

ISSN 1004-0609

CN 43-1238/TG

CODEN ZYJXFK

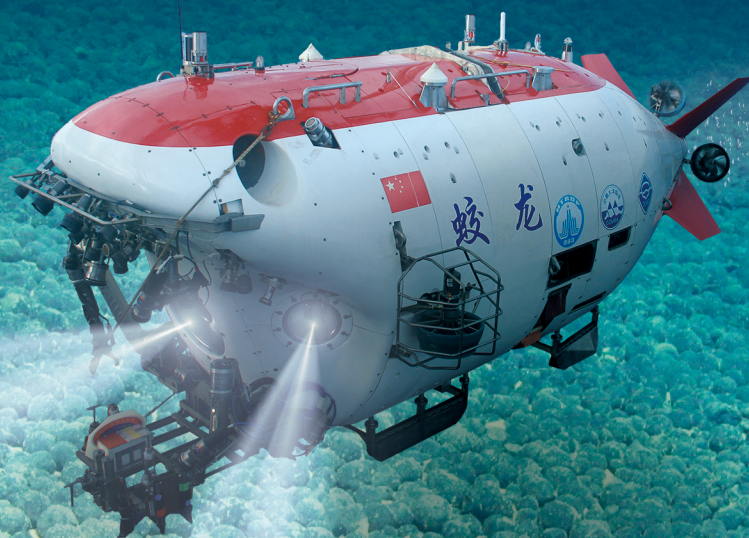
# 中国有色金属学报

The Chinese Journal of Nonferrous Metals

**30** 中国大洋矿产资源  
研究开发协会  
成立 30 周年

October 2021

Volume 31 Number 10



中国科学技术协会 主管  
中国有色金属学会 主办

## 目次

### 中国深海大洋事业跨越发展的三十年

.....刘峰,刘予,宋成兵,李向阳,罗祎,高岩,张丹(2613)

### 深海资源调查与评价

#### 中国大洋硫化物勘探研究的发展与展望

.....刘颖,李家彪,王叶剑,陶春辉,曾志刚,韩喜球,李传顺,周亚东,梁锦(2624)

#### 我国深海多金属结核资源的勘探进展及思考

.....初凤友,姜静,刘禹维,李怀明,李小虎,朱克超,吕士辉,罗祎,曾轩(2638)

#### 西太平洋中国富钴结壳勘探合同区矿床地质

.....何高文,杨永,韦振权,杨胜雄,刘永刚,邓希光,姚会强,邓义楠,高晶晶,  
方念乔,王洋,王汾连,任江波,姜静,邓贤泽,梁东红,马维林,张立敏,姚翔(2649)

#### 深海稀土资源勘查开发研究进展.....黄牧,石学法,毕东杰,于淼,李力,李佳,

张培萍,张霄宇,刘季花,杨刚,周天成,朱爱美(2665)

#### 海底多金属硫化物资源预测:方法与思考.....沈芳,韩喜球,李洪林,王叶剑(2682)

#### 西北太平洋多金属结核区沉积物黏土矿物特征.....王银,吕士辉,苏新,李嘉盈,李怀明,任向文(2696)

#### 基于瞬变电磁法的南大西洋热液硫化物区电性结构

.....杨悦,李传顺,叶俊,李兵,党院,王赛(2713)

#### 国际海底区域矿产资源相关环境问题与管理进展

.....高岩,孙栋,黄浩,王春生,钱培元,王宗灵,史先鹏,宋成兵(2722)

### 深海资源开发技术与装备

蛟龙号载人潜水器在大洋勘探中的发展回顾与展望.....徐芑南,叶聪,王帅,侯德永(2738)

深海自主水下机器人发展及其在资源调查中的应用.....	封锡盛, 李一平, 徐会希, 李智刚(2746)
深海矿产资源载人深潜抵近探测新技术.....	丁忠军, 张奕, 史先鹏, 李德威, 赵庆新(2757)
海底采矿作业车螺旋桨推进器水动力特性研究.....	戴瑜, 张晏仰, 卞家能, 马伟宾, 陈曦(2771)
深海采矿机器人入水冲击流场仿真及试验验证.....	黄鑫, 戴瑜, 苏乔, 程慧云, 朱湘(2782)
深海稀软底质特性及采矿车行走性能研究进展.....	饶秋华, 刘泽霖, 许锋, 黄维, 马雯波(2795)
基于深海底质流变特性和接地比压的集矿机牵引力计算方法.....	许锋, 饶秋华, 刘泽霖, 马雯波(2817)
采矿船月池内部防撞消波装置设计.....	田华勇, 张海彬, 张福民, 周佳, 邵武豪(2829)
内波环境下中间仓单体收放过程中的管柱力学分析.....	王荣耀, 陈国明, 刘伟, 郑皓(2836)

## 深海资源开采与选冶加工

深海多金属结核开采技术发展历程及展望.....	康娅娟, 刘少军(2848)
深海矿产资源选冶加工研究现状及展望.....	蒋训雄, 蒋伟(2861)
大洋多金属结核低温氢还原-酸浸新工艺.....	周小舟, 彭俊, 沈裕军, 黄宗朋, 蔡云卓, 钟山(2881)
深海多金属硫化物开采技术.....	李艳, 梁科森, 李皓(2889)
深海多金属硫化物选冶联合技术研究.....	蒋伟, 周兵仔, 李磊, 蒋训雄, 张登高(2902)
高静水压下海底多金属硫化物破碎机理的数值研究.....	戴欢, 李艳, 李皓, 梁科森(2913)
极端工况下深海扬矿泵 CFD-DEM 耦合仿真与试验研究.....	胡琼, 陈骏, 邓立文, 刘少军(2926)
深海多金属结核商业开采水下垂直提升方案.....	康娅娟, 王长伟, 刘少军, 邹伟生, 许怡赦(2938)
深海开采矿浆泵水力管道提升理论与设计.....	邹伟生, 李浩天, 康娅娟(2953)

后 记.....(I)

责任编辑: 龙怀中, 何学锋, 李艳红

[期刊基本参数] CN 43-1238/TG\*1991\*m\*A4\*350\*zh\*P\*¥80.0\*720\*27\*2021-10

# The Chinese Journal of Nonferrous Metals

## (ZHONGGUO YOUSE JINSHU XUEBAO)

Volume 31 Number 10

(Sum 271)

October 2021

---

### CONTENTS

#### Three decades' development of China in deep-sea field

.....LIU Feng, LIU Yu, SONG Cheng-bing, LI Xiang-yang, LUO Yi, GAO Yan, ZHANG Dan(2613)

#### Survey and Evaluation of Deep-sea Resources

Development and prospect of exploration and research on seafloor polymetallic sulfides of China

.....LIU Ying, LI Jia-biao, WANG Ye-jian, TAO Chun-hui, ZENG Zhi-gang, HAN Xi-qiu,  
LI Chuan-shun, ZHOU Ya-dong, LIANG Jin(2624)

Advancement and implication for polymetallic nodules resources exploration in deep-sea

.....CHU Feng-you, JIANG Jing, LIU Yu-wei, LI Huai-ming, LI Xiao-hu, ZHU Ke-chao,  
LÜ Shi-hui, LUO Yi, ZENG Xuan(2638)

Mineral deposit characteristics of cobalt-rich Fe-Mn crusts in COMRA contract area, Western Pacific Ocean

.....HE Gao-wen, YANG Yong, WEI Zhen-quan, YANG Sheng-xiong, LIU Yong-gang,  
DENG Xi-guang, YAO Hui-qiang, DENG Yi-nan, GAO Jin-jin, FANG Nian-qiao, WANG Yang,  
WANG Fen-lian, REN Jiang-bo, JIANG Jing, DENG Xian-ze, LIANG Dong-hong, MA Wei-lin,  
ZHANG Li-min, YAO Xiang(2649)

Advances on study of exploration and development of deep-sea rare earth resources

.....HUANG Mu, SHI Xue-fa, BI Dong-jie, YU Miao, LI Li, LI Jia, ZHANG Pei-ping,  
ZHANG Xiao-yu, LIU Ji-hua, YANG Gang, ZHOU Tian-cheng, ZHU Ai-mei(2665)

Prediction of seafloor polymetallic sulfide resources: Methods and consideration

.....SHEN Fang, HAN Xi-qiu, LI Hong-lin, WANG Ye-jian(2682)

Assemblage of clay minerals at polymetallic nodules contract area in Northwest Pacific Ocean

.....WANG Yin, LÜ Shi-hui, SU Xin, LI Jia-ying, LI Huai-ming, REN Xiang-wen(2696)

Electrical structure of seafloor massive sulfide deposits in South Mid-Atlantic ridge based on marine transient electromagnetic method.....YANG Yue, LI Chuan-shun, YE Jun, LI Bing, DANG Yuan, WANG Sai(2713)

Progress of environmental research and management related to mineral resources in international seabed

.....GAO Yan, SUN Dong, HUANG Hao, WANG Chun-sheng, QIAN Pei-yuan,  
WANG Zong-ling, SHI Xian-peng, SONG Cheng-bing(2722)

#### Technology and Equipment for Development of Deep-sea Resources

Development review and prospect of Jiaolong manned submersible in ocean exploration

.....XU Qi-nan, YE Cong, WANG Shuai, HOU De-yong(2738)

Development of deep-sea autonomous underwater vehicle and its applications in resource survey	FENG Xi-sheng, LI Yi-ping, XU Hui-xi, LI Zhi-gang(2746)
New technology of manned submersible approach exploration for deep sea mineral resources	DING Zhong-jun, ZHANG Yi, SHI Xian-peng, LI De-wei, ZHAO Qing-xin(2757)
Hydrodynamic characteristics of propeller of subsea mining vehicle	DAI Yu, ZHANG Yan-yang, BIAN Jia-neng, MA Wei-bin, CHEN Xi(2771)
Simulation and experimental verification of water impact flow field of deep ocean mining vehicle entering water	HUANG Xin, DAI Yu, SU Qiao, CHENG Hui-yun, ZHU Xiang(2782)
Research progress on characteristics of deep-sea soft sediment and walking performance of mining vehicle	RAO Qiu-hua, LIU Ze-lin, XU Feng, HUANG Wei, MA Wen-bo(2795)
Traction force calculation method for mining vehicle based on rheological performance of deep-sea sediment and grounding pressure of crawler	XU Feng, RAO Qiu-hua, LIU Ze-lin, MA Wen-bo(2817)
Design and research of anti-collision and wave eliminating device in moonpool of mining vessel	TIAN Hua-yong, ZHANG Hai-bin, ZHANG Fu-min, ZHOU Jia, SHAO Wu-hao(2829)
Mechanical analysis of buffer retrieve/deployment operations considering internal solitary waves	WANG Rong-yao, CHEN Guo-ming, LIU Wei, ZHENG Hao(2836)

### **Exploitation and Processing of Deep-sea Resources**

Development history and prospect of deep sea polymetallic nodules mining technology	KANG Ya-juan, LIU Shao-jun(2848)
Research status and future prospect of metallurgical processing of mineral resources concentration in deep sea	JIANG Xun-xiong, JIANG Wei(2861)
Novel process of treating ocean polymetallic nodules by low temperature hydrogen reduction-acid leaching	ZHOU Xiao-zhou, PENG Jun, SHEN Yu-jun, HUANG Zong-peng, CAI Yun-zhuo, ZHONG Shan(2881)
Mining technology of deep-sea polymetallic sulfide	LI Yan, LIANG Ke-sen, LI Hao(2889)
Study on mineral processing and metallurgical techniques for deep-sea polymetallic sulfides	JIANG Wei, ZHOU Bing-zi, LI Lei, JIANG Xun-xiong, ZHANG Deng-gao(2902)
Numerical study on fragmentation mechanism of seafloor massive sulfides under high hydrostatic pressure	DAI Huan, LI Yan, LI Hao, LIANG Ke-sen(2913)
CFD-DEM coupled simulation and experimental study of deep sea lifting mine pump under extreme working conditions	HU Qiong, CHEN Jun, DENG Li-wen, LIU Shao-jun(2926)
Underwater vertical lifting scheme for commercial mining of deep-sea polymetallic nodules	KANG Ya-juan, WANG Chang-wei, LIU Shao-jun, ZOU Wei-sheng, XU Yi-xie(2938)
Theoretical design on slurry pump hydraulic lift system for marine mineral resources exploitation	ZOU Wei-sheng, LI Hao-tian, KANG Ya-juan(2953)

**Postscript**.....(I)

**(Managing Editors: LONG Huai-zhong, HE Xue-feng, LI Yan-hong)**