 165pp.

Butcher S.S., R.J. Chrlson, G.H. Orians and G.V. Wolfe (eds)(1992), Global Biogeochemical Cycles. Academic Press, San Diego, 379 pp.

2. 质量守恒 Mass Balance

The purpose of this class is to Introduce the concept of Steady State and Residence Time and introduce the tools necessary to develop the two main types of models used in chemical oceanography. These are:

-Box (or reservoir) Models

-Continuous Transport-reaction Models

Readings:

Chameides W.L. and E.M. Perdue (1997), Biogeochemical Cycles. Oxford, 224 pp.

Lasaga A.C. (1980), The kinetic treatment of geochemical cycles. Geochim. Cosmochim. Acta, 44, 815-828.

3. 热力学 Thermodynamics

To understand the chemical oceanography, it is necessary to have some understanding of physical chemistry. Only a few basic concepts are required. The material in this lecture comes from the field of chemical thermodynamics. For the purpose of this class there are only a few basic concepts you need to know in order to conduct equilibrium calculations. With these calculations we can predict chemical composition using chemical models. The main questions we ask are:

1. Is a geochemical system at chemical equilibrium?

2. If not, what reaction (s) are most likely to occur?

Readings:

Drever J.I. (1997), The Geochemistry of Natural Waters. Prentice Hall, Upper Saddle River, NJ, 436pp.

Klotz I.M. (1964), Chemical Thermodynamics. W.A. Benjamin, New York, 468pp.

Morel F.M.M. and J.G.Hering (1993), Principles and applications of Aquatic Chemistry. John Wiley, New York, 588pp.

Stumm W. and J.J. Morgan (1996), Aquatic Chemistry. 3rd edition, John Wiley, New York, 1022 pp.

4. 碳酸盐化学 Carbonate Chemistry

CaCO3 is present in shallow sediments and disappears in sediments below a certain depth in the water column. Is this depth controlled by mineral solubility? The saturation state varies as a function of temperature and pressure and can be calculated from thermodynamics. Fortunately, the equilibrium constants are well known as a function of temperature, pressure and salinity.

Readings:

Langmuir D. (1997), Aqueous Environmental Geochemistry. Prentice Hall, Upper Saddle

River, NJ, 600pp.

5. 海洋硅循环 Silicate Cycle

Beginning in the second half of the twentieth century, the importance of the silicon cycle in marine biogeochemistry began to be appreciated and the key role of diatoms in the export of carbon toward the ocean interior was noted. The silica cycle is strongly intertwined with other major biogeochemical cycles, like those of carbon and nitrogen, and as such is intimately related to marine primary production, the efficiency of carbon export to the deep sea, and the inventory of carbon dioxide in the atmosphere. The budget needs to incorporate advances that have notably changed estimates of river and groundwater inputs to the ocean of dissolved silicon and easily dissolvable amorphous silica, inputs from the dissolution of terrestrial lithogenic silica in ocean margin sediments, reverse weathering removal fluxes, and outputs of biogenic silica.

Drever J.I. (1971), Early diagenesis of clay minerals, Rio Ameca Basin, Mexico. J. Sed. Petrol., 41,

982-994.

Michalopoulos P. and R.A. Aller (1995), Rapid clay mineral formation in Amazon delta sediments:

reverse weathering and oceanic elemental cycles. Nature, 270, 614-617.

Paul J. Tréguer and Christina L. De La Rocha (2013), The World Ocean Silica Cycle, Annual Review of Marine Science 5:1, 477-501

6. 营养盐化学-1 Nutrients-1

7. 营养盐化学-2 Nutrients-2

Two topics include:

- vertical and horizontal segregation

- case studies (Fe and N)

By definition, biolimiting elements are those: necessary to sustain life and exist in low concentrations

For the most part the prototypical macro biolimiting elements are:

P as PO4 Soft Parts

N as NO3

Si as H4SiO4 Hard Parts

Several trace elements can be limiting, most notably iron.

Readings:

Codispoti L.A. (1989), Phosphorus vs Nitrogen limitation of mew and export production. In (W.H. Berger, V.S. Smetacek and G. Wefer, eds) Productivity of the Ocean: Present and Past. Wiley, 377-394.

Dugdale R.C., F.P. Wilkerson and H.J. Minas (1995) ,The role of silicate pump in driving new production. Deep-Sea Research, 42, 697-719.

Dugdale R.C. and F.P. Wilkerson (1998), Silicate redulation of new production in the equatorial Pacific upwelling. Nature, 391, 270-273.

8. 海洋富营养化及缺氧环境化学 Eutrophication and Hypoxia

Production and destruction of organic matter by photosynthesis and respiration will be discussed. Much of this are related to biological oceanography and we talk about biological oceanography from a chemical oceanography perspective, with an emphasis on chemical tracers and feedbacks, such as Eutrophication and Hypoxia.

The topic is important for three key reasons:

1. One cannot understand the chemistry of the oceans without considering biological influences.

2. To understand the limits on biological production in the oceans, we need to understand the underlying chemical constraints (especially the macro (e.g. N and P) and micro (e.g. Fe and Zn) nutrients).

3. The balance between ocean productivity and respiration is called export production.

Readings:

Hale SS, Cicchetti G and Deacutis CF (2016), Eutrophication and Hypoxia Diminish Ecosystem Functions of Benthic Communities in a New England Estuary. Front. Mar. Sci. 3:249.

T.S. Bianchi, S.F. DiMarco a, J.H. Cowan Jr. b, R.D. Hetland a, P. Chapman a, J.W. Day b, M.A. Allison (2010), The science of hypoxia in the Northern Gulf of Mexico: A review, Science of the Total Environment, 408 1471–1484.

9. 期中考试 Mid-Term

10. 同位素化学 Isotopes

Stable and radioactive isotopes are the most useful tracers available to geochemists. In almost all cases the distributions of these isotopes have been used to study oceanographic processes controlling the distributions of the elements. Radioactive isotopes are especially useful because they provide a way to put time into geochemical models. Several light elements such as H, C, N, O, and S have more than one stable isotope form, which show variable abundances in natural samples. This variability is caused by isotopic fractionation during chemical reactions. Heavier elements like Pb also have several stable isotopic forms but their distributions are controlled more by their different sources than by fractionation.

Readings:

Altabet M.A. and L. F. Small (1990), Nitrogen isotopic ratios in fecal pellets produced by marine zooplankton. Geochim. Cosmochim. Acta 54, 155-163.

Berner R.A. (1987), Models for carbon and sulfur cycles and atmospheric oxygen: Application to Paleozoic geological history. Amer. J. Sci., 287, 177-196.

Berner R.A. (1989), Biogeochemical cycles of carbon and sulfur and their effect on atmospheric oxygen over Phanerozoic time. Palaoegraphy, Palaeoclimatalogy, Palaeoecology, 3, 97-122.

Degens E.T. (1968), Biogeochemistry of stable carbon isotopes. In: (Eqlinton and Murphy, eds.) Organic Geochemistry: Methods and Results. Springer, Berlin, 304-329.

11. 海洋有机地球化学 Organic Geochemistry-1

12. 海洋有机地球化学 Organic Geochemistry-2

Topics addressed in Marine Organic Geochemistry

- Carbon budget- DOC&POC measurement/sources and sinks etc.
- Marine food web dynamics–organism's utilization of DOC
- Genesis of prebiotic organic carbon
- Trace metal-organic interactions-solubility, bioavailability, toxicity
- Optical characteristics of seawater-absorption of light, most <300 and visible 350-800nm.
- Other organics such as volatiles, DMS etc.

Readings:

Bombaugh, K.J. (1984),The use of HPLC for water analysis. In: Water Analysis, Vol. III. R.A. Minear and L.H. Keith (eds.), Academic Pess, Inc. pp 317-379.

Kujawinski, E.B. et al. (2002), The application of electrospray ionization mass spectrometry (ESI-MS) to the structural characterization of natural organic matter. Org. Geochem., 33: 171-180.

Schwarzenbach, R.P. and W. Giger (1984), Gas chromatography. In: Water Analysis, Vol. III. R.A. Minear and L.H. Keith (eds.), Academic Pess, Inc. pp. 167-251.

Yunker, M.B., R.W. Macdonald, D.J. Veltkamp and W.J. Cretney (1995), Terrestrial and marine biomarkers in a seasonally ice-covered Arctic estuary- integration of multivariate and biomarker approaches. Marine Chemistry, vol. 49,

13. 海洋沉积物化学 Marine Sediments

The most important processes on the Earth`s surface occur in the ocean where materials and energy are primarily exchanged. In the case of marine chemistry different fields of chemistry from organic to inorganic as well as thermodynamics and biochemistry are involved. Chemical processes occurring in the marine sediment are discussed such as sedimentary organic matter preservation and atmospheric O2 regulation, sedimentary geochemistry of the carbonate and sulphide systems and their potential influence on toxic metal bioavailability.

Readings:

Gianguzza, Antonio, Pelizzetti, Ezio, Sammartano, Silvio (Eds.) 2013, Chemistry of Marine Water and Sediments, Springer Berlin Heidelberg, 484pp.

14. 河口海洋化学 Estuary Biogeochemistry

Estuaries, located at the interface between land and the coastal ocean are dynamic, highly productive systems that, in many cases, have been historically associated with development of many of the great centers of early human civilization. Consequentially, these systems have and continue to be highly impacted by anthropogenic inputs. Estuary biogeochemistry offers an interdisciplinary approach to understanding biogeochemical cycling. The class utilizes numerous illustrations and an extensive literature base to impart the current state-of-the-art knowledge in this field and provides a unique foundation in the areas of geomorphology, geochemistry, biochemistry, aqueous chemistry, and ecology, while making strong linkages to ecosystem-based processes in estuarine sciences.

Readings:

Thomas S. Bianchi (2006), Biogeochemistry of Estuaries 1st Edition, Oxford University Press, 687pp.

15. 海洋生命过程及碳循环 Life Processes and Marine Carbon Cycle

The effects of life processes are felt in every process of the ocean chemistry. Patterns of chemical distributions within the ocean are primarily controlled by biological processes and ocean circulation. Major features of this biogeochemical mosaic include removal of nutrients from warm surface ocean waters, concentration of these same nutrients in deep-ocean waters, and depletion of dissolved oxygen at intermediate water depths. These patterns are imprinted as mixing and advection carry nutrient-laden water from ocean depths into the sunlit upper water. These nutrients are used during photosynthesis to generate particulate and dissolved organic carbon that sink or are mixed into the interior ocean, where they are respired back into dissolved metabolites.

Readings:

Emerson, S., & Hedges, J. (2008), Life processes in the ocean. In Chemical Oceanography and the Marine Carbon Cycle (pp. 173-218). Cambridge: Cambridge University Press.

16. 期末考试 Final

18. 教材及其它参考资料 Textbook and Supplementary Readings

1.Chemical Oceanography and the Marine Carbon Cycle,

Steven Emerson and John Hedges, 2008.

Cambridge University Press

2.Chemical Oceanography. Millero F J. CRC Press, 1996.

课程评估 ASSESSMENT

19. 评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		5		
课堂表现 Class Performance		0		
小测验 Quiz		0		
课程项目 Projects		0		
平时作业 Assignments		15		
期中考试 Mid-Term Test		30		
期末考试 Final Exam		50		

期末报告 **Final Presentation**				
其它（可根据需要改写以上评估方式） **Others (The above may be modified as necessary)**				自我约束 自我提高 This is a self-motivated class

20. 记分方式 **GRADING SYSTEM**

☑ A. 十三级等级制 **Letter Grading** ☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
This Course has been approved by the following person or committee of authority

海洋科学与工程系本科教学委员会 Department of Ocean Science and Engineering Undergraduate Committee