

#### INSTITUTE OF GEOLOGY, CHINESE ACADEMY OF GEOLOGICAL SCIENCES

Add: Baiwanzhuang Road 26, Beijing, China Postcode: 100037 Tel: 010-68999668 68999672 Fax: 010-68997803 E-mail: dzskjc@263.net http://igeo.cags.ac.cn Wechat official account









### **Editorial Committee**

Honorary Directors: SHEN Qihan, XIAO Xuchang, LI Tingdong, REN Jishun, YANG Jingsui and HOU Zengqian

**Director:** XIAO Guiyi

**Deputy Directors:** XU Yong, CHI Zhenqing, MA Chengyi, ZHANG Zhiyong, WANG Wei, YANG Zhiming, ZHAI Qingguo and ZHANG Haifeng

Members (in alphabetical order): DING Xiaozhong, GUO Lei, HAO Yanli, LI Haibing, LIU Chaohui, LIU Pengju, LU Zhanwu, MENG Fancong, WANG Tao, YANG Zhiming, ZENG Lingsen, ZHANG Jin and ZHU Xiangkun

Editors: YANG HONG, ZHOU Liqin, XU Cuiping, XU Zheng, LIAO Hanying, WU Zhenjie, LEI Min, LIU Yixuan and SU Yuchen

Cover Photo: ZHAI Qingguo

Beijing • China June 2022

# **INSTITUTE OF GEOLOGY**

CHINESE ACADEMY OF GEOLOGICAL SCIENCES

# ANNUAL REPORT OF SCIENCE AND TECHNOLOGY





# Annual Report Contents 2021

1. Introduction	2
2. Projects and Funding	5
3. Selected Reserarch Achievements	6
<b>4</b> . Talents and Awards	24
5. Platform for Technology Innovation	
6. International Cooperation and Academic Exchange	
7. Important Academic Activities and Science Popularization	
8. Postgraduate Education	
Table 1-1 Projects funded by the National Natural Science Foundation of China (NSFC)	41
Table 1-2 Projects funded by the Ministry of Science and Technology and other sources	
Table 1-3 Projects funded by the China Geological Survey	51
Table 2-1 English language publications	53
Table 2-2 Chinese language publications with English abstract	



### Preface 2021

The Institute of Geology, Chinese Academy of Geological Sciences (IGCAGS), is a national scientific research institution engaged mainly in fundamental national, strategic, and frontier geological surveys and geoscientific research. Entering the new century, particularly during the past five years, the Institute has made notable progress in scientific research, personnel training, and international cooperation with increasing cooperation and exchange activities, expanded fields of cooperation, abundant output of new research results, and an increasing number of papers published in *Nature, Science*, and other high-impact international scientific journals. In the light of this and to publicize annual progress and achievements of the Institute to enhance its international reputation, an English version of the Institute's Annual Report of Science and Technology has been published since 2010.

The Annual Report 2021 includes the following sections: (1) Introduction; (2) Projects and funding; (3) Selected research achievements; (4) Talents and awards; (5) Platform for technology innovation; (6) International cooperation and academic exchange; (7) Important academic activities and science popularization and (8) Postgraduate education. To avoid confusion in the meaning of Chinese names, all Chinese family names in this Report are capitalized.

We express our sincere gratitude to colleagues of related research departments and centers of the Institute for their support and efforts in compiling this Report and in providing related material—a written record of the hard work of the Institute's scientific research personnel for the year 2021.

Editorial Board of the Annual Report (English Version) of Science and Technology of the Institute of Geology, Chinese Academy of Geological Sciences 10 May, 2022



# 2021 Introduction





The Institute of Geology, Chinese Academy of Geological Sciences (IGCAGS), is a national scientific research institution engaged mainly in fundamental national, strategic, and frontier geological surveys and geoscientific research with the aim of providing geological theory and technological support for national geoscientific research and investigation through undertaking:

(1) Fundamental national, strategic, and frontier geoscientific research and geological surveys;

(2) Investigations and innovative research on major geological problems pertaining to Earth resources and environment;

(3) Multidisciplinary research on tectonic geology and geotectonics, regional geology and metallogeny, stratigraphy and palaeontology, metamorphic rocks and Precambrian geology, petrology and mineralogy, and Quaternary geology; with research in major areas such as continental tectonics and dynamics, deep lithosphere exploration and three-dimensional geological surveys, isotope geology and chronology, and comprehensive geological research and mapping research.

(4) Research on isotopic chronology, geochemical techniques and systems, major key technologies, and instrumentation, including construction, management, and operation of relevant experimental and observational bases.

(5) International geological cooperation and exchange.

The Institute's 254 staff-members include 162 senior professionals, 6 Academicians of the Chinese Academy of Sciences, 5 "New Century Talents Project" nominees, 1 "National Youth Talents Project" nominee, 4 "National Outstanding Contributions to Young Experts" nominees, 6 professionals supported by the "National Natural Science Foundation of China (NSFC) for Distinguished Young Scholars", 4 professionals supported by the "NSFC Excellent



#### Introduction 2021

Young Scholars Fund", 2 professionals supported by the "National High-level Personnel of Special Support Program", and 1 research group supported by the "NSFC Science Fund for Creative Research Groups". The Institute is supported by the "Innovative Talent Training Demonstration Project" and "National Talent and Intelligence Introduction Demonstration Base" of Ministry of Science and Technology (MOST) of China. The Institute was newly named "Geoscience Polularization Research Base" by the Geological Society of China (GSC) and "National popularization Science Education Base" by the China Association for Science and Technology(CAST).













SHEN Qihan

XIAO Xuchang

LI Tingdong

**REN** Jishun

YANG Jingsui

HOU Zengqian

杰 青





LIU Fulai



ZENG Lingsen



YANG Zhiming



SONG Yucai





ZHAI Qingguo



LIU Chaohui



LIU Yan



LIU Yingchao

IGCAGS has trained a large number of highly qualified graduate students, and has designated programs for postdoctoral research, with a postgraduate education system for Masters and PhD students. IGCAGS has 45 doctoral tutors and 61 masters tutors. The institute enrolls ~25 PhD and MA students each year, and currently has 35 postdoctoral researchers.

The Institute has 13 research divisions: Division of Regional Geology and Mapping, Division of Tectonics, Division of Stratigraphy and Paleontology, Division of Igneous Rocks, Division of Metamorphic Rocks and Precambrian Geology, Division of Continental Dynamics, Division of Isotope Geology, Lithosphere Research Center, Beijing SHRIMP Center, Mineral and Energy Resources Center, Earth System Science Center, Informatization Office and Journal and Reference Room.

-3-







### 2021 Introduction

The Institute was newly approved to build the "Jiangsu Donghai Continental Deep Hole Crustal Activity National Observation and Research Station". The Institute also hosts three key laboratories of the Ministry of Natural Resources (MNR) of the People's Republic of China, namely the Key Laboratory of Isotope Geology, Key Laboratory of Stratigraphy and Paleontology, and Key Laboratory of continental Dynamics. Seven academic organizations are affiliated with the Institute: the China Commission of International Continental Scientific Drilling, Commission of Regional Geology and Mineralization of the GSC, Commission of Geological Mapping of GSC, Commission of Stratigraphy and Paleontology of GSC, Commission of Petrology of GSC, Commission of Isotope Geology of GSC, Commission of Metamorphism, and Mineralogy and Geochemistry of GSC.

In recent years, the Institute has undertaken more than 800 research projects including the "National Science and Technology Major Project of MOST", National Scientific Instruments and Equipment, and the National Key Research and Development Plan (including the "National Basic Research Program of China (973 Program)"). Significant research programs are supported by the National Natural Science Foundation and projects of China Geological Survey (CGS).

The Institute has produced a great number of innovative outcomes by promoting the growth of talent, fostering innovative ideas, and enhancing the ability to perform scientific research and meet major national needs, with many innovative achievements in the field of solid-Earth science. The Institute attaches great importance to intellectual property rights, having been authorized for about 65 patents. In the past five years, ten research achievements have been awarded to the Institute, including two National Natural Science Awards, and eight Science and Technology Progress Award from MNR.



## Projects and Funding 2021

#### 2.1 Projects Funded by the National Natural Science Foundation of China (NSFC)

In 2021, the NSFC projects reached a record high: 35 projects were approved, with a direct fund of 43.57 million yuan, including one "Distinguished Young Scholar", six key projects, one special project for major instruments, and 18 general projects. The total fund and the number of key projects reached a record high. The general funding rate is 34%, higher than the national average funding rate (16.6%), ranking in the forefront of domestic geoscience research institutions.

#### 2. Projects Funded by the Ministry of Science and Technology and other sources

The Institute was newly approved one project and one topic of the key projects for the Development and Utilization of Strategic Mineral Resources in the National Key R & D Plan, one research task for the Second Qinghai Tibet Plateau Comprehensive Scientific Investigation, and one special topic for the Investigation of Basic Scientific and Technological Resources, with a total fund of 36.87 million yuan.

#### 3. Projects Funded by the China Geological Survey

In 2021, the Institute undertook 2 geological survey projects and 1 project jointly with Chengdu Center. It has undertaken 14 secondary projects, 5 budget projects and 1 newly established budget project. The total expenditure is 62.9 million yuan.

See attached Table 1 for the projects and funding in 2021.





In 2021, the Institute published 156 papers in *science, geology, JP, GSA bulletin* and other important journals at home and abroad (Table 2 list of papers published in 2021), including 102 SCI papers (82 international SCI papers). In addition, it obtained 1 invention patent, 2 utility patents, 10 software copyrights, 2 new minerals, and 5 national first-class reference materials.

#### **3.1 Research Papers**

# Age and composition of young basalts on the Moon, measured from samples returned by Chang'e-5

Orbital data indicate that the youngest volcanic units on the Moon are basalt lavas in Oceanus Procellarum, a region with high levels of the heat-producing elements potassium, thorium, and uranium. The Chang'e-5 mission collected samples of these young lunar basalts and returned them to Earth for laboratory analysis. We measure an age of  $1963 \pm 57$  million years for these lavas and determine their chemical and mineralogical compositions. This age constrains the lunar impact chronology of the inner Solar System and the thermal evolution of the Moon. There is no evidence for high concentrations of heat-producing elements in the deep mantle of the Moon that generated these lavas, so alternate explanations are required for the longevity of lunar magmatism.





CHE Xiaochao et al., 2021-Science 374(6569):887-890



# Variation of lead isotopic composition and atomic weight in terrestrial materials

The isotopic composition and atomic weight of lead are variable in terrestrial materials because its three heaviest stable isotopes are stable end-products of the radioactive decay of uranium (<sup>238</sup>U to <sup>206</sup>Pb; <sup>235</sup>U to <sup>207</sup>Pb) and thorium (<sup>232</sup>Th to <sup>208</sup>Pb). The lightest stable isotope, <sup>204</sup>Pb, is primordial. These variations in isotope ratios and atomic weights provide useful information in many areas of science, including geochronology, archaeology, environmental studies, and forensic science. While elemental lead can serve as an abundant and homogeneous isotopic reference, deviations from the isotope ratios in other lead occurrences limit the accuracy with which a standard atomic weight can be given for lead. In a comprehensive review of several hundred publications and analyses of more than 8000 samples, published isotope data indicate that the lowest reported lead atomic weight of a normal terrestrial materials is 206.1462 ± 0.0028 (k = 2), determined for a growth of the phosphate mineral monazite around a garnet relic from an Archean high-grade metamorphic terrain in north-western Scotland, which contains mostly <sup>206</sup>Pb and almost no <sup>204</sup>Pb. The highest published lead atomic weight is 207.9351 ± 0.0005 (k = 2) for monazite from a micro-inclusion in a garnet relic, also from a high-grade metamorphic terrain in north-western Scotland, which contains almost pure radiogenic <sup>208</sup>Pb. When expressed as an interval, the lead atomic weight is [206.14, 207.94]. It is proposed that a value of 207.2 be adopted for the single lead atomic-weight value for education, commerce, and industry, corresponding to previously published conventional atomic-weight values.



ZHU Xiangkun et al., 2020-Pure and Applied Chemistry, 93(1): 1-12

# Role of sediment in generating contemporaneous, diverse "type" granitoid magmas

Granite typology categorizes granitoid rocks based upon distinguishing characteristics that are interpreted to indicate sources, conditions of generation, and, by implication, tectonic setting. Complexities of elemental and isotopic geochemistry, however, commonly preclude simple typological interpretation and suggest more complex petrogenetic histories. Granitoids from the Songpan-Ganzi terrane in the eastern Tibetan Plateau were emplaced within a short interval (~15 m.y.). They display mineralogical and geochemical characteristics that are consistent with a wide



range of proposed typologies (I-, S-, and A-type; high Ba-Sr and adakitic variants). Despite their close spatial and temporal association, these granitoids exhibit diversity in geochemical characteristics that indicates a broad spectrum of contributing sources. Radiogenic isotope data reveal a continuum from primitive to evolved crustal compositions; *i.e.*,  ${}^{87}$ Sr/ ${}^{86}$ Sr(*t*) = 0.704–0.715 and  $\varepsilon_{Nd}(t) = +2$  to -11. All granitoid "types" have variable but commonly high zircon  $\delta^{18}$ O (+4.1‰ to +11.6‰) and low whole-rock Li-B-Mg isotopic ratios compared to mantle and/or seawater ( $\delta^{7}$ Li = +5.1‰ to -3.2‰;  $\delta^{11}$ B = -10.7‰ to -16.5‰;  $\delta^{26}$ Mg = -0.23‰ to -0.59‰). These stable isotopic compositions suggest that the Songpan-Ganzi granitic magmas of all "types" had contributions from sediment, ranging from minor to dominant. The highly variable isotopic compositions of the granitoids rule out a single homogeneous source for these diverse yet contemporaneous granitoids. Their compositional variability may have been significantly influenced by sedimentary contributions, and these results demonstrate the difficulty of straightforward assignment and interpretation of granitoids using conventional typology.



LI Shan and WANG Tao et al., 2022-Geology, 50 (4): 427-431

# Short-lived intra-oceanic arc-trench system in the North Qaidam belt (NW China) reveals complex evolution of the Proto-Tethyan Oce

Accompanying Gondwana assembly, widespread but diachronous Ediacaran–early Paleozoic magmatism of uncertain origin occurred along the supercontinent's proto-Tethyan margin. We report new geochemical,isotopic, and geochronological data for Cambrian magmatic rocks (*ca.* 500 Ma) from the Gondwana-derived North Lhasa terrane, located in the present-day central Tibetan Plateau. The magmatic rocks are composed of basalts, gabbros, quartz monzonites, granitoids (with mafic microgranular enclaves), and rhyolites. Nd-Hf isotopic and whole-rock geochemical data indicate that these rocks were probably generated by mixing of mantle-derived mafic and crust-derived felsic melts. The mantle end-member volumes of mafic, intermediate, and felsic rocks are ~75%–100%, 50%–60%, and 0–30%, respectively. Integration of our new data with previous studies suggests that the North Lhasa



terrane experienced long-term magmatism through the Ediacaran to Ordovician (*ca.* 572–483 Ma), with a magmatic flare-up at *ca.* 500 Ma. This magmatism, in combination with other Ediacaran–early Paleozoic magmatism along the proto-Tethyan margin, was related to an Andean-type arc, with the magmatic flare-up event related to detachment of the oceanic slab following collisional accretion of Asian microcontinental fragments to northern Gondwana. Diachroneity of the proto-Tethyan arc system along the northern Gondwanan margin (*ca.* 581–531 Ma along the Arabian margin and *ca.* 512–429 Ma along the Indian-Australian margin) may have been linked to orogenesis within Gondwana. The North Lhasa terrane was probably involved in both Arabian and Indian-Australian proto-Tethyan Andean-type orogens, based on its paleogeographic location at the northern end of the East African orogen.



HU Peiyuan and ZHAI Qingguo et al., 2021-GSA Bulletin, 133(9/10): 2171-2188

# Early Triassic Pachycladina fauna newly found in the southern Lhasa Terrane of Tibet and its palaeogeographic implications

The Lhasa Terrane of Tibet is critical to understanding Early Triassic crustal convergence of Gondwana and Eurasia. However, its palaeo-position during this period remains obscure. This paper considers the disputed tectonic nature of the Lhasa Terrane during Triassic time. The debate has taken the form of two schools of thought regarding the Lhasa Terrane. One holds that the terrane was a stable carbonate platform during Triassic time. The opposing view maintains that the Lhasa Terrane occupied a compressional orogenic belt. These contrasting explanations stem mainly from the absence of a sedimentary record, especially in the southern part of the Lhasa Terrane of Tibet. We



report on results of a biostratigraphic investigation of a dolomite unit considered to be of Guadalupian age in the Comai area, southern Lhasa Terrane. This work yielded the ellisonid conodont species Pachycladina rendona n. sp. Wu and Ji suggesting an Early Triassic age and a low latitude depositional setting of the dolomite. Further, these findings favor correlation of the dolomite with the upper member of the Upper Permian to Lower Triassic Mujiuco Formation. Results of the present study, especially the newly collected Pachycladina fauna, suggest that the Lhasa Terrane was an element of a low-latitude carbonate platform that had separated from Gondwana during the Early Triassic. It is hoped that our findings will promote further research of the Triassic sedimentary history and paleogeographic evolution of the Lhasa Terrane.





WU Guichun and JI Zhansheng et al., 2021-Palaeogeography, Palaeoclimatology, Palaeoecology, 562:110030



# Ca isotope systematics of carbonatites: Insights into carbonatite source and evolution

Carbonatite, an unusual carbonate-rich igneous rock, is known to be sourced from the mantle which provides insights into mantle-to-crust carbon transfer. To constrain further the Ca isotopic composition of carbonatites, investigate the behaviour of Ca isotopes during their evolution, and constrain whether recycled carbonates are involved in their source regions, we report  $\delta^{44/42}$ Ca for 47 worldwide carbonatite and associated silicate rocks using a refined analytical protocol. Our results show that primary carbonatite and associated silicate rocks are rather homogeneous in Ca isotope compositions that are comparable to  $\delta^{44/42}$ Ca values of basalts, while non-primary carbonatites show detectable  $\delta^{44/42}$ Ca variations that are correlated to  $\delta^{13}$ C values. Our finding suggests that Ca isotopes fractionate during late stages of carbonatite is sourced from a mantle source without requiring the involvement of recycled carbonates.



SUN Jian and ZHU Xiangkun et al., 2021-Geochemical Perspectives Letters, 17:doi: 10.7185/geochemlet.2107



# GeoPS: An interactive visual computing tool for thermodynamic modelling of phase equilibria

The availability of thermodynamic data for geologically relevant phases has made practical the calculation of stable phase relations throughout the mantle and crust of terrestrial planets. GeoPS (http://www.geops.org) is a program designed for this purpose in which both input and output are done through an intuitive graphical user interface. GeoPS provides a wide range of phase equilibrium calculations based on a novel Gibbs energy minimization algorithm. The algorithm provides for exceptionally robust and computationally efficient solution to the phase equilibrium problem by successive alternation between a linear programming step to identify stable phase compositions and a non-linear programming step to refine the compositions estimated during the linear programming. Applications include calculation of various types of phase diagrams and path-dependent phase fractionation. By combining an easy-to-use graphical user interface with a robust and efficient solver, GeoPS makes phase equilibrium modelling accessible to researchers and students with minimal training and provides a powerful tool for understanding natural phase relations and for planning experimental work.



XIANG Hua and CONNOLLY A. D. James, 2021-Journal of Metamorphic Geology. https://doi.org/10.1111/jmg.12626



#### Tectonic Controls on the Sedimentation and Thermal History of Supradetachment Basins: A Case Study of the Early Cretaceous Fuxin Basin, NE China

A crustal-scale detachment system, linking cooler hanging wall basins and the hotter footwall Yiwulüshan metamorphic core complex (MCC), is located in the Fuxin area of NE China. The relationship between detachment tectonism and sedimentation along supra-detachment basins remains a challenging topic, and the effect of detachment tectonism on basin-fill and thermal histories is poorly understood. Based on the detailed sedimentological, seismic, and geochemical analysis, we reconstruct the sedimentation and thermal history of the Fuxin Basin in the context of detachment tectonism. Two depositional systems, including a fan delta-shore-shallow lake and a subaqueous fan-semi-deep lake, developed during the early Cretaceous. The sedimentation history reveals that the lakebasin scale started with expansion, and then gradually declined toward the eastern depocenter. During the early Cretaceous, a reconstructed dynamic model for basin-range evolution reveals the three evolution phases of protorift, fault subsidence, and transpression in the Fuxin area. We infer that the evolution of the supra-detachment basin, sedimentation, and thermal records were controlled by detachment tectonism associated with the uplift and exhumation of the Yiwulüshan MCC. Thermal parameters and burial history indicate a general increase in the maximum paleotemperature toward the eastern part of the basin. Effects of sedimentary fill, shear heating, transpression, and fault displacement from detachment tectonism dominated the thermal evolution of this basin. Our results illustrate the importance of the dynamic evolution of the MCC in characterizing the sedimentation and thermal history of supra-detachment basins that contribute to the understanding of subduction systems and their resource development.



JIA Jianliang et al., 2021-Tectonics. https://doi.org/10.1029/2020TC006535



#### Age and origin of accreted ocean plate stratigraphy in the North Qilian belt, NE Tibet Plateau: evidence from microfossils and geochemistry of cherts and siltstones

The accretionary complex (AC) in the North Qilian belt comprises coherent and chaotic units consisting of bedded cherts, pelagic mudstone, shale, turbidites, basalt, limestone, blueschist, eclogite lenses and ophiolitic mélange. Cherts from the Donggoukou and Biandukou outcrops in the north of the blueschist belt contain abundant Middle Ordovician radiolarians together with rare conodonts. Well-preserved radiolarians also occur in cherts associated with high-pressure/low-temperature rocks in the Baijingsi AC outcrop. Conodonts of Floian–Dapingian age and Middle Ordovician radiolarians also occur in the Shihuigou AC. Geochemical analysis of 23 cherts reveals variable SiO<sub>2</sub> contents (74.56–97.16 wt%) and high mean Al/(Al + Fe + Mn) ratios ranging from 0.35 to 0.85, indicating a non-hydrothermal origin. Ce/Ce\* and La<sub>N</sub>/Yb<sub>N</sub> ratios of 0.70–1.22 and 0.67–1.59 respectively are high and variable, similar to those of associated muddy siltstone (0.59–0.96 and 1.14–1.55, respectively), suggesting near-trench deposition with associated terrigenous input. Together with the metamorphic ages of blueschists and eclogites, the North Qilian belt AC formed by accretion of ocean plate stratigraphic successions in response to subduction of the Proto-Tethyan Ocean prior to 450 Ma.



YAN Zhen and XIAO Wenjiao et al., 2021-Journal of the Geological Society, 178(6): 2020-231

# **Enrichment Nature of Ultrapotassic Rocks in Southern Tibet Inherited from their Mantle Source**

Post-collisional ultrapotassic rocks (UPRs) in the Tibetan Plateau exhibit extreme enrichment in incompatible elements and radiogenic isotopes. Such enrichment is considered to be either inherited from a mantle source or developed during crustal evolution. In this study, to solve this debate we combined mineral textures and in situ geochemical composition of clinopyroxene phenocrysts in UPRs from southern Tibet to reveal their crustal evolution, enrichment cause and constrain metasomatism in their mantle source. Results show that the UPRs experienced



an array of crustal processes, *i.e.*, fractional crystallization, mixing, and assimilation. Fractional crystallization is indicated by decreases in Mg# and Ni and enrichment in incompatible elements (e.g. rare earth element (REE), Sr, Zr) toward the rims of normally zoned clinopyroxene phenocrysts (type-I). Magma mixing is evidenced by the presence of some clinopyroxene phenocrysts (type-II, -III) showing disequilibrium textures (e.g. reversed and overgrowth zoning), but in situ Sr isotope and trace element analysis of those disequilibrium zones indicate that late-stage recharged mafic magmas are depleted ( $^{87}$ Sr/ $^{86}$ Sr: 0.70659–0.71977) compared with the primitive ultrapotassic magmas ( $^{87}$ Sr/ $^{86}$ Sr: 0.70929–0.72553). Assimilation is revealed by the common presence of crustal xenoliths in southern Tibetan UPRs. Considering the much lower  $^{87}$ Sr/ $^{86}$ Sr values (0.707759–0.709718) and incompatible element contents of these crustal xenoliths relative to their host UPRs, assimilation should have resulted in geochemical depletion of southern Tibetan UPRs rather than enrichment. The diluting impact of both assimilation and mixing is also supported by the modeling results based on the EC-E'RA $\chi$ FC model combining the growth history of clinopyroxene. Trace elements ratios in clinopyroxenes also imply that the mantle source of southern Tibetan UPRs suffered an enriched and carbonatite-dominated metasomatism. Thus, we conclude that enrichment of southern Tibetan UPRs was inherited from the mantle source.



LI Weikai and YANG Zhiming et al., 2021-Journal of Petrology, 62(8): egab060 https://doi.org/10.1093/petrology/egab060

#### Deep electrical resistivity structure across the Gyaring Co Fault in Central Tibet revealed by magnetotelluric data and its implication

As one of the most prominent deformation features on Tibetan plateau, a series of N-S systematic rifts and V-shaped conjugate strike-slip faults are well developed in central-southern Tibet. However the mechanism for the formation of the rifts and conjugate strike-slip faults is still controversial. An east-west trending magnetotelluric (MT) array has been operated across the Gyaring Co Fault (GCF) at the northern end of the Xainza-Dingjye Rift (XDR) in Lhasa block. Three-dimensional (3-D) inversions are employed to image lithospheric resistivity structure. Combined with the previous north-south MT 3-D inversion result, electrical resistivity models reveal obvious conductive layer in



the mid-to-lower crust beneath the XDR and apparent resistivity change in the vicinity of the GCF. The calculated depth-integrated conductivity shows that the weak mid-to-lower crust (~30 km- ~ 60 km) characterized by high conductance ( $\geq$  ~10,000 S) and melt fraction of ~5–13%, is mainly distributed between the Indus-Yarlung suture (IYS) and the GCF, whereas the relatively rigid crust characterized by low conductance ( $\leq$  ~2000 S) and melt fraction of ~2–4% appears to the northeast of the GCF. The weak mid-to-lower crust in southern Tibet and the abrupt difference in the resistivity characteristics of the mid-to-lower crust in the vicinity of the GCF, suggest the formation of the rifts in Lhasa block is closely associated with the weak mid-to-lower crust. Taken together with the upper mantle seismic features, the weak mid-to-lower crust is believed to be attributed to the underplated Indian plate. An alternative geodynamic model is presented to respond to the eastward extrusion during the ongoing N-S convergence between the Indian and Eurasian plates, that the rigid crust in central Tibet is sandwiched by the weak mid-to-lower crust in southern and northern Tibet, and the rifts form above the weak mid-to-lower crust, whereas the conjugate strike-slip faults develop on the rigid crust in central Tibet.



XUE Shuai et al.,2021- Tectonophysics 809(20): 228835



#### **3.2 Results of the National Natural Science Foundation of China (NSFC) Projects Completed in 2021**

#### Permo-Triassic paleogeography of eastern Tethys: paleontological, sedimentological and paleomagnetic evidence from western Yunnan and Tibet (chief researcher: JIN Xiaochi)

The evolution of Tethys is a major event of the Phanerozoic. Due to its highly complicated evolution process, people remain having varied opinions on many key issues. This project aims to find out more paleobiogeographical, sedimentological, paleomagnetic and other geological constraints on the evolution of the eastern Tethyan realm during the Permo-Triassic times. For the execution of the project, we followed the guidelines: 1) find out paleoenvironmental, paleobiogeographic and pleoclimatologic data by studying sedimentary successions and fossil records on Gondwanaderived blocks, and analyze the paleogeographic configuration of them with the consideration of paleomagnetic data; 2) differentiate and study various geologic units in Tethyan suture zone, in order to obtain information of development and subduction of Tethys. After having carried out intensive field and laboratory investigations and made achievements in 1) Early Permian fusulinid-bearing oolitic limestone of the Tengchong block as an indicator of climate warming, paleobiogeography of the fusulinid Rugososchwagerina of the Baoshan block and the Shan Plateau, and distribution pattern of Middle Permian fusulinids in the Lhasa Block and its paleogeographic significances; 2) differentiation of different siliciclastic sequences in the Changning-Menglian belt and analysis of their sedimentary and tectonic environment, as well as biostratigraphy and sedimentary environment of carbonate successions; 3) Acquisition of paleomagnetic data from strata of different ages in Baoshan, Lhasa, Tethyan Himalaya and South China blocks and interpretation of their paleogeographical indications. The achievement of these results provides new evidence and effective constraints for the in-depth understanding of the evolution of East Tethys.

# Linking metmorphism with orogensis: insight from early Paleozoic orogenic system in the northeastern Tibet (chief researcher: ZHANG Jianxin)

This project focuses on the metamorphic rocks related to accretion and collision orogeny of the early Paleozoic orogenic system in the northeastern Tibet. Based on studies on various types of metamorphism related to two contrasting orogeny, this project will unravel the relationship between different type metamorphism and orogeny in the northeastern Tibet during early Paleozoic. 5 year works of the project yield some important research progresses and results: 1) Based on studies on metamorphism and deformation related to oceanic subduction interface in North Qilian and North Altyn Tagh, the subduction channel model of the early Paleozoic oceanic subduction interface process is proposed. 2) Compressional arc and extensional arc were identified in the northern and southern margin of Qilian block, corresponding to the advancing and retreating accretionary orogenies, respectively. The continental arc in the northern margin of Oilian block has the characteristics of "Andean type" compressional arc. Its lower crust is characterized by high-pressure granulite of 510-460 Ma, which is related to the subduction of paleo-Qilian ocean (Proto-Tethyan Ocean) towards the south. Based on coeval granulite-facies metamorphism, anatexis, and magmatism in the northern margin of the Qilian Block, an Early Paleozoic continental arc section is constructed. The continental arc of the southern margin of the Qilian block (North Wulan) has the characteristics of extensional arc. The arc lower crust is defined by low-pressure/high temperature granulite of 500-450 Ma, resulting from the oceanic subduction towards the north before the deep continental subduction of the Qaidam block. 3) Based on the field relationship, rock assemblage and P-T paths of two adjacent UHP metamorphic units, Yuka and Luliangshan units, two contrasting exhumation patterns of UHP metamorphic rocks related to continental deep subduction along the North Qaidam margin are proposed: The Yuka LT/UHP metamorphic unit exhumed along a cold continental subduction channel. In contrast, the Lylangshan HT/UHP unit vertically exhumed through the mantle wedge into the overriding crustal plate by diapirism (relamination). 4) A late Ediacaran-early Cambrian UHT granulite metamorphic unit is newly identified



in the western margin of Qaidam Basin. It is suggested to be related to the Pan-African orogeny, which was formed by the final assembly of Gondwana. This new discovery and research is of great significance to further understand the origin of Qaidam block, the early Paleozoic tectonic evolution in the northern Tibet and the opening of the proto-Tethyan Ocean. 5) The comprehensive study of different types of metamorphism reveals that the early Paleozoic orogenic system in the northern Qinghai-Tibet Plateau has both characteristics of typical accretionary and collisional orogenic belt. The relationship between different types of metamorphism and orogeny are constructed.

### Leucogranites from the Xingxingxia area, Eastern Xinjiang, NW China: Petrogenesis and their implications for the composition of the ancient crust (chief researcher: HE Zhenyu)

Leucogranites may have been formed by partial melting of continental crust or been derived by extensive fractional crystallization from more intermediate parent magmas, providing indispensable information for the reconstruction of the composition and evolution of the continental crust. To further reveal the crustal evolution processes of ancient microcontinents in response to the accretionary orogeny, we thus conducted detailed field geological, petrographical, geochronological, and petrogeochemical analyses for the leucogranites from the Xingxingxia area of the Central Tianshan microcontinent (CTM). Our achivements are as follows: (1) Leucogranites from the Xingxingxia area can be classified into two types including "leucocratic type" and "intrusive type". They have different occurrences, petrogenesis and crustal evolution implications. (2) The "leucocratic type" leucogranites have formation ages of  $\sim$ 380 Ma and ~310 Ma, which are consistent with the metamorphic ages of their wall rocks respectively, produced by the metamorphism and partial melting of the Precambrian continental basements of the CTM. (3) The "intrusive type" leucogranites have formation age of  $\sim 280$  Ma, which represent highly fractionated melt of the coeval Hongliujing quartz diorite magma, indicating a genetic link between the highly fractionated granite and the cumulate quartz diorite and the in situ crystal-melt separation process. In addition, we reported Mesoproterozoic (ca. 1.4 Ga) crustal growth events and a substantial Palaeoproterozoic supracrustal component in the CTM, by the zircon Hf and O isotopic studies for the mafic and granitic rocks of the CTM and suggested that the microcontinents in the southern Central Asian Orogenic Belt (CAOB) displays most similarities with the Baltica craton, among the cratons bordering the CAOB. Based on these researches, nine papers have been published in the main international journals and Chinese journals, such as ESR, SR, Geology, GSAB, Lithos and GR, and the achivements have also been embodied in two 1: 50000 geological maps. They have attracted a lot of attention and recognition from scientists at home and abroad.

# Cenozoic deformation and related Pb-Zn-Cu mineralization in the Lanping basin (chief researcher: ZHANG Hongrui)

Located in the southeast of the Tibetan collisional orogen, the Lanping basin hosts numerous low temperature hydrothermal polymetallic deposits. Numerous studies had been revealed the spatial and temporal distribution of these deposits. However, the integration of regional deformation and orefield structures is not clear, which leads to three different models of orogenesis and related mineralization in the Lanping basin. This project chose the Lanping basin for case study of coupling between regional deformation and ore-forming structures. The deformation styles and sequence of the Lanping basin had been revealed by geological mapping from three main sections (Hexi-Zhongpai, Madeng-Yingpan and Dali-Yongping), the ore-forming structures had been analyzed during geologic mapping from the Baiyangping, Jinding, Shuixie and Huachangshan deposits, whereas the deformational and ore-forming age had been determined by zircon and apatite (U-Th)/He thermochronology. The major achievements include that: (1) Three metallogenic epochs had been identified in the Lanping Basin, they were 49Ma (Jinman, Lianchen and Huachangshan deposits), 32-25Ma (Baiyangping and Gepoluo deposits) and 23-20Ma (Jinding, Maocaoping and Shuixie deposits). (2) The main ore-forming structures included high anger reverse faults and related fractures. The rotation of Lanping basin was important for the extension of fractures and infilling of the ore-bearing fluids. (3) Finally, The dynamics



relationship between regional deformation and ore-forming structures had been discussed and the coupling model between collisional orogenesis and ore formation had been proposed. These achievements provided valuable information for understanding the coupling between deformation and ore bearing fluid flow, and enriched the contents of orefield structure. The project has published 25 annotated papers. Among them, 11 papers had listed by science citation index (SCI). Besides, the leader of this project (Dr. H.R. Zhang) gain Innovative Research Team member, Ministry of Science and Technology, P. R. China (2018), Second Prize of National Natural Science Award, P. R. China (2019), and Science & Technology Leading Talent, Ministry of Natural Resources, P. R. China (2021).

# Implication of 2.7Ga and 2.1-2.0Ga magmatic events in Fuping Complex, central of the North China Craton (chief researcher: DU Lilin)

The growth and cratonization of early crust are key subjects on the Precambrian geology. Hot debates occur on the Precambrian geological evolution of the North China Craton (NCC). Some researchers propose the NCC initiate cratonization in ca. 2.5 Ga, whereas others insist on the ca. 1.8 Ga. The early Neoarchean and Paleoproterozoic magmatism provides the vital constraints on the evolutionary history of the NCC. In this project we focus on the 2.7 Ga gneiss and 2.1-2.0 Ga granite in Fuping Complex, the middle of the NCC, and investigate the 2.7 Ga gneisses, late Archean supracrustal rocks and 2.1-2.0 Ga granites in south middle part of the Fuping Complex. Based on the field work, we collect 9 samples of 2.7 Ga gneisses and analyze on zircon U-Pb dating, Lu-Hf isotope and whole rock geochemical analyses, meanwhile, we collect samples from Nanying, Gangnan, Shangzhuang and Baiyangling units of 2.1-2.0 Ga granitods and finish the zircon U-Pb dating, whole rock analysis and Lu-Hf isotope. Additionally, we also yield the U-Pb ages of the supracrustal rocks in the Fuping Group. The results show that 2.7 Ga gneiss include two types in which one is dominant by tonalite (TTG) with minor quartz dioritic and dioritic gneiss, and the other is metaintermediate acidic volcanic rock. The TTG gneisses and volcanic rocks are likely formed in the subduct-related setting where TTG gneiss is partial melted from aqueous basic rock at the lower micro-block margin between two blocks, whereas the intermediate to acidic volcanic rock is derived partial melting from the upper block. We also distinguish the metamorphism and deformation in late Archean and yield the metamorphic ages of 2531±15 Ma and 1943±16 Ma in the Yuanfang Formation of the Fuping Group. The middle Paleoproterozoic magmatism concentrates at 2.1-2.0 Ga in the Fuping Complex that is dominated by monzogranite and potassic granite enriched in SiO2 and alkali with hightemperature A-type granite characteristics. Thus, we infer the 2.1-2.0 Ga granite formed in the rift-related environment. Combining previous research with our new data, we present the evolutionary process from early Neoarchean to late Paleoproterozoic in the Fuping Complex. Initial island arc occurred at the margin of Fuping micro-block in 2.7 Ga, in which hot lower subducted block partial melted to form the TTG, dominant by tonalite, and coeval volcanic rocks also happened in the upper block. In late Neoarchean, with the subduction continuing, subducted slab/block and thicken lower crust partial melted to form TTG and Fuping micro-block joined the initial cratonization process of the NCC with the intensive metamorphism and deformation in late Archean. In early Paleoproterozoic, The NCC kept a stable state with minor magmatism in local areas. In middle Paleoproterozoic, 2.2-2.0 Ga magmatism widely distributed in the NCC, which formed in inter-continental rift setting coeval with volcanic-sedimentary rock in different basins. Along the Trans-North China Orogen, 2.2-2.0 Ga magmatic rocks show different zones. Magmatic rocks with age of 2.1-2.0 Ga are dominant in Wutai, Lvliang and Zhongtiao, whereas 2.1-2.0 Ga magmatic rocks mainly occur in Fuping and Zanhuang, and the ages of rift-related basins also show the same feature. In late Paleoproterozoic, with the closure of rifting basins and thicken of the continental crust, the metamorphism widely occur in the Fuping Complex that indicate the finial cratonization of the NCC.

### Basu metamorphic complex, eastern central Tibet: implications for early Jurassic arc-continental collision along middle-eastern Bangong-Nujiang suture (chief researcher: LI Huaqi)

The Bangongco-Nujiang suture is an important tectonic zone in the central Qinghai-Tibet Plateau. However, its ancient ocean property and evolutionary history is unclear and continually controversial. This study focuses on the



recognition of structural deformation, tectonic thermo-chronology, magmatism of the early Jurassic tectonic event occurred within the Basu metamorphic complex, eastern Bangongco-Nujiang suture, which, together with tectonic thermo-chronological dating of the deformational rocks from the adjacent areas, is used to define the background, timing, tectonic and orogenic processes of the early Jurassic tectonism, which can further constrain the nature, early evolution and accretionary orogeny of the eastern Bangongco-Nujiang Ocean. Basu metamorphic complex is divided into the Tongka micro-contimental block and Jiayuqiao metamorphic terrane by the Tongka ophiolitic belt that has meta-basalts showing the N-MORB-type compositions. Structural work indicates that the Tongka block thrusted southwest over the Tongka ophiolitic belt. Mica and amphibole <sup>40</sup>Ar-<sup>39</sup>Ar dating on mylonitic rocks from thrustingcompressional belt and meta-basaltic rock from the Tongka ophiolitic mélange together yield early Jurassic ages of 180-176 Ma, suggesting from structural deformation (cooling) and ophiolite emplacement that the initial collision related to the early Jurassic tectonism should occur slightly prior to 180 Ma. Collision between the Tongka microcontimental block and Jiayuqiao metamorphic terrane can account for the early Jurassic orogenesis. Granitic rocks intruding into the Tongka ophiolitic mélange show the formation age of 178-176Ma that provide the post-collisional magmatic evidence constraining the timing of the early Jurassic orogeny. In addition, mica <sup>40</sup>Ar-<sup>39</sup>Ar dating for the Youxi schists to the northeast and Jiayuqiao schists to the southwest yields plateau ages of 240-250Ma and 124-128Ma, respectively. In summary, taking into account the tectonic outline of the multiple ophiolitic zones and magmatic belts in the region, these data suggest a sequential accretion orogenic model for the eastern Bangongco-Nujiang belt from northeast to southwest during the Triassic through early Jurassic to the early Cretaceous by varying level convergences by diverse-sized terranes/blocks with consumption of different oceanic basins. This definition indicates that opening of the Meso-Tethys after closure of the Paleo-Tethys may be not necessary.

# Rock assemblages and accretionary orogenic processes of the Lajishan mélange in the Central Qilian belt (chief researcher: WANG Tao)

Whether there was an early Paleozoic oceanic basin, as well as the subduction polarity of the oceanic basins and accretionary orogenic processes, there were great controversies in the Lajishan of the central Qilian orogenic belt. The work mainly studied the rock associations, formation environments, and ages of different rocks of the Lajishan mélange. Based on the detailed geological investigation and research, the Lajishan mélange was mainly composed of matrix and rock blocks and granites. The rock blocks included ultrabasic rocks, basic rocks, middle - Basic volcanic rocks, limestones, and cherts. The matrix was mainly composed of strongly deformed mudstone and siltstone. Analysis of rock geochemistry, isotopic tracing, and chronology showed that the volcanic rocks were formed in 476-460Ma, and had the characteristics of island arc volcanic rock, mid-ocean ridge, and oceanic island basalts respectively. The intrusive rocks formed in 438-452Ma, which were I-type granites. Abundant detrital zircons from the siltstone were predominantly early Paleozoic, and the youngest detrital zircon grains constrained the maximum depositional age of the Qingshipo formation was *ca*.  $455.5\pm6.2$  Ma. The data and results obtained in this work will help to carry out regional geological mapping and investigate the metallogenic geological setting and provide important data for the comprehensive and rational establishment of the Early Paleozoic tectonic evolution in the Qilian orogenic belt.

### Petrogenesis and geological significance of the early-Mesozoic mafic intrusions in the Lesser Xing'an Range-Zhangguangcai Range (chief researcher: FENG Guangying)

The Xing'an Mongolian Orogenic Belt (XMOB) is a collage of terranes that were amalgamated through the accretion of a series of micro-continental blocks during the Phanerozoic to the Mesozoic. The tectonic evolution of the XMOB was controlled mainly by subduction of the palaeo-Asian oceanic slab beneath NE Asia throughout the Palaeozoic, overprinted by subduction of the palaeo-Pacific plate during the Mesozoic–Cenozoic. Moreover, the XMOB are famous for its significant crustal growth in the Phanerozoic. The Lesser Xing'an-Zhangguangcai Range located



in the central of the XMOB. The present study focuses on the Early-Mesozoic mafic intrusions from the Lesser Xing'an Range-Zhangguangcai Range, based on the investigation of geochronology (zircon U-Pb) and geochemistry (mineral compositions, major and trace elements), aims to constrain the time and stages of the lithosphere extension, investigate the magma evolution and mantle metasomatism, discuss the nature of the mantle source, the petrogenesis and the geodynamic process of these rocks. These studies have led us to the following conclusions: (1) two major mafic magmatic events have been recognized in the Early-Mesozoic in the Lesser Xing'an-Zhangguangcai Range: 209-202 Ma and 188-182 Ma, respectively; (2) the 209-202 Ma mafic magmatic rocks distributed along the western margin of the Mudanjiang fault. They are highly coupled with the spatial distribution of Mudanjiang fault, and the mantle source of these rocks are slightly enriched and highly hydrated, which indicate that the mantle source experienced metasomatism of sediment-derived melts and fluids released by dehydration of the subducting slab, and mixed in the oceanic sediments of the intercontinental ocean basin. These magmatic assemblage may form in a continental margin arc environment which resulted from the westward subduction beneath the Songnen-Zhangguangcai Range of the Mudanjiang Ocean; (3) the 209-202 Ma mafic magmatic rocks are widely distributed throughout the Lesser Xing'an-Zhangguangcai Range to the Yanji area in NNE direction. These rocks can be divided into two types: the arc magmatic rocks which have been largely metasomatized by the slab-derived fluids or melts and the OIB-type magmatic rocks which have been unaffected by subduction-related fluids and/or melts. The OIBtype pluton represents a critical period of this magmatism, during which slab rollback induced corner flow and asthenospheric upwelling triggered partial melting initially occurred in the garnet stability field (>75-80 km) and then continued upward in the spinel stability field (<75 km). On the contrary, the arc mafic magmatic rocks derived from partial melting of the mantle wedge which has been metasomatized by the slab-derived fluids or melts. These processes occurred in an incipient continental back-arc environment in the upper plate of a palaeo-Pacific slab subducting W-NW beneath East Asia; (4) The occurrence of granodiorite and mafic magmatic enclaves (MMEs) suggstes continuous mantle derived magmatism and an extensional environment in the late Early-Jurrassic (~173 Ma). Mantle magmatic underplating resulted in partial melting of the lower crust and formation of the studied granodiorite, which indicates a lateral crustal growth.

# The metallogenesis of quartz-rich carbonate-hosted Pb-Zn deposits in the thrust-fold belt: A case study of the Malayer-Esfahan Pb-Zn metallogenic belt in Iran (chief researcher: LIU Yingchao)

This project mainly focuses on quartz-rich carbonate-hosted Pb-Zn mineralization in the Malayer-Esfahan foldthrust belt in the Zagros Collisional Orogen of Iran. It carried out the regional geological survey, deposit mapping, microthemometric measurements, and analyzed halogen contents combined with noble gas isotopes and H-O-S-Pb isotopes on the Pb-Zn deposits. The Pb-Zn deposits in the study belt formed when the Arabian and Eurasia plates collided (~65Ma). They were closely related to the dextral transpression structures. Secondary faults and facies transitions related to regional thrust faults control the ore bodies. Many deposits have a Pb+Zn association, though some contain small amounts of Cu. Sphalerite, galena, and pyrite are sulfide assemblages, while quartz, dolomite, calcite, and barite are non-sulfide assemblages. The main ore structures are vein, dissemination, and massive. Strong silicification and dolomitization are the primary alternations. Hydrothermal fluids are made up of a mixture of basinal brines with a low temperature and salinity and magmatic fluids with meteoric water, with a moderate temperature and salinity. The sulfur isotopes indicate that bacterial sulfate reduction and thermal sulfate reduction produced reduced sulfur for the sulfate might come from the dissolved marine sulfate in the connate water of the host carbonate rocks. The Pb isotopes suggest that the metals might come from the upper crust strata in the region. As a whole, the quartz-rich carbonate-hosted Pb-Zn deposits in the Malayer-Esfahan belt formed in a fold-thrust belt with complex structural and magmatic activities. The deposits are not simply MVT Pb-Zn deposits, but carbonatereplacement Pb-Zn deposits (CRD), which usually occur in the detrital of magmatic activities. However, the Pb-Zn mineralization process of these CRD deposits might be similar to that of MVT deposits in the Eastern Tethyan belt, though their fluid origins were more complex. It looks like these deposits can be explained as follows: Oblique



colliding, transpression structures and magmatic activity formation, and basinal brine infiltration leads to fluid gathering and trapping; organic and bacterial preparation leads to sulfate reduction and reduced sulfur formation; stress relaxing leads to fluid excretion, and fluid mixing leads to sulfide precipitation. There were 21 papers published in the project, including 11 SCI papers. Three students obtained master or doctoral degrees. The project was the first to answer the genesis of the quartz-rich carbonate-hosted Pb-Zn deposits in fold-thrust belts and provided original ideas for understanding regional metallogenic rules of the vast carbonate-hosted Pb-Zn mineralization in the Tethyan belt.

#### Study on Titanite (U-Th)/He Dating Technique (chief researcher: CHEN Wen)

For a long time, the experimental process suitable for the (U-Th)/He dating of titanite has not been developed, which is usually using the chemical digestion process of zircon. The experimental process is complex and the operation is dangerous, which limits the application of titanite in the (U-Th)/He dating. The main research content of this project is to establish the (U-Th)/He dating method through instrument debugging, hardware configuration and experimental process exploration; studying the diffusion behavior of He in titanite of different genesis and determining the closure temperature of He in titanite; Demonstrating study on the application of low temperature thermochronology in typical structural zones. The main achievements of the research work are as follows: (1) the experimental process of single grain titanite (U-Th)/He dating is established, including the experimental process of He isotope analysis, sample digestion and U, Th isotope analysis. The reliability of the experimental process is verified by using standard titanite samples. (2) The He diffusion characteristic parameters and He closure temperature of titanite in different genetic rocks were measured. At the cooling rate of 10°C/Ma, the closure temperature of He in titanite from tuff is 173°C(grain radius 74µm) and 198°C (grain radius 174µm), the closure temperatures of He in titanite from quartz diorite, K-feldspar granite and gneiss are 188°C, 195°C and 200°C respectively. (3) A number of applied research results of (U-Th)/He low-temperature thermochronology have been obtained: the late Paleozoic-Cenozoic tectonic thermal evolution process of Awulale area in the Middle Tianshan Mountains has been determined, which proves that this area has experienced three rapid cooling events in the late Paleozoic-Cenozoic, which occurred in 310Ma-230 Ma, 230Ma-150Ma and 40Ma to now respectively, and the maximum uplift is more than 5km; Mapping 1:50000 "denudation depth map of Xinmintun area, Linxi County, Inner Mongolia (since 160Ma)"; The tectonic evolution model of the Western Tianshan is established: collision orogeny in the late Paleozoic - Mountain collapse and strong exhumation in the Late Permian Triassic - slow planation in the Jurassic Early Cretaceous - Mountain reactivation in the late Cretaceous Eocene; The study shows that a significant uplift cooling event occurred in the southern margin of Daxinganling in the eastern part of the northern orogenic belt from Late Jurassic to early Cretaceous; The thermochronological study shows that the cooling history of the South Tianshan region shows great, temporal and spatial differences. The multi-stage cooling and exhumation events are mainly caused by the remote effect of multi terrane collision in the Tethys tectonic domain.

The scientific significance of the research results of the project is to help solve the lack of technology in the "temperature window" at 120°C-180°C of low-temperature thermochronology research, and promote the development and progress of low-temperature thermochronology research.

# **3.3 Results of Projects from the Ministry of Science and Technology Completed in 2021**

#### Deep structure and ore-forming process of main mineralization systems in the Tibetan Orogen (chief researcher: HOU Zengqian)

The main innovative achievements of the project are as follows:

(1) Multiple geophysical methods were employed to reveal the lithospheric structure of the Tibetan Plateau. The results show that: the subducting slab of the Indian continent had undergone north-south tearing and differential



subduction, and the subducting front appeared decoupling of the crust and mantle, that the crust terminated about 50km to the north of the Indus-Yarlung suture, wheras the mantle subducted northwardly further to the Bangong-Nujiang suture on a large scale, inducing the upwelling of the Asian asthenosphere; in the hinterland and southeastern margin of the plateau, large-scale discontinuous low-velocity anomalies are found with nearly equidistantly distributed. An innovative concept, "mantle channel flow", is proposed that the mantle flow is the deep mechanism that controls the large-scale growth of the plateau.

(2) Combined with zircon Hf isotope mapping, the deep seismic reflection data revealed the fine structure and architecture of the huge thick crust in the Gangdese belt, and shown that the southern, central and northern Lhasa terrane is characterized by different seismic reflection characteristics, Hf isotopic compositions and petrochemical components, suggesting that the new formed crust, the reconstructed crust and the ancient crust are juxtaposed spatially and Superimposed each other. It is put forward that the mantle-derived magma underplating and crustal tectonic shortening in the pre-collision and syn-collision period, is the key mechanism leading to the formation of the huge thick crust in the Gangdese collision belt.

(3) Research on multi-disciplinary comprehensive projects reveals the vital processes of deep ore formation in the two giant metallogenic belts, and different crustal blocks are observed to control different metallogenic zones and metal associations. Several factors have been suggested as critical as to large-scale mineralization in the main collisional orogenic belt, including the subduction and tearing of continental plates, pre-enrichment of metals in thickened crust, and the stable development of multistage magma chambers. While major constraints on large-scale mineralization in the side collisional orogenic belt are driven by thermodynamics of mantle channel flow, the exchange of materials within layers, and discontinuities of the lithosphere. The formation of large-scale lead-zinc deposits is a result of the lateral migration of crustal fluids and the extraction of metal along deep fault zones following collisions and compression.

(4) By comprehensive exploration and study of the Qulong-Jiama, Jinding, and Ailaoshan deposit concentration areas, it is possible to determine the three-dimensional structure of the collisional metallogenic system and the metallogenic source transport storage system, and to identify the development mechanism of the continental collisional metallogenic system. There have been established new metallogenic models of continental collisional porphyry copper deposit, fold thrusting MVT lead zinc deposit, and collisional orogenic gold deposit, which are quite different from the international popular classical metallogenic models.

(5) A geophysical exploration of the Zhaxikang-Cuonadong Deposit Concentration Area was conducted and a 3D geological and geophysical model was developed to hydrate the deep area (0-3000m) of the deposit. A technique that detects the location and occurrence space of deep ore bodies, and that guides the deep and peripheral W-Sn-Be-Pb-Zn deposits outside of the mining area to gain significant breakthroughs in the prospecting process.



The Institute won the second-class prize in Land and Resources Science and Technology Award in 2020



Late Paleozoic ridge subduction and porphyry mineralization in the Central Asian orogenic belt, the research achievement of the team led by Research Professor YIN Jiyuan, has organically researched magmatic rocks, structural styles, and mineralization in the West Junggar of the Central Asian orogenic belt and determined the special rock assemblage, structural styles, and metallogenic effects under the ocean ridge subduction, which has important reference significance for identifying the ocean ridge subduction and mineralization that may have occurred in other regions.

# Two achievements of the Institute selected in the "Top Ten Advances in Geological Science and Technology" in 2021

Two achievements led by the Institute were selected in the "Top Ten Advances in Geological Science and Technology" of CGS and CAGS in 2021, namely, "Research of Chang'e-5 basalt indicating the magmatic activity still existed on the Moon about 2 billion years ago" and "Revision of Lead Isotopic Composition and Lead Atomic Weight of Earth Material".

"Research of Chang'e-5 basalt indicating the magmatic activity still existed on the Moon about 2 billion years ago", led by LIU Dunyi and participated by CHE Xiaochao, LONG Tao, WANG Chen, *etc.*, firstly proved that the Moon still had magmatic activity 1.96 billion years ago, secondly, confirmed that the Chang'e-5 basalt originated from the lunar mantle. Thirdly, this age constrains the lunar impact chronology of the inner Solar System and the thermal evolution of the Moon.



"Revision of Lead Isotopic Composition and Lead Atomic Weight of Earth Material" was led by ZHU Xiangkun and participated by BENEFIELD Jacuelline, COPLEN Tyler, GAO Zhaofu, *etc.* (i) Based on the classification of samples, the lead isotope data of each kind of samples were statistically analyzed, and the variation range of lead isotope composition was determined; (ii) By calculating the atomic weight of lead in each sample, the minimum and



maximum atomic weight of lead in each type of sample are determined; (iii) Based on the analysis of the calculated results of all samples, it is determined that the minimum value of lead atomic weight is  $206.1462 \pm 0.0028$ , and the maximum value is  $207.9351 \pm 0.0005$ ; (iv) For the first time, it is clearly proposed that the atomic weight of lead is not a constant, the variation range of the atomic weight of lead in ordinary earth samples is determined, and the atomic weight value of lead for teaching purposes is given. (v) Based on the research results, the International Commission on Isotopic Abundances and Atomic Weights (CIAAW) issued a notice under the authority of the International Union of Pure and Applied Chemistry (IUPAC), announcing that the atomic weight of lead was revised from  $207.2 \pm 0.1$  to the interval value [206.14, 207.94].



### On September 30, Research Professor Marie-Luce CHEVALIER was awarded the "Friendship Award of the Chinese Government".



Marie-Luce CHEVALIER born in 1979, dual Belgian and French national, is an international expert in active tectonics and tectonic geomorphology of the Tibetan Plateau. In 2010, she started working full-time at the Institute of Geology, Chinese Academy of Geological Sciences as a "Huang Jiqing Young Talent". In 2015, she obtained the qualification of postgraduate tutor. Two PhD and one master students already graduated, and she has an additional 2 ongoing PhD students. She has been in China for almost 12 years, and has long been devoted to doing research on active tectonics, earthquake hazard, and paleoclimate change on the Tibetan Plateau. She has published 20 papers as first and/or corresponding author in top international journals such as Science, Earth and Planetary Science Letters, *etc.*, as well as 37 as co-author. In 2020, she was awarded the "Tenth Huang Jiqing Youth Geological Science and Technology Award" by the Geological Society of China. She presided over the key international cooperative research projects of China-France and China-Belgium National Natural Science Foundation of China, and

directly promoted bilateral and multilateral cooperative research in geosciences between China and the United States, Germany, and Switzerland. The earthquake hazard evaluation system, as well as the earthquake hazard evaluation and prediction in the southwest region and along the Sichuan-Tibet railway construction, provided important technical support, and contributed to the development of geological science theory and understanding in the fields of active structures on the Tibetan Plateau and large-scale fault zones. She introduced a number of famous French scientists to participate in the earthquake disaster assessment of the Tibetan Plateau in China, and helped Chinese scholars and students to conduct exchanges and further studies at the University of Lyon, Grenoble-Alpes University, and the Strasbourg Institute of Geophysics, *etc.*, to build a bridge of friendship for scientific research and academic exchanges between China and France.



On August 18, Research Professor SONG Yucai was supported by the NSFC Fund for Distinguished Young Scholars



Yucai Song, a research professor from the Research Center of Mineral Resources and Energy Geology. He works mainly on Mississippi Valley-type (MVT) Zn-Pb deposits from the Himalayan-Tibetan and Zagros orogens. He has provided convinced evidences that continent collision-related fold and thrust belts are important tectonic settings for MVT Zn-Pb mineralization, identified evaporite diapirs serving as important traps for MVT Zn-Pb ores, and established a genetic model for MVT mineralization processes in fold and thrust belts. Together with his colleagues, he proposed that the continent collision-related fold and thrust belt, rather than the foreland, was the target for prospecting MVT ores in the northern Sanjiang orogen, and predicted the locations of deep-buried main orebodies in the Duocaima deposit after he determined the ore controls and accomplished the geophysical survey, which helped the finding of more resources in the deposit. Now, Duocaima is a world-class Zn-Pb deposit worth more than one hundred billion yuan.

He is now in charge of the NSFC National Outstanding Youth Fund, the National Key Research and Development Program, and the NSFC Key Project Fund. He earned the first-prize of the Land Resources Science and Technology Award (R3/15) in 2016. He published over 80 papers in the academic journals such as *"Economic Geology"*, *"Economic Geology Special Publication"*, and *"Mineralium Deposita"*. He is the regional vice president of SGA, associate secretary general of the Committee of Regional Geology and Metallogeny, Geological Society of China, (guest) editors of "Deposit Geology" and "Science Bulletin", and the member of the Innovation Team in Key Areas "Metallogenesis of Continent Collision", the Ministry of Science and Technology.

On November 5, the Ministry of Natural Resources announced the list of talents and teams selected for the "High-Level Scientific and Technological Innovation Talent Project" of the MNR in 2021. Two of our institute were selected into the second echelon, four were rated as scientific and technological leading talents, nine were rated as young scientific and technological talents, and one research team was rated as scientific and technological innovation team.

No.	Name of the talent/team	Talent type
1	LI Haibing	the Second Echelon Talent
2	SONG Yucai	the Second Echelon Talent
3	LU Zhanwu	Scientific and Technological Leading Scientist
4	SHI Yuruo	Scientific and Technological Leading Scientist



5	ZHANG Hongrui	Scientific and Technological Leading Scientist
6	ZHANG Jin	Scientific and Technological Leading Scientist
7	DONG Hanwen	Young Scientific and Technological Talents
8	HU Peiyuan	Young Scientific and Technological Talents
9	LIU Pinghua	Young Scientific and Technological Talents
10	LONG Tao	Young Scientific and Technological Talents
11	SUN Jian	Young Scientific and Technological Talents
12	TIAN Zhonghua	Young Scientific and Technological Talents
13	XIONG Fahui	Young Scientific and Technological Talents
14	YANG Ben	Young Scientific and Technological Talents
15	YIN Jiyuan	Young Scientific and Technological Talents
16	YAN Zhen/Innovation Team on Sedimentary Geotectonics and Composite Orogeny	Scientific and Technological Innovation Team

In the 2021 National Region Geological Survey Excellent Maps Exhibition of CGS, the Institute won 1 brilliant map and 2 excellent maps.

Brilliant map:

"1:50000 active fault map of the Zheduoshan-Kangding segment of the Xianshuihe fault zone"

Main finishers: **PAN Jiawei,** LI Haibing, CHEVALIER Marie-Luce, SUN Zhiming, LIU Dongliang









Excellent map: "Thematic geological map of the Tuomoerrite mélange, North Qaidam belt"

硕 张文龙

Main finishers: FU Changlei, YAN Zhen, CHEN Lei, LI Junhui, LI Wufu

Excellent map: "Thematic geologic map of the Shuangjing-Bilutai area"

Main finishers: LIU Jianfeng, LI Jinyi, ZHAO Shuo, ZHANG Wenlong, GE Maohui





## Platform for Technology Innovation 2021

# The Institute was officially approved to build the National Field Scientific Observation and Research Station

On October 11, the MNR issued a notice approving the construction of 69 national field scientific observation and research stations, among which the "Jiangsu Donghai Continental Deep Hole Crustal Activity National Observation and Research Station" of the Institute is listed. This is the first national observation and research station approved by the Institute and one of the five national field stations approved by the MNR at the same time.



# The Institute won the excellent award in the open sharing of major scientific research infrastructure and large-sacale scientific research instruments by the Ministry of Science and Technology and the Ministry of Finance in 2021

On December 2, the general office of the Ministry of science and technology and the general office of the Ministry of Finance jointly issued the notice on the "open sharing of evaluation and assessment results of major scientific research infrastructure and large scientific research instruments of central universities, scientific research institutes and other institutions in 2021". A total of 346 units from 25 departments across the country participated in the assessment, involving 42000 sets of scientific research instruments with an original value of more than 500,000 yuan. Including 50 units, the Institute has been evaluated as excellent, which is the third consecutive year.

By the end of 2021, the Institute has 65 sets of large-scale scientific research instruments with a unit price of more than 500,000 yuan, with an original value of 152.79 million yuan. Among them, there are 24 sets of rock, mineral, element and isotope analysis instruments, 6 various microscopes, 12 geophysical equipment and 23 other instruments. They can provide Ar-Ar dating, ICPMS laser U-Pb dating, electron probe analysis, SHRIMP U-Pb dating, non-traditional isotope determination of Mg,F, Sr Nd Pb isotope determination, (U-Th)/He dating and other services. The large-scale instruments are placed in the headquarter of BaiWanzhuang, Beiqing Road Base and the SHRIMP Center, giving priority to testing needs of the Institute, ensuring the completion of the key work of the Institute, and actively carrying out opening-up to promote cooperative research and academic exchanges inside and outside the Institute.



# **2021** Platform for Technology Innovation

No.	Name of the instrument	Model	Contact person	<b>Contact informaton</b>
1	Thermal ionization mass spectrometer	MAT262	PAN Chenxu	010-68999755
2	High sensitivity, high resolution secondary ion probe Mass spectrometer	SHRIMP-II	WANG Chen	010-56833555
3	Multiple receiver inductively coupled plasma mass spectrometer	NU PLASMA HR	LI Zhihong	010-68995979
4	Noble gas mass spectrometer	Helix MC	ZHANG Yan	010-68999758
5	Electron probe	JXA-8100	MAO Xiaohong	010-68995044
6	3D laser scanner	VZ-1000	PAN Jiawei	010-68992879
7	Fission track analysis system	M2m	LIU Dongliang	010-68990664
8	Helium isotope dating quadrupole mass spectrometer	Alphachron MKII	SUN Jingbo	010-68999819
9	Laser ablation multiple receiver plasma mass spectrometer	neptune plus	NIU Xiaolu	010-68990674
10	Rock fabric analyzer	Quanta 450 FEG	LIANG Fenghua	010-68995044
11	Scanning electron microscope - cathode light system	Nova NanoSEM 450	XU Xiangzhen	010-68990674
12	High resolution cathodoluminescence combiner	ULTRA plus	WANG Fang	wangfang_mr@163. com
13	High-resolution laser microscope confocal raman spectrometer	LabRAM HR Evolution	WANG Chen	010-56833555
14	Fourier transform infrared spectrometer	VERTEX 70v	FENG Guangying	010-68990674
15	Scanning electron microscope	EVO 18	ZHANG Jin	zhangjinem@sina.com
16	Thermal field emission scanning electron microscope	MERLIN COMPACT	CHE Xiaochao	010-56833633
17	Carbon and nitrogen isotope analysis system	IsoPrime100	WANG Yong	010-68999683
18	Single inclusion/mineral micro area composition analysis system	7900ICPMS+nwr-193UC	YANG Zhiming	010-68992350
19	Thermal ionization mass spectrometer	TIMS	LI Shizhen	010-68995979
20	Electron-Ion dual beam	Versa 3D LoVac	XIONG Fahui	xiongfahui@126.com
21	Transient electromagnetic instrument	V8	YANG Zhiming	010-68992350
22	High precision gravimeter	CG-5	YU Changqing	010-68997371
23	High resolution 3D computed tomography system	X-TEK XTH225ST	CHEN Shouming	ming1003@163.com
24	High resolution microscopic transmission raman spectrometer	HR Evolution	ZHANG Cong	congzhang@pku.edu.cn
25	Multi-receiver inductively coupled plasma mass spectrometer	Nu plasma II	ZHU Zhiyong	010-68999755
26	Integrated mineral analyzer	TIMA3-X LMH	DONG Xin	010-68999744
27	Multiple collector secondary ion mass spectrometry	SHRIMP IIe-MC	WANG Chen	010-56833555



### International Cooperation and Academic Exchange 2021

#### **6.1 Attendance at International Conferences**

The HAYABUSA 2021, 8th Symposium of the Solar System Materials was held with an Online Meeting System from 15 to 18 November 2021. Prof. LIU dunyi and CHE Xiaochao were invited to attend and provided an oral presentation on "The young basalts on the Moon: Pb–Pb isochron dating in Chang'e-5 Basalt CE5C0000YJYX03501GP."



### 6.2 Foreign visits by members of the Institute

Invited by Giulio Di Toro, a full Professor on Structural Geology (also a Member of European Academy of Sciences). Dr. WANG Huan visited the University of Padua since 24, October, 2021, to conduct a collaborative research on the mechanics of seismic faulting, also related to the 2008 Wenchuan Mw7.9 earthquake.





# **2021** International Cooperation and Academic Exchange

Dr. ZHU Zhicai went to the University of Bristol for postdoctoral cooperative research in March 2021, through the 'Postdoctoral International Exchange Program'. Co-supervised by Professor Reaearcher LIU Yongqing in the Institute and Prof. Michael J. Benton in the University of Bristol and Dr. Andrew J. Newell from the British Geological Survey, Dr. ZHU mainly works on sedimentology and palaeoclimate change across the terrestrial Permian-Triassic crisis boundary in eastern Ordos basin, North China. This study is significant to better understand the relationship between biotic evolution and environmental change.



Funded by the Chinese Scholarship Council, PhD student TENG Xia studies at the University of Göttingen for one year. Invited by Prof. Thomas Müller (professor of metamorphic petrology), TENG Xia started her visiting study at the University of Göttingen on August 29th, 2021. Presently she is using the experimental petrology method to investigate the mechanism of reaction textures in high-grade metamorphic rocks.





# International Cooperation and Academic Exchange 2021

#### 6.3 Academic Visitors to the Institute

On Nov. 9, Prof. ZHANG Zeming invited Prof. Matthew J. KOHN from the United States of American to visit the Institute. Prof. Kohn presented us a fascinating workshop entitled "Long-lived (>20 Myr) partial melts in the Greater Himalaya – evidence and geodynamic implcations", which is held both online and offline. The on-site discussion was lively and received a good response.



#### 7.1 Important Academic Activities

In 2021, the Institute held a total of 18 academic conferences and 49 academic reports. The academic atmosphere was activated mainly through the Geoscience Lecture Hall, HUANG Jiqing Geoscience Frontier Forum, Geoscience Frontier Reports and general academic reports, forming a "four-in-one" academic activity system.



#### The 2021 Academic Workshop of the Institute of Geology, January 18, 2022

To facilitate the exchange and discussion of scientific and technological results obtained during 2021, the Institute of Geology held its 2021 Academic Workshop on 18 January, 2022. According to the current needs of the prevention and control of the COVID-19, the meeting was conducted in a combination of on-site and online meetings. More than 300 people, including Academician LI Tingdong, Academician HOU Zengqian, Director XIAO Guiyi and Secretary of the Party committee Xuyong, as well as scientific researchers and graduate students from the Institute, attended the meeting.

The meeting focused on the work progress and research highlights of the Institute in 2021, and 28 scientific researchers were invited to give reports. Academician HOU Zengqian introduced in detail the idea and scheme of establishing the State Key Laboratory of deep earth science and exploration technology; Research Professor LI Haibing introduced the construction scheme and progress of the "Jiangsu Donghai Continental Deep Hole Crustal Activity National Observation and Research Station "; Research Professor SONG Yucai, a new "Distinguished Young Scholar", made a report on the latest research results on Re-Os dating and genesis of pyrite in MVT deposit.

# The first "HUANG Jiqing Geoscience Frontier Forum" of the Institute was successfully held

On 20 July 2021, the first "HUANG Jiqing Geoscience Frontier Forum" of the Institute was successfully held. At the invitation of Academician HOU Zengqian Academician DAI Minhan, a marine chemist, attended the forum as a special guest and made a theme report on carbon neutralization, carbon cycle and marine carbon sink. Director XIAO Guiyi attended and Academician HOU Zengqian presided over the meeting.

The report is wonderful in content, which enables geologists to further understand carbon neutralization, carbon cycle and marine carbon sink from different angles and levels. The participating experts are deeply inspired and benefit a lot. During the questioning session, the participants had a heated and in-depth discussion with Academician Dai. The meeting was conducted by combining on-site and online video conference, with more than 100 on-site participants and more than 370 online participants.

Academician HUANG Jiqing (1904-1995) of the Institute is one of the pioneers and important founders of



modern Chinese geology. He is known as a great master in the field of Geology and a famous structural geologist, stratigraphic paleontologist and petroleum geologist in China. In order to commemorate Mr. HUANG Jiqing's outstanding contribution to the geological cause of the motherland, carry forward his patriotic and professional virtues and rigorous style of study, and express his respect and memory for Mr. Huang Jiqing, our institute specially held the "Huang Jiqing Geoscience Frontier Forum". The forum is intended to be an academic stage for "gathering academic experts and colliding with ideological sparks", and invite well-known geoscientists at home and abroad to carry out extensive exchanges and discussions on major scientific issues at the frontier and interdisciplinary of Geosciences, as well as basic and strategic geoscience issues facing national needs.



#### 7.2 Science Popularization in 2021

The institute was rated as the "2021 Science Popularization and Research Base" by the Geological Society of China.

#### **Science Popularization Activities**

The experts of the Institute carried out 19 popular science activities of various types, including lectures and research practice. There were about 3500 offline popular science audiences and a wide range of live popular science audiences.

-35-

#### The Sea and Land

On May 25, Academician LI Tingdong and Dr. Liu Yong were invited to Zhongguancun No. 2 primary school in Haidian District, Beijing to give a lecture on geological science popularization, which brought a knowledge feast to more than 560 first-year students and teachers to show the changes and evolution of nature on land and sea.







#### Loess and Stone: the Beauty of Geology

On June 8, Research Professor SU Dechen gave a lecture on geological science popularization to about 300 teachers and students of Yan'an Experimental Primary School: Lloess and Stone - the Beauty of Geology.

#### What is the use of geology

At the invitation of the lecture hall of the China Science and Technology Museum, Associate Research Professor DNG Hanwen made a speech entitled "what is the use of geology?" Nearly 3000 people watched online.



【甲科爾乙州至目預研裡】 (地長学到底有什么用?》 时间:2021年10月1日(周五)10.00-11:30 题目:《地质学到底有什么用?》 系列:好奇心想象力系列拼座 嘉宾:董汉文(中国地质科学院地质研究所,博士、副研究员)



#### The Story of the High Mountains

On May 17, Dr. ZHAO Zhongbao held a popular science lecture - the story of Gao Shan at the invitation of the Junior High School Department of Beijing Xicheng Foreign Language School.

#### **Science Popularization Products**

The Institute published one popular science book this year. Officially published 13 popular science papers in magazines and 14 articles on wechat official account. In terms of popular science videos, the latest scientific research achievements of the Chang'e No. 5 sample have been reported twice on the CCTV news channel. The Institute participated in the production of 3 popular science documentaries on CCTV and Beijing Satellite TV, produced and released 7 popular science videos on the Tencent video platform, produced nearly 100 popular science short videos on the wechat video, and shared 8 episodes of short video "Geological Wonders Series" in the geological cloud.





<b>学习强国</b> 中共中央宣传部"学习强国"学习平台	陨石:揭示太阳系	形成与演化的标本	(1)     (
蛇绿岩: 定位远古海洋的"坐标" 3	<text><text><text><text><text></text></text></text></text></text>	<text><text><text><text><text></text></text></text></text></text>	



Some popular science products published or participated in by the Institute in 2021

#### 7.3 Other Important Activities Organized and successfully passed the Performance Appraisal of Central Scientific Research institutions in 2021

In early November, the Institute was selected as one of the central scientific research institutions that participated in the performance evaluation in 2021. On November 16, it passed the expert review of performance indicators organized by the Ministry and Bureau. On December 2, it passed the third-party evaluation of MNR and reported to MOST. On December 23, it successfully passed the performance evaluation of MOST.



### Won the excellent award in the "2021 Responsibility Assessment of Scientific and Technological Innovation Objectives" among units directly under the China Geological Survey.

In January 2022, China Geological Survey issued a notice on the assessment results of the responsibility of scientific and technological innovation objectives in 2021. The Institute and five other units were assessed as "excellent".



# Signed a strategic cooperation agreement with the Department of Natural Resources of Tibet Autonomous Region

On September 26, XIAO Guiyi, director of the Institute, led a team to visit the Department of Natural Resources of Tibet Autonomous Region (DNRTAR) for investigation and signed a strategic cooperation agreement.

The signing of this strategic cooperation agreement will definitely promote deeper friendship and a more solid foundation for cooperation, which is of epoch-making significance. Based on the strategic cooperation agreement, the two sides will follow the principle of "complementary advantages, win-win cooperation and synergistic development", adhere to the demand-oriented approach, strengthen communication, pragmatically promote business cooperation and jointly create a new situation in the natural resources business in Tibet.



#### Won the "Excellent Organization Award" of the 5th National Youth Geology Conference

In July, the 5th National Youth Geology Conference initiated by the Youth Work Committee (YWC) of the Geological Society of China was held in Guiyang. Many young scientists from the Institute actively participated in the organization. The Institute was affirmed by YWC and won the "Excellent Organization Award". Associate Research Professor DONG Hanwen received the award on behalf of the Institute.





### Postgraduate Education 2021

In 2021, a total of 15 doctoral students and 18 master's students graduated successfully and obtained degrees. As the backbone of the project, they have participated in 76 scientific research projects of the Institute and published 73 papers as the first author, including 33 English SCI, 13 Chinese SCI, 13 EI and 14 core papers; Two of them were supported by the Chinese Scholarship Counil (CSC).



Graduation video for graduates

#### Summer camp activities for College Students

From July 13 to 20, the Institute organized the third Longmen Mountain summer camp for outstanding college students. 22 college students majoring in Geosciences from 17 domestic universities, including China University of Geosciences (Beijing), Jilin University, Ocean University of China and Hehai University, participated in the summer camp. During the 8-day trip, the campers investigated the surface fractures, geological disasters and earthquake relics caused by the 2008 Wenchuan Earthquake, and visited the scientific drilling field monitoring base and the red patriotic education base in the Wenchuan Earthquake fracture zone. This activity stimulated students' interest and patriotism in exploring Earth Sciences.









# Field investigation for postgraduates and red education activities of May 4th Youth Day

From May 10 to 11, the Personnel Education Department organized graduate students to carry out field investigation in Yunmeng Mountain Area of Miyun and visited the memorial hall of BAI Yihua. XU Yong, Secretary of the Party committee of the Institute, and Associate Researcher GUO Lei led the team. This activity improved the students' field work practice ability, broadened their knowledge, enhanced the exchange between students and inherited the patriotism of the May 4th Movement.







### Table 1-1 Projects funded by the National Natural Science Foundation of China (NSFC)

	National Science Fund for Distinguished Young Scholars				
No.	Chief Investigator	Project	Duration	E-mail address	
1	YANG Zhiming	Economic Geology	2019-2023	zm.yang@hotmail.com	
2	SONG Yucai	Metallogenesis of Mississippi Valley-type Pb-Zn deposits	2022-2026	song_yucai@aliyun.com	
		<b>Excellent Young Scientists Fund</b>			
No.	Chief Investigator	Project	Duration	E-mail address	
1	LIU Yan	Genesis of carbonatite-related REE deposits	2020-2022	ly@cags.ac.cn	
2	LIU Yingchao	Mineral Deposit	2020-2022	lychappy@126.com	
		Key Projects			
No.	Chief Investigator	Project	Duration	E-mail address	
1	JIN Xiaochi	Permo-Triassic paleogeography of eastern Tethys: paleontological, sedimentological and paleomagnetic evidence from western Yunnan and	2017-2021	jinxchi@cags.ac.cn	
2	ZHANG Jianxin	Linking metmorphism with orogensis: insight from early Paleozoic orogenic system in the northeastern Tibet	2017-2021	zjx66@yeah.net	
3	WANG Tao	Deep juvenile and old composition, architecture and genesis of the largest juvenile crustal region in the Central Asian Orogenic Belt	2019-2023	taowang@cags.ac.cn	
4	LI Haibing	Mechanism of seismic rupture propagation in the Longmen Shan Fault	2019-2023	lihaibing06@163.com	
5	CHEN Wen	Development of high procision and high resolution laser miceoprobe system for in situ noble gas isotope analysis	2022-2026	chenwenf@vip.sina.com	
6	WAN Yusheng	The formation and evolution of the oldest continental crust in China	2022-2026	wanyusheng@bjshrimp.cn	
		International (Regional) Cooperation and Excha	nge Projects		
No.	Chief Investigator	Project	Duration	E-mail address	
1	YANG Jingsui	Diamond in Oceanic Peridotites -Chromitites and Deep Recycled Mantle in the Global Ophiolite Record	2018-2022	yangjsui@cags.ac.cn	
2	Marie-Luce CHEVALIER	Tectonic geomorphology and imaging of geohazard effects along two major strike-slip faults in Central Asia and China	2020-2021	mlchevalier@hotmail.com	
3	Marie-Luce CHEVALIER	Spatio-temporal variation of kinematic characteristics and seismic hazard assessment along the Xianshuihe fault system	2021-2025	mlchevalier@hotmail.com	
4	LI Shan	Crustal evolution in accretionary orogens: origin and significance of post-accretion magmatism in the Central- Asian Orogenic Belt and the Arabian-Nubian Shield	2021-2024	lishan428@163.com	





	Major Research Plan				
No.	Chief Investigator	Project	Duration	E-mail address	
1	LIU Fulai	Multiple metamorphic events of Paleo-Tethys to Neo- Tethys evolutions: constraints on the collisional orogeny between ocean (or continent)	2019-2022	lfl0225@sina.com	
2	ZHANG Zeming	Metamorphism, anataxis and magmatism of the eastern Gangdese magmatic arc: Implications for the growth and reworking of the continental crust	2019-2022	zzm2111@sina.com	
3	SONG Yucai	Mississippi Valley-type (MVT) lead-zinc deposits in fold and thrust belts during continental collision: comparison between the Tibetan and Zagros orogens	2019-2022	song_yucai@aliyun.com	
4	YANG Zhiming	Origin of porphyry Cu deposits in postcollisional setting: case studies from the Gangdese belt in southern Tibet	2020-2023	zm.yang@hotmail.com	
5	LI Qiusheng	Crust-Mantle Interaction and Deep Background of Tungsten Mineralization in Nanling-Wuyi Conversion Zone	2020-2022	lqs1958@163.com	
6	LU Zhanwu	Studies of the lithospheric stucture and its relationship to deep background of beryllium-tin-tungsten polymetallic mineration in the Cuonadong Dome, southern Tibet	2020-2022	luzhanwu78@163.com	
7	ZHANG Hongrui	The enrichment and emplacement mechanism of cobalt in the Lanping-Simao cobalt belt, western Yunnan	2020-2022	hongrui_1982@126.com	
8	ZENG Lingsen	Mesozoic magmatism in the Himalayan orogenic belts and the tectonic processes along the Northern Indian continental margin	2021-2024	zenglingsen@cags.ac.cn	
9	YANG Tiannan	Reconstructing the Neotethyan subduction kinematics of the Zagros orogenic belt	2021-2024	yangtn@cags.ac.cn	
10	PAN Xiaofei	Metallogenesis of superlarge W-Cu ore systems in South China: exsampled byZhuxi and Dahutang ore deposits	2021-2024	pan_smile0551@sina.com	
11	LIU Fulai	Properties of multiple major metamorphic-tectonic deformation events and their constraints on the migration- enrichment process of the critical metal cobalt in the composite orogenic belt	2021-2024	lfl0225@sina.com	
12	JIN Xiaochi	Comparative study of Late Paleozoic sedimentary successions and paleontological records of the tectonic units in western Yunnan and Southeast Asia: refining our understanding of the evolution of Paleo-Tethys	2022-2025	jinxchi@cags.ac.cn	
13	YANG Zhiming	Tethyan metallogeny	2022-2025	zm.yang@hotmail.com	
14	WANG Tao	Map compilation of granitoids and critical metal deposits of China	2022-2025	taowang@cags.ac.cn	
15	LIU Yan	Enrichment of REE in carbonatite magma source area and its dynamic background	2022-2025	ly@cags.ac.cn	
16	ZHU Xiangkun	Strategic Research: Study on Development Strategy of Metal Stable Isotope Geochemistry	2022.01 - 2022.12	xiangkun@cags.ac.cn	



No.	Chief Investigator	Project	Duration	E-mail Address
1	LIU Yan	Contribution of metasomatism in carbonatited mantle and dissolution of fluids from carbonatitic melts to the formation of giant Maoniuping REE deposit in Sichuan, China	2018-2021	ly@cags.ac.cn
2	HE Zhenyu	Xingxingxia area, Eastern Xinjiang, NW China: Petrogenesis and their implications for the composition of the ancient crust	2018-2021	ahhzy@163.com
3	ZHANG Hongrui	Cenozoic deformation and related Pb-Zn-Cu mineralization in the Lanping basin	2018-2021	hongrui_1982@126.com
4	JIA Jianliang	Efficiency and mechanism of organic carbon burial in Cretaceous lacustrine fine-grained sediments: Insights from mineral surface protection in an anoxic environment	2018-2021	jiaj10228@163.com
5	SU Dechen	Meso - Neoproterozoic seismic records and multi-stage rifting in the North China Craton	2018-2021	sudechen@163.com
6	DU Lilin	Implication of 2.7Ga and 2.1-2.0 Ga magmatic events in Fuping Complex, central of the North China Craton	2018-2021	dulilin7310@cags.ac.cn
7	WANG Fang	Multiple metamorphism and geochronology of metamorphic complex in southwestern margin of Yangtze Block	2018-2021	wangfang_mr@163.com
8	WANG Wei	The Neoarchean anatexis of the eastern North China Craton and its geological significance	2018-2021	wuchangyuww@sina.com
9	LIU Jianhui	The nature of the polyphase magmatic events and metamorphic volcanic-sedimentary successions in the Kuandian area: Constraint on the tectonic setting of the Paleoproterzoic Jiao-Liao-Ji Tectonic belt	2018-2021	liujianhui1999@163.com
10	LI Huaqi	Basu metamorphic complex, eastern central Tibet: implications for early Jurassic arc-continental collision along middle-eastern Bangong-Nujiang suture	2018-2021	muzi_7540@163.com
11	LI Yuan	Study on the deformation-metamorphism sequences of the Xigaze ophiolite in South Tibet, China: Implication for the evolution of the Neo-Tethyan ocean	2018-2021	liyuancags@126.com
12	LI Shan	Petrogenesis of Triassic granitoids in Sumatra, Indonesia constraint on continental crust formation and evolution of the southern Paleo-Tethys	2018-2021	lishan428@163.com
13	WANG Tao	Rock assemblages and accretionary orogenic processes of the Lajishan mélange in the Central Qilian belt	2018-2021	real_wt@126.com
14	SUN Jian	The recycling of marine sediments and rare-earth-element mineralization: a multiple-isotope study	2018-2021	sunjiantc@163.com
15	FENG Guangying	Petrogenesis and geological significance of the early- Mesozoic mafic intrusions in the Lesser Xing'an Range- Zhangguangcai Range	2018-2021	fengguangying198@163. com
16	LIU Yingchao	The metallogenesis of quartz-rich carbonate-hosted Pb-Zn deposits in the thrust-fold belt: A case study of the Malayer- Esfahan Pb-Zn metallogenic belt in Iran	2018-2021	lychappy@126.com





17	SONG Yucai	Giant accumulations of barite and metals in the world-class Mehdiabad Pb-Zn deposit, Iran	2018-2021	song_yucai@aliyun.com
18	CHEN Wen	Study on Titanite (U-Th)/He Dating Technique	2018-2021	chenwenf@vip.sina.com
19	ZHANG Hongshuang	The study on lithospheic geometry and extensional mechanism in southeastern China-Receiver function analysis of dense broadband seismic array	2018-2021	zhs1981@126.com
20	WANG Xuri	New discoveries of fossil birds from the Jehol Biota in the Great Khingan Range area of Northeast China and their palaeogeographic	2019-2022	wang198109@163.com
21	LIU Pengju	Microfossils from the early Cambrian in the Yangtze Platform and its biostratigraphic signification	2019-2022	pengju@cags.ac.cn
22	JI Shu'an	Study on the Late Cretaceous protoceratopsid fauna from Alxa region, Inner Mongolia	2019-2022	jishu_an@sina.com
23	HUANG Hao	paleogeographic analysis of Permo- Carboniferous fusulinids in the Changning-Menglian Belt, western Yunnan	2019-2022	geohaohuang@gmail.com
24	ZHANG Zeming	High-grade metamorphism and partial melting of the eastern Himalayan orogen	2019-2022	zzm2111@sina.com
25	SHEN Tingting	Petrology and exhumation mechanism of ultradeep subducted serpentinites and enclosed eclogites from southwestern Tianshan	2019-2022	ttshen@pku.edu.cn
26	TIAN Zuolin	High-pressure metamorphism and collision orogenic processes of the micro-massifs from the central-eastern Bangong-Nujiang Suture Zone	2019-2022	zuolintian@163.com
27	DONG Xin	Metamorphism and partial melting of the metabasic rocks in Yadong region, Himalayan orogen	2019-2022	dongxin5811935@163. com
28	WU Cailai	Petrogenesis of Palaeozoic granites in the southern Altun terrane and their significance in continental dynamics	2019-2022	wucailai@126.com
29	HE Bizhu	The paleogeography evolution from Middle to Late Ordovician in the central and northern parts of the Altun, NW China	2019-2022	hebizhu@cags.ac.cn
30	CAI Jia	Phase equilibria modeling on the metamorphic evolution of the Bengbu high-pressure mafic granulite in the southern margin of the North China Craton and its petrogenesis	2019-2022	caijia91052@126.com
31	XIE Hangqiang	Neoarchean and Paleoproterozoic tectono -thermal events in Eastern Hebei Province and their implications	2019-2022	rock@bjshrimp.cn
32	SHI Yuruo	Geochronology and origin of the Cenozoic volcanic rocks in Tengchong area	2019-2022	shiyuruo@bjshrimp.cn
33	SI Jialiang	The identification of new earthquake fossils and their implications to the seismic fault activity	2019-2022	gongrenbaqin@126.com
34	LIU Dongliang	Paleomagnetic records to decipher the Cenozoic collision process between the Pamir and the Southwestern Tian Shan	2019-2022	pillar131@163.com
35	CAO Hui	microstructure and tectonics- Tectonochronology study of monazite LASS and micro-drilling	2019-2022	caohuicugb@hotmail.com



36	HU Peiyuan	Origin of the Lhasa terrane in Tibet constrained by Neoproterozoic tectono-magmatic event in the Ren Co area	2019-2022	azure_jlu@126.com
37	YAN Zhen	Texture and composition of the Lajishan accretionary wedge and the reconstruction of the ancient oceanic basin	2019-2022	yanzhen@mail.iggcas. ac.cn
38	GAO Li' e	Behavior of radiogenic isotopes during crusatal anatexis in the Himalayan orogenic belt	2019-2022	liegao09@163.com
39	ZHU Xiangkun	The controlling factors for the termination of global-scale Precambrian banded iron formations	2019-2022	xiangkun@cags.ac.cn
40	PAN Xiaofei	Ore-forming fluid of Zhuxi ultra-large W-Cu deposit, Jiangxi Province and its significance on the mineralization	2019-2022	pan_smile0551@sina.com
41	YIN Jiyuan	Uplift and exhumation of West Tianshan since the late Paleozoic: Constraints from multi-thermochronology	2019-2022	yinjiyuan1983@163.com
42	WANG Xuri	New discoveries of fossil birds from the Jehol Biota in the Great Khingan Range area of Northeast China and their palaeogeographic	2019-2022	wang198109@163.com
43	YANG Ben	Systematics and biostratigraphy of the early Cambrian small shelly fossils in South Sichuan	2020-2023	benyang@cags.ac.cn
44	WU Guichun	The Conodont Biostratigraphy of Triassic on the Western BangongCo-Nujiang Fault Zone	2020-2023	1874267892@qq.com
45	ZHANG Cong	The metamorphic geology studies on the Sumdo Paleo- Tethys (U)HP subduction zone from the Lhasa terrane and its constrains on the opening of the Neo-Tethys Ocean	2020-2023	congzhang@pku.edu.cn
46	XIANG Hua	The activity models of Ti-bearing minerals and Ti isopleths thermobarometers study	2020-2023	xianghua2710@gmail.com
47	KOU Caihua	Petrogenesis for the Neoproterozoic mafic-ultramafic rocks in the western Jiangnan Orogen: constrains from the in-situ analyses on single mineral grains	2020-2023	caihuakou@163.com
48	LIU Shoujie	P-T-t evolution and overprinting of high-grade poly metamorphism in the Central Zone of Limpopo Belt, South Africa	2020-2023	sjliu@bjshrimp.cn
49	LIU Pinghua	A combined study of In situ U–Pb dating of monazites in thin sections by laser ablation split stream and garnet geochronology using microsampling: a case study of Neoarchean meta-supracrustal rocks in Gongchangling and Mengjiatun, North China Craton	2020-2023	lph1213@126.com
50	ZHANG Jin	Formation mechanism, deformation processes and tectonic settings of ophiolitic mélanges in the northern Alxa Block	2020-2023	zhangjinem@sina.com
51	GUO Lei	Formation mechanism of Early Cretaceous asymmetric granitic domes in NE Asia and its constraint on crustal extensional processes	2020-2023	guolei_cn@sina.com
52	WANG Huan	Physical-chemical properties of the pseudotachylytes in the Longmen Shan fault belt and their seismic rupture mechanisms at seismogenic	2020-2023	wanghuan4585@126.com





53	LI Jin	Cd isotopes application in reconstructing marine primary productivity during the interglacial Cryogenian period	2020-2023	lijin80119@hotmail.com
54	CHAI Peng	Refined ore-forming process of the Naozhi intermediate sulfidation epithermal gold-polymetallic deposit in Yanji area, Jilin province	2020-2023	cx001chaipeng@163.com
55	LI Suping	Comparative morphology and radiation of early angiosperm pollen in Northeast China and Portugal	2021-2024	lisuping@cags.ac.cn
56	ZONG Pu	Effect of the end-Devonian Hangenberg Event on brachiopod faunas: case studies from western Junggar and South China	2021-2024	zongpu0501@163.com
57	YAO Jianxin	Research on the boundary stratotype of Anisian (Middle Triassic□in Southwest China	2021-2024	yaojianxin@cags.ac.cn
58	MENG Fancong	Genesis of graphite-bearing meta-mafic rocks in the serpentinite from Qingshuiquan area, East Kunlun, NW China	2021-2024	mengfancong@yeah.net
59	LIU Yongqing	Sedimentary anatomy of temperate glacier deposits-A case study from the Yuermeinak glacier of the Cryogenian Marinoan age, Akesu, Xinjiang, NW China	2021-2024	liuyongqing@cags.ac.cn
60	WANG Dan	Petrogenesis of Archean ultramafic-mafic rocks from Guyang, Inner Mongolia: implications for the nature of mantle and tectonic regime on early Earth	2021-2024	wangd221@gmail.com
61	ZHOU Xiwen	Genesis and metamorphic evolution of Archean supracrustal rocks in the Jiapigou region □ Southern Jilin Province	2021-2024	xwzhou@cags.ac.cn
62	ZHANG Yinghui	Phase equilibria on the Metamorphism and Partial Melting of the west margin in Trans-Hudson Orogen	2021-2024	yhzhang@sina.cn
63	ZHANG Jianxin	Deformation-metamorphism feedback of the ductile shear zones in the northern West Qinling Orogen and their insight into orogenesis	2021-2024	zjx66@yeah.net
64	ZHENG Yong	Thrust-nappe and uplift of Longmen Shan, eastern Tibet: New insights from direct dating on klippen	2021-2024	zygeology@163.com
65	ZHAO Lei	The origin of seamounts in northern West Junggar and their tectonic significance	2021-2024	360359537@qq.com
66	FU Changlei	Geological record and timing of subduction initiation in the Lajishan paleo-ocean basin	2021-2024	changlei.fu@cags.ac.cn
67	ZHAI Qingguo	Ophiolite in the Zangbei Lake area, Tibetan Plateau: New constraints on the tectonic evolution of the Bangong- Nujiang Tethyan Ocean	2021-2024	zhaiqingguo@126.com
68	ZHU Zhiyong	Calibration of Barium Isotope Fractionation Fractor between K-Feldspar and Granitic Melt	2021-2024	zhiyong_zhu@cags.ac.cn
69	ZHANG Zhiyu	A systematic study on fluid mineralization of the giant Dahutang tungsten orefield in Jiangxi Province: a case study of the Dalingshang ore district	2021-2024	zhangzhiyu@cags.ac.cn
70	WANG Haiyan	Tectonic deformation and suture pattern of the eastern part of the Central Asia orogenic belt	2021-2024	hyanwhy@126.com



71	TANG Feng	The stratigraphy and assemblages of the Jiangchuan biota in eastern Yunnan	2022-2025	523734337@qq.com
72	JIN Xiaochi	Clarification of Permian siliciclastic sequences in the Changning-Menglian Belt, western Yunnan, and analyses of their tectono-sedimentary environments	2022-2025	jinxchi@cags.ac.cn
73	XIANG Hua	Thermodynamic modelling of oxygen fugacity and fluid composition evolution in oceanic subduction zone	2022-2025	xianghua2710@gmail.com
74	XIONG Fahui	Oxygen fugacity of different mineral inclusions in Bulqiza Podiform chromitite, Albania and their implications	2022-2025	283459354@qq.com
75	HE Zhenyu	The compositional zoning of silicic volcanic rocks and the evolution of crustal magma system	2022-2025	hzy@cags.ac.cn
76	LIU Jianhui	The generation and evolution of Early continental crust recorded by Paleo-Neoarchean TTG-granitic gneiss in the Haiyangsuo complex	2022-2025	liujianhui1999@163.com
77	WANG Fang	Multiple metamorphic and magmatic events, and tectonic evolution of the relic slices of Precambrian basement in the Paleo-Tethys orogenic belt, northwestern Vietnam	2022-2025	wangfang_mr@cags.ac.cn
78	LIU Chaohui	Constraints on the onset time of the early plate tectonics from the early Paleoproterozoic mafic magmatisms in the Trans-North China Orogen, North China Craton	2022-2025	denverliu82@gmail.com
79	TIAN Zhonghua	Nature of Mesoproterozoic 1.4 Ga structural-thermal event and its implication to accretionary orogenesis after break- off of the Columbia supercontinent in Weihai- Rushan area, North Sulu	2022-2025	tianzhonghua@cags.ac.cn
80	DONG Hanwen	Rheology of the high grade metamorphic-anatectic rocks in Duoxiongla dome of the Eastern Himalayan Syntaxis	2022-2025	donghanwen123@126. com
81	ZHANG Lei	Rock magnetism of different behaviors environment in Guanxian-Anxian fault zone, Longmen Shan, China	2022-2025	zhanglei881102@126.com
82	CAI Zhihui	Study on the formation of Muztaghata-Kongur Shan gneiss dome: the implications for the growth of the Pamir Plateau	2022-2025	cai-zhihui@hotmail.com
83	HUANG He	The evolution of fluorine in alkaline granitic magmatic- hydrothermal systems in the northern Tarim and its implications for the enrichment of rare metals	2022-2025	huanghe@cags.ac.cn
84	XUE Shuai	The 3-D electrical structure beneath the Yardoi dome and Cuonadong dome, and its study for the mechanism of formation of the domes in northern Himalaya	2022-2025	xueshuai1211@163.com
85	ZHANG Hongshuang	Vertical stratified structure and deformation of the lithosphere beneath southeastern Tibetan Plateau	2022-2025	zhs1981@126.com
86	YU Changqing	Variation characteristics of deep structure and shear zone of Longmenshan fault zone	2022-2025	geoyucq@hotmail.com
87	LI Wenhui	Research on Fine Crustal Structure and Deformation of Compression-Extension Intersectional area, South Central Tibetan Plateau	2022-2025	dereklee1984@126.com





88	ZHENG Hongwei	The Characteristics of crustal and mantle structure in continental collisional porphyry copper deposits: Comparisons of the Gangdese and Yulong metallogenic belt	2022-2025	zhenghongwei004@sina. com		
al the sh	Yong Scientists Fund					
No.	Chief Investigator	Project	Duration	E-mail address		
1	ZHAO Shuo	Late Paleozoic volcanic-sedimentary formations and their provenance in the northwestern Lesser Xing'an Range: Constraints on closure timing of the Heihe-Nenjiang suture zone	2019-2021	zhaoshuo@cags.ac.cn		
2	ZHANG Jianjun	Nd-Hf isotopic decoupling in granitoids from the Kungeyite pluton of Qinghe region, southeast of Chinese Altai: causes and implications for their source interpretation	2019-2021	jianjunzhang@live.cn		
3	ZHANG Lei	Formation depth of pseudotachylyte in the Longmen Shan thrust belt constrained by rock magnetism	2019-2021	zhanglei881102@126.com		
4	ZHU Junbin	Triassic sedimentary sequences in Linxi area of Inner Mongolia and their tectonic implications	2019-2021	zhujunbin0819@163.com		
5	ZHU Zhiyong	The genesis of Makeng iron deposit in Fujian Province and its relationship with the high silica granite—evidence from Fe isotope	2019-2021	zhiyong_zhu@cags.ac.cn		
6	GAO Zhaofu	Spatial evolution of Fe-S-Pb isotopes in the Dongshengmiao deposit and its constraints on the mineralizing process	2019-2021	gaozhaofu@163.com		
7	BAO Zemin	Methodology of Rare Earth Element TOF-SIMS In-situ Analysis in Zircon	2019-2021	baozm@bjshrimp.cn		
8	CHE Xiaochao	Combined U-Series and U-Pb dating of speleothem calcite, a case study of Panxian Dadong Paleolithic Site	2019-2021	cxc@bjshrimp.cn		
9	XUE Shuai	Joint inversion of Magnetotelluric data and Seismic Surface wave to study crust-mantle structure of the Lhasa block	2019-2021	xueshuai1211@163.com		
10	SHANG Xiaodong	Evolution of Ediacaran Tianzhushania in the Yangtze Gorges area and its biostratigraphic implications	2020-2022	shangxdong@sina.com		
11	YAN Zhen	Research on Early Permian carbonate buildups in Xing- Meng area	2020-2022	yanzhen20071239@126. com		
12	XIE Qiuhong	Origin of the carbonate minerals in the high-Si alkali basalts in Karamay, Xinjiang, and its constraints on the petrogenesis	2020-2022	qhxie01@163.com		
13	WANG YUNFENG	Cu precipitation mechanism in Tinggong porphyry Cu deposit, Tibet	2020-2022	wangyunnfeng@163.com		
14	ZHAO Zhongbao	Forming and Tectonic Evolution of the Longriba Fault, Inside the Eastern Tibetan Plateau	2020-2022	zhaozhb04@163.com		
15	GE Maohui	The formation age and metamorphism of the supracrustal rocks of the Mashan Complex in the Jiamusi Block and its tectonic implication	2020-2022	gmh19900125@126.com		
16	ZHANG Heng	Paleoproterozoic magmatic and metamorphic events in southwestern Yangtze Block and their tectonic implications	2020-2022	heng0520@126.com		



#### Study on the controlling mechanisms and the environmental 17 WANG Xun effects of the early Mesoproterozoic oceanic oxygenation event 2020-2022 xunwang90@163.com in North China Integrated hydraulic fracturing monitoring technology 18 LIANG Yao research using Krauklis wave, LPLD event and microseismic 2020-2022 liangmyq@sina.com information Petrological study of graphite-rich eclogite from Chinese southwestern Tianshan UHP metamorphic belt and its 19 ZHU Jianjiang 2021-2023 zjj19901216@126.com implication for the migration and evolution of carbonbearing fluids in subduction zone Petrogenesis of rodingite in ophiolite-A case study on 20 TANG Yue 2021-2023 245494037@qq.com rodingite in the Bange area, northern Tibetan plateau Crystal-rich enclaves in high-silica volcanic rocks from 21 YAN Lili Yandangshan, eastern Zhejiang: Insights into the magma 2021-2023 llyan0625@163.com reservoir evolution processes Crustal anatexis of the Leo Pargil dome in SW Tibet and its 22 YAN Lilong implications for the along-strike variations of the Himalayan 2021-2023 lilong\_yan@qq.com orogenic belt The unidirectional solidification textures in the giant Dahutang tungsten deposit, Northwest Jiangxi Province, 23 FAN Xianke 2021-2023 fanxianke@cags.ac.cn China: Implications for the evolution of primary magmatic fluids and tungsten mineralization Sedimentologic and paleogeographic implications of Late 24 ZHENG Jianbin Paleozoic clastic rocks in the central zone of the Changning-2021-2023 zhengjianbin@cags.ac.cn Menglian Belt in western Yunnan, China The helium migration and enrichment process of crust-25 ZHANG Wen 2021-2023 wenzhangen@outlook.com derived helium in natural gas fields traced by noble gases Mineralization age, genesis mechanism and tectonic 26 LI Pengchuan implication of two types of iron deposits in the Baishan 2021-2023 lipengchuan@foxmail.com area, southern Jilin Province Structural characteristic and geochronology of the shear zone in the central Alxa Block, and its implications on 27 ZHANG Beihang 2021-2023 276925733@qq.com the tectonic evolution of the Central Asian Orogenic Belt (CAOB) Triassic tectonic evolution of the Qiangtang Block, Tibetan 28 XU Wang Plateau: Constraints from metamorphism and geochronology 2021-2023 wangxugeo@cags.ac.cn of eclogites in central Qiangtang Study on Fine 3-D Velocity Structure and Vp/Vs distribution 29 WANG Xiaoran of Lithosphere Mantle-Tomography Analysis based 2021-2023 wxr\_1119@163.com onBroadband Dense Array Transformation of post-cranial key features in early 30 **REN Xinxin** 2022-2024 laotourenxin@126.com evolutionary stage of sauropod dinosaurs Petrogenesis and metamorphic P-T-t trajectory of eclogites in the Song Ma suture zone in the Vietnam: Implications for 31 WANG Huining 2022-2024 wanghuining1@126.com the subduction-orogeny geodynamic process of the Paleo-Tethys





#### Table1-2 Projects funded by the Ministry of Science and Technology and other sources

No.	Chief Investigator	Project	Duration	E-mail address
1	QIN Kezhang	Deep structure and ore-forming process of the composite orogenic-metallogenic systems in NE China	2017-2020	kzq@mail.iggcas.ac.cn
2	ZHANG Jin	3D lithosphere framework of compound orogenic belt of North China and its metallogenic background	2017-2021	zhangjinem@sina.com
3	LIU Yan	Distribution of mineral resources and their potential assessment	2018-2022	ly_0620@126.com
4	LONG Tao	Development of multiple receivers for a new secondary ion mass spectrometer	2018-2021	longtao@bjshrimp.cn
5	TONG Ying	Integration of the tectonic-magmatism- mineralization studies in metallogenic systems	2018-2022	yingtong@cags.ac.cn
6	LIU Yanxue	Prototype restoration and structural reconstruction of typical Uranium-bearing basins and its constraints on deep mineralization	2018-2021	lyxue@sohu.com
7	GUO Lei	Big data extraction and mapping technology of deep-time petrology	2019-2023	guolei_cn@sina.com
8	GAO Rui and LU Zhanwu	Fine structure and shallow response of lithosphere in key areas	2019-2022	ruigao126@126.com, luzhanwu78@163.com
9	LI Haibing	Comprehensive investigation and Study on fault activity habit along Pamir West Kunlun and Xinzang highway	2019-2022	lihaibing06@163.com
10	ZENG Lingsen	The deep geological process of the Himalayan block and the rise of the collisional orogenic belt	2019-2022	zenglingsen@cags.ac.cn
11	MA Xuxuan	Coupling study of tectonic-magmatic evolution and rare metal mineralization in the West Kunlun	2019-2022	xuxuan.ma@hotmail.com



12	ZHAI Qingguo	Continental accretion and formation of the third pole in the Tethys domain	2019-2022	zhaiqingguo@126.com
13	XIONG Fahui	Multistage formation process of podlike chromite A Study on the genesis of abnormal mineral inclusions	2019-2022	283459354@qq.com
14	WANG Tao	Methodology on deciphering the material architecture of the lithosphere	2019-2024	taowang@cags.ac.cn
15	HUANG He	Methodology on deciphering the material architecture of the lithosphere beneath typical regions of the accretionary orogenic belt	2019-2024	huanghecugb@126.com
16	WANG Tao	New methods for tracing deep material and the theory and methodology for revealing the three-dimensional lithospheric composition architecture	2019-2024	taowang@cags.ac.cn
17	ZHU Xiangkun	Metal isotopes tracing technique of atmospheric oxygenation associated with deep carbon and oxygen cycle	2019-2024	xiangkun@cags.ac.cn
18	LIU Dunyi	International lunar research station - lunar chronology research	2020-2023	liudunyi@bjshrimp.cn
19	LIU Dunyi	Study of the lunar impact flux	2020-2022	liudunyi@bjshrimp.cn
20	KUANG Hongwei	The last glaciation of Precambrian and the evolution of earth, environment and life	2020-2022	kuanghw@126.com
21	ZHANG Heng	Metallogenesis and prospecting prediction of copper and gold polymetallic deposits in Zhusileng and Wuliji area, Alxa area, Inner Mongolia	2020-2024	heng0520@126.com
22	LIU Yan	Scientific investigation of bulk metal resources in Qinghai Tibet Plateau	2021-2024	ly_0620@126.com
23	PAN Jiawei	Investigation on Cenozoic geological structure system of China earthquake science experimental site and its adjacent areas	2021-2026	43469518@qq.com
24	SONG Yucai	Metallogenic regularity and early warning decision support technology of global strategic minerals	2021-2025	song_yucai@aliyun.com
25	ZHAI Qingguo	Regional metallogenic setting of rare metals such as pegmatite type or clay lithium in Western China	2021-2025	zhaiqingguo@126.com

2021

### Table1-3 Projects funded by the China Geological Survey

No.	Chief Investigator	Project	Duration	E-mail address
1	GUO Lei	Basic geological survey of the material and evolution of the crust circle in the key sections of Alxa and Southeast Tibet	2019-2021	guolei_cn@sina.com
2	ZHU Xiangkun	Basic geological survey of Meso- Neoproterozoic epigenetic system in Eastern Hebei and Yangtze Gorges	2019-2021	xkzhu0824@gmail.com
3	LIU Pinghua	Basic geological survey of Precambrian structural belt in the central and eastern part of North China Craton	2019-2021	lph1213@126.com
4	ZHANG Jin	Basic geological survey of Northen Organic Belt between Xilamulun and Hegenshan	2019-2021	zhangjinem@sina.com







#### **Table2-1 English language publications:**

- Bai Mingkun, Marie-Luce Chevalier, Philippe Hervé Leloup, Li Haibing, Pan Jiawei, Anne Replumaz, Wang Shiguang, Li Kaiyu, Wu Qiong, Liu Fucai, Zhang Jinjiang. 2021. Spatial Slip Rate Distribution Along the SE Xianshuihe Fault, Eastern Tibet, and Earthquake Hazard Assessment. Tectonics, 40(11), e2021TC006985.
- Bao Chuang, Zhu Xiangkun, Gao Zhaofu. 2021. Iron isotope constraints on the genesis of magnetite ore in the Huogeqi deposit of Inner Mongolia autonomous region in northern China. Ore Geology Reviews, 133, 104116.
- Cai Zhihui, He Bizhu, Li Guangwei, Jiao Cunli, Yun Xiaorui. 2021. Early Cretaceous deformation in the southern Tashkorgan region: Implications for the tectonic evolution of the northeastern Pamir. China Geology, 67-76.
- Cai Zhihui, He Bizhu, Meert J. G., Ma Xuxuan, Jiao Cunli, Liu Ruohan, Chen Xijie, Yun Xiaorui. 2021. Neoproterozoic tectonic transition from subduction-related convergence to continental extension of the Tarim Block, NW China. Precambrian Research, 362, 106278.
- Che Xiaochao, A. Nemchin, Liu Dunyi, Long Tao, Wang Chen, M. D. Norman, K. H. Joy, R. Tartese, J. Head, B. Jolliff, J. F. Snape, C. R. Neal, M. J. Whitehouse, C. Crow, G. Benedix, F. Jourdan, Yang Zhiqing, Yang Chun, Liu Jianhui, Xie Shiwen, Fan Runlong, Li Dapen, Liu Zengsheng, S. G. Webb. 2021. Age and composition of young basalts on the Moon, measured from samples returned by Chang'e-5. Science, 374, 887–890.
- Chen Xiaoshuai, Kuang Hongwei, Liu Yongqing, Le Heron, D.P., Wang Yuchong, Peng Nan, Wang Zhixian, Zhong Quan, Yu Huiliang, Chen Jinxin. 2021. Revisiting the Nantuo Formation in Shennongjia, South China: A new depositional model and multiple glacial cycles in the Cryogenian. Precambrian Research, 2021, 356, 106132.
- Chevalier Marie-Luce, Replumaz Anne, Wang Shiguang, Pan Jiawei, Bai Mingkun, Li Kaiyu, Li Haibing. 2021. Limit of monsoonal precipitation in southern Tibet during the Last Glacial Maximum from relative moraine extents. Geomorphology, 397,108012.
- Dong Chunyan, Bai Wenqian, Xie Hangqiang, Wilde S.A, Wang Yuqing, Wang Shijin,Liu Dunyi, Wan Yusheng. 2021. Early Neoarchean oceanic crust in the North China Craton: Evidence from geology, geochemistry and geochronology of greenstone belts in western Shandong. Lithos, 380-381,105888.
- Duan Qingsong, Du Lilin, Song Huixia, Ren Liudong, Wyman Derek A., Geng Yuansheng, Wang Jianlong, Yang Chonghui. 2021. Petrogenesis of the 2.3 Ga Lengkou metavolcanic rocks in the North China Craton: Implications for tectonic settings during the magmatic quiescence. Precambrian Research, 357, 106151.
- Fan Xianke, Hou Zengqian, Zhang Zhiyu, John Mavrogenes, Pan Xiaofei, Zhang Xiang, Xiang Xinkui.2021. Metallogenic ages and sulfur sources of the giant Dahutang W-Cu-Mo ore field, South China: Constraints from muscovite 40Ar/39Ar dating and in situ sulfur isotope analyses. Ore Geology Reviews, 104141.
- Fan Xianke, Zhang Zhiyu, Hou Zengqian, John Mavrogenes, Pan Xiaofei, Zhang Xiang, Dai Jialiang, Wu Xianyuan. 2021. Magmatic processes recorded in plagioclase and the geodynamic implications in the giant Shimensi W-Cu-Mo deposit, Dahutang ore field, South China. Journal of Asian Earth Sciences, 212, 104734.
- Feng Guangying, Yang Jingsui, Niu Xiaolu, Liu Fei, Qiu Tian, Yildirim Dilek. 2021. Formation processes and tectonic implications of mantle peridotites of the Yushigou ophiolite in the North Qilian Orogenic Belt, NW China. Lithos, 400-401, 106430.
- Feng Guangying, Yildirim Dilek, Niu Xiaolu, Yang Jingsui. 2021. Geochemistry and geochronology of OIBtype, Early Jurassic magmatism in the Zhangguangcai range, NE China, as a result of continental back-arc extension. Geological Magazine, 158, 143-157.





- Feng Tang, Sicun Song, Guangxu Zhang, Ailin Chen, Junping Liu. 2021. Enigmatic ribbon-like fossil from Early Cambrian of Yunnan, China. China Geology, 205–214.
- Gao Li-E, Zeng Lingsen, Wang Haitao, Gao Jiahao , Shang Zhen , Zhao Linghao, Hou Kejun, Guo Chunli, Ma Xuxuan. 2021. Contrasting Sr–Nd–Hf isotope systematics in Early Jurassic magmatic rocks from the Lhasa terrane: Implications for the lithospheric architecture of the Lhasa terrane. Lithos, 402-403:106050.
- Gao Li-E, Zeng Lingsen, Zhao Linghao, Gao Jiahao, Shang Zhen. 2021. Behavior of apatite in granitic melts derived from partial melting of muscovite of metasedimentary sources. China Geology, 4(1):44-55.
- Gao Li-E, Zeng Lingsen, Zhao Linghao, Hou Kejun, Guo Chunli, Gao Jiahao, Wang Yaying. 2021. 2021.
  Geochemical behavior of rare metals and high field strength elements during granitic magma differentiation:
  A record from the Borong and Malashan Gneiss Domes, Tethyan Himalaya, southern Tibet. Lithos, 398-399:106344.
- Gao Zhaofu, Zhu Xiangkun, Wang Dan, Pan Chenxu, Yan Bin, Li Jin. 2021. Insights into hydrothermal controls and processes leading to the formation of the Late Ediacaran Gaoyan stratiform manganese-carbonate deposit, Southwest China. Ore Geology Reviews, 139, 104524.
- Ge Maohui, Li Zhuang, Li Long, Zhang Jinjiang, Liu Kai. 2021. Zircon and monazite U-Pb ages of the Mashan Complex of the Jiamusi Block of NE China: a link to Gondwana? [J]. International Geology Review, 1-16.
- Ge Maohui, Li Long, Wang Tao, Zhang Jinjiang, Tong Ying, Guo Lei, Liu Kai, Feng Lin, Song Peng, Yuan Jianguo. 2021. Hf isotopic mapping of the Paleozoic-Mesozoic granitoids from the Jiamusi and Songnen blocks, NE China: Implications for their tectonic division and juvenile continental crustal growth. Lithos, 386-387.
- Gong Mingyue, Zhang Yinghui, Tian Wei, Fu Bin. 2021. Depositional age and genesis of the host strata of the Shuangjianzishan Ag-Pb-Zn deposit: Implications for the Late Carboniferous magmatic-hydrothermal activities and tectonic evolution of the eastern entral Asia orogenic belt. Ore Geology Reviews, 135, 104207.
- He Yuan, Zhu Xiangkun, She Yuwei, Ma Jianxiong, Sun Jian, Gao Zhaofu, Wan Hongqing, Chen Yuelong. 2021. Mechanism of formation of podiform chromitite: Insights from the oxidation states of podiform chromitites and host peridotites from the Luobusa ophiolite, southern Tibet. Ore Geology Reviews, 139, 104483.
- Hu Peiyuan, Zhai Qingguo, Cawood Peter A., Zhao Guochun, Wang Jun, Tang Yue, Zhu Zhicai, Wang Wei, Wu Hao. 2021. Cambrian magmatic flare-up, central Tibet: Magma mixing in proto-Tethyan arc along north Gondwanan margin. Geological Society of America Bulletin, 133,2171-2188.
- Hu Peiyuan, Zhai Qingguo, Zhao Guochun, Wang Jun, Tang Yue, Zhu Zhicai, Wang Wei, Wu Hao. 2021. Cambrian and Cryogenian tectonothermal events in the Amdo microcontinent, Central Tibet: Implications for paleogeographic reconstruction and tectonic evolution of northern Gondwana. Palaeogeography, Palaeoclimatology, Palaeoecology, 569,110332.
- Hu Zhaoping, Zeng Lingsen, Michael W. Förster, Zhao Linghao, Gao Li-E, Li Huan, Yang Yizeng, Li Shuangqing. 2021. Recycling of subducted continental crust: Geochemical evidence from syn-exhumation Triassic alkaline mafic rocks of the southern Liaodong Peninsula. Lithos, 400–401, 106353.
- Jia Jianliang, Liu Zhaojun. 2021. Particle-size fractionation and thermal variation of oil shales in the Songliao Basin, NE China: Implication for hydrocarbon-generated process. Energies, 14(21), 7191.
- Jia Jianliang, Wu Yanjia, Miao Changsheng, Fu Changlei, Xie Wenquan, Qin Jianyi, Wang Xiaoming. 2021. Tectonic controls on the sedimentation and thermal history of supra-detachment basins: A case study of the early Cretaceous Fuxin Basin, NE China. Tectonics, 40(5), e2020TC006535.
- Jia Jianliang, Zhou Renjie, Liu Zhaojun, Han Xuehui, Gao Yuan. 2021. Organic matter-driven electrical resistivity of immature lacustrine oil-prone shales. Geophysics, 86(4), MR165–MR178.
- Ju Shubin, Wang Xuri, Liu Yichuan, Wang Yang. 2021. A reassessment of Iteravis huchzermeyeri and Gansus zheni from the Jehol Biota in western Liaoning, China. China Geology, 4, 197-204.
- Kou Caihua, Liu Yanxue, Li Tingdong, Ding Xiaozhong, Zhang Heng, Liu Yong. 2021. Petrogenesis and tectonic



implications of the neoproterozoic mafic-ultramafic rocks in the western Jiangnan Orogen: Insights from in situ analysis of clinopyroxenes. Lithos, 392–393, 106156.

- Li Fangbing, Donald Penman, Noah Planavsky, Andrew Knudsen, Zhao Mingyu, Wang Xiangli, Terry Isson, Huang Kangjun, Wei Guangyi, Zhang Shuang, Shen Jun, Zhu Xiangkun, Shen Bing. 2021. Reverse weathering may amplify post-Snowball atmospheric carbon dioxide levels. Precambrian Research, 364, 106279.
- Li Haibing, M. L. Chevalier, P. Tapponnier, Pan Jiawei, J. Van der Woerd, A. S. Mériaux, F. J. Ryerson, G. Peltzer, Z. Sun, Si Jialiang, Pei Junling, Xu Xiwei. 2021. Block Tectonics Across Western Tibet and Multi-Millennial Recurrence of Great Earthquakes on the Karakax Fault. Journal of Geophysical Research: Solid Earth, 126, e2021JB022033.
- Li Weikai, Yang Zhiming, Chiaradia, M., Zhou Liming, Hou, Zengqian. 2021. Enrichment nature of ultrapotassic rocks in southern Tibet inherited from their mantle source. Journal of Petrology, 62, 1-15.
- Ling Yuan, Zheng Mianping, Wang Shuxian, Sun Qing, Xie Bingjing, Zhang Chengjun. 2021. The impact of climatic and environmental factors on n-Alkanes indices in southwestern Tibetan Plateau. Acta Geologica Sinica (English Edition), 95,2, 648–658.
- Liu Chaohui, Zhao Guochun, Liu Fulai, Xu Wang. 2021. Coexistence of A-and I-type granites in the Lüliang Complex: Tectonic implications for the middle Paleoproterozoic Trans-North China Orogen, North China Craton. Lithos, 380–381, 105875.
- Liu Dongliang, Li Haibing, Chevalier M-L, Sun Zhiming, Pei Junling, Pan Jiawei, Ge Chenglong, Wang Ping, Wang Huan, Wu Chan. 2021. Activity of the Baiganhu Fault of the Altyn Tagh Fault System, northern Tibetan Plateau: Insight from zircon and fission track analyses. Palaeogeography, Palaeoclimatology, Palaeoecology, 570, 110356.
- Liu Dongliang, Li Haibing, Ge Chenglong, Bai Mingkun, Wang Yadong, Pan Jiawei, Zheng Yong, Wang Ping, Liu Fucai, Wang Shiguang. 2021. Northward growth of the West Kunlun Mountains: insight from the ageelevation relationship of new apatite fission track data. Front. Earth Sci, 9, 784812.
- Liu Fei, Dilek Yildirim, Yang Jingsui, Lian Dongyang, Li Guanlong and Wu Yong. 2021. A middle Triassic seamount within the western Yarlung Zangbo suture zone, Tibet: The earliest seafloor spreading record of Neotethys to the North of East Gondwana. Lithos, 388-389:106062.
- Liu Jianhui, Wang Xiangjian, Chen Hui. 2021. Interacontinental extension and geodynamic evolution of the Paleoproterozoic Jiao-Liao-Ji belt, North China Craton: Insights from coeval A-type granitic and mafic magmatism in eastern Liaoning Province. GSA Bulletin, 133(7/8), 1765-1792.
- Liu Jianhui, Ding Zhengjiang, Chen Hui, Wang Xiangjian, Liu Fulai. 2021. Early hydrosphere-rock interactions and intra-crustal recycling recorded by remarkably high-δ18O Mesoarchean granitoids in the Sulu orogenic belt, eastern China. Precambrian Research, 362, 106311.
- Liu Jianhui, Liu Fulai, Ding Zhengjiang, Yang Hong, Liu Pinghua, Liu Lishuang, Chen Hui, Wang Xiangjian. 2021. Zircon U-Pb geochronology and Hf isotope analyses of the Wulian complex in the Sulu orogenic belt, eastern China: tectonic affinity and implications for early Precambrian crustal growth and recycling. Geological Magazine, 158, 295–310.
- Liu Pinghua, Liu Fulai, Tian Zhong-Hua, Wang Da, Cai Jia, Zhang Wen. 2021. Polymetamorphic events in the Jiao-Liao-Ji Belt, North China Craton: Evidence from integrated zircon, xenotime, and monazite LA-ICP-MS U-Pb dating. International Geology Review, 63:5, 630-657.
- Marie-Luce Chevalier, Anne Replumaz, Shiguang Wang, Jiawei Pan, Mingkun Bai, Kaiyu Li, Haibing Li. 2021. Limit of monsoonal precipitation in southern Tibet during the Last Glacial Maximum from relative moraine extents. Geomorphology, 397,108012.
- Ma Xuxuan, Gao Li-E., Zhao Zhongbao, Chen Xijie, Li Haibing. 2021. Early Eocene leucocratic sill/dike swarms in the Gangdese belt, southern Tibet: tectonic. China Geology, 4, 56-66.
- Niu Xiaolu, Dilek Yildirim, Liu Fei, Feng Guangying, Yang Jingsui. 2021. Early Devonian Ultrapotassic





Magmatism in the North China Craton: Geochemical and Isotopic Evidence for Subcontinental Lithospheric Mantle Metasomatism by Subducted Sediment–Derived Fluids. Geological Magazine, 158, 158-174.

- Pan Xiaofei, Ren Yufeng, Hou Zengqian, Ouyang Yongpeng, Gong Xuejing, Li Qiuyun, Yang, Yanshen. 2021. Petrogenesis and Geodynamic Implications of a Newly Discovered Basanite Dike in Zaolin, Jingdezhen City, South China. Lithosphere, 1, 9732167.
- Qin Qie, Wang Tao, Huang He, Zhang Zhaochong, Tong Ying, Song Peng, Zhang Jianjun. 2021. Late Carboniferous and Early Permian garnet-bearing granites in the South Tianshan Belt, NW China: Two Late Paleozoic magmatic events and implications for crustal reworking. Journal of Asian Earth Sciences, 220:104923.
- Shen Weibing, Zhu Xiangkun, Yan Bin, Qin Haoyi. 2021. Sequence stratigraphy of the Cryogenian Nantuo Formation in South China: Constraints on Marinoan glaciation dynamics. Journal of Asian Earth Sciences, 214, 104776.
- Sun Jian, Zhu Xiangkun, Belshaw, N.S., Chen Wei, Doroshkevich, A.G., Luo Wenjuan, Song Wenlei, Chen Beibei, Cheng Zhiguo, Li Zhihong, Wang Yang, Kynicky, J., Henderson, G.M. 2021. Ca isotope systematics of carbonatites: Insights into carbonatite source and evolution. Geochemical Perspectives Letters, 17, 11-15.
- Sun Jingbo, Chen Wen, Qin Kezhang, Danišík M, Evans N J, McInnes B I A, Shen Ze, Zhao Shuangfeng, Zhang Bin, Yin Jiyuan and Tao Ni. 2021. Mesozoic exhumation of the Jueluotage area, Eastern Tianshan, NW China: constraints from (U–Th)/He and fission-track thermochronology. Geological Magazine, 158 (11),1960-1976.
- Sun Maoyu, Monecke, T., Reynolds, T.J., and Yang Zhiming. 2021. Evolution of the magmatic-hydrothermal system at the Yulong porphyry deposit, eastern Tibetan Plateau, China: Insights from optical microscopy, cathodoluminescence investigations, and fluid inclusion petrography. Mineralium Deposita, 56, 823-842.
- Tang Yue, Zhai QingGuo, Hu PeiYuan, Wang Wei, Yan Zhen, Wang HaiTao, Zhu ZhiCai. 2021. Forearc lava stratigraphy of the Beila Ophiolite, north-central Tibetan Plateau: Magmatic response to initiation of subduction of the Bangong-Nujiang Meso-Tethys Ocean. Palaeogeography, Palaeoclimatology, Palaeoecology, 582, 110663.
- Tian Zhonghua, Liu, F., Yan, Z., Liu, P., Xu, W., Liu, L., Wen, F., and Xiao, W. 2021. Palaeoproterozoic turbidite deposition in the Liaodong Penisula, northeastern North China craton-Constraints from the Gaojiayu formation of the Liaohe Group. Precambrian Research, 352, 106008.
- Tian Zhonghua, Wen, F., Liu, F., Zhu, H., and Ye, Z. 2021. Formation of Foliations and their Related Minerals from Diagenetic to Medium-grade Metamorphic Rocks: A Case Study of the Hongyanjing and Liao-Ji Backarc Basins, China. Acta Geologica Sinica English Edition, 95(4), 1158-1170.
- Tian Zhonghua, Xiao, W, Windley, B. F., Huang, P., Zhang, J. e., Ao, S., Zhang, Z..2021. Two key switches in regional stress field during multi-stage deformation in the Carboniferous-Triassic southernmost Altaids (Beishan, NW China): Response to orocline-related roll-back processes. GSA Bulletin, 133(11-12), 2591-2611.
- Wan Yusheng, Liu Shoujie, Song Zhiyong, Wilde S.A., Wang Laimin, Dong Chunyan, Xie Hangqiang, Xie Sshiwen, Hou Jianhua, Bai Wenqian,Liu Dunyi. 2021. The complexities of Mesoarchean to late Paleoproterozoic magmatism and metamorphism in the Qixia area, Eastern North China Craton: geology, geochemistry and SHRIMP U-Pb zircon dating. American Journal of Science, 321,1-82.
- Wan Yusheng, Xie Hangqiang, Williams I.S, Dong Chunyan, Liu Dunyi. 2021. Dating Metamorphism. In: Alderton, David; Elias, Scott A. (eds.) Encyclopedia of Geology, 2nd edition, 2,569-583.
- Wang ChaoYang, Meng En, Lin Shoufa, Li YanGuang. 2021. Late Neoarchean metavolcanic rocks from the Tonghua area, Southern Jilin Province, China: Constraints on the formation and evolution of the northeastern North China Craton. Precambrian Research, 362, 106266.
- Wang Dan, Guo Jinghui, Romer Rolf L., Liu Fulai, Ouyang Dongjian. 2021. Coeval shoshonitic and



calc-alkaline mantle-derived magmatism in an ancient continental arc root. Contributions to Mineralogy and Petrology, 176:57.

- Wang Fang, Liu Fulai, Schertl Hans-Peter, Liu Pinghua, Ji Lei, Xu Wang. 2021. Diversity of zircon U-Pb geochronology of meta-sedimentary rocks from the Gaixian Formation, South Liaohe Group, Jiao-Liao-Ji belt: Implications for different provenance and crustal evolution. Precambrian Research, 362, 106317.
- Wang Huining, Liu Fulai, Sun Zaibo, Ji Lei, Cai Jia, Zhu Jianjiang. 2021. Identification of continentaltype eclogites in the Paleo-Tethyan Changning-Menglian orogenic belt, southeastern Tibetan Plateau: Implications for the transition from oceanic to continental subduction. Lithos, 106215, 396-397.
- Wang Ping, Liu Dongliang, Li Haibing, Chevalier M-L, Wang Yadong, Pan Jiawei, Zheng Yong, Ge Chenglong, Bai Mingkun, Wang Shiguang. 2021. Sedimentary Provenance Changes Constrain the Eocene Initial Uplift of the Central Pamir, NW Tibetan Plateau. Frontier in Earth Science, 9, 741194.
- Wang Yue, Zhu Xiangkun, Tang Chao, Mao Jingwen, Chang Zhaoshan. 2021. Discriminate between magmaticand magmatic-hydrothermal ore deposits using Fe isotopes. Ore Geology Reviews, 130, 103946.
- Wu Didi, Li Shan, Chew D., Liu Tieyi, Guo Donghai. 2021 Permian-Triassic magmatic evolution of granitoids from the southeastern Central Asian Orogenic Belt: Implications for accretion leading to collision. SCIENCE CHINA Earth Sciences, 64, 788-806.
- Wu Guichun, Ji Zhansheng, Gary, L, Yao Jianxin. 2021. The Upper Triassic deposits of the west Bangong-Nujiang Suture Zone and their palaeogeographic implications. Scientific Reports, 11, 19509.
- Wu Guichun, Ji Zhansheng, Tea-Kolar, J., Yao Jianxin, Gary, L. 2021. Early Triassic Pachycladina fauna newly found in the southern Lhasa Terrane of Tibet and its palaeogeographic implications. Palaeogeography, Palaeoclimatology, Palaeoecology, 562,110030.
- Wu Xiancan, Shi Yuruo, Anderson J L. 2021. SHRIMP U-Pb dating of detrital zircons from the Permian sandstones along the southern and northern margins of Xar Moron River, central Inner Mogolia: implications for provenance and the tectonic evolution of the eastern segment of the Central Asian Orogenic Belt. American Journal of Science, 321, 152-177.
- Xiong Fahui, Zoheir, B., Wirth, R., Milushi, I., Qiu Tian., Yang Jingsui. 2021. Mineralogical and isotopic peculiarities of high-Cr chromitites: Implications for a mantle convection genesis of the Bulqiza ophiolite. Lithos, 398-399, 106305.
- Xu Wang, Liu Fulai, Zhai Qingguo, Dong Yongsheng. 2021. Petrology and P-T path of blueschists from central Qiangtang, Tibet: Implications for the East Paleo-Tethyan evolution. Gondwana Research, 94, 12-27.
- Xue Shuai, Chen Yun, Liang Hongda, Li Xin, Liang Xiaofeng, Ma Xiaobing. 2021. Deep electrical resistivity structure across the Gyaring Co Fault in Central Tibet revealed by magnetotelluric data and its implication. Tectonophysics, 809, 228835.
- Yan Zhen, Xiao Wenjiao, Jonathan C. Aitchison, Yuan Chao, Liu Chuanzhou, Fu Changlei. 2021. Age and origin of accreted ocean plate stratigraphy in the North Qilian belt, NE Tibet Plateau: evidence from microfossils and geochemistry of cherts and siltstones. Journal of the Geological Society, 178(6), jgs2020-231.
- Yang Ben, Steiner, M. 2021. Terreneuvian bio- and chemostratigraphy of the South Sichuan Region (South China). Journal of the Geological Society, 178, jgs2020-2167.
- Yang Yanshen, Pan Xiaofei, Hou Zengqian, Deng Yang. 2021. Redox states and protoliths of Late Mesozoic granitoids in the eastern Jiangnan Orogen: Implications for W, Mo, Cu, Sn, and (Au) mineralization. Ore Geology Reviews, 134, 104038.
- Yang Yanshen, Pan Xiaofei, Hou Zengqian, Deng Yang, Ouyang Yongpeng, Meng Delei, Xie Tao. 2021. Petrogenesis, redox state, and Mineralization potential of Triassic granitoids in the Mengshan district, South China. Frontiers in Earth Science, 9, 657618.
- Yin Jiyuan, Xiao Wenjiao, Christopher J. Spencer., Sun Min, Chen Wen, Huang Huiqing, Yuan Chao, Zhang Yunying, Tao Zaili, Huang He, Xia Xiaoping. 2021. The role and significance of juvenile sediments in the





formation of A-type granites, West Junggar oceanic arc (NW China): zircon Hf-O isotopic perspectives. Geological Society of America Bulletin, 133 (7-8), 1560–1574.

- Zeng Lingsen, Gao Li-E, Zhao Linghao, Hou Kejun. 2021. The role of titanite in shaping the geochemistry of amphibolite-derived melts. Lithos, 402-403, 106312.
- Zhang Cong, Shen Tingting, Zhang Lifei, Lin Congcong, Zhang Zhongwei, Qin Xueqing, Hu Han, Qiu Tian, Xiang Zhenqun and Zhang Jianxin.2021. The Formation and Evolution of Uvarovite in UHP Serpentinite and Rodingite and its Constraints on Chromium Mobility in the Oceanic Subduction Zone. Acta Geologica Sinica (English Edition), 95(5), 1456–1471.
- Zhang Jianjun, Wang Tao, Tong Ying, Huang He, Song Peng. 2021. New Exploration of Tracking Deep Ancient Crustal Components: A Combined Analysis of Xenocrystic/Inherited Zircon Information within Different Genetic Types of Granitoids in Chinese Altai. Acta Geologica Sinica (English Edition), 95(z1):106~108.
- Zhang Jin, Dickson Cunningham, Yun Long, Qu Junfeng, Zhao Heng, Zhang Beihang, Niu Pengfei, Hui Jie. 2021. Kinematic variability of late Cenozoic fault systems and contrasting mountain building processes in the Alxa block, western China. Journal of Asian Earth Sciences, 205, 104597.
- Zhang Jin, Wang Yannan, Qu Junfeng, Zhang Beihang, Zhao Heng, Yun Long, Li Tianyi, Niu Pengfei, Nie Fengjun, Hui Jie, Zhang Yiping. 2021. Mesozoic intracontinental deformation of the Alxa Block in the middle part of Central Asian Orogenic Belt: A review. International Geological Review, 63, 1490-1520.
- Zhang Jin, Wang Yannan, Zhang Beihang, Qu Junfeng, Yun Long, Niu Pengfei, Zhao Heng. 2021. Tectonothermal events in the central North China Craton since the Mesozoic: constrained by lowtemperature thermochronology. Tectonophysics, 804, 228769.
- Zhang Lei, Li Haibing, Sun Zhiming, Cao Yong, Wang Huan. 2021. Microstructural evolution of pseudotachylyte-bearing rocks during increasing temperatures: Evidence from rock-heating experiments. Journal of Structural Geology, 149, 104398.
- Zhang Wen, Chen Wen, Sun Jingbo, Shen Ze, Zhang Yan. 2021. Thermal history and exhumation processes in the Chinese South Tianshan: constraints from 40Ar/39Ar and (U-Th)/He ages. International Journal of Earth Sciences, 110(5), 1575-1592.
- Zhang Xiaowei, Tong Ying, Wang Tao, Zhao Hui, Guo Lei, Tserendash N., Puntsag D. 2021. Petrogenesis and Tectonic Significance of Carboniferous Granites on the North Side of the Solonker Suture, Central South Mongolia. Acta Petrologica ET Mineralogica, 95, 481-499.
- Zhao Shuo, Liu Jianfeng, Zhang Yuting, Zhang Jin, Xu Wenliang, Li Jinyi. 2021. Geochronology and petrogenesis of the Yuanbaoshan leucogranite in southeast Inner Mongolia: Implications for the collision between the Sino-Korean and Siberian paleo-plates. Lithos, 384-385, 105981.
- Zhao Zhongbao, Li Chao, Ma Xuxuan. 2021. How does the elevation changing response to crustal thickening process in the central Tibetan Plateau since 120 Ma? China Geology, 4(1), 32-43.
- Zheng Jianbin, Jin Xiaochi, Huang Hao, Yan Zhen, Wang Haifeng, Bai Lingqi. 2021. Sedimentology and detrital zircon geochronology of the Nanpihe Formation in the central zone of the Changning-Menglian Belt in western Yunnan, China: revealing an allochthon emplaced during the closure of Paleo-Tethys. International Journal of Earth Sciences, 110(8), 2685-2704.
- Zheng Rongguo, Li Jinyi, Zhang Jin, Xiao Wenjiao. 2021. A prolonged subduction-accretion in the southern Central Asian Orogenic Belt: Insights from anatomy and tectonic affinity for the Beishan complex. Gondwana Research, 95, 88–112.
- Zheng Rongguo, Jinyi Li, Jin Zhang, Wenjiao Xiao, Qianjun Wang. 2021. Permian oceanic slab subduction in the southern Beishan: Reply to comment by Liu et al. on "Permian oceanic slab subduction in the southernmost Central Asian Orogenic Belt: Evidence from adakite and high-Mg diorite in the southern Beishan". Lithos, 396–397, 106244.
- Zhu Jianjiang, Liu Fulai, Liu Fuxing, Shi Chuang, Wang Fang, Xu Wentao. 2021. Carbon isotope and genesis



studies of graphite deposits in the Liaohe Group of the Jiao-Liao-Ji Orogenic Belt. Acta Petrologica Sinica, 37(2): 599-618.

2021

- Zhu Jianjiang, Liu Fulai, Wang Fang, Xie Shiwen, Cai Jia, Ji Lei, Wang Huining. 2021. Geochemistry and Geochronology of the Jinghong Ophiolites: Implications for the Tectonic Evolution of the Eastern Paleo-Tethys. Acta Geologica Sinica - English Edition, 95(5), 1509–1526.
- Zhu Jianjiang, Liu Fulai, Wang Fang, Xu Wentao, Liu Fuxing, Shi Chuang. 2021. Carbon isotope and geochemical characteristics of the Paleoproterozoic graphite deposits in the Jiao-Liao-Ji belt, North China Craton: Implications for genesis and depositional environment. Precambrian Research, 362, 106320.
- Zhu Xiaosan, Lu Minjie. 2021. Fault structures and magmatic intrusions inferred from magnetic data for the Southern Great Xing'an Range, Northern China. Ore Geology Reviews, 135, 104206, 1-16.

#### Table2-2 Chinese language publications with English abstract

- Bai Huaqing, Kuang HongWei, Liu Yongqing, Wu Feng. 2021. Sedimentary environments and palaeoclimate of the upper Jurassic deposits in the North German Basin. Journal of Palaeogeography(Chinese Edition), 23(2), 405–420.
- Che Yawen, Liu Jianfeng, Zhao Shuo et al. 2021. Early early-Cretaceous post-collisional tectonic setting of the southern segment of the Great Xing'an Range: Evidence from the Lanjiayingzi gabbro-diorite in Linxi area. Geological Bulletin of China, 40(1), 152-163.
- Deng Yang, Pan Xiaofei, Yang Yanshen, et al .2021. Re-Os dating of Molybdenite of the Dongmen Cu-Mo ore area in Xinyu, Jiangxi province and its metallogenic significance. China Mining magazine,30(11):169-177.
- Di Yinglong, Zeng Lingsen, Chen Jing, Gao Li-E, Zhang Lifei. 2021. The mechanism of exsolution lamellae in basic granulite facies scapolite: An example from the granulite in the Ama Drime Massif, southern Tibet. Acta Petrologica Sinica, 37(11), 3435-3444.
- Dong chunyan, Ma mingzhu, Xie Hangqiang, Zhang Yuxu, Wan Yusheng. 2021. Magmatism and metamorphism of the Early Precambrian basement in the Bayan Obo area, Inner Mongolia: Zircon SHRIMP U-Pb dating and LA-MC-ICPMS Hf analysis. Acta Petrologica Sinica, 37(02),417-32.
- Duan Ruihan, Liu Chaohui, Shi Jianrong. Late Neoarchean magmatic arc extends westward in the southern of Yinshan Block: Evidence from geochronology and geochemistry of the Wulatezhongqi and Wulatehouqi area. Acta Petrologica Sinica, 37 (5), 1372-1404.
- Fu Changlei, Yan Zhen, Wang Bingzhang, Chen Lei, Li Junhui. 2021. Discovery of the Paleoproterozoic metamorphic basement in the Tuomoerrite area of North Qaidam:Contraint on the location of Early Paleozoic suture. Geological Bulletin of China, 40(8),1215-1230.
- Fu Changlei, Yan Zhen, Wang Bingzhang, Niu Manlan. 2021. Identification of the relics of paleo-seamount in orogens: A case study from the geological mapping in Qingshashan and Donggou areas within the Lajishan suture zone. Geological Bulletin of China, 40(1), 31-40.
- Fu Changlei, Yan Zhen, Xiao Wenjiao et al. 2021. Identification and geological significance of the Early Paleozoic Tianjunnanshan remnant ocean basin in the Zongwulong belt, NE Tibetan Plateau. Acta Petrologica Sinica, 37(8),2401-2418.
- Gao Li-E, Zeng Lingsen, Yan Lilong, Gao Jiahao, Zhao Linghao. 2021. Enrichment mechanisms of Sn-Cs-Tl in the Himalaya leucogranite. Acta Petrologica Sinica, 37(10), 2923-2943.
- Hao Guangming, Zeng Lingsen, Zhao Linghao. 2021. Miocene-Pleistocene crustal anatexis in the Namche Barwa Massif, southern Tibet. Acta Petrologica Sinica, 37(11), 3501-3512.
- He Zhenyu and Yan Lili. 2021. Zircon trace element geochemistry constrains on the silicic volcanic system. Acta Petrologica et Mineralogica, 40 (5), 939–951.
- Hou Zengqian, Xu Bo, Zheng Yuanchuan, Zheng Hongwei, Zhang Hongrui. 2021. Mantle flow: The deep mechanism of large-scale growth in Tibetan Plateau. Chinese Science Bulletin, 66(21), 2671-2690.





- Huang Gang, Song Yucai, Zhuang Liangliang, Tian Lidan, Wu Wei and Zhang Ying. 2021. Characteristics and genesis of sediment-hosted celestite deposit: An overview. Mineral Deposits, 40(5):1100~1118.
- Hu Peiyuan, Zhai qingguo, Tang yue et al.2021. Geochemistry, zircon U-Pb age, Lu-Hf isotopes and tectonic setting of the Early Paleozoic gneissic granites from the Nyainrong microcontinent, Tibet Plateau. Geological Bulletin of China, 40,1203-1214.
- Hu Peiyuan, Zhai qingguo, Zhao Guochun, Tang yue et al. 2021. Andean-type orogeny along the northern Gondwana margin: evidences of zircon U-Pb ages geochemistry data of the Ordovician granites from the Amdo area, northern Tibet. Acta Petrologica Sinica, 37(8),2401-2418.
- Ji Shu'an. 2021. The Chinese translated name of the fossil reptile Monjurosuchus splendens from Jehol Biota and the brief research history on its systematic position. Geological Review, 67 (2), 279-288.
- Liao Cheng, Yang Tiannan, Liang Mingjuan, Xin Di, Dong Mengmeng, Xue Chuandong. 2021. Sedimentary geology of the western margin of the Eocene Jianchuan basin in southeast Tibetan Plateau and its tectonic implications. Acta Petrologica ET Mineralogica, 40(4), 729-746.
- Li Chunrui, Li Haibing, Pan Jiawei, Liu Dongliang, Bai Mingkun, Liu Fucai, Zhang Jinjiang. 2021. Calcite microstructure, geochemistry and chronology within the fault zone reveal the paleoseismic records of the Yadong rift, southern Tibet. Acta Petrologica Sinica, 37(10):3185-3204.
- Li Chenglong, Li Haibing, Wang Huan, Zhang Jinjiang. 2021. Petrological and geochemical characteristics and deformation behavior of the Beichuan section of the Wenchuan Earthquake Fault Zone. Acta Petrologica Sinica, 37(10):3145-3167.
- Li Guangxu, Zeng Lingsen, Gao LiE, Gao Jiahao, Zhao Linghao. 2021. Early Cretaceous magmatism of the Langxian Complex in the eastern Gangdese batholith, southern Tibet: Neo-Tethys Ocean Subduction Reinitiation. Acta Petrologica Sinica, 37(10), 2995-3034.
- Li Guangxu, Zeng Lingsen, Zhao Linghao, Gao Li-E, Gao Jiahao. 2021. Petrogenesis and geodynamic significances of the early Late Cretaceous intrusion in the Langxian Complex, eastern Gangdese batholith of souuthern Tibet. Acta Petrologica Sinica, 37(11):3348-3376.
- Li Haibing, Pan Jiawei, Sun Zhiming, Si Jialiang, Pei Junling. 2021. Continental tectonic deformation and seismic activity : a case study from the Tibetan Plateau. Acta Geologica Sinica, 95(1), 194-213.
- Li Huaqi, Li Tianfu, Ji Fengbao. 2021. Geochemical analysis and amphibole 40Ar-39Ar dating for meta-basalts from Tongka ophioliti mélange, eastern Nujiang belt. Geological Bulletin of China, 40(8), 1279-1290.
- Li Jin, Tang Suohan, Ma Jianxiong, Zhu Xiangkun. 2021. The preparation of reference material for Fe isotope measurement of magnetite samples. Acta Petrologica et Mineralogica, 40(3), 535-541.
- Li Jin, Tang Suohan, Ma Jianxiong, Zhu Xiangkun. 2021. Principles and Treatment Methods for Metal Isotopes Analysis. Rock and Mineral Analysis, 40(5), 627-636.
- Li Qiuyun, Yang Zhiming, Wang Rui, Sun Maoyu, Qu Huanchun. 2021. Zircon trace elemental and Hf-O isotopic compositions of the Miocene magmatic suite in the giant Qulong porphyry copper deposit, southern Tibet. Acta Petrologica ET Mineralogica, 40(6), 1023-1048.
- Li Runwu, Tong Ying, Su Shangguo. 2021. Comparison Between Erdenet Porphyry Cu-Mo and Oyu Tolgoi Porphyry Cu-Au Deposits in the Central Asian Metallogenic Domain. Journal of Earth Sciences and Environment, 43, 506-527.
- Liu Fei, Li Guanlong, Bo Rongzhong, Yang Jingsui. 2021. Spresding ridge subduction of Bangong-Nujing Ocern:Evidence from geochemistry and Sr-Nd isotope of Middle Jurassic gabbro dikes in the Zongbai accretionary complex. Geoloical Bulletin of China, 40(8), 1247-1264.
- Liu Fei, Yang Jingsui, Niu Xiaolu, Li Guanlong and Feng Guangying. 2021. Early Cretaceous Dongbo ophiolite in the western part of the Yarlung Zangbo Suturs Zone, Tibet:Constraints on multi-stages from ultra-slow spreading influences by a mantle plume to intra-oceanic subduction. Acta Geologica Sinica, 37 (10):0000-0000.



Liu Yan. 2021. Analysis of global climate change in the next one hundred years. Geological Survey of China, 8, 3, 1-11.

- Liu Yan, Shu Xiaochao. 2021. An Overview of Fenitization in Carbonatite-Related Rare Earth Element Deposits. Bulletin of Mineralogy, Petrology and Geochemistry, 40, 1-9.
- Li Wenhui, Wang Haiyan, Gao Rui, Lu Zhanwu, Li Hongqiang, Hou Hesheng, Xiong Xiaosong, Ye Zhuo. 2021. Research on Upper Crust Velocity Structure of the Qinling Orogen and adjacent Regions. Earth Science Frontier, 29.2(2022):12.
- Lu Peng, Tong Ying, Meng Qiuyi, Zhang Huafeng. 2021. Timing and petrogenesis of the Late Permian A-type granitic dyke swarm in Ulungur East Junggar. Geological Bulletin of China, 40, 58-70.
- Lu Zhanwu, Li Wenhui, Zhang Xinyan, Li Qiusheng, Cai Yuguo, Ren Yanzong, Wang Guangwen. 2021. A Geophysical technology for thematic geological mapping:Short period dense array. Geological bulletin of China, 40(1):1-12.
- Mo Lingchao, Liu Fulin, Zhang Changzheng, et al. 2021. Mineralization timing and geodynamic background of the Jinchanggouliang gold deposit in Inner Mongolia. Acta Petrologica Sinica, 37(6), 1799-1812.
- Mao Xiaohong, Zhang Jianxin, Lu Zenglong and Zhou Guisheng. 2021. Early Paleozoic reactivation of the Precambrian basement on the northern margin of the Qilian block: Evidence from phase equilibria and zircon U-Pb dating of meta-mafic rocks. Acta Petrologica Sinica, 37(10), 3095-3117
- Niu Xiaolu, Liu Fei, Feng Guangying, Mao Xiaohong. 2021. Petrogenesis of the Late Silurian to Early Devonian potassic alkaline rocks on the northern margin of the North China Craton and their constraints on the tectonic evolution. Acta Petrologica et Mineralogica, 40(5):835-858.
- Pan Jiawei, Bai Mingkun, Li Chao, Liu Fucai, Li Haibing, Liu Dongliang, Marie L uce CHEVALIER, Wu Kungang, Wang Ping, Lu Haijian, Chen Peng, Li Chunrui. 2021. Coseismic surface rupture and seismogenic structure of the 2021.5.22 Maduo(Qinghai) MS 7.4 earthquake. Acta Geologica Sinica, 95(6):1655-1670.
- Qiu Tian, Yang Jingsui, Wu Weiwei, Xiong Fahui, Rui Huichao, Jiang Jiuyang. 2021. Petrogenesis of chromitites and its records of Ti metasomatism in crust鄄mantle transition zone, Bulqiza ophiolite massif, Albania. Sedimentary Geology and Tethyan Geology, 41(3):485-504.
- Qiu Tian, Zeng Lingsen, Shen Tingting. 2021. Progresses on carbon sequestration through carbonation of maficulatrmafic rocks. Geological Survey of China, 8(4):20-32.
- Qi Xuexiang, Sheng Hui, Wei Cheng, Ren Yufeng, Cai Zhihui, Ji Fengbao, Liang Fenghua, Liu Xufeng. 2021. Longlin-Ruili subduction-accretionary complex belt in the southeastern Gaoligong orogen, and its relationship with the evolution of the Meso-Tethyan Ocean. Acta Petrologica Sinica, 37(10), 3067-3094.
- Qu Junfeng, Zhang Lifei, Zhang Jin, Zhang Bo. 2021. Petrology and geochronology on the high-pressure pelitic granulite from Bulunkoule complex in West Kunlun and its tectonic implication. Acta Petrologica Sinica, 37(2), 563-574.
- Ren Liudong, Zong Shi, Wang Yanbin, Liu Ping. 2021. Formation process and petrological implication of the borosilicate assemblage grandidierite, prismatine and tourmaline in the high-grade quartzofeldspathic gneisses in the Larsemann Hills, East Antarctica. Acta Petrologica Sinica, 37(2), 575-588.
- Ren Yanzong, Lu Zhanwu, Zhang Xinyan, Xue Shuai, Liu Zilong, Cheng Yongzhi, Cai Yuguo. 2021. Progress in data acquisition and processing technology of portable node seismographs. Progress in Geophysics(in Chinese), 36(2):0779-0791.
- Sun Lijing, Zhao Zhongbao, Pan Jiawei, Liang Fenghua, Zhang Jinjiang. 2021. The stress and strain state of Yalahe fault in the Kangding segment of the Xianshuihe fault zone and its seismogenic environment. Acta Petrologica Sinica, 37(10):3225-3241.
- Tang Suohan, Li Jin, Pan Chenxu, Liu Hui, Yan bin. 2021. Preparation of the Reference Materials for Rb-Sr and Sm-Nd Isotope Analysis. Rock and Mineral Analysis, 40(2), 285-295.
- Tang Yue, Zhai Qingguo, Hu Peiyuan, Wang Wei. 2021. Petrogenesis of anorthosite in the Laguoco ophiolite,





western part of the Bangong-Nujiang suture zone and its constraint to the evolution of the Meso-Tethys Ocean. Geological Bulletin of China, 40(8):1265-1278.

- Tian Yihong, Zeng Lingsen, Gao Li-E, Wang Yaying, Hou Kejun. 2021. Late Permian felsic magmatism along the Tethyan Himalaya, south Tibet and tectonic implications. Acta Petrologica Sinica, 37(10), 3035-3047.
- Tian Zhonghua. 2021. Structural complexity of the suture zone: A case study from the multi-phase modified suture zone in the Sulu area. Chinses Journal of Geology, 56(2):635-666.
- Wan Yusheng, Xie Hangqiang, Wang Huichu, Liu Shoujie, Chu Hang, Xiao Zhibin, Li Yuan, Hao Guangming, Li Pengchuan, Dong Chunyan, Liu Dunyi. 2021. Discovery of early Eoarchean-Hadean zircons in eastern Heibei, North China Craton. Acta Geologica Sinica, 95(2), 277-291.
- Wan Yusheng, Xie Hangqiang, Wang Huichu, Li Pengchun, Chu Hang, Xiao Zhibin, Dong Chunyan, Liu Shoujie, Li Yuan, Hao Guangming, Liu Dunyi. 2021. Discovery of ~3.8 Ga TTG rocks in Hebei, North China Craton. Acta Geologica Sinica, 95(5), 1321-1333.
- Wang Dan, Guo Jinghui, Ma Xudong. 2021. Nb/Ta variations in Archean TTG: Implications for "Nb-Ta paradox". Acta Petrologica Sinica, 037(02), 341-355.
- Wang Guangwen, Wang Haiyan, Li Hongqiang, Li Wenhui, Pang Yongxiang. 2021. Research and application of seismic forward simulation technology in deep reflection seismic profile detection. Geophysical and Geochemical Exploration, 45(4),970-980.
- Wang Huan, Li Haibing, Sun Zhiming, He Xiangli, Liu Dongliang, Pan Jiawei, Zhang Lei. 2021. Discovery of the pseudotachylytes in the Qiangtang Rift, Tebit, and their petrological characteristics and rectonic significance. Acta Petrologica Sinica, 37(10):3131-3145.
- Wang Yanbin, Wang Hao, Ren Liudong, Tong laixi, Ian S Williams. 2021. Zircon U-Pb ages of the mafic gneiss and leucogneiss from the Bailey Peninsula: Constraints on the timing of the tectonothermal events related to the amalgamation of Rodinia in the Windmill Islands, East Antarctica. Journal of Geomechanics, 27(5):768-782.
- Wang Yuqing, Dong Chunyan, Bai Wenqian, et al. 2021. Supracrustal Enclaves in the Late Neoarchean Lianhuashan Monzogranite in the Lianghuashan Area, Western Shandong: SHRIMP U-Pb Zircon Dating and Geochemistry. Journal of Jilin University (Earth Science Edition), 51(1), 141-153.
- Wang Yang, Zhang Hongrui. 2021. Structure and Composition of Collisional Orogen in the Southeastern Margin of Tibetan Plateau, China: Constraints from Petrogeochemistry and Geophysics. Journal of Earth Sciences and Environment, 43(03), 449-468.
- Wen Fei, Tian Zhonghua. 2021. A metamorphic and deformational study of meta-pelites in the Liaohe Group located at Liaodong Peninsula: significance to process of Paleoproterozoic orogenesis and exhumation. Acta Petrologica Sinica, 37(2), 619-635.
- Wu Qiong, Li Haibing, Chevalier ML, Mi Guilong, Li Chao, H Xiangli, Li Yalin. 2021. Rock characteristics, internal structure and physical-chemical properties of Qianning Segment in Xianshuihe fault zone.. Acta Petrologica Sinica, 37(10):3204-3225.
- Xiang Zhongjin, Yan Quanren, Xia Lei, Xia Wenjing. 2021. The tectonic setting of the Early-Middle Triassic volcanic-sedimentary associations in Funing-Nap o area, the south margin of Nanpanjiang Basin, South China.Geological Bulletin of China, 40(1), 138-151.
- Xie Shiwen, Liu Fulai, Wang Fang.2021. Petrogenesis of Late Devonian volcanic rocks in the Jinghong area, southwestern Sanjiang region and its geological implications. Acta Petrologica Sinica, 37(2):481-496.
- Xu Wang, Liu Fulai, Ji Lei, Xu Wentao, Wang Dan. 2021. Middle Permian-Late Triassic magmatism in the Deqen-Weixi area of the Sanjiang Orogenic Belt: Implications for Paleo-tethyan evolution. Acta Petrologica Sinica, 37(2), 462-480.
- Xue HuaiMin. 2021. Geochronology, geochemistry and stratospheric interaction of Late Mesozoic granitoids near the boundary between Anhui and Zhejiang provinces in the eastern segment of the Jiangnan orogenic



belt. Acta Petrologica Sinica, 37(2), 433-461.

Xue Huaimin, Cao Guangyue. 2021. Volcanic lithofacies, volcanic tectonic framework and volcanism process in the southwestern segment of Huanggangliang volcanic structural uplift in Great Xing'an Range, NE China. Acta Geologica Sinica, 95(3), 643-666.

- Yan Zhen, Fu Changlei, Niu Manlan, Zhang Ji, Xiao Wenjiao, Wang Zongqi. 2021. Recognition and significance of accretionary prism in orogenic belts. 56(2), 430-448.
- Yang Shengbiao, Yang Jingsui, Li Yuan, et al. 2021. Late Jurassic magmatism in the Neo-Tethys Ocean:Evidence from zircon U-Pb ages and geochemistry of dolerites in the Bainang Terrane, southern Tibet.Geological Bulletin of China, 40 (8), 1231-1246.
- Yin Shuping, Xie Yuling, Liang Yayun. 2021. A review of REE enrichment and fractionation mechanism during magma evolution of ore-forming carbonatite and significance of mineral zonation in carbonatite. MINERAL DEPOSITS, 40(5), 949-962.
- Yun Xiaorui, Cai Zhihui, He Bizhu, Zhang Shengsheng, Liu Ruohan, Zheng Menglin, Chen Huiming and Li Zhenyu. 2021. Mesozoic-Cenozoic thermal evolutionary history of the northeastern margin of the Gonghe basin, Qinghai: low-temperature thermal chronology evidences from the Gouhou and the Dangjiasi Complex. Acta Petrologica Sinica, 37(10):3241-3260
- Zhang Beihang, Zhang Jin, Qu Junfeng, Zhao Heng, Niu Pengfei, Hui Jie. 2021. Intracontinental deformation, Paleo-stress field and tectonic setting in northeastern Alxa Block since Late Mesozoic. Geological Bulletin of China, 40(1), 110-124.
- Zhang Beihang, Zhang Jin, Qu Junfeng, Zhao Heng, Wang Yannan, Li Jinyi, Niu Pengfei, Zhao Shuo, Zheng Rongguo, Li Yanfeng, Yun Long, Zhang Yiping, Hui Jie. 2021. Luliangshan: A Mesozoic Basement Involved Fold System in the Central North China Craton. Earth Science, 46(7), 2423-2448.
- Zhang Beihang, Zhang Wenlong, Zhang Jin, Qu Junfeng, Zhao Heng, Niu Pengfei. 2021. 1:50000 Geological Map Database of Bayan Hara Map-sheet, Inner Mongolia, China. Geology in China, 48(S2), 1-11.
- Zhang Hongrui, Hou Zengqian. 2021. Comparisons of the Collision Processes and Related Metallogenesis of Zagros and Himalaya Orogens. Journal of Earth Sciences and Environment, 43(03), 436-448.
- Zhang jin, Qu Junfeng, Liu Jianfen, et al. 2021. The evolution of the Xar Moron tectonic belt in the eastern Central Asian Orogenic Belt:Constraints from evidences of deformation and low—temperature thermochronology. Sedimantary Geology and Tethyan Geology, 41(2):190-217.
- Zhang Jianxin, Lu Zenglong, Mao Xiaohong, Teng Xia, Zhou Guisheng, Wu Yawei, Guo Qi. 2021. Revisiting the Precambrian micro-continental blocks within the Early Paleozoic orogenic system of the northeastern Qinghai-Tibet Plateau: Insight into the origin of Proto-Tethyan Ocean. Acta Petrologica Sinica, 37(01):74-94.
- Zhang Xiaowei, Tong Ying, Zhao Hui, Wang Tao, Guo Lei. 2021. Petrogenesis of the Carboniferous granitoid intrusions in Dornogovi Province, Southern Mongolia: Evidence from zircon U-Pb geochronology, Sr-Nd-Hf isotope and wholerock geochemistry. Acta Petrologica ET Mineralogica, 40, 465-483.
- Zhang Zeming, Ding Huixia, Dong Xin, Tian Zuolin, Du Jinxue. 2021. Metamorphism and tectonic mechanisms of subduction zones. Acta Petrologica Sinica, 37(11), 3377-3398.
- Zhu Jianjiang, Liu Fulai, Liu Fuxing, Shi Chuang, Wang Fang, Xu Wentao. 2021. Carbon isotope and genesis studies of graphite deposits in the Liaohe Group of the Jiao-Liao-Ji Orogenic Belt. Acta Petrologica Sinica, 37(2):599-618.
- Zhu Jianjiang, Zhang Lifei, Zhang Lu. 2021. Decarbonation and carbonation processes in subduction zone. Acta Petrologica et Mineralogica, 40(5):952-964.