

# ICSLR 2021

INTERNATIONAL  
CONFERENCE OF  
THE ISSLR ON  
INLAND SALT  
LAKES AND  
SALINAS



**14th International  
Conference of the  
ISSRL (International  
Society for Salt Lake  
Research)**

**18-22 OCTOBER 2021  
Murcia, Spain**

# Book of Abstracts



## Index

WELCOME TO ICSLR 2021 .....	8
COMMITTEES .....	9
Scientific committee .....	9
Local organizing committee .....	10
Coordinators .....	10
Members .....	10
Secretariat .....	10
TOPICS .....	10
PROGRAMME SUMMARY .....	11
PLENARY SPEAKERS .....	12
EXTENDED PROGRAMME .....	13
Schedule Zoom room 1. Monday 18 .....	13
Schedule Zoom room 1. Tuesday 19 .....	14
Schedule Zoom room 1. Wednesday 20 .....	15
Schedule Zoom room 1. Thursday 21 .....	16
Schedule Zoom room 1. Friday 22 .....	17
Schedule Zoom room 2. Monday 18 .....	18
Schedule Zoom room 2. Tuesday 19 .....	19
Schedule Zoom room 2. Wednesday 20 .....	20
Schedule Zoom room 2. Thursday 21 .....	22
Schedule Zoom room 2. Friday 22 .....	23
Communications .....	24
Introduction to the Observation and Research Station of Salt Lakes in Tibetan Plateau .....	25
Geological Characteristics and Genesis of The Solid Potash Salt Deposit in The No.3 Fault Depression Zone in Northwest Lop Nur, Xinjiang .....	26
The key constraint conditions for the formation and exploration prospect of fractures and Pore Brine of anticline in Qaidam Basin QingHai, China .....	28
Abnormal enrichment mechanism of potassium-rich brine deposit in Lop Nor Basin, Xinjiang Province ..	29
Geology and Origin of Dawadi Potassium Nitrate Deposit in Lop Nor, Xinjiang Province, China .....	30
Classification of salt mineral metallogenic units in Qaidam basin .....	31
Plio-Quaternary global cooling driven Asian inland aridity and salification .....	32
Hydrochemical Characteristics and Material Sources of the Mami Tso Saline Lake Lithium-Boron Deposit in Tibet, China .....	33

Study on Large-scale Lithium Mine Base in Zabuye Saline Lake, Tibet.....	34
Hydromagnesite precipitation in the alkaline lake Dujiali, central Tibet Plateau: A natural analogue for carbon storage .....	35
New progress in the investigation of lithium-potassium rich brine in northeastern Sichuan Basin, China .....	36
Geochemical characteristics of the Majiagou Formation in the central-eastern Ordos Basin recorded reciprocating transitions of restricted and open environments.....	37
The Cenozoic salt tectonics in the Kuqa depression of Tarimu basin and its influence on the hydrocarbon accumulation .....	38
Discovery and genesis of the ‘new type of polyhalite potassium ore’ in the Lower Triassic, Puguang area of northeastern Sichuan Basin, SW China.....	39
The material source of New Type of Polyhalite Potassium Deposit in Puguang area, Northeast Sichuan--Evidence of Geochemical characteristics.....	41
Mineralization Model of Mesozoic Potash Resources in the Simao Basin .....	42
Method Innovation of Lithium-bearing Salt Lake and Deep Brine Extraction Technology .....	43
Paleolimnological analysis of metal contamination and eutrophication of Great Salt Lake, Utah .....	44
The Formation Mechanism and Paleoclimate Environmental Evolution of Lop Nur Based on UAV Hyperspectral Platform.....	45
Surviving onshore soil microbial communities differ among the Qing-Tibetan lakes with different salinity .....	46
N <sub>2</sub> O producing and consuming bacteria respond differently to ecological drivers in the lakes on the Qinghai-Tibet Plateau .....	47
Microbial role in carbon cycling in the saline lakes of the Qinghai-Tibetan Lakes .....	48
Bicarbonate uptake rates and diversity of RuBisCO genes in saline lake sediments .....	49
The Rozel Point Tar Seeps and its Unique Hypersaline Environment at Great Salt Lake, Utah USA.....	50
Effects of WWTP discharges on the carbon metabolic rates and greenhouse gases emissions of temporary saline lagoons.....	51
Input of allochthonous and autochthonous organic matter stimulates microbial mineralization of organic carbon in the lake sediments with different salinity .....	53
Geo-spatial modelling to prioritize restoration opportunities of the evanescent largest Saline Wetland Ecosystem (Sambhar Lake) of India .....	54
Spatial heterogeneity of surface water temperature in the hypersaline Dead Sea .....	55
Ecological status analysis of Mar Menor through Remote Sensing.....	56
Land cover and uses classification cartography within the Mar Menor coastal lagoon basin .....	57
Managing Lake Urmia, Iran for diverse restoration objectives: Moving beyond a uniform target lake level .....	59
Exploration and Characterization of Artemia Resource in Tibet Salt Lakes and their Utilization in aquaculture.....	60

Listening to the Landscape: Connecting people to salt lake country, a case study at Weeweera (Lake George) NSW .....	62
Rapid Assessment of Ecosystem Services of the Sambhar Salt Lake, India .....	63
Conservation and management strategies for inland saline wetlands of Thar deserts in the light of UN Decade of Ecosystem Restoration .....	64
A method to sample and treat salt and brine samples for plastic pollution testing .....	65
The Smelly, the Slimy and the Salty: a Model for Connecting People to our Unique Saline Lakes .....	66
The likely status of inland salt lake ecosystems in 2050: Reminiscing and revisiting Bill Williams .....	68
A certificate system for salt production in solar evaporation Salinas .....	69
Tracing hypersaline lagoonal decline: Finding the first ecological domino and why it is important .....	70
Environmental recovery of old salt ponds: the case of the "Coterillo pond" in the salt ponds of San Pedro del Pinatar (Murcia, Spain) .....	72
Management of inland saline lakes: a key factor in their climate regulation capacity .....	73
Since when were saltern crystallizer brines colored red? .....	74
A microbial history of a changing Great Salt Lake .....	75
Historical location and evolution of Lop Nor based on SAR maps and DEM.....	76
The 5000-year development history of Yuncheng Salt Lake—A study.....	77
Mercury Bioaccumulation and Biomagnification in Great Salt Lake, Utah, USA.....	78
Origin and circulation of springs based on hydrochemistry and water isotopes (O,H,3H) in Nangqen and Changdu basin, Southwestern China .....	79
Efficient utilization of potassium and lithium resources in sulfate salt-lake: system engineering, state prediction and precise process control of salt-ponds .....	80
Electrochemical controlled selective extraction of lithium from brine .....	81
New Progress in Lithium Extraction Technology for the Salt Lake Resources.....	83
Characterization of dissolved organic matter in the hypersaline Da Qaidam Lake in Qinghai Tibet Plateau and its change in solar ponds by using a multi-analytical approach .....	84
Capture of lithium by water-insoluble particles in salt lake .....	85
Removal of magnesium components from high-magnesium salt-water system in a temperature-changing process.....	86
Thermodynamic properties and volumetric properties of the aqueous borates containing lithium and cesium ions in the salt lake brine system: heats of dissolution, dilution, mixing, osmotic coefficients, water activities, and the applications of ion-interaction model.....	87
Phase Equilibria of the System RbCl + CsCl + PEG + H <sub>2</sub> O at 288.2, 298.2, and 308.2 K.....	88
Thermodynamic properties and volumetric properties of the aqueous borates containing lithium and cesium ions in the salt lake brine system: heats of dissolution, dilution, mixing, osmotic coefficients, water activities, and the applications of ion-interaction model.....	89
Phase Equilibria of Salt-Water System Focused on Qaidam Basin Magnesium Sulfate Type Salt Lake Brine at 298.2 and 323.2 K .....	90
Dissolution enthalpies and the thermodynamic properties of sodium metaborates .....	91



Isopiestic investigation and Pitzer thermodynamic model of lithium borates aqueous system.....	92
Volumetric properties of the ternary system (CsCl + Cs <sub>2</sub> SO <sub>4</sub> + H <sub>2</sub> O) and its subsystems from 283.15 to 363.15 K and atmospheric pressure: Experimental and thermodynamic model .....	93
Viability and Hatchability of Brine Shrimp ( <i>Artemia franciscana</i> ) Cysts after Passing Through the Digestive System of Eared Grebes.....	94
Research progress of application of saline Cladocera in aquatic ecotoxicology .....	95
Changes of microbial mineralization and community composition in response to multiple levels of grass organic matter addition in a hypersaline lakes.....	96
Great Salt Lake on exhibit: The ArtScience of Winogradsky columns .....	97
Characterization of Halophyte Rhizosphere Microbiomes at Great Salt Lake, Utah.....	98
Fresh, soda and saline: the effect of salinity and water chemical types on bacterial community composition based on global data.....	99
Seasonal patterns and trophic relationships of planktonic eukaryotes in soda pans .....	100
Estimating Primary Productivity in Great Salt Lake, Utah .....	101
Metabarcoding under salt: microbial ecology of five hypersaline lakes at Rottnest Island (WA, Australia) .....	102
Impact of Eared Grebes on the Population of Brine Shrimp in Great Salt Lake, Utah, USA.....	103
Flight wing size variation across a geographical range in <i>Pogonus diplochaetoides</i> (COLEOPTERA: CARABIDAE: POGONINI) .....	104
Phylogeography of <i>Branchinecta media</i> (Schmankewitsch, 1873) (Branchiopoda: Anostraca), a species adapted to hypersaline aquatic habitats .....	105
Systematization of the Biodiversity of Crustaceans and Molluscs of the Aral Sea.....	106
Stress promoted facilitation in microbial communities? Increasing saline stress reduces co-exclusions while co-occurrences remain stable.....	108
Evolution patterns of two tribes of tiger beetles (Coleoptera: Cicindelidae) in Australian salt lakes.....	109
Glacial refuges and cryptic speciation in the Palearctic tiger beetle <i>Calomera littoralis</i> (Coleoptera: Cicindelidae).....	110
Microbial diversity of hypersaline colorful salt ponds in Yuncheng salt lake, Shanxi Province, China .....	111
Environmental variables influencing abundance of two congeneric water beetles species from supratidal rockpools.....	112
Taxonomic diversity of extremophilic microbial communities in the salt lakes of the Barguzin depression (Baikal rift zone) in relation to the geochemical conditions.....	113
Ecological status, ecosystem services and threats to saline lakes: global analysis of 68 lakes .....	115
Demonstration of comprehensive utilization of Ecological Agriculture in Dry Salt Lake .....	117
Posters .....	119
Origin and evolution of halite in the Lanping-Simao Basin of southeastern Tibetan Plateau, China: Evidence from the stable isotope of <sup>37</sup> Cl, <sup>87</sup> Sr/ <sup>86</sup> Sr .....	120
Visualization study on spatial structure change of Brine Aquifer in Luobei Depression mining area based on GMS.....	121

Significant Progress Made in Deep Brines potassium-bearing in continental basins in China .....	123
A new direction for marine potash prospecting: Xiali formation of Jurassic of Qiangtang basin in Tibet, China .....	124
The macroscopic and microscopic characteristics of the new type of polyhalite potassium salt ore and its implications for mineralization : A new record from the CXD1 well in the northeast of Sichuan .....	125
Correlation scheme research between Late Quaternary evaporite deposition period and glaciation period of the saline lake in Qaidam Basin .....	126
Chemical Analysis of Water and the Resource of Br, K respects of Oilfield Brines from Ordovician and Carboniferous in Tarim, China .....	127
A new understanding of boundary fault which controls formation of potassium sag in Majiagou Period of Ordovician in the eastern margin of Ordos Basin.....	128
Study on the mineral composition of modern Tufa in Zabuye Salt Lake, Tibet.....	129
Towards the protection to two inland saltern ecosystems in the Alto Vinalopó Valley, Spain.....	130
Origins of the Cretaceous evaporite deposits of the Lanping–Simao Basin, in Western China and the Khorat Plateau in Thailand and in Laos: Evidence from the stable isotopes of halite .....	131
Enrichment patterns of the shallow brine in the Luobei depression of the Lop Nor salt lake, Xinjiang ...	133
Thermodynamic modeling and phase diagram prediction of chloride type and sulfate type salt-lake brine systems .....	135
Directional separation of solid waste in salt lakes.....	136
Selective recovery of strontium from oilfield water by ion-imprinted alginate microspheres modified with thioglycolic acid.....	137
Salt Lake Research and Salt Chemical Analysis .....	138
Refining study of Dalangtan deep brine by freezing and solarization in Qaidam basin .....	139
Solvent Thermal Synthesis of high-Performance Copper Hexacyanoferrate for Cs <sup>+</sup> Removal from the Salt Lake .....	140
Volume Properties for the Aqueous Solution of Yttrium Trichloride at Temperatures from 283.15 to 363.15 K and Ambient Pressure.....	141
Abundant and novel taxa in the microbial community of soda-saline lakes in Inner Mongolia .....	142
Bioprospecting on antimicrobial activity and diversity of soil-derived actinobacteria from different depth in one site of Lake Gudzhirganskoe in Siberia .....	143
Potential biotechnological uses of microbes inhabiting Pink Lagoon, Torrevieja, Alicante .....	145
Some features of the biotopic diversity features of microbial communities of the meromictic soda Lake Doroninskoye (Zabaikalie, Russia) .....	146
The role of cyanobacteria in nitrogen fixation of phototrophic communities in the Kulunda Steppe soda lakes (Altai Region, Russia) .....	148
Microbial and Planktonic Biodiversity in Tibetan Salt lakes .....	150
LIFE INVASAQUA: Raising Awareness and Preventing Aquatic Invasive Alien Species in the Iberian Peninsula .....	152
Researching the archaeological and ecological heritage of the Central Italian Tyrrhenian coast.....	153



## WELCOME TO ICSLR 2021

Saline lakes and inland saltscapes are common on every continent and are of considerable economic, ecological, and scientific value. Since 1979, an informal international association of salt lake researchers from a variety of disciplines have sponsored a series of triennial conferences to foster scientific exchange and further our understanding of saline lakes. The International Society of Salt Lake Research (ISSLR) was founded in 1994 to establish effective liaison between persons interested in any aspect of inland saline waters, to encourage these interests, and to educate the public in the scientific use, management, and conservation of salt lakes. These triennial conferences are always held in locations rich in this natural and cultural heritage and, for the first time in over three decades, it will be celebrated again in Europe. The theme of the 14th International Conference on Salt Lake Research is “Inland Salt Lakes, Salt Flats and surrounding habitats”. In addition to the usual high-level scientific work presented in them, this conference will also offer the opportunity to know the work of other stakeholders (NGOs, consultants, managers) in them.

We do hope that you enjoy your attendance at the ICSLR 2021!





## COMMITTEES

### Scientific committee

Mianping Zheng, Center for Saline Lake and Epithermal Deposits and President of the ISSLR, China

Egor Zadereev, Institute of Biophysics SB RAS, Russia

Aharon Oren, Hebrew University of Jerusalem, Israel

Emil Boros, Hungarian Academy of Sciences, Hungary

Jonathan Clark, Weber State University, USA

Tianlong Deng, Tianjin University of Science and Technology, China

Zsolia Horvath, WasserCluster Lunz, Austria

Peter Hudson, South Australian Museum, Australia

Lucila Castro, Pacific Biodiversity Institute, Argentina

Bindy Datson, Actis Environmental Services, Australia

Antonio Camacho, University of Valencia, Spain

Francisco Comín, Pyrenean Institute of Ecology – CSIC, Spain

José Ariza, University of Huelva, Spain

Mariano Paracuellos, University of Almería, Spain

Francisco Belmonte, University of Murcia, Spain

Gustavo Ballesteros, University of Murcia, Spain

Andrés Millán, University of Murcia, Spain

Josefa Velasco, University of Murcia, Spain

Rosa M<sup>a</sup> Martínez Espinosa, University of Alicante, Spain

M<sup>a</sup> del Carmen Rodríguez, University of Alicante, Spain

José Álvarez Rogel, Technical University of Cartagena, Spain

Katia Hueso, Pontifical University Madrid / IPAISAL, Spain

Máximo Florín, University of Castilla-La Mancha

Rosa M.<sup>a</sup> Gómez, University of Murcia

Francisco Robledano, University of Murcia

Diógenes Costa, Federal University of Rio Grande do Norte

María Asunción Romero Díaz, University of Murcia, Spain

Emilio Ortega Casamayor, CSIC Director, Spain

Ramón García Marín, University of Murcia, Spain



## Local organizing committee

### Coordinators

Katia Hueso, Pontifical University Madrid / IPAISAL, Spain

Francisco Belmonte, University of Murcia, Spain

### Members

Gustavo Ballesteros, University of Murcia, Spain

Ramón García Marín, University of Murcia, Spain

Diana Hernández, University of Murcia, Spain

### Secretariat

BIOCYMA Environmental and Quality Consultant, S.L.

The private company BIOCYMA S.L., with experience organizing events and experts in saline ecosystems. Tasks of the secretariat:

- Documentation for participants
- Congress broadcast
- Registration
- Communication
- Web site / social media
- Proceedings and certificates

## TOPICS

1. Geology (salt deposits, salt mineralogy, brine resources) / Physical geography
2. Chemistry and chemical engineering of salt lakes
3. Biology
4. Microbiology
5. Ecology and biodiversity
6. Related natural resources and ecosystem services (agriculture, aquaculture, leisure, recreation and sustainable tourism, health and wellness in saline lakes, etc.)
7. Conservation, management and heritage
8. Historical aspects of saline lakes
9. Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology
10. Paleolimnology: environmental change recorded by salt lake sediments
11. Remote sensing and ecosystem modelling to support lake management and decision making
12. Cultural and artistic aspects of saline lakes



## PROGRAMME SUMMARY

	Zoom room 1	Time		Zoom room 2	Time
<b>Monday 18</b>	Opening ceremony	9.00-10.00			
	Session 1 (1)	10:00-11:15		Session 2	10:00-11:15
	Session 1 (1)	Coffe-break 11:30-14:00 Lunch		Session 2	Coffee-break 11:30-14:00 Lunch
	Session 1 (1)	15:30-16:45		Session 2	15:30-18:00
<b>Tuesday 19</b>	Session 1 (1)	09:00-10:40		Session 2	09:00-10:40
	Session 1 (1)	Coffee break 11:00-12:00		Session 3	Coffee break 11:00-13:00
	Session 1 (10)	12:00-13:00 Lunch		Session 4	Lunch 15:30-16:45
<b>Wednesday 20</b>	Session 1 (9)	09:00-12:00		NGO round table	09:00-11:00
	Session 1 (11)	Coffee break 12:15-14:00		Posters	Coffee break 11:30-15:00
				Posters	Lunch 16:00-19:00
<b>Thursday 21</b>	Session 6	9:00-12:00		Session 4	09:00-11:30
	Session 7	Coffee break 12:15-14:00 Lunch		Session 5	Coffee break 11:45-13:00
	Session 7	15:30-17:30		Session 5	Lunch 15:30-18:00
<b>Friday 22</b>	Session 7	09:00-11:30		Session 5	09:00-10:40
	ICSLR meeting	Coffee break 12:15-14:30 Lunch		Session 5	Coffee break 11:00-12:15
	Closing ceremony	15:30-16:30			Lunch

## PLENARY SPEAKERS

Session	Title of plenary lecture	Lecturer
(1) Geology (salt deposits, salt mineralogy, brine resources)/Physical geography. (9) Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology (10) Paleolimnology: environmental change recorded by salt lake sediments. (11) Remote sensing and ecosystem modelling to support lake management and decision making	Linking the past and future creating salinology	Mianping Zheng
(2) Chemistry and chemical engineering of salt lakes	Mineral precipitation sequences and brine evolution of Asian saline lakes	Marina N. Kolpakova (winner of the best paper award)
(3) Biology	Quantifying nutrient inputs by gulls to a fluctuating lake, aided by movement ecology methods	Víctor Martín Vélez (winner of the best paper award)
(4) Microbiology	Carbon cycle and greenhouse gases exchange in saline lakes: insights to microbiota	Antonio Camacho
(5) Ecology and biodiversity	Research across scales to understand impacts of salinization on ecology of inland freshwater lakes	Meryem Becioglu
(6) Related natural resources and ecosystem services (agriculture, aquaculture, leisure, recreation and sustainable tourism, health and wellness in saline lakes, etc.)	Natural resources and ecosystem services of salt lakes in southeast Spain: from conventional uses to innovative solutions in the face of persistent and emerging threats	Francisco Robledano
(7) Conservation, management and heritage. (8) Historical aspects of saline lakes. (12) Cultural and artistic aspects of saline lakes.	The future of Salt Lakes is in our hands: A diverse and dynamic approach to study and protect Mar Chiquita, an immense lake in the heart of Argentina.	Lucila Castro

# EXTENDED PROGRAMME

## Schedule Zoom room 1. Monday 18

Timetable	Time	Event	Title	Lecturer	Nº
9:00-10:00		Opening ceremony	Welcome words from the local organizers and partners, ISSLR board members. Announcement and congratulation of ISSLR Young Scientist Triannual Award winners.	Local authorities / ISSLR	
10:00-10:45	0:45:00	Plenary talk session 1	Linking the past and future creating salinology.	Mianping Zheng	
10:45-11:15	0:30:00	Round table			
11:15-11:30		Coffee break			
11:30-14:00	0:25:00	Communication session 1: (1) Geology/Physical geography	Introduction to the Observation and Research Station of Salt Lakes in Tibetan Plateau	Chuanrong YE, Mianping ZHENG, Yuanyi ZHAO, Lingzhong BU, Jiangjiang YU, Zhen NIE, Wenxi CHEN, Xianhua HOU	018
	0:25:00		Geological Characteristics and Genesis of The Solid Potash Salt Deposit in The No.3 Fault Depression Zone in Northwest Lop Nur, Xinjiang	Li Boyun, Zhang Fankai, Deng Yufei, Yu Yongmei, Dong Lianbing, Li Wenxue, Wang Lingfen, Ma Baocheng	019
	0:25:00		The key constraint conditions for the formation and exploration prospect of fractures and Pore Brine of anticline in Qaidam Basin	Li Hongpu, Pan Tong, Li Dongsheng, Li Degang, Han Guang, Jin Fang, YuanWenhu, JiaJiantuan	022
	0:25:00		Abnormal enrichment mechanism of potassium-rich brine deposit in Lop Nor Basin, Xinjiang Province	Ma Lichun, Wang Kai, Zhang Yu, Tang Qingfeng, Sun Mingguang, Song Gao	023
	0:25:00		Geology and Origin of Dawadi Potassium Nitrate Deposit in Lop Nor, Xinjiang Province, China	Yu Zhang, Lichun Ma, Kai Wang	024
	0:25:00		Classification of salt mineral metallogenic units in Qaidam basin	Pan Tong, Han Guang, Li Hongpu, Li Dongsheng, Jia Jiantuan, Yuan Wenhu	033
14:00-15:30		Lunch			
15:30-16:45	0:25:00	Communication session 1: (1) Geology/Physical geography	Plio-Quaternary global cooling driven Asian inland aridity and salification	Xiaomin Fanga, Zhisheng Anb, Jinbo Zana, Minhui Lia, Erwin Appelc, Zhengguo Shib, Shengli Yangd, Wenxia Hane	035
	0:25:00	Geology/Physical geography	Geological and Hydrochemical Characteristics and Material Sources of the Mami Tso Saline Lake Lithium-Boron Deposit in Tibet	Shiyong YU; Guohua YAO; Yuanyi ZHAO	052
	0:25:00		Study on Large-scale Lithium Mine Base in Zabuye Saline Lake, Tibet	Yuanyi ZHAO; Shiyong YU	053

## Schedule Zoom room 1. Tuesday 19

Timetable	Time	Event	Title	Lecturer	Nº
09:00-10:40	0:25:00	Communication session 1: (1) Geology/Physical geography	Hydromagnesite precipitation in the alkaline lake Dujiali, central Tibet Plateau: A natural analogue for carbon storage	<b>Yongjie Lin</b>	<b>076</b>
	0:25:00		New progress in the investigation of lithium-potassium rich brine in northeastern Sichuan Basin , China	XING-Enyuan, ZHANG Yongsheng, ZHENG Mianping , PENG Yuan, GUI Baoling, SU Kui, NIU Xincheng , ZUOFanfan, SHANG Wenjun, MA Qiankun, CUI Xinyu	<b>081</b>
	0:25:00		Geochemical characteristics of the Majiagou Formation in the central-eastern Ordos Basin recorded reciprocating transitions of restricted and open environments	<b>Haitong Zhao</b> , Yongsheng Zhang, Enyuan Xing, Jinhua Luan, Xiong Zhang	<b>083</b>
	0:25:00		The Cenozoic salt tectonics in the Kuqa depression of Tarimu basin and its influence on the hydrocarbon accumulation	Hongwei Yin, Wei Wang, Wenqiao Xu, Gengxiong Yang, Wanhui He	<b>085</b>
10:40-11:00		Coffee break			
11:00-12:00	0:25:00	Communication session 1: (1) Geology/Physical geography	Mineralization Model of Mesozoic Potash Resources in the Simao Basin	Zhongying Miao, Mianping Zheng, Pengcheng Lou, Qihui Xu, Jianming Xu, Linfeng Shi, Xuefei Zhang, Gao Song	<b>098</b>
	0:25:00		Method Innovation of Lithium-bearing Salt Lake and Deep Brine Extraction Technology	Mianping Zheng, <b>Tao Ding</b> , <b>Mingming Li</b>	<b>104</b>
12:00-13:00	0:25:00	Communication session 1: (10) Paleolimnology: environmental change recorded by salt lake sediments	Paleolimnological analysis of metal contamination and eutrophication of Great Salt Lake, Utah	Wayne A. Wurtsbaugh, Katrina A. Moser and Peter R. Leavitt	<b>032</b>
	0:25:00		The Formation Mechanism and Paleoclimate Environmental Evolution of Lop Nur Based on UAV Hyperspectral Platform	Yang Lan, Zhang Tingting, Gong Huaze, Geng Yuyang, Tian Guangjin	<b>054</b>
14:00-15:30		Lunch			



## Schedule Zoom room 1. Wednesday 20

Timetable	Time	Event	Title	Lecturer	Nº
09:00-12:00	0:25:00	Communication session 1: (9) Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology	Surviving onshore soil microbial communities differ among the Qing-Tibetan lakes with different salinity	Jianrong Huang, <b>Jian Yang</b> , Hongchen Jiang, Geng Wu, Zhanling Xie and Hailiang Dong	<b>004</b>
	0:25:00		N <sub>2</sub> O producing and consuming bacteria respond differently to ecological drivers in the lakes on the Qinghai-Tibet Plateau	<b>Xiaoxi Sun, Jian Yang</b> , Hongchen Jiang, <b>Beichen Wang</b>	<b>010</b>
	0:25:00		Microbial role in carbon cycling in the saline lakes of the Qinghai-Tibetan Lakes	Hongchen Jiang, <b>Jian Yang</b>	<b>015</b>
	0:25:00		Bicarbonate uptake rates and diversity of RuBisCO genes in saline lake sediments	<b>Beichen Wang</b> , Jianrong Huang, <b>Jian Yang</b> , Hongchen Jiang, Haiyi Xiao, Jibin Han, Xiyang Zhang	<b>025</b>
	0:25:00		The Rozel Point Tar Seeps and its Unique Hypersaline Environment at Great Salt Lake, Utah USA	Cayla Martin, Greg McDonald, and Jaimi K. Butler	<b>029</b>
	0:25:00		Effects of WWTP discharges on the carbon metabolic rates and greenhouse gases emissions of temporary saline lagoons	<b>Daniel Morant</b> , Carlos Rochera, Antonio Picazo, Alba Camacho-Santamans, Javier Miralles-Lorenzo & Antonio Camacho	<b>110</b>
	0:25:00		Input of allochthonous and autochthonous organic matter stimulates microbial mineralization of organic carbon in the lake sediments with different salinity	<b>Mingxian Han, Jian Yang</b> , Hongchen Jiang	<b>118</b>
12:00-12:15		Coffee break			
12:15-14:00	0:25:00	Communication session 1: (11) Remote sensing and ecosystem modelling to support lake management and decision making	Geo-spatial modelling to prioritize restoration opportunities of the evanescing largest Saline Wetland Ecosystem (Sambhar Lake) of India	<b>Rajashree Naik</b> and Laxmi Kant Sharma	<b>001</b>
	0:25:00		Spatial heterogeneity of surface water temperature in the hypersaline Dead Sea	Pavel Kishcha and Boris Starobinets	<b>006</b>
	0:25:00		Ecological status analysis of Mar Menor through Remote Sensing	<b>Pedro Escudero Lozano</b> , Daniel Ibarra Marinas and <b>Diana Hernández Mármol</b>	<b>008</b>
	0:25:00		Land cover and uses classification cartography within the Mar Menor coastal lagoon basin	Carmen Valdivieso-Ros, Francisco Alonso-Sarría, Francisco Gomaríz-Castillo	<b>045</b>
14:00-15:30		Lunch			

## Schedule Zoom room 1. Thursday 21

Timetable	Time	Event	Title	Lecturer	Nº
9:00-9:45	0:45:00	Plenary talk session 6	Natural resources and ecosystem services of salt lakes in southeast Spain: from conventional uses to innovative solutions in the face of persistent and emerging threats	Francisco Robledano	
9:45-10:15	0:30:00	Round table			
10:15-12:00	0:25:00	Communication session 6: (6) Related natural resources and ecosystem services (agriculture, aquaculture, etc.)	Managing Lake Urmia, Iran for diverse restoration objectives: Moving beyond a uniform target lake level	Somayeh Sima, David E. Rosenberg b, Wayne A. Wurtsbaugh, Sarah E. Null, Karin M. Kettenring	040
	0:25:00		Exploration and Characterization of Artemia Resource in Tibet Salt Lakes and their Utilization in aquaculture	Sui Liying <b>Gao Meirong</b> Han Xuekai Duan Hu Wang Zhenqian Zhang Bo	055
	0:25:00		Listening to the Landscape: Connecting people to salt lake country, a case study at Weeweera (Lake George) NSW	Peri Coleman	058
	0:25:00		Rapid Assessment of Ecosystem Services of the Sambhar Salt Lake, India	Kulshreshtha Seema and Reddy G. V.	071
12:00-12:15		Coffee break			
12:15-13:00	0:45:00	Plenary talk session 7	The future of Salt Lakes is in our hands: A diverse and dynamic approach to study and protect Mar Chiquita, an immense lake in the heart of Argentina.	Lucila Castro	
13:00-13:30	0:30:00	Round table			
13:30-14:00	0:25:00	Communication session 7: (7) Conservation, management and heritage.	Conservation and management strategies for inland saline wetlands of Thar deserts in the light of UN Decade of Ecosystem Restoration	Laxmi Kant Sharma	002
14:00-15:30		Lunch			
15:30-17:35	0:25:00	Communication session 7: (7) Conservation, management and heritage.	A method to sample and treat salt and brine samples for plastic pollution testing	Ana Claudia Fegies, Cristina Espinosa de los Monteros López, María Balbás de la Fuente, Carlos Morales Polo, Raquel Caro Carretero, Katia Hueso Kortekaas, M <sup>a</sup> del Mar Cledera Castro	013
	0:25:00		The Smelly, the Slimy and the Salty: a Model for Connecting People to our Unique Saline Lakes	Jaimi Butler	028
	0:25:00		The likely status of inland salt lake ecosystems in 2050: Reminiscing and revisiting Bill Williams	Francisco A. Comín	038
	0:25:00		A certificate system for salt production in solar evaporation salinas	Katia Hueso Kortekaas, Renato Neves, Gustavo Ballesteros Pelegrín	051
	0:25:00		Tracing hypersaline lagoonal decline: Finding the first ecological domino and why it is important	Faith S Coleman	067

## Schedule Zoom room 1. Friday 22

Timetable	Time	Event	Title	Lecturer	Nº
9:00-11:30	0:25:00	Communication session 7: (7) Conservation, management and heritage.	Environmental recovery of old salt ponds: the case of the "Coterillo pond" in the salt ponds of San Pedro del Pinatar (Murcia, Spain).	<b>Diana Hernández Mármol</b> , Gustavo A. Ballesteros Pelegrín, A. Daniel Ibarra Marinas, <b>Antonio Zamora Parra</b> , <b>Pedro Escudero Lozano</b> , Francisco Belmonte Serrato.	<b>101</b>
	0:25:00		Management of inland saline lakes: a key factor in their climate regulation capacity	Alba Camacho-Santamans & <b>Daniel Morant</b>	<b>112</b>
	0:25:00	Communication session 7: (8) Historical aspects of saline lakes.	Since when were saltern crystallizer brines colored red?	Aharon Oren	<b>007</b>
	0:25:00		A microbial history of a changing Great Salt Lake	Bonnie K. Baxter	<b>027</b>
	0:25:00		Historical location and evolution of Lop Nor based on SAR maps and DEM	ZHANG Tingting, SHAO Yun, GENG Yuyang, GONG Huaze	<b>046</b>
	0:25:00		The 5000-year development history of Yuncheng Salt Lake—A study	Guohong Zhang	<b>082</b>
11:30-12:15		Coffee break			
12:15-14:30		ISSLR general meeting of all society members	Annual reports from the President, the Editor, Secretary/Treasurer of the Society. Nominations for the new Board members and for the place of the next ISSLR conference. Discussion on the future of the Society.  The meeting is open for all conference participants and all registered society members.		
14:30-15:30		Lunch			
15:30-16:30		Closing ceremony	Announcement of the Bill Williams award winners for the best oral and poster talks. Farewell words. On-line drinking at the end is welcomed.		

## Schedule Zoom room 2. Monday 18

Timetable	Time	Event	Title	Lecturer	Nº
10:00-10:45	0:45:00	Plenary talk Winner of the Best Paper Award session 2	Mineral precipitation sequences and brine evolution of Asian saline lakes	Marina N. Kolpakova	
10:45-11:15	0:30:00	Round table			
11:15-11:30		Coffee break			
11:30-14:00	0:25:00	Communication session 2: (2) Chemistry/Chemical properties	Mercury Bioaccumulation and Biomagnification in Great Salt Lake, Utah, USA	<b>Abigail F. Scott</b> , Frank J. Black	<b>036</b>
	0:25:00		Origin and circulation of springs based on hydrochemistry and water isotopes (O,H,3H) in Nangqen and Changdu basin, Southwestern China	<b>Xiwei Qin</b> , Haizhou Ma, Xiyang Zhang, Xiasong Hu, Guorong Li, Huaide Chen, Jibin Han, Yongshou Li, Weiliang Miao, Wenhua Han, Sha Yang, Qian Song and Mei Wu	<b>039</b>
	0:25:00		Efficient utilization of potassium and lithium resources in sulfate salt-lake: system engineering, state prediction and precise process control of salt-ponds	<b>Huan Zhou</b> , Qing Hao, Meng li Zhang, Pan Ping Xia, Feng dan Wei, Si Wu	<b>049</b>
	0:25:00		Electrochemical controlled selective extraction of lithium from brine	<b>Xiaoyu Zhao</b> , Yanfei Wang	<b>057</b>
	0:25:00		New Progress in Lithium Extraction Technology for the Salt Lake Resources	Wang Zhiqiang, Feng Zhijun	<b>059</b>
	0:25:00		Characterization of dissolved organic matter in the hypersaline Da Qaidam Lake in Qinghai Tibet Plateau and its change in solar ponds by using a multi-analytical approach	Yaoling Zhang, Keli Yang, Wu Li, Yaping Dong	<b>060</b>
14:00-15:30		Lunch			
15:30-18:00	0:25:00	Communication session 2: (2) Chemistry/Chemical properties	Capture of lithium by water-insoluble particles in salt lake	Huaigang Cheng, Yan Li, Jin Kang, Enze Li, Fangbin Xue, Fangqin Cheng	<b>061</b>
	0:25:00		Removal of magnesium components from high-magnesium salt-water system in a temperature-changing process	Huaigang Cheng, Jiaoli Gao, Enze Li, Jin Kang, Fangbin Xue, Fangqin Cheng	<b>062</b>
	0:25:00		Thermodynamic properties and volumetric properties of the aqueous borates containing lithium and cesium ions in the salt lake brine system: heats of dissolution, dilution, mixing, osmotic coefficients, water activities, and the applications of ion-interaction model	Kangrui Sun, Fei Yuan, Long Li, Yafei Guo and <b>Tianlong Deng</b>	<b>066</b>
	0:25:00		Phase Equilibria of the System RbCl+CsCl+PEG+H <sub>2</sub> O at 288.2, 298.2, and 308.2 K	Yu Xudong, Wang Lin, Huang Qin, Li Maolan, Zeng Ying	<b>075</b>
	0:25:00		Thermodynamic properties and volumetric properties of the aqueous borates containing lithium and cesium ions in the salt lake brine system: heats of dissolution, dilution, mixing, osmotic coefficients, water activities, and the applications of ion-interaction model	Kangrui Sun, Fei Yuan, Long Li, Yafei Guo and <b>Tianlong Deng</b>	<b>077</b>
	0:25:00		Phase Equilibria of Salt-Water System Focused on Qaidam Basin Magnesium Sulfate Type Salt Lake Brine at 298.2 and 323.2 K	Zeng Ying, Feng Shan, Liao Shuang, Ye Guozhen, Luo Jian, Lv Na, Yu Xudong	<b>080</b>

## Schedule Zoom room 2. Tuesday 19

Timetable	Time	Event	Title	Lecturer	Nº
09:00-10:40	0:25:00	Communication session 2: (2) Chemistry/Chemical properties	Dissolution enthalpies and the thermodynamic properties of sodium metaborates	Fei Yuan, Long Li, Yafei Guo, Shiqiang Wang and Tianlong Deng	088
	0:25:00		Isopiestic investigation and Pitzer thermodynamic model of lithium borates aqueous system	Kaiyu Zhao, Yafei Guo, Lingzong Meng and <b>Tianlong Deng</b>	089
	0:25:00		Volumetric properties of the ternary system (CsCl + Cs <sub>2</sub> SO <sub>4</sub> + H <sub>2</sub> O) and its subsystems from 283.15 to 363.15 K and atmospheric pressure: Experimental and thermodynamic model	Kangrui Suna, Ziwei Bia, Yanqin Menga, Yafei Guoa, Lingzong Mengb, <b>Tianlong Deng</b>	090
10:40-11:00		Coffee break			
11:00-11:45	0:45:00	Plenary talk Winner of the best paper award session 3	Quantifying nutrient inputs by gulls to a fluctuating lake, aided by movement ecology methods	Víctor Martín Vélez	
11:45-12:15	0:30:00	Round table			
12:15-13:05	0:25:00	Communication session 3: (3) Biology	Viability and Hatchability of Brine Shrimp ( <i>Artemia franciscana</i> ) Cysts after Passing Through the Digestive System of Eared Grebes	Michael R. Conover	011
	0:25:00		Research progress of application of saline Cladocera in aquatic ecotoxicology	Wen Zhao, Xingye Qiao, Dongpeng Yin	064
14:00-15:30		Lunch			
15:30-16:15	0:45:00	Plenary talk session 4 Microbiology	Carbon cycle and greenhouse gases exchange in saline lakes: insights to microbiota	Antonio Camacho	
16:15-16:45	0:30:00	Round table			

## Schedule Zoom room 2. Wednesday 20

Timetable	Time	Event	Title	Lecturer	Nº
09:00-11:00		NGO round table	Association of Naturalists of the Southeast, La Carraca Association, Calblanque Association, Global Nature Foundation, IPAISAL Projects: LIFE Salinas (LIFE17 NAT/ES/000184) and LIFE Invasaqua (LIFE17 GIE/ES/000515)		
11:00-11:30		Coffee break			
11:30-15:00	0:15	Poster session: (1) Geology/Physical geography, (9) Inland lakes in a changing world and (10) Paleolimnology: environmental change recorded by salt lake sediments	Origin and evolution of halite in the Lanping-Simao Basin of southeastern Tibetan Plateau, China: Evidence from the stable isotope of $^{37}\text{Cl}$ , $^{87}\text{Sr}/^{86}\text{Sr}$	<b>Shaorong Du</b> , Mianping Zheng	<b>037</b>
	0:15		Visualization study on spatial structure change of Brine Aquifer in Luobei Depression mining area based on GMS	Lingfen Wang, Yongmei Yu, Boyun Li, Fankai Zhang, Yufei Deng, Wenxue Li, Xu Han, He Qin	<b>041</b>
	0:15		Significant Progress Made in Deep Brines potassium-bearing in continental basins in China	Hou Xianhua	<b>070</b>
	0:15		A new direction for marine potash prospecting: Xiali formation of Jurassic of Qiangtang basin in Tibet, China	Xinsheng Niu, Xifang Liu, Mianping Zheng, Wenxi Chen	<b>078</b>
	0:15		The macroscopic and microscopic characteristics of the new type of polyhalite potassium salt ore and its implications for mineralization : A new record from the CXD1 well in the northeast of Sichuan	<b>Fanfan Zuo</b> , Yongsheng Zhang, Mianping Zheng	<b>079</b>
	0:15		Correlation scheme research between Late Quaternary evaporite deposition period and glaciation period of the saline lake in Qaidam Basin	<b>Andong Chen</b>	<b>093</b>
	0:15		Chemical Analysis of Water and the Resource of Br, K prospects of Oilfield Brines from Ordovician and Carboniferous in Tarim, China	Su Kui, Zheng Mianping	<b>094</b>
	0:15		A new understanding of boundary fault which controls formation of potassium sag in Majiagou Period of Ordovician in the eastern margin of Ordos Basin	Baoling Gui, Yongsheng Zhang , Enyuan Xing, <b>Yuan Peng</b> , <b>Fanfan Zuo</b> , <b>Haitong Zhao</b> , Yahui Mao, Suyang Jiang	<b>095</b>
	0:15		Study on the mineral composition of modern Tufa in Zabuye Salt Lake, Tibet	ZHANG Xuefei	<b>102</b>
	0:15		Towards the protection to two inland saltern ecosystems in the Alto Vinalopó Valley, Spain	Rosa María Martínez-Espinosa	<b>114</b>
	0:15		Origins of the Potash deposits in the Lanping-Simao Basin, western China, the Khorat Basin in Thailand and the Sakon Nakhon Basin (SNB) in Laos	Minghui Lia, Maodu Yana, Shurui Suna, Xiaomin Fang , Zengjie Zhangd, Jiao Lia	<b>047</b>
	0:15	Poster session (2): Chemistry/Chemical properties	Thermodynamic modeling and phase diagram prediction of chloride type and sulfate type salt-lake brine systems	Qing Hao, <b>Huan Zhou</b> , Si Wu, Meng li Zhang, Pan Ping Xia	<b>050</b>
	0:15		Directional separation of solid waste in salt lakes	Huagang Cheng, Jingyi Yang, Aniu Qian, Fangbin Xue, Enze Li, Fangqin Cheng	<b>063</b>
	0:15		Selective recovery of strontium from oilfield water by ion-imprinted alginate microspheres modified with thioglycolic acid	Can Liu, Xiaoping Yu, Chi Ma, Yafei Guo, <b>Tianlong Deng</b>	<b>086</b>



15:00-16:00		Lunch			
16:00-19:00	0:15	Poster session (2): Chemistry/Chemical properties	Salt Lake Research and Salt Chemical Analysis	WU Qian, ZHENG Mian-ping, BU Ling-zhong, YU Jiang-jiang	092
	0:15		Refining study of Dalangtan deep brine by freezing and solarization in Qaidam basin	Wu zhiming, Wang gang, Nie zhen, Wang yunsheng, Zheng mianping	105
	0:15		Solvent Thermal Synthesis of high-Performance Copper Hexacyanoferrate for Cs <sup>+</sup> Removal from the Salt Lake	Chi Ma, Zhenzhen Jiang, Senjian Han, <b>Tianlong Deng</b> , Yafei Guo	108
	0:15		Volume Properties for the Aqueous Solution of Yttrium Trichloride at Temperatures from 283.15 to 363.15 K and Ambient Pressure	Zhenzhen Jiang, Chi Ma, Gaoling Liu, Kangrui Sun, Mingli Li, Yafei Guo, Lingzong Meng, <b>Tianlong Deng</b>	109
	0:15	Poster session (4): Microbiology	Abundant and novel taxa in the microbial community of soda-saline lakes in Inner Mongolia	<b>Dahe Zhao</b> , Shengjie Zhang, Qiong Xue, Heng Zhou, Jian Zhou, Hua Xiang	017
	0:15		Bioprospecting on antimicrobial activity and diversity of soil-derived actinobacteria from different depth in one site of Lake Gudzhirganskoe in Siberia	<b>Qin Yang</b> , Puyu Guo, Elena Abidueva, Di Liu, Irina M. Lisevich, Ilya A. Osterman, Petr V. Sergiev, Olga A. Dontsova, Hanwen Zhang, Xiaojing Zhou, Qinpei Lu, Shaowei Liu, Feina Li, Xiaojun Li, Xinxin Hu, Xuefu You, Chunmei Xue and Chenghang Sun	043
	0:15		Potential biotechnological uses of microbes inhabiting Pink Lagoon, Torrevieja, Alicante.	Rosa María Martínez-Espinosa and Guillermo Martínez-Martínez	115
	0:15	Poster session (5): Ecology and Biodiversity	Some features of the biotopic diversity of microbial communities of the meromictic soda Lake Doroninskoye (Zabaikalie)	Evgeniya Matyugina, Natalia Belkova	042
	0:15		The role of cyanobacteria in nitrogen fixation of phototrophic communities in the Kulunda Steppe soda lakes (Altai Region, Russia)	Samylina O. S., Namsaraev Z. B., Tourova T. P., Sorokin D. Y.	056
	0:15		Microbial and Planktonic Biodiversity in Tibetan Salt lakes	<b>Gao Meirong</b>	111
	0:15	Session 6: (6) Related natural resources and ecosystem services (agriculture, aquaculture, etc.)	LIFE INVASAQUA: Raising Awareness and Preventing Aquatic Invasive Alien Species in the Iberian Peninsula	López-Cañizares, C, Olivo del Amo, R., Guillén, A., Torralva, M., Ruiz-Navarro, A., Oliva-Paterna, F.J.	117
	0:15	Poster session (7): Conservation, management and heritage	Researching the archaeological and ecological heritage of the Central Italian Tyrrhenian coast	Luca Alessandri, Peter A. J. Attema, Jan Sevink	014

## Schedule Zoom room 2. Thursday 21

Timetable	Time	Event	Title	Lecturer	Nº
9:00-11:30	0:25:00	Communication session 4: (4) Microbiology	Changes of microbial mineralization and community composition in response to multiple levels of grass organic matter addition in a hypersaline lakes	<b>Jian Yang</b> , Hongchen Jiang, Wen Liu, Liuqin Huang, Jianrong Huang, <b>Beichen Wang</b> , Hailiang Dong, Rosalie K. Chu, and Nikola Tolic	<b>005</b>
	0:25:00		Great Salt Lake on exhibit: The ArtScience of Winogradsky columns	Anna Jackson, Sierra Watson and Bonnie K. Baxter	<b>026</b>
	0:25:00		Characterization of Halophyte Rhizosphere Microbiomes at Great Salt Lake, Utah	David L. Parrott	<b>030</b>
	0:25:00		Fresh, soda and saline: the effect of salinity and water chemical types on bacterial community composition based on global data	<b>Attila Szabó</b> , Emil Boros, <b>Zsuzsanna Márton</b> , Zsófia Horváth, Csaba Vad, Tamás Felföldi and Anna J. Székely	<b>031</b>
	0:25:00		Seasonal patterns and trophic relationships of planktonic eukaryotes in soda pans	<b>Zsuzsanna Márton</b> , <b>Attila Szabó</b> , Bianka Csitári, Zsófia Horváth, Emil Boros, Tamás Felföldi, Anna J. Székely	<b>034</b>
	0:25:00		Estimating Primary Productivity in Great Salt Lake, Utah	<b>Eric C. Dunham</b> , Elizabeth M. Fones, Joel Carpenter, Bonnie K. Baxter, Eric S. Boyd	<b>073</b>
11:30-11:45		Coffee break			
11:45-12:30	0:45:00	Plenary talk session 5: (5) Ecology and biodiversity	Research across scales to understand impacts of salinization on ecology of inland freshwater lakes	Meryem Becioglu	
12:30-13:00	0:30:00	Round table			
14:00-15:30		Lunch			
15:30-18:00	0:25:00	Communication session 5: (5) Ecology and biodiversity	Metabarcoding under salt: microbial ecology of five hypersaline lakes at Rottneest Island (WA, Australia)	Mattia Saccò, Nicole E. White, Matthew Campbell, Sebastian Allard, William F. Humphreys, Paul Pringle, Farid Sepanta, Alex Laini, Morten Allentoft	<b>009</b>
	0:25:00		Impact of Eared Grebes on the Population of Brine Shrimp in Great Salt Lake, Utah, USA	Michael R. Conover and Leah M. Delahoussaye	<b>012</b>
	0:25:00		Flight wing size variation across a geographical range in Pogonus diplochaetoides (Coleoptera: Carabidae: Pogonini)	Peter HUDSON, Mark STEVENS	<b>016</b>
	0:25:00		Phylogeography of Branchinecta media (Schmankewitsch, 1873) (Branchiopoda: Anostraca), a species adapted to hypersaline aquatic habitats	<b>Lucía Sainz-Escudero</b> , Silvia Perea, Paula C. Rodríguez-Flores, Mario García-París	<b>021</b>
	0:25:00		Systematization of the Biodiversity of Crustaceans and Molluscs of the Aral Sea	Nikolai V. Aladin, Miguel Alonso, Igor S. Plotnikov, and Alexey O. Smurov	<b>048</b>
	0:25:00		Stress promoted facilitation in microbial communities? Increasing saline stress reduces co-exclusions while co-occurrences remain stable	Mateu Menéndez-Serra, Vicente J. Ontiveros, Albert Barberan, Emilio O. Casamayor	<b>065</b>

## Schedule Zoom room 2. Friday 22

Timetable	Time	Event	Title	Lecturer	Nº
09:00-10:40	0:25:00	Communication session 5: (5) Ecology and biodiversity	Evolution patterns of two tribes of tiger beetles (Coleoptera: Cicindelidae) in Australian salt lakes	Alejandro López-López, Peter Hudson, José Galián	068
	0:25:00		Glacial refuges and cryptic speciation in the Palearctic tiger beetle <i>Calomera littoralis</i> (Coleoptera: Cicindelidae)	Alejandro López-López, Nicolás Torres-Mantelet, José Galián, Trinidad León-Quinto	069
	0:25:00		Microbial diversity of hypersaline colorful salt ponds in Yuncheng salt lake, Shanxi Province, China	Fanjing Kong, Liwei Wang, Mianping Zheng	072
	0:25:00		Environmental variables influencing abundance of two congeneric water beetles species from supratidal rockpools	García-Meseguer AJ, Mirón-Gatón JM, Botella-Cruz M, Millán A, & Velasco J	106
10:40-11:00		Coffee break			
11:00-12:15	0:25:00	Communication session 5: (5) Ecology and biodiversity	Taxonomic diversity of extremophilic microbial communities in the salt lakes of the Barguzin depression (Baikal rift zone) in relation to the geochemical conditions	E V Lavrentyeva, T G Banzaraktsaeva, V B Dambaev, L P Kozyreva, A A Radnagurueva, AM Plyusnin & D D Barkhutova	107
			Ecological status, ecosystem services and threats to saline lakes: global analysis of 68 lakes.	Egor Zadereev, Ramesh Oliver Wilson, Ors Abram, Ekaterina Afonina, Tania Anderson, Elena Anufrieva, Balgit Bazarova, Yuriy Bazhenov, Svetlana Borzenko, Luciana Gomes Barbosa, Bonnie Baxter, Emil Boros, Enrique H. Bucher, Antonio Camacho, Alba Camacho-Santamans, Emilio O Casamayor, Rick Cavicchioli, Peri Coleman, Florencia Colla, Bindy Datson, Maria Farias, Tadesse Fetahi, Larisa Golovatuk, Evgenia Gorlacheva, Peter Hudson, Katia Hueso, Irina Kalioujniaia, Bakhtiyor Karimov, Mills Keely, Ilga Kokorite, Anastasia Komova, Lothar Krienitz, Seema Kulshreshtha, Ron Larson, Oksana Lipka, Tatiana Lopatina, Evgenia Matugina, Quentin Mauvisseau, John Melack, <b>Daniel Morant</b> , Edmundo Moreno, Zorigto Namsaraev, Aharon Oren, Sandra Poikane, Christopher Rogers, David Ryves, Marta Sanchez, Anna C. Santamans, Michael Schagerl, Elena Selivanova, Nickolai Shadrin, Somayeh Sima, Natalya Tashlykova, Katrin Teubner, Brian Timms, Svetlana Ulanova, Wayne Wurtsbaugh, Thomas Zechmeister, Alfred Burian	113
	0:25:00		Demonstration of comprehensive utilization of Ecological Agriculture in Dry Salt Lake	Chunying Zhang	116
14:30-15:30		Lunch			

# Communications

---



## Introduction to the Observation and Research Station of Salt Lakes in Tibetan Plateau

Chuanyong YE, Mianping ZHENG, Yuanyi ZHAO, Lingzhong BU, Jiangjiang YU,  
Zhen NIE, Wenxi CHEN, Xianhua HOU

*MNR Observation and Research Station of Salt Lakes in Tibetan Plateau, Institute of Mineral Resources, CAGS*

The various types of salt lakes are widely distributed on the Tibetan Plateau (referred to as Third Pole), which not only have an important influence on the global water cycle, ecological environment and human activities, but also have special mineralization resources characteristics. It is the main distribution area of strategic resources such as potassium and lithium that are largely needed in China. At the same time, the salt lake on the Tibetan Plateau is a natural laboratory, which contains rich information of ancient and modern environmental changes, and is an important carrier of global change research. Therefore, from the 1990s, Mianping Zheng, a professor from the Institute of Mineral Resources of the Chinese Academy of Geological Sciences, led a team to build the Observation and Research Station of Salt Lakes in Tibetan Plateau (SLTP). Currently, SLTP consists of five observation points: Zabuye Salt Lake in Tibet, Dangxiong Co Salt Lake in Tibet, Bange Co Salt Lake in Tibet, West Taijnar Salt Lake in Qinghai and Qarhan Salt Lake in Qinghai. SLTP has a total area of 46,000 square meters and the building area is about 2,200 square meters. The infrastructure can ensure field observation and research in SLTP. Focusing on core scientific issues of the formation and evolution of salt lakes and their responses to the interaction of different spheres of the earth, SLTP has obtained the parameters of atmosphere, hydrosphere, biosphere and lithosphere, containing 38 items. SLTP has accumulated more than 30 years of continuous data about brine, river water, spring water and salt sediment, using radar water level telemeter and other equipment, combined with manual observation. Combined with field experiments, the team members revealed the supernormal enrichment pattern of strategic minerals such as potassium and lithium, and quantitatively reconstructed the process of climate and environmental changes on the Tibetan Plateau from modern times. SLTP directly serves the research of salt lake resources and environment on the Tibetan Plateau, and provides key data for solving scientific problems such as mineral precipitation conditions, and quantitative research on sedimentology and global climate change.

Five key words: Salt lake, Resources, Environment, Observation, Tibetan Plateau

Email address for questions: [yechuanyong@cags.ac.cn](mailto:yechuanyong@cags.ac.cn)



## Geological Characteristics and Genesis of The Solid Potash Salt Deposit in The No.3 Fault Depression Zone in Northwest Lop Nur, Xinjiang

*(Preliminary version)*

Li Boyun, Zhang Fankai, Deng Yufei, Yu Yongmei, Dong Lianbing, Li Wenxue, Wang Lingfen, Ma Baocheng

*Geology Institute of China China Chemical Geology and Mine Bureau, Beijing, 100101*

*SDIC Xinjiang Luobupo Potash Co., Ltd, Hami, 839000*

Luobupo Salt Lake in Xinjiang Province can be divided into three structural units: Luobei fault subsidence zone, Xinqing platform and Tenglong platform. The ore deposits are gypsum, glauberite, halite and other halides. There are abundant potassium containing brine existing in the intergranular pores of halite deposit, forming a large scale of liquid potash deposit. Based on previous studies, the Northern Luobupo area is consist of a series of graben fault subsidence zone which dip into north-north-east 20 ° direction. There are 7 strike graben fault subsidence, with a spacing of 5~10km, which constitute the Luobupo graben system (Liu et al., 2006). The remote sensing images shows that he No.3 fault depression zone in Northwest Lop Nur, the inner Luobei fault subsidence and Tienan fault subsidence, three depression zones are obviously in darker colour, and the areas which is have moisture surface are more likely to related to the deposition of potash ore deposits and magnesium salt ore deposits. According to the preliminary investigation of the No.3 fault depression zone in Northwest Lop Nur, it is found that these surfaces reveal apparent potash mineralization. The No.3 fault depression zone subsidence is located at west zone within Xinqing platform, which is about 70km long and 2~4km wide. The geomorphic characteristic of the fault subsidence is low in the middle and high on the edge, respectively. The sedimentation in the depression is dominate by Quaternary Holocene chemical deposits. The surface is mostly overlain by 10 cm glauberite bearing siltstone, and the lower part is consisted of potash mineralization strata containing siltstone bearing halite ranging from 0.3m to 2.1 m thick and 0.93 m in average. The lower part of the ore deposit is consisted of halite bearing glauberite clay which including small amount of potash bearing ore deposit. The grade of potash ore deposit decrease from top to bottom. The thickness of the ore deposit is dominated by the geomorphic of the the fault subsidence. Horizontally, the thickness is attenuate from middle to the western and eastern edges; while vertically, the northern and southern edge are thinner compare to the inner zone. Potassium bearing ores are mainly salt bearing polyhalite with silt, followed by silt bearing kainite, and Carnallite with rock salt can be seen locally. The content of KCl in the ore ranges from 2.11% to 8.44%, and the average grade is 3.67% while the grade for most areas is between 3% and 4%. The content of KCl vertically increased from bottom to top and was positively correlated with the content of halite. There is intercrystalline brine in the depression, which occurs in the intercrystalline pores of halite or Glauberite strata. The buried depth of water level is 0.8~2.7m, and the water content is medium to weak. The salinity of brine is 314~367g / L with K<sup>+</sup> content between 8.03 ~13.18g/l, The hydrochemical type of brine is sulfate type magnesium sulfate subtype. The correlation diagram indicates into picromerite phase, and some samples are located in the blodite phase. The injection point of samples is closer to the end of Mg<sup>2+</sup> in the phase diagram which indicate that the evolution and concentration of brine in this subsidence is higher than



that in shallow brine in Luobei subsidence. The result is consistent with the fact that there are more potassium crystallization existing in this area. Luobupo Lake Basin originated from the Himalayan Movement in Quaternary. In the late Pleistocene, the neotectonic movement continued and developed NNE trending extension fracture, resulting in faulting in the northern uplift area and formed the Luobei subsidence. The structural configuration of Luobei subsidence, Xinqing platform and Tenglong platform in the northern Luobupo area was basically formed. After that, the neotectonic movement in this area still had a slight movement, which characterized by the formation of secondary uplift and fault subsidence in Xinqing and Tenglong platform and Luobei subsidence. The No.3 Fault depression zone in Northwest Lop Nur is one of them. With the climate gradually changed from wet to dry since Holocene, the water of lake was gradually thickening, and the sediment mainly changed from sedimentary clay to sulfate, sulfate and chloride dominant. Due to the rapid evaporation rate of brine and the influence of soluble material components from provenance, a more complex mineral assemblage was formed. In conclusion, the potash deposits in this area are interpreted as Modern Salt Lake evaporation genesis.

Five key words: Luobupo Salt Lake, Fault depression zone, Solid potash salt deposit, Polyhalite, evaporation genesis

Email address for questions: 276260609@qq.com



## The key constraint conditions for the formation and exploration prospect of fractures and Pore Brine of anticline in Qaidam Basin QingHai, China

Li Hongpu, Pan Tong, Li Dongsheng, Li Degang, Han Guang, Jin Fang, Yuan Wenhui,  
Jia Jiantuan

*Salt L.*

In recent years, many anticline fracture pore brines which have high potential economic value due to the lithium, potassium, boron and associated bromine and iodine that the brines contained have been discovered in Qaidam Basin. However, the key geological factors restricting the formation of this type of brines have been less studied, affecting the progress of further exploration work. In order to study the control effect of sedimentary strata, fractures and folds on the pore brine of anticline fractures in Qaidam Basin, and to serve the exploration work of deep brine in the basin, Multiple anticlines, such as Xiaoliang Mountain, Jianding Mountain, Shizigou, Youquanzi, Yousan Mountain, Eboliang Anticline, Yahu Anticline, Lenghu Anticline, Jianshi Mountain, Luoyan Mountain, Hongshan Anticline, Youduanzi Anticline, and Kitmirik Anticline, were studied. The data of Li<sup>+</sup>, K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, B<sub>2</sub>O<sub>3</sub>, Cl<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>, density and salinity which were analyzed by element correlation analysis, characteristic coefficient analysis, combined with Piper trigram analysis, stable isotope and inert gas helium in brine, gas helium, neon, argon and 4He/20Ne Isotope ratio analysis shows that the formation of structural fissures pore brine was affected by the dual effects of the depositional environment and deep faults at that time. Since the Paleogene, under the gradual arid paleoclimate conditions, a large amount of original surface water has been continuously concentrated by surface evaporation, and part of the uncrystallized groundwater became high salinity fluid which occurred in the pores of the formation. As the thickness and static pressure increase with the depositional process, the high-salinity brine seeped into the surrounding sedimentary strata and reacted with the pore water of the surrounding rock in a reducing environment and its composition changed as result. At the end of Pliocene, due to the influence of Himalayan movement, folds and faults occurred in Cenozoic strata in the basin, the high-salinity brine seeped into the fault fissures which were used as migration channels and storage spaces to transport the dissolved brine to tens kilometres away or preserved in fault fissures and formation pores. Then at the same time, the fluids rich in Li, Na, K, Ca, Mg, Cl, F, CO<sub>3</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>, Br etc migrated to Cenozoic strata along the deep faults, and finally formed deeply buried structural fissure pore brines. So In the exploration of structural fissure pore brines in Qaidam basin, attention should be paid to the core area of a series of the Paleogene to Neogene NW-NW anticline structures which also developed fault fissures.

Five key words: Formation condition, Lithium resources, Exploration prospect, Fractures and Pore Brine of anticline, Qaidam basin

Email address for questions: 745430898@qq.com

## Abnormal enrichment mechanism of potassium-rich brine deposit in Lop Nor Basin, Xinjiang Province

Ma Lichun<sup>1</sup>, Wang Kai<sup>1</sup>, Zhang Yu<sup>1</sup>, Tang Qingfeng<sup>2</sup>, Sun Mingguang<sup>1</sup>, Song Gao<sup>1</sup>

1. MNR Key Laboratory of Metallogeny and Mineral Assessment, Beijing, Institute of Mineral Resources, CAGS, Beijing, 10037;

2. Beijing Center for Physical and Chemical Analysis, Beijing, 100089

*Department of Saline Resources and Environment*

Lop Nor is the largest single sulfate-type liquid potash deposit in the world, and the Genesis of the deposit has been controversial. In this paper, the Genesis of potassium-rich brine deposits in Lop Nor is discussed from the viewpoint of hydrochemistry, based on a large number of chemical measured data of salt springs, underground phreatic water and surface water. The results show that the chlorine coefficient of potassium-rich brine is  $0.76^{1.24}$ , and the potassium-chloride Coefficient is  $38.58^{60.49}$ . The main body of the brine shows the characteristics of dissolving-filtering Brine, indicating the mixing of Brine from other sources. It is the first time to find Ca-Cl type brine in the eastern fault zone of Lop Nor basin and Dawadi, which has typical characteristics that rich in  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Cl}^-$ , poor in  $\text{HCO}_3^-$ ,  $\text{CO}_3^{2-}$ ,  $\text{SO}_4^{2-}$ , indicating deep hydrothermal supply in Lop Nor basin. In the ore-forming process, the Ca-Cl type brine can change the composition and crystallization route of the original ore-forming Brine directly through the effect of "Mixing Brine", so that its mineralization degree is increased, and it is rich in K and Na. The reformed "sodium-rich" brine reacted with gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ), and formed glauberite ( $\text{Na}_2\text{Ca}(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ ), which existed among the porous glauberite crystals, forming super-high Salinity potassium-rich brine.

Five key words: Lop Nor, Potash deposits, Potassium-rich brine, Enrichment mechanism, Brine chemistry

Email address for questions: mlichun@cags.ac.cn

## Geology and Origin of Dawadi Potassium Nitrate Deposit in Lop Nor, Xinjiang Province, China

Yu Zhang<sup>1</sup>, Lichun Ma<sup>1</sup>, Kai Wang<sup>1,2</sup>

*1. MNR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China*

*2. China University of Geosciences (Beijing), Beijing 100083, China*

*Department of Saline Resources and Environment*

The source of nitrate deposits had been a subject of debate. Most recent studies have focused on the isotopic signatures (nitrogen, triple oxygen, chromium, iodine) in Atacama Desert of Chile, Mojave Desert of United States, McMurdo Dry Valleys of Antarctica and Turpan-Hami area of China (Böhlke et al., 1997; Michalski et al., 2005; Qin et al., 2012; Pérez-Fodich et al., 2014), which provide new insights toward the origin of the nitrate deposit. There is a rare salt lake type potassium nitrate deposit in which contain solid and brine deposit in Lop Nor Dawadi area, in the eastern margin of the Tarim Basin, Xinjiang province, China. In Lop Nor, there are a huge amount of sulfate-type potassium-rich brine deposits and polyhalite  $[K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O]$  deposits in Luobei depression, which is located in the north of Lop Nor. However, the adjacent depression Dawadi and the southern margin of the Eastern Tianshan Mountains develop typical nitrate-type potassium salt deposits. For the two adjacent depressions with similar climate background, there are completely different types of potash deposits, which has attracted the attention of salt lake geologists. To know the geology and origin of the potassium nitrate deposit in Dawadi, here, based on previous studies, we reorganized and systematically studied, and collected a large number of underground brine samples from the periphery of the mining area from drilling holes. At the same time, a comprehensive and systematic survey of salt spring water and underground brine was carried out in Lop Nor and Dawadi areas. Besides we also carry out comparative studies on other typical nitrate deposits all over the world. And show that the deposit mainly develops minerals such as niter, nitronatrite, halite, hummerstonite, gypsum, thenardite, mirabilite, besides potassium-rich brine ore bodies occur in the pores of halite, mirabilite and argillaceous-arenaceous clastic sediments. It was also found that the Tertiary clastic layer at the periphery of the deposit is not only rich in high salinity brine, but also has an abnormally high nitrate content than Luobei depression. At the same time, a deep hydrothermal type (Ca-Cl) brine, whose nitrate content is dozens of times that of ordinary groundwater. Our results have implications for that Dawadi and Luobei depression belong to different groundwater systems and are not connected to each other, groundwater plays a pivotal role in the mineralization process, and the deep source may be important for the potassium nitrate deposit in Dawadi.

Five key words: Potassium nitrate deposit, Geology, Origin, Dawadi, Lop Nor

Email address for questions: zhangyu191@mails.ucas.ac.cn



## Classification of salt mineral metallogenic units in Qaidam basin

Pan Tong, Han Guang, Li Hongpu, Li Dongsheng, Jia Jiantuan, Yuan Wenhua

*Qinghai Bureau of Geological and Mineral Exploration and development*

The scientific division of metallogenic units is the concentrated embodiment of the research results under regional metallogenic rules, and it is also the basis of geological prospecting, resource potential evaluation and regional metallogenic prediction. Based on the Cenozoic tectonics and geological environment of Qaidam basin, the principles of salt minerals are highlighted, the principles of petrofacies, palaeoclimate and hydrology of salt-bearing minerals are comprehensively analyzed, and the latest prospecting results are reflected, systematic elaborates the classification scheme of metallogenic units under Qaidam basin IV level division, on the basis of above work, the metallogenic unit of northern Qaidam basin IV level is divided into five IV sub-belts. Differentiate IV level analysis discusses the ore-forming subzone into the salt geological background, salt mineral combination and so on, to lay a good foundation for further research on salt-forming rules of Qaidam basin, in order to provide future potential evaluation and guidance to Qaidam basin salt mine in the mineral prospecting.

Five key words: Metallogenic units, Metallogenic belt, Prospecting, Salt-forming rules, Qaidam basin

Email address for questions: pant66@163.com and 745430898@qq.com

## Plio-Quaternary global cooling driven Asian inland aridity and salification

Xiaomin Fang<sup>1</sup>, Zhisheng An<sup>2</sup>, Jinbo Zan<sup>1</sup>, Minhui Li<sup>1</sup>, Erwin Appel<sup>3</sup>, Zhengguo Shi<sup>2</sup>, Shengli Yang<sup>4</sup>, Wenxia Han<sup>5</sup>

*1. CAS Key Laboratory of Continental Collision and Plateau Uplift, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Lincui Rd. 16, Beijing 100101, China*

*2. State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, P.O. Box 17, Xi'an 710075, China*

*3. Department of Geoscience, University of Tübingen, Tübingen, Germany*

*4. Key Laboratory of Western China's Environmental Systems (Ministry of Education), College of Earth and Environmental Sciences, Lanzhou University, Lanzhou, 730000, China*

*5. Shandong Provincial Key Laboratory of Water and Soil Conservation & Environmental Protection, School of Resource and Environmental Sciences, Linyi University, Linyi 276000, China*

Asia inland, strongly influenced by westerlies-controlled climate, is a key source of global atmospheric dust, and plays a significant role in the earth's climate system and modulating inland aridity and salification. However, it remains unclear how the westerlies modulate aridity, dust emission and salification from this region and what forcings behind are. Here, we report a unique high-resolution eolian dust record covering the past 3.6 million years (Ma), retrieved from the thickest loess borehole sequence (671-m) recovered to date, at the southern margin of the Taklimakan desert and a high-resolution 2.8 Ma salification record from deep (980 m) borehole in the western central Qaidam Basin in the Asian interior. The results show that eolian dust accumulation, which is closely related to aridity and the westerlies, indicates existence of a dry climate, desert area, and stable land surface, promoting continuous loess deposition since at least ~3.6 Ma. This region experienced long-term stepwise drying at ~2.7, 1.1 and 0.5 Ma, coeval with a dominant periodicity shift from 41-ka cyclicity to 100-ka cyclicity between 1.1 and 0.5 Ma. These features match well with global ice volume variability both in the time and frequency domains (including the Mid-Pleistocene Transition) highlighting global cooling-forced aridity and westerlies climate changes on these timescales. These stepwise drying and events modulated salification in the Asian inland region. Numerical modelling demonstrates that global cooling can dry Asian inland and intensify the westerlies, which facilitates dust emission and transport, providing an interpretive framework. Increased dust may have promoted positive feedbacks (e.g., decreasing atmospheric CO<sub>2</sub> concentrations and modulating radiation budgets), contributing to further cooling. Unraveling the long-term evolution of Asian inland aridity and westerlies climate is an indispensable component of the unfolding mystery of global climate change and plays key role in exploration of salification and salt resources in the Asian inland region.

Key words: Plio-Quaternary, Global cooling, Asian inland, Eolian dust, Aridity and salification

Email address for questions: Fangxm@itpcas.ac.cn





## Hydrochemical Characteristics and Material Sources of the Mami Tso Saline Lake Lithium-Boron Deposit in Tibet, China

Shiyong YU; Guohua YAO; Yuanyi ZHAO

*Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing,  
100037, China*

*Key Laboratory of Saline Lake Resources and Environment of Land and Resources,  
Beijing, 100037, China*

*School of Earth Science and Resources China University of Geosciences, Beijing  
100083, China*

*Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing,  
100037, China*

*Key Laboratory of Saline Lake Resources and Environment of Land and Resources,  
Beijing, 100037, China*

The Mami Tso saline lake is located 76 km southwest of Gaize County, Ngari Prefecture, Tibet, between 83°29'~83°35' E and 32°01'~32°11' N, with an altitude of 4343m. Lithium chloride resource in saline lake brine is 251×104 tons, grade 5.6 g/l, and solid boron resource at the bottom of the lake is 3600×104 tons. The reserves of liquid lithium and solid boron have reached large-super lager deposit, and lithium and boron resources are the first in Tibet. The hydrochemical type of saline lake brine is sodium sulfate subtype, the lake water is weakly alkaline, and the average content of Li<sup>+</sup> and B<sub>2</sub>O<sub>3</sub> are 0.72g/l and 1.3g/l, respectively. Hydrochemical type of Donglongzangbu river changed from Na·Ca·HCO<sub>3</sub>·Cl type to Ca·Na·Mg·HCO<sub>3</sub>·Cl type with obvious zonation. The average contents of Li<sup>+</sup> and B<sub>2</sub>O<sub>3</sub> in river water were 0.9 mg/l and 14.7 mg/l, respectively, which could supply 409 t/yr. of LiCl and 979 t/yr. of B<sub>2</sub>O<sub>3</sub> to the saline lake. Chemical control mechanisms of saline lakes brine and rivers are evaporation - crystallization and rock weathering. Salt-forming elements are mainly derived from the weathering of tourmaline granite and deep crustal materials. River water and spring water are used as migration medium to recharge the Mami Tso saline lake.

Five key words: Hydrochemical, Material sources, Lithium, Boron, Mami Tso Saline Lake, Tibet

Email address for questions: shiyongyu1996@163.com

## Study on Large-scale Lithium Mine Base in Zabuye Saline Lake, Tibet

Yuanyi ZHAO; Shiyong YU

*Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing,  
100037, China*

*Key Laboratory of Saline Lake Resources and Environment of Land and Resources,  
Beijing, 100037, China*

*Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing,  
100037, China*

*Key Laboratory of Saline Lake Resources and Environment of Land and Resources,  
Beijing, 100037, China*

A mineral resource base is a region that has some or a variety of mineral resources, or a region where mineral resources are developed centrally according to the extent and relevant conditions of mineral resources. Zabuye large-scale lithium mine base is composed of Zabuye saline lake, Mami Tso saline lake and Lhaguo Tso saline lake, which is an important lithium resource base in China. The amount of lithium resources ( $\text{LiCl}$ ) is  $720 \times 10^4$  tons, equivalent to 14 large lithium mines. The amount of boron resources ( $\text{B}_2\text{O}_3$ ) is  $4456 \times 10^4$  tons, which is equivalent to 89 large boron ores, and the resources of rubidium and cesium are rich. Appropriate lithium extraction process should be selected in industrial development to improve enterprise efficiency. The solar pond lithium extraction technology for carbonate saline lake is basically mature, and the membrane method and adsorption method for sulfate saline lake are mature. The electric power and traffic facilities in the base are basically covered. In the process of saline lake lithium resources development, attention should be paid to the ecological environment protection, and realize the sustainable green development of saline lake resources.

Five key words: Large-scale Lithium Mine Base, Zabuye Saline Lake, Tibet, Material Sources, Lithium

Email address for questions: [yuanyizhao2@sina.com](mailto:yuanyizhao2@sina.com)

## Hydromagnesite precipitation in the alkaline lake Dujiali, central Tibet Plateau: A natural analogue for carbon storage

Yongjie Lin

*MNR Key Laboratory of Saline Lake Resources and Environment, Institute of Mineral Resource, Chinese Academy of Geological Sciences, Beijing 100037, China*

The mineral hydromagnesite,  $\text{Mg}_5(\text{CO}_3)_4(\text{OH})_2 \cdot 4\text{H}_2\text{O}$ , is a common form of hydrated Mg-carbonate in alkaline lakes, which has attracted great interest due to its potential capacity to store  $\text{CO}_2$  by mineral carbonation. Dujiali Lake, a highly alkaline ( $\text{pH}=9.37$ ) closed lake, in the central Tibet Plateau, is one of the few modern environments on the earth's surface that has experienced extensive hydromagnesite precipitation during the Holocene ( $5845 \pm 30$  to  $6090 \pm 25$  cal a BP), providing a window to understand the prevalent physicochemical process of carbon sequestration in saline aquifers. The chemical composition of surface waters around Dujiali Lake evolved from a rock weathering type with  $\text{Ca}\cdot\text{Mg}\cdot\text{HCO}_3$  to a more concentrated sodic  $\text{Na}\cdot\text{SO}_4\text{-Cl}$  water type as a result of evaporation. Combined with carbon-oxygen isotope analysis suggests supergene formation with authigenic carbonate crystallization from evaporation water is the dominant precipitation process (inorganic in nature), while atmospheric  $\text{CO}_2$  provided a carbon source for the hydromagnesite precipitation. The hydromagnesite does not precipitate in the present day based on the Phreeqc modeling and field evaporation experiment. Due to the precipitation of hydromagnesite in alkaline lake require high  $\text{Mg}/\text{Ca}$ , and a model based on the magnesium isotope geochemistry predicts that calcite (or aragonite,  $\text{CaCO}_3$ ) precipitation is needed to raise  $\text{Mg}/\text{Ca}$  in the first instance to get hydromagnesite in the alkaline lake. The thermal decomposition mechanisms of hydromagnesite were examined using TGA-MS combined with the in situ XRD, SEM, and FT-IR at varying heating rates and under either He or  $\text{CO}_2$  atmospheres, and the thermal decomposition of hydromagnesite is an endothermic process. Given that the hydromagnesite deposits have been stable over thousands of years, in a carbon storage scenario, artificial sinks of anthropogenic  $\text{CO}_2$  that mimic the conditions of Dujiali Lake would be stable long enough to reduce atmospheric  $\text{CO}_2$  concentrations and combat global climate change.

Five key words: Hydromagnesite, Alkaline lake, Carbon storage, Dujiali Lake, Tibet Plateau

Email address for questions: linyongjie2014@163.com

## New progress in the investigation of lithium-potassium rich brine in northeastern Sichuan Basin, China

XING-Enyuan<sup>1,2</sup>, ZHANG Yongsheng<sup>1,2</sup>, ZHENG Mianping<sup>1,2</sup>, PENG Yuan<sup>1,2</sup>,  
GUI Baoling<sup>1,2</sup>, SU Kui<sup>1,2</sup>, NIU Xinsheng<sup>1,2</sup>, ZUO Fanfan<sup>1,2</sup>, SHANG Wenjun<sup>1,2</sup>,  
MA Qiankun<sup>1,2</sup>, CUI Xinyu<sup>1,2</sup>

*1. MNR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, CAGS, Beijing, 100037, China*

*2. Research and Development Center of Saline Lakes and Epithermal Deposits, CAGS*

In recent years, with the rapid development of science and technology, the use of lithium and its compounds is increasingly important and extensive, and the demand for lithium resources is growing rapidly. Since the successful extraction of lithium in Atacama salt lake in Chile, 1997, the exploitation of lithium resources in salt lake brine has become the main direction of the international investigation, exploitation and utilization of lithium resources. According to the research of our team, the Triassic deep brine in northeastern Sichuan Basin is regarded as a comprehensive brine resource with high value, such as lithium, potassium, boron, bromine, iodine and strontium, which deserves great attention, especially the black brine in lower and middle Triassic strata has the highest lithium content. Recent research shows that: Brine lithium, boron and other elements in the Triassic deep brine are closely related to the early Triassic volcanic activity. In the early Triassic regressive process, in the northeastern Sichuan Basin seawater is not only riched in the original Marine elements such as potassium, bromine, iodine, also promoted lithium and boron to dissolved out of the volcanic rock or volcanic sediments, formed the Marine lithium-potassium rich brine. It was sealed in the carbonate strata of the Early and Middle Triassic. In addition, the 'green-bean rock' (GBR, a potassium-rich felsic tuff) known by predecessors is closely related to lithium in brine and is probably regarded as the direct source of lithium. But in this study, it is believed that GBR may be a set of sediments formed at the same time as the lithium-potassium rich brine after the volcanic eruption in Sichuan Basin, which has a good indication for the formation time of brine. Rather than being the source of lithium in brine, GBR is more as a fraternal relationship with the brine, and their mothers should be the early volcanic materials. The lithium-potassium rich brine and GBR are different products that formed during the geological evolution under the influence of volcanic activities in the Early to Middle Triassic, when subduction initiation of the Paleo-Tethys Ocean began. Due to the marine origin of the brine that enriches lithium, the Triassic marine lithium-potassium rich brine in the northeastern Sichuan Basin may have a wider resource prospect than a present terrestrial lithium-rich salt lake.

Five key words: Northeastern Sichuan Basin, Triassic, Marine, Lithium-potassium rich brine, Paleo-Tethys Ocean

Email address for questions: First author email address: 469833578@qq.com ;  
Corresponding author email address: zys\_601@126.com , Zhengmp2010@126.com



## Geochemical characteristics of the Majiagou Formation in the central-eastern Ordos Basin recorded reciprocating transitions of restricted and open environments

Haitong Zhao <sup>1,2,3,4</sup>, Yongsheng Zhang <sup>3,4</sup>, Enyuan Xing <sup>3,4</sup>, Jinhua Luan <sup>1,2</sup>, Xiong Zhang <sup>1,2</sup>

1. *Chongqing Institute of Geology and Mineral Resources, Chongqing 401120, China*

2. *Chongqing Key Laboratory of Exogenic Mineralization and Mine Environment, Chongqing 401120, China*

3. *Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China*

4. *MNR Key Laboratory of Saline Lake Resources and Environments, Beijing 100037, China*

The origin of carbonate and evaporite sedimentary records in the North Shannxi compression depression (NSCD) is equivocal. The Middle Ordovician was dominated by regression and genesis of Middle Darriwilian Isotope Carbon Excursion event (MDICE). The Majiagou succession of NSCD were all constrained by the Huaiyuan Epeirogeny Event 1 and Event 2. The study highlights that five shallowing-upward sequences from M1 to M5 (Majiagou 1 member to Majiagou 5 member) stacked within the long-term reciprocating changes of transgression and regression that characterizes the North Shannxi salt basin (NSSB). Here, we present a detailed study of Majiagou carbonate rocks marked by  $\delta^{13}\text{C}_{\text{carb}}$  values ranging from of -7.45‰ to 2.16‰. The values of  $\delta^{13}\text{C}_{\text{carb}}$  indicate significant increasing and decreasing trends at the lower and upper parts of M56 (Majiagou 5-member, six sub-member). These carbon isotope chemostratigraphy results were applied to correlate the values of the carbonates and are combined with conodont samples. A comparison with the stratigraphic positions and magnitudes of contemporaneous profiles showed that this excursion constrained the geological age of the Darriwilian 2,3 period. The results also showed a reciprocating transition of a restricted and an open environment. The shift in  $\delta^{13}\text{C}_{\text{carb}}$  values coincides with upward shallow facies change from relatively deep-water phase at -0‰ and shallow water phase marked by strong positive value. The shallow exposed facies showed obviously negative values caused by meteoric alteration and late alteration. The NSCD indicated individual basin conditions; thus, the Majiagou C-isotope profile reflects basin-specific conditions during the global Darriwilian regression period and is not an indicator of global C-cycle disturbances.

Five key words:  $\delta^{13}\text{C}_{\text{carb}}$ , Majiagou Formation, Darriwilian, North Shannxi depression, Ordos, North China

Email address for questions: zhaohxtxl@163.com (H.T.Zhao); zys\_601@126.com (Y.S. Zhang, Corresponding author)



## The Cenozoic salt tectonics in the Kuqa depression of Tarimu basin and its influence on the hydrocarbon accumulation

Hongwei Yin, Wei Wang, Wenqiao Xu, Gengxiong Yang, Wanhui He

*School of Earth Sciences and Engineering, Nanjing University*

Kuqa depression is located in the north-western margin of the Tarimu basin, which is one of the most important hydrocarbon provinces in China. Research and exploration practice confirm that the Cenozoic salt is critical to the hydrocarbon accumulation in the depression. In this study, we investigate the distribution of the Cenozoic salt, analyses salt brine source, and finally discuss the influence of salt tectonics on the hydrocarbon accumulation in the Kuqa depression. Thick Cenozoic evaporites are widely distributed in the Kuqa depression. The primary salt forming ages of the depression are Paleogene and Miocene, where the Paleogene salt of the Kumugeliemu Group is mainly distributed in the central and western part of the depression and the Miocene salt of the Jidike Formation is mainly distributed in the eastern part of the depression. The  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope ratio of the salt samples from Kuqa depression is between 0.708718 and 0.710868, where the Sr isotopic ratio of the Paleogene Kumugeliemu Group is relatively lower than the Miocene Jidike Formation. Combining with previous research results, we suggest that the brine of the Paleogene salt of the Kumugeliemu Group is mostly derived from seawater, while the brine of the Miocene salt of the Jidike Formation is derived from a mixture of seawater and terrestrial brine. The Cenozoic salt layers have significant influences on the structural deformation and hydrocarbon accumulation in the Kuqa depression. Generally salt layer works as a regional detachment, which decouple the structural deformation in the strata below and above the salt layer. In addition, due to the influences of the various salt distribution, salt tectonics in the Kuqa depression has characteristic of obvious along-strike variation, particularly in the strata above salt, e.g., salt cored anticlines and wide synclines with huge synkinematic sedimentations are developed in the central of the Kuqa depression, while near the western margin of the Kuqa depression there are salt thrusts and synclines with thin synkinematic sedimentations. In the Mesozoic strata below the salt, the deformation zone is generally narrow and primarily developed along the Kelasu belt, and composed of tight imbricate structures. These imbricate structures provide the structural traps for the Cretaceous hydrocarbon reservoirs. Salt has critical influences on the formation of the subsalt imbricate structures, and controls the entrapment and accumulation of the hydrocarbon in the Kuqa depression.

Five key words: Salt Tectonics, Kuqa Depression, Tarimu Basin, Hydrocarbon accumulation

Email address for questions: hwyin@nju.edu.cn



## Discovery and genesis of the 'new type of polyhalite potassium ore' in the Lower Triassic, Puguang area of northeastern Sichuan Basin, SW China

ZHENG Mianping<sup>1,2</sup>, ZHANG Yongsheng<sup>1,2</sup>, XING-Enyuan<sup>1,2</sup>, GUI Baoling<sup>1,2</sup>, ZUO Fanfan<sup>1,2</sup>, SHANG Wenjun, NIU Xinsheng<sup>1,2</sup>, SU Kui<sup>1,2</sup>, PENG Yuan<sup>1,2</sup>, SHI Lizhi<sup>1,2</sup>, QIAN Cheng<sup>1,2</sup>

*1. MNR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, CAGS, Beijing, 100037, China*

*2. Research and Development Center of Saline Lakes and Epithermal Deposits, CAGS*

In the past few years, the team of Mian-ping Zheng academicians of Institute of Mineral Resources, Chinese Academy of Geological Sciences found a kind of clastic polyhalite that is associated with the salt rock, occurring in the Jialingjiang Formation of the Lower Triassic, in Puguang area, Northeast Sichuan. Because of the soluble characteristics of halite, this potassium-bearing deposits accompanied by halite and clastic polyhalite could be exploited by water solution method, which had the obvious advantages of low mining cost and large-scale development. So this potassium-bearing deposits was named as a "new type of polyhalite potassium ore" (Zheng Mianping, Zhang Yongsheng \* et al., 2018), which is a new type of Marine soluble high-quality sulfate potash deposit. Based on the comprehensive collection, analysis and collation of the relevant research results at home and abroad, the mineralogical, petrological and geochemical characteristics of some drilling core samples obtained in the early stage were studied, and the 'high-energy plate-depression'(storm) event deposition potassium model of the "new type of polyhalite potassium ore" was established. In August 2020, with the completion of CXD1 drill core, industrial "new type of polyhalite potassium ore" with a cumulative thickness of 62.81m was found in 4th-5th Member of Jialingjiang Formation(T1j5-4), of the Lower Triassic, which clearly define the vertical distribution characteristics of the "new type of polyhalite potassium ore". At the same time, the continuous and complete core samples containing potassium belonging to T1j5-4 also provide a new idea and more complete evidence for the genetic study of the "new type of polyhalite potassium ore". Puguang area is located in the northeast section of the high dipping anticline belt in eastern Sichuan, which is a transitional zone between the Yangtze platform and the Qinling geosynclinal fold system, and is a multi-boundary structural junction. Since Mesozoic and Cenozoic, it has experienced long-term and changeable structural evolution, showing a very complex structural framework. "new type of polyhalite potassium ore" occurring in the bottom of T1j5-4, the plastic gypsum-salt layer makes it become the most important area on the slip layer. Under the influence of extrusion tectonic movement, the slip layer, in T1j5-4, happened to transverse flow or deform. This kinds of tectonic movement caused polyhalite thin layer formed early to be broken, and stir into the nearby salt rock. In a word, the genesis of "new type of polyhalite potassium ore" is controlled by two key factors, which were the original deposition of the ancient salt lake and the later reconstruction under the background of active tectonics.

Five key words: New type of polyhalite potassium ore, Marine soluble potassium salt ore, Genesis, Slip layer, Active tectonic

Email address for questions: First author email address: Zhengmp2010@126.com ;  
Corresponding author email address: zys\_601@126.com



## The material source of New Type of Polyhalite Potassium Deposit in Puguang area, Northeast Sichuan--Evidence of Geochemical characteristics

SHANG Wenjun<sup>1,2</sup>, ZHANG Yongsheng<sup>1,2</sup>, XING Enyuan<sup>1,2</sup>, GUI Baoling<sup>1,2</sup>, ZUO Fanfan<sup>1,2</sup>, PENG Yuan<sup>1,2</sup>

*1. MNR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, CAGS, Beijing, 100037, China*

*2. Research and Development Center of Saline Lakes and Epithermal Deposits, CAGS*

A new type of polyhalite potassium ore, characterized by the distribution of clastic polyhalite in the halite, is located in the marine evaporite of the lower Triassic Jialingjiang Formation of the Puguang area of Northeast Sichuan. In order to study its source material and to provide a reference for such research in the future, the strontium, sulfur isotopic and REE techniques are applied to the polyhalite, and the experimental results are compared with the gypsum and mungbean rocks in the Sichuan Basin. The results show that except for the high  $\delta^{34}\text{S}$  and  $87\text{Sr} / 86\text{Sr}$  values of clay rich anhydrite samples, the  $\delta^{34}\text{S}$  and  $87\text{Sr} / 86\text{Sr}$  characteristics of the detrital polyhalite in halite matrix and its bottom anhydrite samples are similar. The characteristic of  $\delta^{34}\text{S}$ ,  $87\text{Sr} / 86\text{Sr}$  and REE, which are homologous, and similar to the  $\delta^{34}\text{S}$  characteristics of global marine sulfate and  $87\text{Sr} / 86\text{Sr}$ , REE composition of global seawater in the same period. Therefore, its material sources seawater of the same period. The determination of its provenance has undoubtedly narrowed the scope of discussion of the metallogenic model and provides a framework for future research.

Five key words: New type of polyhalite potassium deposit, Strontium isotope, Sulfur isotope, Source of ore substances, REE, Puguang area

Email address for questions: First author email address: swjun26@126.com ; Corresponding author email address: swjun26@126.com

## Mineralization Model of Mesozoic Potash Resources in the Simao Basin

Zhongying Miao<sup>1</sup>, Mianping Zheng<sup>1</sup>, Pengcheng Lou<sup>2</sup>, Qihui Xu<sup>2</sup>, Jianming Xu<sup>1</sup>,  
Linfeng Shi<sup>1</sup>, Xuefei Zhang<sup>1</sup>, Gao Song<sup>1</sup>

*1. MNR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China*

*2. China University of Geosciences, Beijing 100083, China*

The Simao Basin is located in southwestern China, whose geotectonic position is in the Eastern Tethys tectonic domain, and the sedimentary strata are mainly "red beds" of the Mesozoic-Cenozoic. At present, the only KCl type potash deposit with industrial value in China has been found in the red beds of Mesozoic. However, the scale of potash resources found in Simao Basin is much smaller than that in Khorat Basin and Karakum Basin, which are both sides of the Tethys tectonic domain. Due to the shortage of original resources or insufficient in exploration? It has been the focus of controversy among geologists of mineral deposits for many years. Mr. Zheng Mianping, President of International Society for Salt Lake Research, deeply analyzed the relationship between the evolution of Tethys and the potash mineralization in Simao Basin: It is considered that there was an obvious transgression event in the Middle Jurassic, which provided sufficient material source for potash mineralization in Simao Basin. The subsequent tectonic evolution of the Tethys not only created a closed sedimentary environment for the salt-forming and potassium-forming of the residual seawater, but also provided the channel conditions for the plastic flow to the shallow layer after salt-forming. Therefore, the potash deposits currently discovered in the shallow strata Lower Cretaceous Mengyejing Formation are only a small part. In the deeper strata, the Jurassic Hepingxiang Formation also has larger-scale and better-quality potash deposits. Therefore, a "two-storey" potash-forming model in Simao basin is proposed. Under the guidance of this theoretical understanding, the focus of potash investigation in Simao Basin has shifted from shallow strata to deep strata. Based on the analysis of sedimentary background, salt-forming conditions and potassium-forming potential, combined with geophysical means such as gravity, electrical method, 2D seismic and 3D seismic, the deployed drilling projects successively discovered thick layers of potassium-bearing rock salt at a location exceeding 2200 m in 2012 and 2019. The KCl content of individual intervals was greater than 13 wt%, reaching industrial grade. The exploration practice not only strongly proved the "two-storey" potash-forming model, but also opened up a broad space for potassium prospecting in the Middle Jurassic marine strata in the eastern part of the Tethys domain. It not only leads the investigation of potash in the basin to the deep strata, but also has very important enlightenment significance for the adjacent Korat Basin and Qiangtang Basin to find potash in the Middle Jurassic marine strata.

Five key words: Mesozoic Potash Resources, Simao Basin, "two-storey potash-forming model", Mengyejing Formation, Jurassic salt diapirism

Email address for questions: Zhengmp@126.com and zhymiao@foxmail.com



## Method Innovation of Lithium-bearing Salt Lake and Deep Brine Extraction Technology

Mianping Zheng, Tao Ding, Mingming Li

*Department of Saline Resources and Environment, Institute of Mineral Resources, CAGS*

Lithium is a new energy metal and is becoming a strategic mineral resource for the development of new energy resources. Based on the production practice and investigation of Li-bearing brine resources, we analyze the characteristics of different types of salt lakes and deep brine resources, compare the existing problems of chemical technology and production practices of Li-bearing brines in China and abroad. And we propose the idea of advanced extraction of lithium from Li-bearing brine, and the research and development of the advanced extraction of lithium salt from the original brine or after moderate concentration, instead of or less use of the original brine for the long-term evaporation and concentration of the mother brine, and we create advanced extraction of lithium resources technology from the system of different types of brine resources. It will be a major technological revolution in the use of solar pond technology for thousands of years. It can not only make full use of the world's precious lithium brine resources, shorten the production cycle of lithium extraction from salt lake brine, but also save a large area of salt field land and a lot of bedding materials and funds, moreover it also has the profound significance to the sustainable development of global lithium resources and protect salt field pastures and wetlands.

Five key words: Advanced extraction of lithium, Different types of lithium brine, Establishment of advanced extraction of lithium system technology, Shortening the production cycle of brine extraction of lithium, Protecting grassland wetlands, Saving materials and funds.

Email address for questions: zhengmp2010@126.com



## Paleolimnological analysis of metal contamination and eutrophication of Great Salt Lake, Utah

Wayne A. Wurtsbaugh, Katrina A. Moser and Peter R. Leavitt

*Utah State University*

We used lead-210 dated sediment cores to measure historical changes in the deposition of 22 metals and a variety of eutrophication metrics in Great Salt Lake (USA). The lake is impacted by one of the world's largest copper mines and by municipal and industrial wastewater from greater metropolitan Salt Lake City. Metal concentrations in sediments were low prior to the onset of mining in the catchment in 1860 CE. Concentrations of copper, lead, zinc, cadmium, mercury, and other metals began increasing in the late 1800s, with peaks in the 1950s, concomitant with enhanced mining and smelting activities. Sedimentary metal concentrations in the 1950s were 20-40-fold above background levels for copper, lead, silver, and molybdenum. However, concentrations of most metals in surficial sediments have decreased 2-5-fold, reflecting: 1) storage and mineralization of sedimenting materials in a deep brine layer (monimolimnion), reducing metal transport to the sediments; 2) improved pollution control technologies, and; 3) reduction in mining activity beginning in the 1970s and 1980s. Despite reductions, concentrations of many metals in surficial sediments remain above acceptable contamination thresholds for aquatic ecosystems with migratory birds, and consumption advisories for mercury have been placed on three waterfowl species. Given the importance of saline lakes to migratory birds, metals contamination from mining and metals production should be a focus of saline lake remediation. Analysis of sedimentary pigments, geochemistry, and algal and invertebrate micro-fossils from the main lake (Gilbert Bay) revealed a pattern of increasing eutrophication. Sedimentary nitrogen content increased beginning around 1900 and plateaued after 1960s, whereas  $\Delta^{15}\text{N}$  and  $\Delta^{13}\text{C}$  decreased over this period. Phaeophytin and  $\beta$ -carotene, indicators of total algal abundance, peaked around 1940 when raw sewage was still being discharged into the lake. In one core, these pigments declined until the present, whereas in another core closer to the discharge of hypereutrophic Farmington Bay, they declined slightly and then stabilized from 1960 to present. Eutrophication in Gilbert Bay does not produce harmful algal blooms and brine shrimp there may benefit from nutrient additions. Dating on a core from Farmington Bay was not reliable before 1960, but all eutrophication parameters have increased steadily since then. This bay receives secondary-treated wastewater from an urban area with over 1.5 million residents, and blooms of cyanobacteria (*Nodularia*) there are excessive. Remains of brine fly larvae (*Ephydra spp.*) and brine shrimp cysts in Gilbert Bay increased markedly after the construction of the railway causeway that divided the lake, and caused salinities to drop in this part of the lake. However, the causeway also allowed a deep brine layer to form, changing preservation and redox conditions in the sediments, potentially confounding chronological interpretations. Brine shrimp cysts recovered from 250-year-old sediments hatched, although the rate of hatching was low in the deep sediments. Overall, the cores demonstrated marked pollution within the lake, but the effects on the biota vary between bays and over the decades.

Five key words: Metal, Pollution, Paleolimnology, Eutrophication, Saline

Email address for questions: wayne.wurtsbaugh@usu.edu





## The Formation Mechanism and Paleoclimate Environmental Evolution of Lop Nur Based on UAV Hyperspectral Platform

Yang Lan<sup>1,2,3</sup>, Zhang Tingting<sup>1,2</sup>, Gong Huaze<sup>1</sup>, Geng Yuyang<sup>1</sup>, Tian Guangjin<sup>3</sup>

1. *Laboratory of Target Microwave Properties, Deqing Academy of Satellite Applications, Zhejiang, 313200, China*

2. *Aerospace Information Research Institute, Chinese Academy of Sciences, Datun Road, 100101 Beijing, China*

3. *School of Government, Beijing Normal University, Beijing, 100875, PR China*

Under the background of global warming, the research on the change of the ecological environment in the arid core area is extremely important. Saline lakes are natural laboratories for depositing minerals, which recorded all information of the change lake environment, accurate identification of sedimentary mineral components can provide direct evidence for the reconstruction of paleoclimate and environment. As the subsidence center of arid hinterland in Asia, Lop Nur provides the specific geography and geological environment for variety sedimentary salt. However, few studies the heterogeneity of mineral components in bright and dark lakeshore, and the paleoclimatic change in the process of salty lake disappearance. The utilization of Unmanned Aerial Vehicles (UAV) has significant advantages for sampling data in harsh weather conditions, it is easy and flexible to carry and safe to operate, it can collect a mass of high spatial resolution data due to the operation in medium-low scale space. In this study, the hyperspectral data and multispectral images were obtained by the UAV platform, spectral library of eight pure endmember minerals was established, then the SUnSAL spectral sparse unmixing was used to identify the sedimentary mineral components of mixed spectral curves, distribution of sedimentary minerals on bright and dark textures is analyzed. The coupling relationship between the ratio of sedimentary salt minerals to clay minerals ( $R_{S/C}$ ) in the lake shoreline, the type of salt crust micro-geomorphology and the spectral reflectance curve were analyzed. The paleoclimatic evolution of Lop Nur is reconstructed based on the climatic significance of minerals. Our results show: (1) the apparent reason for forming bright and dark textures in the remote sensing image is the differences in the micro-geomorphology of the salt crust, and the microscopic reason is the differences in the composition species and content proportion of the sedimentary minerals. Reflectance value of lake shoreline is dominated by  $R_{S/C}$ , the high  $R_{S/C}$  contributes to the high reflectivity, presents bright texture, the low  $R_{S/C}$  contributes to the low reflectivity, presents dark texture. (2) The bright texture indicates the warm-arid paleoclimatic, while the dark texture indicates the cold-humid climate. Lop Nur lake undergone extreme alternating paleoclimate change of warm-dry and cold-humid and it evolved from a lush oasis suitable for human survival to an arid uninhabited area.

Five key words: UAV remote sensing, Lop Nur, Sparse spectral unmixing, Salt lake, Paleoclimate change.

Email address for questions: yanglan3126@mail.bnu.edu.cn

Communication session 1: (9) Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology\_004

## Surviving onshore soil microbial communities differ among the Qing-Tibetan lakes with different salinity

*(Preliminary version)*

Jianrong Huang, Jian Yang, Hongchen Jiang, Geng Wu, Zhanling Xie and Hailiang Dong

*State Key Laboratory of Biogeology and Environmental Geology*

Little is known about the onshore microbial contribution to the microbial communities in nearby lakes and its response to salinity. In this study, transplanting experiments were established by caging onshore soils with dialysis bags followed by in situ 50-day incubation in nearby lakes with different salinity on the Qinghai-Tibetan Plateau. At the end of the experiment, geochemical and microbial analyses were performed on the original soils, caged soils and lake waters and sediments at the incubation sites. The results showed that the salinity increased significantly ( $P < 0.05$ ) in the caged soils and such salinity increases showed significant ( $P < 0.05$ ) positive correlation with the salinity of the studied lakes. The microbial community composition and predicted functions in the caged soils were significantly ( $P < 0.05$ ) changed in comparison with their corresponding original soils, and such variation could be mainly explained by the succession of members of the Proteobacteria, Bacteroidetes and Actinobacteria from the original soils to their corresponding caged soils. The onshore microbial contribution appeared to be limited (up to 11.2% for sediment and negligible for water, respectively) to nearby lake microbial communities. Nevertheless, the survival of onshore soil microbial communities was mainly limited by the salinity of the receiving lakes.

Five key words: Qinghai-Tibetan Plateau, Lakes, Onshore soil microbial communities, Contribution, Salinity

Email address for questions: [huangrong3166@126.com](mailto:huangrong3166@126.com)



Communication session 1: (9) Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology\_010

## **N<sub>2</sub>O producing and consuming bacteria respond differently to ecological drivers in the lakes on the Qinghai-Tibet Plateau**

*(Preliminary version)*

Xiaoxi Sun, Jian Yang, Hongchen Jiang, Beichen Wang

*State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences*

The distribution of nitrite<sup>-</sup> and N<sub>2</sub>O<sup>-</sup> reducing bacteria in lakes with different salinity remain limited. Here, we studied the abundance and diversity of nitrite<sup>-</sup> and N<sub>2</sub>O<sup>-</sup> reducing bacteria in six QTP lake sediments covering a wide range of salinity (from freshwater to salt saturation). Results showed that the nitrite reducers were numerically more abundant than N<sub>2</sub>O reducers in the studied QTP lake sediments. The abundances of nitrite reducers and N<sub>2</sub>O reducers ranged 7.14×10<sup>3</sup>-8.26×10<sup>8</sup> and 0-6.51×10<sup>7</sup> copies per gram sediment (dry weight), respectively. These two populations had distinct response patterns to ecological factors. In terms of abundance, salinity was the main driving for N<sub>2</sub>O reducers, but has less effect on nitrite reducers. In the perspective of community structure, nitrite<sup>-</sup> and N<sub>2</sub>O<sup>-</sup> reducing bacterial population were mainly regulated by mineralogical and physicochemical factors, respectively. Our findings highlight a niche differentiation between nitrite and N<sub>2</sub>O reducer populations, implying a high N<sub>2</sub>O potential in QTP lakes and offering a community-based explanation for salinity associated N<sub>2</sub>O emissions in harsh environments.

Five key words: Nitrite reducers, N<sub>2</sub>O reducers, Salinity, Qinghai-Tibetan Plateau, nosZ-II

Email address for questions: sunxiaoxi20121219@126.com



## Microbial role in carbon cycling in the saline lakes of the Qinghai-Tibetan Lakes

Hongchen Jiang, Jian Yang

*China University of Geosciences*

In order to investigate how microbial organic carbon degradation and carbon fixation respond to salinity change in high-mountain lakes, simulation experiments were established by using the surface sediments collected from the Qinghai Tibet Plateau. An integrated approach was employed including geochemistry and geomicrobiology. The results showed that In the aspect of organic matter degradation and mineralization, the input of exogenous organic matter can promote the degradation and mineralization of the existing organic matter (i.e. positive priming effect, i.e. PE) in the saline lakes on the Qinghai Tibet Plateau, and the organic C degradation intensity is negatively correlated with salinity; in the process of promoting positive PE, fungi play an important role through co-metabolism with prokaryotic microorganisms. Microbial communities in high salinity lakes have stronger ability to degrade organic matter with high carbon number and high complexity than those in low salinity lakes, which is mainly due to the influence of salinity on the selection of carbon source types. Microbial degradation of organic matter is mainly achieved through the interaction of a variety of microorganisms, that is, different microbial co-occurrence networks were formed for different types of organic matter. Specifically, alkane degrading bacteria from lakes with different salinities have the ability to degrade n-alkanes, which indicated that microbial degradation can change the composition of n-alkanes in sediments, thus affecting the reliability of paleoclimate /paleoenvironment proxy indicators based on n-alkanes. In terms of microbial carbon sequestration: the carbon sequestration rate of microorganisms (including algae and prokaryotic microorganisms) in the saline lakes of the Qinghai Tibet Plateau is negatively correlated with salinity. Based on this correlation, it is calculated that the annual organic carbon sequestered by microbial C fixation in the saline lakes of the Qinghai Tibet Plateau can reach 89-187 TG, which is two to three orders of magnitude higher than the emitted C (mainly CO<sub>2</sub>) from these lakes. In summary, microbes play an important role in carbon cycling in the saline lakes of the Qinghai Tibet Plateau, and the Tibetan saline lakes may be a carbon sink.

Five key words: Microbial role, Saline lakes, Qinghai-Tibetan Plateau, Carbon cycling, Organic Carbon

Email address for questions: [Jiangh@cug.edu.cn](mailto:Jiangh@cug.edu.cn)



Communication session 1: (9) Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology\_025

## Bicarbonate uptake rates and diversity of RuBisCO genes in saline lake sediments

Beichen Wang, Jianrong Huang, Jian Yang, Hongchen Jiang, Haiyi Xiao, Jibin Han, Xiyang Zhang

*State Key Lab of Biogeology and Environmental Geology, China University of Geosciences*

There is limited knowledge of microbial carbon fixation rate, and carbon-fixing microbial abundance and diversity in saline lakes. In this study, the inorganic carbon uptake rates and carbon-fixing microbial populations were investigated in the surface sediments of lakes with a full range of salinity from freshwater to salt saturation. The results showed that in the studied lakes light-dependent bicarbonate uptake contributed substantially (>70%) to total bicarbonate uptake, while the contribution of dark bicarbonate uptake (1.35–25.17%) cannot be ignored. The light-dependent bicarbonate uptake rates were significantly correlated with pH and turbidity, while dark bicarbonate uptake rates were significantly influenced by dissolved inorganic carbon, pH, temperature and salinity. Carbon-fixing microbial populations using the Calvin-Benson-Bassham pathway were widespread in the studied lakes, and they were dominated by the *cbbL* and *cbbM* gene types affiliated with Cyanobacteria and Proteobacteria, respectively. The *cbbL* and *cbbM* gene abundance and population structures were significantly affected by different environmental variables, with the *cbbL* and *cbbM* genes being negatively correlated with salinity and organic carbon concentration, respectively. In summary, this study improves our knowledge of the abundance, diversity and function of carbon-fixing microbial populations in the lakes with a full range of salinity.

Five key words: Microbial carbon fixation rate, *cbbL* gene, *cbbM* gene, Lakes, Salinity

Email address for questions: 18707191168@163.com



Communication session 1: (9) Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology\_029

## **The Rozel Point Tar Seeps and its Unique Hypersaline Environment at Great Salt Lake, Utah USA**

Cayla Martin, Greg McDonald, and Jaimi K. Butler

*Westminster College*

*Great Salt Lake Institute*

Naturally occurring tar seeps, located on the north arm of Great Salt Lake (Utah, USA), provides an opportunity to study unique hypersaline ecosystems. Oil and gas migrate through cracks and fissures along fault lines, and spreads along the surface of the dry lake bed. The resulting tar seeps are numerous and vary in size. During the warmer months, the surface of the Rozel Point tar is sufficiently sticky, and it can lead to the entrapment of a range of animals. Using direct observations and motion-activated cameras, our data suggests that the most common species entrapped is the American White Pelican. However, the entrapment of other birds, a coyote, and rodents suggest a diverse selection of animals that visit the seeps. We plan on using paleontological methods to identify the different species and draw conclusions as to why such animals are visiting the seeps. Factors that may influence visitations and entrapments include lake levels, temperature, entrapped animals as future prey for scavengers, and the appearance of the tar seeps as they reflect light. Using this site at Great Salt Lake as a modern analogue, we will compare our analysis to other significant petroleum-enriched sites such as the LaBrea Tar Pits.

Five key words: Tar seeps, Ecology, Entrapment, Palaeontology, Motion activated cameras

Email address for questions: [cm0414@westminstercollege.edu](mailto:cm0414@westminstercollege.edu)





## Effects of WWTP discharges on the carbon metabolic rates and greenhouse gases emissions of temporary saline lagoons

*(Preliminary version)*

Daniel Morant, Carlos Rochera, Antonio Picazo, Alba Camacho-Santamans, Javier Miralles-Lorenzo & Antonio Camacho

*Cavanilles Institute for Biodiversity and Evolutionary Biology, University of Valencia*

'La Mancha Húmeda' Biosphere Reserve, located in the centre of the Iberian Peninsula, is one of the regions with the most outstanding ecological complexes of saline steppe lakes in the Mediterranean. This area is a wide plain with a large number of endorheic basins and a sort of temporary meso- or hypersaline lakes. The presence of water and the depth of the water column are determined by the precipitation-evapotranspiration balance, causing salt accumulation in the lake bed. Magnesium sulphate is the dominated salt in medium salinity lakes, with sodium chloride increasing its relative abundance as salinity increases. While some of these lakes maintain their temporary and hypersaline character, many others have been highly altered. These altered lakes usually receive external freshwater inputs, acting as the final point of wastewater treatment plants (WWTP) from towns nearby, currently with limited treatment. Their natural hydrologic regime and salinity are thereby modified, and nutrients are poured to the lakes. Taking advantage of wastewater inlets, some conservation plans are addressed towards the maintenance of the water as a claim to migrant waterfowl and promoting and aesthetic values of these steppe wetlands of temporary origin. These alterations cause a change in the water regime of the lakes, in the chemistry of the water, as well as in the functioning of the system. One of the most relevant characteristics that can be affected by these alterations is the carbon balance and its ability to retain carbon or emit greenhouse gases. In this work, we aimed to determine the main implications of the most common alteration of saline lakes in 'La Mancha Húmeda' Biosphere Reserve, i.e. the hydrologic and chemical alteration due to WWTP discharges, on their metabolic rates and C balances. Metabolic rates related to carbon exchange, as well as direct greenhouse gases (GHG) emissions, were measured in the different compartments of different lakes, both altered and well-preserved. The results showed a clear significant difference between both types. The conserved lakes maintained a pronounced temporary hydroperiod and higher salinities, showing lower metabolic rates in annual terms. On the contrary, the lakes altered by wastewater pouring showed higher metabolic activity, especially in the plankton compartment, associated with eutrophication caused by the nutrient-rich poured waters, and a marked reduction in salinity. The extent of the hydroperiod and the higher content of organic matter in the sediment resulted into increases in methane emissions, especially during the warmer months, when the altered lakes still retained water. In conclusion, we observe how the hydrological, and consequently trophic, changes, caused by the usual discharges from WWTP to the endorheic saline lakes in a Biosphere Reserve, represent a drastic modification in the structure and functioning of these characteristic systems, affecting their carbon balances. The management of these lakes and their discharges could be key to reverse the alterations caused, recovering their natural hydrological, ecological and chemical characteristics, as well as their functioning with respect to their carbon balance and the reduction of the GHG emissions.

Five key words: Temporary saline lakes, Carbon metabolism, Wastewater, Ecological alteration, Greenhouse gases emissions



Email address for questions: [daniel.morant@uv.es](mailto:daniel.morant@uv.es)



Communication session 1: (9) Inland lakes in a changing world: anthropogenic and climate change effects on hydrology, chemistry and ecology\_118

## **Input of allochthonous and autochthonous organic matter stimulates microbial mineralization of organic carbon in the lake sediments with different salinity**

Mingxian Han, Jian Yang, Hongchen Jiang

*State Key Laboratory of Biogeology and Environmental Geology*

*China University of Geosciences*

There is limited knowledge about how microbial mineralization of autochthonous and allochthonous organic matter (OM) responds to salinity change in saline lakes. Here, we investigated the mineralization of algal and grass OM (representing autochthonous and allochthonous OM, respectively) by microbes in lake sediment with different salinity (1, 40 and 120 g L<sup>-1</sup>) by using geochemical and microbial analyses. The addition of algal and grass OM significantly increased the CO<sub>2</sub> production rates in the studied sediments. The difference of CO<sub>2</sub> production rates between the sediments with salinity of 40 and 120 g L<sup>-1</sup> was more significant than that between those with salinity of 1 and 40 g L<sup>-1</sup>. Algal and grass OM can induce positive priming effect (PE), and the PE intensity induced by grass OM was significantly higher than that induced by algal OM. PE intensity induced by algal and grass OM input decreased with increasing salinity. Both prokaryotic and fungal communities contributed to the mineralization of algal and grass OM in the studied sediments, and bacterial taxa affiliated with Actinomycetia, Alphaproteobacteria, Bacilli, Bacteroidia, Clostridia and Gammaproteobacteria played important roles. Furthermore, prokaryotic community compositions significantly changed in response to the addition of algal and grass OM, while fungal community compositions significantly changed only in response to addition of grass OM. Collectively, the input of allochthonous and autochthonous OM will accelerate the mineralization of native OM in saline lakes, and allochthonous OM exhibited stronger influence on microbial mineralization of native OM than autochthonous OM.

Five key words: Algal and grass OM, Microbial mineralization, Priming effect, Prokaryotic community, Fungal community

Email address for questions: hanmxian@163.com



Communication session 1: (11) Remote sensing and ecosystem modelling to support lake management and decision making\_001

## Geo-spatial modelling to prioritize restoration opportunities of the evanescent largest Saline Wetland Ecosystem (Sambhar Lake) of India

Rajashree Naik and Laxmi Kant Sharma

*Central University of Rajasthan*

*Sambhar Salt Lake, India*

Saline lakes occupy 44% and 23% of volume and area of all lakes around globe. These lakes might suffer from extended dryness, reduced hydroperiod, or complete desiccation by 2025 as seen in Aral Sea and Lake Urmia. These have influenced billion-dollar global markets of salt, shrimp, and minerals besides environmental disruption. These triggered the curiosity about the Indian saline lakes, as India ranks third in global salt market exporting approximately 230 million tons to 198 countries. However, current study is conducted on Sambhar Lake, largest inland saline Ramsar site contributing 9.86% of total salt production. The lake is undergoing partial desiccation due to illegal saltpan encroachment stealing brine worth 300 million USD. The current study aimed to assess its trend of degradation, identify ecological indicators, and predict future status at landscape level. For this investigation, geospatial modelling was conducted for 96 years (1963-2059) at decadal scale with Cellular Automata-Markov model, ground data (birds-soil-water). Land Use Land Cover classification was conducted using CORONA aerial imagery of 1963 (before start of any satellite mission) and Landsat satellite imageries using supervised classification for 1972, 1981, 1992, 2009, 2019 and future prediction under Land Change Modeler of TerrSet platform for 2029, 2039, 2049 and 2059. Acquired images were classified into 8 classes as Aravalli hills, barren land, saline soil, salt crust, saltpans, waterbody, settlement, and vegetation integrated with bird-soil-water and field information. Past trend shows reduction of waterbody from 30.7 to 3.4% at constant rate (4.23%) to saline soil. Saline soil increased by 9.3% subsequently increasing barren land by 4.2%; saltpans by 6.6% and settlement by 1.2% till 2019. Future predictions show loss of 40% wetland and net increase in 30% vegetation, 40% settlement, 10% saltpan, 5% barren land, and net loss of 20%, each by Aravalli and salt crust by 2059. Saline soil conversion to barren land will be largest loss of 120%. Additionally, soil-water-birds census result state a loss of its saline character; subsequently reduction of migratory bird from 3 million to 3000. Saltpan-encroachment, groundwater extraction, hydrological structure construction, water diversion, and biological disruptions, have altered its water budget, hydrological communications, habitat, and productivity. In the light of UN Decade on Ecosystem Restoration (2021- 2030), restoration strategies are suggested, if delayed, more restoration capital may be required than its revenue generation as happened in the case of Owen's lake in California when US\$ 3.6 billion was spent for its dust mitigation for 25 years.

Five key words: Saltpans, Illegal mining, Cellular Automata Markov, Land Change Modellar, Migratory birds

Email address for questions: rajashree.bini06@gmail.com



## Spatial heterogeneity of surface water temperature in the hypersaline Dead Sea

Pavel Kishcha and Boris Starobinets

*Tel Aviv University, Israel*

The Dead Sea is a terminal hypersaline lake with a depth of 300 m, at a unique location at ~430 m b.s.l.. Over the past four decades the Dead Sea has been drying up due to climate change in the Eastern Mediterranean causing an imbalance between water inflow and evaporation. As a result, Dead Sea water level has dropped at the rate of ~1 m/year, and sinkholes started developing around this saline lake. In this study we investigated the diurnal cycle of spatial heterogeneity in Dead Sea surface temperature (SST) based on METEOSAT geostationary satellite data of 5x5 km resolution (2005-2015). Using METEOSAT geostationary satellite data we found spatial heterogeneity in Dead Sea SST, which was pronounced throughout the daytime, and SST homogeneity at night. In summer, SST at the east side exceeded by several degrees SST at the middle and west parts. This was observed despite the uniform solar radiation and the absence of vertical water mixing. A specific feature of the hypersaline Dead Sea is strong nonlinear absorption of solar radiation, in contrast to fresh-water lakes. This is reflected in thermal layering from the surface down to a depth of 4 – 5 m, in the summer months. Therefore, in the presence of water mixing, the maximum of SST should be observed several hours later than that of LST due to high heat capacity of bulk water. Unexpectedly, METEOSAT showed that, in summer, SST peaked at the same time, 13 LT, as LST over surrounding land areas. This fact is evidence that there was no noticeable water mixing. In the absence of water mixing and under uniform solar radiation in the summer months, evaporation was the main causal factor of the observed spatial heterogeneity in SST: maximal evaporation (causing maximal surface water cooling) took place at the middle part of the Dead Sea, while minimum evaporation took place at the east side of the lake. The observed spatial heterogeneity in Dead Sea SST should be included in regional atmospheric models.

Five key words: Saline lakes, Dead Sea

Email address for questions: [pavel@cyclone.tau.ac.il](mailto:pavel@cyclone.tau.ac.il)

## Ecological status analysis of Mar Menor through Remote Sensing

*(Preliminary version)*

Pedro Escudero Lozano, Daniel Ibarra Marinas and Diana Hernández Mármol

*University of Murcia*

The Mar Menor is a hypersaline lagoon of international importance due to its high natural value. It is one of the largest coastal lagoons in Europe (170 km<sup>2</sup>), is included in the Ramsar Convention for the conservation of wetlands and in the Natura 2000 Network as a Special Area of Conservation (SAC) and Special Protection Area for Birds (SPA), as well as being one of the Specially Protected Areas of Mediterranean Importance (SPAMI). In this way, its natural value is recognised, with numerous species of fauna and habitats associated with the lagoon and its surroundings. However, its ecological status has been damaged by pollution from agricultural, as well as urban and mining sources. The entry of pollutants into the lagoon is mainly through runoff, mainly through the rambla El Albujón, and through groundwater. This process, which has been going on for decades, has led to the deep degradation of the Mar Menor and its eutrophic state, with episodes of anoxia and high mortality of species that make it highly vulnerable. Using multispectral satellite images from the Sentinel-2 satellite (European Space Agency), the water quality indicators chlorophyll and turbidity were analysed using spectral indices. The objective is to obtain the evolution of the chemical state of the lagoon in relation to the parameters chlorophyll and turbidity for the period 2013-2021. The results show an increase in the concentration of both chlorophyll and turbidity, which are highly correlated, especially concentrated at the mouth of the El Albujón rambla and in front of the urban beaches.

Five key words: Mar Menor, Remote Sensing, Ecological Status, Spectral Indices and Water Quality

Email address for questions: [pedro.escudero@um.es](mailto:pedro.escudero@um.es)





## Land cover and uses classification cartography within the Mar Menor coastal lagoon basin

Carmen Valdivieso-Ros, Francisco Alonso-Sarría, Francisco Gomaríz-Castillo

*Instituto Universitario del Agua y el Medio Ambiente, Euro-Mediterranean Water Institute*

Land uses and covers and its changes are one of the Essential Climate Variables with influence on topics of crucial importance for Global Change, ranging from environmental changes to land management at all spatial scales (global, regional and local). Mar Menor coastal lagoon is one of the most important ecosystems in western mediterranean coast, but its existence has been endangered by an intense process of eutrophication. The basin of the lagoon is one of the main agricultural surfaces in Murcia Region, cultivated since ancient times, but progressively changed from rainfed to irrigated agriculture during the last fifty years using water transferred, underground water from aquifers, and desalination plants. Intensive farming joint to an increase of urbanisation has polluted acuifers and lagoon waters since the last decades of past century. All this factors has conducted to a critical water degradation which has derived in mass die-off of aquatic species. Map and monitoring land use and cover and its changes with accuracy is essential to control, reduce and revert this situation. The Sentinel program from the European Spatial Agency (ESA) is one of the most recent missions focusing on many different aspects of Earth observation, including land monitoring. Sentinel-2 (S2) are two twin-polar orbiting satellites (2A and 2B). They contain a Multi-Spectral Instrument (MSI) that samples 13 spectral bands including visible, near-infrared and shortwave infrared with high temporal and spatial resolution in the visible and near-infrared bands. Land uses and cover classification in this Semi-arids mediterranean areas, where high fragmentation in landscape complicates the task, has been successfully addressed using a multi-temporal approach with one image per season and indices, including a wider range of spectral properties per class. The use of Random Forest as classifier algorithm also allows improving accuracy in land use and cover classification. In this study is presented the cartography resulting of a multiseasonal classification, after correction of training and validation data set. Initial data set for first classification is composed by 40 bands (B02, B03, B04, B05, B06, B07, B08, B08A, B11 and B12) from 4 images preprocessed using ACOLITE processor for atmospheric correction, set as the best algorithm to correct images in the area in previous research, and derived indices (4 NDVI, 4 NDBI, 4 SAVI, 4 MNDWI and 4 TCB). Dates for images was one per season every three months. Accuracy achieve for this classification was of 0,77 and kappa index of 0,72. However, selecting images equally distributed within a year is not representative from an agronomic point of view. Therefore, a new data set has been selected for a second classification with one image and derived indices per season again, but in dates which include as many different type of crops as possible in phenological growth stage before harvesting. This classification has reached an accuracy rate of 0,81 and 0,78 of kappa index. After that, it has been obtained by cross-validation the accuracy achieved for every single training and validation areas, to set individual accuracy for every polygon in the data set. It has been discovered that some polygons were sistematically wrongly labelled for unknown reasons, but they would be jeopardizing the potential improvement of accuracy, so it was tested the remotion of polygons under the threshold of 0,15 of accuracy of the data set. Thus, a new classification has been computed with this set of training and validation polygons where overall accuracy and kappa index has been booosted until 0,89 and 0,87.

Five key words: Sentinel-2, Land use and cover classification, Random forest, Cross-validation, Training data set

Email address for questions: [mcarmen.valdivieso@um.es](mailto:mcarmen.valdivieso@um.es)



Communication session 6: (6) Related natural sources and ecosystem services (agriculture, aquaculture, leisure, recreation and sustainable tourism, health and wellness in saline lakes, etc.)\_040

## **Managing Lake Urmia, Iran for diverse restoration objectives: Moving beyond a uniform target lake level**

Somayeh Sima, David E. Rosenberg b, Wayne A. Wurtsbaugh, Sarah E. Null, Karin M. Kettenring

*Tarbiat Modares University*

There is widespread interest in restoring drying saline lakes. At Iran's hypersaline Lake Urmia, managers have sought a uniform target lake level of 1274.1 m above sea level to lower salinity below 263 g L<sup>-1</sup> and recover *Artemia* to sufficient densities to support flamingos. We suggest that addressing a broader range of objectives will allow more flexibility for managing the lake. We define eight restoration objectives to lower salinity, sustain *Artemia* and flamingo populations, separate islands from each other and the mainland, reduce lakebed dust, maintain commercially valuable ions, and improve recreational access from resort beaches. We use 40 years of experimental, field, satellite, and model data to relate each objective to lake level. We describe variations through time and associated uncertainties for meeting each objective. We show that: 1) Lake variations prevent setting a precise target restoration level; 2) The current target may not sufficiently lower salinity to recover *Artemia* to sufficient densities to support flamingos; 3) Restoration objectives do not converge to a single lake level; tradeoffs are murky; 4) Lake Urmia managers should focus on multiple ecosystem services and track how they are met as lake level varies over time; and 5) As information about the lake improves, managers should adapt their management strategies to meet the most attainable objectives.

Five key words: Water management, Lake level, Uncertainty, Multiple objectives, Saline lake

Email address for question: [somayeh.sima@gmail.com](mailto:somayeh.sima@gmail.com)



Communication session 6: (6) Related natural sources and ecosystem services (agriculture, aquaculture, leisure, recreation and sustainable tourism, health and wellness in saline lakes, etc.)\_055

## Exploration and Characterization of Artemia Resource in Tibet Salt Lakes and their Utilization in aquaculture

Sui Liying, Gao Meirong, Han Xuekai, Duan Hu, Wang Zhenqian, Zhang Bo

*Asian Regional Artemia Reference Center, College of Marine and Environmental Sciences, Tianjin University of Science and Technology*

Brine shrimp *Artemia* are widely existed in salt lakes and solar saltwork evaporation ponds. As zooplanktonic crustacean, *Artemia* plays an important role in aquatic food chain and ecosystem in hypersaline environment. Moreover, *Artemia* nauplii are also indispensable live feed for marine fish and crustacean larvae, due to its smaller size, better nutritional value and easy hatchery operation. The salt lakes are mainly distributed in Naqu and Ali area in Tibet, with an average altitude of 4000-4500 m. Supported by Fishery S&T Aid Tibet project, three surveys with a total route distance of 10,000 km were conducted in 2019-2020, to investigate the geographical distribution of *Artemia* populations in Tibet, and to evaluate the *Artemia* resource reserves as well as their potential for commercial exploration. *Artemia* population were found in more than ten salt lakes, namely Qixiang Co, Lagkor Co, Dangqiong Co, Bango Co, Dong Co, Nier Co, Gibu Chaca, Yanhu, etc., with the salinity range of 40-100 g/L. Among them, *Artemia* cysts from Qixiang Co and Lagkor Co have been commercially harvested and processed since 1990s. The historical records indicate that, like other inland lakes, the annual cysts yield in Tibetan salt lakes fluctuates considerably. In 2020, the total dry cyst yield from Tibetan salt lakes (mostly from Qixiang Co) have reached more than 300 tons, accounting for 1/3 of total domestic cysts yield. So far there are seven identified bisexual *Artemia* species and many parthenogenetic *Artemia* in the world. The *Artemia* population originated from Lagkor Co has been identified as *Artemia tibetiana* in 1990s. However, using molecular markers COI and 12S-16S, our latest study found that the Tibetan *Artemia* populations in different salt lakes may have been differentiated to a certain extent, and whether there is a subspecies or cryptic species relationship between them is not clear, which requires further study. The *Artemia* cysts from Tibetan salt lakes are characterized with the large size (average cyst diameter ranging of 270-330  $\mu$ m), dark-red coloration, rich in HUFA (EPA content ranging of 25-50 mg/g DW, and DHA content ranging of 1-4 mg/g DW), higher antioxidative enzyme (T-AOC and T-SOD) activity, and better separation between cyst shell and nauplii upon hatching-out, therefore can better meet the nutrition and production needs of marine larviculture. In China, nearly 70% *Artemia* cyst product are sold to shrimp hatchery. Thus, the nutritional value of *Artemia* is of important to the shrimp larvae. We compared *Artemia* cysts and newly hatched *Artemia* nauplii from Qixiang Co, and other three commercial *Artemia* cyst products originated from the Great Salt Lake in the USA, Aibi Lake in Xinjiang and Bohai Bay saltponds, China. The results showed Qixiang Co *Artemia* had the largest cyst diameter, Instar I nauplii length and individual dry weight, as well as crude protein and crude fat content, and arachidonic acid (ARA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) content. Through feeding *Artemia* nauplii to *Litopenaeus vannamei* postlarvae, we found that although feeding *Artemia* nauplii from different origins did not resulted in significant difference in survival rate and body length, as well as muscle crude protein and crude fat content of the shrimps ( $P>0.05$ ), significantly higher ARA, EPA and DHA content were observed in the shrimp muscles fed Qixiang Co *Artemia* ( $P<0.05$ ). Moreover, the shrimps fed Qixiang Co and Aibi *Artemia* had better resistance to high salinity and ammonia nitrogen stress. In summary, *Artemia* is the major bioresource with high



commercial value in Tibetan salt lakes. Tibetan *Artemia* has better nutritional value and benefit to the larviculture of some aquatic species. However, there are still less understanding in aspects of considerable fluctuation of annual *Artemia* cyst yield, genetic differentiation of *Artemia* from different lakes, etc. Further investigation and study are thus needed to develop a sustainable harvesting strategy based on regular monitoring of *Artemia* resources as well as other biological and physiochemical parameters in the lakes, to explore the efficient molecular tools for biodiversity analysis, and to apply efficient harvesting and processing techniques for high quality cyst production, aiming to explore and utilize the Tibetan *Artemia* resource in more sustainable way, and to benefit to the salt-lake economy in Tibet.

Five key words: *Artemia*, Salt lakes, Tibet, Biodiversity, Aquaculture

Email address for questions: [suily@tust.edu.cn](mailto:suily@tust.edu.cn)



Communication session 6: (6) Related natural sources and ecosystem services (agriculture, aquaculture, leisure, recreation and sustainable tourism, health and wellness in saline lakes, etc.)\_058

## **Listening to the Landscape: Connecting people to salt lake country, a case study at Weeweera (Lake George) NSW**

Peri Coleman

*Delta Environmental Consulting*

When it comes to assessing how connected people feel to a particular place, aesthetic values have long been the surrogate that informs policymakers and others assessing a particular landscape's worthiness of preservation. In practical terms this approach seems to have been dominated by an assumption that the vertical elements of the landscape is what triggers feelings of awe. So tall forests, mountains, cliffs and rocky outcrops all score well under this type of assessment, and are often protected, but areas such as saltmarshes and salt lakes may score poorly and thus be vulnerable to developmental impacts. The "Nature Play" and "Cultural Ecosystems Services Assessment" approaches have recently emerged in the northern hemisphere. Within the latter approach cultural services are assessed as part of a wider ecosystems service framework. Recent attempts apply the CESA approach in the southern hemisphere, to less "vertically endowed" habitats include one in saltmarshes at St Kilda (Clarke, Thet, Sandhu and Dittmann, 2021). For saltlakes we still depend on anecdotal evidence from artists and poets, both in Australia and worldwide, for an inkling of the cultural significance of salt lake habitats. In 2019 geologist Anne Felton and botanist Peri Coleman offered an immersive experience of Weeweera (Lake George), a salt lake in NSW, in the hopes of deepening the participants' connection to country, and especially this particular salt lake. Art and journal entries, along with a final anonymous survey, were used to estimate changes in participants' responses to the landscape of Weeweera. Clarke BD, AK Thet, HS Sandhu and S Dittmann (2021) "Integrating Cultural Ecosystem Services valuation into coastal wetlands restoration: A case study from South Australia" in *Environmental Science & Policy* 116:220-229

Five key words: Cultural ecosystems services, Weeweera, Salt lakes, Saltmarshes, Landscapes

Email address for questions: [peri@deltaenvironmental.com.au](mailto:peri@deltaenvironmental.com.au)





Communication session 6: (6) Related natural sources and ecosystem services (agriculture, aquaculture, leisure, recreation and sustainable tourism, health and wellness in saline lakes, etc.)\_071

## Rapid Assessment of Ecosystem Services of the Sambhar Salt Lake, India

Kulshreshtha Seema<sup>1</sup> and Reddy G. V.<sup>2</sup>

*1. Department of Zoology, Govt Shakambhar PG College, Sambhar Lake (Jaipur), Rajasthan, India*

*2. Formerly. PCCF (HoFF) Forest Department and Chairman Rajasthan State Biodiversity Board, Government of Rajasthan, Jaipur, India*

Landlocked saline lakes are unique ecosystems with immense value to people in arid and semiarid landscapes. The Ramsar Site-Sambhar Lake, situated in Rajasthan, India, is historically famous for its salt production for over more than 500 years. This playa lake is a well-known flamingo habitat and a major wetland for winter visitors while being a culturally important place for the local community. Overexploitation of the lake water and underground water for salt production is putting the ecosystem services in peril. This study was carried out to assess various ecosystem services provided by the lake to develop an appropriate policy framework for safeguard the various services and livelihoods of the marginalized and dependent people of the region. There are currently no standard assessment methods in use for evaluating the salt lakes specifically. Alternatively, the Rapid Assessment of Wetland Ecosystem Services (RAWES) technique adopted by the Ramsar Commission was used for assessment of this hypersaline lake, as it is based on field indicators, and is systematic in approach while incorporating wise use dimensions by diverse stakeholders. The study area was stratified into six land-use zones, i.e., 1. main lake 2. salt pans 3. freshwater satellite wetlands 4. forested area 5. human settlements and, 6. crop fields. Ancillary data from our previous studies since 2004 and the available literature were used for comparison. The RAWES survey found that at least 32, out of 36 ecosystem services were provided by these sites and Ecosystem Services Index (ESI) was calculated for each ecosystem service at all the six sites. Despite a low sample size, statistically significant differences were observed in the range of services produced between the six ecosystem units depending on the land use and ecological characteristics. The result of the RAWES assessment clearly points out that, an unsustainable (excessive) use of provisioning ecosystem services is leading to critical disturbances in the main lake ecosystem and adversely impacting the other ecosystem services, which in the long run, might threaten the existence of the lake itself. The absence of clear government policy and governance mechanisms for controlling the negative anthropogenic factors is found to be the main cause for such dire consequences. Appropriate policy measures are suggested for sustainable production of salt and long-term sustainability of the lake and its ecosystem services.

Five key words: Excessive Salt-Extraction, Shakambhari Temple, Flamingo Habitat, Sambhar Playa, Rapid Assessment of Saline Lakes

Email address for questions: drseemakulshreshtha@gmail.com



## Conservation and management strategies for inland saline wetlands of Thar deserts in the light of UN Decade of Ecosystem Restoration

Laxmi Kant Sharma

*Central University of Rajasthan*

*Saline wetlands of Thar deserts*

Saline wetlands are fragile, dynamic systems, transient at larger spatio-temporal scales and strongly affected by long-term human activities. Traditional ecological knowledge represents an important source of information for erstwhile management practices. Our objective was to review historical and traditional knowledge based saline wetland ecosystem management and conservation of Thar desert of India which is world's 17th-largest desert, and the world's 9th-largest hot subtropical desert. We searched for historical traditional knowledge in online databases and books, reports and official documents collected from Sambhar Salt ltd., Sambhar Library and Salt museum. The findings were analyzed and interpreted. There are four major inland saline lakes in the regions such as Sambhar, Deedwana, Lunkaransar and Panchpadra of which only Sambhar is a Ramsar and IBA site. Among the online sources reviewed, we found 400 publication for Thar desert from 1854–2021. It was identified from the literature that the goddess Shakambari presented Sambhar lake to the local people 2500 years ago. It is stated that the conversion of the lake from sweet to saltwater lake could be referred to the time frame of formation of Iranian deserts Dast-e-Lut and Dast-e-Kavir. Data showed that wetlands in the region served as basic salt mining areas, particularly for edible salt exporting about 9.86% of India's annual salt export of 230 million tones since time immemorial. These lakes were fed by ephemeral rivers Mendha, Roopangarh, Khandel and Kharian along with their tributaries and distributaries. However, construction of 675 check dams and more than 2000 illegal bore wells stealing brines have deteriorated the wetlands nearly effacing their identity. The important outcomes were wetlands becoming patchy and decreasing ground water level, reduction of migratory species due to reduction of halophytes and halophiles. These outcomes from historical sources lay firm foundations for developing innovative nature-based conservation and management methods, specifically for the Sambhar lake, India's largest saline wetland. These will in return help to include this lake under any of the protected area network of the country, revive its pristine condition in the light of UN Decade of Ecosystem Restoration

Five key words: Thar desert, Inland saline, Wetlands, Illegal salt pan encroachment, Conservation strategies

Email address for questions: [laxmikant\\_evs@curaj.ac.in](mailto:laxmikant_evs@curaj.ac.in)



## A method to sample and treat salt and brine samples for plastic pollution testing

Ana Claudia Fegies<sup>1</sup>, Cristina Espinosa de los Monteros López<sup>1</sup>, María Balbás de la Fuente<sup>1</sup>, Carlos Morales Polo<sup>1</sup>, Raquel Caro Carretero<sup>1</sup>, Katia Hueso Kortekaas<sup>1,2</sup>, M<sup>a</sup> del Mar Cledera Castro<sup>1</sup>

*1. Department of Mechanical Engineering, ICAI, Comillas Pontifical University, Madrid*

*2. IPAISAL – Instituto del patrimonio y los Paisajes de la Sal*

Plastic pollution in food-grade salt is an environmental problem of growing concern. Numerous recent studies have researched the quantity and type of (micro-) plastic pollution in food grade salts across the world. Most of these studies focus on bulk and/or packaged salts, thereby focusing on the presence of them in the final product, rather than seeking to understand the source of this form of pollution. This contribution aims at proposing a methodology that allows to sample salt and brines from different stages of the salt production and preparation process in solar evaporation salinas. The focus is not only on finding plastic but comparing the quantity and type of pollution found in the different samples of a given site. By obtaining samples in the different stages, it will be possible to distinguish potential pathways of pollution with a higher degree of accuracy and therefore to address the causes of pollution in a more efficient way. This contribution is divided in two parts: First, the sampling methods in the field, both for brine and salts obtained in solar evaporation salinas. This sampling can be applied in both artisanal and industrial salinas, anywhere in the world and regardless of local specificities in the production method. It can also be used in inland solar evaporation salinas, an endemic type of facility found mainly in the Iberian Peninsula. The second part of the contribution describes the storing, handling and preparation of the samples in the laboratory, before the analysis of the quantity and type of microplastics. Both the field and laboratory methods described here are simple, yet robust, universally applicable and require little resources to implement. This will allow interested researchers to do their own sampling and research on plastics in food grade salt in a way that allows easy comparison and further improvement.

Five key words: Micro plastics, Salinas, Food grade salt, Testing procedure, Pollutants

Email address for questions: [mcledera@comillas.edu](mailto:mcledera@comillas.edu)



## The Smelly, the Slimy and the Salty: a Model for Connecting People to our Unique Saline Lakes

Jaimi Butler

*Westminster College*

*Great Salt Lake Institute*

What is the disgusting smell? How come my skin is so itchy? Nothing lives there, why should we care? These are all questions we hear about our unique saline lake ecosystems. For the past twelve years, Great Salt Lake Institute (GSLI) at Westminster College (Utah, USA) has worked to connect people to our unique salty neighbor through research and education. We employ a variety of methods to generate excitement with diverse audiences from lake scientists to school kids and even retired art lovers exploring their local museum. Examples of outreach: Publishing: In addition to publishing in peer reviewed journals with our students and faculty we have created other venues for informing Great Salt Lake communities. Great Salt Lake Biology: A terminal lake in a time of change is an academic book written by lake experts and edited by GSLI staff and faculty to educate researchers and lake managers. Our children's book, The GREAT Great Salt Lake Monster Mystery, published with student illustrations, takes you on a journey to find the fabled lake monster and all of the other cool and smelly things about GSL. Museums: We work closely with our local museums to enrich exhibits about Great Salt Lake. The Natural History Museum of Utah features a Great Salt Lake gallery with interactive exhibits about the lake and even an audio tour that was planned with GSLI assistance. We are partners with the Utah Museum of Fine Arts to help steward Robert Smithson's Spiral Jetty. In this role we have been able to add a scientific perspective into the art world in a novel way including designing an exhibit about water complete with Winogradsky columns in the museum and assisting an accomplished artist that created a piece in their main gallery based on GSL. In-Person events: Great Salt Lake Institute inspires, co-hosts and participates in many live events. Examples include the Great Salt Lake Bird Festival and Spider Festival. We host on-site training for politicians, teachers, informal educators, and managers about GSL. We have had students help community members paint with microbes. We have even given talks in the local pub to engage a diverse audience. Virtual events: The COVID pandemic halted all in-person events and allowed us to envision a change in our outreach. We created a virtual webinar series called the Salty Science Series to highlight scientists and connect the Great Salt Lake Community in a public friendly way. This also allowed us to digitally archive this information on our YouTube Channel. Online Presence: Great Salt Lake Institute has been active in most social media platforms. We love to share interesting and salty things about GSL in a very informal and flexible way to connect our community to all aspects of the lake including art, culture, current events, and highlight other organizations work about GSL. Boards and committees: GSLI staff and faculty participate on many boards and committees that study, inform, help manage and conserve GSL. This allows us to coordinate with diverse people and perspectives in the watershed. Media: GSLI has become a trusted organization that many journalists come to first with questions regarding the science of GSL. In 2021 we have connected millions of people through newspaper articles, radio interviews and on-camera interviews. These methods all lead to a robust outreach program reaching a variety of people that impact and are impacted by our shrinking and important lake. We encourage you to connect the saline lakes you study and invite you to use our successes and failures to better connect with your community.



Five key words: Outreach, Publishing, Saline lakes, Storytelling, Science communication

Email address for questions: [jbutler@westminstercollege.edu](mailto:jbutler@westminstercollege.edu)





## The likely status of inland salt lake ecosystems in 2050: Reminiscing and revisiting Bill Williams

Francisco A. Comín

*Instituto Pirenaico de Ecología-CSIC*

The classical management approach of saline lake ecosystems focused on ecological issues, including the conservation of their biological communities and physical-chemical characteristics. Major objectives clearly included the conservation of their hydrological dynamics, temporal fluctuations and the intense relationships between biological population dynamics and water chemical characteristics. However, the peculiarity of saline lake ecosystems is that they are located in a limited watershed, in many cases a closed watershed, so processes and activities in the watershed impact on the saline lake. So, the concept of saline lake ecosystem includes the watershed. Consequently, its management should be planned and performed at watershed scale, which has been frequently neglected. W.D. (Bill) Williams was one of the key persons rising awareness for the conservation and promoting their rationale management based on scientific research results. He discussed and reviewed a number of impacts and management actions. In this work, the classical proposals for inland salt lake management are reviewed and innovative approaches in the framework of sustainable development are discussed. A literature review shows that classical management approaches of inland salt lakes included return impacted salt lakes to initial conditions through, mostly, eliminating the processes impacting them. Returning water flows was successful in Mono Lake but did not take place in Aral Sea where controversial practices as constructing a barrier in the lake to fill its north part is mixed with geo-political strategies. Lake Eyre and Lake Cantara South are mostly submitted to climate change impacts with relatively low direct impacts from human activities: more frequent but shorter rainfall episodes which may lower the development period of organisms after dessication. At the turn of the century, a wider approach emerged after the concept of sustainable development. In addition to focus at watershed scale management, already considered at Bill's time, the integration of social, economic and environmental issues was incorporated to management proposals by different authors. Lake Gallocanta case study is described and discussed as a paradigm of inland salt lake management. The overwhelming group of management regulations existing during the 1970-2000 did not change for the last 20 years due to an permanent conflict of interest between management authorities and agricultural farms, which exemplifies the need to incorporate social and economic incentives to environmental issues for the benefit of salt lake ecosystem conservation including their inhabitants. Up to the end of the nineties environmental aspects prevailed in the management of Lake Gallocanta. The social issues were incorporated after intense human depopulation. And economic interests are emerging recently to balance the requirements of sustainable development. Alternative management scenarios –tecnification, adaptation– are discussed in front of climate change and other global changes impacting Lake Gallocanta. The analysis of these management alternatives can be useful to improve the status of other inland salt lakes around the world.

Five key words: Management, Salt lakes, Sustainable development, Climate change, Scenarios

Email address for questions: [comin@ipe.csic.es](mailto:comin@ipe.csic.es)





## A certificate system for salt production in solar evaporation Salinas

Katia Hueso Kortekaas, Renato Neves, Gustavo Ballesteros Pelegrín

*IPAISAL / Universidad Pontificia Comillas*

Many solar evaporation salinas are located in natural protected areas and need to comply with management regulations to protect the biodiversity and habitats they occupy. The production of salt can therefore be affected by these regulations. One of the actions proposed by the LIFE Salinas project is the design of a certification for salts that are produced in these types of salinas, to acknowledge and encourage a balanced management of environmental and productive criteria, so that the natural values of the site are seen as an asset that contributes to the quality of salt, rather than a hindrance. With it, both the environmental and socioeconomic axes of sustainability are addressed. The certificate is based on three main aspects: the product itself, the salt making process and the landscape. It is designed to be granted to salts that comply with criteria of organoleptic excellence, clean and respectful production processes and the coherence with the protection of landscape, including both its natural and cultural values. Other certificates for salt exist, but they do not encompass these aspects in one single system or seal. This certificate is especially useful for smaller solar evaporation salinas that have traditional salt making methods, operate at artisanal scale or at small industrial scale with high environmental quality standards. The certification is also well suited for inland solar evaporation salinas, an endemic and endangered type of salt making sites that exist in few places across the globe and are especially well represented in the Iberian Peninsula. The certificate will be issued by an independent consortium formed by IPAISAL (an NGO from Spain) and Mãe d'Água (a consultancy firm from Portugal) with a deep knowledge of traditional salt making in natural protected areas and has no particular interests in any specific site. The consortium will have the technical support from the University of Murcia. Up to date, pilot tests are being run in the four salinas from Portugal and Spain participating in the LIFE Salinas project, namely San Pedro del Pinatar in Murcia, Ibiza in the Balearic islands, Castro Marim in Algarve and Samouco in the Tagus estuary.

Five key words: Quality, Protected areas, Natura 2000, Saltscapes, Food-grade salt

Email address for questions: [salinasdeinterior@gmail.com](mailto:salinasdeinterior@gmail.com)



## Tracing hypersaline lagoonal decline: Finding the first ecological domino and why it is important

Faith S Coleman

*Federation University, Australia*

Hypersaline lagoonal environments are highly retentive systems. It only takes a small change in the inputs or outputs to upset their fine chemical and biological balance. While easy to shift a hypersaline lagoonal system from its historic balance, the impacts of these changes may not be evident in monitoring data or to human observation until a complete state-shift has occurred, due to the significant degree of hysteresis within these ecosystems. The high levels of hysteresis present in hypersaline lagoons also make restoration tricky, as sudden changes can result in the system going into “shock” if the change was greater than the ecosystem's inherent resilience, or over-shooting the target, resulting in a sudden and permanent change (without significant correction) beyond the expected outcome. Trying to identify the cause of an ecological decline in a hypersaline lagoon can be like trying to reverse a fallen domino stack, decades or centuries after the original or early post-European anthropogenic impact(s) occurred. In many cases, long-forgotten anthropogenic impacts result in a cascade of related ecological changes. Identifying the original cause of these cascading changes can be challenging. However, once the original impact(s) has been identified, restoration plans for these systems are often more systematic, simpler and more predictable than restoration plans based on a series of symptomatic corrections. A restoration plan where the early anthropogenic impact(s) and the presence of natural ecological succession have been taken into account is likely to yield a more stable solution, requiring fewer ongoing corrective actions. This presentation will use the South Lagoon of the Coorong (South Australia) as a case study, demonstrating how the original impact(s) are currently being determined using a range of historic scientific and cultural sources, including identifying when the decline first started and the challenge of identifying whether the decline was originally initiated by a calcium/sulphate cycle imbalance, change in hydrokinetics, increased nutrient inputs, decreased nutrient outputs or a simple salinity shift. The Lakes and Coorong wetland is a 130 km long wave-dominated estuary. The bay-head delta and central basin (Lakes Alexandrina and Albert) have been separated from the flood and ebb tide delta (Murray Mouth) and back-barrier coastal lagoons (Coorong) by man-made barrages. This wetland complex is the estuary of the River Murray, which receives water from four states, along with a number of lower-order streams and Salt Creek, which flows directly into the South Lagoon, near the southern-most end of the wetland complex. The Coorong also receives water from groundwater seeps along its >500km long shoreline and seawater exchange at the 160-200m wide, <16m deep Murray Mouth, tiny in comparison, at the northern end of the Coorong. This wetland has been a political and scientific hot potato for many decades. Over the last twenty years, it has often been claimed that the poor health of the South Lagoon is due to the tail-end effects of the Millennium Drought. Unfortunately, while that is part of the story, historic research is showing that the ecosystem in the South Lagoon has been in decline for more than a century. Of particular interest to the ISSLR, Professor Bill Williams contributed to this debate in the 1960s-70s, claiming that the ionic composition of the South Lagoon was different to that of seawater and that the salinity levels of the 38km-long South Lagoon were fluctuating as part of a decadal or longer cycle rather than having a salinity that was continuously increasing, as had been stated by a number of his peers. How William's statements have stood up to the test of time will of course be touched on in this time-travelling look at the South Lagoon of the Lakes and Coorong Ramsar-listed wetland.

Five key words: Coorong, Australia, Hysteresis, State-shift, Salinity

Email address for questions: [faith@ecoprotem.com](mailto:faith@ecoprotem.com)



## Environmental recovery of old salt ponds: the case of the "Coterillo pond" in the salt ponds of San Pedro del Pinatar (Murcia, Spain)

Diana Hernández Mármol, Gustavo A. Ballesteros Pelegrín, A. Daniel Ibarra Marinas, Antonio Zamora Parra, Pedro Escudero Lozano, Francisco Belmonte Serrato.

*Universidad de Murcia*

Obtaining common salt or table salt (sodium chloride) from the evaporation of water (sea or continental) containing it in solution was one of the first 'mining' (mineral extraction) activities in human history. The extraction process requires the passage of water through various shallow ponds, built to cause the successive decantation of other dissolved salts, such as sulphates or carbonates, until sodium chloride is obtained in the last ponds, known as 'crystallisers'. The salt ponds, especially the so-called 'heaters' and 'concentrators', are, by their nature, small artificial salt ponds of great biodiversity, used by a multitude of migratory birds. However, when the salt activity is abandoned, these ponds lose their water surface, which only recovers in specific episodes of heavy rainfall. The aim of this work is to show the recovery process of one of these abandoned salt ponds, specifically the Coterillo pond in the salt ponds of San Pedro del Pinatar (Murcia), adapting it for the recovery of its biodiversity and use by migratory birds. The preliminary results of the biological monitoring show a rapid recolonisation of the system by the fartet (*Aphanius Iberus*), a small fish endemic to the southeast Iberian Peninsula and listed as Endangered (EN) by the IUCN, and locally extinct in Coterillo since 2012 as a result of the saline stress to which the environment was subjected. In addition, the aquatic macroinvertebrate community has seen an increase in its taxonomic diversity, with several species of coleopteran indicators of ecological quality being detected in saline environments, such as *Nebrioporus ceresyi*, *Ochthebius corrugatus* or *Enochrus bicolor*. At the same time, and as a consequence of the increase in these essential faunal taxa at the base of the food chain, the waterfowl community has diversified and increased in terms of abundance. Likewise, by means of photointerpretation, the historical evolution of the Coterillo pond has been obtained using images from the Photogrammetric Flight carried out by the US Army between 1956 and 1957 and the National Aerial Orthophotography Plan (PNOA) of 2019, among others. Moreover, remote sensing techniques and algorithms were used to create land cover classifications associated with this space over the selected time interval.

Five key words: Salt ponds, History, Remote sensing, Biodiversity, Conservation

Email address for questions: [diana.h.m@um.es](mailto:diana.h.m@um.es)



## Management of inland saline lakes: a key factor in their climate regulation capacity

Alba Camacho-Santamans & Daniel Morant

*Cavanilles Institute for Biodiversity and Evolutionary Biology, University of Valencia*

Management of aquatic ecosystems strongly interacts with the ecological features and ecosystem services as management measures can to modify their structure and functioning. Certain management measures can weaken or strengthen some factors or services in favour of others. Particularly, climate change mitigation can be highly influenced by the actions carried out on water, sediment and soil, and aquatic and marginal vegetation. However, climate change mitigation is not usually considered, and some management actions can reduce the carbon sequestering capacity, and increase the greenhouse gases (GHG) emissions, especially of CH<sub>4</sub> and CO<sub>2</sub>, to the atmosphere. The aim of this work was to analyse how some of the most common management measures performed on inland saline lakes affect their carbon balance and GHG emissions, thus compromising their climate change mitigation service. The carbon balance and methane emissions of three differentially managed inland saline shallow lakes, located in La Mancha Húmeda Biosphere Reserve (Spain), were studied. One of these lakes is well-preserved, maintaining its natural temporary and hypersaline condition. Another lake is altered by freshwater inputs from a river, to maintain the lake permanently flooded to be used as a bathing area in summer. The third studied lake receives freshwater inputs from a wastewater treatment plant, with high nutrient loads, in order to expand the flooding period favouring waterfowl settlement. Marginal vegetation communities in the two latter lakes differed from the original halophyte community, and water salinity was much lower than under natural conditions. The C-metabolic rates and GHG emissions were modelled under these three different management scenarios. After having quantified the effects of the management actions on the carbon balance and GHG emissions, an assessment matrix was built to evaluate the effect of each management measure on the different natural values, anthropic uses and ecosystem services to obtain a holistic perspective of the effect of management on the ecological values, social perception and climate change mitigating capacity of the lakes. Results of the modelling showed how the carbon balance was highly related to the water regime and marginal vegetation coverage. The carbon sequestration capacity of these lakes was mainly sustained by the marginal vegetation productivity. The extension of the flooding period and decreasing salinity level mediated by freshwater pouring caused increases of GHG emissions, especially due to the presence of water during the warmer months. Contrarily, the carbon sink capacity increased when the natural conditions of these shallow temporary saline lakes were restored. From the interpretation of the modelling results, some recommendations were defined for each of the three studied lakes, considering their current condition and management, in order to maintain or even increase its climate change mitigation service.

Five key words: Temporary saline lakes, Management, Climate change mitigation, Greenhouse gases emissions, Ecosystem services

Email address for questions: [albacamachosantamans@gmail.com](mailto:albacamachosantamans@gmail.com)





## Since when were saltern crystallizer brines colored red?

Aharon Oren

*The Hebrew University of Jerusalem, Jerusalem 9190401, Israel*

In 1991, Carol Litchfield published an essay entitled 'Red—the magic color for solar salt production', reviewing the connection between salt production by evaporation of seawater and other saline water sources and the red coloration of crystallizer brines. Crystallizer ponds of coastal and inland solar salterns worldwide are generally colored pink, red, or orange. The most important microorganisms that contribute to the color are archaea of the class Halobacteria; their membranes are rich in bacterioruberin carotenoids and purple retinal proteins (bacteriorhodopsin, halorhodopsin). There also are halophilic red members of the bacteria such as *Salinibacter*, which contains the carotenoid salinixanthin and retinal proteins. Red saltern crystallizer ponds typically contain  $2 \cdot 10^{10} > 7$  prokaryotic cells/ml.  $\beta$ -Carotene-rich *Dunaliella salina* cells (Chlorophyceae) may also contribute to the brine color. Surprisingly, reports about salt making from antiquity, the Middle Ages, and even until the 18th century did not explicitly mention pigmented brines. No such records are found in the descriptions by Pliny (*Naturalis Historia*, 1st century), Manilius (*Astronomica*, 1st century) and Namatianus (*De Reditu Suo*, 5th century). No descriptions were found of red brines in the salterns operated by the Venetians around the Mediterranean since the Middle Ages. They are not mentioned by Georgius Agricola (Georg Bauer) in his *De Re Metallica* (1556), and in an anonymous account of French salterns published in 1669. In a few places where salterns are operated today using the traditional technology used in the Middle Ages, such as in Sečovlje (Slovenia) and Ston (Croatia), crystallizer brines contain only  $\sim 1.6 \cdot 3.1 \cdot 10^6$  prokaryotic cells/ml, numbers too small to color to the water red. The first report from the Western world of red brines in coastal salterns probably dates from 1765: the *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers* by Diderot and coworkers. However, in China it was documented already two centuries earlier in the Ben Cao Kang Mu, a compendium of *Materia Medica* completed by Li Shizhen in 1578, based on older sources. The lack of early records of red saltern brines in Europe and the earlier report of such brines from China may be due to differences in the way the salterns were operated. In China, the residence time of the brine in the crystallizer ponds was long; Li Shizhen wrote: 'Many days later, the water will be red'. In the traditionally operated salterns at Sečovlje and Ston, brine is led to the crystallizers once or twice a day, and salt is harvested almost continuously. In Roman times and during the Middle Ages, the same method was probably used. Also in the French salterns described in 1669, workers 'draw the Salt every other day'. The brine residence time in the crystallizer ponds may then be too short to allow massive development of red-pink microorganisms. However, in the French salterns described in 1765, the residence time was much longer: 'When a pond starts to produce salt, it only gives salt once every 8 days, and when it heats up one harvests twice or thrice per week'. In most modern salterns, salt is harvested once or twice per year. Thus, microorganisms can develop during many weeks to the community densities needed to color the brines red-pink.

Five key words: History, Archaea, Carotenoids, Pigmentation, Salterns

Email address for questions: [aharon.oren@mail.huji.ac.il](mailto:aharon.oren@mail.huji.ac.il)





## A microbial history of a changing Great Salt Lake

Bonnie K. Baxter

*Westminster College*

*Great Salt Lake Institute*

Over geologic time, the water in the Bonneville basin has risen and fallen, leading to the modern Great Salt Lake (Utah, USA). Paleo-humans lived along the shores of the ancient Lake Bonneville and lower lake levels, and as it shrunk to the present margins. Indigenous peoples inhabited the surrounding desert and wetlands of Great Salt Lake in recent times. Nineteenth century Euro-American explorers and pioneers described the geology, geography, and flora and fauna of Great Salt Lake, but their work attracted white settlers to Utah, who changed the lake immeasurably. Human intervention in the 1950s created two large sub-ecosystems, bisected by a railroad causeway. The north arm approaches ten times the salinity of seawater, while the south arm salinity is a meager four times that of the oceans. The presentation will explore the stories of the people who observed and researched the salty microbiology of Great Salt Lake, whose discoveries demonstrated the presence of bacteria, archaea, algae, and protozoa that thrive in this lake. These scientists documented the lake's microbiology as the lake changed, with input from human waste and the creation of impounded areas. Modern work on the microbiology of Great Salt Lake has added molecular approaches and illuminated the community structures in various regions, and fungi and viruses have now been described. The exploration of Great Salt Lake from early human inhabitants to current microbiologists reflects the environmental history and informs our understanding of this terminal lake with its ever-changing shorelines.

Five key words: Great Salt Lake, Microbiology, History, Anthropomorphic, Scientists

Email address for questions: [bbaxter@westminstercollege.edu](mailto:bbaxter@westminstercollege.edu)



## Historical location and evolution of Lop Nor based on SAR maps and DEM

ZHANG Tingting, SHAO Yun, GENG Yuyang, GONG Huaze

*Key Laboratory of Target Microwave Properties and Remote Sensing of Zhejiang Province*

Lop Nor was a vast ancient playa located in the east of the Tarim Basin, northwest of China. Lop Sea was considered as the lake basin of Lop Nor since Quaternary. However, the possibility of Lop Nor being away from Lop Sea in historical periods is worth discussing, which is important for interpreting proxy records in sediment profiles. In this paper, the evolution of Lop Nur and Lop Nur sea in the historical period is summarized by various methods. First of all, the Qianlong Thirteen-Row Atlas, an ancient imperial atlas of the Qing Dynasty, which was completed around 1760, indicated that the Tarim River formed a relatively large lake in its modern upper reaches. Secondly, the DEM with a 10-meter spatial resolution and a relative accuracy of 0.42 meter is derived from TanDEM-X/TerraSAR-X satellite image pairs using the interferometry method, and verified with ICESat-GLAS laser footprints and local DEM obtained by UAV. According to the DEM, the highest water level in Loulan depression is about 790 m asl, and the possible lake area and volume of Loulan depression are 354.3 km<sup>2</sup> and 0.41 km<sup>3</sup> respectively. Finally, based on the spatial analysis of historical documents, expedition reports, sediment profiles and archaeological evidence, it can be deduced that the lacustrine deposition was discontinuous in Lop Sea. Six episodes in the evolution history of the drainage system in eastern Tarim Basin were summarized. Based on the results obtained, it is concluded that Lop Sea was not on a permanent lacustrine deposit condition over the last 2000 years. The terminal lake of the Tarim River, Lop Nor, changed its location and area according to the water supply because of climate change and human activities. Interpretations of the sediments in Lop Sea must be treated with care. The lake level could hardly exceed 790 m asl in Loulan period, thus the corresponding maximum lake area was about 8,000 km<sup>2</sup>. The evolution between Loulan period and medieval flooding period was not clear right now, but the Lop Sea might be desiccated with the demise of the Loulan civilization. After the medieval flooding, Lop Sea did not receive drainage of the Tarim River until about 1901~1906 AD. Lop Nor in Qing Dynasty was in a region around Tikenlik. Water area of the lower Tarim River was decreasing in the last 2000 years. The high-accuracy DEM provided a reference for the location of further field work in Lop Sea. The method proposed in this paper will be efficient for the research of inland lakes or rivers in global arid regions. The proved depositional condition variations could be used for future interpretation of proxy records in sediment. Additional field work would be needed to figure out the paleo environment and human activities in Lop region, and the DEM provides a reference for the sample site in Lop Sea.

Five key words: Historical period, Lake basin topography, TanDEM-X InSAR, Lacustrine deposit, Drainage evolution

Email address for questions: zhangtt@radi.ac.cn



# The 5000-year development history of Yuncheng Salt Lake—A study

*(Preliminary version)*

Guohong Zhang

*Shanxi Coking Coal Yuncheng Salt Chemical Group Co., Ltd.*

Yuncheng Salt Lake, formerly known as Hedong Salt Pond or Xiechi Pond in the ancient times, is one of the earliest salt lakes to be developed in the world, with a development history of almost 5000 years (the carbon-14 age of the clay layer underlying the 5.76 m mirabilite plate is measured to be 4653±87a.B.P.). This paper studies the 5000-year development history of Yuncheng Salt Lake, and describes how man has managed to solve the production techniques, product quality, facilities, and flood control associated with table salt, mirabilite, magnesium sulfate, and magnesium chloride during the development and utilization of salt lake mineral resources, with focus on the land reclamation–watering–sunning, five-step shoveling, and mirabilite quality enhancement methods. Our findings are expected to provide useful references for the separation and recovery of soluble salts in other salt lakes. In addition, we also investigate the possibility of developing health care and tourism projects by taking advantage of the unique wetland ecological resources like salt lake black mud and brine, and the potential of developing *Artemia* and *Dunaliella salina*.

Five key words: Yuncheng Salt Lake, Table salt, Mirabilite, Land reclamation–watering–sunning, five-step salt shoveling, Black mud, Development and utilization

Email address for questions: [hgyyglb@163.com](mailto:hgyyglb@163.com)



## Mercury Bioaccumulation and Biomagnification in Great Salt Lake, Utah, USA

Abigail F. Scott, Frank J. Black

*Westminster College (Utah)*

Mercury (Hg) contamination of Great Salt Lake, Utah, USA (GSL) ecosystems has been a persistent concern for the health of both humans and wildlife, especially for waterfowl, shore birds, and their prey. While surface water Hg levels are below the Environmental Protection Agency (EPA)'s aquatic life standard of 12 ng/mL, total Hg concentrations in the deep brine layer (DBL) of the stratified south arm of GSL are typically 30-70 ng/mL, per Cold Vapor Atomic Fluorescence Spectroscopy (CVAFS). The DBL contains the highest concentration of methylmercury (MeHg) ever measured in a natural body of water (25.5 ng/L, per CVAFS). While all forms of Hg are toxic, MeHg is the most concerning form because it is efficiently absorbed upon ingestion, has a much slower rate of depuration than accumulation, and is the only form of Hg that is consistently biomagnified up food webs. The world's first waterfowl consumption advisory resulted from the discovery that Hg wet weight concentrations in the muscle of three species of ducks (Cinnamon Teal, Common Goldeneye, Northern Shoveler) at GSL exceeded EPA screening value of 0.3 mg/kg, per Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Hg research in GSL ecosystems has focused on birds and their common prey, which are brine flies and brine shrimp, because the greatest concerns for potential negative impacts of Hg toxicity at GSL are for birds and hunters who target waterfowl. While Hg concentrations in brine shrimp and brine fly larvae pose a low to moderate toxicity risk to birds, Hg concentrations in waterfowl increase as they feed higher on the food chain. Hg blood levels in GSL birds commonly exceeded toxicity benchmarks and GSL has been labeled as an avian Hg hotspot. Trends of reduced snowpack, precipitation, and decreased lake volume are concerning for the future of Hg in GSL ecosystems.

Five key words: Mercury, Toxicity, Birds, Biomagnification, Great Salt Lake

Email address for questions: [abby.scott@utah.edu](mailto:abby.scott@utah.edu)



## Origin and circulation of springs based on hydrochemistry and water isotopes (O,H,3H) in Nangqen and Changdu basin, Southwestern China

*(Preliminary version)*

Xiwei Qin<sup>1,2,3</sup>, Haizhou Ma<sup>2,3</sup>, Xiying Zhang<sup>2,3</sup>, Xiasong Hu<sup>1</sup>, Guorong Li<sup>1</sup>, Huaide Chen<sup>2,3</sup>, Jibin Han<sup>2,3</sup>, Yongshou Li<sup>2,3</sup>, Weiliang Miao<sup>2,3</sup>, Wenhua Han<sup>2,3,4</sup>, Sha Yang<sup>1</sup>, Qian Song<sup>1</sup> and Mei Wu<sup>1</sup>

*1. Department of Geological Engineering, Qinghai University, Xining, 810016, China;*

*2. Key Laboratory of Comprehensive and Highly Efficient Utilization of Salt Lake Resources, Qinghai Institute of Salt lakes, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, 810008 Xining, China;*

*3. Key Laboratory of Salt Lake Geology and Environment of Qinghai Province, Qinghai Institute of Salt Lakes, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, 810008 Xining, China;*

*4. University of Chinese Academy of Sciences, 100049 Beijing, China*

Geothermal and brine resources are very rich in Nangqen and Changdu (NQ-CD) basin. However, origin and spatio-temporal evolution processes in hot and saline springs remain unclear. Geochemical and water isotopic (O, H, 3H) studies on geothermal and saline springs were conducted in the NQ-CD basin. All saline springs in study area are of Na-Cl type and geothermal waters are of various types. The oxygen and hydrogen isotopic compositions of springs in the NQ-CD basin are primarily controlled by meteoric water or ice-snow melt water and influenced by water-rock interactions. It is found that saline springs of the study area is derived from halites and sulfates dissolution in tertiary Gongjue red bed and hot springs in the CD basin are greatly influenced by the dissolution of carbonatites and sulfates from Bolila (T3b) and Huakaizuo (J2h) formation. On the basis of silica geothermometry and silicon-enthalpy hybrid model, the apparent reservoir temperature and reservoir temperature for hot springs in Changdu basin are 57-130°C and 75-214°C, respectively. The deuterium excess parameters indicate that most hot springs are recently recharged rain water and saline springs have a weaker groundwater regeneration capacity than hot springs. The tritium data show that the ranges of calculated residence time for springs in this study are 25 to 55 a and hot springs in CD basin may originated from different two hydrothermal systems. The geochemical characteristics of the NQ-CD springs are similar to those of Lanping-Simao basin, indicating the same solute sources. Thus, the combined use of water isotope technique coupled with hydrogeochemistry proves to be an effective tool to establish the origin and spatio-temporal evolution in the spring waters.

Five key words: Saline and hot springs, Water isotope, Recharge and solute sources, Residence time, Nangqen-Changdu basin

Email address for questions: 495975224@qq.com

## Efficient utilization of potassium and lithium resources in sulfate salt-lake: system engineering, state prediction and precise process control of salt-ponds

*(Preliminary version)*

Huan Zhou, Qing Hao, Meng li Zhang, Pan Ping Xia, Feng dan Wei, Si Wu

*College of Chemical Engineering & Materials Science, Tianjin University of Science & Technology, China*

Efficient and ecological utilization of resources is a major concern of salt lake industry, and the extensive process management for the natural evaporation crystallization process with large-scale equipment limit the efficient utilization of resources at present. To realize the accurate control of salt pond process, it is necessary to accurately express the process features of salt ponds system, and effectively predict the solid and liquid phase composition and stock state of salt pond. Therefore, two stages of fundamental research have been carried out, one is the multi temperature phase equilibrium and dynamic characteristics of complex water salt systems, the other is the systematic engineering research of salt production process. The research in the first stage focus on 'Comprehensive Thermodynamic Models of Multi-component Brine System for Multi-temperature Phase Diagram Prediction and Application', and the excellent results of brine properties calculation, multi temperature phase equilibrium and complete phase diagram prediction at entire temperature region have been achieved for the chloride type brine of  $\text{Li}^+$ ,  $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$  //  $\text{Cl}^-$  -  $\text{H}_2\text{O}$  systems and sulfate type brine of  $\text{Li}^+$ ,  $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$  //  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$ - $\text{H}_2\text{O}$  systems. The second stage research of this work: the ideas of 'systematic process and precise control of salt ponds process' was proposed basing on thermodynamics, system engineering and salt field engineering, and four key issues are concerned: (1) thermodynamic modeling of brine evaporation behaviors and salt precipitation dynamic for sulfate type brine during multi temperature process, (2) systematic modeling of salt ponds process, (3) predicting the response of solid and liquid state in salt ponds to the nature conditions, (4) the scheme of improving the utilization of brine resources in Yiliping Salt Lake. Some results of systematic process have been achieved and used to improve the salt-ponds production process of Yiliping salt lake.

Five key words: Salt-lake, Phase diagram, Thermodynamic Models, Salt ponds process

Email address for questions: [zhouhuan@tust.edu.cn](mailto:zhouhuan@tust.edu.cn)





## Electrochemical controlled selective extraction of lithium from brine

(Preliminary version)

Xiaoyu Zhao, Yanfei Wang

*Tianjin University of Science and Technology*

In recent years, with the development and application of new energy storage technology, the energy industry and high-tech vehicle-mounted lithium ion batteries have significantly increased the demand of lithium resources. Annual demand for lithium in the form of lithium carbonate is expected to exceed 5 million tons by 2025. The global seawater/brine reserve account for about 80% of the total. How to effectively extract lithium from seawater and brine will be the future development trend. Extracting lithium resources efficiently from brine at a low cost is becoming a key technology for addressing energy and environmental issues. Compared to traditional extraction of lithium using solar evaporation, the electrochemical extraction is advantageous in many aspects, including elevated efficiency, superior selectivity, and low environmental pollution. Addressing on above issues, we did a series of works.  $\text{LiNi}_{0.038}\text{Mo}_{0.012}\text{Mn}_{1.95}\text{O}_4$  (LNMMO) with good Lattice structure and nano morphology was successfully prepared, pairing with activated carbon (AC) yielded obvious cost-effective and environmentally friendly. A continuous flow NMMO/AC hybrid supercapacitor (CF-NMMO/AC) was developed for selective capture of  $\text{Li}^+$  in aqueous solution by combining NMMO/AC hybrid supercapacitor with self-designed continuous flow control system. The device delivered high  $\text{Li}^+$  extraction efficiencies reaching 14.4 mg/g per one cycle in simulated brine by consuming only 7.91 Wh/mol  $\text{Li}^+$ . The overall process produced 97.2%  $\text{Li}^+$  in simulated brine at optimized operating conditions. Overall, CF-NMMO/AC system provided higher efficiency, superior selectivity, and moderate energy utilization for  $\text{Li}^+$  recovery from brine. However, multi-metal composition and possible corrosiveness of seawater/brine requires high capacity electrode with high selectivity and cycle stability. To address this issue, this work proposed a less layer graphene gauze modified Ni-rich cathode material  $\text{LiNi}_{0.6}\text{Co}_{0.2}\text{Mn}_{0.2}\text{O}_2$  core-shell structure microsphere (rGO/NCM) with shell thickness of 3 nm. The graphene gauze offers high electron transfer pathways instead of ion transfer between lattices, which reduced the NCM lattice collapse probability effectively. This was verified by ex-situ XRD and electrochemical results of high capacity, good cycle stability and rate performance in both organic and aqueous systems. rGO/NCM//AC delivered high  $\text{Li}^+$  extraction efficiencies reaching 13.84 mg/g per one cycle in simulated brine by consuming only 1.4 Wh/mol  $\text{Li}^+$ . The overall process produced 93%  $\text{Li}^+$  in simulated brine at optimized operating conditions. Competitive electrode materials used in electrochemical extraction requires high cyclic stability in corrosive ion rich seawater/brine. In this work, a three-dimensional (3D) nanostructured hybrid inorganic-gel framework electrode of polypyrrole/ $\text{Al}_2\text{O}_3$  was introduced on the surface of  $\text{LiMn}_2\text{O}_4$  for the first time. It paired with activated carbon to construct an asymmetric lithium capacitor with advantages of cost-effective, good cycle stability in brine, high selectivity and capacity. The  $\text{Li}^+$  extraction energy consumption was 1.41 Wh·mol<sup>-1</sup> $\text{Li}^+$  with capacity of 1.85 mmol·g<sup>-1</sup> in simulated brine. The capacity retention after 30 cycles was 91.66% at 1 C-rate. These promising results indicate that the PPy/ $\text{Al}_2\text{O}_3$  modified LMO possesses high extraction efficiency and long-term stability in complex brine medium. We further proposed a strategy that heterogeneous structure may expected to reduce the Jahn–Teller effect. Another to be solved issue of previous works is loss of lithium recovery rate. The AC electrode should desorb  $\text{Cl}^-$  to recovery solution, in order to meet the electrical neutrality criterion, while  $\text{Li}^+$  were de-intercalated from LMO electrode to

recovery solution. However, ion exchange behavior results in that part of lithium moved to AC electrode and adsorbed. The recovery rate of lithium hence reduced inevitably. To solve this problem, nanocrystalline bismuth (ncBi) electrode was proposed as a negative electrode to prevent lithium-ion exchange in this work, considering its conversion mechanism of Cl-storage. Consequently, The excellent chlorine storage capacity of the ncBi electrode was verified by a comparison of several key indexes during the cyclic lithium extraction process in LSNCM//ncBi and LSNCM//AC batteries. The lithium extraction recovery efficiency was as high as 99%. The lithium extraction results in simulated brine indicated that the LSNCM//ncBi desalination battery is a feasible and promising method for lithium extraction.

Five key words: Lithium extraction, Brine, Electrochemical adsorption, Electrode materials, Flow control operation

Email address for questions: xyz@tust.edu.cn



## New Progress in Lithium Extraction Technology for the Salt Lake Resources

*(Preliminary version)*

Wang Zhiqiang, Feng Zhijun

*Xi'an Lanshen New Material Technology Co., Ltd.*

With the continuous development of electric vehicle, energy storage, new materials, etc., there is strong market demand for lithium. The efficient development and utilization of lithium resources have become a main concern and a hot subject to researching institutes and industry of lithium all over the world, and some of them have developed some new lithium extraction technologies. China has the most diversified and sophisticated salt lakes in the world for which it is a big challenge for the industry and scientists to extract the lithium and the others chemical elements with lower costs and more efficiency. Until now, there are many traditional and non-traditional technologies applied in the extraction of lithium from the salt lakes in China such as magnesium-lithium separation and evaporation pool technology, together with the rich industrial experiences and high level of engineering integration. No less importantly, China has applied the most advanced technologies such as resin adsorption, membrane separation technology etc. in various salt lakes for some years and has had some important achievements. LANSHEN CRM One-step Advanced Lithium Extraction Technology is one of the highlights of them. Instead of crystallization process of sodium and potassium in evaporation pool, LANSHEN CRM catches the lithium ions directly from raw lithium-containing brine in the salt lake with a specific lithium adsorbent, with the effect of separating lithium ions only in one step and maintains the others elements as usual and clean of chemical agents external which are sufficient to refill the effluent back into the salt lakes. Compared with such technologies as membrane, electrodialysis, the other types of adsorptions, evaporation and precipitation technologies, there is almost no lithium loss in the extraction process of LANSHEN CRM and very friendly to the environment of salt lake. It is characterized with low investment and operation cost, little water consumption and noticeably short production cycle. It has been applied successfully in China's salt lake projects such as Minmetal's Yi li Ping etc.

Five key words: Lithium extraction, Raw brine, One-step, Environmental protection, Costs

Email address for questions: wzhq@lanshn.com

## Characterization of dissolved organic matter in the hypersaline Da Qaidam Lake in Qinghai Tibet Plateau and its change in solar ponds by using a multi-analytical approach

Yaoling Zhang, Keli Yang, Wu Li, Yaping Dong

*Qinghai Institute of Salt Lakes, Chinese Academy of Sciences*

Inland salt lakes commonly exist in arid and semi-arid regions. Since being hydrologically terminal and having long water residence times, the concentrations of dissolved organic matter (DOM) in salt lakes are generally high. As a result, DOM in salt lakes plays a significant role in global carbon cycling, especially in arid regions. So far, however, only a few studies have focused on the features and compositions of DOM in salt lake systems and the character and cycling of it remain largely unknown. In this study, DOM samples from intercrystalline and surface brines of the hypersaline Da Qaidam Lake, and three ephemeral input rivers, namely Datouyang River (DR), Baligou River (BR), and Wenquangou River (WR) of the lake were isolated by solid phase extraction and characterized by a multi-analytical approach including Fourier transform ion cyclotron resonance mass spectrometry coupled with electrospray ionization (ESI FT-ICR MS), solid-state  $^{13}\text{C}$  nuclear magnetic resonance ( $^{13}\text{C}$  NMR), Fourier transform infrared spectroscopy (FTIR), and carbon stable isotopic analysis ( $\delta^{13}\text{C}$ ). Moreover, the change of DOM compositions in different stage of solar ponds which used to isolate useful inorganic salts by natural evaporation was also tracked. Results indicated that there were big differences of the DOM compositions between lake and riverine samples. In general, the riverine samples contained more aromatics and unsaturated components than the lake samples. The DR and BR river samples were dominated by CHO formulas and had higher average molecular mass, while the lake samples contained more CHOS and CHON formulas and possessed lower average molecular mass. The WR sample was dominated by CHOS formulas and contained the lowest average molecular mass probably due to the big influence from hot springs for the river. For the lake-only formulas, most formulas contained hetero-atoms and were mainly aliphatics/proteins and tannin-like components. However, the river-only formulas were mainly lignins and/or CRAM-like components. Since the limited input from rivers and the long water residence time, the DOM composition of the lake samples is mainly driven by autochthonous sources through photochemical and microbial degradation reactions. For the solar pond samples, the DOC concentrations increased more than 15 times from initial brine to bittern brine ponds during the natural evaporation process, which indicated the refractory of the salt lake DOM. Overall, the aliphatics increased but the aromatics and carbohydrates decreased for the brine DOM during the natural evaporation process of the solar ponds, which suggested more saturated DOM compounds left behind mainly through photochemical oxidation and microbial degradation reactions. These saturated and reluctant components such as aliphatics will be concentrated and may cause adverse effects on the quality of inorganic salt products isolated from the salt lake brines. Our study further the knowledge of the source and compositions of DOM in hypersaline lake systems and provide new insights into the change of DOM in solar ponds and its potential effects on the quality of salt products isolated from salt lakes.

Five Key words: Dissolved organic matter, Solar ponds, Da Qaidam Lake, ESI FT-ICR MS,  $^{13}\text{C}$  NMR

Email address for questions: zhyl@isl.ac.cn



## Capture of lithium by water-insoluble particles in salt lake

Huaigang Cheng, Yan Li, Jin Kang, Enze Li, Fangbin Xue, Fangqin Cheng

*Shanxi University*

Salt lake resources are strategic resources in the country, along with the development of salt lake potassium extraction, the development of magnesium lithium has become the key to salt lake production. However, the loss of lithium in the process of salt lake lithium extraction is great, resulting in huge resource waste and economic loss, and the link and mechanism of lithium loss are still unclear. To address this challenge, our group proposes a strategy for in situ real-time monitoring of lithium ion migration. We design and synthesize a highly sensitive and selective lithium ion fluorescent probe, and then build an excitation light source, a signal receiver, and a computer data processing device to obtain the migration pattern of lithium ions by realizing the in situ real-time dynamic monitoring of lithium ions. Based on this research idea, a lithium ion fluorescent probe based on naphthalimide and crown ether was designed and synthesized in this paper. Naphthalimide has good fluorescence properties and can be easily modified, which has been widely used in the synthesis of various fluorescent molecular probes in recent years, while aza-12-crown-4 ether can selectively complex lithium ions. The detection limit and selectivity of the probe in response to lithium ions were investigated by fluorescence spectroscopy, and the results showed that the probe has high sensitivity and good selectivity for lithium ions. In addition, the binding constant ( $K_a$ ) of the probe with  $\text{LiClO}_4$  was calculated by nuclear magnetic titration study and using nonlinear fitting to obtain  $10^7 \text{ M}^{-1}$ . This research idea has potential applications for elucidating the migration pattern of lithium resources in salt lake brine and the mechanism of multi-scale Mg-Li separation.

Five key words: Brine, Lithium, Salt Lake, Synthesis, Probe

Email address for questions: hg.cheng@foxmail.com and cfangqin@sxu.edu.cn



## Removal of magnesium components from high-magnesium salt-water system in a temperature-changing process

*(Preliminary version)*

Huaigang Cheng, Jiaoli Gao, Enze Li, Jin Kang, Fangbin Xue, Fangqin Cheng

*Shanxi University*

For the salt-water system with a high magnesium-to-lithium ratio, there are technical difficulties in the removal of magnesium and the extraction of lithium. In order to recover magnesium and lithium resources efficiently, under the theoretical guidance of the phase diagram of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Li}^+$ ,  $\text{Mg}^{2+}/\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ - $\text{H}_2\text{O}$  system, a process of magnesium-removal by adding Glauber's salt ( $\text{NaSO}_4 \cdot 10\text{H}_2\text{O}$ ) was put forward: a certain mass of Glauber's salt was added to the brine with high  $\text{Mg}/\text{Li}$  ratio after potassium extraction, followed by forming  $\text{MgSO}_4$  hydrates in a temperature-changing crystallization process. At about  $60^\circ\text{C}$ , the nucleus of magnesium sulfate hexahydrate is formed in the metastable brine, and high purity magnesium sulfate crystals are precipitated through the non-equilibrium dynamic cooling process. By separating the crystal from the liquid, the mother liquor with a low magnesium-lithium ratio can be obtained. The results showed that the quality of Glauber's salt is one of the important factors affect the purity of crystals. When the mass ratio between Glauber's salt and feed brine reached 41.67%, the purity of magnesium sulfate crystal formed after non-equilibrium dynamic cooling was more than 99.5%. By using this method, the magnesium-lithium ratio of brine was reduced from more than 40 to less than 20.

Five key words: Salt lake, Tail brine, Glauber's salt, Lithium, Magnesium

Email address for questions: [chenghg@sxu.edu.cn](mailto:chenghg@sxu.edu.cn)



## Thermodynamic properties and volumetric properties of the aqueous borates containing lithium and cesium ions in the salt lake brine system: heats of dissolution, dilution, mixing, osmotic coefficients, water activities, and the applications of ion-interaction model

Kangrui Sun, Fei Yuan, Long Li, Yafei Guo and Tianlong Deng

*Tianjin Key Laboratory of Marine Resources and Chemistry, College of Chemical Engineering and Materials Science, Tianjin University of Science and Technology, Tianjin 300457, China*

Lithium metaborate is high-quality piezoelectric material for mobile communication, and lithium pentaborate can be used as a high-quality laser material and so on. Cesium borates can be used in infrared detection, infrared vision, night vision, and other military applications, and cesium is also an indispensable material in the manufacture of atomic clocks and global positioning system. In order to establish the thermodynamic model of complex salt lake brine systems containing lithium and cesium ions to utilize the valuable salt lake resources effectively and comprehensively, the thermodynamic information and knowledge on the salt lake system containing lithium and borate ions are of great significance not only to understand the ion-interaction between solute-solvent and solute-solute as well as the effects of ion strength, temperature on excess free energy but also to provide fundamental data in predicting the crystallizing and evaporating behaviors of these salt lakes. Studies on the thermodynamic properties of the salt lake brine systems containing lithium and borate ions are of great significance to establish the predictive solubility model of electrolytes to promote the industrial exploitation of those valuable salt lake resources effectively and comprehensively. In this topic, the following four aspects are presented: Firstly, the heats of dissolution, dilution and mixing for borates (MBO<sub>2</sub>, M<sub>2</sub>B<sub>4</sub>O<sub>7</sub> and MB<sub>5</sub>O<sub>8</sub>, M = Li and Cs) were measured at different ion-strengths and temperatures by micro-calorimeter technique. Secondly, isopiestic techniques were introduced for the binary and ternary systems containing lithium and cesium ions. Thirdly, the volumetric properties, including apparent molar volume and the coefficient of thermal expansion of the binary and ternary aqueous cesium borate systems, were demonstrated by the vibrating-tube densimeter technique. Finally, the Pitzer ion-interaction model of electrolytes was employed to reveal the single salt parameters, mixing-ion parameters, and their temperature-dependence equation and the corresponding correlation coefficients of all parameters.

Five key words: Thermodynamics, Microcalorimeter, Isopiestic method, Volumetric property, Pitzer model

Email address for address: [tldeng@tust.edu.cn](mailto:tldeng@tust.edu.cn)



## Phase Equilibria of the System RbCl + CsCl + PEG + H<sub>2</sub>O at 288.2, 298.2, and 308.2 K

(Preliminary version)

Yu Xudong, Wang Lin, Huang Qin, Li Maolan, Zeng Ying

*College of Materials and Chemistry & Chemical Engineering, Chengdu University of Technology*

It is very difficult to separate Rb and Cs from the chloride type brine due to the similar properties and structures of RbCl and CsCl which makes a solid - solution formed easily between them. By adding polyethylene glycol (PEG) into the salt - water system, it causes a change in the properties of the solvent, and then the crystallization rule of salt in it may be changed, so it can be expected to work on the separation of mixing salts of rubidium and cesium. Thus, it will be of great significance to study the phase equilibria of the systems containing rubidium chloride (RbCl), cesium chloride (CsCl), polyethylene glycol (PEG), and water. Accordingly, the phase equilibria of ternary systems CsCl + PEG1000/4000/6000/8000/10000/20000 + H<sub>2</sub>O, and quaternary systems RbCl + CsCl + PEG1000/4000/8000 + H<sub>2</sub>O at 288.2, 298.2, and 308.2 K were determined by isothermal dissolution method or turbidimetric method. For ternary system CsCl + PEG + H<sub>2</sub>O at 288.2, 298.2 and 308.2 K, with the temperature or molecular weight of polyethylene glycol increasing, it is more conducive to the formation of the liquid-liquid equilibrium region (2L). At the same temperature, with the increase of molecular weight of polyethylene glycol, the area of liquid-liquid equilibrium (2L), area of one liquid phase with one solid phase (L+S), and area of one liquid phase with two solid phases (L+2S) of the system increase, while the unsaturated liquid region (L) decreases. When the molecular weight of polyethylene glycol is constant, with the increase of temperature, the unsaturated liquid region (L) and area of one liquid phase with one solid phase (L+S) increase, while the area of one liquid phase with two solid phases (L+2S) decreases, area of liquid-liquid-solid equilibrium (2L+S) changes slightly. Phase equilibria of quaternary systems RbCl + CsCl + PEG1000/4000/8000 + H<sub>2</sub>O at 288.2, 298.2, and 308.2 K were studied with the different value of R (the ratio of PEG in PEG + H<sub>2</sub>O mixed solvents), and different value of K ( $K = w_{\text{CsCl}} : w_{\text{RbCl}}$ ). When the molecular weight of PEG is 1000, the comparison of phase diagrams of RbCl + CsCl + PEG + H<sub>2</sub>O with R = 0, 0.2, 0.4 shows that the solubility of CsCl and RbCl in mixed solvents decreased with the increase of R, and the crystallization regions of single salts RbCl and CsCl increased. When the molecular weight of PEG is 4000 or 8000, the crystallization region of RbCl increase obviously in system RbCl + CsCl + PEG + H<sub>2</sub>O at 288.2, 298.2, and 308.2 K, and when the value of R = 0.35~0.55, the solid solution [Rb, Cs] Cl transformed into RbCl with an introduction of PEG4000 or PEG8000 in the RbCl + CsCl + H<sub>2</sub>O salt - water system.

Five key words: Rubidium chloride, Cesium chloride, Polyethylene glycol (PEG), ATPS, Phase equilibria

Email address for questions: xwdlyxd@126.com

## **Thermodynamic properties and volumetric properties of the aqueous borates containing lithium and cesium ions in the salt lake brine system: heats of dissolution, dilution, mixing, osmotic coefficients, water activities, and the applications of ion-interaction model**

Kangrui Sun, Fei Yuan, Long Li, Yafei Guo and Tianlong Deng

*Tianjin Key Laboratory of Marine Resources and Chemistry, College of Chemical Engineering and Materials Science, Tianjin University of Science and Technology, Tianjin 300457, China*

Studies on the thermodynamic properties of the salt lake brine systems containing lithium and borate ions are of great significance to establish the predictive solubility model of electrolytes to promote the industrial exploitation of those valuable salt lake resources effectively and comprehensively. In this topic, the thermodynamic properties and volumetric properties of the aqueous solutions containing lithium and cesium ions were studied systematically. This presentation includes four aspects: Firstly, the heats of dissolution, dilution, and mixing for borates ( $\text{MBO}_2$ ,  $\text{M}_2\text{B}_4\text{O}_7$  and  $\text{MB}_5\text{O}_8$ ,  $\text{M} = \text{Li}$  and  $\text{Cs}$ ) were measured at different ion-strengths and temperatures by micro-calorimeter technique. Secondly, the isopiestic method was employed for the binary and ternary systems containing lithium and cesium ions. Thirdly, the volumetric properties, including apparent molar volume and the coefficient of thermal expansion of the binary and ternary aqueous cesium borate systems, were demonstrated by the vibrating-tube densimeter technique. Finally, the Pitzer ion-interaction model of electrolytes was employed to reveal the single salt parameters, mixing-ion parameters, temperature-dependence equation, and the corresponding correlation coefficients of all parameters.

Five key words: Thermodynamics, Microcalorimeter, Isopiestic method, Volumetric property, Pitzer model

Email address for questions: [guoyafei@tust.edu.cn](mailto:guoyafei@tust.edu.cn) and [tldeng@tust.edu.cn](mailto:tldeng@tust.edu.cn)

## Phase Equilibria of Salt-Water System Focused on Qaidam Basin Magnesium Sulfate Type Salt Lake Brine at 298.2 and 323.2 K

(Preliminary version)

Zeng Ying, Feng Shan, Liao Shuang, Ye Guozhen, Luo Jian, Lv Na, Yu Xudong

*College of Materials and Chemistry & Chemical Engineering, Chengdu University of Technology*

Qaidam basin is rich in magnesium sulfate type salt lake brine resources. These salt lake brine abundant with lithium, potassium, rubidium, and cesium, have great development value. According to the characteristic of the composition and geological reserves of Qaidam basin salt lake brine, the phase equilibria of the subsystems of the complex system  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ ,  $\text{Cs}^+$ ,  $\text{Mg}^{2+}$  //  $\text{SO}_4^{2-}$  -  $\text{H}_2\text{O}$  at 298.2 K and 323.2 K were studied by using the isothermal dissolution equilibrium method. The main results are as the follows: (1) the solubilities, densities, and refractive indices of the system above mentioned at different temperatures were measured, the dissolution and precipitation characteristics of sulfates of lithium, rubidium, cesium, etc. at different temperatures and under different ion interactions were analyzed, and the crystallization zone sizes of various salts and their changing trend with temperature were determined. (2) Combined with Schreinemarkers wet residue method, X-ray powder diffraction (XRD), polarizing microscope (PM), scanning electron microscope (SEM) and energy dispersion spectroscopy (EDS), the technology of salt at equilibrium identification was improved, and the solid phase identification method of complex alkali (alkaline earth) metal sulfate system phase diagram was established. (3) The regularity of salt crystallization of alkali (alkaline earth) metal sulfate and the relationship of salt interaction were found. The solid solution  $[(\text{K}, \text{Rb})_2\text{SO}_4]$ ,  $[(\text{K}, \text{Cs})_2\text{SO}_4]$ , and  $[(\text{Rb}, \text{Cs})_2\text{SO}_4]$  are easily formed of the potassium sulfate, rubidium sulfate, and cesium sulfate; salt  $\text{Li}_2\text{SO}_4$  and other alkali metal sulfate easy to form a variety of double salts:  $3\text{Li}_2\text{SO}_4 \cdot \text{Cs}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ ,  $\text{Li}_2\text{SO}_4 \cdot \text{Cs}_2\text{SO}_4$ ,  $3\text{Li}_2\text{SO}_4 \cdot \text{Rb}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ ,  $\text{Li}_2\text{SO}_4 \cdot \text{Rb}_2\text{SO}_4$ ,  $\text{Li}_2\text{SO}_4 \cdot \text{K}_2\text{SO}_4$ , and  $3\text{Na}_2\text{SO}_4 \cdot \text{Li}_2\text{SO}_4 \cdot 12\text{H}_2\text{O}$ ; besides salt  $\text{Li}_2\text{SO}_4$ ,  $\text{MgSO}_4$  and other alkali metal sulfate easy to form a variety of double salts:  $\text{Na}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 4\text{H}_2\text{O}$ ,  $\text{K}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 6\text{H}_2\text{O}$ ,  $\text{K}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 4\text{H}_2\text{O}$ ,  $\text{Cs}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 6\text{H}_2\text{O}$ , and  $\text{Rb}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 6\text{H}_2\text{O}$ , the crystallization form of picromerite ( $\text{K}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 6\text{H}_2\text{O}$ ) change to leonite ( $\text{K}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 4\text{H}_2\text{O}$ ) with the temperature increase; the crystallization form of  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  change to  $\text{Na}_2\text{SO}_4$ ,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  change to  $\text{MgSO}_4 \cdot 6\text{H}_2\text{O}$  with the temperature increase. The solubilities, phase diagrams, and the research results obtained in this project are indispensable basis thermodynamic data, which can give the guidance to make an energy conservation and efficient comprehensive utilization process of the sulfate type brine rich in lithium, rubidium, and cesium.

Five key words: Phase equilibria, Double salt, Solid solution, Sulfate type, Hydrate salt

Email address for questions: zengyster@163.com

## Dissolution enthalpies and the thermodynamic properties of sodium metaborates

Fei Yuan<sup>1</sup>, Long Li<sup>2</sup>, Yafei Guo<sup>1</sup>, Shiqiang Wang<sup>2</sup> and Tianlong Deng<sup>1</sup>

1. *College of Chemical Engineering and Materials Science, Tianjin University of Science and Technology, Tianjin 300457, P. R. China*

2. *College of Marine and Environmental Sciences, Tianjin Key Laboratory of Marine Resources and Chemistry, Tianjin 300457, P. R. China*

In the Qinghai-Tibet Plateau of China, over 700 salt lakes with an area larger than 1 km<sup>2</sup> hold high boron resources. At present, almost 70% of boron is obtained from salt lake brine by applying evaporation in countries such as Argentina, Bolivia, Chile, and China. Boron and its compounds play an important role in modern energy and material sciences including boride cermet, permanent magnets, superconductors, boron-based fuel-rich propellants and borate whisker materials. Establishing a thermodynamic model of brine systems can effectively guide utilization of salt resources. More specifically, the thermodynamic properties of inorganic salts containing borate ions are of great significance, not only to understand the thermodynamic behavior of borate in natural systems, including ion-interactions between solute-solvent and the effects of ion strength, but also to provide fundamental data in predicting the crystallizing and evaporating behaviors of these salts. Moreover, NaBO<sub>2</sub> is an important boron compound, specifically in the industrial production of NaBH<sub>4</sub>, which is a promising solid carrier for hydrogen due to its ease and tunable hydrogen release by hydrolysis. Besides, NaBH<sub>4</sub> as a reducing agent can remove mercury from concentrated fish protein and prepare graphene. Hence, accurate thermodynamic data of NaBO<sub>2</sub> could be helpful to further set up a theoretical foundation for better designing the synthetic route of NaBH<sub>4</sub>. The dissolution enthalpy of NaBO<sub>2</sub>·4H<sub>2</sub>O and NaBO<sub>2</sub>·2H<sub>2</sub>O were determined by a microcalorimeter TAM IV, and their thermodynamic parameters including enthalpy, entropy and Gibbs free energy as well as the dissolution equilibrium constant, activity coefficient and osmotic coefficient of the saturated solution with NaBO<sub>2</sub> at 298.15 K were systematically studied and are reported for the first time.

Five key words: Dissolution, Sodium metaborates, Thermodynamic properties, Enthalpy, Equilibrium constant

Email address for questions: guoyafei@tust.edu.cn



## Isopiestic investigation and Pitzer thermodynamic model of lithium borates aqueous system

(Preliminary version)

Kaiyu Zhao<sup>1</sup>, Yafei Guo<sup>1</sup>, Lingzong Meng<sup>2</sup> and Tianlong Deng<sup>1</sup>

1. *Tianjin Key Laboratory of Brine Chemical Engineering and Resource Eco-utilization, Tianjin University of Science and Technology, Tianjin 300457, PRC*

2. *School of Chemistry and Chemical Engineering, Linyi University, Linyi, 276000, PRC*

Lithium borates are widely applied in lithium-ion batteries, modern glass production, and the energy storage industry for their unusual structure and functional groups. Lithium metaborate brings functional additives in the preparation of electrode materials, which can hugely improve the electrochemical performance and energy storage ability of lithium-ion batteries with such specific functional groups. As for lithium tetraborate, due to its unique crystal structure, it can significantly enhance the optical properties and hardness of nonlinear visual glass materials. Hence the market demand for the particular species of lithium borates increased sharply in the recent decade due to these excellent characteristics. Natural lithium borates have mainly existed with the formation of  $\text{LiB}(\text{OH})_4 \cdot 6\text{H}_2\text{O}$ ,  $\text{Li}_2\text{B}_4\text{O}_5(\text{OH})_4 \cdot \text{H}_2\text{O}$ , and  $\text{LiB}_5\text{O}_6(\text{OH})_4 \cdot 3\text{H}_2\text{O}$  in liquid mineral resources, especially in the salt lake brines of the Qinghai-Tibet Plateau. Due to the complex structure and absence of thermodynamic data for the different species of hydrated lithium borates, it is difficult to understand the formation process and mechanism of the various species of lithium borates deposits in salt lake brines that would facilitate their efficient extraction. Thus, it is highly desirable to obtain the fundamentally thermodynamic parameters and behaviors for different species of lithium borates minerals by the isopiestic method, which is significant to reveal the ion-interactions between different species lithium borates and its aqueous solution systems and to clarify the geochemical characteristics of lithium borates minerals in salt lake brines. In this work, the water activities and osmotic coefficients of the aqueous systems for three natural lithium borated at 288.15 K were elaborately measured using a modified gravimetric isopiestic apparatus. The formation sequence of lithium borates minerals was explained according to the water activities. On the basis of experimental data, the Pitzer model was used to describe the thermodynamic properties and ion-interactions of this ternary system and its subsystem.

Five key words: Salt lake, Lithium borates, Water activity, Osmotic coefficients, Pitzer ion-interaction model

Email address for questions: guoyafei@tust.edu.cn



## Volumetric properties of the ternary system (CsCl + Cs<sub>2</sub>SO<sub>4</sub> + H<sub>2</sub>O) and its subsystems from 283.15 to 363.15 K and atmospheric pressure: Experimental and thermodynamic model

Kangrui Sun<sup>1</sup>, Ziwei Bi<sup>1</sup>, Yanqin Meng<sup>1</sup>, Yafei Guo<sup>1</sup>, Lingzong Meng<sup>2</sup>, Tianlong Deng<sup>1</sup>

*1. Tianjin Key Laboratory of Brine Chemical Engineering and Resource Eco-utilization, College of Chemical Engineering and Materials Science, Tianjin University of Science and Technology, Tianjin 300457, PR China*

*2. School of Chemistry and Chemical Engineering, Linyi University, Lingyi 27600, PR China*

Cesium (Cs) and its compounds have extensive applications in industrial, agricultural, and medical fields for remarkable electrical and optical properties, high thermal conductivity, and vigorous chemical activity. It is academically known that the thermodynamic properties of solids and aqueous solutions are both the theoretical foundation for the utilization as well as separation for liquid mineral resources. Fundamental chemical engineering thermodynamic data such as solubility data, density and apparent molar volumes are not only inspected the structural interactions for the ion-ion, ion-solvent and solvent-solvent, but also evaluated or explained the corresponding physicochemical properties to guide the comprehensive utilization of the resources. Therefore, it is essential to understand the thermodynamic properties of the aqueous solutions involved in cesium. The salt-water interactions on single salt aqueous solutions of cesium sulfate and cesium chloride, as well as their mixing solutions, have been investigated by a combination of density measurements by an Anton Paar Digital vibrating-tube densimeter and the correction of the Pitzer model of electrolyte. The volumetric properties including apparent molar volume ( $V_\phi$ ) and the coefficient of thermal expansion of the solution ( $\alpha$ ) of the binary systems (CsCl + H<sub>2</sub>O), (Cs<sub>2</sub>SO<sub>4</sub> + H<sub>2</sub>O) and the ternary system (CsCl + Cs<sub>2</sub>SO<sub>4</sub> + H<sub>2</sub>O) from 283.15 to 363.15 K at 5 K intervals and atmospheric pressure were derived. Variation trends of these volumetric properties against temperature and molality were revealed minutely. The Pitzer single salt parameters ( $\beta_{MX}^{(0)v}$ ,  $\beta_{MX}^{(1)v}$  and  $C_{MX}^v$ , MX = CsCl and Cs<sub>2</sub>SO<sub>4</sub>), mixing ion-interaction parameters ( $\theta_{Cl,SO_4}^v$  and  $\psi_{Cs,Cl,SO_4}^v$ ) as well as the correlation coefficient  $a_i$  in the temperature-dependence equation ( $F(i, p, j) = a_1 + a_2 \ln(T/298.15) + a_3(T-298.15) + a_4/(620-T) + a_5/(T-227)$ ) have been obtained according to Pitzer ion-interaction model of electrolytes. These results are helpful to understanding the ion-interaction of aqueous solutions.

Five key words: Cesium sulfate, Cesium chloride, Density, Apparent molar volume, Pitzer model

Email address for questions: guoyafei@tust.edu.cn and tldeng@tust.edu.cn

## Viability and Hatchability of Brine Shrimp (*Artemia franciscana*) Cysts after Passing Through the Digestive System of Eared Grebes

*(Preliminary version)*

Michael R. Conover

*Utah State University*

Brine shrimp (*Artemia franciscana*) are an important resource found in Great Salt Lake, Utah, USA and serve as a vital food for migrating and staging birds in the fall. Brine shrimp produce live young, as well as hard-walled eggs called cysts; the latter are of great economic value, and most cysts produced in GSL are commercially harvested. It is unclear the impact that millions of eared grebes (*Podiceps nigricollis*) have on the brine shrimp population in GSL. This study evaluated cyst viability (percentage of cysts that contain an embryo) and hatchability (percent of cysts that later hatch) of cysts that had passed through the digestive tract of eared grebes and cysts obtained directly from GSL at the same site where each grebe was collected. Viability was significantly different for cysts collected from the water column (29%), stomach (0.7%), and intestines (5%). Hatchability also was significantly higher for cysts collected from the water column (19%) than from the stomach (0.3%) or intestines (3%). These results indicate that grebes nutritionally benefit from eating cysts, which may become an important food source for grebes in late fall after cold water has killed all adult brine shrimp. Still, enough brine shrimp survive their passage through the digestive system that grebes can vector hatchable shrimp to other waterbodies.

Five key words: Commercial harvest, Cysts, Dispersal, Fall-staging, Hatchability, Viability

Email address for questions: [mike.conover@usu.edu](mailto:mike.conover@usu.edu)

## Research progress of application of saline Cladocera in aquatic ecotoxicology

*(Preliminary version)*

Wen Zhao, Xingye Qiao, Dongpeng Yin

*Key Laboratory of Hydrobiology in Liaoning Province, College of Fisheries and Life Science, Dalian Ocean University, Dalian 116023, China*

*Moina mongolica* and *Daphniopsis tibetana* are typical saline Cladocera, which has the characteristics of wide salinity range, fast reproduction and high density culture. In this paper, the characteristics and life history of *M. mongolica* and *D. tibetana* were reviewed. The application status and main achievements of two species Cladocera in ecotoxicology in recent years were summarized from the aspects of heavy metals, persistent organic pollutants, red tide algae, commonly used drugs, petroleum and petroleum compounds. At the same time, the existing problems of the toxicity of saline Cladocera in different reproductive status and intergenerational embryos were discussed and prospected, as well as the strengthening of molecular omics, population protection and the establishment of estuarine and marine environmental monitoring standards in the future.

Five key words: *Moina mongolica*, *Daphniopsis tibetana*, Ecotoxicology, Environmental pollutants, Red tide algae

Email address for questions: zhaowen\_1963@163.com

## Changes of microbial mineralization and community composition in response to multiple levels of grass organic matter addition in a hypersaline lakes

*(Preliminary version)*

Jian Yang, Hongchen Jiang, Wen Liu, Liuqin Huang, Jianrong Huang, Beichen Wang, Hailiang Dong, Rosalie K. Chu, and Nikola Tolic

*State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan*

Lakes receive large amounts of terrestrially derived dissolved organic matter (tDOM). However, little is known about how aquatic microbial communities interact with tDOM in lakes. Here, by performing microcosm experiments we investigated how microbial community responded to tDOM influx in six Tibetan lakes of different salinities (ranging from 1 to 358 g/L). In response to tDOM addition, microbial biomass increased while dissolved organic carbon (DOC) decreased. The amount of DOC decrease did not show any significant correlation with salinity. However, salinity influenced tDOM transformation, i.e. microbial communities from higher salinity lakes exhibited a stronger ability to utilize tDOM of high carbon numbers than those from lower salinity. Abundant taxa and copiotrophs were actively involved in tDOM transformation, suggesting their vital roles in lacustrine carbon cycle. Network analysis indicated that 66 operational taxonomic units (OTUs, affiliated with Gammaproteobacteria, Alphaproteobacteria, Bacteroidia, Actinobacteria, Rhodothermia, Verrucomicrobiae, Halobacteria, Bacilli, and Planctomycetacia) were associated with degradation of CHO compounds, while four bacterial OTUs (affiliated with Gammaproteobacteria, Bacteroidia, Actinobacteria, and Alphaproteobacteria) were highly associated with the degradation of CHOS compounds. Network analysis further revealed that tDOM transformation may be a synergistic process, involving cooperation among multiple species. In summary, our study provides new insights into a microbial role in transforming tDOM in saline lakes and has important implications for understanding the carbon cycle in aquatic environments.

Five key words: Saline lakes, Microbial utilization, Terrestrially derived dissolved organic matter, Microbial community composition

Email address for questions: yangjiancug@126.com



## Great Salt Lake on exhibit: The ArtScience of Winogradsky columns

*(Preliminary version)*

Anna Jackson, Sierra Watson and Bonnie K. Baxter

*Westminster College*

*Great Salt Lake Institute*

Russian microbiologist, Sergie Winogradsky, invented the columns that bear his name in the 1880s. He demonstrated that mimicking natural conditions in a lab setting resulted in observations that paralleled those in the wild, and Winogradsky columns are still used today to study microbial communities. These self-contained microcosms, filled with soil and water samples, provide a visual display of the stratification of microorganisms to their optimal conditions, visible in mats and colorful communities in the sediment and water. We collaborated with local science and art museums to create columns that would excite visitors about Great Salt Lake (Utah, USA). One of our goals was highlighting the regions of the lake that have distinctly different salinities while another was to showcase the similarities of creativity in both art and science. To enrich our understanding of the microbial communities in different columns, we studied the polycultures of the columns through microscopy, pigment analysis, and DNA sequencing. We will present this data and highlight the significance of building bridges between art and science and between museum guests and salt lake research.

Five key words: Microbiology, Museums, Artsience, Saline lake, Winogradky

Email address for questions: [aej0223@westminstercollege.edu](mailto:aej0223@westminstercollege.edu)



## Characterization of Halophyte Rhizosphere Microbiomes at Great Salt Lake, Utah

*(Preliminary version)*

David L. Parrott

*Westminster College*

*Great Salt Lake Institute*

The saline soils comprising the shoreline of Great Salt Lake, Utah (GSL) provide a unique habitat for both halophytes (salt-tolerant plants) and the microorganisms that inhabit their rhizosphere. While plant diversity has been well documented at GSL, little is known about the microbial diversity in the rhizosphere. Here we present preliminary data characterizing the halophyte rhizosphere microbiome at two GSL locations; the more saline North Arm near the artwork, Robert Smithson's Spiral Jetty (SJ), and the less saline South Arm on Antelope Island (AI). The rhizosphere of several plants along the shoreline at both SJ and AI locations was sampled. For each sample, plants were identified, soil salinity was quantified, DNA was isolated, and microbial cultures were established on either MGM or TSA medium. Numerous unique isolates were observed on both media, indicating the presence of both halophiles and non-halophiles in the rhizosphere. Subsequent 16s rDNA sequencing substantiated this, identifying a combined total 58 species of Archaea and more than 1100 Bacterial species among all collected samples. Our data suggest differences in the composition of rhizosphere microbiomes depending on location, soil type and salinity, and plant species. Decreased diversity of both Archaeal and Bacterial species was observed in rhizospheres at SJ compared to AI. Interestingly, a corresponding increase in the representation of halophilic Archaea at SJ was observed, possibly linked to the much higher salt concentration in the North Arm. Our results provide insight into the halophyte rhizosphere microbiome and expand our current knowledge of halophyte-halophile relationships.

Five key words: Microbiology, Halophyte, Rhizosphere, Saline lake, Microbiome

Email address for questions: [dparrott@westminstercollege.edu](mailto:dparrott@westminstercollege.edu)





## Fresh, soda and saline: the effect of salinity and water chemical types on bacterial community composition based on global data

*(Preliminary version)*

Attila Szabó, Emil Boros, Zsuzsanna Márton, Zsófia Horváth, Csaba Vad, Tamás Felföldi and Anna J. Székely

*Swedish University of Agricultural Sciences*

Moderately saline and alkaline environments such as soda and salt lakes are expected to become more common globally due to accelerating salinization. Despite their worldwide importance, their microbial communities are still largely unexplored. Do habitats with different salinity and water chemical types (carbonate or chloride anion dominance) have a distinct bacterial composition? How bacterial communities at the freshwater-brackish transition would respond to changing climate? To answer these questions, we compared several bacterial 16S rRNA gene amplicon datasets (344 samples from 165 sites) obtained from various freshwater, brackish and saline aquatic habitats worldwide. The selected sample sets were processed with approximately the same wet lab protocol targeting the V3-V4 region of the 16S rRNA gene. During the bioinformatic analysis, sequences were filtered rigorously to avoid artifacts. In addition to the amplicon data set, all available soda lake metagenomes were collected from around the world for comparison with metagenomes of other saline aquatic habitats. Our further aim was to create an inventory of the biogeography, diversity and evolutionary origin of keystone alkaline lake microorganisms. Our results showed remarkable differences in bacterial community composition of freshwater, soda and saline habitats, along with communities representing transitions between these environments. Interestingly, community structure also depended on the sampled biogeographic region. Above a certain salinity threshold, samples were clearly separated according to the dominant anions (carbonate or chloride). In the case of soda lakes, planktonic actinobacteria (acIII-A1, Luna1-A2, uc\_Nitriiruptoraceae) and uncultured members of the Rhodobacteraceae family were typical taxa. The decrease in relative abundance of certain freshwater groups (LD12, Flavobacterium, Aquirufa, Limnohabitans, Hydrogenophaga) indicated transition to brackish waters, while certain taxa such as Halomonas and some Synechococcus lineages were characteristic for chloride-dominated saline waters.

Five key words: Alkaline lake, Microbial communities, Soda lake, Saline, Brackish

Email address for questions: attila.szabo.ttk@gmail.com



## Seasonal patterns and trophic relationships of planktonic eukaryotes in soda pans

Zsuzsanna Márton, Attila Szabó, Bianka Csitári, Zsófia Horváth, Emil Boros, Tamás Felföldi, Anna J. Székely

*Eötvös Loránd University*

Soda lakes are saline-alkaline lakes with sodium, carbonate and bicarbonate as dominant ions. In these extreme aquatic environments, high pH and elevated salinity are frequently associated with high amounts of dissolved organic carbon and colored dissolved organic matter in the water, especially in periods of intensive evaporation. These special aquatic habitats are characteristic in the Pannonian Steppe Region (Carpathian Basin, Hungary). However still little is known about the native planktonic microeukaryotes of these pans. Our research aim was to determine the taxonomic composition, ecological role and trophic relationships of the inhabiting eukaryotic community. Sampling sites were chosen to represent characteristic soda habitats of the Pannonian Steppe region. Samples were collected from five soda pans (Böddi-szék, Kelemen-szék, Sós-ér, Zab-szék and Pan number 60) throughout three seasons (spring, summer, autumn) biweekly from April to November in 2017. The taxonomic composition of planktonic pro- and eukaryotes was revealed with next-generation DNA sequencing, while the composition and abundance of microcrustaceans were determined by microscopy. Co-occurrence patterns of the planktonic members were examined by network analysis. Indicator species analysis was used to determine abundant OTUs that are characteristic to each season. Based on our results, eukaryotic communities of the pans differed throughout the seasons, spring and summer communities being most different from each other. The dominant microeukaryotic taxa in all five pans were picoeukaryotic green algae (*Choricystis*, *Chloroparva*), heterotrophic nanoflagellate (*Spumella*) and aquatic fungi. Two soda pans dried out during the sampling period; due to this stochastic effect, the eukaryotic community composition of these pans was remarkably different between each drying-out period and refilling. A picoeukaryotic green algae, *Nannochloropsis*, was a characteristic genus during spring, while the taxon *Choricystis* and an unclassified eukaryotic group were identified as summer indicator species. Microcrustaceans (*Arctodiaptomus spinosus*, *Moina brachiata*), heterotrophic nanoflagellates (genera *Spumella*, *Paraphysomonas*), ciliates (genera *Halteria*, *Vorticella*) and parasites (the genus *Pirsonia*, the class *Chytridiomycetes*) represented the main top-down controllers for the phyto- and bacterioplankton. Remarkable shifts were also observed in the bacterioplankton composition, since conditions with elevated pH and salinity were favored by characteristic soda lake taxa, such as *acIII-A1*, *Nitriliruptoraceae*, *Rhodobaca* and *Ectothiorhodospinus*. In summary, our results demonstrated that the high variability of the planktonic communities of temperate shallow soda pans is driven by seasonal changes that affect the structure of the entire planktonic trophic network, while local drought events have substantial role in establishing in between pans variability.

Five key words: Seasonal patterns, Trophic relationships, Microeukaryotes, Soda pans, Alkaline lakes

Email address for questions: mzsuzsi06@gmail.com

## Estimating Primary Productivity in Great Salt Lake, Utah

Eric C. Dunham<sup>1</sup>, Elizabeth M. Fones<sup>1</sup>, Joel Carpenter<sup>2</sup>, Bonnie K. Baxter<sup>2</sup>, Eric S. Boyd<sup>1</sup>

*1. Department of Microbiology and Cell Biology, Montana State University*

*2. Great Salt Lake Institute, Westminster College*

Great Salt Lake (GSL) is a critical wetland ecosystem supporting millions of migrating birds and the economy of Utah, in part through the estimated \$193 million per year derived from recreation and the harvest of brine shrimp cysts. Despite the critical importance of GSL both ecologically and economically, little is known of the extent and variation in Cyanobacteria-driven primary production that forms the base of the food chain and to what extent microbialite structures contribute. In a temporal study, we examined primary and secondary productivity over four seasons in sites with and without microbialites. To directly measure productivity, we used <sup>14</sup>C radiotracer assays to estimate carbon fixation rates by both benthic and planktonic organisms in GSL over a seasonal cycle spanning summer 2020 to spring 2021. At each sampling event, microcosms were inoculated with either 5 mL unfiltered GSL water or 5 mL filtered water plus 1 mL of a slurry made from filtered water and benthic microbial mat biomass. Samples were spiked with approximately 5  $\mu$ Ci <sup>14</sup>C-labelled acetate or bicarbonate and incubated at the temperature of GSL water measured during sample collection for 30 minutes either exposed to or protected from sunlight. Microcosm incubations were terminated by freezing. The proportion of <sup>14</sup>C substrate incorporated into biomass and the total concentration of substrate present in each microcosm under light and dark conditions were used to calculate rates of net primary productivity (for bicarbonate-amended microcosms) and net secondary productivity (acetate-amended microcosms). The rates of net primary and secondary productivity for both benthic and planktonic organisms were used in conjunction with measurements of microbial biomass and radiant light intensity measurements to estimate the total annual carbon fixation rates for GSL and the outsized contribution of microbialites. Under the conditions prevailing during our first sampling event, in July 2020, these rates were estimated to be 159 fmol C mL<sup>-1</sup> h<sup>-1</sup> in darkness and 977 fmol C mL<sup>-1</sup> h<sup>-1</sup> in sunlight for planktonic organisms and 423 pmol C mL<sup>-1</sup> h<sup>-1</sup> in darkness and 2070 pmol C mL<sup>-1</sup> h<sup>-1</sup> in sunlight for benthic organisms. Processing of the assays performed in October 2020 and January and April 2021 will complete the productivity dataset and provide a framework for making the first quantitative estimates of primary productivity in GSL and a baseline for monitoring the future health of this critical ecosystem. Parallel biomass samples were taken at each sampling event for use in DNA extraction and PCR amplification of 16S rRNA genes in order to profile both benthic and planktonic communities and reveal the microbial populations most likely responsible for this activity and the temporal variation in their relative abundances. Sequencing of these samples is underway. Taken together, the results of this study will provide a holistic understanding of the foundation of the trophic web supporting the GSL wetland ecosystem. They will provide a means to compare the rate of net primary productivity of GSL to those of other major ecosystems and to begin to quantify the effect of microbial primary productivity on the scientific and economic health of the GSL watershed, which is experiencing a steep decline in elevation.

Five key words: Primary production, Carbon fixation, Seasonal variation, Cyanobacteria, Ecosystem services

Email address for questions: eric.dunham@montana.edu



## Metabarcoding under salt: microbial ecology of five hypersaline lakes at Rottnest Island (WA, Australia)

*(Preliminary version)*

Mattia Saccò, Nicole E. White, Matthew Campbell, Sebastian Allard, William F. Humphreys, Paul Pringle, Farid Sepanta, Alex Laini, Morten Allentoft

*Trace and Environmental DNA (TrEnD) Laboratory, School of Molecular and Life Sciences, Curtin University, Perth, 6102, WA (Australia)*

Hypersaline ecosystems - water lenses where concentration of salt exceeds 35 g/L - host microbial communities which are highly adapted to their poly-extreme conditions. However, our current knowledge on the vast range of taxonomic diversity and functional metabolisms characterising hypersaline wetlands is still in its infancy, and the preservation of these delicate environments depends on how quickly we unravel their ecological mechanisms. DNA metabarcoding provides a powerful tool to investigate environmental dynamics of aquatic ecosystems, and its use under high salt can be highly informative. Here, we make use of DNA metabarcoding techniques to analyse the microbial patterns (diversity and functions) from five hypersaline lakes located at Rottnest Island (Western Australia). Our results indicate that the five hypersaline lakes host moderately to extremely halophilic microbes in water, being TDS (Total Dissolved Solids) and alkalinity amongst the most influential parameters driving the community assemblages. Overall, our findings suggest that DNA metabarcoding allows rapid but reliable ecological assessment of the hypersaline aquatic microbial communities at Rottnest Island. Further studies involving different hypersaline lakes across multiple seasons will help elucidate the full extent of the potential of this tool in brine.

Five key words: Hypersaline lake, DNA metabarcoding, Functional genomics, Microbes, Rottnest Island

Email address for questions: [mattia.sacco@curtin.edu.au](mailto:mattia.sacco@curtin.edu.au)



## Impact of Eared Grebes on the Population of Brine Shrimp in Great Salt Lake, Utah, USA

Michael R. Conover and Leah M. Delahoussaye

*Utah State University*

About 2.2 million eared grebes (*Podiceps nigricollis*) spend each fall on USA's Great Salt Lake (GSL); the birds start to arrive in August, and most remain until December. Grebes on GSL forage almost exclusively on adult brine shrimp (*Artemia franciscana*) during this period. I used a bioenergetic approach in which I measured how much energy a grebe needs daily to survive and how much digestible energy an adult brine shrimp contains to determine the impact of grebe depredation on brine shrimp populations. Each grebe needs to consumer 28,000 adult brine shrimp daily to obtain enough energy to survive and migrate to wintering grounds in Gulf of California. Hence, the 2.2 million GSL grebes on the GSL consume  $6.2 \times 10^{10}$  adult brine shrimp daily or  $186 \times 10^{10}$  during November. By the end of October, the production of new adult brine shrimp ceases as females switch from producing live young to cysts, and the adult brine shrimp become a standing crop of  $466 \times 10^{10}$ . Hence, the number of grebes on the GSL consume 40% of the adult brine shrimp standing crop during November. Our results indicate that most years there are enough brine shrimp in GSL to sustain the grebe population, but in some years, the brine shrimp population is insufficient to sustain all of the grebes.

Five key words: Bioenergetic model, Brine shrimp *Podiceps nigricollis*, Population dynamics, Predator-prey interactions, Top-down control of prey

Email address for questions: [mike.conover@usu.edu](mailto:mike.conover@usu.edu)





## Flight wing size variation across a geographical range in *Pogonus diplochaetoides* (COLEOPTERA: CARABIDAE: POGONINI)

Dr. Peter HUDSON, Dr. Mark STEVENS

*South Australian Museum, Earth and Biological Sciences, Adelaide, South Australia*

Loss of flight capability in the tribe POGONINI is rare outside of Australia, only occurring in one species in America and some populations of another in Europe. Worldwide the tribe contains 12 genera and in excess of 80 species. There are two genera in Australia, with seventeen described species of *Pogonus* and one species of *Syrdenoidius*. Three of the Australian species are known to have vestigial flight wings. One Australian species, *Pogonus diplochaetoides*, with populations in Western Australia, Northern Territory and South Australia, exhibits a geographic clinal variation in wing length morphology, with some populations having vestigial wings. We examined both molecular (mtDNA COI) and male genitalia to determine any clinal variation corresponding to wing morphology and to identify the presence of possible cryptic species. Previously, such variation in wing morphology within a species has only been recorded for *Pogonus chalceus*, which is distributed along the Atlantic coast from Denmark down to the Mediterranean coast and north Africa. The species is known to have populations that have reduced wings, and we compare this phenomenon to the Australian *P. diplochaetoides*.

Five key words: *Pogonus*, Saltlake, Flightless, CARABIDAE, Biodiversity

Email address for questions: peterhudson54@yahoo.com.au



## Phylogeography of *Branchinecta media* (Schmankewitsch, 1873) (Branchiopoda: Anostraca), a species adapted to hypersaline aquatic habitats

Lucía Sainz-Escudero<sup>1,2</sup>, Silvia Perea<sup>1,3</sup>, Paula C. Rodríguez-Flores<sup>1,4</sup>, Mario García-París<sup>1</sup>

*1. Museo Nacional de Ciencias Naturales (MNCN-CSIC), Madrid, España*

*2. Fundación Global Nature, Madrid, España*

*3. Universidad Nacional Autónoma de México, Copilco, Coyoacán, D.F., México*

*4. Centro de Estudios Avanzados de Blanes, Girona, España*

The temporary nature of some continental aquatic saline wetlands allows for the existence of numerous stenoic species. *Branchinecta media* is an example of animal adapted to these aquatic and hyper-saline habitats. The extent of occurrence of *B. media* occupies the Palearctic Region, from the Western Mediterranean to Eastern Mongolia, although it has been only recorded from a few localities in Spain, Algeria, Tunisia, Romania, Ukraine, Azerbaijan, Kazakhstan, Mongolia and a distant record in northern Russia. Intraspecific diversity across Iberian and Romanian populations of *B. media*, was analysed using phylogeographic analyses through molecular data. Single Nucleotide Polymorphisms (SNPs), were also used to reveal at a fine-scale the current genetic structuring within the Iberian populations, reflecting levels of gene flow. The absence of suitable habitats between geographically distant populations of *B. media* makes necessary the use of fine scale genetic data to identify possible conservation units.

Five key words: Conservation, Gene flow, Populations, Systematics

Email address for questions: [luciase@mncn.csic.es](mailto:luciase@mncn.csic.es)

## Systematization of the Biodiversity of Crustaceans and Molluscs of the Aral Sea

Nikolai V. Aladin<sup>1</sup>, Miguel Alonso<sup>2</sup>, Igor S. Plotnikov<sup>1</sup> and Alexey O. Smurov<sup>1</sup>

*1. Zoological Institute, Russian Academy*

*2. Department of Evolutionary Biology, Ecology and Environmental Sciences, Faculty of Biology, f Sciences, St. Petersburg, Russia*

The Aral Sea is terminal water body of Syr Darya and Amu Darya rivers, large endorheic saline lake. Before the modern anthropogenic regression, it was brackish water with an average salinity ~10‰. Since 1960s, mainly due to the increasing irreversible withdrawal of water, first of all, for irrigation, flow of the rivers started to decline, the water level began to drop and salinity increased. This regression caused changes in the fauna. Growing salinity resulted in the disappearance of the most freshwater species at first and then favoured brackish-water invertebrates. In Aral 18 species of cladocerans are known. The most belongs to freshwater faunal complex. Others 5 are Ponto-Caspian endemics from Onychopoda. Widely euryhaline calanoid copepod from continental saline waters, *Arctodiaptomus salinus*, dominated among planktonic crustaceans until late 1950s, but later its abundance decreased due to extermination by introduced planktivorous fishes, and since 1974 it is extinct. It was replaced by marine calanoid *Calanipeda aquaedulcis*, introduced in 1965–1970. From Cyclopoida, only *Halicyclops rotundipes* belongs to marine fauna. All other belong to the freshwater complex. Before salinization *Mesocyclops leuckarti* was the most numerous. In Aral 15 species from Harpacticoida are known. Of them, *Schizopera aralensis*, *S. reducta*, and *Enhydrosoma birsteinii* are endemics. Of 13 known species of Ostracoda, 11 are native and other 2 are apparently recent invaders. The most widespread is *Cyprideis torosa*. A total of 6 species of Malacostraca are known in Aral. Native is Ponto-Caspian amphipod *Dikerogammarus aralensis*. Others are invaders appeared in 1958–1970: marine shrimp *Palaemon elegans* and crab *Rhithropanopeus harrisi* were introduced accidentally during acclimatization of fish and invertebrates; Ponto-Caspian mysids *Paramysis* spp. were introduced as food for fish. The shrimp caused extinction of amphipod by 1973. In the Aral fauna, 9 species and subspecies of Bivalvia are known, one of which is invader, and 2 species of Gastropoda. Bivalve mollusk *Cerastoderma* sp. (earlier identified as *C. rhomboides*) initially inhabited the entire Aral, except for heavily salinized areas. Due to salinization, it disappeared by 1978. Other species, marine *C. glaucum*, originally lived only in salinized areas, but with increasing salinity, it spread throughout the sea. Endemic bivalves *Adacna minima minima*, *A. m. sidorovi* and *A. vitrea bergi* became extinct due to salinization in late 1970s. Bivalves *Dreissena* were represented by three endemic forms. *D. polymorpha aralensis* lived only in the freshened areas of Aral, in rivers and lakes. Due to salinization, it disappeared from Aral in 1970s. *D. p. obtusecarinata* and *D. caspia pallasii* lived only in the sea itself and became extinct due to salinization: in the 1970s and by the end of 1980s respectively. Widely euryhaline marine bivalve *Abra segmentum* was introduced in 1960–1963 as food for fish. Native gastropod *Ecrobia grimmeri* now lives only in Small Aral, and is absent in hyperhaline Large Aral. Ponto-Caspian gastropod *Theodoxus pallasii* disappeared from Aral in 1980s due to salinization. By the end of 1980s biodiversity of crustaceans and mollusks decreased catastrophically. Mysids, all freshwater Cladocera and Copepoda disappeared. Only about 10 species of Crustacea and 3 species of Mollusca survived salinization. With the level fall, Aral divided into two water bodies, Small (Northern) Aral and Large (Southern) Aral. Construction of the dam in former Berg Strait became possible to decrease of Small Aral salinity and gradual restoration of biodiversity. Freshening of Small Aral and formation of freshened

zone at Syrdarya delta made possible natural reintroduction of many disappeared invertebrates which also inhabit Syrdarya and lakes in its lower reaches. Now biodiversity of crustaceans increased. Many freshwater and brackish water species are found in Small Aral. By the 2000s, gastropod *T. pallasi* returned into freshened area. Now bivalve *D. polymorpha aralensis* is also found here. Large Aral has turned into hyperhaline water body inhabited by only a few species. Crustaceans are represented in Large Aral only by one species of Cyclopoida, at least one species of Harpacticoida, one of Ostracoda and naturally introduced in the late 1990s brine shrimp *Artemia*. All 3 species of mollusks disappeared until 2010.

Five key words: Aral Sea, Salinization, Biodiversity, Crustaceans, Mollusc

Email address for questions: [malonso@ub.edu](mailto:malonso@ub.edu)



## **Stress promoted facilitation in microbial communities? Increasing saline stress reduces co-exclusions while co-occurrences remain stable**

Mateu Menéndez-Serra, Vicente J. Ontiveros, Albert Barberan, Emilio O. Casamayor

*Centre for Advanced Studies of Blanes (CEAB-CSIC), Spanish Council for Scientific Research, Accés Cala St. Francesc 14, E-17300 Blanes, Spain*

*Department of Environmental Science, University of Arizona, Tucson, AZ, 85721, USA*

Salinity fluctuations constitutes a high stress factor for microorganisms, strongly determining distributions and abundances at a global scale. Inland environments covering wide salinity gradients are perfect scenarios for assessing the role of increasing stress over microbial community composition and structure, and their effects have been widely studied. However, there is a knowledge gap regarding how increasing stress affects microbial biological interactions. We applied the combination of a probabilistic method for estimating significant co-occurrences/exclusions and a conceptual framework for filtering out associations potentially linked to environmental and/or spatial factors in a set of endorheic saline ponds of the Monegros desert lacustrine system (NE Spain). We carried out a network analysis over the full microbial population –including bacteria, eukarya and archaea– along severe salinity fluctuations in ponds connected by dispersal processes. We found that most of the observed co-occurrences/exclusions were potentially explained by environmental niche and/or dispersal limitation, reinforcing the need of specific methodologies for network construction along environmental gradients. Interestingly, co-occurrences assigned to potential biological interactions remained stable in terms of number and network structure as salinity increased, suggesting that the studied salt gradient was not promoting interspecific facilitation processes. This observation matches the lack of described facilitation mechanisms linked to osmotic stress in aquatic environments. Conversely, co-exclusions assigned to potential biological interactions decreased in number and network structure along the gradient, pointing to a decrease of interspecies competition as salinity increased. Overall, our results evidenced how the use of novel methodologies for network construction along environmental gradients might allow to better understand biological interactions in changing environments.

Five key words: Microbial, Stress, Network, Competition, Facilitation

Email address for questions: [mateu.menendez@ceab.csic.es](mailto:mateu.menendez@ceab.csic.es)



## Evolution patterns of two tribes of tiger beetles (Coleoptera: Cicindelidae) in Australian salt lakes

*(Preliminary version)*

Alejandro López-López, Peter Hudson, José Galián

*Universidad de Murcia*

During the aridification of Australia, starting 10 million years ago, numerous salt lakes formed following the courses of ancient rivers. This led to the isolation and subsequent speciation of populations of numerous taxa. Nonetheless, there can also be genetic flow between lakes when they are sporadically filled by rains and water flows from one lake to the next following the course of the palaeorivers, which happens every 50 years on average. In this work, we analyse the evolutionary patterns of two poorly studied genera of tiger beetles, *Pseudotetracha* and *Rivacindela*. *Pseudotetracha* are nocturnal and flightless and *Rivacindela* are diurnal and generally capable of flight. Both are very active on the lake surface. Our work unveils the hidden diversity in these taxa, generated during the isolation of populations during the aridification of the continent, including cryptic taxa that challenge their traditional taxonomy. The main clades within each genus are generally restricted to systems of lakes or palaeodrainage basins. The results also show how *Rivacindela* has a higher capability of colonization of new lakes across long distances, following a stepping-stone model, than the flightless *Pseudotetracha*.

Five key words: Phylogeography, Evolution, Australia, Aridification, Coleoptera

Email address for questions: [atanvard@gmail.com](mailto:atanvard@gmail.com)



## Glacial refuges and cryptic speciation in the Palearctic tiger beetle *Calomera littoralis* (Coleoptera: Cicindelidae)

Alejandro López-López, Nicolás Torres-Mantelet, José Galián, Trinidad León-Quinto

*Universidad de Murcia*

Pleistocene glaciations had a determining role for shaping the current distribution and diversity of organisms, especially in the Palearctic region. In this work, we carry out a phylogeographic analysis of Iberian and Eastern European populations of the tiger beetle *Calomera littoralis* (Fabricius, 1787), in order to infer the processes that may have affected their evolutionary history. According to our results, the genetic diversity of central Iberian *C. littoralis* is very low. The haplotype networks also suggest that these populations experimented a genetic bottleneck in the past, probably related to the last glacial maxima, and similar to that observed in other cicindelid taxa. These results highlight the remarkable dispersal capacity of this species, being able to move freely from one locality to another, despite the relatively long distances of sub-optimal habitat that separates them. The genetic data contrast with that of the Eastern European populations, with higher genetic diversity and no hints of any past bottleneck. This can be explained by the different characteristics of both (Iberian and Pontic) glacial refuges. The high degree of genetic differentiation between the three *C. littoralis* clades, and the inclusion of *C. lunulata* between them, suggests that the three analysed populations could be considered as different cryptic species. In that case, *C. littoralis* may correspond to a species complex that is still undergoing a process of speciation, similar to that observed in *Cicindela campestris*.

Five key words: Iberian Peninsula, Coleoptera, Evolution, Phylogeography, Speciation

Email address for questions: [atanvard@gmail.com](mailto:atanvard@gmail.com)





## Microbial diversity of hypersaline colorful salt ponds in Yuncheng salt lake, Shanxi Province, China

Fanjing Kong, Liwei Wang, Mianping Zheng

*Key laboratory of salt lake resources and environments, Natural Resources Ministry;  
Institute of mineral resources, Chinese Academy of Geological Sciences*

Yuncheng salt lake has a long history in salt production and its ecological system was effected greatly by human activities. Many hypersaline salt ponds of the region display red or green colors every summer season. In order to learn about the differences of ecological systems in hypersaline pools, the community compositions of microbes in these ponds from all three domains (Bacteria, Archaea and Eukarya) were surveyed with highput DNA sequencing of 16S ribosomal gene and ITS region. OTUs, relative abundance, alpha diversity, and beta diversity were analyzed. The factors causing different colors of hypersaline pools were discussed.

Five key words: Yuncheng salt lake, Microbial diversity, 16S rRNA gene, ITS, Colorful salt ponds

Email address for questions: kongjie69@hotmail.com



## Environmental variables influencing abundance of two congeneric water beetles species from supratidal rockpools

García-Meseguer AJ, Mirón-Gatón JM, Botella-Cruz M, Millán A, & Velasco J

*Ecology and Hydrology Department, University of Murcia, Spain*

Supratidal rockpools are singular and highly dynamic habitats at the interface between land and sea. Organisms living in them are subjected to intense stress because of temperature, salinity and desiccation pressures, which are associated with rising and falling of sea level, waves, wind, precipitation and strong sunlight exposure. Rockpools have low species richness, but resident species exclusive and strongly adapted to these extreme conditions. In this work we focused on two congeneric water beetle species belonging to the genus *Ochthebius* (Family Hydraenidae), *O. quadricollis* and *O. lejolisii*, which frequently cohabit southern Iberian Mediterranean rockpools. The main objective of this work was to identify the variables determining their abundance. For this, monthly samples, over the course of a year, were randomly taken in ten pools from two localities (Cala Reona and Cala de las Pulgas, Murcia Region). In addition to individuals of both species, we also recorded for each pool: distance to sea, size, temperature, conductivity, type of substrate, coverage percentage of periphyton and coarse particulate organic matter. We applied Spearman correlations and GLM models to the data. Abundance of both species was negatively correlated. The best models obtained for each species considered the significant effect of four variables: distance to sea, conductivity, pool depth and periphyton. There was a positive correlation between the distance to sea and the abundance of both species, however *O. quadricollis* was more abundant in deeper pools than *O. lejolisii*, which preferred shallower pools. In addition, the abundance of *O. quadricollis* was positively related with conductivity and periphyton coverage, contrary to the case of *O. lejolisii*.

Five key words: Water beetles, Rockpools, Abundance, Environmental variables, GLM

Email address for questions: [aj.garciameseguer@um.es](mailto:aj.garciameseguer@um.es)



## Taxonomic diversity of extremophilic microbial communities in the salt lakes of the Barguzin depression (Baikal rift zone) in relation to the geochemical conditions

(Preliminary version)

E V Lavrentyeva<sup>1,2</sup>, T G Banzaraktsaeva<sup>1</sup>, V B Dambaev<sup>1</sup>, L P Kozyreva<sup>1</sup>, A A Radnagurueva<sup>1</sup>, AM Plyusnin<sup>3</sup> & D D Barkhutova<sup>1</sup>

1. *Institute of General and Experimental Biology SB RAS, 6 St Sakhyanovoi, Ulan-Ude, Russia*

2. *Buryat State University, 20a Str Smolina, Ulan-Ude, Russia*

3. *Geological Institute SB RAS, 8 St Sakhyanovoi, Ulan-Ude, Russia*

Sulfate lake Gudzhirganskoe (pH 9.86, mineralization 100 g/L) and soda lake Nukhe-Nur (pH 9.62, mineralization 9.8 g/L) are salt lakes located in the Barguzin Depression at a distance of 45 km. The Depression belongs to the Baikal rift zone which is characterized by widespread open faults. Along the faults thermal fissure-vein water is discharged in the near-edge and in the central parts of the Depression. The region is characterized by a cryoarid climate and significant temperature fluctuation throughout the year. The annual amplitude of absolute air temperatures reaches 90 °C, the maximum air temperature in summer is + 38 °C, the minimum in winter is -52 °C (Namsaraev et al, 2007). Due to the discharge of the thermal spring the sulphate sodium type of the water is formed in Lake Gudzhirganskoe. The input of sulfate ion is associated with the interaction of thermal waters with Cambrian sedimentary rocks of marine genesis, which is also indicated by the heavy isotopic composition of sulfur. Nitrogen thermal waters are in the lake Nukhe-Nur where, as a result of actively occurring processes of evaporation and freezing, solutions are concentrated and the chemical composition of the lake water is transformed in the soda direction. The lakes have a unique macro- and microcomponent composition of water and the mineral composition of bottom sediments. The taxonomic diversity of prokaryotes in different biotopes of these lakes was studied using the analysis of amplicons of the 16S rRNA gene. The study had shown that extremophilic microbial communities are formed in these salt lakes. Differences in taxonomic composition were noted for biotopes. In all biotopes, the predominance of bacteria Alphaproteobacteria, Gammaproteobacteria, Bacteroidetes, Cyanobacteria and Firmicutes was found. Actinobacteria and Deinococcus-Thermus dominated. Archaea representatives accounted for 0.013–4.5%. It should be noted that in Lake Gudzhirganskoe the microbial community is represented mainly by moderately halophilic and halophilic bacteria, while in Lake Nukhe-Nur the microbial community is represented by moderately alkalophilic bacteria. Thus, the data obtained made it possible to assess the current state of the lakes and the taxonomic diversity of microbial communities in the biotopes of the Gudzhirganskoe sulfate lake and the Nukhe-Nur soda lake, depending on the geochemical conditions of the lake formation. The work was supported by the Russian Foundation for Basic Research, project 18-44-030021 r\_a, and partially within the framework of the State Assignment 121030100229-1 “Microbial communities of extreme natural ecosystems of the Baikal region: structural and functional organization and biotechnological composition” for Institute of General and Experimental Biology, Siberian Branch, Russian Academy of Sciences.

Five key words: Salt lake, Microbial community, Taxonomic diversity, Geochemical conditions, Baikal rift zone

Email address for questions: [darima\\_bar@mail.ru](mailto:darima_bar@mail.ru)



## Ecological status, ecosystem services and threats to saline lakes: global analysis of 68 lakes

Egor Zadereev, Ramesh Oliver Wilson, Ors Abram, Ekaterina Afonina, Tania Anderson, Elena Anufriieva, Balgit Bazarova, Yuriy Bazhenov, Svetlana Borzenko, Luciana Gomes Barbosa, Bonnie Baxter, Emil Boros, Enrique H. Bucher, Antonio Camacho, Alba Camacho-Santamans, Emilio O Casamayor, Rick Cavicchioli, Peri Coleman, Florencia Colla, Bindy Datson, Maria Farias, Tadesse Fetahi, Larisa Golovatuk, Evgenia Gorlacheva, Peter Hudson, Katia Hueso, Irina Kalioujnaia, Bakhtiyor Karimov, Mills Keely, Ilga Kokorite, Anastasia Komova, Lothar Krienitz, Seema Kulshreshth, Ron Larson, Oksana Lipka, Tatiana Lopatina, Evgenia Matugina, Quentin Mauvisseau, John Melack, Daniel Morant, Edmundo Moreno, Zorigto Namsaraev, Aharon Oren, Sandra Poikane, Christopher Rogers, David Ryves, Marta Sanchez, Anna C. Santamans, Michael Schagerl, Elena Selivanova, Nickolai Shadrin, Somayeh Sima, Natalya Tashlykova, Katrin Teubner, Brian Timms, Svetlana Ulanova, Wayne Wurtsbaugh, Thomas Zechmeister, Alfred Burian

*Krasnoyarsk Research Center*

Saline lakes are widespread in all continents. They are located mostly in closed remote basins in arid climate. These ecosystems in comparison with freshwater counterparts are underrepresented in limnological and ecological research due to several reasons. In addition, these lakes very often considered a less important in comparison with freshwater lakes, as the use of saline water for drinking or other direct purposes is prohibited by high ionic content. As a result, these lakes often are less or not adequately protected. Here we present first quantitative and qualitative data set collected for almost 70 saline lakes across seven continents on the ecosystem services provided by saline lakes and most important ecosystem threats. The data set covers lake in the wide range of salinities (from 1 to almost 400 g/l), sizes (from 0.2 to 20300 km<sup>2</sup>), maximal depth (from 0.1 to 294 m). Our data demonstrated that salinity is not the key determinant of the number of ecosystem services provided by saline lakes. Alternatively, the lake size and remoteness are the key determinants in provisioning multiple ecosystem services. The most frequently mentioned ecosystem services provided by saline lakes were education/scientific services and recreational and tourism services. However, we revealed salinity related shifts in the type of ecosystems services provided by saline lakes. With the increase of salinity the relative importance of such ecosystem services as provision of water, provision of biological resources, and regulation and maintenance of local climate/weather decreased, while the importance of such ecosystem services as provision of mineral resources, cultural and spiritual services and medical and spa treatment increased. We also revealed values of several critical salinities above or below which such ecosystem services as provision of biological resources or mineral extraction is sharply declines. This clear difference between saline and freshwater lakes should be taken into account in conservation and management strategies. Survey demonstrated that climate change and land use pose the greatest threat to saline lakes. Again, the salinity was an important factor that determined the importance of different threats. With the increase of salinity the relative importance of such threats as climate change, intensification of grazing decreased while the relative importance of land use, water abstraction and mining increased. Our survey also documented over 150 threatened species that studied saline lakes support globally. Overall, our results clearly demonstrated that salinity itself is not the factor that reduces the number of ecosystem services provided by the lake. We

demonstrated that salinity determines the type of ecosystem services provided by the lake with gradual substitution of ecosystem services related to the direct use of water and biological resources to the provision of minerals, medical or different cultural (scientific, spiritual, etc.) services. With the growing threat of salinization, water level decline in many closed basins and worldwide observed shrinking of many saline lakes the strategies of adaptive management should be adopted to ensure that the cumulative values of ecosystem services provided by saline lakes is not diminished.

Five key words: Saline lakes, Ecosystem services, Biodiversity

Email address for questions: [egzadereev@gmail.com](mailto:egzadereev@gmail.com)





## Demonstration of comprehensive utilization of Ecological Agriculture in Dry Salt Lake

(Preliminary version)

Chunying Zhang

*Yancheng Lvyuan Salt Soil Agricultural Science and Technology Co., Ltd*

*Research institutions, government and enterprises related to ecological management of Dry Salt Lake*

As the global climate deteriorates and the desertification trend of lakes intensifies, it has caused an extreme ecological environment and poses a great threat to people's life, production and economic development. Zheng Mianping, academician of the Chinese Academy of Geological Sciences, suggested the development of characteristic salt lake agriculture according to local conditions. Yancheng Lvyuan Salt Soil Agricultural Science and Technology Co., Ltd., aiming at the current situation of traditional salt lake desert investment, long cycle and low efficiency technology, has innovated the systematic research of variety selection, supporting cultivation technology and product development and utilization, and achieved important breakthrough of improvement results. Using the traditional system breeding and modern coercive directional breeding breeding system, with the aim to resist salt, keep high yield and high quality, in order to breed a new variety of halophytes, "Lvhai Jianpeng 1" shows stronger salt resistance, barren, resistance characteristics, maintain alkali inherent rich nutritional value, both grass, vegetables, medicine, oil, feeding, and other functions, and biological yield is high, and make dry salt lake become the pioneer plant and breakthrough which can help restore vegetation and improve the ecology breakthrough. A supporting cultivation technology system covering varieties, tillage, sowing, fertilizer planting, planting and irrigation has been established. The implementation of this system promotes the rapid formation of saline-alkali plant communities and the ecological evolution of plant diversity. A series of salt lake vegetable products including fresh vegetables, quick-freeze, dehydration and vegetable salt have been developed. From salt lake management to salt lake agriculture, create social and ecological benefits at the same time improve economic benefits, and achieve the purpose of governance, development and income of dry salt lake. Through field observation, and collection, comparison and analysis of salt lake soil samples, the project shows that Suaeda glauca cultivation plays an important role in reducing surface temperature, weakening ground evaporation, withholding sand and saline-alkali dust, and improving the physicochemical properties of soil surface. The quantitative analysis and evaluation of the ecological benefits of Suaeda glauca planting provide theoretical and practical reference for the ecological treatment of dry salt lakes and even the vast arid and semi-arid areas. Success cases. Anguliniao, located in Zhangbei County, Zhangjiakou City, Hebei Province, is known as the "pearl of the Bashang". However, due to drought and other reasons, the water level continued to decline, and Anguliniao lake completely dried up at the end of 2004. Due to the loss of water source, the surrounding grassland degenerated rapidly, showing signs of desertification, seriously affecting the ecological environment of the surrounding area. By 2020, the ecological governance of 100,000 mu of dry salt lake in Anguliniao lake has been completed, and the artificial community, growth and evolution and plant diversity were established. 65 new kinds of plants were added, divided into 26 families and 53 genera, and the damaged ecological environment has been gradually restored. After the survey, 40,000 mu and 50,000 mu reached the standard of salt lake vegetable fields. The implementation of the project has significantly improved the scientific level of comprehensive treatment, improvement and

utilization of salt soil in China, and provided a broad demonstration model and popularizable technical route. Expected development direction. Based on our country has solemn commitment to the global “carbon peak” and “carbon neutral” goal, to achieve high quality development and ecological environment quality continuous improvement background, the development of ecological restoration management and photovoltaic, realize the optimization of land resources, will be the ecological benefit, social and economic benefits win-win important gripper.

Five key words: Dry Salt Lake, Salt-land agriculture, Ecological governance, Salt-tolerant plants, Suaeda glauca

Email address for questions: 1052112242@qq.com



# Posters

---



## Origin and evolution of halite in the Lanping-Simao Basin of southeastern Tibetan Plateau, China: Evidence from the stable isotope of $^{37}\text{Cl}$ , $^{87}\text{Sr}/^{86}\text{Sr}$

Shaorong Du, Mianping Zheng

*Department of Saline Resource and Environment, CAGS, CHINA*

The Lanping-Simao Basin was located on the southeastern Tibetan Plateau, China and formed a massive evaporites. The study of the origin and evolution of evaporites in the basin is difficult and still controversial since the basin was strongly deformed by the tectonic movement. In this paper, 40 evaporite samples from the core MK-3 were collected from the MPD area and analysed their evaporite minerals by XRD and stable Cl-Sr isotopic compositions. The evaporites were the first time that collected from the deep more than 2km and  $\delta^{37}\text{Cl}$  values of the halites have been reported to explain the origin and evolution of the evaporite in the Lanping-Simao Basin. The origin of the evaporite was inquired based on the evaporite minerals and the geochemical data of the halite in the Mengyejing area. Conclusions were as follows: the main evaporite minerals are halite and the amount of anhydrite, sylvite are small. The  $\delta^{37}\text{Cl}$  values of the halite set from  $-0.38\text{‰}$  to  $0.57\text{‰}$ , average  $0.203\text{‰}$ , within the seawater  $\delta^{37}\text{Cl}$  value ( $0 \pm 0.5\text{‰}$ ) and the  $^{87}\text{Sr}/^{86}\text{Sr}$  values of the halite range from 0.707562 to 0.710195, all these suggest the origin of the deep evaporite are from the ancient seawater in the basin. And the evaporites of the MPD may come from the deep evaporite layer with the tectonic movement according compared the sedimentary features, evaporite minerals composition,  $\delta^{37}\text{Cl}$  and  $^{87}\text{Sr}/^{86}\text{Sr}$  isotopic signature with the shallow deposit since both of them are located in the same area. In addition, this paper discusses the origin evolution of the MPD with the previous studies. The  $\delta^{37}\text{Cl}$  and  $^{87}\text{Sr}/^{86}\text{Sr}$  values from the profile show that the origin of the MPD is changed from marine with trace of nonmarine fluids to marine mixed with nonmarine fluids. And in the late, the proportion of nonmarine fluids is increasing.

Five key words: Origin, Evolution, Evaporite, Cl-Sr isotopes, Mengyejing potash deposit

Email address for questions: shr\_du@163.com

## Visualization study on spatial structure change of Brine Aquifer in Luobei Depression mining area based on GMS

Lingfen Wang<sup>1</sup>, Yongmei Yu<sup>2</sup>, Boyun Li<sup>1</sup>, Fankai Zhang<sup>2</sup>, Yufei Deng<sup>1</sup>, Wenxue Li<sup>2</sup>,  
Xu Han<sup>1</sup>, He Qin<sup>2</sup>

*1. Geology Institute of China Chemical Geology and Mine Bureau*

Luobei depression is located in the northern part of Lop Nor, which is the largest dry salt lake in the world. It is rich in liquid potash resources —brine. The brine aquifer system is a multi-layer structure, which is formed by the superposition of one unconfined brine Aquifer and several confined brine aquifers. There are relative aquicludes between each brine aquifer, and there are also clay inter-layers with uneven distribution and unequal area in each layer of the brine aquifer. The distribution and thickness of the clay interlayers will have a great influence on the estimation accuracy of mineral resources reserves. So, it is particularly important to precisely characterize the spatial distribution of aquifers, aquicludes and clay interlayers to carry out visualization studies. In this paper, the hydrogeological structure model of potash mining area in Luobei depression is constructed with the aid of the stratum simulation module in GMS software, using borehole data, stratigraphic section data, geological map and DEM data. The model includes 4 aquifers, 3 relative aquicludes and 8 clay interlayers. The advanced GMS-SOLID module technology is applied to realize the "multi-orientation and cutting" 3D visualization of the hydrogeological structure of the Luobei depression mining area, which provides the basis for accurately expressing the spatial structure of the aquifer and revealing the spatial information of the aquifer. It lays a foundation for the effective management, scientific development and accurate estimation of brine resources. Through systematic drilling engineering control, rich shallow brine and deep confined brine have been exposed in Luobei depression. In the depth of 90 meters, there is one layer of unconfined brine (W1) and three layers of confined brine (W2, W3 and W4). In recent years, with the large scale exploitation, the brine resources are continuously consumed, the underground brine water level also drops and different degrees of depression cone appears. Because of the difference between liquid potash and solid potash, the occurrence characteristics of brine and the thickness of ore body also change greatly. Using 77 representative boreholes in the study area, the geological structure model of mining area is constructed by using GMS software. The results show that : ①there is a layer of clay interlayer in the stratum where W1 exists, through the spatial analysis function of the model, it is calculated that the volume of this layer (excluding the clay interlayer) is 30,800,000,000 cubic meters, and the volume of the clay interlayer is 1,500,000,000 cubic meters. ②there are three layers of clay interlayer in the stratum where W2 exists, the volume of this layer is 15,600,000,000 cubic meters, and the volumes of the clay interlayers from top to bottom are 1,760,000,000 cubic meters, 701,000,000 cubic meters, and 235,000,000 cubic meters respectively. ③there are two layers of clay interlayer in the stratum where W3 exists, the volume of this layer is 15,900,000,000 cubic meters. From top to bottom, the volumes of the first and second clay interlayers are 1,620,000,000 cubic meters and 337,000,000 cubic meters respectively. ④there are two layers of clay interlayer in the stratum where W4 exists, the volume of this layer is 13,000,000,000 cubic meters. From top to bottom, the volume of the first clay interlayer is 2,250,000,000 cubic meters, and the volume of the second clay interlayer is 414,000,000 cubic meters. The stratum structure model can accurately and clearly reflect the hydrogeological structure of mining area and the spatial relationship of aquifer and aquiclude. The visualization of hydrogeological structure is realized, which has higher simulation precision. This provide basis for understanding the sedimentary characteristics of strata and Exploring

hydrogeological information. It has also laid a good foundation for establishing the numerical simulation model of groundwater. In the past, the reserve calculation of liquid potash resources was based on the method of geological blocks as the solid. The volume of orebody calculated by block method is the product of the horizontal projection area and the average thickness of block. In many cases, due to the existence of non-ore interbeds in the orebody, the estimated reserves deviate greatly from the actual reserves. The method of establishing the Aquifer Structure Model in this paper can effectively eliminate the non-ore layers, and greatly improve the calculation accuracy. It will help Salt Lake resource management more efficient and with greater meticulous. The study on the spatial structure of aquifer system is of great practical significance.

Five key words: Lop Nor, GMS, Stratigraphic Structure, Visualization, Resource Reserve

Email address for questions: w5203205@163.com





Poster session: (1) Geology/Physical geography and (9) Inland lakes in a changing world\_070

## Significant Progress Made in Deep Brines potassium-bearing in continental basins in China

Hou Xianhua

*Institute of mineral resources, Chinese Academy of Geological Sciences*

China's external dependence on potash has decreased from more than 70% to 50%. Continental Salt Lake have always been an important support for China's potash self-sufficiency. Potash producing areas are mainly distributed in Qarhan of Qinghai and Lop Nur of Xinjiang, especially in Qaidam Basin, with a contribution rate of 80%. Based on the basic research of paleoclimate and salt sedimentary structure, Academician Zheng mianping's potash team inferred that the new strata of lower Pleistocene (Q1) in the western Qaidam Basin have potential for potassium exploration. Through seismic data reprocessing and interpretation, it is predicted that there is a large thickness of gravel type brine reservoir in the deep of Heibei depression in the west of Qaidam. The drilling verification of well Hei ZK10 is arranged. The results show that the hole encountered a large thickness of potassium rich brine. The drilling depth of the hole is 700 m, the thickness of the brine layer is 600 m, the water inflow of a single well is 6073 m<sup>3</sup> / d, the maximum drawdown is 8.47 m, and the brine pumping time is 104 hours, The stable time is 24 hours, and the unit water inflow is 750 m<sup>3</sup> / d·m. The average content of KCl is 0.68%. Through the analysis of salt composition, sulfur, strontium, potassium, boron, magnesium isotopic characteristics, inclusion composition and homogenization temperature, the origin and material source of deep brine are preliminarily mastered. The discovery of large amount of deep brine type potash resources in Western Qaidam is expected to make this area become the backup replacement area of Qarhan, the largest potash mine in China.

Five key words: Potash, Continental salt lake, Qaidam basin, Drilling, Deep brines

Email address for questions: [hxh2858@126.com](mailto:hxh2858@126.com)



Poster session: (1) Geology/Physical geography and (9) Inland lakes in a changing world\_078

## **A new direction for marine potash prospecting: Xiali formation of Jurassic of Qiangtang basin in Tibet, China**

Xinsheng Niu, Xifang Liu, Mianping Zheng, Wenxi Chen

*Institute of Mineral Resources, Chinese Academy of Geological Sciences*

Potash is the most important raw material for potash fertilizer, but China's potash resources have long been inadequate to meet modern agricultural production requirements. Therefore, it is urgent to find enough marine potassium resources. Qiangtang basin is a marine basin with the most fully developed and widest distribution area of the marine Jurassic in China, and also an important part of the East Tethys salt belt. It has been found that the Xiali Formation of Jurassic in the Qiangtang basin has better conditions for potash formation, and Xiali Formation is the priority target strata for potash prospecting in the Qiangtang Basin. The main basis is as follows: 1) There are a series of modern saline springs developed in Dogai Coring and Youyiquan area in Qiangtang Basin. The geochemical characteristic coefficients of these saline springs water show obvious potassium anomaly, which reflects the objective existence of evaporite in deep strata. 2) The geochemical research on the source of saline spring water in Dogai Coring area and Youyiquan shows that the salt dissolved in these springs waters comes from the Jurassic Xiali Formation. 3) The research for Lithofacies palaeogeography of Qiangtang basin suggested that a relatively closed tidal flat and lagoon environment appeared in the Northern Qiangtang basin during the Xiali period, surrounded by shore and separated from the deep sea by sandbar in the south, which formed the advantaged salt-forming and potassium-forming environment. In conclusion, it is suggested that the Xiali Formation of Jurassic in Qiangtang Basin has relatively good conditions for salt and potassium formation from the analysis of potassium anomaly, provenance, paleoclimate and lithofacies paleogeography. The Xiali Formation should be the most important target strata for potash prospecting in this area in the future, and the key area should be Dogai Coring area.

Five key words: Potash, Tibet, Qiangtang, Xiali Formation, Dogai Coring

Email address for questions: 214887627@qq.com



Poster session: (1) Geology/Physical geography and (9) Inland lakes in a changing world\_079

## **The macroscopic and microscopic characteristics of the new type of polyhalite potassium salt ore and its implications for mineralization : A new record from the CXD1 well in the northeast of Sichuan**

Fanfan Zuo, Yongsheng Zhang, Mianping Zheng

*Institute of Mineral Resources, CAGS*

As a kind of bulk mineral resources in shortage supply, the exploration and development of potassium salt has always been a hot issue concerned by salt lake scientists in China. Especially, the exploration of marine potash minerals has not made a major breakthrough in modern and ancient salt basins in China. In recent years, sedimentary potash deposits, the main potassium-forming mineral of which is composed of sulfate-type polyhalite have been discovered in the Triassic epicontinental sea basin of Sichuan, China. However, they are known as being symbiosis or interbedded with anhydrite and dolomite and therefore it is difficult to be exploited and utilized because of the deep buried depth. On the contrary, the newly discovered “new type of polyhalite potassium salt ore”, which is characterized as clastic granular polyhalite symbiotic with salt or distributed in a salt matrix, can be mined and utilized by water solution method and provide a new directions and new fields for marine potassium exploration in Sichuan Basin. In this research, this newly discovered polyhalite and the symbiotic halite is evaluated using both polarizing microscope and electron probe microanalysis (EPMA). It reveals that most of the clastic granular polyhalite is actually composed of both polyhalite and anhydrite, with a variable content of the latter, ranging from 5%-70%. The two minerals have different optical characteristics under the polarizing microscope, especially the distinct interference color. Both the polarizing microscopic analysis and the EPMA indicate that the boundary between the polyhalite, anhydrite and halite is clear and the metasomatism is rare, which indicate that the different minerals are all formed in the primary sedimentation process. Furthermore, some of the polyhalite show microdiversity within a single mineral under EPMA, which may be caused by the minor change of strontium contents and will be confirmed in the further study by analysis of the main and trace elements in the mineral micareas. Overall, the research related to the new type pf polyhalite potassium salt ore can provide some new evidence for deciphering the origin of this special potassium salt ore and finally play a leading role for making new breakthroughs in ore prospecting of marine soluble solid potassium salt.

Five key words: New type of polyhalite potassium salt ore, Microscopic characteristic, Mineral genesis, Sichuan Basin, Triassic

Email address for questions: Fanfan.zuo@hotmail.com



## Correlation scheme research between Late Quaternary evaporite deposition period and glaciation period of the saline lake in Qaidam Basin

Andong Chen

*Institute of Mineral Resources, Chinese Academy of Geological Sciences*

Climate is one of the dominant factors which control evaporite deposits in Qaidam Basin. The aim of this paper is to make a comparison between the evaporite deposit period and glacial period since marine oxygen isotope stage 8 (MIS8). In this paper, five middle Pleistocene-Holocene evaporite bearing profiles in salt lakes of the western Qaidam Basin are taken as study objects. U-series dating was applied to obtain the evaporite deposition age, and X-ray diffraction analysis was applied to identify the evaporite minerals. The U-series age of mirabilite and halite layer in D19 profile of the Chahansilatu Playa corresponding to marine oxygen isotope stage (MIS) 7. The dating age in MXK2 profile of the Chahansilatu Playa are correspond to the penultimate glacial period MIS6. The U-series age of mirabilite and halite layer in KP4 profile of the Kuntayi Playa correspond to the MIS4. The dating age of D18 profile of the Chahansilatu Playa belong to the late stage of last glacial MIS2. The age of U-series in YP3 profile of Yiliping corresponding to MIS1, but with large dating error. XRD analysis confirmed that salt minerals in the 5 profiles were mainly mirabilite, halite and gypsum. Combining the study of this paper and evaporite deposits data of other salt lakes in the Qaidam Basin, this paper proposes that the late Quaternary MIS8-MIS6 and the MIS4-MIS1 are important salt-forming periods of the late Quaternary in the Qaidam Basin.

Five key words: Qaidam Basin, Salt lake, Evaporite deposit period, Quaternary glaciation period, U-series dating

Email address for questions: 478957683@qq.com

## Chemical Analysis of Water and the Resource of Br, K respects of Oilfield Brines from Ordovician and Carboniferous in Tarim, China

*(Preliminary version)*

Su Kui, Zheng Mianping

*Department of Saline Resources and Environment*

China is lack of bromine and potassium seriously. Oilfield brines is the headline goal of bromine and potassium resources exploration. Applicants grab 24 oilfield brines samples from various wells of Ordovician and 22 samples from Carboniferous in Tarim basin were acquired. Chemical analyses were developed for understanding origin and resources potential of oilfield brines from Ordovician and Carboniferous. Ionic composition indicates that of 24 samples in Ordovician, the content of Br in 8 samples distributed in various wells and layers exceed industrial grade (200 mg/l), as well as the content of KCl in 5 samples exceed industrial grade (0.5%); and of 22 samples in Carboniferous, the content of Br in 13 samples distributed in various wells and layers exceed industrial grade, but the content of KCl in all samples may not reach industrial grade. With the huge water yield, the data represents good Br resource prospects of oilfield brines in Ordovician and Carboniferous in Tarim, and oilfield brines in Ordovician have good KCl resource prospects. After the Parameter of  $(Br-/Cl-)\times 10^3$ ,  $CMg/Ccl$ ,  $CNa/Ccl$ ,  $K/Cl\times 10^3$  and  $K/Br$  were analysed, oilfield brines from Ordovician and Carboniferous can be classified into 3 types: sedimentary transformation, dissolution-filtration, and composite formation mechanism of sedimentary transformation and the dissolution and filtration of solid salts. In addition, oilfield brines of Ordovician in part originated from dissolution of potash minerals, which indicate the possibility in the search for solid potash from Paleozoic in the Tarim Basin.

Five key words: Tarim, Ordovician, Oilfield brines, Bromine, Potassium

Email address for questions: ssskkk@126.com



Poster session 1: (1) Geology/Physical geography and (9) Inland lakes in a changing world \_095

## **A new understanding of boundary fault which controls formation of potassium sag in Majiagou Period of Ordovician in the eastern margin of Ordos Basin**

*(Preliminary version)*

Baoling Gui, Yongsheng Zhang, Enyuan Xing, Yuan Peng, Fanfan Zuo, Haitong Zhao, Yahui Mao, Suyang Jiang

*Institute of Mineral Resources Chinese Academy of Geological Sciences*

The Majiagou formation of Ordovician in the northern shaanxi salt basin has a good potential for potassium formation, but only thin and thick beds of potash salt mineralization have been found, and no large-scale potash ore has been found yet. By structure analysis of seismic profiles in eastern margin of Ordos Basin, we believe that, there was an old normal fault in the period of deposition of sixth sub-member of Majiagou Formation in Jinxi flexure fold belt. The old normal fault formed the Syndepositional depression, a large number of rich brine potassium within the sag, the continuing drought strong evaporation conditions, continuous enrichment, brine potassium into window appears, sylvine large-scale precipitation, forming a monoblock Marine quality stone solid potassium salt deposits. During the Mesozoic era, the squeezing stress caused the potassium sag to rise, forming a pattern of ancient depression and present uplift, and the potassium salt layer rose to the shallow part, which is convenient for economic exploitation by water solution method.

Five key words: Eastern margin of Ordos, Jinxi flexure fold belt, Majiagou Formation in ordovician, Marine potash, Structural forming of potassium, Pattern of ancient depression and present uplift

Email address for questions: guizi0603@163.com





## Study on the mineral composition of modern Tufa in Zabuye Salt Lake, Tibet

*(Preliminary version)*

ZHANG Xuefei

*Institute of Mineral Resources, Chinese Academy of Geological Sciences*

Tufa, also known as Travertine, is a continental carbonate deposit that surrounds a lake or spring. Travertine is widely distributed in qinghai-tibet Plateau, and it is distributed and studied from the eastern border to the western hinterland. The Zabuye Salt Lake on the qinghai-tibet Plateau is the only lake in the world that naturally produces lithium carbonate. There are numerous Tufa hills in the North Lake of Zabuye and it is separated from the North Lake by a large area of ancient Tufa in South Lake. According to the age of partial Horizon Travertine, the spring water is the main contribution of lithium resources in the lake area. Because of the difference in Ph between the spring water and the lake water, the spring water mixed with the lake water rapidly formed travertine deposits, and this geochemistry process is still ongoing. In this paper, the mineral composition of travertine in modern sediments is studied. It is found that the travertine is mainly  $\text{CaCO}_3$  sediments and the mineral composition is calcite and Aragonite. Among them, calcite is Rhombic automorphite, Aragonite is mainly solid or hollow needle-like crystal. They were separated under the microscope, and then their element compositions were analyzed. The differences of rare elements such as Li, Rb and CS were compared, and the formation mechanism of calcite and Aragonite was discussed.

Five key words: Zabuye Salt Lake, Travertine, Calcite, Aragonite, Calcium carbonate precipitation

Email address for questions: zhangxuefei2000@163.com

## Towards the protection to two inland saltern ecosystems in the Alto Vinalopó Valley, Spain

Rosa María Martínez-Espinosa

*University of Alicante*

Two of the inland solar salterns (termed Redonda and Penalva), located in the Alto Vinalopó Valley (Alicante, Spain), have been used during centuries for NaCl extraction. They were part of a humid ecosystem constituted by a large central lagoon called "La Laguna de Villena" and small formations of more saline water that constitute the current salt pans. In 1803 the Spanish King Charles IV commissioned various works of civil engineering to dry the area, which until that time had been an ecosystem that served as a stopover site for migratory birds or usual place for species of birds such as herons, lapwings, ducks and plovers. In this study, both salterns were characterized regarding their geological and physical-chemical characteristics and their microbial biodiversity. A preliminary eukaryotic diversity survey was also performed using saline water. The chemical characterization of the brine has revealed that the saline groundwater extracted to fill these inland solar salterns is thalassohaline. Regarding to microbial diversity, members of the *Halobacteriaceae* and *Haloferacaceae* families can be easily detected in the microbial populations of these habitats. Those microorganisms are focusing attention worldwide due to their potential biotechnological applications. Possible origins of the haloarchaea detected in this study are also discussed. The recent appearance of bird populations as results of frequent rains during spring in 2020 and 2021 has been perceived as positive for bird populations in this area although they slightly negatively affect microbial blooms during spring. Even though the recovery of bird populations as well as the valuable richness of microbial diversity highlight the significant environmental value of these solar salterns. To protect and reinforce the environmental value of these ecosystems, some approaches based on ecology, restoration, land use planning etc. are discussed. Acknowledge: VIGROB-309 (University of Alicante)

Five key words: Flamingos, *Dunaliella*, Haloarchaea, Bird populations, Salt mining exploitation.

Email address for questions: [rosa.martinez@ua.es](mailto:rosa.martinez@ua.es)



## Origins of the Cretaceous evaporite deposits of the Lanping–Simao Basin, in Western China and the Khorat Plateau in Thailand and in Laos: Evidence from the stable isotopes of halite

Minghui Li<sup>1,2</sup>, Maodu Yan<sup>1,3</sup>, Shurui Sun<sup>1</sup>, Xiaomin Fang<sup>1,3</sup>, Zengjie Zhang<sup>4</sup>, Jiao Li<sup>1,2</sup>

*1. Institute of Tibetan Plateau Research, Chinese Academy of Sciences (CAS), Beijing 100085, China*

*2. Key Laboratory of Tibetan Environment Changes and Land Surface Processes, CAS, Beijing 100085, China*

*3. Key Laboratory of Continental Collision and Plateau Uplift, CAS, Beijing 100085, China*

*4. Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037*

*Institute of Tibetan Plateau Research, Chinese Academy of Sciences*

The Lanping-Simao Basin (LSB) is a Mesozoic-Cenozoic continental margin rift basin in western China. It formed during the opening and closing of the Tethys Ocean. This basin is also known as a “metal belt” as it hosts several metal deposits besides the potash deposit are found there. The main potash-forming stage in LSB has been described as the Mengye Formation, but it is very small scale compared with those in the adjacent basins in Khorat Basin (KB), Thailand and the Sakon Nakhon Basin (SNB), Laos. Due to the occurrence of similar salt minerals within the same tectonic belt and the same deposit era (Cretaceous), the Mengye potash deposit in the LSB should also be large and important. Surprisingly, in ~60 years of exploration, no large potash deposit has been discovered in the area, and no consensus has therefore been reached regarding the fluid origin of the LSB, or indeed that of the potash deposits in the SNB and KB. Almost all large potash deposits are associated with marine fluids (such as the deposits in the United States, Germany, Russia, France and Brazil), whereas some small potash deposits are originated from continentally-sourced fluids (such as deposits in the Qaidam Basin (QB), western Tibet, China). Based on the basins’ evolution, materials of marine origin and/or remnant seawater should be present, but instead the salt layers of the potash deposits in LSB, SNB and KB all present typically continental lithological features. Based on the same tectonic setting and the Cretaceous forming era, the origins of the marine, continental or mixed origins of the Mengye deposits, remain disputed. This study examines and reviews evaporative minerals, Br/Cl molar ratios, and isotopes of S, B, and Sr. The basin’s evaporative minerals are dominated by halite and sylvite. The amounts of anhydrite, chlorocalcite, langbeinite, glaserite, tachyhydrite and glauberite are small. All of these form in both marine and continental environments. All of the Br/Cl molar ratios are lower than those of seawater, and most of them are <0.1, suggesting continental or mixed origin. The  $\delta^{34}\text{S}$ ,  $\delta^{11}\text{B}$  and  $87\text{Sr}/86\text{Sr}$  values for evaporative minerals indicate a continental origin for the potash deposits in the LSB, however, the  $\delta^{11}\text{B}$  values indicate a marine origin in the SNB and KB. Some of the  $87\text{Sr}/86\text{Sr}$  values indicate a continental origin, and some indicate a marine origin. Materials of hydrothermal origin are widely distributed in the basin and may have played an active role for the formation of the potash deposit. Thus, the potash deposits in the basins of LSB, KB and SNB, could be of continental

origin, with a remnant seawater trace. Hydrothermal fluid could play an important role on the origins.

Five key words: Evaporate deposit, Stable isotopes, Halite

Email address for questions: [liminghui@itpcas.ac.cn](mailto:liminghui@itpcas.ac.cn)



## Enrichment patterns of the shallow brine in the Luobei depression of the Lop Nor salt lake, Xinjiang

Xu Han<sup>1</sup>, Fankai Zhang<sup>1</sup>, Boyun Li<sup>1</sup>, Yufei Deng<sup>1</sup>, Lingfen Wang<sup>1</sup>, Yongmei Yu<sup>2</sup>,  
Xuening Li<sup>2</sup>, Wenxue Li<sup>2</sup>

*1. Geology Institute of China Chemical Geology and Mine Bureau*

The Lop Nor potash ore is an inland salt lake potash deposit, which is a large to very large sulphate deposit with mainly liquid-phase, solid-liquid coexisting, and co-occurring sodium and magnesium salts. The ions in the subsurface brine of highly mineralized were often enriched to different degrees at different levels or sites. However, there are relatively few studies on some of the trace elements in the subsurface brine of different reservoirs. The present study focused on the enrichment patterns of Li<sup>+</sup>, B<sup>3+</sup>, Sr<sup>2+</sup> and other trace elements in shallow subsurface brines in the Luobei Depression, used multivariate statistical methods to analyze the correlation between the elements in subsurface brines, and used a combination of self-organising neural network (SOM) and K-means (KM) clustering algorithm to study the spatial variability of shallow subsurface brines, and draw the following conclusions. According to the results of the statistical analysis, the major cations in the shallow subsurface brine were Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup>, with little Ca<sup>2+</sup> and the main anions were Cl<sup>-</sup> and SO<sub>4</sub><sup>2-</sup>, with small amounts of HCO<sub>3</sub><sup>-</sup>, trace amounts of NO<sub>3</sub><sup>-</sup> and almost no CO<sub>3</sub><sup>2-</sup>. The trace elements were higher in B<sup>3+</sup>, followed by Li<sup>+</sup> and Br<sup>-</sup>, and lower in Rb<sup>+</sup>, Sr<sup>2+</sup>, Cs<sup>+</sup>, and I<sup>-</sup>. And the water chemistry types of the brine were sulphate type and magnesium sulphate subtypes. It was found that the major constituents in the shallow subsurface brine showed obvious spatial characteristics, among which K<sup>+</sup> and Cl<sup>-</sup> were more consistently distributed and gradually enriched mainly in the southwestern part of the Luobei Depression. The spatial distribution of Mg<sup>2+</sup> and SO<sub>4</sub><sup>2-</sup> showed the opposite trends to that of K<sup>+</sup> and Cl<sup>-</sup>. They were enriched mainly in the eastern and central parts of the Luobei Depression, which may be related to the different sources of ionic components and the differences in salt crystallization precipitation in different parts of the salt lake during its evolution. The spatial distribution of the trace components B<sup>3+</sup> and Br<sup>-</sup> in the submerged brine were in good agreement with that of Li<sup>+</sup>, which were high in the east and low in the west. The spatial distribution pattern of Sr<sup>2+</sup> presented high in the west and low in the east, which was opposite to Li<sup>+</sup>, B<sup>3+</sup> and Br<sup>-</sup>. Combining the results of SOM-KM clustering and correlation analysis, the chemical components of phreatic brine in the study area could be roughly divided into three groups. The first group contained Mg<sup>2+</sup>, SO<sub>4</sub><sup>2-</sup>, Li<sup>+</sup>, B<sup>3+</sup>, and Br<sup>-</sup>, whose correlation coefficient were greater than 0.80. The second group contained Ca<sup>2+</sup>, Na<sup>+</sup> and Sr<sup>2+</sup>, whose correlation coefficient were greater than 0.75. The third group contained K<sup>+</sup>, Cl<sup>-</sup>, HCO<sub>3</sub><sup>-</sup> and I<sup>-</sup>, whose correlation coefficients were less than 0.30. Similar to phreatic water, the chemical components of confined brine could also be divided into three groups, but their degree of similarity is lower than that of phreatic brine. The phreatic and confined water samples can be clustered into four categories. A analysis study found that the central and eastern parts of the Luobei Depression near the boundary of the Tenglong Terrace were mainly enriched in Mg<sup>2+</sup>, SO<sub>4</sub><sup>2-</sup>, Li<sup>+</sup>, B<sup>3+</sup> and Br<sup>-</sup>. The groundwater in the Tenglong Terrace was enriched with high concentration of SO<sub>4</sub><sup>2-</sup>, and the eastern part of the Luobei Depression was recharged by the SO<sub>4</sub><sup>2-</sup>-rich groundwater of the Tenglong Terrace. The constant enrichment of Mg<sup>2+</sup> along the water flow path and the constant precipitation of Na<sup>+</sup> explain the gradual change of the subsurface brine from the sodium sulphate subtype to the magnesium sulphate subtype. In addition, Li<sup>+</sup>, B<sup>3+</sup> and Mg<sup>2+</sup> had significantly correlation, indicating these ions may have the same origin. The north and south sides of the Luobei Depression and the western side near the

boundary of the Xinqing Terrace were mainly enriched in  $\text{Cl}^-$ ,  $\text{Ca}^{2+}$  and  $\text{Sr}^{2+}$ . While the north of the study area were easily recharged by fissure water in bedrock mountainous areas, resulting in the decrease of brine salinity, the decrease of Glauberite and the increase of  $\text{Ca}^{2+}$ . And  $\text{Ca}^{2+}$  and  $\text{Sr}^{2+}$  were the same main group elements, and their chemical properties are similar, which may have the same source.

Five key words: Lop Nur, SOM-KM, Hydrochemical composition, Spatial characteristics

Email address for questions: 1962185993@qq.com





Poster session (2): Chemistry/Chemical properties\_050

## Thermodynamic modeling and phase diagram prediction of chloride type and sulfate type salt-lake brine systems

*(Preliminary version)*

Qing Hao, Huan Zhou, Si Wu, Meng li Zhang, Pan Ping Xia

*College of Chemical Engineering & Materials Science, Tianjin University of Science & Technology, China*

The salt lakes in the Qinghai-Tibet plateau can be simplified as three types: Chloride, Sulfate and Carbonate, of which the intercrystalline brine stored in Qaidam salt flats include Chloride type of  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ //  $\text{Cl}^-$ - $\text{H}_2\text{O}$  and Sulfate type of  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ //  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ - $\text{H}_2\text{O}$  hexnary systems. Potassium, lithium or magnesium recover from these brines need the knowledge of phase equilibrium under nature conditions and also the tools for accurate expression and prediction of the dynamic behaviors of phase equilibrium. In order to realize the prediction of multi temperature phase equilibrium of complex system, the eNRTL theory was used in consider of the benefit of the interaction parameters can be expressed as Gibbs-Helmholtz equation, which result in liquid parameters (A, B, C) take the respective physical meaning of Gibbs energy increment  $\Delta G$ , enthalpy of formation increment  $\Delta H$  and heat capacity increment  $\Delta C_p$ . On this foundation, the model were further improved in the aspects: (1) the chemical contribution is added to consider the influence of associated structure; (2) the symmetrical reference state were redefined and new expression of activity coefficient for the long-range electrostatic interaction was proposed, which enhance the model capable of expressing high concentration system; (3) the comprehensive optimization scheme to determine the species parameters and liquid parameters are employed to cover the entire temperature region. Results for the two hexnary systems, the liquid parameters for 9 salt-water pairs and 20 salt-salt pairs, solid parameters of 88 species and 7 association structures were determined. The full temperature phase diagrams of 9 binary, all the isotherm diagram for 20 ternary systems were accurately expressed, the full structure diagram of 20 ternary, 15 quaternary covering the temperature region from  $-85^\circ\text{C}$  to  $200^\circ\text{C}$  are satisfactorily predicted, and the accurate prediction of phase equilibrium dynamics in production process under nature condition is expected.

Five key words: Salt-lake Brine, Phase diagram, Electrolyte NRTL Model, Hexnary system

Email address for questions: [zhouhuan@tust.edu.cn](mailto:zhouhuan@tust.edu.cn)



## Directional separation of solid waste in salt lakes

(Preliminary version)

Huaigang Cheng, Jingyi Yang, Aniu Qian, Fangbin Xue, Enze Li, Fangqin Cheng\*

*Shanxi University, Institute of Resources and Environmental Engineering, Shanxi University, Taiyuan, China*

The separation between magnesium and lithium is seriously hindered by the high Mg/Li ratio in some of the magnesium sulfate subtype brines. In this work, the simulated brine with a Mg/Li ratio of 40 was prepared and used ammonia and carbon dioxide as precipitating agents for separation of magnesium and lithium. At the same time, the effects of ammonia concentration and carbon dioxide flow rate on the separation effect of magnesium and lithium were investigated. According to the precipitation characteristics of  $Mg^{2+}$  and  $Li^+$  in ammonia or carbon dioxide aqueous solution, the precipitation process was divided into two stages. In the first stage,  $Mg(OH)_2$  was obtained by filtering the reaction precipitation of  $Mg^{2+}$  and ammonia. In the second stage, carbon dioxide gas was introduced into the filtrate obtained in the previous stage for carbonation reaction.  $Li_2CO_3$  crystal was obtained after the mother liquor was evaporated at a constant temperature of 60°C for 3 h. The results indicated that when the mass fraction of ammonia was 15%, the carbon dioxide flow rate was 67.5 mL/(min·L brine), the  $Mg^{2+}$  precipitation ratio was 99.8%, the lithium ion adsorption loss rate was less than 2% and the purity of  $Li_2CO_3$  crystals was greater than 99%. The results were beneficial for the separation of magnesium and lithium from some of the magnesium sulfate subtype brines.

Five key words: Lithium, Magnesium, Salt lake, Brine, Precipitation

Email address for questions: [chenghg@sxu.edu.cn](mailto:chenghg@sxu.edu.cn) and [cfangqin@sxu.edu.cn](mailto:cfangqin@sxu.edu.cn)

## Selective recovery of strontium from oilfield water by ion-imprinted alginate microspheres modified with thioglycolic acid

Can Liu<sup>1</sup>, Xiaoping Yu<sup>1</sup>, Chi Ma<sup>2</sup>, Yafei Guo<sup>1</sup>, Tianlong Deng<sup>1</sup>

*1. College of Chemical Engineering and Materials Science, Tianjin University of Science and Technology, Tianjin 300457, P. R. China*

*2. College of Marine and Environmental Sciences, Tianjin Key Laboratory of Marine Resources and Chemistry, Tianjin 300457, P. R. China*

The efficient recovery of  $\text{Sr}^{2+}$  from brine is a great challenge due to the interference of a large number of coexisting ions. Herein, a new-type spherical  $\text{Sr}^{2+}$  adsorbent with a diameter of about 2-3 mm was developed by the ion-imprinting method using low-cost and high hydrophilic sodium alginate (SA). It was found that although SA could be granulated in HCl solution, it showed no adsorption ability for  $\text{Sr}^{2+}$ . However, when SA was ion-imprinted with  $\text{Sr}^{2+}$  and then eluted with HCl, the material exhibited excellent adsorption performance. Especially, after modification with thioglycolic acid, the maximum adsorption capacity reached approximately  $177 \text{ mg} \cdot \text{g}^{-1}$ , which was far higher than that of the spherical materials reported at present. The  $\text{Sr}^{2+}$  in the material could be eluted easily with  $0.05 \text{ mol} \cdot \text{L}^{-1}$  HCl at an eluent dosage of only  $0.02 \text{ L} \cdot \text{g}^{-1}$ , and the  $\text{Sr}^{2+}$  concentration in the eluate was nearly 25 times higher than that in the original solution. Because of the ion-sieve effect, the developed adsorbent presented high stability and selectivity when used for  $\text{Sr}^{2+}$  recovery from oilfield water. The attenuation of adsorption capacity was only 0.42% after five adsorption-desorption. The separation factors between  $\text{Sr}^{2+}$  and other ions were all higher than 54, indicating that the selective recovery of  $\text{Sr}^{2+}$  is almost unaffected by coexisting  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ , and  $\text{Ca}^{2+}$ . All these properties suggest that the proposed material has excellent properties and can be used as a candidate for selective recovery of  $\text{Sr}^{2+}$  from oilfield water or other liquid strontium resources.

Five key words: Strontium, Adsorption, Oilfield water, Ion-imprinting, Alginate

Email address for questions: yuxiaoping@tust.edu.cn and tldeng@tust.edu.cn

## Salt Lake Research and Salt Chemical Analysis

WU Qian, ZHENG Mian-ping, BU Ling-zhong, YU Jiang-jiang

*MNR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China*

Salt Lake is not only an important source of a variety of inorganic chemicals, which is rich in valuable inorganic salt resources, but also an information repository of nature and a natural laboratory. It is a sensitive indicator of ancient and modern, and also is an important research object which will be used in the restoration of paleoclimate, paleo-environment and geological structure events, with predicting the future global changes. Salt chemistry analysis is the "eye" of salt lake research work, which can provide an important basis for the mineral exploration, prospecting, mineral reserve calculation and comprehensive utilization of salt lake. At present, a single chemical analysis has been developed to a modern geochemical test and analysis technology with a variety of advanced instruments, and the precision and accuracy of salt chemical analysis and test results is being improved to achieve high efficiency, high speed and high sensitivity. The aim is to establish and improve the method systems of salt lake research and salt chemical analysis technology, making the greater contribution for the geological prospecting work. This paper summarized the status of salt lake and related research in China, and analyzed the relationship between the salt lake research and the salt chemical analysis, in order to promote the mutual promotion and development of salt lake research work and salt chemical analysis technology.

Five key words: Salt lake, Salt lake research, Salt chemical analysis, Qinghai-Tibet Plateau, Aalt deposition

Email address for questions: wuqian0516@163.com



Poster session (2): Chemistry/Chemical properties\_105

## Refining study of Dalangtan deep brine by freezing and solarization in Qaidam basin

Wu zhiming, Wang gang, Nie zhen, Wang yunsheng, Zheng mianping

*Key Laboratory of Resource Chemistry and Eco-environmental Protection in Qinghai-Tibet Plateau, State Ethnic Affairs Commission, Qinghai Minzu University, Xining 810007, China*

*MNR Key Laboratory of Saline Lake Resources and Environments, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China*

In order to ensure the sustainable production of potash fertilizer in Qinghai Qarhan Salt Lake, China, it is necessary to find a reserve base of potash resources in Qinghai Province. There is abundant deep potassium-rich brine in the western Qaidam area of Qinghai Province, which is expected to be the reserve base of potassium fertilizer for Qarhan Salt Lake. Dalangtan deep brine is a representative of low grade potassium ore. The potassium chloride grade of the brine is around the boundary grade, so its availability needs to be evaluated. The brine of Liang M well was studied in this paper, which has a potassium content close to the boundary grade and is difficult to be refined with a Na/K ratio of 55, more than twice as high as the seawater Na/K value. In view of the unique natural conditions in the west of Qaidam Basin, field refining experiments were carried out with freezing and solarization method. NaCl·2H<sub>2</sub>O was precipitated by freezing, and part of sodium chloride and water could be crystalized simultaneously. Furthermore, the brine was treated by evaporation under sun. After that the Na/K value of the brine can be reduced to less than 12 which can meet the raw material requirements for potash fertilizer production.

Five key words: Potassium-rich brine, Sustainable production, NaCl·2H<sub>2</sub>O, Freezing, Solarization

Email address for questions: [nieezhen518@163.com](mailto:nieezhen518@163.com)



## Solvent Thermal Synthesis of high-Performance Copper Hexacyanoferrate for Cs<sup>+</sup> Removal from the Salt Lake

Chi Ma<sup>1</sup>, Zhenzhen Jiang<sup>2</sup>, Senjian Han<sup>1</sup>, Tianlong Deng<sup>1</sup>, Yafei Guo<sup>1</sup>

*1. Tianjin Key Laboratory of Brine Chemical Engineering and Resource Eco-utilization, College of Chemical Engineering and Materials Science, Tianjin University of Science and Technology, Tianjin 300457, PR China*

*2. Central Laboratory of Tibet Autonomous Region Bureau of Geological & Mineral Resources, Lasa, 850033, P.R.China*

Cesium and its compounds has a wide range of applications in national defense, aerospace, catalysis, energy and other high-tech fields due to its active chemical properties and excellent photoelectric properties. A number of salt lakes with an abundance of cesium resources are widely distributed in the western regions of China, in particular, in Xinjian, Xizang and Qinghai provinces. Although the salt lake brine contains considerable cesium resources, its solution composition is extremely complex, and cesium is easy to coexist with sodium, potassium, rubidium and other elements with similar physicochemical properties. What's more, the elements of sodium and potassium are the main components of the salt lake brine and the contents of which are far higher than the content of cesium. These are the problems to be faced in the efficient separation and extraction of cesium the further processing of cesium products. Therefore, it is necessary to provide the novel methods for more effective and efficient separation and extraction for salt lake resources.

In this study, a novel solvent-thermal method was used to synthesize CuHCF (s-CuHCF). Compared with the precipitation method (p-CuHCF) and hydrothermal method (h-CuHCF), the s-CuHCF has a particularly large specific surface area, which leads to its relatively large adsorption capacity for cesium ions. The CuHCF synthesized by this method has the best adsorption effect among Prussian blue analogues known to reported. Moreover, the s-CuHCF with porous structure and excellent stability has the highest adsorption capacity towards Cs<sup>+</sup>, 452.49 mg/g. Batch adsorption experiments indicate s-CuHCF could effectively adsorb Cs<sup>+</sup> at a wide pH range and low Cs<sup>+</sup> concentration within 15 minutes. Furthermore, s-CuHCF can adsorb Cs<sup>+</sup> with a high removal rate of 92.1% in the salt lake brine, showing a favorable selectivity. Adsorption kinetics and isotherm studies unveil the Pseudo-second-order model and Langmuir isotherm model in Cs<sup>+</sup> adsorption. The results show that s-CuHCF synthesized by the solvent-thermal method is a kind of adsorbent with broad application prospects for cesium removal from the salt lake brine.

Five key words: Solvent-thermal synthesis, s-CuHCF, Cesium ions, Adsorption

Email Address for questions: [senjhan@tust.edu.cn](mailto:senjhan@tust.edu.cn) and [guoyafei@tust.edu.cn](mailto:guoyafei@tust.edu.cn)



## Volume Properties for the Aqueous Solution of Yttrium Trichloride at Temperatures from 283.15 to 363.15 K and Ambient Pressure

Zhenzhen Jiang<sup>1,2</sup>, Chi Ma<sup>1</sup>, Gaoling Liu<sup>2</sup>, Kangrui Sun<sup>1</sup>, Mingli Li<sup>2</sup>, Yafei Guo<sup>1</sup>,  
Lingzong Meng<sup>3</sup>, Tianlong Deng<sup>1</sup>

1. *Tianjin Key Laboratory of Brine Chemical Engineering and Resource Eco-utilization, College of Chemical Engineering and Materials Science, Tianjin University of Science and Technology, Tianjin 300457, PR China*

2. *Central Laboratory of Geological Mineral Exploration and Development Bureau of Tibet Autonomous Region, Tibet 850033, PR China*

3. *School of Chemistry and Chemical Engineering, Linyi University, Linyi 27600, PR China*

Rare earth elements (REEs) are vital ingredients of modern technologies, especially in energy, environmental protection, digital technology, the nuclear industry, and medical applications. REEs are also an integral part of electronic devices serving as magnets, catalysts, and superconductors, owing to their chemical, catalytic, electrical, magnetic, and optical properties [1–3]. It is well known that thermodynamic properties like solubilities of phase equilibria and apparent molar volumes at wide temperatures are essential to explore novel methods for more effective and efficient extraction of yttrium and can provide information about the ion interactions [4, 5]. Consequently, studying the thermodynamic properties and constructing a thermodynamics model at multi-temperature for the binary system ( $\text{YCl}_3 + \text{H}_2\text{O}$ ) is of great importance. In order to effectively develop the rare earth elements resources from the salt lake resources, it is essential to understand the volumetric properties of the aqueous solution system to establish the relative thermodynamic model. In this paper, densities of  $\text{YCl}_3(\text{aq})$  at the molalities of (0.08837 to 1.60639)  $\text{mol kg}^{-1}$  from 283.15 K to 363.15 K at 5 K intervals and ambient pressure were measured experimentally by an Anton Paar Digital vibrating-tube densimeter. Based on experimental data, the volumetric properties, including apparent molar volume ( $V_\phi$ ) and the coefficient of thermal expansion of the solution ( $\alpha$ ) of the binary systems ( $\text{YCl}_3 + \text{H}_2\text{O}$ ) were derived. The 3D diagram ( $m_i$ ,  $T$ ,  $V_\phi$ ) of apparent molar volumes against temperature and molality was plotted. On the basis of the Pitzer ion-interaction model of electrolyte, the Pitzer single-salt parameters ( $\beta_{\text{MX}}^{(0)v}$ ,  $\beta_{\text{MX}}^{(1)v}$  and  $C_{\text{MX}}^v$ ) for  $\text{YCl}_3$  and temperature-dependence equation  $F(i, p, T) = a_1 + a_2 \ln(T/298.15) + a_3(T-298.15) + a_4/(620-T) + a_5(T-227)$  as well as their coefficients  $a_i$  ( $i = 1$  to 5) in the binary system were obtained for the first time. The values of the Pitzer single-salt parameters of  $\text{YCl}_3$  agree well with the calculated values corresponding to the temperature-dependence equations, indicating that the single salt parameters and the temperature-dependent formula obtained in this work are reliable.

Five key words: Yttrium trichloride, Apparent molar volume, Pitzer model, ion-interaction

Email address for questions: tldeng@tust.edu.cn

## Abundant and novel taxa in the microbial community of soda-saline lakes in Inner Mongolia

(Preliminary version)

Dahe Zhao, Shengjie Zhang, Qiong Xue, Heng Zhou, Jian Zhou, Hua Xiang

State Key Laboratory of Microbial Resources, Institute of Microbiology, Chinese Academy of Sciences, Beijing, China

Soda-saline lakes are a special type of inland alkaline lake in which the chloride concentration is greater than the carbonate/bicarbonate concentration. Here, we reported the main findings on the microbiology in this double-extreme environment. 1) We systematically investigated the microbiome of the brine and sediment samples of nine artificially separated ponds (salinities from 5.5% to saturation) within two soda-saline lakes in Inner Mongolia of China, assisted by deep metagenomic sequencing. The main inorganic ions shaped the microbial community in both the brines and sediments, and the chloride concentration exhibited the most significant effect. A total of 385 metagenome-assembled genomes (MAGs) were generated, in which 38 MAGs were revealed as the abundant species in at least one of the eighteen different samples. Interestingly, these abundant species also represented the most branches of the microbiome of the soda-saline lakes at the phylum level. These abundant taxa were close relatives of microorganisms from classic soda lakes and neutral saline environments, but forming a combination of both habitats. Notably, approximately half of the abundant MAGs had the potential to drive dissimilatory sulfur cycling. These MAGs included four autotrophic *Ectothiorhodospiraceae* MAGs, one *Cyanobacteria* MAG and nine heterotrophic MAGs with the potential to oxidize sulfur, as well as four abundant MAGs containing genes for elemental sulfur respiration. The possible reason is that reductive sulfur compounds could provide additional energy for the related species, and reductions of oxidative sulfur compounds are more prone to occur under alkaline conditions which support the sulfur cycling. In addition, a unique 1,4- $\alpha$ -glucan phosphorylation pathway, but not a normal hydrolysis one, was found in the abundant *Candidatus* Nanohaloarchaeota MAG NHA-1, which would produce more energy in polysaccharide degradation. This work was published in *Front Microbiol* (2020). Besides, a novel candidate order of phylum *Thermoplasmata* was characterized in the terms of systematics, adaptation, metabolism and evolution (Unpublished data). 2) We performed the large-scale microbial isolation by using 25 media from 141 samples in the same regions. More than 1300 pure isolates were isolated. An abundant heterotroph IM2438 was included which was the representative of MAG GPB-6. The multiple adaptive strategies of this isolate were elucidated (Unpublished data). In addition, several novel taxa were identified and described, such as *Salinadaptatus halalkaliphilus* (*IJSEM*, 2021) and *Natronorubrum halalkaliphilum* (*Arch Microbiol*, 2021). In summary, the research on abundant and novel taxa would shed light on the microbial adaptation into the saline and alkaline environments and help for the development of microbial resource in the soda-saline lakes.

Five key words: Soda-saline lake, Microbiome, Environmental adaptation, Microbial resource, Carbon and sulfur metabolism

Email address for questions: zhaodh@im.ac.cn



## Bioprospecting on antimicrobial activity and diversity of soil-derived actinobacteria from different depth in one site of Lake Gudzhirganskoe in Siberia

*(Preliminary version)*

Qin Yang<sup>1</sup>, Puyu Guo<sup>1, 2</sup>, Elena Abidueva<sup>3</sup>, Di Liu<sup>2</sup>, Irina M. Lisevich<sup>4</sup>, Ilya A. Osterman<sup>4, 5</sup>, Petr V. Sergiev<sup>4, 5</sup>, Olga A. Dontsova<sup>4, 5, 6</sup>, Hanwen Zhang<sup>7</sup>, Xiaojing Zhou<sup>7</sup>, Qinpei Lu<sup>1</sup>, Shaowei Liu<sup>1, 8</sup>, Feina Li<sup>1</sup>, Xiaojun Li<sup>9</sup>, Xinxin Hu<sup>8</sup>, Xuefu You<sup>8</sup>, Chunmei Xue<sup>2</sup> and Chenghang Sun<sup>1, 8</sup>

1. *Department of Microbial Chemistry, Institute of Medicinal Biotechnology, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China*

2. *College of Life Sciences, Jiamusi University, Jiamusi, China*

3. *Institute of General and Experimental Biology, Siberian Branch, Russian Academy of Sciences, Ulan-Ude, Russia*

4. *Center of Life Sciences, Skolkovo Institute of Science and Technology, Moscow, Russia*

5. *Department of Chemistry, A.N. Belozersky Institute of Physico-Chemical Biology, Lomonosov Moscow State University, Moscow, Russia*

6. *Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry, Russian Academy of Sciences, Moscow, Russia*

7. *College of Life Science and Technology, China Pharmaceutical University, Nanjing, China*

8. *Beijing Key Laboratory of Antimicrobial Agents, Institute of Medicinal Biotechnology, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China*

9. *College of Lab Medicine, Hebei North University, Zhangjiakou, China*

For exploring the pharmaceutical actinobacteria from salty environments, 8 soil samples were collected from different depths in one site of Lake Gudzhirganskoe in Siberia. Totally, 635 actinobacterial strains, affiliated to 21 genera in 12 families of 7 orders, were obtained by culture-dependent approaches. The predominant genus was *Streptomyces* (74.5%), followed by *Microbacterium* (4.9%), *Agromyces* (3.5%), *Nocardiosis* (3.0%) and *Kitasatospora* (2.5%). Nine strains showed relatively low 16S rRNA similarities (< 98.65%) with validly described species. Seventy-seven strains were selected to evaluate their antimicrobial activities and mechanisms by paper-disk diffusion method and a double fluorescent protein reporter system (pDualrep2), respectively. Among them, 21 strains affiliated to 6 genera (*Streptomyces*, *Microbacterium*, *Kitasatospora*, *Nocardia*, *Curtobacterium* and *Mycolicibacterium*) showed inhibitory activity against at least one of the tested “ESKAPE” pathogens and two fungal strains. Strain S6b3-1 can produce bioactive metabolites to induce SOS-response in the pDualrep2 system. Fourteen out of 21 strains had antimicrobial activity against at least one of Gram-positive bacteria and 3 strains had antimicrobial activity against at least one of Gram-negative bacteria. Meanwhile,

11 of 21 strains exhibited inhibitory activity against at least one fungus. Notably, *Streptomyces* sp. S6b3-1 was highlighted due to its strong inhibitory activities against Gram-positive bacteria and antibacterial mechanism by inducing SOS response in the reporter system. Bioassay guided separation of culture broth of strain S6b3-1 resulted in isolation and identification of one known analogue of saphenamycin (LG-1). LG-1, (R)-6-[1-(benzoyloxy) ethyl]-phenazine-1-carboxylic acid, was discovered from *Streptomyces* strain for the first time. In conclusion, the study explored preliminarily on actinobacterial diversity and capacity to produce antibiotics from the Lake, which revealed that it deserves to make more efforts for discovery of new actinobacterial species and potential new antibiotics from the salty lake in Siberia.

Five key words: Lake Gudzhirganskoe, Actinobacteria, Diversity, Antimicrobial activities, Phenazine antibiotic

Email address for questions: [sunchenghang@imb.pumc.edu.cn](mailto:sunchenghang@imb.pumc.edu.cn)



## Potential biotechnological uses of microbes inhabiting Pink Lagoon, Torrevieja, Alicante

Rosa María Martínez-Espinosa and Guillermo Martínez-Martínez

*University of Alicante.*

Natural Park named “Lagunas de La Mata y Torrevieja” is in Torrevieja, Southeast of Spain. It is a nice salty ecosystem constituted by two main lagoons, in which one of them (Pink Lagoon of Torrevieja) shows pink-orange color most of the seasons, becoming even red in summer. These two lakes are well known from a European mining point of view, as they are being exploited for the extraction of salt (NaCl). In fact, this salt mine is capable of producing up to 800,000 tons of salt per year. Most of this salt is intended for food use but it also has other applications such as encouraging the thawing of roads or making chemical components (cosmetics formulation for instance). The beautiful colors shown by the lakes are mainly due to the pigments produced by microbes inhabiting the water body. Among these microbial populations, halophilic bacteria and archaea members constituted the predominant populations. Although Pink Lagoon is under exploitation for decades, accurate studies about physical-chemical properties of the water and sediments, as well as characterizations of the microbial population are still scarce. In this work, preliminary data about microorganisms identified are shown (*Dunaliella*, the small eukaryotic shrimp *Artemia salina* and halophilic bacteria and archaea). Discussion about the potential biotechnological uses of the microorganisms predominating in Pink Lagoon are discussed. Among the biotechnological applications, two main approaches reveal as promising: i) the use of the whole cells for the design of bioremediation processes and ii) the uses of molecules synthesized by the microbes as part of formulations in pharmacy or cosmetics (pigments, enzymes, antibiotics) or as replacement of compounds which are not environmentally friendly (biodegradable plastics produced by some microorganism could replace plastics of chemical synthesis which are strongly recalcitrant). Acknowledgements: VIGROB-309 (University of Alicante), Torrevieja Council.

Five key words: Halophilic microorganisms, Carotenoids, Enzymes, Bioplastics, Antibiotics, Bacteriorhodopsin.

Email address for questions: [rosa.martinez@ua.es](mailto:rosa.martinez@ua.es)





## Some features of the biotopic diversity features of microbial communities of the meromictic soda Lake Doroninskoye (Zabaikalie, Russia)

Evgeniya Matyugina<sup>1</sup>, Natalia Belkova<sup>2</sup>

*1. Institute of Natural Resources, Ecology, and Cryology; Siberian Branch of RAS, Chita, Russia 16A Nedorezov Street, 672014*

*2. Scientific Centre for Family Health and Human Reproduction Problems, Irkutsk,*

Lakes represent an integrated limnic system, where the spatial distribution of bacteria is determined by the diversity of ecological niches and biotopes, whereas their variability diverse in space and time. Extreme and stratified conditions in meromictic soda lakes place certain specificities on the distribution and functioning of microbial communities. The complication and/or modification of this specificity are commonly associated with the geographic zoning of the lakes. Meromictic soda Lake Doroninskoye is located in a sharply continental climate, in the zone of permafrost, and is under a thick ice cover for more than 6 months a year. The lake has an alkaline pH, a relatively high salinity of water and bottom sediments (up to 35.0 g / L), a low level of chemocline illumination (0.001%), and has a rare type of alkaline waters formed under conditions of evaporative concentration of sedimentary rocks. Modern molecular and statistical research methods have made it possible to reveal some features of the biotopic diversity of microbial communities of the lake in space and time. Investigations during the ice period revealed the presence of specific biotopes for microbial communities under the thick ice cover of the lake. Thus, in January, in the surface (0-0.15 m) oxygenic mixolimnion, Microbacteriaceae (class Actinomycetia, phylum Actinobacteria) were dominant bacteria. It is interesting to note that representatives of the Microbacteriaceae have an additional energy metabolism - actinorhodopsin photosynthesis, while the main one is respiratory metabolism due to the use of organic substances. Investigations during the ice period in March established that anoxygenic phototrophs - non-sulfuric purple bacteria of Rhodospirillaceae and Rhodobacteraceae of the class Alphaproteobacteria were dominant. They are capable, optionally, along with photosynthesis, of various variants of chemotrophic metabolism. Among the minor part of the microbial community of the chemocline, chemotrophic bacteria were detected with a maximum in the oxygenic layer during this period, in which functional genes are reliably known that are responsible for the essential stages of anoxygenic photosynthesis - the gene of the key enzyme of the Calvin cycle (RuBisCo). These are bacteria - autotrophs and mixotrophs of the genera Bradyrhizobium, Paracoccus, Rhodobacter (Alphaproteobacteria), heterotrophs of the Oceanospirillaceae (Gammaproteobacteria); Burkholderiaceae (Betaproteobacteria). A study of the short-term (day-night) variability of microbial communities in the open period in September showed a clear biotopic spatial differentiation and high heterogeneity of daytime microbial communities than nighttime ones grouped closer to each other. NMDS analysis showed that bacterial communities in different water biotopes were reliably correlated with depth, salinity, oxygen, and Eh. In addition, some bacterial communities were closely associated with specific environmental variables. Thus, the nighttime microbial community of the upper oxygenic mixolimnion (2.5 m) is associated with Eh and oxygen. In comparison, the daytime microbial community of the sulfide layer (4.5 m) is associated with salinity and depth. Exceptions were found for nighttime microbial communities of the oxygenic layer from 2.5 to 3.15 m and daytime microbial communities from 2.5 to 6.0 m: they showed weak correlation, clear differentiation, and high spatial heterogeneity. Rarefaction analysis of bacterial diversity in the night and



daytime, represented by the rarefaction curves, showed that the daytime samples had the maximum OTUs than the nighttime ones. In this case, the maximum values were observed for the chemocline. At night in the upper oxygenic zone, the composition of the microbial community was higher than in other biotopes due to rare phylotypes. Thus, analysis of the diversity of microbial communities of the lake indicates a high spatial and temporal heterogeneity of the lake biotopes.

Five key words: Biotopic diversity, Microorganism, Community, Meromictic soda lake, Geographic zoning

Email address for questions: [evgenia48@mail.ru](mailto:evgenia48@mail.ru)



## The role of cyanobacteria in nitrogen fixation of phototrophic communities in the Kulunda Steppe soda lakes (Altai Region, Russia)

Samylina O. S.<sup>1</sup>, Namsaraev Z. B.<sup>2</sup>, Tourova T. P.<sup>1</sup>, Sorokin D. Y.<sup>1,3</sup>

1. *Winogradsky Institute of Microbiology, Research Center of Biotechnology, Russian Academy of Sciences, Moscow, Russia*

2. *NRC "Kurchatov Institute", Moscow, Russia*

3. *Department of Biotechnology, Delft University of Technology, Delft, Netherlands*

Soda lakes are among the most productive ecosystems on Earth and nitrogen availability is one of the important factors influencing primary production. Shallow soda lakes of the Kulunda Steppe (Altai Region, Russia) represent a spectacular example of double-extreme habitats where high total mineralization is combined with stable alkaline pH values. Moreover, these lakes are characterized by a variable hydrological regime with high-amplitude seasonal and long-term fluctuations of total mineralization. Microbial nitrogen fixation (NF) there is still not well understood. A composition of phototrophic communities and their NF was studied in these lakes during several summer seasons (2008-2016) which allowed us to cover a wide range of salinity (from 25 to 400 g/l). The *nifH* genes belonging to representatives of cyanobacterial genera *Nodularia*, *Nodosilinea*, *Sodalinema* (former 'marine Geitlerinema') and *Euhalothece*, and purple sulfur bacteria *Ectothiorhodospira* were detected in environmental samples at different salinities. The most common phototrophic communities distributed in the studied soda lakes were algal-bacterial communities with the filamentous chlorophyte *Ctenocladus circinnatus*, or a dense ephemeral cyanobacterial biofilms, or the most extreme-tolerant endoevaporitic communities. According to the presence of the potentially diazotrophic phototrophs several types of phototrophic communities were distinguished in the studied lakes: 1. "Heterocystous" communities with *Nodularia* spp. were common in the brines within the salinity range 25-60 g/l; 2. "Non-heterocystous" communities with *Nodosilinea* sp. and *Sodalinema* sp. were present in the range of salinity from 65 to 200 g/l; 3. Algal *C. circinnatus* communities without visible phototrophic diazotrophs were found at the salinities 65 and 85 g/l; 4. Endoevaporitic algal-bacterial communities with green unicellular algae *Dunaliella* sp., unicellular cyanobacteria *Euhalothece* sp. and purple sulfur bacteria *Ectothiorhodospira* sp. developed between the trona crystals at salinities 350-400 g/l. It was found that the phototrophic communities in the Kulunda Steppe soda lakes exhibit NF in a wide range of salinity from 25 to 400 g/l, but its rates significantly decrease at 100 g/l. Salinity was the major factor affecting the composition and NF of the phototrophic communities. "Heterocystous" communities exhibited comparable light and dark NF. "Non-heterocystous" communities exhibited only light NF in a range 55–100 g/l. At 160–210 g/l the phototrophic diazotrophs became less active than chemotrophic in the "non-heterocystous" communities, and the dark NF was a prevailing process if communities didn't contain unicellular cyanobacterium *Euhalothece* sp. At salt-saturating range 350-400 g/l, light NF associated with the communities dominated by extremely halotolerant *Euhalothece* sp. was detected again. The analysis of the genomes of *Sodalinema* sp. P-1104, *Nodosilinea* sp. P-1105 and *Euhalothece* sp. Z-M001 was conducted for determining the structure of their *nif* clusters. The organization of the *nif* cluster was found to be identical in *Nodosilinea* sp. P-1105 and *Euhalothece* sp. Z-M001. It completely corresponded to the structure of a typical cyanobacterial *nif* cluster. It contained auxiliary genes *nifB-fdxN-nifSU* and *nifENXW*, flanking the nitrogenase operon *nifHDK*. On the contrary, the structure of the *nif* cluster in *Sodalinema* sp.

P-1104 was largely similar to typical *nif* cluster of sulfate-reducing Deltaproteobacteria (“desulfo” type). *NifHDK* operon of *Sodalinema* sp. P-1104 contained additional regulatory genes P-II and P-II’, as well as flanking *nifENB* genes involved in the biosynthesis of Fe-Mo cofactors in Deltaproteobacteria, instead of *nifENXW* genes in cyanobacteria. This work was supported by the RFBR grant 19-04-00377 and Ministry of Science and Higher Education of the Russian Federation.

Five key words: Soda lakes, Nitrogen fixation, Phototrophic communities, Cyanobacteria, Extremophiles

Email address for questions: [olga.samykina@gmail.com](mailto:olga.samykina@gmail.com)



## Microbial and Planktonic Biodiversity in Tibetan Salt lakes

Gao Meirong<sup>1</sup>, Han Xuekai<sup>1</sup>, Ma Yingchao<sup>1</sup>, Duan Hu<sup>1</sup>, Wang Zhenqian<sup>1</sup>, Zhang Bo, Zhang Chi<sup>2</sup>, Sui Liying<sup>1</sup>

1. Asian Regional Artemia Reference Center, College of Marine and Environmental Science, Tianjin University of Science and Technology, No.9, 13<sup>th</sup> Avenue, TEDA, Tianjin 300457, China

2. Institute of Fisheries Science, Tibet Academy of Agricultural and Animal Husbandry Sciences, Lhasa, P. R. China

Qinghai-Tibet plateau is the main saline lake region in China, where over 300 saline lakes are distributed with an average altitude of more than 4000 meters (Zheng et al., 1989). Apart from the abundant mineral reserves, the relatively rich biodiversity also exists in Tibetan saline lakes. The higher salinity and alkaline pH, lower average annual temperature and large diurnal temperature variation, and strong UV radiation have contributed to the unique characteristics of the aquatic organisms in these lakes. Some of them have potential to be exploited to the commercial products and applied in aquaculture, food and biomedicine industry. Supported by Fishery S&T Aid Tibet project, an ecological survey was conducted along the northern ring road of Tibet in September 2019, to investigate the microbial, phytoplanktonic and zooplanktonic composition in the salt lakes located in Naqu and Ali region. The samples were collected from the water bodies and sediments in six salt lakes with the salinity range of 40-100 g/L, namely Lagkor Co, Dangqiong Co, Bango Co, Dong Co, Nier Co and Yanhu. The lakes are alkaline with pH ranging from 7.66 to 8.85. The ion composition analysis showed that Nier Co, Yanhu and Dong Co are sodium-sulfate salt lakes, whilst the others are carbonate salt lakes. A total of 55 species of phytoplankton were observed in water samples, including 25 species of Bacillariophyta, 12 species of Cyanophyta, 16 species of Chlorophyta, 1 species (*Heterotrichales* sp.) of Xanthophyta and 1 species (*Euglena* sp.) of Euglenophyta. Three rotifer species *Branchionus plicatilis*, *B. urceolaris* and *B. rotundiformis*, and two copepod species *Arctodiaptomus stewartianus* and *Attheyella dentata* were found in the water sample from Dong Co, whilst no zooplankton were observed in the water samples from other lakes. The brine shrimp *Artemia* from Tibetan salt lakes are characterized by dark red color, larger size, and containing remarkably higher content of highly unsaturated fatty acids (i.e. EPA and DHA), and are widely used in marine fish and shrimp hatchery. The *Artemia* cysts (diapaused embryos) in Qixiang Co and Lagkor Co have been commercially exploited over 20 years. In our survey, *Artemia* nauplii, juveniles and adults, as well as *Artemia* cysts are found in these salt lakes. The population density of *Artemia* biomass in Bango Co, Nier Co, Dangqiong Co and Lagkor Co are 66.2±9.9 ind./L, 2.3±1.0 ind./L, 2.1±1.3 ind./L and 3.1±2.7 ind./L, respectively in July (data obtained from the survey in 2020). It is believed that the *Artemia* populations in Tibetan salt lakes belong to *Artemia tibetiana*. However, using molecular markers COI and 12S-16S, our study on the collected samples showed that the Tibetan *Artemia* populations in different salt lakes may have been differentiated to a certain extent. Based on COI, *Artemia* in Lagkor and the reported *A. tibetiana* are clustered into one branch, and *Artemia* from other salt lakes are clustered into another branch. The 16S-12S phylogenetic tree showed that *Artemia* from these salt lakes were clustered into a single branch. Therefore we suggested that there was intraspecific differentiation between *Artemia* individuals from these salt lakes, and whether a subspecies or cryptic species relationship between them is not clear, which requires further study. The high-throughput sequencing analysis on V3-V4 fragment of 16S rRNA gene showed that Shannon index of Dong Co sediment was the highest, indicating higher bacterial diversity

existed in Dong Co (8.261), while Dangxiong Co sediment had the lowest value (5.683). Genus *Halomonas* dominated in the sediments of Bango Co (9.0%) and Yanhu (11.6%), while *Alkaliflexus* dominated in Dangxiong Co (33.0%), *Izimaplasma* mainly existed in Dong Co (2.3%) and Nier Co (7.0%). Canonical correlation analysis indicated that pH was the main factor that influenced the biodiversity in Dong Co, while the biodiversity of Dangxiong Co and Bango Co mainly correlated to the content of carbonate in the water, and that of Ner Co mainly correlated to the content of magnesium and calcium. In total, 38 single colonies were isolated from the sediment samples in the lakes, of which 29 isolates were identified through 16S rRNA gene sequencing and blasting with NCBI database. Fourteen isolates belonged to genus *Halomonas*. Our survey provided basic information on microbial, phytoplanktonic and *Artemia* biodiversity in Tibetan salt lakes. Further researches need to be focused on aquatic organisms with high economic and scientific research values. And the genetic differentiation of *Artemia* resources in Tibet is particularly needed.

Five key words: Tibet, Salt lakes, Biodiversity, *Artemia*, Microalgae, Microorganism

Email address for questions: gaomr511@tust.edu.cn



Poster session (6): Related natural resources and ecosystem services (agriculture, aquaculture, etc.)\_117

## **LIFE INVASAQUA: Raising Awareness and Preventing Aquatic Invasive Alien Species in the Iberian Peninsula**

López-Cañizares, C., Olivo del Amo, R., Guillén, A., Torralva, M., Ruiz-Navarro, A.,  
Oliva-Paterna, F.J.

*Dpto. Zoología y Antropología, Universidad de Murcia, Spain.*

The Iberian society has limited understanding about the threats posed by Invasive Alien Species (IAS) in freshwater and estuarine ecosystems. The lack of knowledge and awareness about IAS hinders any management policy proposed by the public administration and the development of stakeholders' responsible attitudes towards IAS management strategies. We present the Environmental Governance and Information LIFE project – LIFE INVASAQUA (2018 – 2023) in the Iberian Peninsula. The main goal of LIFE INVASAQUA is to increase Iberian public and stakeholders' awareness on aquatic IAS problems through the development of tools such as codes of conducts, priority species lists, public perceptions studies, educational materials, and others. These actions aim at bringing together policy-makers, stakeholders, scientists and the public in improving an efficient Early Warning and Rapid Response (EWRR) framework for new IAS in freshwater and estuarine habitats in the Iberian Peninsula. The main outcomes of the project will be presented in order to share some of the challenges and solutions encountered during the project implementation. This work receives funds from the LIFE Programme (LIFE17 GIE/ES/000515) of the European Commission.

Five key words: Aquatic invasive alien species, Iberian Peninsula, Awareness, Management, Early-warning

Email address for questions: [celia.lopez10@um.es](mailto:celia.lopez10@um.es)





## Researching the archaeological and ecological heritage of the Central Italian Tyrrhenian coast

Luca Alessandri<sup>1</sup>, Peter A. J. Attema<sup>1</sup>, Jan Sevink<sup>2</sup>

*1. Groningen Institute of Archaeology, University of Groningen*

*2. Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam*

Marine erosion, urbanism and unsustainable tourism have threatened the archaeological heritage of the former saline environments of the Tyrrhenian coasts of Central Italy for a long time now resulting in the loss of primary archaeological and ecological contexts that can inform us on their use for past societies. The ongoing decrease in sediment supply by the dammed rivers, by the reduced mobility of the sediment because of the constructions of structures protruding into the sea (docks, harbours etc) and the ongoing sea-level rise has caused the near disappearance of salt production sites dating as early as the Middle Bronze Age (ca. 1700 BCE) as well as sites of the Roman and medieval periods. Detailed geomorphological study of this coastal area showed that the shoreline moved inland about 100m in the last 4000 years. In our poster, we will present the outline of a new research programme targeting the reconstruction of ancient saline environments along the Tyrrhenian coast and related archaeological sites involved in various modes of salt production. We will apply a novel interdisciplinary methodology that will allow the team to investigate the transition from labour-intensive small-scale production methods (briquetage) to the historically known large scale exploitation of salterns that functioned under increasing and eventually total state control but which have archaeologically received hardly attention. To carry out the archaeological research, the team will apply a field methodology combining geophysical techniques, soil chemistry, excavations, and functional and chemical artefact analysis. Outcomes will be evaluated within the anthropological framework of early state formation, in our case the competitive world of the early Etruscan and Latin city-states, of which early Rome was part. The project will add to the international scientific and societal discussion on the cultural and ecological value of coastal saline environments in present-day society, urgent given the increasing impacts urban sprawl and the tourist industry have on the fragile coastal environments of the Mediterranean. The project is funded for four years by the Netherlands Organisation for Scientific Research (NWO) (grant nr. 406.20.HW.013)

Five key words: Ancient salt production, Briquetage, Central Tyrrhenian Italy, Salterns, Early states

Email address for questions: [l.alessandri@gmail.com](mailto:l.alessandri@gmail.com)

