郑天元 博士　　副教授　硕士生导师

环境工程系

移动电话	18563980281	电子邮箱	zhengtianyuan@ouc.edu.cn
联系地址	青岛市松岭路 238 号，中国海洋大学，环境科学与工程学院 A226		
研究方向	地下环境多场数值模拟软件开发与应用、滨海含水层海水入侵的防控机制和环境效应、多尺度多相流数值模拟及其在地下渗流的应用		

个人简介

围绕地下渗流模拟的前沿科学问题，深入参与开发著名多相流数值模拟软件（Dumux），负责开发了世界知名多相多场耦合数值模拟软件（OpenGeoSys）中热学、热流耦合、流固耦合、热流固耦合等计算模块。在国内外共发表论文 50 余篇，其中 SCI 收录论文 50 余篇，参与出版英文专著 3 部。近 5 年，在国际期刊上以**第一或通讯作者发表 SCI 论文 40 余篇**，其中在 WRR、JGR、JH 等水文、环境等相关领域**顶尖期刊发表论文 30 篇，被引用 600 余次**。主持国家自然科学**面上基金项目**、**青年基金**项目、**国家自然科学基金委-山东省联合基金重点支持项目课题**各 1 项，负责**国家自然科学基金重点项目课题** 1 项，参与完成国家重点研发计划课题 1 项。主要承担的海水入侵防控研究成果获 2021 年**山东省科技进步二等奖**（排名第 3）、2022 年**山东省海洋科技创新奖二等奖**（排名第 1）。现任**美国地球物理学会（AGU）地下水专业委员会委员**，长期担任《Water Resources Research》、《Journal of Hydrology》等国际顶尖学术期刊的审稿人，2020 年入选中国海洋大学英才计划，2022 年当选**山东省高等学校青年创新团队带头人**，担任**水文领域顶尖期刊 Journal of Hydrology 副主编，**2023 年入选中国海洋大学**优秀青年科技人才培育计划**。

教育背景

2014.10 - 2017.12	德国德累斯顿工业大学（Technical University of Dresden）	环境系统科学	博士
2011.09 - 2014.09	德国斯图加特大学（University of Stuttgart）	水资源管理和水利工程	硕士
2007.09 - 2011.07	中国海洋大学	环境工程	学士

工作经历

2021.03 - 至今	中国海洋大学环境科学与工程学院	副教授
2019.01 – 2020.12	中国海洋大学工程学院	博士后
2018.01 – 2019.12	德国亥姆霍兹环境研究中心（Helmholtz Centre for Environmental Research）	环境信息学，博士后

学术兼职

副主编：Journal of Hydrology

客座编辑：Frontiers in Marine Science

美国地球物理学会(AGU)地下水专业委员会委员

世界多孔介质联合会(Interpore)会员

国际期刊审稿人：Water Resources Research, Journal of Hydrology, Science of Total Environment, Frontiers in Marine Science, Water Resource Management, Environmental Research, Environmental Science and Pollution Research, Critical Reviews in Biotechnology 等

荣誉奖励

2021　　山东省科技进步二等奖（3/9），“滨海地下水源地海水入侵防治关键技术及其工程应用”

2022　　山东省海洋科技创新奖二等奖（1/7），“黄海沿海典型区海水入侵综合防治技术研究与应用示范”

承担课程

本科生课程：地下水动力学、环境水文地质学实验。

研究生课程：渗流理论、环境数据统计与分析。

研究进展

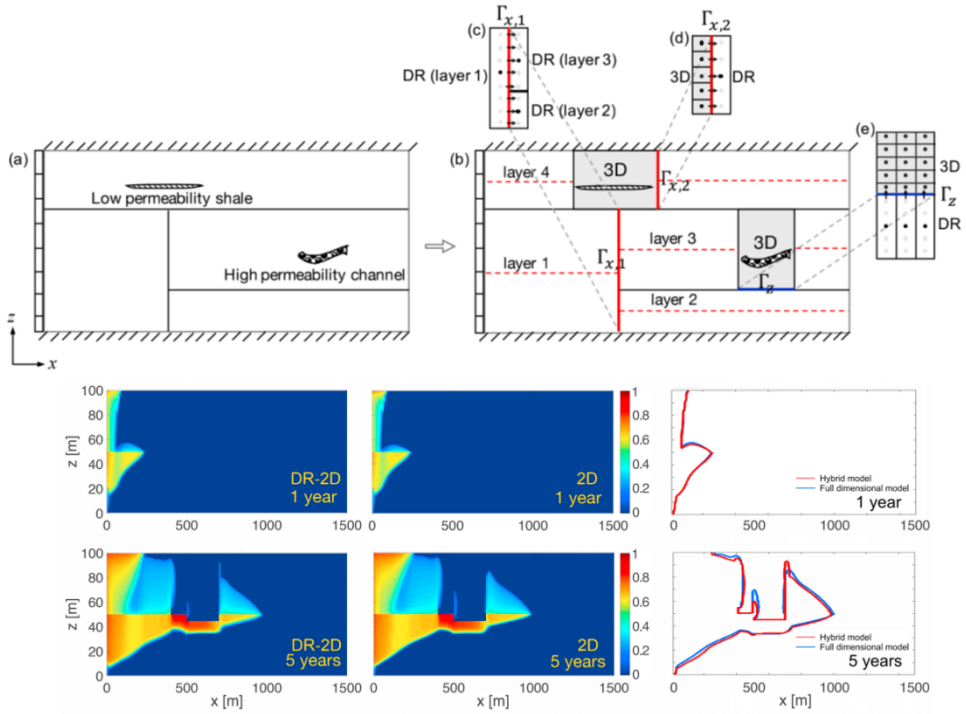
本课题组长期从事多物理化学场条件下地下多相渗流数值模拟相关的工作，基于 OGS 和 DUMUX 进行开源数值模拟软件的开发与应用，致力于海岸带海水入侵、二氧化碳地下封存和浅层地热利用等关键科学问题研究。

①开发了多场耦合多相流数值模拟软件系统

负责完成了 OGS 中热学、热流耦合、流固耦合、热流固耦合等模块的程序编写、算例的云端自动测试（Jenkens）和版本控制与融合（Git）等研究工作，扩展了 OGS 的功能和应用领域，开发的软件和相关算例已经由 Springer 正式出版（Kolditz 等 2016，2018a，2018b）。

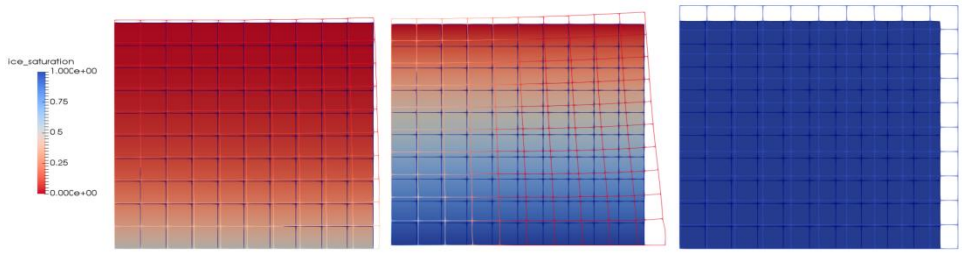
1）建立了多相流全尺寸和降维的耦合算法并应用于二氧化碳地下封存的工作中

鉴于二氧化碳地下封存过程持续时间长和空间尺度大的问题，传统三维两相流模型的计算效率很低，往往采用降维模型的方法来提升计算效率，而地层的局部非均质又限制了降维模型的应用。在 IMPES 算法的基础上，建立了多相流全尺寸模型和降维模型的耦合算法，在非均质的区域使用全尺寸模型，在均质区域使用降维模型，这种耦合算法对比全尺寸模型可以大幅度提升计算效率，并保证了相似的计算精度。



2）建立并开发了热流固耦合结冰模型并应用在浅层地热开发中

在主持开发 OpenGeoSys 热-流-固耦合模块的基础上，基于连续介质固体力学和熵不等原理，推导出相变结冰条件下热-流-固耦合本构方程，提出了稳态和动态两种模拟相变结冰的算法，在 OGS 中开发了热-流-固-结冰全耦合的计算模块，成功地预测了低温条件下换热管内流体和周围地层的温度变化和管道受力变化，提高了地源热泵系统效率计算的准确性。

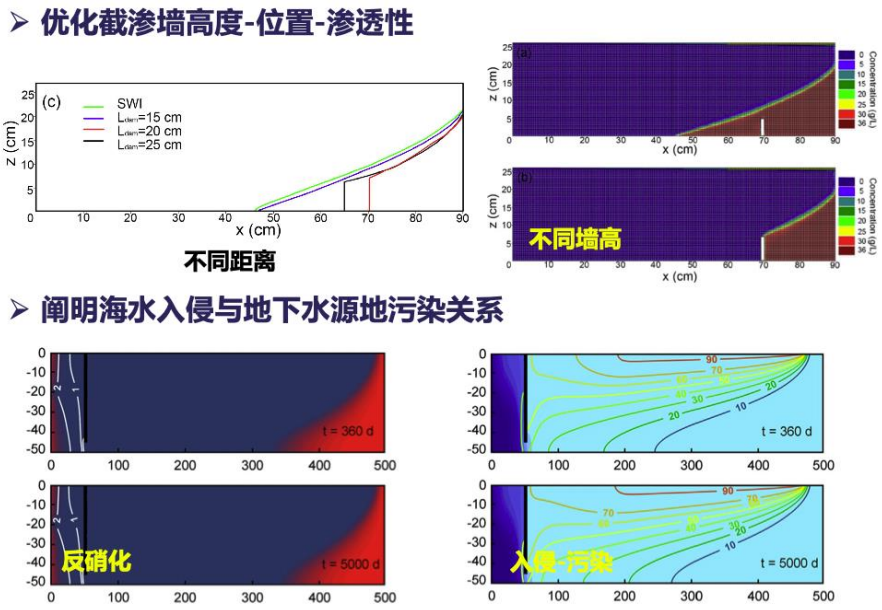


(a) 50 s　(b) 150 s　(c) 1000 s

②发展了海水入侵评价理论与治理方法

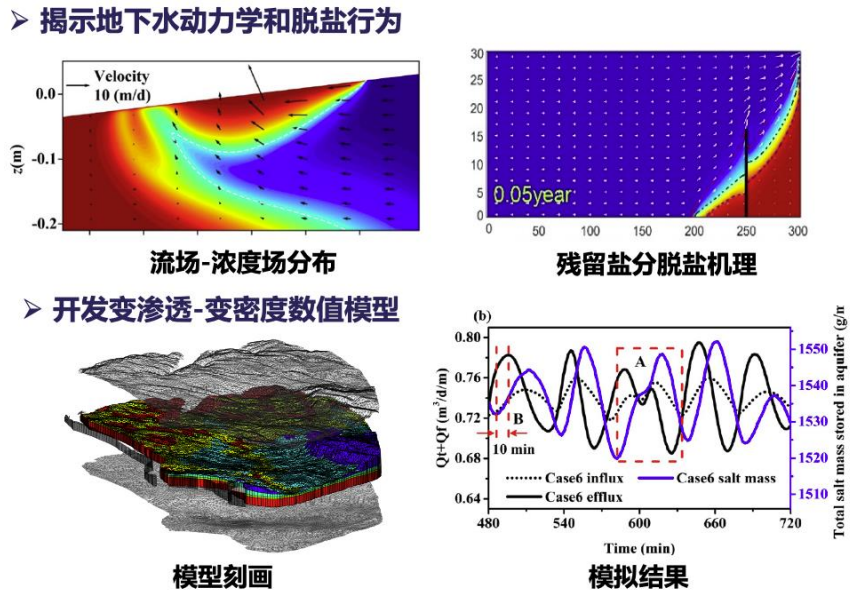
1）揭示了截渗墙防控海水入侵的动力学机制和环境效应

通过建立溶质运移耦合变密度流的海水入侵数值模型，系统阐明了不同截渗工程作用下滨海地下水流场和溶质浓度场的动态变化特征，定量评价潮汐和动态淡水边界条件下，截渗墙结构和含水层性质对地下水海底排泄、咸淡水分布、上游硝酸盐富集的影响效应，优化了截渗墙的结构和布局。



2）建立了地下残留咸水净化机制和治理方案

建立了现场尺度的多尺度地下水渗流-溶质运移数值模型，捕捉了地下残留咸水的自动净化行为，揭示了截渗工程作用下含水层残留咸水净化的动力学机制，明确了咸水净化的真实时间尺度，提出了“自然净化”、“坑湖排水”和“井-湖联排”等咸水治理方案，取得了较好的应用效果。



主要研究成果

代表性期刊论文

[1] Liu Shixuan, **Zheng Tianyuan***, Li Yongxia, Zheng Xilai. (2023). “A critical review of the central role of microbial regulation in the nitrogen biogeochemical process: New insights for controlling groundwater nitrogen contamination”. *Journal of Environmental Management*, 328(2): 116959.

[2] Qiao Shixuan, Chen Youyuan*, Li Jiaxing, Li Yangpei, Peng Tao, Liang Jun, **Zheng Tianyuan**, Fu Kaiming, Chang Qinpeng. (2023). "A novel and efficient $CaCO_3$ scale inhibitor in high-temperature and high-salinity geothermal systems: A deprotonated quadripolymer". *Journal of Applied Polymer Science*, 140(10): e53581.

[3] Sun Qiguo, **Zheng Tianyuan***, Zheng Xilai*, Cao Min, Zhang Bo, Jiang Shiqiang. (2023). "Causal interpretation for groundwater exploitation strategy in a coastal aquifer". *Science of The Total Environment*, 867: 161443.

[4] Shen Zhicon, Wang Dong*, **Zheng Tianyuan**. (2023). "Numerical simulations of the synthetic processes and consequences of secondary hydrates during depressurization of a horizontal well in the hydrates production". *Energy*, 263(21-22): 125675.

[5] Fang Yunhai, Qian Jiazhong*, **Zheng Tianyuan***, Wang Huan, Zheng Xilai, Marc Walther. (2022). "Submarine groundwater discharge in response to the construction of subsurface physical barriers in coastal aquifers". *Journal of Hydrology*, 617(9):129010.

[6] **Zheng Tianyuan**, Li Min, Xia Lu*, Li Xin, Fang Yunhai, Zheng Xilai. (2022). "Influence of pH on bioclogging in porous media during managed aquifer recharge (MAR): Effectiveness and mechanism". *Journal of Contaminant Hydrology*, 252(9): 104119.

[7] Sun Qiguo, **Zheng Tianyuan***, Zhang Bo*, Zheng Xilai. (2022). "An expert-knowledge-based algorithm for time-varying multi-objective coastal groundwater optimization". *Journal of Hydrology*, 867: 161443.

[8] Liu Shixuan, Yang Zhixiang, Liu Yang, Zheng Xilai*, Yang Huiyu, Marc Walther, **Zheng Tianyuan***. (2022). "Improvement of dissolved organic nitrogen extraction accuracy in unsaturated zones". *Hydrological Processes*, 36(9): e14680.

[9] Su Zenghui, Sun Ping, Chen Youyuan*, Liu Jiaxin, Li Jie, **Zheng Tianyuan**, Yang Shiying. (2022). "The influence of alkali-modified biochar on the removal and release of Zn in bioretention systems: Adsorption and immobilization mechanism". *Environmental Pollution*, 310(8): 119874.

[10] Hou Yuxuan, Yang Jie, Chris Russoniello, **Zheng Tianyuan**, Wu Meilin, Yu Xuan*. (2022). "The influence of alkali-modified biochar on the removal and release of Zn in bioretention systems: Adsorption and immobilization mechanism". *Water Resources Research*, 58(7): e2021WR031866.

[11] Yu Lu, **Zheng Tianyuan***, Yuan Ruyu, Zheng Xilai. (2022). "APCS-MLR model: A convenient and fast method for quantitative identification of nitrate pollution sources in groundwater". *Journal of Environmental Management*, 314(2): 115101.

[12] Fang Yunhai, **Zheng Tianyuan***, Guo Bo, Zhan Hongbin, Wang Huan, Zheng Xilai, Marc Walther. (2022). "Transformation in the Stability of Tide-Induced Upper Saline Plume Driven by Transient External Forcing". *Water Resources Research*, 58(6): e2021WR031331.

[13] Fang Yunhai, **Zheng Tianyuan***, Wang Huan, Zheng Xilai, Marc Walther. (2022). "Nitrate transport behavior behind subsurface dams under varying hydrological conditions". *Science of The Total Environment*, 838(9): 155903.

[14] Fang Yunhai, **Zheng Tianyuan***, Wang Huan, Zheng Xilai, Marc Walther. (2022). "Influence of Dynamically Stable-Unstable Flow on Seawater Intrusion and Submarine Groundwater Discharge Over Tidal and Seasonal Cycles". *Journal of Geophysical Research: Oceans*, 127(4): e2021JC018209.

[15] Chang Qinpeng, **Zheng Tianyuan***, Gao Chenchen, Zheng Xilai, Marc Walther. (2022). "How to cope with downstream groundwater deterioration induced by cutoff walls in coastal aquifers". *Journal of Hydrology*, 610(4): 127804.

[16] **Zheng Tianyuan***, Gao Mingpeng, Chang Qinpeng, Zheng Xilai, Marc Walther. (2022). "Dynamic Desalination of Intruding Seawater After Construction of Cut-Off Walls in a Coastal Unconfined Aquifer". *Frontiers in Marine Science*, 9: 857807.

[17] Gao Shaobo, **Zheng Tianyuan***, Zheng Xilai, Marc Walther. (2022). "Influence of layered heterogeneity on nitrate enrichment induced by cut-off walls in coastal aquifers". *Journal of Hydrology*, 609(9): 127722.

[18] Fang Yunhai, **Zheng Tianyuan***, Wang Huan, Guan Rui, Zheng Xilai, Marc Walther. (2021). "Experimental and numerical evidence on the influence of tidal activity on the effectiveness of subsurface dams". *Journal of Hydrology*, 603(4):127149.

[19] Sun Qiguo, **Zheng Tianyuan***, Zheng Xilai, Marc Walther. (2021). "Effectiveness and comparison of physical barriers on seawater intrusion and nitrate accumulation in upstream aquifers". *Journal of contaminant hydrology*, 243(11):103913.

[20] **Zheng Tianyuan***, Guo Bo*, Shao Haibin. (2021). "A hybrid multiscale framework coupling multilayer dynamic reconstruction and full-dimensional models for CO_2 storage in deep saline aquifers". *Journal of Hydrology*, 600: 126649.

[21] Yu Lu, **Zheng Tianyuan***, Hao Yujie, Zheng Xilai. (2021). "Determination of the nitrogen isotope enrichment factor associated with ammonification and nitrification in unsaturated soil at different temperatures". *Environmental Research*, 202: 111670.

[22] Gao Mingpeng, **Zheng Tianyuan***, Chang Qinpeng, Zheng Xilai, Marc Walther. (2021). "Effects of mixed physical barrier on residual saltwater removal and groundwater discharge in coastal aquifers". *Hydrological Processes*, 35(7): e14263.

[23] Fang Yunhai, **Zheng Tianyuan***, Zheng Xilai*, Yang Huiyu, Wang Huan, Marc Walther. (2021). "Influence of Tide Induced Unstable Flow on Seawater Intrusion and Submarine Groundwater Discharge". *Water Resources Research*, 57(4): e2020WR029038.

[24] **Zheng Tianyuan**, Zheng Xilai*, Chang Qinpeng*, Zhan Hongbin, Marc Walther. (2021). "Timescale and effectiveness of residual saltwater desalinization behind subsurface dams in an unconfined aquifer." *Water Resources Research* 57(2): e2020WR028493.

[25] Zhang Bo, **Zheng Tianyuan***, Zheng Xilai*, Marc Walther. (2021). "Utilization of pit Lake on the cleaning process of residual saltwater in unconfined coastal aquifers". *Science of The Total Environment*, 770(7): 144670.

[26] Chang Qinpeng, **Zheng Tianyuan***, Chen Youyuan*, Zheng Xilai, Marc Walther. (2020). "Influence of inland freshwater influx on the natural Desalination of coastal aquifers with a cutoff wall". *Desalination*, 499: 114863.

[27] Fang Yunhai, **Zheng Tianyuan***, Xilai Zheng*, Peng Hui, Wang Huan, Xin Jia, Zhang Bo. (2020). "Assessment of the hydrodynamics role for groundwater quality using an integration of GIS, water quality index and multivariate statistical techniques". *Journal of Environmental Management*, 273: 111185.

[28] Chang Qinpeng, **Zheng Tianyuan***, Chen Youyuan*, Zheng Xilai, Marc Walther. (2020). "Investigation of the elevation of saltwater wedge due to subsurface dams". *Hydrological Processes*, 34(22): 4251-4261.

[29] **Zheng Tianyuan**, Zheng Xilai*, Sun Qiguo*, Wang Lichun, Marc Walther. (2020). "Insights of variable permeability full-section wall for enhanced control of seawater intrusion and nitrate contamination in unconfined aquifers". *Journal of Hydrology*,586: 124831.

[30] Yuan Ruyu, **Zheng Tianyuan***, Zheng Xilai, Liu Dongsheng, Xin Jia, Yu Lu, Liu Guanqun. (2020). "Identification of groundwater nitrate pollution sources in agricultural area using PCA and SIAR methods". *Episodes*, 43(2): 739-749.

[31] Wang Huan, Xin Jia*, Zheng Xilai*, Li Min, Fang Yunhai, **Zheng Tianyuan**. (2020). "Clogging evolution in porous media under the coexistence of suspended particles and bacteria: Insights into the mechanisms and implications for groundwater recharge". *Journal of Hydrology*, 582(12):124554.

[32] Yu Lu, **Zheng Tianyuan***, Zheng Xilai*, Hao Yujie, Yuan Ruyu. (2020). "Nitrate source apportionment in groundwater using Bayesian isotope mixing model based on nitrogen isotope fractionation". *Science of The Total Environment*, 718: 137242.

[33] Li Min, **Zheng Tianyuan***, Zhang Jian, Fang Yunhai, Liu Jiang, Zheng Xilai*, Peng Hui. (2019). "A New Risk Assessment System Based on Set Pair Analysis – Variable Fuzzy Sets for Underground Reservoirs". *Water Resources Management*, 33(1): 4997-5014.

[34] Wang Leyun, Xin Jia*, Nai Hui, **Zheng tianyuan**, Tian Feifei, Zheng Xilai. (2019). "Sorption of DONs onto clay minerals in single-solute and multi-solute systems: Implications for DONs mobility in the vadose zone and leachability into groundwater". *Science of The Total Environment*, 712(3): 135502.

[35] Hu Rongting, Zheng Xilai, **Zheng Tianyuan***, Xin Jia, Sun Qiguo. (2019). "Effects of carbon availability in a woody carbon source on its nitrate removal behavior in solid-phase denitrification". *Journal of Environmental Management*, 246(246):832-839.

[36] **Zheng Tianyuan**, Xilai Zheng*, Huan Wang*, Xin Jia, Zhang Bo, Marc Walther. (2019). "Innovative techniques for measuring the oil content of oil-contaminated porous media". *Groundwater Monitoring & Remediation*, 39(3): 78-83.

[37] Chang Qinpeng, **Zheng Tianyuan***, Zheng Xilai*, Zhang bo, Sun Qiguo, Marc Walther. (2019). "Effect of subsurface dams on saltwater intrusion and fresh groundwater discharge". *Journal of Hydrology*, 576: 508-510.

[38] Sun Qiguo, **Zheng Tianyuan***, Zheng Xilai*,Chang Qinpeng, Marc Walther. (2019). "Influence of a subsurface cut-off wall on nitrate contamination in an unconfined aquifer". *Journal of Hydrology*, 575: 234-243.

[39] Miao Xingyuan, **Zheng Tianyuan***, Olaf Kolditz, Thomas Nagel. (2019). "Phase-field modeling of cracking processes in geomaterials for subsurface geotechnical engineering and energy storage". *15th International Conference of the International Association for Computer Methods and Advances in Geomechanics*.

[40] **Zheng Tianyuan**, Miao Xing-Yuan*, Naumov Dmitri, Shao Haibing, Olaf Kolditz, Thomas Nagel. (2019). "A thermo-hydro-mechanical finite element model with freezing processes in saturated soils". *Journal of Environmental Geotechnics,* 9(2): 1-9.

[41] Zhang Bo, Zheng Xilai, **Zheng Tianyuan***, Xin Jia, Sui Shuai, Zhang Di (2019). "The influence of slope collapse on water exchange between a pit lake and a heterogeneous aquifer". *Frontiers of Environmental Science & Engineering*, 13(2): 20.

[42] Yu Lu, Wu Xiaoqing, Zheng Xilai*, **Zheng Tianyuan***, Xin Jia, Marc Walther. (2019). "An index system constructed for ecological stress assessment of the coastal zone: A case study of Shandong, China". *Journal of Environmental Management*, 232: 499-504.

[43] Sun Zhaoyue, **Zheng Tianyuan***, Xin Jia, Zheng Xilai, Hu Rongting, Fazle Subhan, Shao Haibing. (2018). "Effects of alkali-treated agricultural residues on nitrate removal and N_2O reduction of denitrification in unsaturated soil". *Journal of Environmental Management*, 214: 276-282.

[44] Tang Fenglin, Xin Jia*, Zheng Xilai*, **Zheng Tianyuan**, Yuan Xianzheng, Olaf Kolditz. (2017). "Effect of solution pH on aging dynamics and surface structural evolution of mZVI particles: H_2 production and spectroscopic/microscopic evidence". Environmental Science and Pollution Research, 24(17): 23538-23548.

[45] Hu Rongting, Zheng Xilai*, Xin Jia, Sun Zhaoyue, **Zheng Tianyuan**. (2017). "Selective Enhancement and Verification of Woody Biomass Digestibility as a Denitrification Carbon Source". Bioresource Technology, 244(Pt1): 313-319.

[46] **Zheng Tianyuan**, Miao Xingyuan, Dmitri Naumov, Shao Haibing, Olaf Kolditz, Thomas Nagel*. (2017). "A Thermo-Hydro-Mechanical Finite Element Model of Freezing in Porous Media—Thermo-Mechanically Consistent Formulation and Application to Ground Source Heat Pumps". *VII International Conference on Computational Methods for Coupled Problems in Science and Engineering*.

[47] Tang Fenglin, Xin Jia*, **Zheng Tianyuan**, Zheng Xilai, Yang Xiupei, Olaf Kolditz. (2017). "Individual and combined effects of humic acid, bicarbonate and calcium on TCE removal kinetics, aging behavior and electron efficiency of mZVI particles". *The Chemical Engineering Journal*, 324: 324-335.

[48] Miao Xingyuan, **Zheng Tianyuan**, Uwe-Jens Görke, Olaf Kolditz, Thomas Nagel*. (2017). "Thermo-mechanical analysis of heat exchanger design for thermal energy storage systems". *Applied Thermal Engineering*, 114: 1082-1089.

[49] **Zheng Tianyuan**, Haibing Shao*, Sophie Schelenz, Philipp Hein, Thomas Vienken, Pang, Zhonghe, Olaf Kolditz, Thomas Nagel. (2016). "Efficiency and economic analysis of utilizing latent heat from groundwater freezing in the context of borehole heat exchanger coupled ground source heat pump systems". *Applied Thermal Engineering*, 105: 314-326.

[50] Zheng Xilai*, Zhang Junjie, **Zheng Tianyuan**, Liang Chun, Wang Hongyu. (2014). "A developed technique for measuring water content in oil-contaminated porous media". *Environmental Earth Sciences*, 71(3): 1349-1356.

[51] Chen Lei, **Zheng Tianyuan**, Zhang Junjie, Liu Jie, Zheng Xilai*. (2014). "Effective control of modified palygorskite to NH_4^+-N release from sediment". *Environmental Technology*, 35(1-4): 60-69.

软件开发与著作权

[1] 郑天元，点源注射条件下热流固耦合解析解软件，登记号 2020SR0890208，授权日期：2020.08.13；

[2] 郑天元，多孔介质相变结冰的数值模拟软件，登记号 2020SR0363787，授权日期：2020.04.20；

[3] 郑天元， 流固耦合非饱和压缩解析解软件，登记号 2020SR0353370，授权日期：2020.04.11；

[4] OpenGeoSys6（OGS6）热学模块 https://github.com/ufz/ogs/tree/master/ProcessLib/HeatConduction

[5] OpenGeoSys6（OGS6）热流耦合模块 https://github.com/ufz/ogs/tree/master/ProcessLib/HT

[6] OpenGeoSys6（OGS6）流固耦合模块 https://github.com/ufz/ogs/tree/master/ProcessLib/HydroMechanics

[7] OpenGeoSys6（OGS6）热流固耦合模块 https ://github.com/ufz/ogs/tree/master/ProcessLib/ThermoHydroMechanics

[8] 郑天元，郭波，多尺度多相流模拟软件，Hybrid framework coupling dynamic reconstruction model and full dimensional model, https://bitbucket.org/grubbymoon/multilayerdrve3d/src/master/

代表性课题

1. 中国海洋大学优秀青年科技人才培育计划，"滨海水文地质"，2023.1-2026.12，**主持**

2. 国家自然科学基金面上项目，"填海造陆区地下水-盐变化的动力学机制与环境效应"（项目编号：42272282），2023.1-2026.12，**主持**

3. 国家自然科学青年基金，“截渗墙对含水层海水入侵-淡化的作用机制和环境效应研究”（项目编号：42002250），2021.1-2023.12，**主持**

4. 青岛市水文中心，“大沽河地下水源地污染机理与防治技术研究”，2022.09-2025.08，**主持**

5. 青岛市应用研究项目，“截渗墙作用下含水层残留咸水净化机制与环境效应研究”，2019.8-2021.4，**主持**

6. 中国海洋大学“青年英才”启动经费，“变温条件下含水层海水入侵及其对生态环境的影响效应”，2021.4-2024.3，**主持**

7. 国家基金委-山东省联合基金重点项目，“滨海含水层海水入侵形成与治理机制研究”（项目编号：U1806210），2019.1-2022.12，**课题负责**

8. 中华人民共和国科技部，重大共性关键技术，2016YFC0402800，黄渤海沿海地区地下水管理与海水入侵防治研究，2016.12 至 2021.6，**参与**

9. 国家自然科学基金重点项目，“山东半岛地下水源地硝酸盐富集的关键地球化学过程”（项目编号：41731280），2018.1-2022.12，**参与**

10. 亥姆霍兹联合会科技专项“OpenGeoSys-6(OGS-6)多场耦合数值模拟软件的开发”，2016.1-2022.12，**参与**

11. 德国经济能源部项目，“智能地下热储能系统的数值模拟和分析(IGLU)”，2014-2019，**参与**

12. 德国经济能源部项目，“能源转型过程中地热问题及其对环境的影响(ANGUS II)”，2013-2018，**参与**