2019 Annual Report Contents

Preface 2019

The Institute of Geology, Chinese Academy of Geological Sciences (IGCAGS), is a national public scientific research institution and is mainly engaged in national fundamental, public, strategic and frontier geological survey and geoscientific research. Entering the new century, and in particular during the past 5 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 increased number of papers published in "*Nature*", "*Science*" and other high-impact international scientific journals. In the light of this new situation and in order to publicize, in a timely manner, annual progress and achievements of the Institute to enhance its international reputation, an English version of the Institute's Annual Report has been published since 2010.

The Annual Report 2019 includes the following 8 parts: (1) Introduction; (2) Selected Research Achievements; (3) Talents and Awards; (4) Projects and Funding; (5) International Cooperation and Academic Exchange; (6) Important Academic Activities in 2019; (7) Postgraduate Education; (8) Publications. In order 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 providing related material – a written record of the hard work of the Institute's scientific research personnel for the year 2019.

Editorial Board of
The Annual Report (English Version) of the Institute of Geology,
Chinese Academy of Geological Sciences
17 April, 2020

1 2019 Introduction

The Institute of Geology, Chinese Academy of Geological Sciences (IGCAGS), is a national public scientific research institution and is mainly engaged in national fundamental, public, strategic and frontier geological survey and geoscientific research, aiming to provide fundamental geological theory and technological support for national geoscientific research and investigation:

(1) To carry out national fundamental, public, strategic and frontier geoscientific research and fundamental geological survey.

(2) To carry out investigation and innovation research on major basic geological problems in the field of earth resources and environment.

(3) To carry out fundamental disciplinary research on tectonic geology and geotectonics, regional geology and metallogeny, stratigraphy and palaeontology, metamorphic rocks and Precambrian geology, petrology and mineralogy, and Quaternary geology; to conduct research in major areas, such as continental tectonics and dynamics, deep lithosphere exploration and three-dimensional geological survey, isotope geology and chronology, comprehensive geological research and mapping research.

(4) To carry out research on isotopic chronology and geochemical techniques and systems, major key technologies and instruments and equipment; to undertake the construction, management and operation of relevant experimental and observational bases.

(5) To carry out basic geological international cooperation and exchanges.

The Institute has a total of 260 staff members, which includes 152 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, 5 professionals supported by the "National Natural Science Foundation of China (NSFC) for Distinguished Young Scholars", 4 professionals supported by the "NSFC Excellent 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 was 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.

IGCAGS has trained a large number of excellent, highly qualified graduate students. It also has designated programs for postdoctoral research. The Institute has a post-graduate education system for Master's and PhD students. IGCAGS has 40 doctor tutors and 44 master tutors. The institute enrolls about 20 PhD and MA students each year, and currently has 42 postdoctoral researchers.

The Institute has 11 research divisions, namely Division of Regional Geology and Mapping, Division of Tectonics, Division of Stratigraphy and Paleontology, Division of Metamorphic Rocks and Precambrian Geology, Division of Igneous Rocks, Laboratory of Continental Dynamics, Laboratory of Isotope Geology, Lithosphere Research Center, Beijing SHRIMP Center, Mineral and Energy Resources Center, and Three-dimensional Geological Survey and Research Center. In addition, Beijing SHRIMP Center is National Fundamental Resources Platform of Science and Technology.

The Institute also has 3 key laboratories of Ministry of Natural Resources of the People's Republic of China (MNR), namely the Key Laboratory of Isotope Geology, the Key Laboratory of Stratigraphy and Paleontology and the Key Laboratory of Continental Dynamics. In addition, the Key Laboratory of Deep-Earth Dynamics is running in accordance with the State Key Laboratory.

7 academic organizations are affiliated in the institute, namely China Commission of International Continental Scientific Drilling, Commission of Regional Geology and Mineralization of the Geological Society of China (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, Mineralogy and Geochemistry of GSC.

In recent years, the Institute has undertaken more than 500 research projects, including the "National Science and

Technology Major Project of MOST", National Scientific Instruments and Equipment, the National Key Research and Development Plan [including the "National Basic Research Program of China (973 Program)"], significant research programs supported by the National Natural Science Foundation, as well as projects of China Geological Survey (CGS), and so on.

The Institute has produced a great number of innovative results by promoting the growth of talents, fostering innovative ideas, and enhancing the ability to perform scientific research and meet major national needs, and has achieved a large number of innovative achievements in the field of solid Earth science. The Institute attaches great importance to intellectual property rights, having been authorized for about 25 patents. In recent years, 7 research achievements have been awarded to the Institute, including 3 National Natural Science Awards, and 4 Science and Technology Progress Award from MNR.

Fig. 1 Main building of the Institute

Organizational Framework

*Administrative Departments

General Office
Party Committee Office
Service and Security Department
Finance Department
Department of Personnel and Education
Department of Science and Technology
Department of Experimental Administration
Department of Discipline Inspection and Supervision

* Technical Support Organizations

National Geological Mapping and Research Center, China Geological Survey
Collaborative Research Center for Stratigraphy and Paleontology, China Geological Survey
Three-dimensional Geological Survey Center, China Geological Survey

* Technology Platforms

Beijing SHRIMP Center of the National Science and Technology Resource Sharing Service Platform
Key Laboratory of Isotope Geology, Ministry of Natural Resources
Key Laboratory of Stratigraphy and Paleontology, Ministry of Natural Resources
Key Laboratory of Continental Dynamics, Ministry of Natural Resources

* Affiliated Academic Organizations

China Commission for International Continental Scientific Drilling
Commission for Regional Geology and Mineralization, Geological Society of China

* Publications

Acta Petrologica et Mineralogica

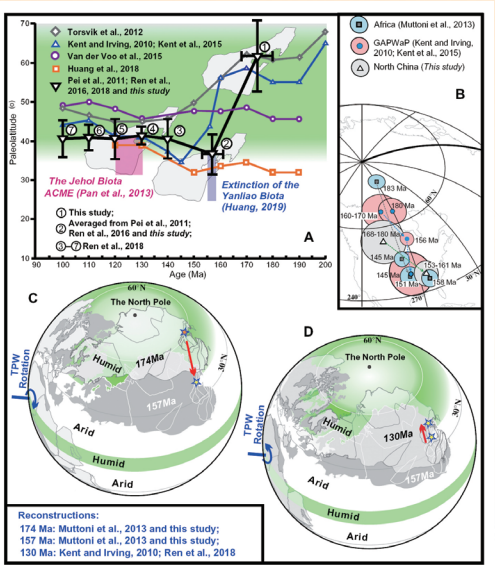
* Research Fields

▲Regional geology, mapping and database construction
▲Regional and global tectonics
▲Origin and evolution of life, paleontology and stratigraphy
▲Sedimentary basins and evolution of paleogeography and paleoenvironments
▲Precambrian geology and early crustal evolution
▲Cenozoic geology and modern geological and ecological environments
▲Ultrahigh pressure metamorphism and metamorphic belts
▲Petrology, mineralogy and mineral deposits
▲Continental dynamics and mantle dynamics
▲Geological setting of mineralization and regional mineralization
▲Three-dimensional geological surveying
▲Deep geophysical probing and lithospheric structures
▲Geological theory, method system and applications of isotopes

2.1 Research Papers

A true polar wander trigger for the Great Jurassic East Asian Aridification

ABSTRACT: A drastic environmental change occurred during the Middle to Late Jurassic as much of East Asia transitioned from a wet seasonal to an extremely arid climate. The timing, scope, and especially mechanism for this aridification are contentious. In this study, we report paleomagnetic data and ages from Jurassic volcanic rocks in North China and for the first time reveal a large-scale southward displacement of ~25° for the Eastern Asian blocks (EABs) sometime between 174 ± 6 Ma and 157 ± 4 Ma. We suggest that the rapid motion documented by our paleomagnetic studies resulted from large-scale true polar wander (TPW). The TPW rotation displaced the EABs from the Northern Hemisphere humid-temperate belt into the subtropical/tropical arid zone. The resultant latitudinal motion coincided with a remarkable environmental change recorded over 10,000,000 km^2 in East Asia between *ca*. 165 Ma and 155 Ma. We call the climate transition the "Great Jurassic East Asian Aridification" and argue that TPW-induced climatic shifts were also responsible for the demise of the Yanliao Biota and subsequent radiation of the Jehol Biota during the Late Jurassic and Early Cretaceous.

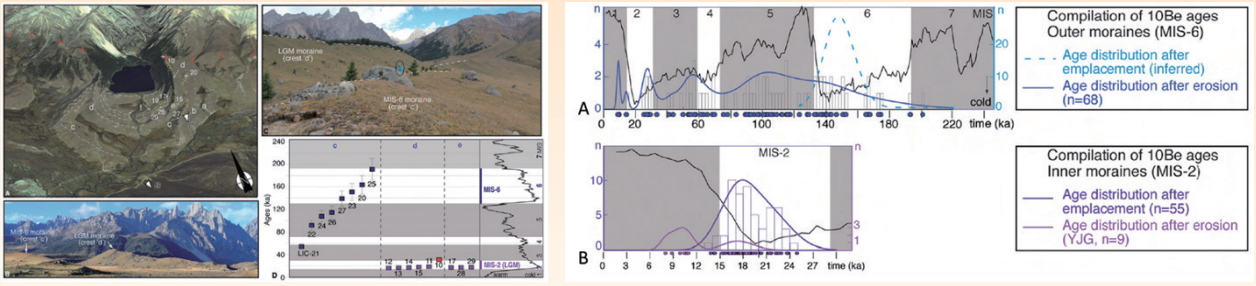


YI Zhiyu and LIU Yongqing *et al.,* 2019- *Geology*, 47 (12): 1112–1116

Deciphering old moraine age distributions in SE Tibet showing bimodal climatic signal for glaciations: Marine Isotope Stages 2 and 6

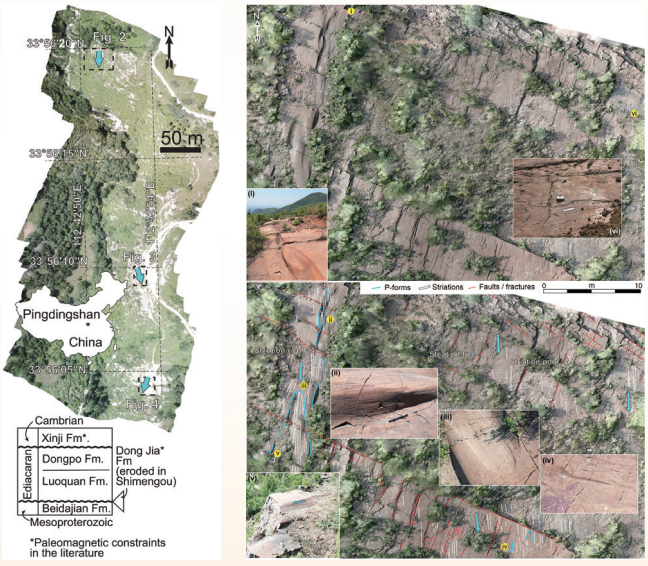
ABSTRACT: Determining the timing and extent of past glaciations in Tibet is essential to reconstruct regional paleoclimate and understand how atmospheric circulation varies due to the high altitude low latitude Tibetan Plateau. In SE Tibet, geomorphological field observation of glacial deposits shows two main imbricated moraines. We apply statistical analyses to a compilation of eight new ^{10}Be cosmogenic exposure ages from two moraine crests at GMX site and 128 previously published but recalculated exposure ages from 30 additional crests in the region. The results show that ages from the sharpest inner moraines range from 14–25 ka, corresponding to the full range of Marine oxygen Isotope Stage (MIS)-2 (*i.e.*, Last Glacial Maximum, LGM) with less than 2% of older outliers. The outer moraines have a fundamentally different distribution with scattered ages from 10 to 200 ka, obtained using the same method of sampling, dating, and age modeling proven robust for dating the LGM inner moraines, therefore excluding a methodologic artifact. This large scatter prevents the application of any statistical analysis to the age distribution. At a site with well-developed and preserved imbricated moraines (Cuopu), the outer moraine's oldest ages are MIS-6, with the oldest one being at the MIS-6/MIS-7 limit, identical to what is observed in the regional compilation. Following our observations for the LGM moraines where <2% of older outliers are present, the outer moraines in SE Tibet could not be younger than MIS-6. This implies that no glacial advance occurred during MIS-3 which is surprising because MIS-3 moraines have been reported to be the most extensive elsewhere in the Himalayan–Tibetan orogen. Indeed, glaciers are sensitive to both precipitation increase and temperature decrease but whether one factor

is prevalent remains debated especially on the Tibetan Plateau. Considering negligible erosion of the boulders, as observed in the field at Cuopu, the most conservative interpretation of our observations is that the true emplacement age of the outer moraines external to the LGM moraines is MIS-6. In that case, glacial advances in SE Tibet correlate with the two coldest periods of the Northern Hemisphere cooling cycles, MIS-2 and MIS-6, indicating that these glaciers are mostly sensitive to a decrease in temperature.



MARIE-LUCE Chevaliera and Anne Replumazb, 2019- *Earth and Planetary Science Letters*, 507: 105-118

Bird's-eye view of an Ediacaran subglacial landscape



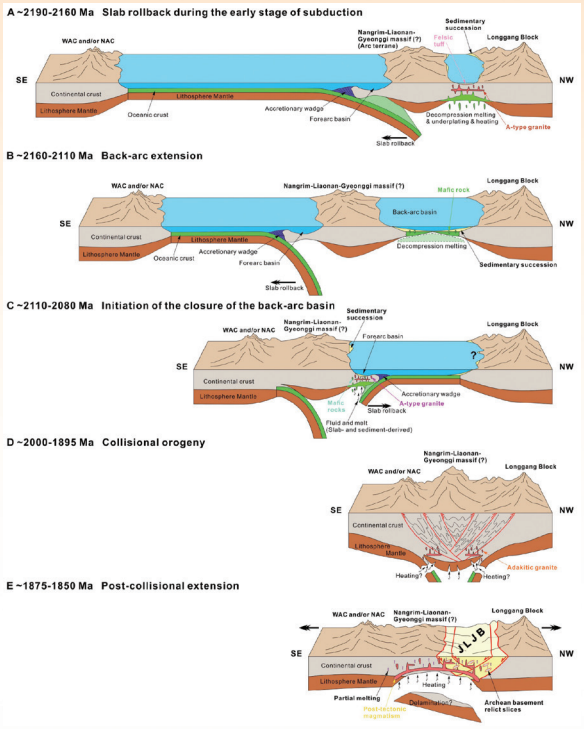
HERON Le Paul Daniel*, VANDYK Matthew Thomas and KUANG Hongwei* *et al*., 2019- *Geology*, 47 (8): 705-709

ABSTRACT: Depositional evidence for glaciation (dropstones, diamictites) is common in Neoproterozoic strata, and often debated, but erosional evidence (*e.g*., unconformities cut directly by ice) is rare. Only two such unconformities are known to have been well preserved globally from the Ediacaran Period (in western Australia and central China). This paper provides the first full description of a spectacular subglacial landscape carved beneath ice masses in the Shimengou area of central China, with classical subglacial bed forms including general faceted forms, müschelbruche, cavetto, spindle forms, and striations that testify to an abundance of meltwater during subglacial erosion. These features were produced during the southward, somewhat sinuous, flow of a temperate to polythermal ice mass.

Geochronological and geochemical insights into the tectonic evolution of the Paleoproterozoic Jiao-Liao-Ji Belt, Sino-Korean Craton

ABSTRACT: The Sino-Korean Craton, which is part of the Columbia supercontinent, was originally formed and stabilized by the amalgamation of several distinctly different tectonic units during the Paleoproterozoic period. Although the early tectonic framework of the Sino-Korean Craton remains controversial, the Paleoproterozoic Jiao-Liao-Ji Belt is accepted to divide the eastern unit of this craton into Archean Nangrim-Liaonan and Longgang

blocks. This orogenic belt is thus the key to revealing the geodynamic processes that occurred during the assemblage and breakup of the Paleoproterozoic supercontinent Columbia. Due to late polyphase tectonothermal events (*e.g*., subduction of the paleo-Pacific Plate), considerable and continuing controversy has surrounded how this Paleoproterozoic orogenic belt formed, with models including (1) opening and closing of an intracontinental rift, (2) collision of a continent-arc-continent system, (3) a rifting-initial ocean formation-oceanic subduction–collision cycle, and (4) opening and closure of a back-arc basin or retro-arc foreland basin.



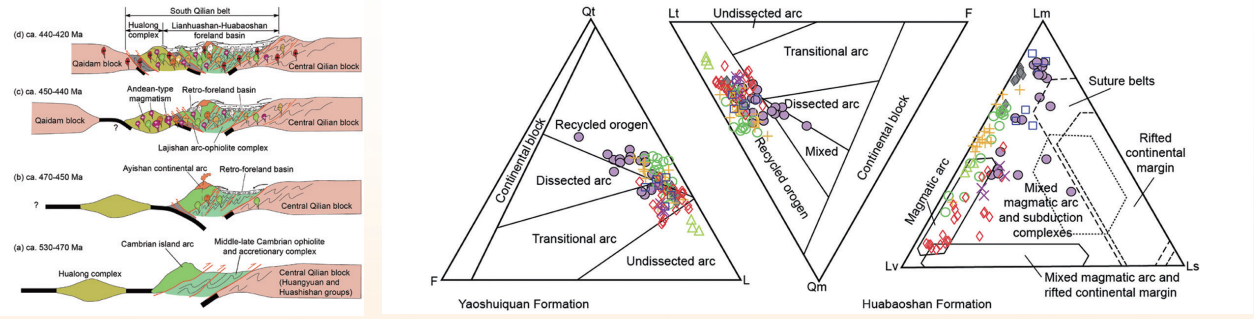
XU Wang and LIU Fulai, 2019- *Earth-Science Reviews*,193:162-198

Here, we synthesize the geochronological, geochemical, and isotopic data on the Paleoproterozoic igneous rocks in the JLJB. The available data suggest that the Paleoproterozoic magmatism in the JLJB lasted from *ca*. 2200 Ma to *ca*. 1800 Ma, with five magmatic flare-ups at *ca*. 2190–2160 Ma, *ca*. 2160–2110 *Ma*, *ca*. 2110–2080 Ma, *ca*. 2010–1895 Ma and *ca*. 1875–1850 Ma. These data, in combination with previous studies on voluminous meta-sedimentary rocks, Archean basement relict slices and granitic leucosomes within the JLJB, allow us to reconstruct the tectonic evolution of the JLJB based on rock petrogenesis as described below. (1) During the early stage of northwestward subduction of Paleoproterozoic oceanic plate between the Longgang-Liaonan-Nangrim Block (*i.e*., the Eastern Block) and the West Australian Craton (WAC) and/or North Australian Craton (NAC), strong slab rollback resulted in trench retreat and extension of the overriding plate (*i.e*., the Longgang-Liaonan-Nangrim Block) and induced upwelling and decompression melting of asthenospheric mantle to produce basaltic magma. The overriding Archean continental crust was heated by the underlying basaltic magma and melted to produce ~2190–2160 Ma aluminous A2-type granites, and minor basaltic magma mixed with this crustal melt to form ~2180–2160 Ma calc-alkaline, andesitic-rhyolitic tuffs. (2) With ongoing extension, the overriding plate thinned, and a back-arc basin opened and widened. The asthenospheric mantle that was metasomatized by limited subduction-related fluids and/or melts began to melt in the spinel-garnet stability field, and produced ~2160–2110 Ma tholeiitic mafic rocks with the geochemical features of both mid-oceanic ridge basalt (MORB) and volcanic arcs. (3) Decreased back-arc mafic magmatism suggests that subduction ceased due to collision between the WAC and/or NAC and the active subduction zone during ~2110–2080 Ma. After the collision, the subduction polarity reversed, from northwestward to southeastward, forming new subduction initiation in the southeastern margin of the back-arc basin, and this new subduction further resulted in forearc extension. Decompression melting of the subarc mantle produced basaltic magma, which was metasomatized by subducted slab- and ancient sediment-derived melts to form ~2110–2080 Ma mafic rocks with both calc-alkaline and tholeiitic features. Simultaneously, the overriding continental crust was heated by the basaltic magma and melted to form ~2110–2080 Ma aluminous A2-type granites. These processes, including opening and closure of back-arc basin, were accompanied by the deposition of voluminous sedimentary rocks in this back-arc basin, and the deposition lasted for at least 180 Ma. (4) After the collision between the WAC and/or NAC, the arc terrane (Nangrim-Liaonan Block + Gyeonggi massif?) and the Longgang Block, the orogeny that involved Archean basement rocks, Paleoproterozoic sedimentary rocks and associated mafic and granitic intrusions began. This process was accompanied by prograde or peak metamorphism and minor magmatism, which

produced the ~2000–1895 Ma adakitic granites derived from partial melting of thickened lower crust. (5) During the late Paleoproterozoic, termination of the collisional orogenic event occurred, as evidenced by strong postcollisional extension, which generated widespread ~1875–1850 Ma igneous rocks in the JLJB and was accompanied by a regional partial melting event related to the exhumation of the JLJB. In summary, the five stages of magmatism, and associated sedimentation and metamorphism in the JLJB record a complete tectonic cycle, including oceanic plate subduction, back-arc extension, closure of the back-arc basin, collisional orogeny and postcollisional extension. These processes further support the conclusion that plate tectonic processes in the Paleoproterozoic period resulted in the amalgamation of microcontinents and arcs to form the Sino-Korean Craton and the Columbia supercontinent.

Retro-foreland basin development in response to Proto-Tethyan ocean closure, NE Tibet Plateau

ABSTRACT: The compositions and ages of the sediments within retro or foreland basins that are formed and preserved adjacent to collisional orogens can reflect the nature of colliding tectonic elements. The nonmarine Yaoshuiquan and Huabaoshan formations in the South Qilian belt on the NE Tibetan Plateau deposited within a retro-foreland basin setting during latest Ordovician to Late Silurian time in response to arc-continent collision. Detritus derivation from a Cambro-Ordovician arc-ophiolite complex contains mixed 530-480 Ma oceanic-crust together with contributions from a 479-450 Ma continenta-arc early in development of the basin. The Cambrian arc-accretionary system and Central Qilian block united to form the basement of a continental arc at ~450 Ma, and both then contributed sediments to the Lianhuashan-Huabaoshan basin. After the Hualong complex accreted to the north, a broad Andean-type margin developed along the southern margin of the Central Qilian block from 450 to 440 Ma. These processes generated a wider basin that received detritus from both the south and the north. Consumption of the Proto-Tethyan Ocean ended with collision between the Qaidam and Hualong blocks, which led to mass wasting of detritus from the Andean-type igneous rocks and both blocks with the basin from 440 to 420 Ma.

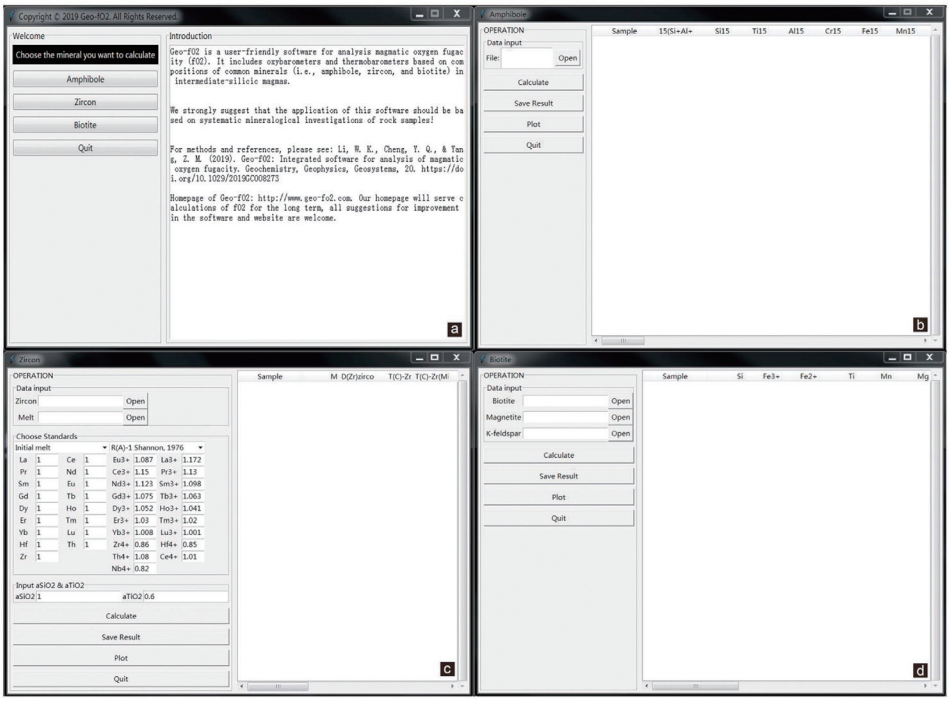


YAN Zhen *et al*., 2019- *Tectonics*, 38(12): 4229-4248

Geo-fO_2: Integrated software for analysis of magmatic oxygen fugacity

ABSTRACT: Oxygen fugacity (fO_2) is a fundamental thermodynamic property governing redox potential in solid Earth systems. Analysis of magmatic fO_2 aids our understanding of the valence state and solubility of multivalent elements during magma evolution. Specialized software, Geo-fO_2, was developed for calculating magmatic fO_2 on the basis of oxybarometers and thermobarometers for common minerals (amphibole, zircon, and biotite) in intermediate-silicic magmas. With user-friendly interfaces, it is easy to input files (.csv or Excel files), output data in Excel

files, and plot results as binary diagrams that can be saved as vector graphics and modified using image-processing software.

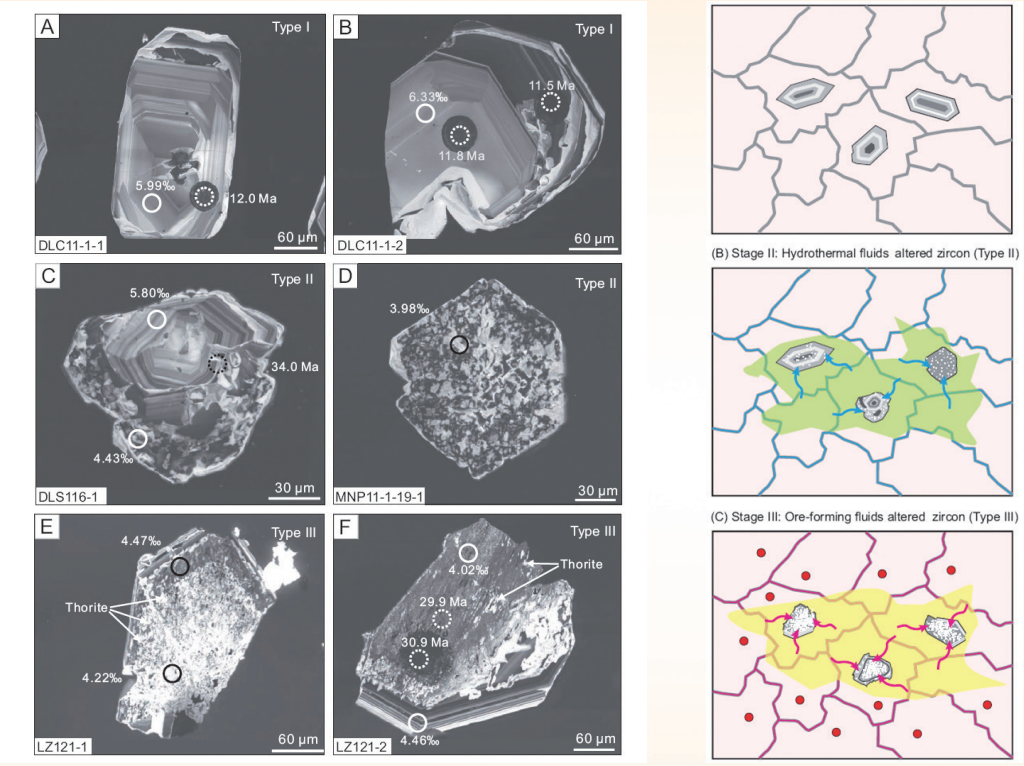


LI Weikai and YANG Zhiming *et al.*, 2019- *Geochemistry, Geophisics and Geosystems*, https://doi.org/10.1029/2019GC008273

Zircon alteration as a proxy for rare earth element mineralization processes in carbonatite-nordmarkite complexes of the Mianning-Dechang Rare Earth Element Belt, China

ABSTRACT: Zircon is a common accessory mineral in igneous rocks, including carbonatite-nordmarkite complexes. Zircons can record radiation damage and hydrothermal alteration through changes in oxygen isotope values, crystal structures, and geochemical and petrographic characteristics. The Mianning-Dechang rare earth element (REE) belt in China hosts 12 carbonatite-nordmarkite complexes and related Cenozoic REE deposits. We investigated zircons from these nordmarkites to understand the formation of the REE deposits. Three types of zircon from fresh and altered nordmarkite were identified. Type I zircons are unaltered, type II zircons experienced fenitization associated with hydrothermal alteration, and type III zircons were strongly affected by ore-forming fluids and REE mineralization. Type III zircons have higher Th, U, light REE, and REE contents (43,100, 52,000, 7,420, and 9,000 ppm, respectively) than type I zircons (1,450, 8,100, 265, and 1,130 ppm, respectively) and type II zircons (1,370, 19,520, 334, and 1,210 ppm, respectively). Petrographic observations, Raman spectra, and geochemical characteristics show that from type I to III zircons the crystals experienced increased radiation damage, hydrothermal alteration, and metasomatism by ore-forming fluids and show a transition to hydrothermal zircon. Type I, type II, and type III zircons have D_{α}^{T} (alpha dose) values of 0.6 to 29.5, 7.1 to 207, and 64 to 687 α-decay events/mg, with averages of 12.7, 87.36, and 144 a-decay events/mg, respectively. In general, the radiation damage trend shows that the Raman frequency is ~995 cm^{-1}, even at high levels of radiation damage. However, the Raman frequency of type III zircon can reach 991 cm^{-1} with a line width of 28 cm^{-1}, indicating type III zircons have a lower degree of crystallinity than type I and II zircons

as a result of the effects of additional alteration by ore-forming fluids rich in Th and U. The involvement of ore-forming fluids and influx of meteoric water into the magmatic water is evident from the $\delta^{18}O$ values of type I, II, and III zircons of 5.15‰ to 8.65‰, 1.50‰ to 6.24‰, and 1.92‰ to 5.86‰, respectively. U-Pb dating of type I zircons yields similar ages within a given deposit. Type II and III zircons could not be dated for the formation ages of REE deposits due to their high degree of alteration, abundant mineral inclusions, and variable common and radiogenic Pb contents. Given the chemical composition of the hydrothermal fluids and REE minerals, the geochemical characteristics of type III zircons suggest that highly evolved ore-forming fluids rich in Na, K, Ca, Cl, SO_4, F, REEs, Th, U, Zr, Hf, and Pb facilitated zircon alteration. It is therefore concluded that the changes in zircon geochemistry and crystal characteristics could serve as a proxy for carbonatite-nordmarkite–related REE mineralization processes and as an indicator for REE exploration. A schematic model of the formation of type I, II, and III zircons and REE mineralization stages in the Mianning-Dechang REE deposits is presented.

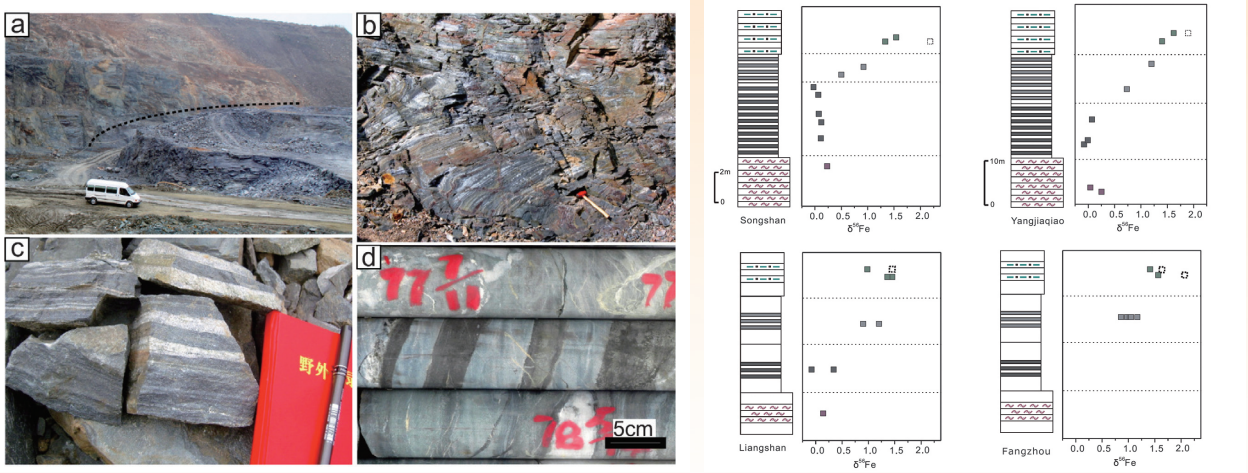


LIU Yan *et al*., 2019- *Economic Geology,* 114: 719-744

Iron isotopic variations of the Cryogenian banded iron formations: A new model

ABSTRACT: The Fe isotope composition of banded iron formation (BIF) is regarded as a powerful tracer in paleoceanography, and the Cryogenian banded iron formation associated with "Snowball Earth Events" provides a precious record of environmental change in the Neoproterozoic. However, Fe isotope studies on Cryogenian BIFs are rare and previous interpretations of Cryogenian Fe isotope data are problematic. Here we present a systematic investigation of the Fe isotope composition of the Cryogenian Xinyu BIF sections from four localities in the Yangtze region, South China. These BIF sections comprise banded magnetite quartzite, banded chlorite-magnetite quartzite, and magnetite-bearing chlorite phyllite, in stratigraphically ascending order. The $\delta^{56}Fe_{IRMM-014}$ values of the Xinyu BIF

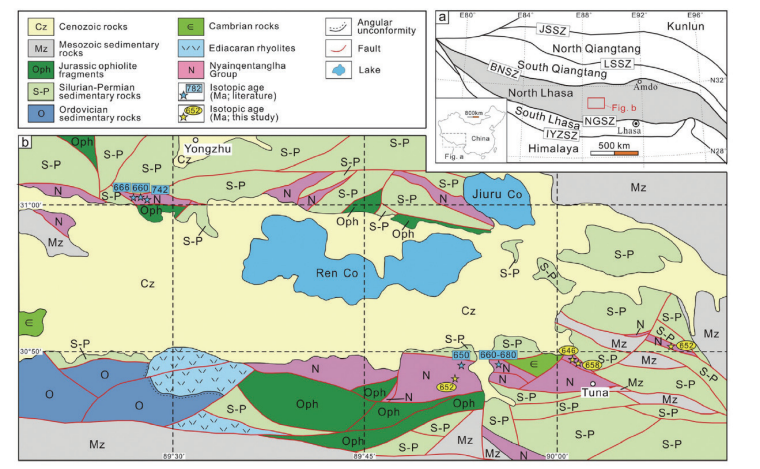
vary significantly and show an overall increase upsection, from *ca*. 0‰ to *ca*. 1.5‰. This stratigraphic trend in Fe isotope compositions is similar to those reported previously for Cryogenian BIFs in North America and Australia, and thus seems to be a common phenomenon. We interpret Fe isotope variation in Cryogenian BIF to be essentially controlled by varying degrees of Fe precipitation in seawater, rather than resulted from "a water column Fe isotope gradient" as proposed previously. The variation in the degree of Fe precipitation can be controlled by changes of Eh and/or pH conditions in seawater resulting from transgression or ocean acidification.

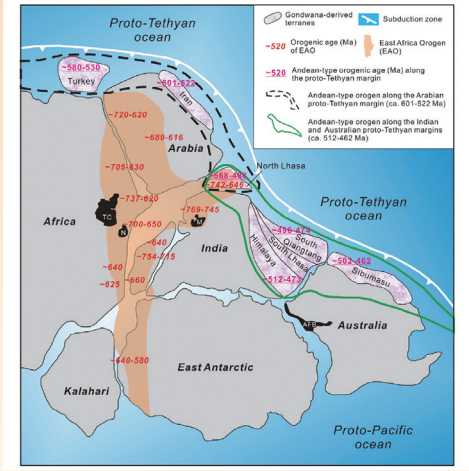


ZHU Xiangkun *et al*., 2019- *Precambrian Research*, 331, https://doi.org/10.1016/j.precamres.2019.105359

Late Cryogenian magmatic activity in the North Lhasa terrane, Tibet: Implication of slab break-off process

ABSTRACT: The North Lhasa terrane in Tibet is generally interpreted to be paleotectonically unrelated to the East African Orogen (EAO) and is instead thought to have derived from northeastern India or northwestern Australia. In this study, we present petrogenetic and geochronological results pertaining to the analysis of gabbros (*ca*. 652 Ma), diorites (*ca*. 658 and 646 Ma), and tonalites (*ca*. 652 Ma) from the North Lhasa terrane. The gabbrosare calc-alkaline and exhibit arc-like geochemical features. Low positive zircon $\varepsilon_{Hf}(t)$ values (+1.0 to +3.8), high zircon $\delta^{18}O$ (6.25‰ to 7.94‰), and low negative whole-rock $\varepsilon_{Nd}(t)$ values (−3.5 to −1.4) indicate that the gabbros were derived fromthe lithospheric mantle, with geochemical modification by a subduction component. The diorite suite is characterized by a wide range of whole-rock chemistries (*e.g*., SiO_2=51.33–61.98 wt %) and Hf–O–Sr isotopic compositions ($\varepsilon_{Hf}(t)$=−10.8 to−0.1; $\delta^{18}O$=5.17‰ to 7.11‰; I_{Sr}=0.706 to 0.710), and negative whole-rock $\varepsilon_{Nd}(t)$ values (−7.0 to −4.7). These diorites are geochemically similar to OIB and are interpreted to be products of the partial melting of a relatively deep mantle source (N85 km) prior to extensive modification by continental crustal material. The tonalites are adakitic and have moderate $Mg^{\#}$ values (47–54), low compatible element abundances, positive zircon $\varepsilon_{Hf}(t)$ values (+3.4 to +6.2), high I_{Sr} values (0.714 to 0.715), and small negative whole-rock $\varepsilon_{Nd}(t)$ values (−1.6 to −0.4). These tonalitesmost likely formed by the melting of thickened Mesoproterozoic continental crust. The generation of these *ca*. 650 Ma magmatic rocks was related to slab break-off in a collision zone. By integrating the findings of previous studies with the data of the present study, we suggest that the North Lhasa terrane was most likely located in the northern segment of the EAO in paleotectonic reconstructions of the Gondwana supercontinent.

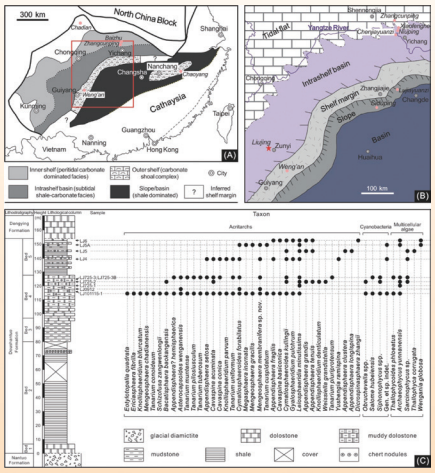


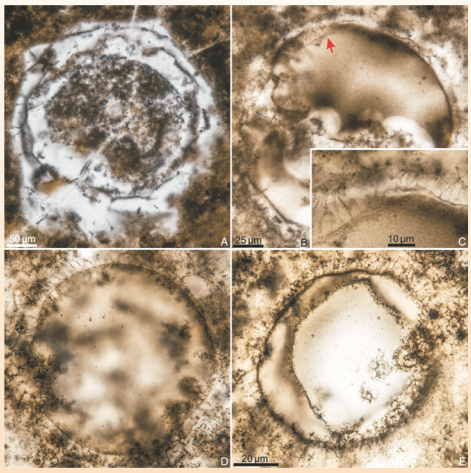


HU Peiyuan and ZHAI Qingguo *et al*., 2019- *Gondwana Research*, 71: 129-149

Acritarchs from the Doushantuo Formation at Liujing section in Songlin area of Guizhou Province, South China: Implications for early-middle Ediacaran biostratigraphy

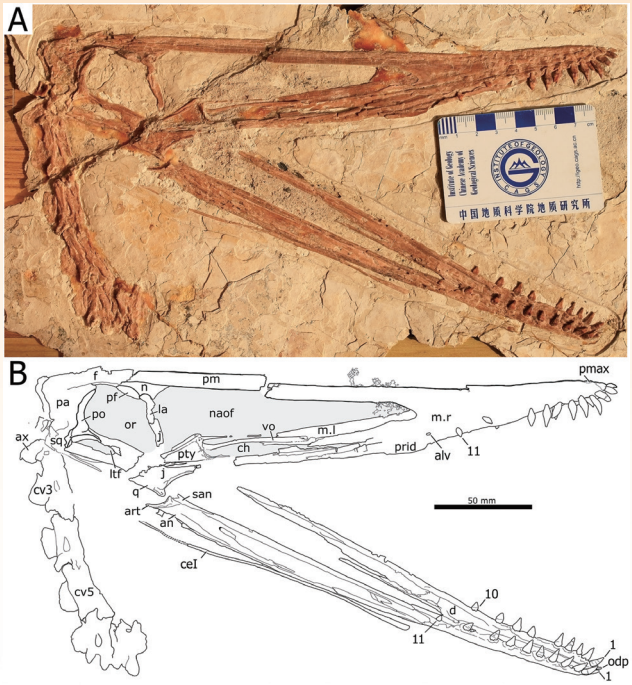
ABSTRACT: A taxonomically diverse and morphologically disparate microfossil assemblage is recovered from the upper Doushantuo Formation in the Liujing section of Songlin area, Guizhou Province, including acanthomorphic and sphaeromorphic acritarchs, multicellular algae, and filamentous cyanobacteria. Acritarch *Mengeosphaera membranifera* sp. nov. is newly erected and genus *Cymatiosphaeroides* and several species (*C. forabilatus, C. kullingii, Bacatisphaera baokangensis*) are emended in the systematics. The acanthomorphic species are dominated by *Cymatiosphaeroides forabilatus and Mengeosphaera membranifera* sp. nov. The Liujing assemblage shares many species with other Ediacaran coeval assemblages from South China, Australia, Siberia, the East European Platform, India, Mongolia and Svalbard, and indicates a significant taxonomic similarity to the global, age-diagnostic assemblages. New occurrence of those known taxa in the Liujing succession documents the biodiversity of the Ediacaran acritarchs in South China. The Liujing assemblage extends the palaeogeographic distribution of the Ediacaran acritarchs and may be assigned to the *Tanarium conoideum–Cavaspina basiconica* Assemblage Zone that was recognized in the Yangtze Gorges area of South China. Alternatively, it could be partially correlated with the barren interval between *T. conoideum–C. basiconica* Assemblage Zone and the overlying *Tanarium pycnacanthum–Ceratosphaeridium glaberosum* Assemblage Zone.





SHANG Xiaodong and LIU Pengju *et al*., 2019- *Precambiran Research,* 304-307: 258-279

Nurhachius luei, a new istiodactylid pterosaur (Pterosauria, Pterodactyloidea) from the Early Cretaceous Jiufotang Formation of Chaoyang City, Liaoning Province (China) and comments on the Istiodactylidae



ABSTRACT: A new istiodactylid pterosaur, *Nurhachius luei* sp. nov., is here reported based on a complete skull with mandible and some cervical vertebrae from the lower part of the Jiufotang Formation of western Liaoning (China). This is the second species of *Nurhachius*, the type-species being *N. ignaciobritoi* from the upper part of the Jiufotang Formation. A revised diagnosis of the genus *Nurhachius* is provided, being this taxon characterized by the presence of a slight dorsal deflection of the palatal anterior tip, which is homoplastic with the Anhangueria and *Cimoliopterus*. *N. luei* sp. nov. shows an unusual pattern of tooth replacement, with respect to other pterodactyloid species. The relationships within the Istiodactylidae and with their closest taxa are investigated through a phylogenetic analysis by parsimony.

ZHOU Xuanyu *et al*., 2019- *PeerJ*, 320-321: 302-314

2.2 Results of the National Natural Science Foundation of China (NSFC) Projects Completed in 2019

Crustal anatexis and deep orogenic processes (chief researcher: ZENG Lingsen)

We have carried out a systematic investigation on the nature of petrography, mineralogy, geochemistry, and geochronology of high-grade metamorphic, migmatitic and leucogranitic rocks from Himalayan and Sulu orogenic belt. We have acquired important data to constrain the geochemical nature and timing of crustal anatectic events in this studied area and achieved a number of important progresses which were published in 37 contributions (among which 26 are SCI Indexed). Major progresses are listed as following: (1) Miocene leucogranites along the Himalayan orogenic belt largely resulted from two distinct melting reactions, muscovite dehydration versus fluxed melting of muscovite, in the metapelitic rocks; (2) Differential dissolution of accessory phases (*e.g*. garnet, titanite, and monazite) play an critical role in regulating the trace element and radiogenic isotope (Nd and Pb) compositions of anatectic melts; (3) The Himalayan orogenic belt experienced a major phase of crustal anatexis at ~28-29 Ma, which requires the exhumation of the Himalayan crystalline sequence as early as Oligocene; (4) Life-time of leucogranitic magma to form relatively large leucogranitic pluton within the Himalayan orogen commonly is 1-2 Ma and partial melting and metamorphism show pulse-like behavior; (5) The protoliths of granitic gneisses formed at ~1850 Ma, ~800 Ma, and ~500-430 Ma, respectively. In particular, the early Paleozoic granites show similar geochemical characteristics to those in the Cenozoic leucogranites; (6) The mafic dike swarms within the Tethyan Himalaya formed from ~140 to ~130 Ma, and the Cuomei LIP could extend to west of the Kangma gneiss dome; (7) Types

and modes of crustal anatexis are largely controlled by the P-T-X conditions which in turn strongly depend on the tectonic processes experienced by the Himalayan orogen. Therefore, the geochemical nature of original leucogranitic melts from the deep crustal rocks could be used a probe to constrain the tectonic processes in other orogenic belts worldwide. Data and new results achieved from this project not only test the predictions from previous experiments and theoretic modeling, but also discover strong effects of different modes of crustal anatexis on the HFSE and the coupling of Sr-Hf-Pb isotopic system in crustally derived melts. New insights yielded from this project could serve an important example for others to follow in the study of other young or ancient orogenic belts and provide new constraints on the geochemical behavior of element and isotopes during crustal anatexis.

A high-resolution study on the Cryogenian interglacial oceanography: a record from Yangtze basin (chief researcher: ZHU Xiangkun)

Detailed investigation on oceanographic evolution during the interglacial Datangpo Formation of Nanhua system (Cryogenian) is important for better understanding the relationship between the environmental evolution and the emergence and expansion of early animals. Based on the research and development of the related geochemical tools, this project has carried out a detailed geological and geochemical investigation on Cryogenian succession in South China, the most complete sedimentary record of Upper Cryogenian System in the world. The main contributions include: 1) The Chang'an/Tiesi'ao glaciation and Nantuo glaciation in South China are corresponding to the Sturtian glaciation and Marinoan glaciation, respectively, where the glaciations have undergone a dynamic evolution. 2) The Datangpo Formation conformable contacts with the surrounding rock and records the complete information during the interglacial period, showing that Sturtian glaciation terminated at *ca*. 659 Ma. 3) The interglacial manganese ore formed from the reduction of manganese-based oxides, which precipitated from the formed in the oxic environment. 4) The Datangpo Formation records increased oxygenation in the Nanhua Basin, which is terminated by sulfide environment. 5) The redox condition during the Nanhua system is closely related with the biological evolution in the early time of the earth. These findings are significant for reconstruction of the interglacial oceanographic evolution with respects to redox state and for providing a set of chemstratigraphic references for further stratigraphic and paleoceanographic studies on Cryogenian interglacial formations.

The spatial extension, multiple metamorphism and magmatism, and tectonic evolution of the Jiao-Liao-Ji orogenic belt, North China Craton (chief researcher: LIU Fulai)

The Jiao-Liao-Ji orogenic belt (JLJB), North China Craton (NCC) records a long-term complex tectonic-thermal evolutionary history from Paleoproterozoic until Triassic, including multiple metamorphic-magmatic events and complex tectonic deformation events. Thus, this orogenic belt provides a well natural laboratory for investigating metamorphic evolution and magmatic process. On the basis of integrated studies of metamorphism, magmatism, quantitative phase equilibrium modeling and U-Pb and Ar-Ar dating, important and newly scientific results have been obtained as following. It has been revealed that the JLJB consists mainly of voluminous meta-sedimentary rocks. By the integrated studies of geochemistry and zircon U-Pb dating of meta-mafic rocks and felsic tuff within the belt, the various protoliths of these metamorphic rocks were formed in a back-arc, rather than an intra-rift tectonic setting at 2.2-2.11 Ga. On the southeastern margin of the JLJB, a (HP-UHT) granulite facies metamorphic belt accompanied by voluminous migmatites has been identified for the first time, which records an isothermal decompression clockwise P-T-t path and extends at least 1000 km from Jiaobei, passing through Liaonan, until Ji'an area in south Jilin. These new data powerfully support that the JLJB is a typical collision orogenic belt during Paleoproterozoic. The geochemical and zircon U-Pb data reveal that five episodic magmatic events (2.19-2.16, 2.16-2.11, 2.11-2.08, 2.0-1.89 and 1.88-1.85 Ga) occurred at an initial extensive setting prior to orogeny, until an uplifting-thinning tectonic setting during post-orogeny. Multiple magmatic events and a granulite facies metamorphic event have been identified in the Benbu area, indicating that the SW part of the JLJB probably passes through the Tanlu Fault, and extends until the Benbu area. Archean metamorphic rocks as relic slices were identified within the JLJB, which record ~2.5 Ga and

~1.9-1.8 Ga thermal events, indicating these slices involved into the Paleoproterozoic orogenic process. All new data has revealed that the Longgang Block and Langrim-Liaonan-Jiaodong block on the both sides of the JLJB should be attributed to the Eastern Block of NCC. A distinct Triassic metamorphic event has been identified for the first time on the southeastern margin of the JLJB, indicating the JLJB experienced multiple orogenesis from Paleoproterozoic until Triassic. We propose a multiphase metamorphic belt extending at least 1000 km from Jiaobei terrane, passing through Yellow Sea to Changhai islands, until Donggang area in south Liaoning. Both Paleoproterozoic and Triassic orogenic events severely destroyed and dismembered the Archean Langrim-Liaonan-Jiaodong Block. Thus, a new tectonic model for the JLJB, including a Paleoproterozoic arc-continent collisional orogeny between Langrim-Liaonan-Jiaodong and Longgang blocks, and a Triassic continent-continent collisional orogeny between the North and South China blocks has been proposed.

The detail structure of lithosphere and deep process of the deformation in the transition from the northeastern Tibetan Plateau to the Alashan, Ordos and Sichuan Craton basins (chief researcher: GAO Rui)

The northeastern Tibetan Plateau and its surrounding transition zones, from Tibetan Plateau to the Alashan block and Ordos craton and Sichuan basin, is a natural laboratory for investigating the lithospheric deformation and deep process of intra-continent. Two reasons derive the above statement. The first is that the complex lithospheric structure and deformation in this region has recorded the lithospheric processes of the tectonic transitions from Tibet Plateau to the surrounding craton, and the second is that it has controlled some important tectonic processes, such as continental material convergence-thickening-collapse and lateral escaping. The tectonic transition zones to be studied in this project are also the main resource and seismic belts in China. Thus, Investigating the fine lithospheric structure and deformation process in the studying region not only has important scientific significance, but also help to understanding the deep background of seismic hazards and hydrocarbon generation. We propose here an integrated study of the fine lithospheric structure in the key area. The deep seismic reflection profile were used as the primary imaging tools. The existing data are integrated with some supplied geological and geophysical observations to interpret and reconstruct the whole lithospheric deformation behavior and deformation style, and have revealed the lithospheric deformation contrast and deep process in the tectonic transition belts. Additionally, these results have contributed to a better understanding of some geodynamic issues, including the uplift and lateral extension of the Tibetan plateau, and the intra-continental tectonic deformation, and their impact on resources and earthquake hazards.

Precambrian Geology (chief researcher: LIU Chaohui)

Based on the demands of the project, we have conducted geochronology, provenance and tectonic setting studies on the meta-supracrustal sequences and meta-mafic dykes in the Lüliang Complex, middle Trans-North China Orogen (TNCO), and the main results are below. Whole-rock geochemical and Sm-Nd isotopic, and zircon U-Pb, Lu-Hf isotopic and geochemical data are reported for two episodes of metamorphosed mafic dykes from the. Although both episodes of mafic magmatism were derived from variable degrees of interaction between a depleted mantle wedge and subducting slab-derived hydrous fluids and melts, the younger one (2082-2068 Ma) had more depleted whole-rock $\varepsilon_{Nd}(t)$ and zircon $\varepsilon_{Hf}(t)$, higher $(Ta/La)_N$ ratios and weaker Nb, Ta and Ti anomalies in the primitive mantle-normalized trace element diagram compared with the older one (2187-2147 Ma), implying a less enriched mantle source and less addition of slab-derived component in a subduction zone. More importantly, an increase of U/Yb and Ce/Ce* ratios from 2187 Ma to 2147 Ma magmatic zircons implied gradually enhanced subducting slab-derived fluid addition, whereas a synchronous increase of Yb/Gd ratio indicated crustal thinning. In consideration of flare-up of the 2.20-2.17 Ga Chijianling-Guandishan calc-alkaline granitoids and the close-following bimodal volcanism and alkaline granitoid magmas, we propose an important kinematic transition from compressional to extensional continental subduction system at ~2.17 Ga in the long-lived continental arc of the TNCO. Geochemistry of the Yejishan meta-sedimentary rocks indicate weak source weathering and dominantly chemical immature features, whereas the Lanhe and Heichashan samples display opposite features. U-Pb ages of detrital zircons from the Lanhe Groups indicate that they

are mainly derived from the Chijianling-Guandishan TTG gneisses (2199-2151 Ma) and meta-volcanic rocks from the Lüliang and Yejishan Groups (2213-2156 Ma), the Gaijiazhuang porphyritic gneisses (2375-2364 Ma) and the Yunzhongshan TTG gneisses (2499 Ma) respectively, whereas minor detrital zircons from the early Neoarchean crust of the Eastern Block. For the Heichashan Group, the dominant 2.2-2.0 Ga detrital zircons were probably recycled from the underlying Jiehekou Group and the minority is directly derived from the early Paleoproterozoic granitoids in the Lüliang Complex. The youngest detrital zircon age peaks of ~2.17 Ga and ~1.82 Ga place maximum depositional ages on the Lanhe and Heichashan Groups respectively, whereas the local 1.81-1.79 Ga massive granites place constraint on their minimum depositional ages. Taking into account the lithostratigraphic features, provenance and formation ages, we suggest that the Lanhe Group formed in a shrinked remnant back-arc basin and the Heichashan Group was deposited in a foreland basin. Conversion of the tectonic basin from the middle Paleoproterozoic back-arc basin to the late Paleoproterozoic foreland basin is well consistent with the model that the single collision to form the basement of the North China Craton happened at ~1.85 Ga.

Ediacaran silicified microfossils from the Hunan and Guizhou provinces and its biostratigraphic correlation (chief researcher: LIU Pengju)

Microbiota (mainly acanthomorphic acritarchs), which is the major organisms in the early Ediacaran biosphere, is very important for studying the origin and evolution of life, and stratigraphic subdivision and correlation of the Ediacaran system. In recent years, important progress has been made in the study of early Ediacaran microbiotas and their biostratigraphic correlation, but some geological problems, such as the division of biozones, the precise biostratigraphic correlation, application in the Global Standard Section and Point/GSSP, and affinity of some microfossils, etc., are far from being solved. Further discovery and research of new microfossils are urgently needed. Silicified Ediacaran microfossils have not been reported from the Hunan and Guizhou provinces in the past, therefore the studying for the silicified microfossils from these areas can not only enrich the features of Ediacaran microbiota but also provide new materials to solve the above geological problems. In the past four years, the research group has made some important progress through detailed field investigation and comprehensive research in Guizhou, Hunan and Hubei areas, which are highlighted in the following aspects: 1) 4 new genus and 25 new species have been erected, which enriched the Ediacaran microbiota. 2) Abundant microfossils were firstly found from the intrashelf basin in South China, extending the distribution of the microbiota. 3) We found a previously unreported Large Ornamented Ediacaran Spherical Microfossils with simple slit-shaped and daughter cells, and thought these spherical microfossils are not animal embryos. In other words, the new microfossils implicate that not all Large Ornamented Ediacaran Spherical Microfossils are animal embryos. 4) The restudying the tubular microfossils of Weng'an biota further confirms that the Weng'an tubular microfossils constitute a disparate assemblage of cyanobacteria and algae, but none represents early Ediacaran animals. 5) Transitional Ediacaran–Cambrian small skeletal fossil assemblages were found from South China and Kazakhstan. 6) According to the stratigraphic distribution of microfossils, four new biozones with potential global application were established. 7) The model of diagenetic process facilitating fossil mineralization and preservation within chert nodules of the Doushantuo Formation was presented. These achievements not only have new discoveries and new understandings, but also clarify some problems existing in the past, which have important guiding significance for the further development of related work in the future.

Macrofossil biotas in the late Ediacaran-Cambrian boundary interval of South China and biostratigraphic correlation (chief researcher: TANG Feng)

Since the "Snowball-earth Event", multicellular life had radio evolution in taxonomy. The known rich and diverse fossil record of the Ediacaran-Cambrian transition in southern China is one of the most robust exceptional records to reconstruct the rapid succession from the Ediacaran life radiation to Cambrian explosion. Since the "Snowball-earth Event", multicellular life had radio evolution in taxonomy. The known rich and diverse fossil record of the Ediacaran-Cambrian transition in southern China is one of the most robust exceptional records to reconstruct the rapid succession from the Ediacaran life radiation to Cambrian explosion. This project focuses on the classification

and comparative study of the macrofossils and biostratigraphic data from the Ediacaran-Cambrian strata and suggests new biomarker and stratotype of Ediacaran - Cambrian boundary in South China. Through the detailed measurement of several sections in the eastern Yunnan region, the production stratification and zonation of macrofossils in each section are measured, and the distribution of the problematic worm-like fossils and the combination characteristics with other macrofossils are characterized by 1. *Helminthopjat-Shaanxilithes* assemblage zone, 2. *Sabellidites* zone, 3. *Harlaniella* zone. Newly discovered 2 and 3 zones are correlated with SSF *Circotheca-Anabarites -Protohertzina* Zone in China, and are explicit in range and abundant in south China. With the previous well-studied SSF assemblages, high resolution biostratigraphy comparison of Ediacaran-Cambrian transitional strata can be presented as following: (1) The Assemblage Zone of small shell fossils in the Meishucun Section in eastern Yunnan has similar characteristics in other parts of south China. (2) Worm-like fossils cf. *Sabellidites* and cf. *Harlaniella* were found at the top of the Ediacaran and at the lowermost Cambrian in the eastern Yunnan, which could be an extraordinary biostratigraphy character and distinguish from Middle and Upper Cambrian. *Sabellidites* and *?Harlaniella* zones are charactered by abundant fossils in a relatively short time, which can be used as the boundary marker between the Ediacaran and Cambrian. (3) The two types of worm-like fossils can be used to subdivide the upper Ediacaran and the lower Cambrian strata by combining the tubular marker fossils of *Shanxilithes* and *Cloudina*. These early skeletonized fossils are widely distributed in the lower part of the Jiucheng and Gaojiashan sections. (4) From different lithostratigraphic sections in eastern Yunnan, *Shanxilithes* are confirmed as body fossil through SEM analyzes and are available for international stratigraphy correlation. Two abundant record of worm-like fossil in overlying indecently correlate to Nordic *Sabellidites* and *Harlaniella* records in Russia, but the phylogenetics and taxonomy of these fossils still remain enigmatic.

Tracing the ancient subcontinental lithospheric mantle: Example from the garnet peridotite from Lüliangshan terrane, North Qaidam UHP metamorphic belt (chief researcher: ZHANG Cong)

The North Qaidam ultrahigh pressure metamorphic belt preserves garnet peridotites and eclogites with different origin and time of formation, providing a nature laboratory to study the orogenic evolutionary, formation mechanism of ancient subcontinental lithospheric mantle and crust-mantle interaction. Our project studies the garnet peridotite and eclogite from the North Qaidam orogenic belt by means of petrology, mineralogy and phase diagram modelling coupled with minor mineral geochronology, such as zircon and monazite. We have proposed a topo discrimination model based on the peak metamorphic *P-T* conditions of the orogenic garnet peridotite. By studying the metamorphism of the eclogites, we have identified Proterozoic metamorphism in the North Qaidam orogenic belt except the Paleozoic processes. For comparison, we also examined the metamorphism of eclogite from the Sumdo orogenic belt in south Lhasa block, which was recognized as Paleo-Tethys oceanic subduction zone, and concluded that the large peak metamorphic condition span in the orogenic belt might be caused by the different calculation methods and exhumation processes.

Petrogenesis of the Paleoproterozoic metamorphic supracrustal sequence and meta-mafic intrusions in Liaoning and Jilin provinces: constraints on the regional tectonic evolution (chief researcher: MENG En)

For a long time, “continental rift”, “arc-continent collision” and “continent- continent collision” have existed in the Paleoproterozoic tectonic setting and the formation and evolution mechanism of the Jiao-Liao-Ji belt. In general, it is due to the lack of systematic research in the material composition, protolith formation, analysis of source areas, tectonic setting and chronological framework on the Paleoproterozoic geological bodies, especially for the metamorphosed volcano-sedimentary rocks in Liaoji area. In view of the above key problems, this project has carried out comprehensive and systematic field geological investigation and comprehensive comparative analysis of age, provenance and structural background, *etc*. On the basis of previous studies on the meta-supracrustal rock series of

Ji'an group, Laoling group and South and North Liaohe Group, including the newly recognized "Guanghua rock group" in the north of Tonghua City, south of Jilin Province in recent years. Based on the comprehensive study of the metamorphic sedimentary rocks in the study area, it is found that the protolith of the metamorphic sedimentary rocks in the northern sub-belt (including "Guanghua rock group") and the southern sub-belt should be later than 2.03 Ga, and they have been transformed by the metamorphism events of 1.91 and 1.85 Ga. The clastic materials are mainly from the Paleoproterozoic granite, contemporaneous volcanic rocks and a small amount of basement granites. Based on the zircon age, Lu-Hf isotopic characteristics, petrochemistry properties, structural discrimination diagram characteristics of high field strength elements and regional geological data, which are similar to those of typical convergent plate marginal basins, we believe that the metasedimentary rock series in the North Liaohe Group, Laoling group and "Guanghua rocks Group" should be formed in the back arc basin, while the metasedimentary rock series in the South Liaohe group and Ji'an Group should be formed in the active continental margin. In the same way, the research results of metavolcanic rocks in the study area show that the peak age of magmatic zircons in the metavolcanic rocks is 2189 Ma, the majority of $\varepsilon_{Hf}(t)$ is positive, and contains metamorphic zircons with the peak age of 1.91 Ga and a small amount of 1.85 Ga, as well as the captured zircons from late Neoproterozoic to early Paleoproterozoic (2.71-2.31 Ga). The analysis of petrology, element and isotopic geochemistry shows that except for the characteristics of tholeiite in Laoling Group and "Guanghua rocks group", the protoliths of these metavolcanic series formed at about 2.19 Ga are mainly composed of basaltic andesite-andesite and middle-high potassium calc-alkaline series of volcanic rocks composed of a small amount of basalt and dacite. According to the characteristics of magmatism, the magma of basic member should originate from the depleted lithospheric mantle wedge metasomatized by subduction fluid or melt. Based on the regional data, we believe that the metavolcanic rocks of South Liaohe Group and Ji'an Group should be formed in the active continental margin environment, while the metavolcanic rocks of Laoling Group and "Guanghua rock Group" should be formed in the structural environment of back arc basin. Based on the above research results, we have determined that the Paleoproterozoic tectonic setting of the Liao-Ji Belt is an arc-continent collision orogenic belt.

Metamorphic and deformational history of the fossil subduction channels: examples from the North Qilian and North Altun (chief researcher: ZHANG Jianxin)

The subduction channel is defined as a relatively thin and weak zone with independent kinematics between the descending and overriding plates during slab subduction. The materials in the channel consist of low density, low viscosity, highly sheared metasediments- and/or serpentinite-rich matrix and relatively rigid blocks, showing characteristic mélange. HP/LT mélange exposed in orogenic belt is an important symbol of the fossil subduction channel, and its metamorphism and deformation record the interaction process of the subduction interface. Based on detailed field geological mapping and structural observation, combined with petrology and chronology, the HP/LT melanges related to oceanic crust subduction are studied in the North Qilian (NQL) and North Altyn Tagh (NAT). Some important studied results have been obtained: 1) the spatial distribution and rock associations of HP/LT mélange belts in the NQL and NAT are identified, and field relationship between different rocks are confirmed; 2) the NQL and NAT HP/LT metamorphic zones have typical block-in-matrix structures, showing characteristic mélange. Combined with the previous data, it is determined that the different types of rocks in the HP/LT melanges have variable protolith properties and ages, and are derived from different tectonic settings. 3) Macro- and micro-structural analyses suggest that the dominant deformation in the NQL HP/LT melange belt show a top-to-the-south shear sense, reflecting the forced return flow during exhumation in subduction channel. 4) Petrographic studies and phase equilibrium modellings show that the different rocks in the NQL and NAT mélange belts underwent different peak metamorphic conditions and *P-T* evolution histories, and experienced a common metamorphism and deformation under blueschist facies to greenschist conditions. 5) Synthesizing the structural, petrological, geochemical and geochronological data suggest a subduction channel model related to oceanic subduction during early Paleozoic in the NQL and NAT. The different materials detached from subducted oceanic crust and overlying slabs into subduction channels at different

depths of the subduction zone and experienced their own independent tectonic thermal history along the subduction interface. They have been juxtaposed at a relatively shallow level within a subduction channel and experienced a common metamorphic and deformational superposition in the blueschist-greenschist facies condition.

Study on the kinematics stages and tectonic backgrounds of the main fault systems in and around the Alxa Block (chief researcher: ZHANG Jin)

As a part of the southern CAOB, the Alxa Block has experienced multiple tectonic events since the late Paleozoic and has ranged from a plate margin to an intraplate setting. Our study demonstrates that compressional stresses derived from block amalgamation during terminal Paleo-Asian Ocean closure, the earliest identifiable Paleozoic deformation in the Alxa Block is the northeast-trending ductile shearing between the Alxa Block and the North China Craton and small blocks in the Paleo-Asian Ocean (379-351 Ma). Several regional Late Permian east-west-trending dextral shear zones are found in the Alxa Block, they are the Longshoushan, Badanjilin, Beidashan and Yabrai shear zones, they may be a part of the shear zone along the entire CAOB which is ca. 3000 km long. The tectonic driving force responsible for the ductile deformation in the Alxa Block is the eastward movement of the Yili Block. Far-field Triassic compressional plate boundary forces related to the collision between the NCC and the Yangtze Craton to the south caused a large sinistral shear zone developing in the eastern Alxa Block (250-210 Ma). The Alxa Block was deformed by large-scale sinistral shearing and rotated approximately 30°anticlockwise. Far-field Jurassic compressional plate terminal closure of the Mongol-Okhotsk seaway to the north, the low-angle westward subduction of the Paleo-Pacific Ocean to the east, and the Lhasa-Qiangtang collision to the south combined to deform the Alxa Block from different directions, form shortening structures with various strikes and invert previous extensional basins. Later extensional forces related to the eastward rollback of the Paleo-Pacific Ocean Plate caused the occurrence of Early Cretaceous basalts and coeval rift basins with various extensional faults in the Alxa Block. In the Late Cretaceous, the Eurasian Plate experienced oblique collision along its southeastern margin, a sinistral transpression system developed along the eastern Alxa Block, and the east-west-trending extensional basins in the interior of the Alxa block were inverted. Cenozoic NE-directed compressional stress derived from Indian Plate convergence and collision; and the gravitational potential energy stored in the elevated Tibetan Plateau contributed to NE-directed compressive stress. The Altyn Tagh Fault extends eastwards but does not connect with the active fault in the interior of the Alxa Block. In addition, an active sinistral strike-slip fault is found in the interior of the Alxa Block in this study (*i.e.*, the Alxa strike-slip system). The formation and propagation of the Alxa strike-slip system result from northward compression by the Qinghai-Tibetan Plateau.

Nature of Daheishan mafic-ultramafic complex from Yiwu area in East Junggar and comparative study on ophiolites in East and West Junggar (chief researcher: ZHAO Lei)

The Karamaili ophiolite is located at the northeastern margin of Junggar Basin, which is a very important tectonic unit in the Northern Xinjiang and Central Asian area. The evolution of Karamaili oceanic basin still remains some problems due to hot-debated issues on the ages and characteristics of Karamaili ophiolite. This project had presented field geological investigation, geochronological and geochemical data for the Daheishan mafic-ultramafic complex lying at the easternmost of Karamaili ophiolitic belt, compared the Silurian-Carboniferous tectono-sedimentation in north and south sides to Karamaili ophiolitic belt. At the same time, this project had determined the constituents, ages and property of ophiolitic belt in the northern West Junggar, thus providing new evidences for comparison between Karamaili ophiolite belt and northern West Junggar ophiolite belt, and reestablishment of the ancient oceanic and continental pattern in the northern Xinjiang and its neighboring areas. Three different rock assemblages were identified in the Hebukesaier ophiolitic mélange in the northern West Junggar, namely the typical ophiolite unit, the seamount unit and the post-collision volcanic rock unit. The gabbro in ophiolite yielded a zircon SHRIMP U-Pb age of 512±9 Ma, the ocean island basalt (OIB) in seamount yielded a zircon SHRIMP U-Pb age of 475±4 Ma, and the post-collision metarhyolite yielded a zircon LA-ICP-MS U-Pb age of 435±2 Ma. We reported a new ophiolitic

mélange named the E'min ophiolitic mélange in northern West Junggar. A gabbro exhibited a zircon SHRIMP U-Pb age of 476±2Ma. The E'min ophiolitic mélange has a geochemical make-up similar to those of suprasubduction-zone (SSZ)-type ophiolites formed in a forearc setting and may represent the initial subduction in northern West Junggar. In this project, the Cambrian to Ordovician intra-oceanic subduction-related plutons were first recognized from the Chagantaolegai ophiolitic mélange in the northern West Junggar. The diorite and coarse-grained granite yielded zircon U-Pb (LA-ICP-MS) ages of 503±2 Ma and 481±3 Ma, respectively. This project also focused on the Paleozoic tectonic settings in the Karamaili tectonic zone revealed by comparison of the Silurian-Carboniferous tectono-sedimentation in its north and south sides, and recognized Late Ordovician-Early Silurian island-arc related granite plutons in the Zhifang area in the north side of Karamaili tectonic zone. Therefore, we proposed no ocean existed in the Karamaili tectonic zone during Late Paleozoic and the oceanic basin represented by the Karamaili ophiolitic mélange was closed before Middle Silurian. This project determined the rock assemblages and spatial distribution of Daheishan mafic- ultramafic complex. The complex was dominated by gabbros and originated from magma with relatively low degree of differentiation. The Re-Os age of gabbro was 514 ± 68 Ma, which was speculated to form in the same subduction environment as that of early Paleozoic Zhifang granites.

Thermochronologic constraint for exhumational process in the West Junggar metallogenic belt (chief researcher: YIN Jiyuan)

Ore deposit study includes both deposit genesis and preservation. The West Junggar and Tianshan metallogenic belts have become the hot study areas for ore prospecting and metallogenic model, however, the timing of hydrothermal activity, deposit preservation condition and unroofing mechanism lack well-documented constraints. This project focuses mainly on Baogutu and Tuwu Yandong porphyry copper deposits in Xinjiang, combined with the petrogeochemical and multi-isotopic geochronological studies of the intrusive rocks in the important sections of western Junggar and Tianshan metallogenic belts. We have made the following achievement: (1) Revealed the timing of hydrothermal activity, multi-stage cooling and unroofing process of Baogutu porphyry copper deposit; (2) Identify the multi-stage rapid cooling events in the West Junggar and reconstruct its exhumation uplift process; (3) Revealed the preservation conditions and controlling factors of Tuwu Yandong porphyry deposit: early thick burial and later extremely slow exhumation; (4) Revealed the complexity and diversity of the subduction process of the paleo-Asian Ocean; (5) Identified the multi-phases and spatial difference of the intracontinental orogenic process for the Tianshan metallogenic belt and their coupling relationship with regional tectonic events. The above researches have led to the publication of 14 peer-reviewed papers (Including 10 international SCI papers) on international scientific journals on the first authorship, such as GSA Bulletin, Tectonophysics, Gondwana Research and Ore Geology Reviews.

Studies of the “bright spots” structures in the deep seismic reflection profiles in central and western Tibet (chief researcher: LU Zhanwu)

Deep seismic reflection profiles are high-resolution techniques for detecting the fine structure of the earth's crust. In recent years, many deep-reflection “bright spots” characterized by abnormally high amplitudes have been found on deep seismic reflection profiles in the central and western Tibetan plateau. It is of great significance to understand the deep structure and dynamic process of the thick crust of the Qinghai-Tibet plateau to explain the origin of these deep reflective “bright spots”. This project use advanced data method to process the deep reflection data of the Qiangtang block and the Karakoram fault zone and get a lot of the purified “bright spot” shot gather data. Then, we use analysis of amplitude and polarity, combined with the S wave velocity, the structure of the electrical and the regional geological research to discuss formation the deep reflection “bright spot” structure. We suggest that the causes of “bright spot” events in different locations in the central and western Qinghai-Tibet plateau are quite different. In the northern border of central uplift of the Qiangtang block, “bright spot” reflection may result from mafic batholith or ancient crystalline basement, and in southern Qiangtang basin in central Tibet and Karakoram-Gangdese belt in western Tibet, “bright spot” reflection are more likely to be related to the magmatic activity as a result of the crustal thickening in the Qinghai-Tibet plateau. The research of this project explains the complexity and difference of the genesis of the “bright spot” reflection in the central and western part of the Qinghai-Tibet Plateau, and provides valuable clues for

the differentiation of the formation process of the extremely thick crust of the Qinghai-Tibet Plateau.

The deep process and geodynamics of Mesozoic tectonic transition in the intersection area of Nanling range-Wuyi mountain, southeastern China: Applying highly dense array of broadband seismic observation (chief researcher: LI Qiusheng)

The junction area of Nanling-Wuyishan is an ideal place to study the deep background and dynamic mechanism of Mesozoic tectonic system transformation in the Southeastern China. On the basis of 40 km × 40 km array of "South China deep structure exploration" project, 60 sets of broadband seismographs were put into the study to form a dense coverage of the key areas of concern. The array has been in operation for 2 years. Processing and analyzing the acquired data and the shared data by receiver function, finite-difference tomography, etc., we build a three-dimensional structure model of the crust and upper mantle of 0-700 km. According to the characteristics of crust mantle structure and VP/VS, especially the coupling relationship between the weak zone of lithosphere and the shallow structure (Ganjiang fault, Jiangshao fault) and the distribution of magmatic rocks. It is believed that the Mesozoic tectonic transformation of Nanling Wuyi is mainly controlled by the geodynamic process of Tethys ocean closure, continent-continent collision, westward subduction of paleoPacific plate and subduction altering of Pacific (Philippines) plate from Eocene to now.

2.3 Results of Projects from the Ministry of Science and Technology Completed in 2019

TOF- SIMS scientific instrument for isotopic geology (chief researcher: LIU Dunyi)

Two large time-of-flight Secondary Ion Mass Spectrometers (TOF-SIMS-SI and TOF-SIMS-REE) have been developed, which are used for the in-situ micro-analysis of mineral stable isotope and rare earth elements. TOF-SIMS-SI's primary ion beam for actual measurement has a diameter of 0.5 micron, with a mass resolution up to 14,662 (m/z=267) and a mass scope of 1-350. The accuracy in the testing of the sulfur isotope in galena samples reaches 0.5‰, an advanced level in China. TOF-SIMS-REE's primary ion beam for actual measurement has a diameter of 2 micron, with the mass resolution of two reflections up to 21,720 (m/z=228), the TOF mass resolution of multiple reflections up to 35,000 (m/z=91) and a mass scope of 1-320. The accuracy in the testing of NIST610 standard glass rare earth elements is better than 9.2%, an internationally advanced level.

2.4 Results of China Geological Survey Projects Completed in 2019

Metamorphic pilot geological survey of key geological topics in the North China Craton and its surrounding areas (chief researcher: LIU Fulai and LIU Pinghua)

Scientific geological mapping spatial database of 3000 km^2 Archean-Paleoproterozoic metamorphic basement in the North China Craton (NCC) has been established. 3.0-2.95 Ga TTG gneisses and potassic granites have been identified in Zanhuang, Gongchangling, or other areas of the NCC, of which spatial distributions, rock assemblages and genesis evolution have been studied. 3.9-3.8 Ga zircon Hf model ages have been obtained from the Gongchangling potassic granites, which indicates that the granitoids in the Gongchangling area were derived from recycling materials of Eoarchean ancient crust. Abundant 2.7 Ga metamorphic pillow basalts have been identified in the Liuxing Formation, Qixingtai area, western Shandong. Until so far, it is the most massive Archean pillow basalts exposed area in the NCC. Detrital zircon age investigation of South and North Liaohe groups reveals that two sub-groups can be

compared, and can be unified as one group. Detrital zircon age spectrums of the Lieryu Formation show one dominant age peak at 2.13 Ga for that of South Liaohe Group, and at 2.17 Ga for that of North Liaohe Group. Gaojiayu and Dashiqiao formations of both South and North Liaohe groups have two detrital zircon age peaks of ~2.5 Ga and 2.2-2.1 Ga. Lieryu, Gaojiayu and Dashiqiao formations of the North Liaohe Group have consistent youngest detrital age peaks, which limits their maximum sedimentary ages to be 2.17 Ga. Based on the detrital zircon age peak of ~1.86 Ga obtained in part Gaixian Formation of the South Liaohe Group, we suggest that this part of the metasedimentary rocks should be disintegrated from the Gaixian Formation. In the Jiao-Liao-Ji belt, typical high temperature (high pressure) granulite facies metamorphic rocks have been identified in the Wuhe area of Anhui and Jiaobei, eastern Liaoning and southern Jinan areas. The granulites, forming a ~1000 km granulite facies metamorphic deformation belt, are characterized by near-isothermal decompressional orogenesis-type *P-T-t* paths. Complex structure zones were recorded between the Longgang block and the Longzishan Formation of the Liaohe Group. From south to north, Mesozoic brittle normal faults are superimposed in the Paleoproterozoic ductile thrust zone. "1:5 0000 Geological Mapping Guide of Early Precambrian Middle-High Grade Metamorphic Rocks Survey" has been compiled. A leading research team focused on metamorphic rocks and early Precambrian geological survey has been established. In 2018, it was selected as the third batch of "High-level Innovative Science and Technology Personnel Training Project" Science and Technology Innovation Team by the Ministry of Natural Resources.

Application demonstration of three-dimensional geological survey in the southeast Inner Mongolia (chief researcher: GUO Lei and GUAN Ye)

1. On the basis of the identification of the main modelling units and the target geological bodies (two stages of magmatic rocks-Triassic and Early Cretaceous), deep exploration was carried out using geophysical means such as gravity, magnetic and magnetotelluric method, and the three-dimensional spatial distribution characteristics of two-stage intrusive rocks and faults in the deep were determined.

2. Identified the mineralization model and geological setting of the typical polymetallic deposits, represented by Shuangjianzishan, Baiyinnuoer and Haobugao, etc. Formation of the deposit is mainly controlled by northeast or northwest conjugated faults and ore-bearing Permian stratum. The deposits also spatially closely related to the Yansanian magmatic activity, and produced near the edges of the regional magmatic rock bodies.

3. High-precision gravity data inversion defined the spatial distribution of deep faults and low-density anomalies. The magnetic data inversion confirmed the deep distribution characteristics of intrusive rocks with high magnetic anomalies. Two-dimensional and three-dimensional inversion of magnetotelluric sounding data under the constraint of gravity and magnetic methods established a three-dimensional physical property model. Different gravity-magnetic-electrical methods have good constraints on determining the three-dimensional structure of target geological bodies such as two-stage intrusive rocks and Permian strata related to silver-polymetallic mineralization.

4. Using the SKUA-GoCAD and Python software platforms and the existing 3D visualization system, achieved the distribution and sharing of 3D geological models by PDF3D, allowing users to display and utilize the layers of different geological units as required.

Key tectonic survey and pilot mapping of orogenic belts (chief researcher: ZHANG Zeming and ZHANG Jin)

Based on the thematic mapping and integration of comprehensive research results, the project has made the following important innovative achievements: revealing the closing time, location and tectonic evolution of the Paleo-Asian Ocean in the eastern Central Asian Orogenic Belt (CAOB); revealing the compositions, ages and attributes of the main tectonic units of the CAOB as well as the early Paleozoic tectinic evolution; discovering the Indosinian high-pressure metamorphism of the Cathaysian Block, and discussing its tectonic significance; identifying the composition of the lower crust of the Gangdise magmatic arc and the growth of the continental crust; and establishing the dispersion model of the main blocks in the Chinese mainland from the Paleozoic to early Mesozoic.

Study on major Phanerozoic magmatism events in China and pilot mapping of orogenic belts (chief researcher: XUE Huaimin and TONG Ying)

1. Based on pilot mapping of different types of magmatic rocks, the mapping method system has been preliminarily constructed. It includes several achievements including: the mapping methodology of homologous intrusive Unit - Suite (sequence) - Super Suite (sequence) has been constructed; a new mapping method on intrusive rock formed by mixing of heterogeneous magma has been proposed; in continental volcanics area, a new mapping method has been tested to establish mapping unit with volcanic mechanism as the carrier, with taking non-layered volcanic rocks the same status as extrusive rocks; the mapping unit, composition and genesis have been connected in mapping of ophiolite area. Through the summary and extension of these methods, problems restricting the mapping of magmatic rocks have been generallly solved.

2. The mapping methods of denudation depth of granite, the veins in mining area and the isotope of intrusive rock have been explored and improved. The isotopic mapping provides new evidences for the exploration on the composition and structure of the deep crust, the boundary of the geotectonics and the main direction of ore exploration. It provides new ideas, methods and examples for the exploration of major international frontier issues, *e.g*. the growth of the earth's crust, and has a certain international influence.

3. Based on the establishment of the database and mapping, the integration and summary have been carried out, the temporal and spatial evolution of Phanerozoic magmatism in the North orogenic belt and other orogenic belts have been preliminarily revealed, and the framework of Phanerozoic continental assemblage and dispersion in China has been constructed.

Comparison of trans-boundary minerogenic belts and map compilation of central and eastern Asia (chief researcher: REN Liudong and ZHENG Ning)

Compilation of the Atlas of Geological Maps of Northern-Central-Eastern Asia and Adjacent Areas at the scale of 1:250 M, including 4 kinds of maps, geological map, tectonic map, minerogenic map (metal and non-metal) and minerogenic map of energy resources (oil, gas and coal) in northern-central-eastern Asia and adjacent areas, has been conducted.

The map-compilation group of the five countries (China, Russia, Mongolia, Kazakhstan and Korea) has systematically classified and correlated the strata from Archean to Quaternary of the whole region, determined the stages and classifications of the magmatic rocks according to the formation time and lithology. The project has established a platform to study and solve the problems on geology and mineral resources of the Central and Eastern Asia, and substantially improved the level of the geological research of the region, clarifying the regional prospecting directions for different minerals and founding a comprehensive basis on geological and mineral information for carrying out the "Belt and Road" strategy. Through joint excursions and mutual researches of the five-country group, the principle of map compilation on energy resources has been determined, that is, with the guiding ideology that "both coal and coal measures are important sources of the oil-gas reserves", all the coal, oil and natural gas are compiled on the same map for the first time. Some critical geological problems have been solved, like the recognition of the affinity of the Gyeonggi massif of the Korean Peninsula, which belongs to neither the North China Craton nor the Yangtze Craton, and is actually the eastwards extension of the Dabie-Sulu orogenic belt between the two cratons. The southern and central Tianshan Mts. of China, or the southern Tianshan Mts. of central Asia, pass through Kyrgyzstan, Uzbekistan, and central Kazakhstan to southern Uralian tectono-minerogenic belt. In addition, comparison study has been proceeded on the geological setting for minerogenesis and mineral features of the Andes and Gangdese minerogenic belts, and understanding of the minerogenic mechanism and rules has been enhanced for the two minerogenic belts.

Geological survey project for Tethys-Tibet Plateau and tectonic setting of major metallogenic belts (chief researcher: ZHANG Jianxin and CAI Zhihui)

1. Based on the study of Markam, Muli and Kerda gneiss domes, located in the Songpan-Ganzi region, we

recognized a middle crustal detachment which is a linkage among granitic intrusion, partial melting, Barrovian-type metamorphism and Li-Mineralization, and further built up new tectonic and Li-metallogenic model.

2. We concluded that the Cenozoic leucogranites in the Himalaya orogenic belt formed by two types of crustal anatexis: fluid-fluxed melting of muscovite and fluid-absent muscovite dehydration melting. It provided a fundamental tool of petrogenesis of granitoids and that granites in orogenic belts could be used to refine our understanding for tectonic setting.

3. Newly obtained deep seismic profiles across the Tethyan Himalaya and Gangdese metallagenic belt showing the crustal deformation of collisions zone between the subducted Indian plate and the Asian plate from the surface to depths. The deep structure of the Gangdese metallagenic belt provided critical evidence for studying formation of the polymetallic ore resources.

4. The investigations revealed that the GHC consists of an orogen-parallel, top-to-the-west detachment with the E-W trending stretching lineation in the upper part, and a thick mylonitic, top-to-the-south thrust system with the N-S trending stretching lineation in the lower part. The former was inferred as the Greater Himalayan Detachment (GHD) whereas the latter was named the Greater Himalayan Thrust (GHT). U-Pb ages suggested that the extrusion of the GHD initiated at ~33 Ma whereas the GHT began at ~34 Ma and then progressively migrated southward until ~26 Ma near the MCT. The GHD and GHT could be traced eastward to the Nyalam and Yadong regions and westward to the Pulan area. Combined with previous studies, we proposed that the THD was formed due to the N-S compression, crustal thickening and partial melting in the Himalayan orogen, as a structural boundary between the THS and GHC since the Eocene. The Miocene STD was superimposed on the south-verging THD due to the passive roof of the thrusting. Hence, the THD was the predecessor of the STD.

5. We found that a series of S-N trending normal faults and their associated conjugate strike slip faults had been developed in Qiangtang Basin since 20-13 Ma. Multiple groups of fissure and joint, especially S-N trending franctures, densely distributed in the Basin. These S-N trending structures might have an impact on the hydrocarbon reservoir structure.

Survey and comparison of the giant Gangdese-Sanjiang and Middle Tethys metallogenic belts (chief researcher: SONG Yucai and CHAI Peng)

This project focuses on porphyry Cu, sediment-hosted Zn-Pb, and carbonatite-related REE deposits in the Gangdese-Sanjiang metallogenic belt. Based on a series of geological mapping of corridors, regions, and important ore deposits, together with comparison of metallogenesis with the Tethyan tectonic domain, this project finds the theory of the genesis of porphyry Cu deposits in continental collision settings, establishes a preliminary genetic model of MVT Zn-Pb deposits in the collisional thrust belts, and improves the genetic model of carbonatite-related REE deposits in continental collision settings. Meanwhile, geological environments for pre-collisional and collisional porphyry Cu deposits in the Gangdese metallogenic belt have been well determined and 10 ore prospecting areas have been established. In summary, this project has solved a series of key bottlenecks that hampered ore prospecting in the study areas; the project has also promoted the establishment and application of the theory of continent-continent collisional metallogenesis, all of which provide important ore exploration protocol in the study areas.

Comprehensive inverstigation of chormitite in Yarlung-Zangbo and Bangong-Nujiang suture zone (chief researcher: YANG Jingsui and XIONG Fahui)

Chromitite is the main source of chromium, the irreplaceable raw material for the special steels e.g. stainless steel, and an important strategic resource in the fields of military industry and aerospace. The chromitite is on the one hand a strategic deposit in China; on the other hand, over 98% of the raw materials depend on foreign import. On the basis of geological mapping, geophysical exploration and comprehensive research, we have done great work of a comprehensive survey of chromite in the Yarlung Zangbo suture zone and the Bangong-Nujiang suture zone in Tibet. Seven prospecting target areas in Dongqiao and Dingqing massif bodies in the Middle East of the Bangong-Nujiang suture zone were delineated, and the ore-forming signs of chromitite were established. A multi-stage model for the formation of podiform chromitite was proposed, which can be useful for the next step of exploration provides direction and technical support.

In February 2019, Research Professor **YANG Zhiming** was awarded the "**Scientific and Technological Leading Scientist**" of "National High-level Personnel of Special Support Program" by the Organization Department of the CPC Central Committee.

Graduated with a Doctor's Degree of Science from Chinese Academy of Geological Sciences in 2008, YANG Zhiming was promoted to research professor in 2015. He obtained the "NSFC Distinguished Young Scholars Fund" in 2018, and acted as the head of "Innovation Team in Key Field" of "Continental Collision Mineralization" awarded by the Ministry of Science and Technology in 2018. He was also the winner of the second prize (R2) in the 2019 National Natural Science Award. At present, he is the Vice Director of Energy & Resources Center in the Institute, Member & Fellow of Society of Economic Geologists (SEG), Guest Professor of James Cook University (Australia), and Editor of *Mineral Deposits, Acta Geologica Sinica · English Edition* and *Geotectonica et Metallogenia.* He has long been engaged in the research of porphyry Cu-Mo-Au and intrusive body-related Au deposit and has published over 30 papers in many international mainstream journals in recent five years, such as *SEG Special Publication, Economic Geology and Journal of Petrology*. He has recognized a new type of gold deposit "Magma Type Gold Deposit", revealed its mineralization mechanism, and revealed the characteristics and metallogenic material sources of collision type porphyry copper deposits, making substantial contribution for the "metallogenic theory of collision type porphyry copper deposits".

Fig.3.1 Research Professor YANG Zhiming

In February 2019, Associate Research Professor **LI Shan** was awarded the "**Top-Notch Young Professional**" of "National High-level Personnel of Special Support Program" by the Organization Department of the CPC Central Committee.

Graduated with a Doctor's Degree of Science from Chinese Academy of Geological Sciences in 2013, LI Shan held a post-doctoral position at the Department of Geology of National Taiwan University during 2014-2016. He is now a tectonics associate research fellow using the petrology, tectonics, and geochemistry to understand the formation and evolution of orogen and magmatism. His tectonics research achievements include: 1) in the southern margin of the world's largest Phanerozoic accretionary orogenic belt (Central Asian Orogenic Belt), the magmatic evolution from accretion to collision has been identified, and the granite petrogenetic model of multi-terranes soft collision established, which provides a basis for the understanding of magmatic response to the evolution from plate margin to intra-continent; 2) a provocative petrogenetic mechanism of intra-plate or intra-continental granite after multi-terranes soft collision has been proposed, which is related to the fluids released by multiple slabs, improving the understanding of the far-field effect of plate marginal geodynamics. In the past eight years, 13 SCI papers have been published by the first author, including *JGR-Solid Earth, Tectonics* and *Earth-Science Reviews.*

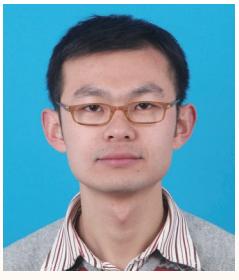


Fig.3.2 Associate Research Professor LI Shan

In August 2019, Associate Research Professor **LIU Yingchao** was supported by **the NSFC Fund for Excellent Young Scholars**.

Graduated with a Master's Degree of Geochemistry and a Doctor's Degree of Mineralogy, Petrology and Mineral Deposits from Chinese Academy of Geological Sciences in 2012, LIU Yingchao was promoted as an associate research professor in 2015. She conducted cooperation and communication as a visiting scholar at Australian National University and Colorado School of Mines in 2015 and 2018, respectively. She has been engaged in the research of the typical Pb and Zn deposits in the Chinese Tibet Plateau-Himalaya Orogenic Belt and Iranian Zagros Orogenic Belt of the Tethys Collision Orogenic System, and has obtained innovative achievements in respect of the core research of the new theory of Pb and Zn mineralization in carbonate rocks in the fold and thrust system, and established the system of lead and zinc mineralization related to magmatic hydrothermal fluids during continental collision. She was also the winner of the "Geological Society of China Youth

Fig.3.3 Associate Research Professor LIU Yingchao

Geological Science & Technology Award (Golden Hammer Award)" in 2019. She has Published 23 papers as the first author or corresponding author in domestic and foreign mainstream journals, such as *Economic Geology, Ore Geology Reviews, Gondwana Research and Acta Petrologica Sinica.*

In August 2019, Associate Research Professor **LIU Yan** was supported by **the NSFC Fund for Excellent Young Scholars**.

Fig.3.4 Associate Research Professor LIU Yan

Graduated with a Doctor's Degree of Science from China University of Geosciences, Beijing in 2010, LIU Yan has been engaged in the research of the origin of carbonatite and its complex-type REE deposits since 2010 and has published 18 papers as the first author or corresponding author in *Economic Geology, Mineralium Deposita, Lithos and Ore Geology Reviews*, which elaborately described the formation of carbonatite and its complex-type REE deposits; and profoundly revealed that the formation of carbonatite and its complex-type REE deposits went through two large-scale supernormal concentration process.

The Institute won the second prize in the National Natural Science Award in 2019

Academician HOU Zengqian, Research Professor YANG Zhiming and ZHANG Hongrui *et al.* won the second prize in the National Natural Science Award in 2019 for their research work "Metallogenic Theory of Postcollisional Porphyry Copper Deposits (PCDs)" in global comparison and detailed study of Tibet Plateau PCDs belt. They made scientific discoveries that could support this new theory: (1) demonstrated that metallogenic porphyry came from the partial melting of the thickened newborn lower crust; (2) found that the water required by mineralization came from the mixed injection of the mantle-derived alkaline magma and the decomposition of hornblende in the source zone; (3) demonstrated that the metallogenic metals and sulphur mostly derived from the melting decomposition of the sulfide that was deposited in lower crust before collision; (4) found that postcollisional PCDs showed a pattern of intensively superposed alteration mineralization zoning. The creation of metallogenic theory of postcollisional PCDs has significantly raised the international status of China in this field, and broadened the exploration area of PCDs across the world, and provided guidance for the prospecting of PCDs in collision belts. EARTH, an internationally famous journal, pointed out that this achievement "provides a new insight to the world into how PCDs form".

国家自然科学奖

证 书

为表彰国家自然科学奖获得者，特颁发此证书。

项目名称：碰撞型斑岩铜矿成矿理论

奖励等级：二等

获 奖 者：侯增谦（中国地质科学院地质研究所）

中华人民共和国国务院

2019 年 12 月 18 日

证书号：2019-Z-104-2-01-R01

Fig. 3.5 HOU Zengqian *et al*. won the second prize of National Natural Science Award in 2019

The Institute won two second-class prizes in Land and Resources Science and Technology Award in 2019

Evolution and International Comparison of Chinese Ediacaran Palaeobiota System, the research achievement of **the team led by Research Professor LIU Pengju,** has organically integrated the scientific theories and methods of paleontology, biostratigraphy, chemical stratigraphy and chronostratigraphy. Through years of research and exploration, major breakthrough was seen in the research of the biostratigraphy and chronostratigraphy of Ediacaran and the application was successful, solving the problem of the biostratigraphic and chronostratic division of Early-Middle Ediacaran in our country.

Magmatic Evolution of the South Margin Structure of Central Asian Orogenic Belt, the research achievement of **the team led by Research Professor SHI Yuruo**, has systematically revealed the geologic evolution characteristics of the south margin of Central Asian Orogenic Belt through the long-term and profound research upon the widely exposed granite in the South Margin of Central Asian Orogenic Belt (including central Inner Mongolia, Xinjiang Mount Tianshan and Chinese Beishan).


国土资源科学技术奖

获奖证书

获奖成果：中国埃迪卡拉系古生物群系统演化及其国际对比

获奖等级：二等

获 奖 者：中国地质科学院地质研究所

二〇二〇年一月

证书号：KJ2019-2-35-D1


国土资源科学技术奖

获奖证书

获奖成果：中亚造山带南缘构造岩浆演化

获奖等级：二等

获 奖 者：中国地质科学院地质研究所

二〇二〇年一月

证书号：KJ2019-2-40-D1

Fig. 3.6 Two second-class prizes in Land and Resources Science and Technology achieved by the Institute in 2019

4.1 Projects funded by the National Natural Science Foundation of China (NSFC)

Distinguished Young Scholars Fund				
No.	**Chief Investigator**	**Project**	**Duration**	**E-mail address**
1	YANG Zhiming	Economic Geology	2019-2023	zm.yang@hotmail.com
2	ZENG Lingsen	Crustal Anatexis and Deep Orogenic Processes	2015-2019	lzeng1970@163.com
Excellent Young Scholars Fund				
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
3	LIU Chaohui	Precambrian Geology	2017-2019	denverliu82@gmail.com
Key Projects				
No.	**Chief Investigator**	**Project**	**Duration**	**E-mail address**
1	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
2	LI Haibing	Mechanism of seismic rupture propagation in the Longmen Shan Fault	2019-2023	lihaibing06@163.com
3	JIN Xiaochi	Permo-Triassic paleogeography of eastern Tethys: paleontological, sedimentological and paleomagnetic evidence from western Yunnan and Tibet	2017-2021	jinxchi@cags.ac.cn
4	ZHANG Jianxin	Linking metamorphism with orogensis: insight from early Paleozoic orogenic system in the northeastern Tibet	2017-2021	zjx66@yeah.net

5	ZHU Xiangkun	A high-resolution study on Cryogenian interglacial oceanography: a record from the Yangtze basin	2015-2019	xiangkun@cags.ac.cn
6	LIU Fulai	The spatial extension, multiple metamorphism and magmatism, and tectonic evolution of the Jiao-Liao-Ji orogenic belt, North China Craton	2015-2019	lfl0225@sina.com
7	GAO Rui	Detailed structure of the lithosphere and deep processes of deformation in the transition from the northeastern Tibetan Plateau to the Alashan, Ordos and Sichuan Craton basins	2015-2019	gaorui@cags.ac.cn

International (Regional) Cooperation and Exchange Projects

No.	Chief Investigator	Project	Duration	E-mail address
1	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
2	YU Changqing	Dense profile probing depth extent of Pengguan Complex and Longmenshan Fault	2018-2020	geoyucq@hotmail.com
3	YANG Jingsui	Diamond in oceanic peridotites -chromitites and deep recycled mantle in the global ophiolite record	2018-2022	yangjsui@cags.ac.cn
4	LI Haibing	Fault friction over time: coseismic weakening and postseismic healing in situ	2016-2020	lihaibing06@163.com

Major Research Plans

No.	Chief Investigator	Project	Duration	E-mail address
1	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
2	LI Qiusheng	Crust-Mantle Interaction and Deep Background of Tungsten Mineralization in Nanling-Wuyi Conversion Zone	2020-2022	lqs1958@163.com
3	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

4	ZHANG Hongrui	The enrichment and emplacement mechanism of cobalt in the Lanping-Simao cobalt belt, western Yunnan	2020-2022	hongrui_1982@126.com
5	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
6	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
7	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
8	QI Xuexiang	**Mesozoic** mélange belt in the southeastern Gaoligong orogen, west Yunnan, and its relationship with the southern extension of the Banggonghu-Nujiang suture	2018-2020	qxuex2005@163.com
9	ZHAI Qingguo	Tectonomagmatism associated with the opening of the Paleo-Tethys Ocean: Key study on the central Qiangtang northern Tibet	2018-2020	zhaiqingguo@126.com

Emergency Management Projects

No.	Chief Investigator	Project	Duration	E-mail address
1	LIU Dunyi	Inverstigation of changes in the flux of impactors throughout the history of the Moon-the technological reserve for the chronology study of the lunar samples of Cheng'e project	2019.1-2019.12	liudunyi@bjshrimp.cn
2	SHI Yuruo	The formation age and magmatic evolution history of the Moon: In-situ geochronology and geochemistry analyses on lunar samples	2019.1-2019.12	shiyuruo@bjshrimp.cn

General Projects

No.	Chief Investigator	Project	Duration	E-mail Address
1	YANG Ben	Systematics and biostratigraphy of the Early Cambrian small shelly fossils in South Sichuan	2020-2023	benyang@cags.ac.cn
2	WU Guichun	The conodont biostratigraphy of Triassic on the western Bangong Co-Nujiang Fault Zone	2020-2023	1874267892@qq.com
3	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

4	XIANG Hua	The activity models of Ti-bearing minerals and Ti isopleths thermobarometers study	2020-2023	xianghua2710@gmail.com
5	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
6	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
7	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
8	ZHANG Jin	Formation mechanism, deformation processes and tectonic settings of ophiolitic mélanges in the northern Alxa Block	2020-2023	zhangjinem@sina.com
9	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
10	WANG Huan	Physical-chemical properties of the pseudo-tachylytes in the Longmen Shan fault belt and their seismic rupture mechanisms at seismogenic region	2020-2023	wanghuan4585@126.com
11	LI Jin	Cd isotopes application in reconstructing marine primary productivity during the interglacial Cryogenian period	2020-2023	lijin80119@hotmail.com
12	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
13	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
14	LIU Pengju	Microfossils from the early Cambrian in the Yangtze Platform and its biostratigraphic signification	2019-2022	pengju@cags.ac.cn
15	JI Shu'an	Study on the Late Cretaceous protocera-topsid fauna from Alxa region, Inner Mongolia	2019-2022	jishu_an@sina.com
16	HUANG Hao	Paleogeographic analysis of Permo- Carboniferous fusulinids in the Changning-Menglian Belt, western Yunnan	2019-2022	geohaohuang@gmail.com
17	ZHANG Zeming	High-grade metamorphism and partial melting of the eastern Himalayan orogen	2019-2022	zzm2111@sina.com

18	SHEN Tingting	Petrology and exhumation mechanism of ultradeep subducted serpentinites and enclosed eclogites from southwestern Tianshan	2019-2022	ttshen@pku.edu.cn
19	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
20	DONG Xin	Metamorphism and partial melting of the metabasic rocks in Yadong region, Himalayan orogen	2019-2022	dongxin5811935@163.com
21	WU Cailai	Petrogenesis of Palaeozoic granites in the southern Altun terrane and their significance in continental dynamics	2019-2022	wucailai@126.com
22	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
23	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
24	XIE Hangqiang	Neoarchean and Paleoproterozoic tectono-thermal events in Eastern Hebei Province and their implications	2019-2022	rock@bjshrimp.cn
25	SHI Yuruo	Geochronology and origin of the Cenozoic volcanic rocks in Tengchong area	2019-2022	shiyuruo@bjshrimp.cn
26	SI Jialiang	The identification of new earthquake fossils and their implications to the seismic fault activity	2019-2022	gongrenbaqin@126.com
27	LIU Dongliang	Paleomagnetic records to decipher the Cenozoic collision process between the Pamir and the Southwestern Tian Shan	2019-2022	pillar131@163.com
28	CAO Hui	microstructure and tectonics- Tectonochronology study of monazite LASS and micro-drilling	2019-2022	caohuicugb@hotmail.com
29	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
30	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
31	GAO Li'e	Behavior of radiogenic isotopes during cruatal anatexis in the Himalayan orogenic belt	2019-2022	liegao09@163.com
32	ZHU Xiangkun	The controlling factors for the termination of global-scale Precambrian banded iron formations	2019-2022	xiangkun@cags.ac.cn

33	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
34	YIN Jiyuan	Uplift and exhumation of West Tianshan since the late Paleozoic: Constraints from multi-thermochronology	2019-2022	yinjiyuan1983@163.com
35	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
36	HE Zhenyu	Xingxingxia area, Eastern Xinjiang, NW China: Petrogenesis and their implications for the composition of the ancient crust	2018-2021	ahhzy@163.com
37	ZHANG Hongrui	Cenozoic deformation and related Pb-Zn-Cu mineralization in the Lanping basin	2018-2021	hongrui_1982@126.com
38	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	jiajl0228@163.com
39	SU Dechen	Meso - Neoproterozoic seismic records and multi-stage rifting in the North China Craton	2018-2021	sudechen@163.com
40	DU Lilin	Implication of 2.7 Ga and 2.1-2.0 Ga magmatic events in Fuping Complex, central of the North China Craton	2018-2021	dulilin7310@cags.ac.cn
41	WANG Fang	Multiple metamorphism and geochronology of metamorphic complex in southwestern margin of Yangtze Block	2018-2021	wangfang_mr@163.com
42	WANG Wei	The Neoarchean anatexis of the eastern North China Craton and its geological significance	2018-2021	wuchangyuww@sina.com
43	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
44	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
45	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
46	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

47	WANG Tao	Rock assemblages and accretionary orogenic processes of the Lajishan mélange in the Central Qilian belt	2018-2021	real_wt@126.com
48	SUN Jian	The recycling of marine sediments and rare-earth-element mineralization: a multiple-isotope study	2018-2021	sunjiantc@163.com
49	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
50	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
51	SONG Yucai	Giant accumulations of barite and metals in the world-class Mehdiabad Pb-Zn deposit, Iran	2018-2021	song_yucai@aliyun.com
52	CHEN Wen	Study on Titanite (U-Th)/He Dating Technique	2018-2021	chenwenf@vip.sina.com
53	WANG Yanbin	Crustal evolutuion of high grade metamorphic block from the Bolingen Islands, Antarctica: Constraints from geochemistry and zircon U-Pb, Hf-O isotopes	2018-2018	yanbinw@cags.ac.cn
54	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
55	XIONG Xiaosong	The detailed crustal structure of the North Qilian-southern margin of Alxa block, and the constraints of the Paleozoic framework to the Cenozoic northward-propagation of the Tibet	2018-2021	xsxung@126.com
56	MENG Fancong	Genetic mineralogy of garnet peridotite-eclogite from the Polar Urals, Russia	2017-2020	mengfancong@yeah.net
57	CHEVALIER Marie-Luce	Tectonic activity along the Xianshuihe fault zone and deformation model constraint of the eastern Tibetan Plateau	2017-2020	mlchevalier@hotmail.com
58	LIU Pinghua	Multiple metamorphic events of the eastern Alxa-Langshan Precambrian metamorphic complex, western Inner Mongolia	2017-2020	lph1213@126.com
59	LIU Yongqing	The Late Jurassic eolian depositional associations in North China, and its implications of palaeoclimate and palaeogeography	2017-2020	liuyongqing@cags.ac.cn
60	LYU Junchang†	Study of the Ganzhou Dinosaurian Fauna from Ganzhou district, Jiangxi Province	2017-2020	lujc2008@126.com
61	NIU Xiaolu	Origin and geological significance of the Indosinian alkaline rocks on the western part of the northern margin of North China Craton, Inner Mongolia	2017-2020	niuxiaoludx@126.com

62	XU Xiangzhen	Detailed FIB and TEM studies from the different types of mantle peridotite	2017-2020	xuxiangzhensjl@aliyun.com
63	YAN Zhen	Study on tectonic evolution of the early Paleozoic Lajishan trench-arc system	2017-2020	yanzhen@mail.iggcas.ac.cn
64	YI Zhiyu	Record of rapid apparent polar wander in East Asia and its significance	2017-2020	yizhiyu09@gmail.com
65	LIU Pengju	Ediacaran silicified microfossils from the Hunan and Guizhou Provinces and their biostratigraphic correlation	2016-2019	pengju@cags.ac.cn
66	TANG Feng	Macrofossil biotas in the late Ediacaran–Cambrian boundary interval of South China and biostratigraphic correlation	2016-2019	tangfeng@cags.ac.cn
67	ZHANG Cong	Tracing the ancient subcontinental lithospheric mantle: Example from garnet peridotite of the Lüliangshan terrane, North Qaidam UHP metamorphic belt	2016-2019	congzhang@pku.edu.cn
68	MENG En	Petrogenesis of the Paleoproterozoic metamorphic supracrustal sequence and meta-mafic intrusions in Liaoning and Jilin Provinces: constraints on the regional tectonic evolution	2016-2019	mengen0416@126.com
69	YANG Chonghui	Magmatic activity in the (2.4-2.3 Ga) global magmatic quiescence: A case study of the North China Craton	2016-2019	chhyang@139.com
70	ZHANG Jianxin	Metamorphic and deformational history of fossil subduction channels: examples from the North Qilian and North Altun	2016-2019	zjx66@yeah.net
71	ZHANG Jin	Study on the kinematics, stages and tectonic backgrounds of the main fault systems in and around the Alxa Block	2016-2019	zhangjinem@sina.com
72	SI Jialiang	Fluid-rock interaction during healing of the Longmenshan fault zone	2016-2019	gongrenbaqin@126.com
73	ZHAO Lei	Nature of the Daheishan mafic-ultramafic complex from the Yiwu area, East Junggar, and comparative study on ophiolites in the East and West Junggar	2016-2019	jleiz@163.com
74	YIN Jiyuan	Thermochronologic constraints on exhumation processes in the West Junggar metallogenic belt	2016-2019	yinjiyuan1983@163.com
75	ZHANG Yan	The study of Ar-Ar dating on ultrafine minerals	2016-2019	yzhang737@sina.com
76	LU Zhanwu	Study of “bright spots” structures in deep seismic reflection profiles in central and western Tibet	2016-2019	luzhanwu78@163.com

77	LI Qiusheng	The deep process and geodynamics of Mesozoic tectonic transition in the intersection area of rhe Nanling Range-Wuyi Mountain, southeastern China: Applying a high dense array of broadband seismic observations	2016-2019	liqiusheng@cags.ac.cn
78	WANG Haiyan	Lithosphere structure and development of the Qinling orogenic belt	2016-2019	hyanwhy@126.com

Young Scientists Fund

No.	Chief Investigator	Project	Duration	E-mail address
1	SHANG Xiaodong	Evolution of Ediacaran Tianzhushania in the Yangtze Gorges area and its biostratigraphic implications	2020-2022	shangxdong@sina.com
2	YAN Zhen	Research on Early Permian carbonate buildups in Xing-Meng area	2020-2022	yanzhen20071239@126.com
3	WANG Yunfeng	Cu precipitation mechanism in Tinggong porphyry Cu deposit, Tibet	2020-2022	wangyunnfeng@163.com
4	ZHAO Zhongbao	Forming and Tectonic Evolution of the Longriba Fault, Inside the Eastern Tibetan Plateau	2020-2022	zhaozhb04@163.com
5	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
6	ZHANG Heng	Paleoproterozoic magmatic and metamorphic events in southwestern Yangtze Block and their tectonic implications	2020-2022	heng0520@126.com
7	WANG Xun	Study on the controlling mechanisms and the environmental effects of the early Mesoproterozoic oceanic oxygenation event in North China	2020-2022	xunwang90@163.com
8	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
9	JI Lei	*P-T-t-D* evolution of Barrovian sequence in the south segment of Ailao Shan complex belt	2019-2021	jileicags@126.com
10	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

11	ZHANG Huichao	Study of gold mineralization in Hüilüshan-Mandongshan gold district (Xinjiang): Insights from phase equilibrium calculation and micro-zone analysis of sulfides	2019-2021	zhanghch2012@126.com
12	ZHANG Lei	Formation depth of pseudotachylyte in the Longmen Shan thrust belt constrained by rock magnetism	2019-2021	zhanglei881102@126.com
13	ZHU Junbin	Triassic sedimentary sequences in Linxi area of Inner Mongolia and their tectonic implications	2019-2021	zhujunbin0819@163.com
14	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
15	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
16	BAO Zemin	Methodology of Rare Earth Element TOF-SIMS In-situ Analysis in Zircon	2019-2021	baozm@bjshrimp.cn
17	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
18	LANG Chao	Study on frequency-domain full waveform imaging method based on big-shot data of deep seismic reflection profiling	2019-2021	langchao@lsec.cc.ac.cn
19	ZHONG Ning	Palaeoearthquake investigation of late Quaternary lacustrine sediments at Shawan in the upper reaches of the Min River	2019-2021	zhongning19860304@126.com
20	BO Jingfang	Research on Middle Triassic scleractinian coral fauna from the Poduan Formation in southwestern Guizhou	2018-2020	jingfangbo@foxmail.com
21	WEI Yi	Palaeoelevation evolution of Tibetan Plateau hinterland during the Eocene - Oligocene– Evidences from ostracods and isotope	2018-2020	ostracods@126.com
22	SHEN Weibing	The study on the geochemical characteristics of pyrite in Nantuo Formation in the Nanhua period, Yangtze Block, South China	2018-2020	swb560316@126.com
23	QU Huanchun	The discovery of sulfide inclusions in the quartz of the UST in Qulong porphyry Cu deposit, Tibet: Constraints on the genesis of ore deposits	2018-2020	quhuanchun@126.com
24	QIU Tian	The characteristics of ore-forming fluid and constraints on genesis of listwaenite-related gold deposit in Sartohay, Xinjiang	2018-2020	qiutian2010@126.com
25	CHENG Ting	High precision U-Pb isochron dating of carbonate minerals	2018-2020	chengting1005@hotmail.com

26	CHAI Peng	Tracking oxygen fugacity of multiphase magmatic processes and study on petrogenesis of Ermi reduced porphyry copper deposit	2017-2019	cx001chaipeng@163.com
27	LONG Tao	High spatial resolution simultaneous dating and determination of trace elements in xenotimes by SHRIMP	2017-2019	longtao@bjshrimp.cn
28	SHE Yuwei	Investigation of iron and chromium isotopes of podiform chromite iron and chromium isotopes of podiform chromite deposits in the Yarlung-Zangbo ophiolite belt, Tibet	2017-2019	sheyuwei@cags.ac.cn
29	WANG Dan	The study of sedimentary N-isotopic compositions in the Nanhua basin during the Cryogenian interglacial period	2017-2019	njuwangdan@163.com
30	WANG Huan	Microstructural, mineralogical and geochemical characteristics of the Wenchuan earthquake fault zone and their deformation mechanisms	2017-2019	wanghuan4585@126.com
31	ZHANG Wen	Age, provenance and tectonic setting of Ji'an and Laoling groups, southern Jilin Province within Jiao-Liao-Ji orogenic /mobile belt	2017-2019	wzhan7@126.com
32	ZHANG Xinyan	Joint traveltime inversion of deep seismic sounding and deep seismic reflection to image the crustal structure and the application	2017-2019	zhangxinyana@163.com
33	ZHENG Yong	Timing of brittle deformation within the Longmen Shan fault zone: New insights from $^{40}Ar/^{39}Ar$ ages of fault-gouges from WFSD-1 drilling core and surface ruptures	2017-2019	zygeology@163.com
34	WANG Yafei	Research on ancient crustal materials in Anshan and eastern Hebei	2017-2019	pengfei4783@163.com
35	GUO Wenfeng	Silicic magma petrogenesis and evolution and the plumbing system of Wangtian'e volcano: constraint from petrogeochemical evidence and thermodynamic modeling	2017-2019	guowenfeng@cags.ac.cn
36	YANG Shaohua	Overring plate properties constraint subduction evolution: the example of the Lhasa Terrane	2017-2019	yangshaohua09@sina.com

† deceased October 2018

4.2 Projects funded by the Ministry of Science and Technology

Fig. 4.2 Two on-going projects belong to the special project named as “Deep Resources Exploration and Mining” in the Framework of National Key Research and Development Program of China

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	2017-2020	zhangjinem@sina.com
3	HOU Zengqian	Deep structure and ore-forming process of main mineralization systems in the Tibetan Orogen	2016-2020	houzengqian@126.com
4	LU Zhanwu	Fine structure of the lithosphere and deep processes in the main collision zone of the Tibetan Plateau	2016-2020	luzhanwu78@163.com
5	LI Qiusheng	Fine lithospheric structure and deep processes of the side colliding belt of Tibetan Plateau	2016-2020	lqs1958@163.com
6	YANG Zhiming	Deep structure and ore-forming process of the main porphyry Cu-Mo-Au systems in the Tibetan Orogen	2016-2020	zm.yang@hotmail.com
7	ZHANG Zeming	Deep Earth processes and ore-forming events in the Tibetan Orogen	2016-2020	zzm2111@sina.com
8	KUANG Hongwei	Meso- to Neoproterozoic stratigraphic frame and depositional event correlation in China	2016-2020	kuanghw@126.com
9	TONG Ying	Integration of the tectonic-magmatism- mineralization studies in metallogenic systems	2018-2021	yingtong@cags.ac.cn

10	LIU Yanxue	Prototype restoration and structural reconstruction of typical uranium-bearing basins and its constraints on deep mineralization	2018-2021	lyxue@sohu.com
11	GUO Lei	Big data extraction and mapping technology of deep-time petrology	2019-2023	guolei_cn@sina.com
12	GAO Rui and LU Zhanwu	Fine structure and shallow response of lithosphere in key areas	2019-2022	ruigao126@126.com, luzhanwu78@163.com
13	DING Xiaozhong	The compilation of the lunar digital geological map	2015-2020	xiaozhongding@sina.com
14	HOU Zengqian	Supply path and security strategy of strategic key mineral resources in China	2019-2020	houzengqian@126.com
15	LIU Yan	Distribution of mineral resources and their potential assessment	2018-2022	ly_0620@126.com
16	LONG Tao	Development of multiple receivers for a new secondary ion mass spectrometer	2018-2021	longtao@bjshrimp.cn

4.3 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
6	LIU Yongqing	Basic geological survey of basin- mountain system in the northern part of Eastern Mountain System	2019-2021	liuyongqing@cags.ac.cn
7	HUANG Hao	Basic geological survey of typical palaeobiota and key strata in western Mongolia, western Henan and northwestern Hubei	2019-2021	hh1936@163.com
8	YAN Zhen	Basic geological survey of Dulan and Tianshui in the Central Orogenic System	2019-2021	yanzhen@mail.iggcas.ac.cn
9	LI Wenhui	Deep geological survey in key areas of Gangdese tectonic belt	2019-2021	dereklee1984@126.com
10	GAO Li'e	Regional geological survey of Maga malashan tectonomagmatic belt in southern Tibet	2019-2021	liegao09@163.com
11	PAN Jiawei	Regional geological survey of large fault zone in northen and eastern Bayan Kara block	2019-2021	panjiaweibb@gmail.com
12	QI Xuexiang	Regional geological survey of Lhasa-Tengchong tectonomagmatic belt	2019-2021	qxuex2005@163.com

13	WANG Tao	Special investigation on key geological problems of Permo Carboniferous in North China	2019-2021	real_wt@126.com
14	LI Qiusheng	Exploration of deep 3D geological structure in the Xiongan New Area	2019-2021	lqs1958@163.com
15	ZHAO Lei	Tectonic evolution of China and compilation of International Asian tectonic map	2019-2021	zhaolei224@126.com
16	DING Xiaozhong	Renewal and sharing of geological maps of land and sea areas in China	2019-2021	xiaozhongding@sina.com
17	TONG Ying	Database construction and sharing application of basic Geology (Petrology)	2019-2021	yingtong@cags.ac.cn
18	REN Liudong	Geological background analysis of large-scale resource base in metallogenic domain of ancient Asia	2019-2021	ldren@cags.ac.cn
19	WANG Xuri	Investigation and protection monitoring demonstration of important Paleontological fossils in China	2019-2021	wang198109@163.com

5.1 Attendance at International Conferences

ZHANG Jianxin and colleagues attended the 13th International Eclogite Conference (IEC-13) (Petrozavodsk, Russia)

The 13th International Eclogite Conference (IEC-13) was held in the Institute of Geology of the Karlian Research Center of Russian Academy of Sciences, Petrozavodsk, Russia, from June 24 to 27, 2019. Drs. ZHANG Jianxin, MENG Fancong, ZHOU Xiwen and LU Zenglong attended the conference and participated in the pre-conference field trip during June 18-23 in Saint- Petersburg- Gridino- Kandalaksha- Petrozacodsk.

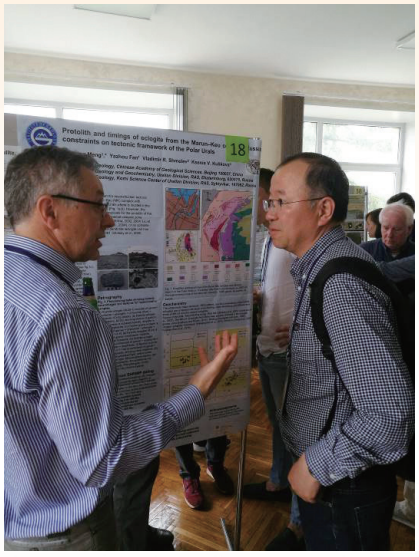


Fig. 5.1.1 MENG Fancong (right) at his poster presentation

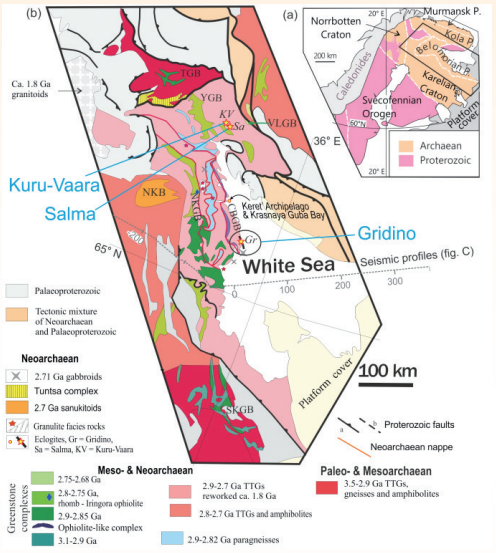


Fig. 5.1.2 The geologic map of the field trip areas

Fig. 5.1.3 Group photo at the conference

WANG Tao and colleagues co-organized and attended the workshop and field excursion of the IGCP-662 project "Orogenic architecture and crustal growth from accretion to collision" (Ulaanbaatar, Mongolia)

As the first leader of the IGCP-662 project "Orogenic architecture and crustal growth from accretion to collision", Prof. WANG Tao, together with Drs. ZENG Lingsen, XUE Huaimin, ZHANG Lei, LU Zhanwu, WANG Haiyan, HE Zhenyu, HUANG He, ZHANG Jianjun and SONG Peng, co-organized and attended the Workshop and Field Excursion "Gobi-Altai accretionary orogen" of the IGCP-662 project, held in Mongolia, during July 3 to 11, 2019.

Fig. 5.1.4 Group photo at the conference

Fig. 5.1.5 WANG Tao introduces the progress and plan for the next step

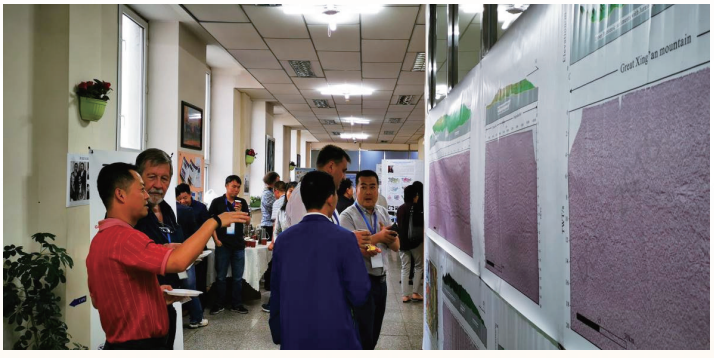


Fig. 5.1.6 Discussion at the posters

Fig. 5.1.7 Discussion during the field trip

DING Xiaozhong and colleagues attended the 17th workshop on the Cooperative Project "Deep Processes and Metallogeny of the Northern-Central-Eastern Asia" (Ulaanbaatar, Mongolia)

The Project of "Deep Processes and Metallogeny of North-Central-Eastern Asia" is an international cooperative project collaborated by members from the five countries of China, Russia, Mongolia, Kazakhstan, and Republic of Korea for more than 15 years. They take turns to hold the annual workshop. The 17th workshop, organized by the Geological and Mining Policy Implementation and Coordination Development at the Ministry of Mining and Heavy Industry of Mongolia, was held in Ulaanbaatar, Mongolia from August 5-9, 2019. Headed by Dr. DING Xiaozhong, Director of the Division of Regional Geology and Mapping of the Institute, a delegation of 10 members, with Academician LI Tingdong and Dr. REN Liudong (the leader of the project) included, attended the workshop and a post-Workshop field excursion.

Fig. 5.1.8 Group photo of the Heads of Delegations of the five countries

Fig. 5.1.9 REN Liudong gives an oral presentation

Fig. 5.1.10 Group photo after the field trip to a tungsten mine

YANG Jingsui and colleagues attended the Goldschmidt Conference 2019 (Barcelona, Spain)

The Goldschmidt Conference 2019 was held from August 16 to 27, 2019 in Barcelona, Spain. Academician YANG Jingsui, Drs. ZHU Xiangkun, WANG Tao, LIU Fulai, HE Zhenyu, and 12 young geologists of the Institute attended the conference. Academician YANG Jingsui co-convened and organized Session 03b "New Perspectives on Ophiolites, Podiform Chromitites and Deep Crust-Mantle Recycling ". Other members delivered oral and poster presentations.

Fig. 5.1.11 YANG Jingsui (second from left) at the conference

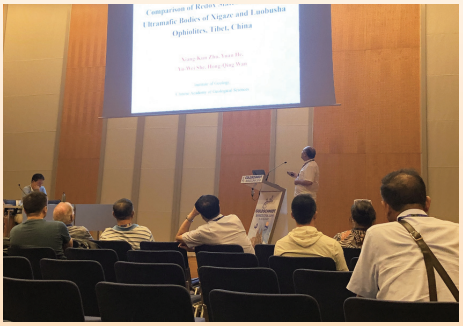


Fig. 5.1.12 ZHU Xiangkun makes an oral presentation

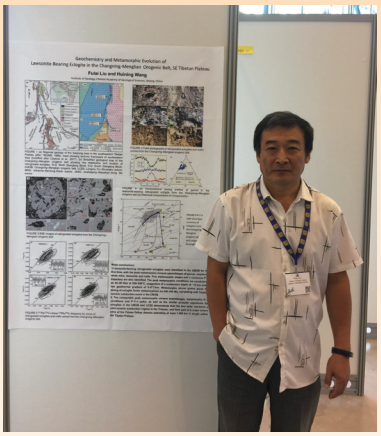


Fig. 5.1.13 LIU Fulai gives a poster presentation

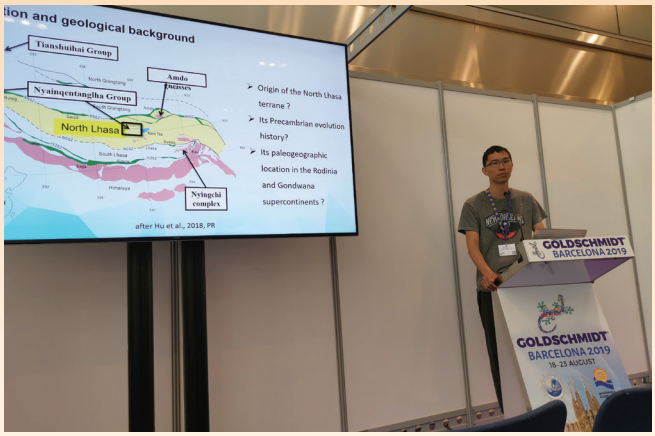


Fig. 5.1.14 HU Peiyuan makes an oral presentation

SONG Yucai and colleagues attended the Biennial Meeting of the Society for Geology Applied (SGA) to Mineral Deposits (Glasgow, UK)

The Biennial Meeting of the Society for Geology Applied to Mineral Deposits took place in Glasgow (The University of Glasgow) from August 27-30, 2019. Drs. SONG Yucai, ZHANG Hongrui and LIU Yingchao attended the Meeting and made oral presentations. Dr. SONG Yucai also participated in the "Irish Base Metal Deposits" pre-conference field trip held in Ireland from August 22-26, 2019.

Fig. 5.1.15 The sulfide of Avoca deposit deforms plastically

LIU Pengju and colleagues attended the International Meeting on the Ediacaran System and the Ediacaran-Cambrian Transition (IMECT 2019) (Guadalupe, Spain)

Invited by Jose BARRERA, Director of Villuercas-Ibores-Jara UNESCO Global Geopark, Drs. LIU Pengju, YANG Ben and SHANG Xiaodong attended the International Meeting on the Ediacaran System and the Ediacaran-Cambrian Transition (IMECT 2019) and field trips, held on October 17-24, 2019, in Guadalupe, Extremadura, Spain.

Fig. 5.1.16 YANG Ben gives a presentation

Fig. 5.1.17 At the field trip

LIU Shoujie attended the 2019 Annual Convention of the International Association for Gondwana Research and the 16th International Conference on Gondwana to Asia (Kochi, Japan)

Fig. 5.1.18 At the conference

Invited by Prof. Toshiaki TSUNOGAE of the Faculty of Life and Environmental Sciences, University of Tsukuba, Dr. LIU Shoujie, as one of the Associate Editors of Gondwana Research, attended the 2019 Annual Convention of the International Association for Gondwana Research and the 16th International Conference on Gondwana to Asia, held in Kochi, Japan, during November 8 to 12, 2019, and chaired Session 2 entitled "Orogens in China".

YANG Jingsui and colleagues co-organized and attended the 5th IGCP-649 "Diamonds and Recycled Mantle" Workshop and Field Trip (Muscat, Oman)

The 5th IGCP-649 "Diamonds and Recycled Mantle" Workshop and Field Trip, which was hosted by the Sultan Qaboos University and the IGCP-649 Organizing Committee (Academician YANG Jingsui's team of the Institute of Geology), was held in Muscat and related areas for the field trip, Oman, from November 13-22, 2019. Drs. YANG Jingsui, ZHU Xiangkun, ZHAI Qingguo, ZHANG Jin, YAN Zhen, REN Liudong, MENG Fancong, QI Xuexiang, HE Bizhu and 11 other young geologists attended the workshop of IGCP-649 and field trip.

Fig. 5.1.19 The 5th workshop of IGCP-649

Fig. 5.1.20 Academician YANG Jingsui, first leader of the Project, makes a speech on the progress of the Project

Fig. 5.1.21 Prof. Sobhi NASIR lectures on the tectonic process at the field trip

Fig. 5.1.22 Group photo of the field trip

LI Haibing and colleagues participated in the "Sixth International Field Conference on the Tectonic Evolution of the North American Cordillera" and attended the 2019 Fall Meeting of the American Geophysical Union (AGU) (Los Angeles and San Francisco, USA)

Invited by Prof. An YIN of the Department of Earth, Planetary, and Space Science, University of California, Los Angeles, Drs. LI Haibing, ZHANG Jianxin, ZHANG Jin, YU Changqing, SI Jialiang, PAN Jiawei, LU Haijian, WANG Huan, ZHENG Yong, ZHANG Lei, MAO Xiaohong and ZHAO Zhongbao participated in the "Sixth International Field Conference on the Tectonic Evolution of the North American Cordillera" held between November 29 and December 8, 2019. Then nine of them and Dr. XU Xiangzhen attended the AGU 2019 Fall Meeting held on December 10-14 in San Francisco, USA. They delivered oral and poster presentations.

Fig. 5.1.23 Prof. An YIN (third from right) leads the field trip

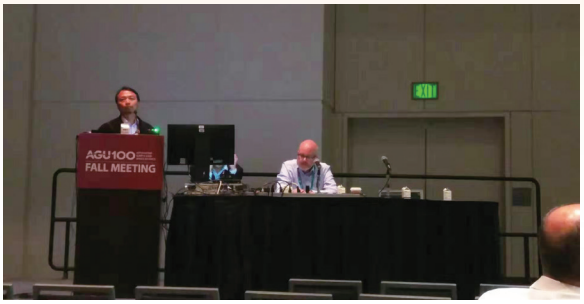


Fig. 5.1.24 LI Haibing makes an oral presentation

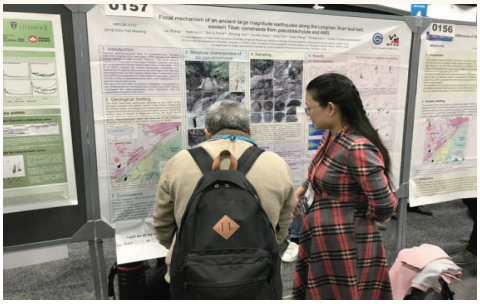


Fig. 5.1.25 ZHANG Lei (right) makes a poster presentation

5.2 Foreign visits by members of the Institute

LIU Fulai and colleagues visited the Hanoi University of Mining and Geology and collaborated in geological field research (Hanoi, Vietnam)

Invited by Associate Professor Ngo Xuan THANH of the Hanoi University of Mining and Geology, Drs. LIU Fulai, WANG Fang, JI Lei, ZHU Jianjiang and WANG Huining visited this university and collaborated in geological field research in the Northwest Vietnam, from April 16 to 30, 2019.

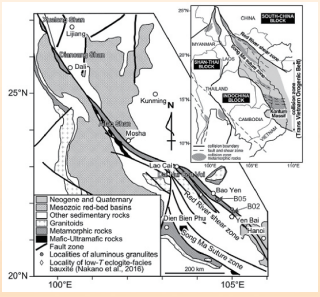


Fig.5.2.1 Regional geological map of Day Nui Con Voi Complex (Nakano *et al.*, 2018)

Fig.5.2.2 Discussion during the field trip

DONG Hanwen and colleagues visited the Tribhuvan University for collaborative research and field work (Kathmandu, Nepal)

Invited by Assoc. Prof. Madan Ratna MANANDHAR, Head of Department of Geology, Tribhuvan University, Drs. DONG Hanwen, XIANG Hua and MA Zeliang visited Nepal for a field work in connection to the research project "Hot Collisional Orogenic Dynamaics: Deformation, Metamorphism and Partial Melting for Exhumation Process of the Great Himalaya Complex (Central Nepal)", from May 25 to June 5, 2019.

Fig.5.2.3 DONG Hanwen discusses with Prof. Ananta P. GAJURE before the field work

Fig.5.2.4 Group photo at the field trip

GUO Lei and colleagues visited Saskatchewan Geological Survey (Saskatchewan, Canada)

Invited by Dr. Ryan MORELLI, Assistant Chief Geologist of the Saskatchewan Geological Survey (SGS), Saskatchewan Ministry of Energy and Resources, Canada, Drs. GUO Lei, ZHANG Yinghui, DING Yi and SHI Rui visited SGS to learn about its geoscience, data management, and 3D modelling projects, from June 14 to 21, 2019.

Fig.5.2.5 Group photo of participants of the two sides after discussion

Fig.5.2.6 Saskatchewan Mining & Petroleum GeoAtlas

JIN Xiaochi undertook UNESCO Global Geopark evaluation and revalidation missions (Haute Provence, France; Majella, Italy)

As one of the evaluators nominated by the UNESCO Global Geoparks Council Bureau, Dr. JIN Xiaochi undertook the mission of the Haute Provence UNESCO Global Geopark's revalidation and the mission of Majella to become a UNESCO Global Geopark, during July 15-25, 2019.

LIU Fei visited the High Mining Metallurgic Institute of Moa and carried out a joint geological field work (Moa, Cuba)

Invited by Dr. Antonio Nunez JIMENEZ of the High Mining Metallurgic Institute of Moa, Dr. LIU Fei visited this Institute for collaborative research and carried out a joint geological field work on the Mayari-Baracoa ophiolite and chromitites in Cuba during July 12 to August 3, 2019.

Fig.5.2.7 Group photo with members from the Department of Geology, the High Mining Metallurgic Institute of Moa

Fig.5.2.8 Group photo at the field trip (examine the Moa-Baracoa ophiolite)

LIU Yongqing and colleagues took part in the field trip on Tectonic Evolution of the Southern São Francisco Craton (São Leopoldo, Brazil)

Invited by Prof. Farid CHEMALE JR. of Universidade do Vale do Rio dos Sinos, Drs. LIU Yongqing, KUANG Hongwei and BAI Huaqing took part in the field trip on Tectonic Evolution of the Southern São Francisco Craton, which was part of the scientific collaboration of Brazilian and Chinese universities to address the paleogeographic reconstruction of the São Francisco Craton and the North China Craton from the Paleoproterozoic to Neoproterozoic, held between August 10 and 27, 2019. During their stay, they also attended the workshop held in the University of São Paulo and delivered oral presentations.

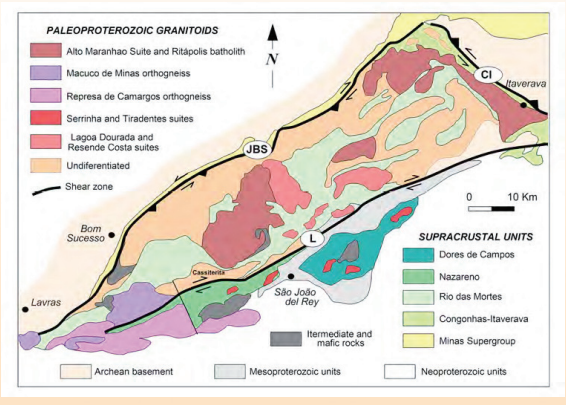


Fig.5.2.9 The MENERIO tectonic belt along the southeastern margin of São Francisco Craton

Fig.5.2.10 At the field trip

SHI Yuruo and BAO Zemin participated in a joint field research (Ulaanbaatar, Mongolia)

Invited by Prof. O. GEREL of the Geosciences Center of Mongolian University of Science and Technology, Drs. SHI Yuruo and BAO Zemin visited this university and participated in a joint field research according to the Collaborative Project Agreement between the two sides, during August 19-31, 2019.

Fig.5.2.11 SHI Yuruo (right) meets Prof. O.GEREL (left) for academic exchanges

Fig.5.2.12 Group photo at the field trip

ZONG Pu conducted cooperative research at the Westfalian Wilhelms University (Munster, Germany)

Invited by Prof. R. Th. BECKER of the Westfalian Wilhelms University, Dr. ZONG Pu visited Prof. Becker's institute and Devonian research group at this university in Munster, Germany, to continue their collaboration on Devonian/Carboniferous ammonoid faunas from China and discuss future options for joint research from October 2-20, 2019. During her stay, ZONG Pu also examined fossiliferous outcrops in the Rhenish Massif.

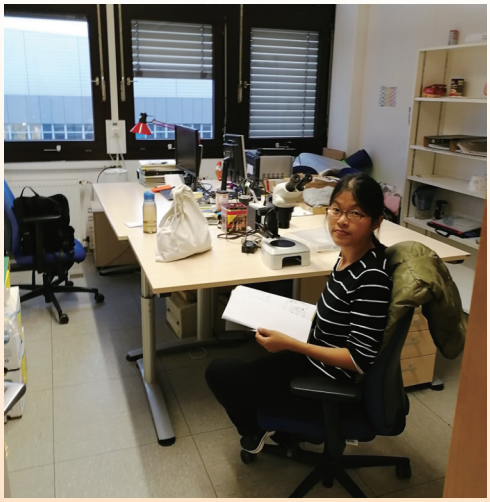


Fig.5.2.13 ZONG Pu at Prof. BECKER's institute

Fig.5.2.14 At the field trip with Prof. BECKER (right)

LI Shan and ZHU Junbin took a joint fieldtrip in West Kalimantan, Indonesia

Invited by Sayed MURTADHA of the Indonesian Association of Geologists, Drs. LI Shan and ZHU Junbin visited Indonesia and took a joint fieldtrip in West Kalimantan, Indonesia on October 22 to November 8, 2019.

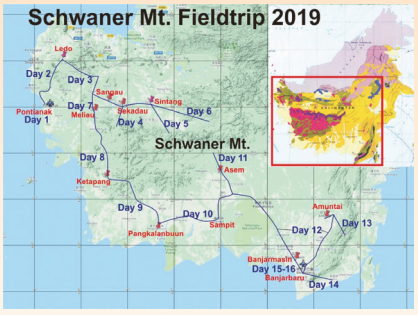


Fig.5.2.15 Areas of the field trip

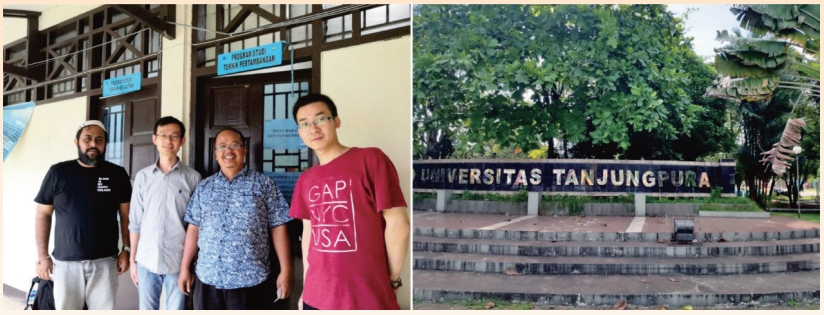


Fig.5.2.16 Visit to Universitas Tanjungpura for future cooperation

LIU Yan carried out collaborative research at the University of Windsor (Ontario, Canada)

Based on their mutual interest on metallogeny of rare metals, Dr. WU Mingqian of the University of Windsor, Ontario, Canada invited Dr. LIU Yan to visit the Department of Earth and Environmental Sciences of this University for collaborative research from December 7 to 15, 2019.

Fig. 5.2.17 Roll of Honor at the Department of Earth and Environmental Sciences, University of Windsor

LI Qiusheng visited the Modeling and Imaging Lab at the University of California, for academic exchanges (Santa Cruz, USA)

Impressed by Dr. LI Qiusheng's experience in investigating of seismic reflection profiles and broadband seismic array, Prof. XIE Xiaobi of the University of California, Santa Cruz invited Dr. LI Qiusheng to visit the Modeling and Imaging Lab at this University to share his recent research results and discuss future collaborations in other mutually interested topics, from December 12 through 22, 2019.

Fig.5.2.18 LI Qiusheng (left) gives a presentation at the Modeling and Imaging Lab

FU Changlei undertook cooperative research at the University of Queensland (Brisbane, Australia)

Invited by Prof. Jonathan AITCHISON, Head of the School of Earth and Environmental Sciences, University of Queensland, Dr. FU Changlei worked and carried out research together with Prof. Aitchison's Tectonics and Biostratigraphy Research Group at this School and conducted some field investigations in New England orogen during September 30 to December 30, 2019.

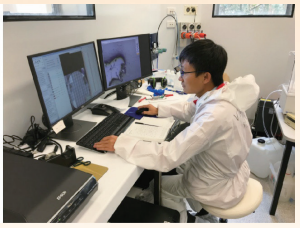


Fig.5.2.19 FU Changlei works at the University of Queensland

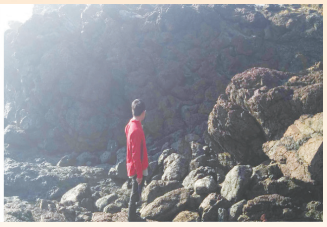


Fig.5.2.20 At the field trip

5.3 Academic Visitors to the Institute

Visit of Prof. Habibollah GHASEMI from the Shahrood University of Technology, Iran

Invited by Dr. SHI Yuruo, Prof. Habibollah GHASEMI from the Shahrood University of Technology, Iran, visited the Institute of Geology for SHRIMP U-Pb dating and cooperative research during January 21-27, 2019. During his stay, he delivered a presentation entitled "Creation and Evolution of the Sabzevar Oceanic Basin, Northeast Iran: Neotethys Rifting over the Neoproterozoic Cadomina Basement".

Fig. 5.3.1 Prof. Habibollah GHASEMI gives a presentation.

Visit of David LEACH from the Colorado School of Mines, USA

Invited by Dr. SONG Yucai, Prof. David LEACH (former researcher of the U.S. Geological Survey) of the Colorado School of Mines, USA, who is an Honorary Professor of the Institute of Geology, visited the Institute and conducted collaborative research for one month of 2019. During his stay, Prof. LEACH instructed Dr. SONG's students for research, and they finished one paper together.

Fig. 5.3.2 Prof. LEACH instructs the students

Visit of Prof. Simon WILDE from Curtin University, Australia

According to the agreement signed by both parties, Prof. Simon WILDE of Curtin University, an overseas senior visiting scholar officially employed by the Beijing SHRIMP Center of the Institute of Geology, visited the Center for two months' cooperative research work, during the period from April 11 to May 5, and October 3-31, 2019. He also helped organize the IPRCC annual training courses.

Visit of Prof. Philippe Herve LELOUP from the Université Claude Bernard Lyon 1, and his team members from the University of Grenoble Alps, France

Invited by Dr. LI Haibing, Prof. Philippe Herve LELOUP from the Université Claude Bernard Lyon 1, and his team members from the University of Grenoble Alps, France, visited the Institute of Geology twice for collaborative research, from May 6-30, 2019, and during October 13 to November 9, 2019, respectively. During their stay, they undertook joint field trips to related areas in Sichuan and Yunnan Provinces of China.

Fig. 5.3.3 Prof. Philippe Herve LELOUP at the field trip

Fig. 5.3.4 Exchanges and discussions of the two sides

Visit of Prof. Giulio Di Toro from the University of Padua, and his team members from the University of Rome and Italian National Institute of Geophysics and Volcano, Italy

Invited by Dr. LI Haibing, Prof. Giulio Di TORO from the University of Padua, and his team members from the University of Rome and Italian National Institute of Geophysics and Volcano, Italy visited the Institute of Geology for collaborative research from July 13 to 22, 2019. During their stay, they undertook a joint field trip to Pi County, Sichuan Province of China.

Fig. 5.3.5 Dr. Stefano ARETUSINI gives a presentation

Fig. 5.3.6 At the field trip

Visit of Prof. Alexander NEMCHIN from Curtin University, Australia

Invited by Beijing SHRIMP Center of the Institute of Geology, Prof. Alexander NEMCHIN from Curtin University, Australia visited this Center twice for lunar rocks cooperation, during July 9 to August 10, and September 26 to October 25, respectively, 2019.

Fig. 5.3.7 Prof. NEMCHIN gives a presentation

Visit of Mr. Gary John SMITH and his colleagues from the Geothermal Scientific Investigations Limited (GIS), New Zealand

Invited by Dr. PI Jinyun, Mr. Gary John SMITH and his colleagues from the Geothermal Scientific Investigations Limited (GIS), New Zealand visited the Institute of Geology and its Chinese Continental Scientific Drilling (CCSD) Long-term Observation Station in Donghai County of Jiangsu Province, China, for 5.2 km deep seismometer deployment during August 10 to September 12, 2019.

Fig. 5.3.8 Lowering of the seismometer

Fig. 5.3.9 Mr. Gary John SMITH gives a science-popularization lecture for Donghai Senior High School students

Visit of Prof. Valery Ja. VUKS from A.P. Karpinsky Russian Geological Research Institute (VSEGEI), Russia

Invited by Profs. KUANG Hongwei and LIU Yongqing, Prof. Valery Ja. VUKS from A.P. Karpinsky Russian Geological Research Institute (VSEGEI), Russia, visited the Institute of Geology during November 7 to 27, 2019, for academic exchanges. During his stay, he participated in the fieldwork in related areas of Shangyangzi in provinces of Sichuan, Chongqing, and Guizhou, China.

Fig. 5.3.10 Activities during the field trip

Fig. 5.3.11 Prof. Valery Ja. VUKS (in the middle) gives a presentation

Visit of Dr. Steve CLEMENT from Ion Optical Consulting, Canada

Dr. Steve CLEMENT, internationally well-known Canadian specialist on Mass Spectrometry and ion optical design, visited the Beijing SHRIMP Center on November 8-24, 2019. The main purpose of his visit was to carry out cooperative work of the project "Application demonstration of TOF-SIMS-REE instrument industrialization", as well as a participation in the optimization of technical specifications for the TOF-SIMS instrument.

6.1 International conferences and field excursions organized and/or held by the Institute

The IPRCC Spring Training Course 2019 "Detrital zircon geochronology and tectonic interpretation"

The IPRCC Spring Training Course 2019, entitled "Detrital zircon geochronology and tectonic interpretation", was held successfully in Beijing on April 6-7. Lectures were given by two internationally renowned experts, namely Prof. Pieter VERMEESCH from University College London, United Kingdom and Dr. Andrew CROSS from Geoscience Australia.

The lectures, covering basic theories, applications and interpretation on the age data, included the following themes: 1) Introduction to geochronology (radioactivity, the age equation, secular equilibrium); 2) Introduction to mass spectrometry; 3) Introduction to R and IsoplotR; 4) Field sampling for geochronological study; 5) Zircon separation and imaging-with an emphasis on CL images; 6) Discordance (common Pb, Pb loss, inheritance, initial disequilibrium); 7) SHRIMP U-Pb detrital zircon case studies: Tanami Region, central Australia and Thomson Orogen, eastern Australia; 8) Age spectra, weighted means, MSWD and maximum depositional ages; 9) multi-sample comparisons and integration with other provenance proxies; and 10) SHRIMP U-Pb dating of authigenic xenotime.

There was an attendance of more than 60 at the lectures. Aside from the presentations given by the lecturers, the attendees had vivid discussions with the lecturers. The discussions were mainly about the basics of the zircon geochronology, reading of the zircon CL images, exploration of the zircon genetics, processing and reading of the zircon age data, studies on the detrital zircon age data and tectonic interpretation, research progress in xenotime U-Pb age dating.

These IPRCC Training Courses have been organized annually since 2010 in order to help young Chinese geologists to have a better understanding of the most important and cutting-edge progress in recent geological research and to promote international cooperation between Chinese and foreign geologists. These series of courses have already become very popular among university students and young geologists. Presentations of the courses in 2019 and of previous years are available on the homepage of the Beijing SHRIMP Center.

Fig. 6.1.1 Prof. VERMEESCH gives the lecture

Fig. 6.1.2 Dr. CROSS gives the lecture

The IPRCC Autumn Training Course 2019 "Crustal melting: migmatites and granites" and post-course field excursion

The IPRCC Autumn Training Course 2019, entitled "Crustal melting: migmatites and granites" was held successfully in Beijing on October 11-13, and the post-course field excursion in western Shandong Province. This training course was aimed at graduate students, post-doctoral researchers, early career scientists and others seeking an in-depth understanding of the processes and timescales associated with the generation, segregation and migration of melt that ultimately forms granite plutons. We invited Prof. Michael BROWN from University of Maryland, USA, Prof. Chris CLARK and Senior Lecturer Tim JOHNSON from Curtin University, Australia, and Assistant Prof. Chris YAKYMCHUK from Waterloo University, Canada, to give lectures.

More than 110 people joined the lectures. Aside from the presentations given by the lecturers, the attendees had vivid discussions with the lecturers. There was time at the end of each day for questions and general discussion of the day's topics, including any disagreements and the best approaches for future studies. Like the Spring Training Course, presentations of the autumn courses are available on the homepage of the Beijing SHRIMP Center.

After the training course, we invited Prof. Michael BROWN and Dr. Chris YAKYMCHUK to guide a field excursion in western Shandong Province. The field excursion included a visit to the Neoarchean supracrustal rocks in Qixingtai area, then to Huangqian and Lihang reservoir to check the TTG and migmatites. People participated in the excursion had a live discussion in the field on the petrogenesis of all the observed rocks.

Fig. 6.1.3 Profs. BROWN and WILDE welcome questions and discussions after their lectures

Fig. 6.1.4 Senior Lecturer TIM JOHNSON gives the lecture

Fig. 6.1.5 Prof. BROWN instructs the field excursion

Fig. 6.1.6 Dr. YAKYMCHUK instructs the field excursion

2019 Workshop on the 1:5M International Tectonic Map of Asia (ITMA5000)

The 2019 Workshop on the 1:5M International Tectonic Map of Asia (ITMA5000), sponsored by China Geological Survey, Chinese Academy of Geological Sciences and the Commission for the Geological Map of the World (CGMW) and organized by Institute of Geology, was held successfully on November 18-22, 2019, in Beijing. The main purpose of the Workshop, which had been decided by the CGMW General Assembly 2018, was to exchange opinions on the geotectonic research results in East and South Asia, and discuss future work and cooperation on the ITMA5000.

Dr. Manuel PUBELLIER, President of CGMW; Academician Aleksandr KHANCHUK of Russian Academy of Sciences, Vice President of CGMW; Dr. Igor POSPELOV, Secretary General of CGMW Subcommission for Tectonic Map; Dr. TRAN Van Tri from the Geological Society of Vietnam; Dr. Koji WAKITA from Yamaguchi University, Japan; Dr. Tserendash NARANTSETSEG from Mongolian Academy of Sciences, together with Academician REN Jishun of the Institute of Geology and many other experts attended the workshop. Dr. LI Jinfa, Vice President of China Geological Survey addressed the opening ceremony.

Fig. 6.1.7 Group photo of the workshop

Fig. 6.1.8 Dr. PUBELLIER (middle) chairs the workshop

6.2 Other Academic Activities

The 2019 Academic Workshop of the Institute of Geology was held on January 13 , 2020

In order to exchange and discuss the scientific and technological results obtained in 2019, the Institute of Geology held the 2019 Academic Workshop on January 13, 2019. About 200 researchers and postgraduate students, including leaders of the Institute, attended the workshop.

The Workshop fell into two parts: in the first part, achiever of the National Natural Science Award in 2019, Academicians HOU Zengqian, and achiever of the second-class prizes in Land and Resources Science and Technology in 2020, Senior research fellows LIU Pengju and SHI Yuruo made invited speeches, presenting their research achievements; and in the second part, 21 young talents of the institute were invited to deliver special reports concerning different research focuses.

The Workshop was a great success and facilitated exchange and discussion of ideas and promoted the research capabilities of the Institute. The annual academic workshop has become a brand activity of the institute, which is not only involved with the older generation of geologists' devotion to China's geology, but also provides a platform for

academic exchanges among the young geologists.

Figure 6.2.1 Researchers and students attending the Workshop

Activities to popularize scientific geological knowledge

To popularize scientific geological knowledge, the Institute of Geology organized 3 large activities entitled “Entering the Chinese Continental Scientific Drilling (CCSD)”, “Continental deformation and environment” and “Carrying forward the Spirit of J. S. Lee, to explore the mystery of the Earth”, including lectures, poster presentations and laboratory visits. The students, together with their parents and teachers, participated earnestly in those activities and had an active interaction with the lecturers and instructors, gaining a basic understanding of Earth Sciences.

Fig. 6.2.2 Activities of lectures and poster presentations

Fig. 6.2.3 Activities of visiting the laboratories

Fig. 6.2.4 Activities at the CCSD site

Twenty-five graduate students were awarded diplomas at the 2019 Graduation Ceremony

Thirteen doctoral and twelve postgraduate students completed their studies and obtained their degrees in 2019, among whom 5 postgraduate students would further their studies as Doctor's Degree candidates, and 9 doctoral graduates as postdoctors. LI Linlin won the title of Excellent Graduates of Beijing General Colleges and Universities; FAN Xianke and YU Chao won the CHENG Yuqi Excellent Graduate Award; XU Wang and GUO Dongxu received the CHENG Yuqi Excellent Thesis Award; LIU Lishuang and TANG Yue were awarded the academic "Outstanding Graduate" honor of the Chinese Academy of Geological Sciences (CAGS), and seventeen additional graduate students received the academic "Excellent Student" honorary title of CAGS. WANG Xiangjian, WANG Mingqian, ZHU Zhicai and LI Chong were awarded the title of Excellent Student Leaders of CAGS. And ZHU Zhicai, WANG Chaoyang and YANG Yaqi won the national scholarship for graduate students in 2019.

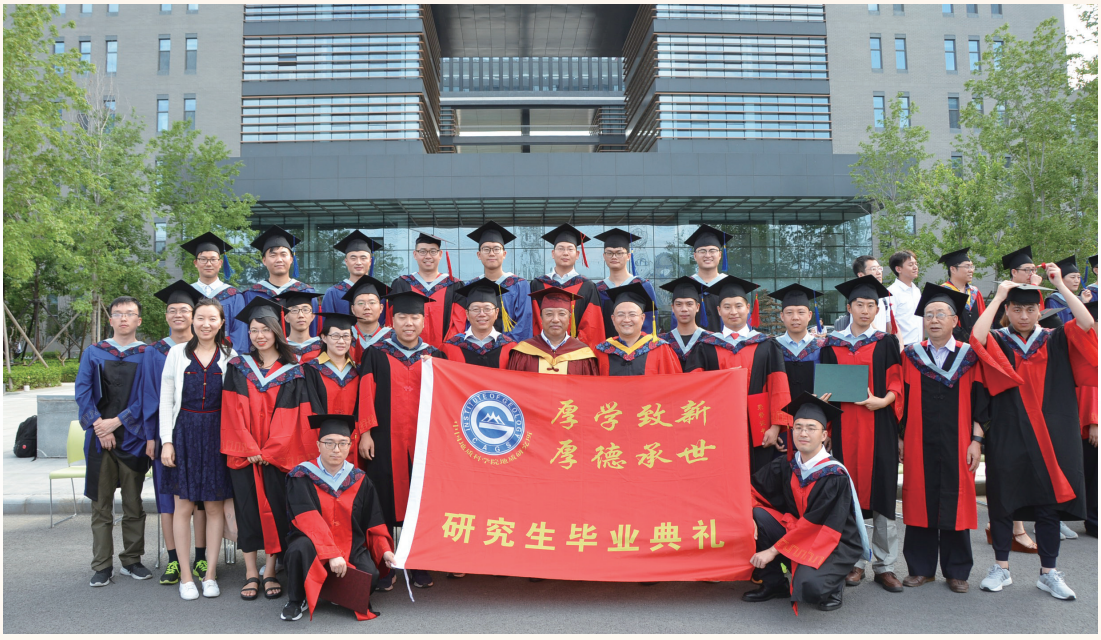


Fig. 7.1 Group photo of the 2019 postgraduate students of the Institute

The Second Geological Summer Camp for University Students was successfully held in Yanshan area by the Institute of Geology

From July 6 to 13, 2019, 20 excellent university students majoring in geology from 15 universities of China gathered at the Institute and participated in the second 8-day geological summer camp in Yanshan area. The campers visited our two key laboratories of the Ministry of Natural Resources, namely, Key Laboratory of Isotope Geology and Key Laboratory of Deep-Earth Dynamics, as well as Beijing SHRIMP Center, to understand the use of various instruments and related important scientific research results. Then in the field, the invited geological experts explained the typical geological phenomena of Yanshan area in detail, and instructed the campers to practice basic skills, which deepened their understanding of earth sciences.

Fig. 7.2 XIAO Guiyi (left), Director-General of the Institute, and Academician REN Jishun (right) have a discussion meeting with the students

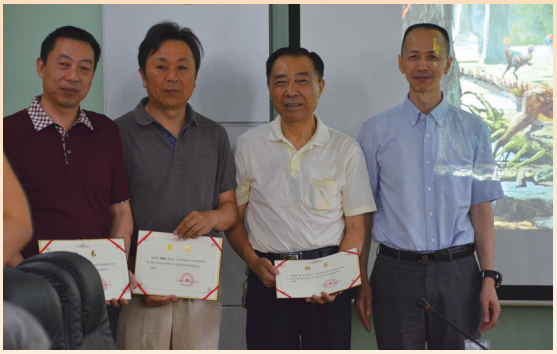


Fig. 7.3 The invited advisors for the camp: Profs. JI Shu'an (left), LIU Pengju (second from left), and JI Qiang (third from left)

Fig. 7.4 Visiting Beijing SHRIMP Center

Fig. 7.5 Group photo of the Camp

Fig. 7.6 The advisors instruct the students during the field trip

8.1 English language publications:

Bai Wenqian, Dong Chunyan, A. P. Nutman, Xie Hangqiang, Liu Dunyi, Wan Yusheng. 2019. Timing of late Neoarchean to late Paleoproterozoic events in the North China Craton: SHRIMP U-Pb dating and LA-ICP-MS Hf isotope analysis of zircons from magmatic and metamorphic rocks in the Santunying area, eastern Hebei. Gondwana Research, 76: 348-372.

Chai Peng, Hou Zengqian, Zhang Hongrui, Dong Leilei. 2019. Geology, fluid inclusion, and H-O-S-Pb isotope constraints on the mineralization of the Xiejiagou Gold Deposit in the Jiaodong Peninsula. Geofluids, https://doi.org/10.1155/2019/3726465.

Chai Peng, Zhang Hongrui, Dong Leilei, Zhang Zhiyu. 2019. Geology and ore-forming fluids of the Dayingezhuang Gold Deposit, Jiaodong Peninsula, eastern China: implications for mineral exploration. Journal of Geochemical Exploration, 204: 224-239.

Chai Peng, Zhang Zhiyu, Hou Zengqian. 2019. Geological and fluid inclusion constraints on gold deposition processes of the Dayingezhuang Gold Deposit, Jiaodong Peninsula, China. Acta Geologica Sinica (English Edition), 93: 955-971.

Dong Hanwen, Meng Yuanku, Xu Zhiqin, Cao Hui, Yi Zhiyu, Ma Zeliang. 2019. Timing of displacement along the Yardoi detachment fault, Southern Tibet: insights from zircon U-Pb and Mica ^{40}Ar-^{39}Ar geochronology. Journal of Earth Science, 30(3): 535-548.

Dong Xin, Zhang Zeming, Niu Yaoling, Tian Zuolin, Zhang Liangliang. 2019. Reworked Precambrian metamorphic basement of the Lhasa terrane, southern Tibet: zircon/titanite U-Pb geochronology, Hf isotope and geochemistry. Precambrian Research, doi: 10.1016/j.precamres.2019.105496.

Fu Changlei, Yan Z, J.C. Aitchison, Guo X.Q., Xia W.J.. 2019. Abyssal and suprasubduction peridotites in the Lajishan ophiolite belt: implication for initial subduction of the Proto-Tethyan Ocean. The Journal of Geology, 127: 393-410.

Gao Li'e, Zeng Lingsen, Hu Guyue, Wang Yaying, Wang Qian, Guo Chunli, Hou.Kejun. 2019. Early Paleozoic magmatism along the northern margin of East Gondwana. Lithos, 334-335: 25-41.

Gao Zhaofu, Zhu Xiangkun, Bao Chuang, Ma Jianxiong, Sun Jian. 2019. Constraints of lead isotopes on regional metallogeny of sediment-hosted sulfide deposits in the Langshan-Zhaertai ore belt, northern China. Journal of Asian Earth Sciences, 184: 103973.

He Bizhu, Jiao Cunli, Huang Taizhu, Zhou Xingui, Cai Zhihui, Cao Zicheng, Jiang Zhongzhen, Cui Junwen, Yu Zhuoyin, Chen Weiwei, Liu Ruohan, Yun Xiaorui, Hao Guangming. 2019. Structural architecture of Neoproterozoic rifting depression groups in the Tarim basin and their formation dynamics. Science China-Earth Sciences, 62(3): 529-549.

Hou Zengqian, Wang Rui. 2019. Fingerprinting metal transfer from mantle. Nature Communications, 10: 3510.

Hu Peiyuan, Zhai Qingguo, Wang Jun, Tang Yue, Wang Haitao, Zhu Zhicai, Wu Hao. 2019. Crustal thickening of the south Qiangtang terrane, Tibetan Plateau: constraint from Late Cretaceous High-Sr/Y granitic rocks. The Journal of Geology, 127: 457-474.

Hu Peiyuan, Zhai Qingguo, Zhao Guochun, Wang Jun, Tang Yue, Wang Haitao, Zhu Zhicai, Wu Hao, Wang Wei, Huang Zhiqiang. 2019. Late Cryogenian magmatic activity in the North Lhasa terrane, Tibet: implication of slab break-off process. Gondwana Research, 71: 129-149.

Hu Peiyuan, Zhai Qingguo, Zhao Guochun, Wang Jun, Tang Yue, Zhu Zhicai, Wu Hao. 2019. The North Lhasa terrane in Tibet was attached with the Gondwana before it was drafted away in Jurassic: evidence from detrital zircon studies. Journal of Asian Earth Sciences, 185: 104055.

Huang He, Zhang Zhaochong, M. Santosh, Cheng Zhiguo, Wang Tao. 2019. Crustal evolution in the South

Tianshan Terrane: constraints from detrital zircon geochronology and implications for continental growth in the Central Asian Orogenic Belt. Geological Journal, 54: 1379-1400.

Kuang Hongwei, Fan Zhengxiu, Liu Yongqing, Peng Nan, Zhu Zhicai, Yang Zhenrui, Wang Zhixian, Yu Huiliang, Zhong Quan. 2019. Stromatolite characteristics of Mesoproterozoic Shennongjia Group in the northern margin of Yangtze Block, China. China Geology, 2: 364-381.

Li Chong, Ren Liudong, Zong Shi, Wang Yanbin, Li Miao. 2019. Confirmation of the major grenville event in the Qinling Complex of the Qinling orogenic belt, Central China. Journal of Earth Science, 30(3): 494–509.

Li Jin, Tang Suohan, Zhu Xiangkun, Li Zihong, Li Shizhen, Yan Bin, Wang Y, Sun Jian, Shi Yao, Dong A, N. S. Belshaw, Zhang X, Liu S.A., Liu J.H., Wang D, Jiang S.Y., Hou K, A. S.Cohen. 2019. Basaltic and solution reference materials for iron, copper and zinc isotope measurements. Geostandards and Geoanalytical Research, 43: 163-175.

Li Suping, D. K. Ferguson, Wang Naiwen, He Xixian, Yao Jianxin, Li Jinfeng. 2019. Pleistocene vegetation in Guangxi, South China, based on palynological data from seven karst caves. Grana, 59(1): 94-106.

Li Weikai, Cheng Y.Q., Yang Zhiming. 2019. Geo-fO2: Integrated software for analysis of magmatic oxygen fugacity. Geochemistry, Geophysics, Geosystems, 20: 2542-2555.

Li Weikai, Yang Zhiming, Cao K., Lu Y.J., Sun M.Y.. 2019. Redox-controlled generation of the giant porphyry Cu-Au deposit at Pulang, southwest China. Contributions to Mineralogy and Petrology, 174(12): 1-34.

Li Zhaoli, Yang Jingsui, Li Tianfu, Chen Songyong. 2019. Helium isotopic composition of the Songduo eclogites in the Lhasa terrane, Tibet: information from the deep mantle. Journal of Earth Science, 30(3): 563-570.

Liu Chaohui, Zhao G..C., Liu Fulai, Cai Jia. 2019. A Paleo- to Mesoarchean micro-continent entrained in the Jiao-Liao-Ji belt at the southeastern North China Craton: evidence from the zircon record in the Bengbu area. Geological Magazine, 156(9): 1565-1586.

Liu Pengju, M. Moczydlowska. 2019. Ediacaran microfossils from the Doushantuo Formation chert nodules in the Yangtze Gorges area, South China, and new biozones. Fossils and Strata, 65: 172.

Liu Pinghua, Liu Fulai, Tian Zhonghua, Cai Jia, Ji Lei, Wang Fang. 2019. Petrological and geochronological evidence for Paleoproterozoic granulite-facies metamorphism of the South Liaohe Group in the Jiao-Liao-Ji Belt, North China Craton. Precambrian Research, 327: 121-143.

Liu Yan, Hou Zengqian, Zhang R.Q., Wang, P., Gao, J.F., M.B. Raschke. 2019. Zircon alteration as a proxy for rare earth element mineralization processes in Carbonatite-Nordmarkite Complexes of the Mianning-Dechang rare earth element belt, China. Economic Geology, 114: 719-744.

M.L. Chevalier, A. Replumaz. 2019. Deciphering old moraine age distributions in SE Tibet showing bimodal climatic signal for glaciations: marine isotope stages 2 and 6. Earth and Planetary Science Letters, 507: 105-118.

Peng X., Zhu Xiangkun, Shi Fuqiang, Yan Bin, Zhang F. F., Zhao N. N., Peng P. A., Li J., Wang D., G.A. Shields. 2019. A deep marine organic carbon reservoir in the non-glacial Cryogenian ocean (Nanhua Basin, South China) revealed by organic carbon isotopes. Precambrian Research, 321: 212-220.

Qi Xuexiang, Wei Cheng, Zhang Chao, Zhang Shiqi, Hu Zhaochu, Ji Fengbao. 2019. Southward extension of the Bangonghu–Nujiang Suture: evidence from Early Cretaceous intermediate and felsic magmatism in the Gaoligong Orogen, China. Journal of Asian Earth Sciences, 175: 1-25.

Shang Xiaodong, Liu Pengju, M. Moczydłowska. 2019. Acritarchs from the Doushantuo Formation at Liujing section in Songlin area of Guizhou Province, South China: implications for early-middle Ediacaran biostratigraphy. Precambrian Research, 334: 105453.

Shen Weibing , Chen Jianfa, Wang Yangyang, Zhang Ke, Fu Xiao. 2019. The origin, migration and

accumulation of the Ordovician gas in the Tazhong III region, Tarim Basin, NW China. Marine and Petroleum Geology, 11: 55-77.

Shi Chenglong, Ding Xiaozhong, Liu Yanxue, Hu Jianzhong, Song Yang. 2019. Geological significance of new zircon U-Pb geochronology and geochemistry: Niuxinshan intrusive complex, northern North China Craton. PLOS ONE, 14(3): e0213156, 1-24.

Shi Chenglong, Ding Xiaozhong, Liu Yanxue, Zhou Xiaodong. 2019. Detrital zircon geochronology and Hf isotope of Paleozoic sedimentary rocks in the Jilin Province, NE China: tectonic significance for microcontinental blocks of eastern Central Asian Orogenic Belt. Geosciences Journal, 23(5): 707-729.

Shi Chenglong, Ding Xiaozhong, Liu Yanxue, Zhou Xiaodong. 2019. Detrital zircon U-Pb dating and Hf isotope study of late Palaeozoic sedimentary rocks in central-eastern Jilin Province, NE China: constraints for tectonic evolution of the eastern segment of the Paleo-Asian Ocean. Geological Journal, 1-21. https://doi.org/10.1002/gj.3525.

Song Peng, Wang Tao, Tong Ying, Zhang Jianjun, Huang He, Qin Qie. 2019. Contrasting deep crustal compositions between the Altai and East Junggar orogens, SW Central Asian Orogenic Belt: evidence from zircon Hf isotopic mapping. Lithos, 328-329: 297-311.

Song Peng, Wang Tao, Tong Ying, Zhang Jianjun, Huang He, Zhang Lei, Qin Qie, Shen Huan. 2019. Carboniferous highly fractionated I-type granites from the Kalamaili Fault Zone, eastern Xinjiang, NW China: petrogenesis and tectonic implications. Acta Geologica Sinica(English Edition), 93(5): 1169-1187.

Song Peng, Wang Tao, Tong Ying. 2019. LA-ICP-MS zircon U-Pb age and Hf isotopic composition of Late Carboniferous granodiorite in the Southern East Junggar, Xinjiang: genesis and tectonic implication. Acta Geologica Sinica(English Edition), 93(S3): 140-141.

Song Yucai, Liu Yingchao, Hou Zengqian, M. Fard, Zhang Hongrui, Zhuang Liangliang. 2019. Sediment-hosted Pb-Zn deposits in the Tethyan domain from China to Iran: characteristics, tectonic setting, and ore controls. Gondwana Research, 75: 249-281.

Tian Zuolin, Zhang Zeming, Dong Xin. 2019. Constraining the age of high-pressure metamorphism of paragneisses from the Eastern Himalayan Syntaxis using zircon petrochronology and phase equilibria. Geological Society, London, Special Publications, 474: 331-352.

Wan Yusheng, Liu Dunyi, Song Biao. 2019. North China Craton: formation and revolution of the oldest continent in China. Science China-Earth Sciences, 64: 641-643.

Wan Yusheng, Wei Chunjing, Yin Changqing. 2019. Preface to the special issue of Precambrian geological events and metallogeny, in honour of Academician Mingguo Zhai. Precambrian Research, 326: 1-5.

Wan Yusheng. 2019. Hadean to Paleoarchean Rocks and Zircons in China. In: Van Kranendonk M J, Smithies R H, Bennett V. (Eds.): Earth's Oldest Rocks (second edition), 294-327.

Wang Chaoyang, Wang Tao, C.V.Staal, Lin S., Zhang J.. 2019. Nd isotopic characteristics of granitoids from the new foundland appalachians. Acta Geologica Sinica (English Edition), 93(S3): 147-149.

Wang D., Zhu Xiangkun, Zhao N. N., Yan Bin, Li X. H., Shi Fuqiang, Zhang F. F.. 2019. Timing of the termination of Sturtian glaciation: SIMS U-Pb zircon dating from South China. Journal of Asian Earth Sciences, 177: 287-294.

Wang Fang, Liu Fulai, Hans-Peter Schertl, Liu Pinghua, Ji Lei, Cai Jia, Liu Lishuang. 2019. Paleo-Tethyan tectonic evolution of Lancangjiang metamorphic complex: evidence from SHRIMP U-Pb zircon dating and 40Ar/39Ar isotope geochronology of blueschists in Xiaoheijiang-Xiayun area, southeastern Tibetan Plateau. Gondwana Research, 65: 142-155.

Wang Huan, Li Haibing, Si Jialiang, Zhang Lei, Sun Zhiming. 2019. Geochemical features of the pseudotachylytes in the Longmen Shan thrust belt, eastern Tibet. Quaternary International, 514: 173-185.

Wang Huan, Li Haibing, Zhang Lei, Zheng Yong, Si Jialiang, Sun Zhiming. 2019. Paleoseismic slip records and uplift of the Longmen Shan, eastern Tibetan Plateau. Tectonics, 38: 354-373.

Wang Huining, Liu Fulai, Li J, Sun Z B, Ji Lei, Tian Zhonghua, Liu Lishuang, M. Santosh. 2019. Petrology,

geochemistry and P-T-t path of lawsonite-bearing retrograded eclogites in the Changning-Menglian orogenic belt, southeast Tibetan Plateau. Journal of Metamorphic Geology, 37: 439-478.

Wang Tao, Wang Xiaoxia, Tong Ying, Huang He, Li Shan, Zhang Jianjun, Guo Lei, Zhang Lei, Song Peng, Qin Qie. 2019. A comparison of Nd isotopes of granitoids from the Central Asian Orogenic Belt and Qinling-Dabie Orogen, and implications for understanding of crustal growth from accretion to collision. Acta Geologica Sinica (English Edition), 93(S3): 150-151.

Wang Wei, Liu Fulai, Ji Lei, M. Santosh. 2019. Geochronology and geochemistry of the Neoarchean Lulong Complex in the eastern Hebei Province, North China Craton: implications on regional crustal evolution. Precambrian Research, 323: 102-125.

Wang Wei, Wang Ming, Zhai Qingguo, Xie Chaoming, Hu Peiyuan, Li Cai, Liu Jinheng, Luo Anbo. 2019. Transition from oceanic subduction to continental collision recorded in the Bangong-Nujiang suture zone: insights from Early Cretaceous magmatic rocks in the north-central Tibet. Gondwana Research, 78: 77-91.

Wang Xuri, Ju Shubin, Wang Yang. 2019. First zircon U-Pb ages of the Pigeon Hill Fossil Locality of the Jehol Biota in the Greater Khingan Mountains, Inner Mongolia. Acta Geologica Sinica (English Edition), 93(4): 1142-1145.

Wang Yafei, Zeng Lingsen, Gao Jiahao, Zhao Linghao, Gao Li'e, Shang Zhen. 2019. Along-arc variations in isotope and trace element compositions of Paleogene gabbroic rocks in the Gangdese batholith, southern Tibet. Lithos, 324-325: 877-892.

Wei Cheng, Zhao Yuhao, Zhu Luhua, Qi Xuexiang, Cai Zhihui, Liu Xufeng, Ma Guangfei. 2019. Sapphirine-bearing pelitic granulite from Ailaoshan orogen, West Yunnan, China: metamorphic conditions and tectonic setting. Journal of Earth Science, 30: 621-635.

Wen Dingjun, He Zhenyu, Zhang Zeming. 2019. Geochemistry and tectonic implications of Early Permian granitic rocks in the Xingxingxia area of Chinese Central Tianshan Arc Terrane. Geological Journal, 54: 1578-1590.

Wu Cailai, Wu Di, C. Mattinson, Lei Min, Chen Hongjie. 2019. Petrogenesis of granites in Wulan area and its relationship with magmatic activity and tectonic evolution in North Qaidam, NW China. Gondwana Research, 67: 147-171.

Wu Guichun, Ji Zhansheng, Liao Weihua, Yao Jianxin. 2019. New biostratigraphic evidence of Late Permian to Late Triassic deposits from central Tibet and their paleogeographic implications. Lithosphere, 11(5): 683-696.

Xie Hangqiang, Wan Yusheng, Dong Chunyan, K. Alfred, Xie Shiwen, Liu Shoujie, Ma Mingzhu, Liu Dunyi. 2019. Late Neoarchean synchronous TTG gneisses and potassic granitoids in southwestern Liaoning Province, North China Craton: zircon U-Pb-Hf isotopes, geochemistry and tectonic implications. Gondwana Research, 70: 171-200.

Xiong Fahui, Liu Z., A. Kapsiotis, Yang Jingsui, D. Lenaz, P.T. Robinson. 2019. Petrogenesis of lherzolites from the Purang ophiolite, Yarlung-Zangbo suture zone, Tibet: origin and significance of ultra-high pressure and other "unusual" minerals in the Neo-Tethyan lithospheric mantle. International Geology Review, 17: 2184-2210.

Xu Huan, Liu Yongqing, Kuang Hongwei, Peng Nan. 2019. Late Jurassic fluvial-eolian deposits from the Tianchihe Formation, Ningwu-Jingle Basin, Shanxi Province, China. Journal of Asian Earth Sciences, 174: 245-262.

Xu Nan, Wu Cailai, Li Shengrong, Xue Boqiang, He Xiang, Yu Yanlong, Liu Junzhuang. 2019. LA-ICP-MS in Situ analyses of the pyrites in Dongyang gold deposit, southeast China: implications to the gold mineralization. China Geology, doi:10.31035/cg2018123.

Xu Wang, Liu Fulai. 2019. Geochronological and geochemical insights into the tectonic evolution of the

Paleoproterozoic Jiao-Liao-Ji Belt, Sino-Korean Craton. Earth-Science Reviews, 193: 162-198.

Xu Xiangzhen, Yang Jingsui, Xiong Fahui, Guo Guolin. 2019. Petrology and geochemistry of the Dangqiong ophiolite, western Yarlung-Zangbo suture zone, Tibet, China. Acta Geologica Sinica (English Edition), 93(2): 344-361.

Yan Bin, Zhu Xiangkun, He Xuexian, Tang Suohan. 2019. Zn isotopic evolution in early Ediacaran ocean: a global signature. Precambrian Research, 320: 472-483.

Yan Zhen, Fu Changlei, J. C. Aitchison, S.Buckman, Niu Manlan, Cao Bo, Sun Yi, Guo Xianqing, Wang Zongqi, Zhou Renjie. 2019. Retro-foreland basin development in response to Proto-Tethyan ocean closure, NE Tibet Plateau. Tectonics, 38: 4229-4248.

Yan Zhen, Liu Jianbo, Jin Xiaochi, Shi Yukun, Wang Haifeng. 2019. Construction model and paleogeographic distribution of Late Pennsylvanian phylloid algal-microbial reefs: a case study in eastern Inner Mongolia, North China. Sedimentary Geology, 383: 181-194.

Yang Yaqi, Zhao Lei, Zheng Rongguo, Xu Qinqin. 2019. Evolution of the early Paleozoic Hongguleleng-Balkybey Ocean: evidence from the Hebukesaier ophiolitic mélange in the northern West Junggar, NW China. Lithos, 324-325: 519-536.

Yang Zhiming, D.R.Cooke. 2019. Porphyry Cu Deposits in China. Society of Economic Geologists Special Publication, 22: 1-56.

Ye Zhuo, Li Qiusheng, Zhang Hongshuang, Li Jiangtao, Wang Xiaoran, Han Rubing, Wu Qingyu. 2019. Crustal and uppermost mantle structure across the Lower Yangtze region and its implications for the late Mesozoic magmatism and metallogenesis, eastern South China. Physics of the Earth and Planetary Interiors, 297: 106324.

Yi Zhiyu, Liu Y., J. Meert. 2019. A true polar wander trigger for the Great Jurassic East Asian Aridification. Geology, 47 (12): 1112-1116.

Yin Jiyuan, Chen Wen, S.N.Thomson, Sun Min, Wang Yannan, Xiao Wenjiao, Yuan Chao, Sun Jinbo, Long Xiaoping. 2019. Fission track thermochronology of the Tuwu-Yandong porphyry Cu deposits, NW China: constraints on preservation and exhumation. Ore Geology Reviews, 113: 103104.

Zhai Qingguo, Zhong Sunlin, Tang Yue, Hu Peiyuan, Jin Xiaochi, Wang Jun, Wang Haitao, Wang Guolong, Li Haoyang. 2019. Late Carboniferous ophiolites from the southern Lancangjiang belt, SW China: implication for the arc-back-arc system in the eastern Paleo-Tethys. Lithos, 344-345: 134-146.

Zhang Beihang, Zhang Jin, Zhao Heng, Nie Fengjun, Wang Yannan, Zhang Yiping. 2019. Tectonic evolution of the western Ordos Basin during the Palaeozoic-Mesozoic time as constrained by detrital zircon ages. International Geology Review, 61(3-4): 461-480.

Zhang Cong, T. Bader, H. L. M. van Roermund, Yang Jingsui, Shen Tingting, Qiu Tian, Li P. 2019. The metamorphic evolution and tectonic significance of the Sumdo HP/UHP metamorphic terrane, central-south Lhasa block, Tibet. Geological Society London, Special Publication, 474: 209-229.

Zhang Cong, T. Bader, Zhang L. M., Shen Tingting, Li P., Li X. P.. 2019. Metamorphic evolution and age constraints of a garnet-bearing mica schist from the Xindaduo area of the Sumdo (U)HP metamorphic belt, Tibet. Geological Magazine, 156: 1175-1189.

Zhang Fan, Wang Yanbin, Du Lilin Yang Chonghui, J.C. Ayers, Yuan Hongqiang, 2019. The Neoarchean-Paleoproterozoic volcanic-sedimentary rocks in the Zanhuang Complex, North China Craton: petrogenesis and implications for tectonic evolution. Precambrian Research, 328: 64-80.

Zhang Hongrui, Hou Zengqian, Yang Tiannan, Yang Zhiming, Chen Jianlin, M. Aghazadeh. 2019. Multiphase porphyry intrusions in the Sungun copper deposit, NW Iran: evidence from SHRIMP zircon U-Pb dating. China Geology, 2: 240-242.

Zhang Huichao, Chai Peng, Zhang Hongrui, Hou Zengqian, Chen S., Sun Y., Peng Q.. 2019. Two-stage sulfide mineral assemblages in the mineralized ultramafic rocks of the Laowangzhai Gold Deposit,

Yunnan, SW China: implications for metallogenic evolution. Resource Geology, 69: 270-286.

Zhang Jianxin, C.G. Mattinson, Yu Shengyao, Li Yunshuai, Yu Xingxing, Mao Xiaohong, Lu Zenglong, Peng Yinbiao. 2019. Two contrasting accretion v. collision orogenies: insights from Early Paleozoic polyphase metamorphism in the Altun–Qilian–North Qaidam orogenic system, NW China. Geological Society, London, Special Publications, 474: 153-181.

Zhang Wen, V. Pease, M.J. Whitehouse, M.M.El-Sankary, M.H.Shalaby. 2019. Pre-Neoproterozoic basement evolution of southwestern Egypt. International Geology Review, 61: 1909-1926.

Zhang Wen, V. Pease, M.J. Whitehouse, M.M.El-Sankary, M.H.Shalaby. 2019. From the Libyan border to the Nile-Neoproterozoic magmatism and basement evolution of southern Egypt. International Geology Review, 61: 2057-2079.

Zhang Zhiyu, Hou Zengqian, Peng H. M., Fan X. K., Wu X. Y., Dai J. L.. 2019. In situ oxygen isotope, trace element, and fluid inclusion evidence for a primary magmatic fluid origin for the shell-shaped pegmatoid zone within the giant Dahutang tungsten deposit, Jiangxi Province, South China. Ore Geology Reviews, 104: 540-560.

Zhao Shuangfeng, Chen Wen, Zhou Lu, Zhou Peng, Zhang Jie. 2019. Characteristics of fluid inclusions and implications for the timing of hydrocarbon accumulation in the Cretaceous reservoirs, Kelasu Thrust Belt, Tarim Basin, China. Marine and Petroleum Geology, 99: 473-487.

Zheng Jianbin, Jin Xiaochi, Huang Hao, Zong Pu. 2019. Sedimentology and detrital zircon geochronology of the Nanduan Formation (Carboniferous) of the Changning-Menglian Belt: indications for the evolution of Paleo-Tethys in western Yunnan, China. International Journal of Earth Sciences, 108: 1029-1048.

Zheng Jianbin, Zong Pu, Huang Hao, Jin Xiaochi. 2019. Early Carboniferous ammonoids from the Nanduan Formation in the Changning-Menglian Belt, western Yunnan, China. Palaeoworld, 29: 88-95.

Zheng Kun, Wu Cailai, Lei Min, Zhang Xin, Chen Hongjie, Wu Di, Gao Dong. 2019. Petrogenesis and tectonic implications of granitoids from western North Altun, Northwest China. Lithos, 340-341: 255-269.

Zheng Ning, Li Tingdong, Cheng Muwei. 2019. Middle-Upper Ordovician radiolarians in Hunan and Jiangxi Provinces, South China: implications for the sedimentary environment and nature of the Nanhua Basin. Journal of Asian Earth Sciences, 179: 261-275.

Zheng Rongguo, Li Jinyi, Xiao Wenjiao. 2019. Middle Paleozoic ridge subduction in Central Beishan of southern Altaids: evidence from geochemical, Sr-Nd and zircon U-Pb-Hf-O isotopic data of Gongpoquan volcanic rocks. Journal of Geological Society, 176: 755-770.

Zheng Rongguo, Li Jinyi, Zhang Jin, Xiao Wenjiao, Li Yi. 2019. Early Carboniferous high Ba–Sr granitoid in southern Langshan of northeastern Alxa: implications for accretionary tectonics along southern Central Asian Orogenic Belt. Acta Geologica Sinica (English Edition), 93(4): 820-844.

Zheng Rongguo, Zhang Jin, Xiao Wenjiao. 2019. Association of Permian gabbro and granite in the Langshan, southern Central Asian Orogenic Belt: age, origin, and tectonic implications. Lithos, 348-349: 105174.

Zheng Rongguo, Zhao Lei, Yang Yaqi. 2019. Geochronology, geochemistry and tectonic implications of a new ophiolitic mélange in the northern West Junggar, NW China. Gondwana Research, 74: 237-250.

Zhong Ning, Jiang Hanchao, Li Haibing, Xu Hongyan, Shi Wei, Zhang Siqi, Wei Xiaotong. 2019. Last degacial soft-sediment deformation at Shawan on the Eastern Tibetan Plateau and implications for deformation processes and seismic magnitudes. Acta Geologica Sinica (English Edition), 93(2): 430-450.

Zhou Guisheng, Zhang Jianxin, Yu Shengyao, Li Yunshuai, Lu Zenglong, Mao Xiaohong, Teng Xia. 2019. Metamorphic evolution of eclogites and associated metapelites from the Yuka terrane in the North Qaidam ultrahigh pressure metamorphic belt, NWChina: constraints from phase equilibrium modeling. Journal of Asian Earth Sciences, 173: 161-175.

Zhou Guisheng, Zhang Jianxin, Yu Shengyao, Li Yunshuai, Lu Zenglong, Mao Xiaohong, Teng Xia. 2019. Metamorphic evolution and tectonic implication of the granulitized eclogites from the Luliangshan terrane in the North Qaidam ultrahigh pressure metamorphic belt, NW China: new constraints from phase equilibrium modeling. Journal of Earth science, 30: 585-602.

Zhou Xuanyu, R.V. Pêgas, M.E.C. Leal, N. Bonde. 2019. Nurhachius luei, a new istiodactylid pterosaur (Pterosauria, Pterodactyloidea) from the Early Cretaceous Jiufotang Formation of Chaoyang City, Liaoning Province (China) and comments on the Istiodactylidae. Peer J, 7: e7688, 1-25. doi: 10.7717/peerj.7688.

Zhu Xiangkun, Sun Jian, Li Z.H. 2019. Iron isotopic variations of the Cryogenian banded iron formations: a new model. Precambrian Research, 331: 1-15.

Zhu Xiaosan, Zheng Hongwei, Lu Minjie. 2019. Lateral variation of aeromagnetic anomaly in South China and its tectonic implications. International Journal of Earth Sciences, 108(5): 1493-1507.

Zhu Zhicai, Zhai Qingguo, Hu Peiyuan, Zhong Sunlin, Tang Yue, Wang Haitao, Wu Hao, Wang Wei, Huang Zhiqiang, Li Haoyang. 2019. Closure of the Bangong-Nujiang Tethyan Ocean in the central Tibet: results from the provenance of the Duoni Formation. Journal of Sedimentary Research, 89: 1039-1054.

Zhu Zhiyong, Yang Tao, Zhu Xiangkun. 2019. Achieving rapid analysis of Li isotopes in high-matrix and low-Li samples with MC-ICP-MS: new developments in sample preparation and mass bias behavior of Li in ICPMS. Journal of Analytical Atomic Spectrometry, 34: 1503-1513.

8.2 Chinese language publications with English abstract

Bai Wenqian, Dong Chunyan, Xie Hangqiang, Wan Yusheng. 2019. The Changcheng System in Ordos Basin: detrital zircon Shrimp U-Pb dating and Hf isotope analysis. Acta Petrologica Sinica, 35(8): 2363-2376.

Bao Peisheng. 2019. Proterozoic ophiolite and chromite. Acta Petrologica Sinica, 35(10): 2971-2988.

Dong Xin, Tian Zuolin. 2019. Multistage tectono-thermal events in the Yadong area of the Himalayan orogenic belt: evidence from zircon and monazite U-Th-Pb geochronology. Acta Petrologica et Mineralogica, 38(4): 431-452.

Dong Xin, Zhang Zeming, Tian Zuolin, Li Bing. 2019. Early Jurassic metamorphism and anatectic melting of the eastern Lhasa terrane. Acta Geologica Sinica, 93(10): 2446-2462.

Duan Xuepeng, Meng Fancong, Fan Yazhou. 2019. The constraints of kaersutite and pargasite on metallogeny in Xiarihamu mafic-ultramafic intrusion, East Kunlun. Acta Petrologica Sinica, 35(6): 1819-1832.

Feng Guangying, Niu Xiaolu, Liu Fei, Liu Shen, Yang Jingsui. 2019. Petrogenesis of late Early Jurassic granodiorites and associated dioritic enclaves in the Zhangguangcai Range and its tectonic implications. Acta Geologica Sinica, 93 (10): 2598-2616.

Fu Changlei, Yan Zhen, Wang Bingzhang. 2019. Discussion on the age and tectonic affinity of the mafic rocks in Qingshui-Zhangjiachuan of the conjunction area between the Qinling and Qilian orogenic belts. Acta Petrologica Sinica, 35(10): 3141-3160.

Fu Haobang, Liu Yan, Zheng Xu, Jia Yuheng, Ding Yan. 2019. Geochronology, geochemistry and metallogenic characteristics of Muluozhai deposit in southwestern Sichuan Province. Mineral Deoposits, 38(3): 491-508.

Gao Li'e, Zeng Lingsen, Hu Guyue, Gao Jiahao, Zhao Linghao, Wang Yaying. 2019. Rare metal enrichment in leucogranite within Nariyongcuo gneiss dome, south Tobet. Earth Science, 44(6): 1860-1876.

Ge Maohong, Zhang Jinjiang, Liu Kai, Li Zhuang. 2019. Detrital zircon U-Pb dating for the mica schist from the Heilongjiang complex in Mudanjiang area and its geological implications. Chinese Journal of

Geology, 54(4): 1265-1289.

Geng Yuansheng, Kuang Hongwei, Du Lilin, Liu Yongqing, Zhao Taiping. 2019. On the Paleo-Mesoproterozoic boundary from the breakup event of the Columbia supercontinent. Acta Petrologica Sinica, 35(08): 2299-2325.

Han Rubing, Li Qiusheng, Xu Yixian, Zhang Hongshuang, Chen Hao, Lang Chao, Wu Qingyu, Wang Xiaoran. 2019. Deep structure background and Poission's ration beneath the intersection zone of Nanling and Wuyi. Chinese Journal of Geophysics, 62(7): 2477-2489.

Han Shuai,Li Haibing,Pan Jiawei,Lu Haijian,Zheng Yong,Liu Dongliang,Bai Mingkun,Zhang Jinjiang. 2019. Evolution history of the Chem Co pluton, Longmu Co region and its tectonic implication: constraints from geochemistry and geochronology. Acta Petrologica Sinica, 36(6): 1647-1672.

He Bizhu, Jiao Cunli, Huang Taizhu, Zhou Xingui, Cai Zhihui, Cao Zicheng, Jiang Zhongzheng, Cun Junwen, Yu Zhuoying, Chen Weiwei, Liu Ruohan, Yun Xiaorui, Hao Guangming. 2019. Structural architecture of Neoproterozoic rifting depression groups in the Tarim basin and their formation dynamics. Science China-Earth Sciences, 49(4): 635-655.

Hu Peiyuan, Zhai Qingguo, Zhao Guochun, Tang Yue, Wang Haitao, Zhu Zhicai, Wang Wei, Wu Hao. 2019. Middle Neoproterozoic magmatic event in the western Nam Tso area, Tibetan Plateau:constraint on the origin of the North Lhasa terrane. Acta Petrologica Sinica, 35(10): 3115-3129.

Kang Dongyan, Zhang Zeming, Dong Xin, Tian Zuolin, Xiang Hua, Mo Xuanxue. 2019. Anticlockwise P-T-t path and tectonic mechanism of metapelites from the eastern Gangdese arc, southern Tibet. Acta Petrologica Sinica, 35(2): 349-362.

Kuang Hongwei, Geng Yuansheng, Liu Yongqing, Wang Yuchong, Xia Xiaoxu, Peng Nan, Fan Zhengxiu, Chen Xiaoshuai, Bai Huaqing. 2019. Revision of "the bottom of Shennongjia Group" and stratigraphic implication in the northern margin of Yangtze Craton. Acta Geologica Sinica, 93(1): 72-93.

Kuang Hongwei, Liu Yongqing, Geng Yuansheng, Bai Huaqing, Peng Nan, Fan Zhengxiu, Song Huanxin, Xia Xiaoxu, Wang Yuchong, Chen Xiaoshuai. 2019. Important sedimentary geological events of the Meso-Neoproterozoic and their significance. Jounal of Palaeogeography (Chinese Edition), 21(1): 1-30.

Kuang Hongwei, Liu Yongqing, Peng Nan, Zhu Zhicai, Wang Yuchong, Liu Hai, Song Huanxin, Tang Yong, Song Changgui, Fan Zhengxiu, Xia Xiaoxu, Chen Xiaoshuai. 2019. Carbon isotopic characteristics and sedimentology of Ediacaran cap carbonates: a case study from the Shennongjia area, northern Yangtze carton. Acta Geologica Sinica, 93(9): 2139-2157.

Li Haibing, Wang Huan, Li Chunrui, He Xiangli, Li Chenglong. 2019. The progress in earthquake research: a review of the global earthquake scientific drilling. Acta Geoscientica Sinica, 40(1): 117-134.

Li Jinyi, Liu Jianfeng, Qu Junfeng, Zheng Rongguo, Zhao Shuo, Zhang Jin, Sun Lixin, Li Yongfei, Yang Xiaoping, Wang Lijia, Zhang Xiaowei. 2019. Major geological features and crustal tectonic framework of Northeast China. Acta Petrologica Sinica, 35(10): 2989-3016.

Li Jinyi, Liu Jianfeng, Qu Junfeng, Zheng Rongguo, Zhao Shuo, Zhang Jin, Wang Lijia, Zhang Xiaowei. 2019. Paleozoic tectonic units of northeast China: continental blocks or orogenic belts? Earth Science, 44(10): 3157-3177.

Li Jinyi, Zhang Jin, Liu Jianfeng, Qu Junfeng, Zheng Rongguo, Zhao Shuo, Wang Lijia, Zhang Xiaowei. 2019. Crustal tectonic framework of China and its formation processes: constraints from structural deformation. Journal of Geomechanics, 25(5): 678-698.

Li Ming, Lin Baoyu, Li Wufu, Yan Yufeng, Wang Guoliang, Wang Chuntao, Chen Fabin, Li Huanxue. 2019. Distribution and ages of Cambrian and Ordovician marine Red Beds in the north margin of Qiadam Basin, Qinghai Province. Acta Geologica Sinica, 93(10): 2403-2425.

Li Ming, Lin Baoyu, Song Yanyan. 2019. Distribution and ages of Ordovician and Silurian marine Red Beds in Tibet. Acta Geoscientica Sinica, 40 (3): 428-446.

Li Zhi, Yan Danping, Chen Wen, Li Lin, Chen Feng. 2019. The structural style and genetics mechanism of the Longshan dome in Xiangzhong basin, Xuefengshan orogenic belt. Acta Geologica Sinica, doi:10.19762/j.cnki.dizhixuebao.2019092.

Lin Baoyu, Li Ming, Wu Zhenjie. 2019. Distribution and ages of the Devonian marine Red Beds from Xizang (Tibet) Autonomous Region. Acta Geologica Sinica, 93(10): 2383-2402.

Liu Chaohui, Liu Fulai, Cai Jia, Zhang Wen. 2019. Comparisons of the Fengyang and Wuhe groups in the Bengbu area with meta-sedimentary successions in the Jiaobei area: constraints from zircon U-Pb-Lu-Hf isotopic and trace element studies. Bulletin of Mineralogy, Petrology and Geochemistry, 38(4): 681-703.

Liu Fei, Niu Xiaolu, Lian Dongyang, Feng Guangying, Zhao Hui. 2019. 433 Ma extension-related magmatism in Zhongba terrane, Southern Tibet: constraints from U-Pb zircon chronology, geochemical and Hf isotopic compositions of Boku two-mica granite. Acta Geologica Sinica, 93(10): 2556-2574.

Liu Fei, Yang Jingsui, Lian Dongyang, Yu Xiaoyan, K. R. Gwandu. 2019. Metallogenic features of diamondiferous kimberlites in Botswana and China: enlightenment for exploration of same type deposits. Geology in China, 46(1): 43-76.

Liu Pinghua, Zou Lei, Tian Zhonghua, Ji Lei, Shi Jianrong. 2019. Determination of Late Paleozoic metamorphic event in the Langshan area, western Inner Mongolia: new evidence from LA-ICP-MS zircon U-Pb dating of the Wulashan g Group. Geological Bulletin of China, 38(10): 1691-1710.

Liu Pinghua, Zou Lei, Tian Zhonghua, Ji Lei, Shi Jianrong. 2019. Discovery and geological significance of an early Paleozoic (ca.420Ma) metamorphic event from the eastern Alxa Block: new evidence from monazite and zircon LA-ICP-MS U-Pb dating. Earth Science, 44(7): 2241-2460.

Liu Ruohan, He Bizhu, Zheng Menglin, Peng Yang, Chen Weiwei, Yu Zhuoying, Yun Xiaorui, Xu Shilu. 2019. Tectonic-sedimentary evolution during Late Triassic-Jurassic period in the eastern part of the Qiangtang basin, Tibet. Acta Petrologica Sinica, 35(6): 1857- 1874.

Liu Xufeng, Ren Yufeng, Qi Xuexiang, Wei Cheng. 2019. Geochemistry and implications of the Mid-Jurassic basalts on east margin of the Gaoligong tectonic zone, western Yunnan. Acta Petrologica Sinica, 35(6): 1757-1772.

Liu Yan. 2019. Effects of huge anthropogenic carbon emission: inspiration from comprehensive investigations of Tibetan Plateau. Geological Survey of China, 6(3): 1-13.

Liu Yingchao, Yang Zhusen, Yu Yushuai, Ma Wang, Yue Longlong, Tang Bolang. 2019. Characteristics and genesis of the Zhaofayong Karst-controlled MVT Deposit in the Changdu Region, Tibet. Acta Geoscientica Sinica, 40 (6): 853-870.

Liu Zilong, Lu Zhanwu, Jia Junlian, Li Wenhui, Ren Yanzong. 2019. Using deep seismic reflection to profile deep structure of ore concentrated area: current status and case historie. Earth Science, 44(6): 2084-2105.

Lu Yuxiao, Yang Jingsui, Dong Yufei, Xiong Fahui, Chen Xiaojian, Li Guanlong, Bo Rongzhong. 2019. The MOR-type lherzolites in Peng Co ophiolite in the middle segment of Bangong-Nujiang suture in Tibet. Acta Geologica Sinica, 93(10): 2575-2597.

Ma Wang, Liu Yingchao, Yang Zhusen, Li Zhenqing, Zhao Xiaoyan, Yue Longlong. 2019. Characteristics of ore-forming fluids of Lietinggang-Leqingla Pb-Zn-Fe-Cu-Mo polymetallic deposit in Tibetan: evidence from fluid inclusions and stable isotope compositions. Earth Science, 44 (6): 1957-1973.

Niu Pengfei, Qu Junfeng, Zhang Jin, Zhang Beihang, Zhao Heng. 2019. Deformation study of the Diebusige complex in the Langshan area and its tectonic implications. Acta Geologica Sinica, 93 (8): 1867-1884.

Pengyang, Lu gang. 2019. Study on buttress unconformity in Late Palaeozoic carbonates of northwestern Guangxi. Geological Review, 65(4): 794-809.

Qi Xuexiang, Wei Cheng, Cai Zhihui, Huang Menghui, Liu Yanxue, Zhang Chao, Ji Fengbao. 2019. Sedimentary age of metamorphic rocks of Gaoligong Group in Tengchong Block, western Yunnan and

its relationship with subduction/accretion of Prototethys: evidences from detrital zircon U-Pb dating and geochemistry. Acta Geologica Sinica, 93 (1): 94-116.

Qin Shengkai, Zhang Zeming, Jiang Yuanyuan, Chen Yanfei, Zhang Ning, Zhang Chengyuan. 2019. Metamorphic P-T path and tectonic implication of the sillimanite-garnet-biotite schist in the eastern Gangdese magmatic arc. Acta Petrologica Sinica, 35(2): 363-375.

She Yuwei, Zhu Xiangkun, He Yuan, Wan Hongqing. 2019. The formation of gabbro and diabase in the Xigaze ophiolite: implications for a slow-spreading ridge. Geology in China, 46(6): 1372-1383.

Tang Yue, Zhai Qingguo, Hu Peiyuan, Xiao Xuchang, Wang Haitao, Wang Wei, Zhu Zhicai, Wu Hao. 2019. Jurassic high-Mg andesitic rocks in the middle part of the Bangong-Nujiang suture zone, Tibet: new constraints for the tectonic evolution of the Meso-Tethys ocean. Acta Petrologica Sinica, 35(10): 3097-3114.

Tao Zaili, Yin Jiyuan, Chen Wen, Li Dapeng, Xu Zhihua, Du Qiuyi. 2019. Sr-Nd-Hf isotopic characteristics of early Permian I-type granites in the Southern Tianshan: petrogenesis and implications for continental crustal growth. Earth Science, 44(10): 3565-3582.

Wan Yusheng, Guo Ruipeng, Tian Jingxiang, Song Zhiyong, Xie Shiwen, Dong Chunyan, Bai Wenqian. 2019. Discovery of Mesoarchean-early Neoarchean TTG Rocks in Laizhou area in eastern Shandong of North China Craton--Shrimp U-Pb zircon dating. Shandong Land and Resouces, 35(4): 1-16.

Wang Fang, Liu Fulai, Liu Pinghua, Cai Jia, Shi Jianrong, Ji Lei, Liu Lishuang. 2019. Timing of anatexis and provenance of meta-sedimentary rocks in Shigu-Liming area. Acta Petrologica et Mineralogica, 38(6): 881-896.

Wang Guangwen, Wang Haiyan, Li Hongqiang, Zhang Hongshuang, Li Wenhui, Zhang Xiaowei. 2019. Research status and progress of surface wave exploration technology. Advances in Geosciences, 9(9): 799-815.

Wang Haitao, Zeng Lingsen, Gao Li'e, Hu Zhaoping, Wang Yafei, Zhan Linghao, Gao Jiahao, Xu Qian. 2019. Timing and geochemical characteristics of the Riduo granitic pluton within the Gangdese batholith, southern Tibet. Acta Petrologica Sinica, 35(2): 439-455.

Wang Huan and Li Haibing. 2019. Seismic slip records preserved in fault rocks. Acta Geoscientica Sinica, 40(1): 135-156.

Wang Huan, Li Haibing, Si Jialiang, Zhang Lei. 2019. Geochemical variations of the pseudotachylytes during their formation and subsequent uplift processes in the Longmenshan thrust belt. Acta Geoscientica Sinica, 40(1): 199-211.

Wang Huining, Liu Fulai, Ji Lei, Tian Zhonghua, Xu Wang, Liu Lishuang. 2019. Petrology, geochemistry and metamorphic evolution of Lancang Group in the Changning-Menglian complex belt and its implications on the tectonic evolution of the Paleo-Tethys. Acta Petrologica Sinica, 35(6): 1773-1799.

Wang Tao, Guo Lei, Li Shan, Wang Xiaoxia, Wang Chaoyang. 2019. Some important issues in the study of granite tectonics. Journal of Geomechanics, 25(5): 899-919.

Wang Xuri, Wu Wenhao, Li Tao, Ji Qiang, Li Yinxian, Guo Jinfang. 2019. A new titanosauriform dinosaur (Dinosauria:Sauropoda) from Late Jurassic of Junggar. Global Geology, 38(3): 581-588.

Wang Yunpeng, Niu Xiaolu, Yang Jingsui, Li Yuan, Xu Xiangzhen, Feng Guangying, Xiong Fahui, Liu Fei, Liu Zhao, Tian Yazhou, Guo Guolin, Lian Dongyang, Zhao Yiyu. 2019. Study on the drilling core(DSD-1)of Dongbo peridotite massif, Yarlung Zangbo suture zone, western Tibet. Acta Geologica Sinica, 93(10): 2486-2508.

Xu Nan, Wu Cailai,, Lei Min, Zhang Xin, Chen Hongjie, Guo Wenfeng, Zheng Kun, Gao Dong, Liu Junzhuang. 2019. Petrogenesis, zircon U-Pb chronology, and Lu-Hf isotopic characteristics of monzonitic granite from Mangya area. Earth Science, 43(S2): 64-84.

Xu Qian, Zeng Lingsen, Gao Jiahao, Zhao Linghao, Wang Yafei, Hu Zhaoping. 2019. Geochemical

characteristics and genesis of the Songka Late Cretaceous adakitic high-Mg diorite in the southern margin of Gangdese, southern Tibet. Acta Petrologica Sinica, 35(2): 455-472.

Xu Qian, Zeng Lingsen, Gao Jiaohao, Gao Li'e, Wang Yafei, Hu Zhaoping, Zhao Linghao. 2019. Geochemical characteristics and genesis of the Miocene high Sr/Y intermediate-felsic magmatic rocks in eastern Gangdese batholith, southern Tibet. Acta Petrologica Sinica, 35(6): 1627-1647.

Xu Xiangzhen, Xiong Fahui,Yang Jingsui, Ba Dengzhu, Zhang Ran, Duan Jianbing, Zhao Jiao. 2019. Zircon U-Pb dating and geochemistry of the Kare gabbro in the middle segment of the Gangdese belt and its tectonic implications. Acta Geologica Sinica, 93(10): 2542-2555.

Xu Zhihua, Yin Jiyuan, ChenWen, Li Dapeng, Sun Jingbo, Yu Shun, Du Qiuyi. 2019. Chronology, geochemical characteristics and tectonic significance implication of late Devonian I-type granite in the northeast of eastern Junggar, Xinjiang. Acta Geologica Sinica, 93(11): 2797-2812.

Xue Huaimin. 2019. Late Mesozoic adakitic intrusive rocks in Ningzhen district, Lower Yangtze River reaches: ages, geochemical and genesis. Acta Geologica Sinica, 93(1): 147-169.

Yu Chao, Yang Zhiming, Zhou Limin, Zhang Liangliang, Li Zhenqing, Zhao Miao, Zhang Jiayu, Chen Weiyan, Suo Mingshi. 2019. Impact of laser focus on accuracy of U-Pb dating of zircons by LA-ICPMS. Mineral Deposits, 38: 21-28.

Yuan Lupeng, Wang Yong, Yao Peiyi, Jiang Nan, Dong Jin, Tian Fei, Tang Wenkun. 2019. The discovery of Mid-Holocene transgressive strata in Xiongxian County, Hebei Province. Geological Bulletin of China. 38(6): 911-915.

Yun Xiaorui, Cai Zhihui, He Bizhu, Zheng Menglin, Jiao Cunli, Peng Yang, Liu Ruohan. 2019. Early Paleozoic and Mesozoic orogenic records in Amdo region, Tibet: Zircon U-Pb geochronology and Hf isotopic compositions from the Amdo micro-continent and South Qiangtang terrane. Acta Petrologica Sinica, 35(6): 1673-1692.

Zeng Lingsen, Zhao Linghao, Gao Li'e, Hou Kejun, Wang Qian. 2019. Magmatic garnet from Mid-Miocene co-genetic high Sr/Y granite and leucogranite from the Himalayan orogenic belt, southern Tibet. Acta Petrologica Sinica, 35(6): 1599-1627.

Zhai Qingguo, Gao Jun, Song Shuguang. 2019. New progress in ophiolite and tedtonics of China: Preface. Acta Petrologica Sinica, 35(10): 2943-2947.

Zhang Fan, Wang Yanbin, Yang Chonghui, Du Lilin, Yuan Hongqing. 2019. Shrimp U-Pb zircon dating of clastic sedimentary rocks of the Guandu Group, Zanhuang Complex, Hebei Province, and its geological significance. Geological Bulletin of China, 38 (8): 1335-1343.

Zhang Heng, Gao Linzhi, Zhang Chuanheng, Ding Xiaozhong, Li Tingdong, Song Biao, Liu Haogang, Gong Chengqiang, Zhang Jibiao. 2019. Paleoproterozoic magmatic and metamorphic events in southwestern Yangtze Block: the position and evolution of the Yangtze Block within the Nuna supercontinent. Geological Bulletin of China, 38(11): 1568-1580.

Zhang Heng, Gao Linzhi, Zhou Hongrui, Song Biao, Ding Xiaozhong, Zhang Chuanheng, Liu Haogang, Gong Chengqiang. 2019. Chronology progress of the Guandaokou and Luoyu groups in the southern margin of North China Craton: constraints on zircon U-Pb dating of tuff, by means of the SHRIMP. Acta Petrologica Sinica, 35(8): 2470-2486.

Zhang Jianjun, Tong Ying, Wang Tao, Huang Wei, Zhao Jianxin, Hou Jiyao. 2019. Petrogenesis and tectonic significance of Early Carboniferous dyke swarms in Lüshigou pluton of Qiongheba area, East Junggar, Xinjiang. Acta Petrologica et Mineralogica, 38 (5): 606-630.

Zhang Jianjun, Zhang Lei, Wang Tao, Shi Xingjun. 2019. Geochemical, age and Hf-in-zircon isotopic characteristics and geological significance of granite and MME from the Mandelinwula pluton, northern Alxa block, Inner Mongolia. Geological Bulletin of China, 38(10): 1675-1690.

Zhang Lei, Li Haibing, Sun Zhiming, Cao Yong, Wang Huan. 2019. A review of rock magnetism for fault

rocks. Acta Geoscientica Sinica, 41(1): 157-172.

Zhang Lei, Li Haibing, Sun Zhiming, Cao Yong, Wang Huan. 2019. Metallic iron formed by melting and its seismogenic setting indication. Acta Petrologica Sinica, 35(6): 1875-1891.

Zhang Ran, Xiong Fahui, Xu Xiangzhen, Liu Zhao, Yang Jingsui. 2019. The feature and tectonic setting of chromitite from the Yilashan ophiolite in Tibet. Acta Geologica Sinica, 93(7): 1655-1670.

Zhang Yan. 2019. Study on the sericite separation used for $^{40}Ar/^{39}Ar$ dating. Rock and Mineral Analysis, 38(6): 599-608.

Zhang Zeming, Ding Huixia, Dong Xin, Tian Zuolin. 2019. Formation and evolution of Gangdese magmatic arc, south Tibet. Acta Petrologica Sinica, 35(2): 275-294.

Zhang Zeming, Ding Huixia, Dong Xin, Tian Zuolin. 2019. Two contrasting eclogite types in the Himalayan orogen and differential subduction of Indian Continent. Earth Science, 44(5): 1602-1619.

Zhao Heng, Zhang Jin, Li Yanfeng, Qu Junfeng, Zhang Beihang, Niu Pengfei, Yun Long, Zhang Yiping, Wang Yannan. 2019. Spatial and temporal variations of granitoids in the Altay orogen and their implications for tectonic setting and crustal growth: perspectives from Chinese Altay. Acta Geologica Sinica, 93 (7): 1601-1617.

Zhao Lei, Niu Baogui, Xu Qinqin, Yang Yaqi. 2019. An analysis of Silurian- Carboniferous sedimentary and structural characteristics on both of Karamaili ophiolitic belt of Xingjiang and its significance. Geology in China, 46 (3):616-628.

Zheng Kun, Wu Cailai, Wei Chunjing, Gao Yuanhong, Guo Wenfeng, Chen Hongjie, Xu Nan. 2019. Geochemistry, zircon U-Pb geochronology and Hf isotopic characteristics for syenogranite and diorite from the western segment of North Altyn. Acta Petrologica Sinica, 35(2): 541-557.

Zheng Kun, Wu Cailai, Wu Di, Gao Dong, Chen Hongjie, Xu Nan. 2019. Petrogenesis of the Kazisayi monzograntie from North Altun and its tectonic implications. Acta Geologica Sinica, 93(10): 2531-2541.

Zou Lei, Liu Pinghua, Tian Zhonghua, Ji Lei, Shi Jianrong. 2019. The late Paleozoic metamorphic complex of the Precambrian metamorphic basement from the eastern Alxa Block: new evidence from zircon LA-ICP-MS U-Pb dating of the Boluositanmiao complex. Earth Science, 44(4): 1406-1423.