CUGB Student Chapter 2023 Field trip report

Orogenic Gold Deposits and REE Deposits in China

April, 26th, 2023 – October, 1st, 2023

Presented by: China University of Geoscience (Beijing) SEG Student Chapter

Introduction

To introduce orogenic gold deposits and REE deposits to the newcomers of the SEG student Chapter, we organized field trips from 26th April 2023 to 1st October 2023. On these field trips, we visited the typical orogenic gold deposits (Linglong gold deposit, Zaozigou gold deposit, Jiagantan gold deposit, Jinshan gold deposit) and REE deposits (Weishan REE deposit) in China. These trips were led by Prof. Kunfeng Qiu, Ph.D. Jie Wang, Ph.D. Pengcong Zhang, Ph.D. Tao Cui and Ph.D. Dengyang He, Ph.D. Jianan Fu, and Ph.D. Jiayi Wang. These trips focused on the structure and mineralization of the orogenic gold deposits, with particular attention to tectonic factors influencing the mineralization. Meanwhile, this trip helped students gain insight into the regional geology and the mining history in this area.

Participants

Name	SEG Member	Academic Position
Kunfeng Qiu	Advisor	Teaching and Technical Professor
Haocheng Yu		Postdoctoral fellow
Jingyuan Zhang	Students Member	Ph.D. Student
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Pengcong Zhang	Students Chapter Member	Ph.D. Student
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Tao Cui	Students Chapter Member	Ph.D. Student
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Geological setting

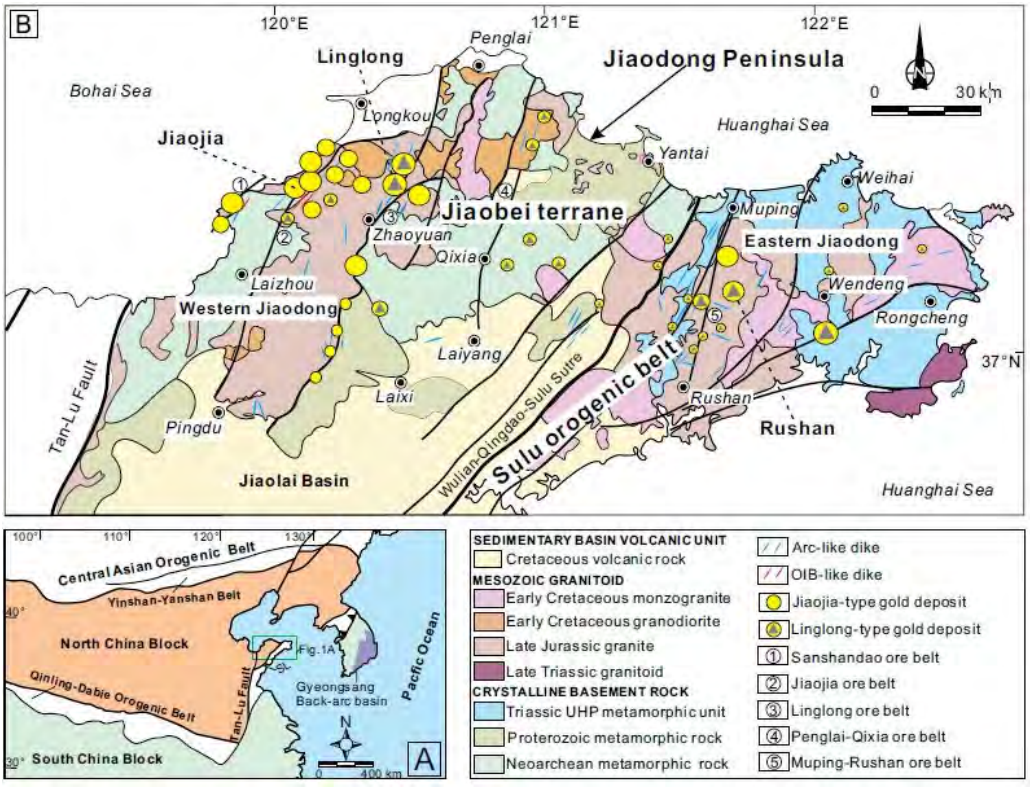

Fig. 1. Simplified Geological Map of the Jiaodong Peninsula in China

The Linglong gold deposits and Jiaojia gold deposits are located in the Jiaodong peninsula which is situated on the southeastern edge of the North China Block, bounded by the Tanlu Fault Zone in the west and adjacent to the Luxi Block (Fig. 1A). The Jiaodong Peninsula is composed of two tectonic units: the Jiaobei terrane in the northwest and the Sulu Ultrahigh Pressure Metamorphic Belt in the southeast. The basement is mainly composed of the Neoarchean tonalite-trondhje-mite-granodiorite (TTG) gneisses (Jiaodong Group), as well as the Paleoproterozoic (Jingshan Formation) and Neoproterozoic (Penglai Formation) metasedimentary sequences (Fig. 1B). The igneous rocks in Jiaodong gold province are featured by 160-150 Ma Linglong granites, 130-120 Ma Guojialing granodiorites, and 130-110 Ma mafic dikes.

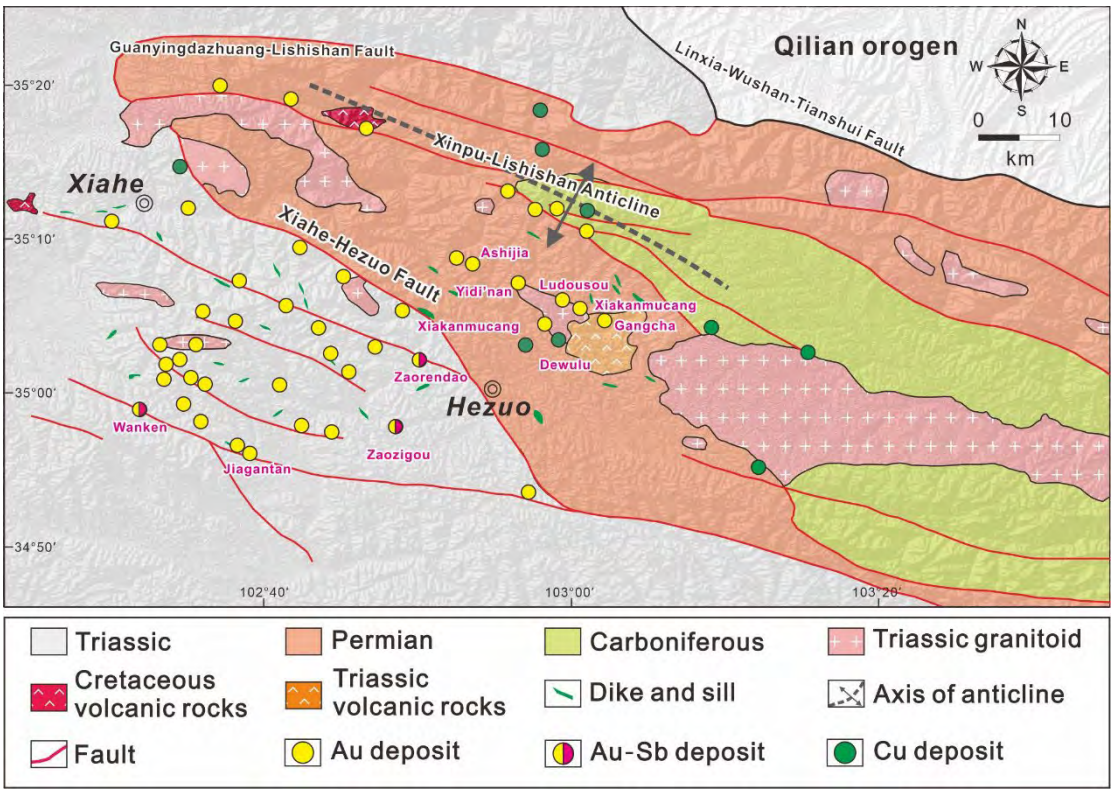

Fig. 2. Geological map of Xiahe-Hezuo Polymettalic district

The Zaozigou Au-Sb deposit, Jiagantan Au deposit, and Ludousou Au deposit are located in the Xiahe-Hezuo polymetallic district which sits in the most northwestern segment of the West Qinling orogen (Fig. 2). The West Qinling orogen refers to the western segment of the Qinling orogen, which is an important part of the Qinling-Qilian-Kunlun orogenic belt across central China. The studied area is dominated by late Paleozoic to early Mesozoic greenschist-facies slate and a minor volume of Triassic and Cretaceous volcanic rocks, which have experienced low-grade metamorphism. Widespread Early to Middle Triassic felsic to intermediate intrusions were placed into the late Paleozoic to early Mesozoic supracrustal rocks. Intrusive rocks are mostly granodiorite and quartz diorite and are aligned in the NW direction. These magmas were derived from the partial melting of Paleoproterozoic crustal materials during the subduction of the Paleo-Tethys oceanic slab. The Xiahe-Hezuo district is well endowed with large mineral resources. The lode Au and Au-Sb deposits of the district are mostly located along NW-striking faults and are hosted by late Paleozoic to early Mesozoic greenschist-facies slates and by Triassic intrusions.

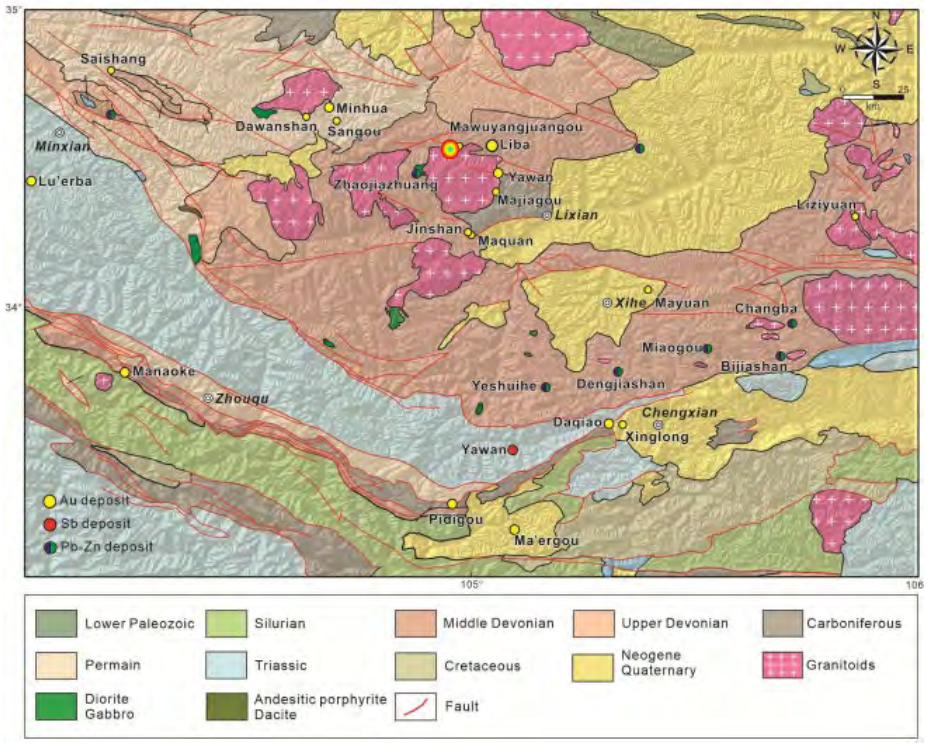

Fig. 3. Geological map of Longnan district

The Jinshan Au deposit is located in the Longnan district which sits in the northwestern segment of the West Qinling orogen. The stratigraphy of the area comprises Middle Devonian sediments. The major structure is the NW and WNW striking fault (Fig. 3). Secondary W- to WNW-striking faults are present, hosting the majority of gold resources. The area has been intruded by a series of porphyritic granite and diabase dikes, ranging from one meter to tens of meters in width and tens to hundreds of meters in length.

The Weishan rare earth element deposit (Weishan REE deposit) is located in the southwestern Yicheng uplift of the western Luxi Terrane (Fig. 4). The Luxi Terrane is located in the eastern part of the North China Craton (NCB). The boundaries of the Luxi Terrane are defined by the Tan-Lu fault to the east, the Liaocheng-Lankao fault to the west, the Qihe-Guangrao fault to the north, and the Fengpei fault to the south (Fig. 4). The Luxi Terrane are dominated by Late Archean gneisses, amphibolites and TTG, Paleoproterozoic granitoids, Mesozoic and Cenozoic continental clastic rocks, volcaniclastics, intermediate-basic igneous rocks, mafic dykes, carbonatites, and alkaline rocks.

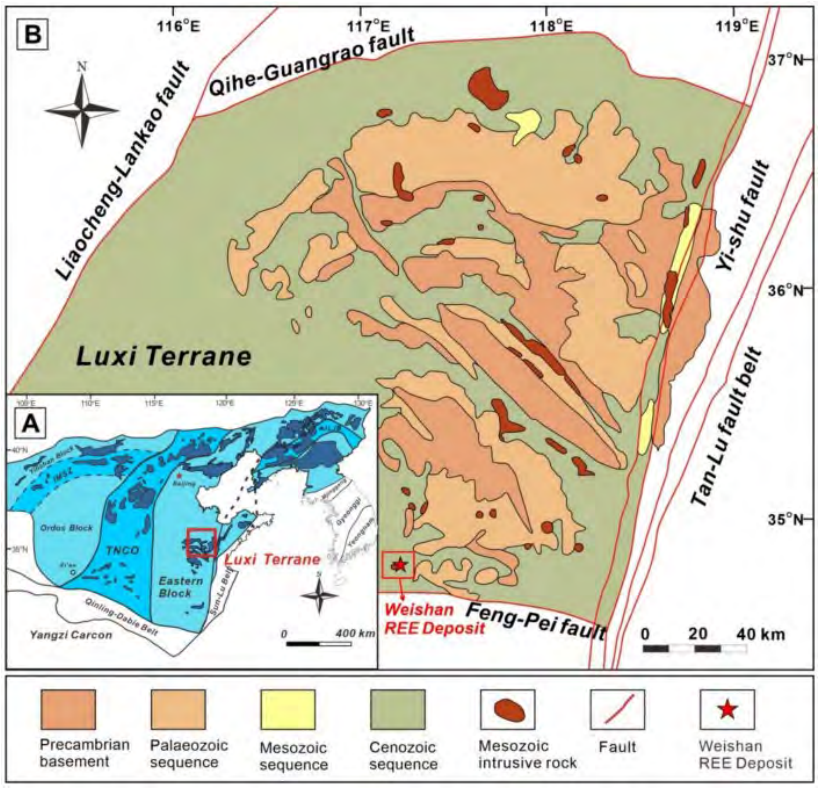

Fig. 4. Simplified geological map of the Luxi Terrane in China.

Itinerary

Field Trip I

Date: 05/31/2023-06/12/2023

Place: Jiaojia gold deposit

Trip leader: Ph.D. Jingyuan Zhang and Ph.D. Pengcong Zhang

Sponsors: Stewart R. Wallace Fund, China University of Geosciences, Beijing and NSFC of Prof. Kunfeng Qiu

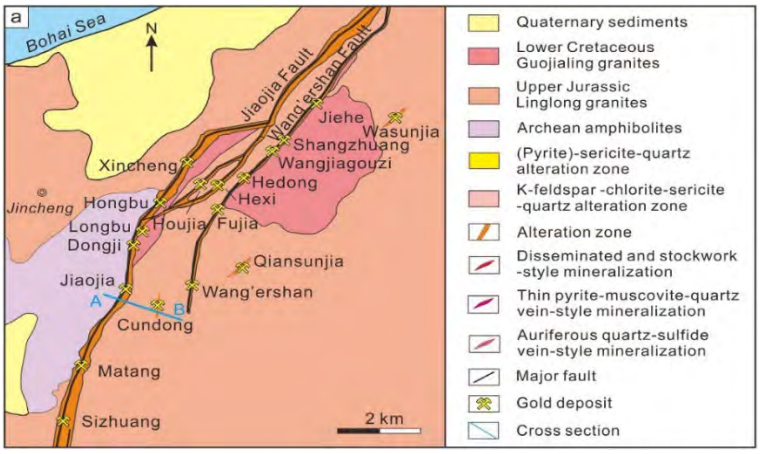

Fig. 5. Simplified Geological Map of the Jiaojia Gold Deposit

The Jiaojia gold deposit is located in the middle part of the Jiaojia-Xincheng

fault system within the Jiaobei uplift (Fig. 5), with gold resources of more than 200 tonnes. The average grade is about 3 g/t.

The outcrop in the mining district includes Lingling granite, Guojialing granite, and Jiaodong group amphibolite with Linglong granite as the major host rocks. Mafic dikes and pegmatite are also commonly observed in the field (Fig. 6). The ore bodies have a trending of about 30° and dips 25° to 38° with an average of 31°. The Jiaojia gold deposits are typical disseminated and stockwork-style deposits (Fig. 6).

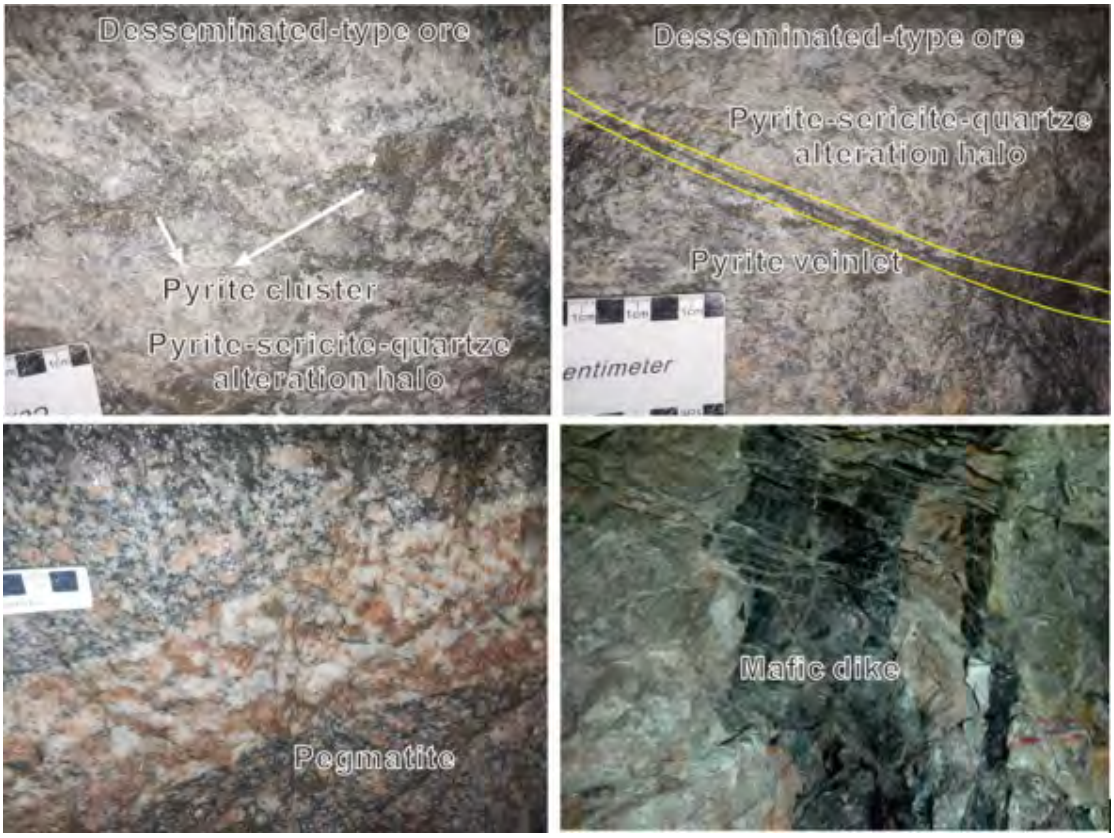

Fig. 6. Field photo of Jiaojia Gold Deposit

The observed alteration is characterized by a pink K-feldspar alteration which overprints on fresh Linglong biotite granite and sericitization which overprints on the K-feldspar alteration zone (Fig. 6). The sericitization is commonly developed near the ore bodies while the K-feldspar alteration occurs in a relatively distal zone.

Field Trip II

Date: 08/01/2023-08/31/2023

Place: Linglong gold deposit

Trip leader: Ph.D. Tao Cui and Ph.D. Pengcong Zhang

Sponsors: Stewart R. Wallace Fund, China University of Geosciences, Beijing and NSFC of Prof. Kunfeng Qiu

Fig. 7. The photograph in the Linglong gold deposit.

The Linglong Gold deposit has a gold resource of about 118.5 t with an average grade of 5.30 g/t. The host rock is mainly Middle Jurassic biotite monzogranite which locally contains Archean gneiss xenoliths. A large number of mafic dikes are developed within the gold deposit, mainly composed of dark lamprophyre, diorite, and light pegmatite.

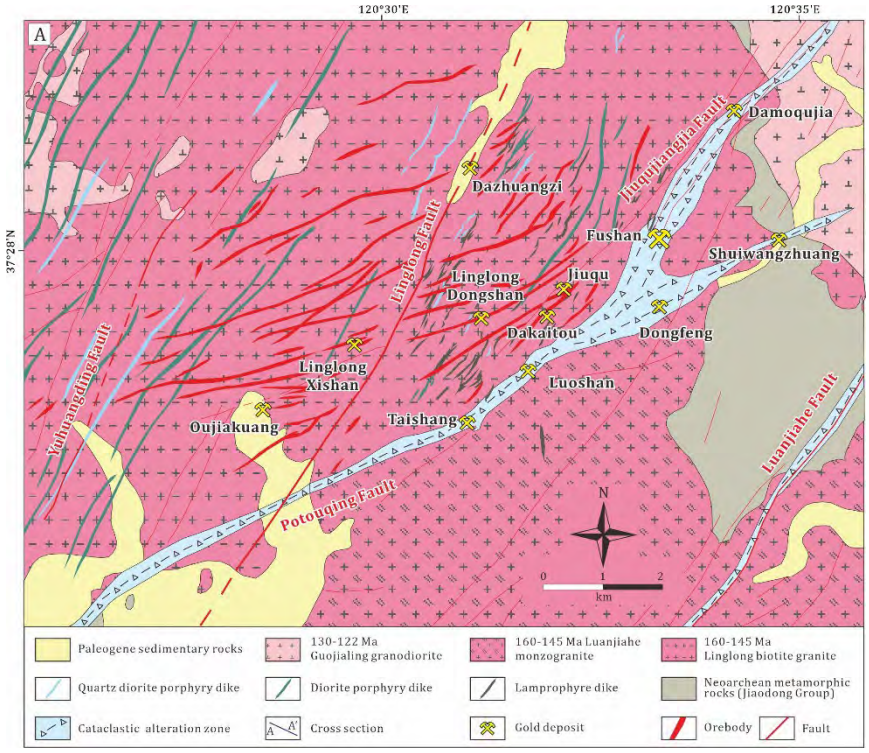

Fig. 8. Simplified Geological Map of the Linglong Gold Deposit

The Linglong gold deposit is composed of Dongshan, Xishan, Jiuqu, and Dakaitou ore bodies (Fig. 8). The orebodies of Linglong are quartz–pyrite veins with numerous branches, occurring in the form of vein clusters or veinlets. The orebodies are controlled by NE striking and NW dipping faults (Fig. 9).

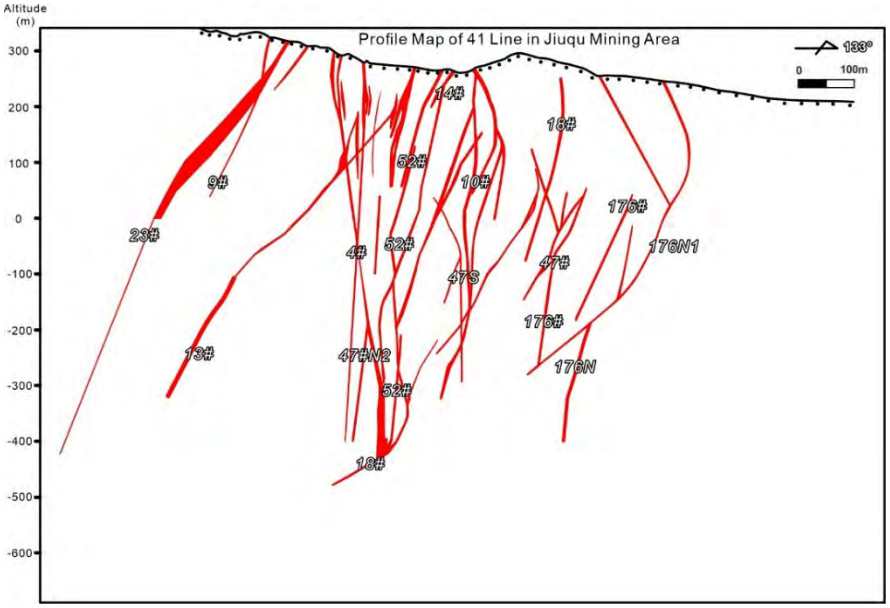

Fig. 9. Profile Map of 41 Line in the Linglong Gold Deposit

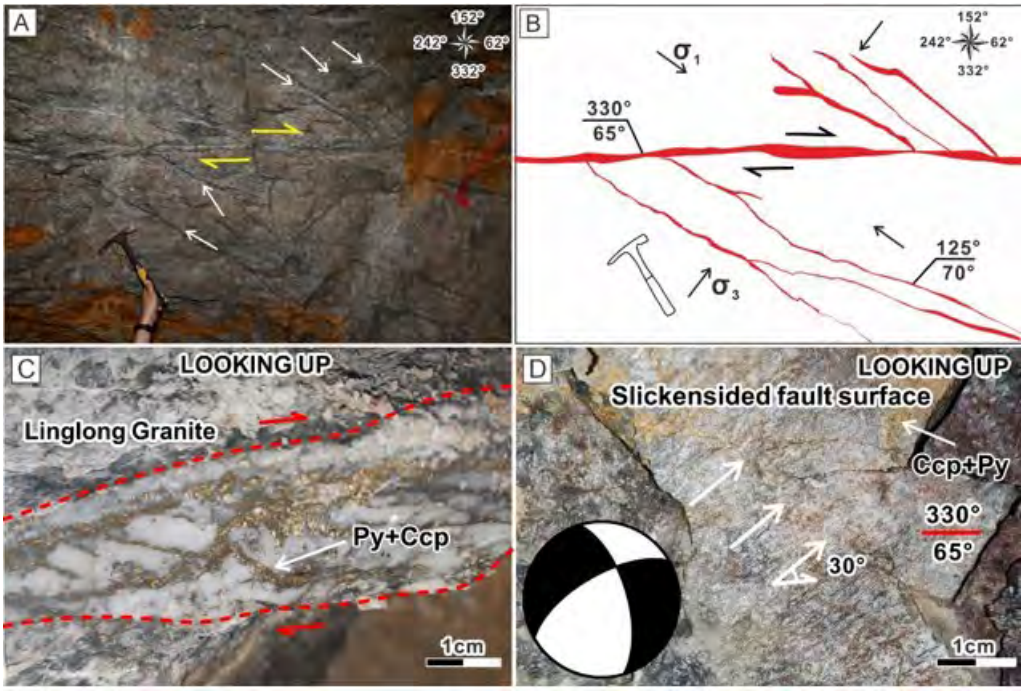

Fig. 10. Underground exposures showing the structure of the Linglong orebody.

A large number of secondary fractures produced by brittle deformation are developed in the contact zone of the hanging wall and footwall and are filled with quartz polymetallic sulfide veinlets (Fig. 10A-C). The relationship between the fault-filled vein and the extension vein indicates the sinistral strike-slip and normal displacement (Fig. 10A, B). A group of slickensides are developed on the fault surface, accompanied by pyrite and chalcopyrite mineralization (Fig. 10D), indicating northwest-southeast minimum principal stress.

The ores are mainly gold-bearing quartz sulfide veins and pyrite-seritic altered rocks (Fig. 11). The ore minerals are mainly pyrite and chalcopyrite, and the gangue minerals include quartz, potassium feldspar, plagioclase, calcite and sericite.

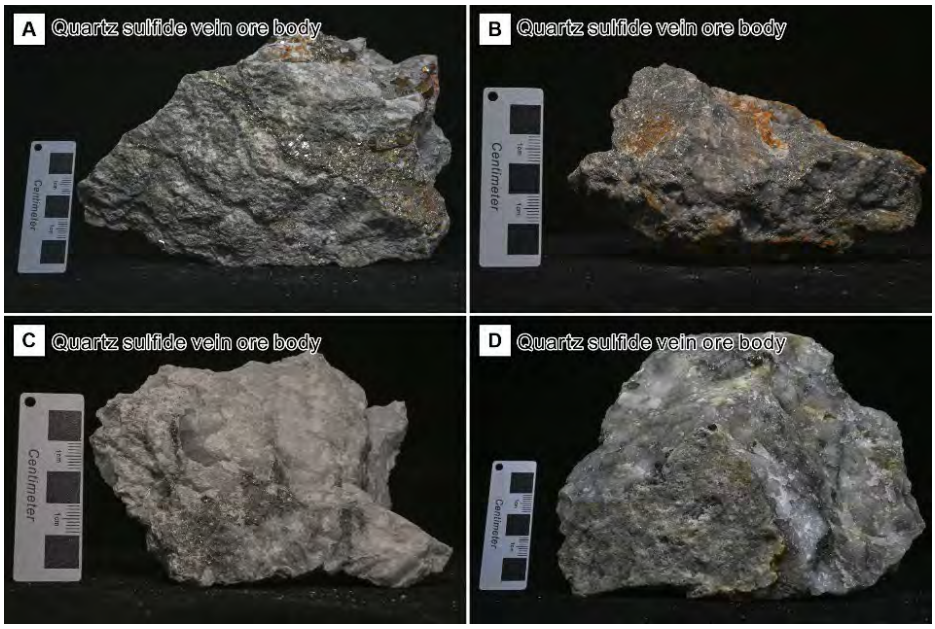

Fig. 11. Ores of the Linglong Gold Deposit

Field Trip III

Date: 07/01/2023-07/10/2023

Place: Zaozigou deposit

Trip leader: Ph.D. Pengcong Zhang and Ph.D. Jie Wang

Sponsors: China University of Geosciences, Beijing, and NSFC of Prof. Kunfeng Qiu

The giant Zaozigou deposit (34° 57′ 56″ N, 102° 48′ 41″ E) contains gold resources of more than 106 tonnes with a grade of 3.42 g/t. It is located 9 km SW to Hezuo City in the Gansu Province, central China (Fig. 12).

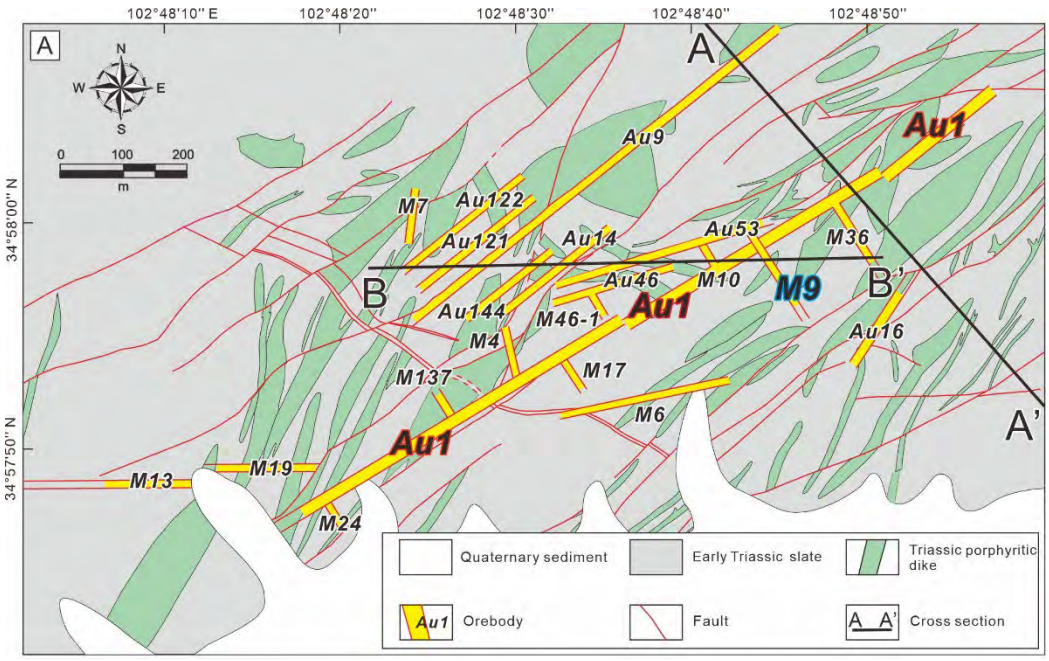

Fig. 12. Geological sketch map of the Zaozigou Au-Sb deposit

The giant Zaozigou deposit is hosted by slates of the Triassic Gulangdi Formation and by intermediate to felsic dikes that were emplaced in slate rocks during the Triassic. The main rock types that host the deposit include siliceous, calcareous, silty, and argillaceous slates (Fig. 13). Most dikes are quartz-plagioclase-porphyritic dacite with minor quartz-plagioclase-porphyritic granodiorite (Fig. 13). Two styles of mineralization have been identified which are comprised of early disseminated and stockwork ores and late stibnite-quartz ± dolomite ± gold vein mineralization within altered dacite and slate. The early disseminated lodes are controlled by NE-trending, steeply-dipping fault. The later vein lodes are controlled by NE-trending steeply-dipping faults and gently-dipping E-W trending faults.

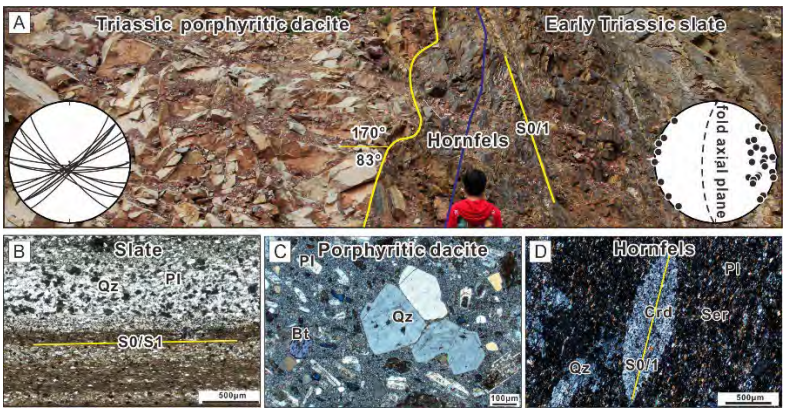

Fig. 13. Field photo of Zaozigou deposit

Field Trip IV

Date: 07/10/2023-07/20/2023

Place: Jiagantan gold deposit

Trip leader: Ph.D. Dengyang He

Sponsors: China University of Geosciences, Beijing and NSFC of Prof. Kunfeng Qiu

The Jiagantan gold deposit contains gold resources of more than 150 tonnes with a grade of 2.73 g/t. The stratum outcropping in the Jiagantan gold deposit is the early Triassic Longwuhe Formation, which is composed of feldspathic sandstone, lithic sandstone, and silty slate. The stratum is southwest-dipping, with a dip angle of ~70°. The structural framework in this gold district is shown as the WNW-trending reverse faults, interlayer fracture zones, and a few small-scaled intraformational synclines and anticlines.

Fig. 14. Photo in Jiagantan deposit

Orebodies are veined, lenticular, or scrotiform in shape, and hosted by feldspathic sandstones with subordinate silty slates. These gold orebodies are clustered in a WWN-trending belt, and constrained by WWN-trending reverse

faults and interlayer fracture zones. Both oxidized and hypogene ores are present in the deposit. According to the mineral association and occurrence, the hypogene mineralization can be classified into two main types: (1) disseminated pyrite and arsenopyrite in sandstone and silty slate; (2) millimeter- to centimeter-wide quartz-sulfide veins in sandstone (Fig. 15). The former one constitutes the majority of gold mineralization. Primary sulfide minerals are dominated by pyrite, with trace amounts of arsenopyrite, stibnite, chalcopyrite, and galena. Gold mainly occurs as invisible gold within pyrite and arsenopyrite. Quartz, calcite, sericite, and minor amounts of illite are the gangue minerals here.

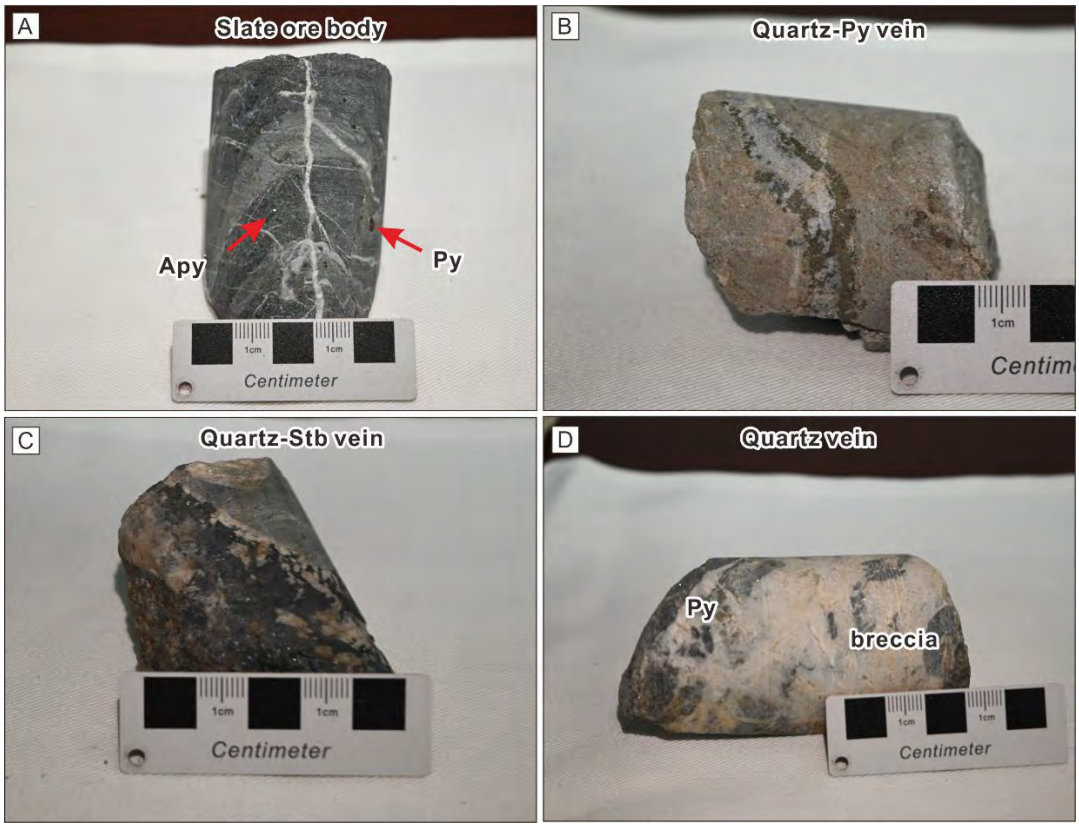

Fig. 15. Ore Type of Jiagantan deposit

Field Trip V

Date: 07/26/2023-08/04/2023

Place: Ludousou deposit

Trip leader: Prof. Kunfeng Qiu

Sponsors: China University of Geosciences, Beijing and NSFC of Prof. Kunfeng Qiu

The Ludoujian gold deposit of the district are mostly located along NW-striking faults. The ore-controlling faults in this area are divided into three roughly parallel regional fault zones, including the Guanyindazhuang-Lishishan Fault, the Xiahe-Hezuo Fault, and the Sangkenan-Gelina Fault.

Fig. 16. Observation of geological phenomena in the field

The Ludoujian gold deposit is hosted by tuff and quartz diorite porphyry. Strong sericitization, potashification, and sulfidation occurred in the quartz diorite porphyry. The quartz diorite porphyry near the ore body encapsulates quartz and then encapsulates tourmaline, thus forming tourmaline breccia.

Three types of orebodies have been identified in Ludousou gold deposit, including quartz-tourmaline-sulfide vein type Au orebody, disseminated pyritization, tourmalinization quartz diorite porphyry breccia type Au orebody and quartz-stibnite type Au-Sb orebody (Fig. 17). Disseminated pyritization, tourmalinization quartz diorite porphyry breccia type Au orebody and quartz-stibnite type Au-Sb orebody are controlled by fault, which is subjected to NW-trending stress. The occurrence of the quartz-tourmaline-sulfide vein-type gold ore body is consistent with the joint occurrence of the quartz diorite porphyry surrounding rock.

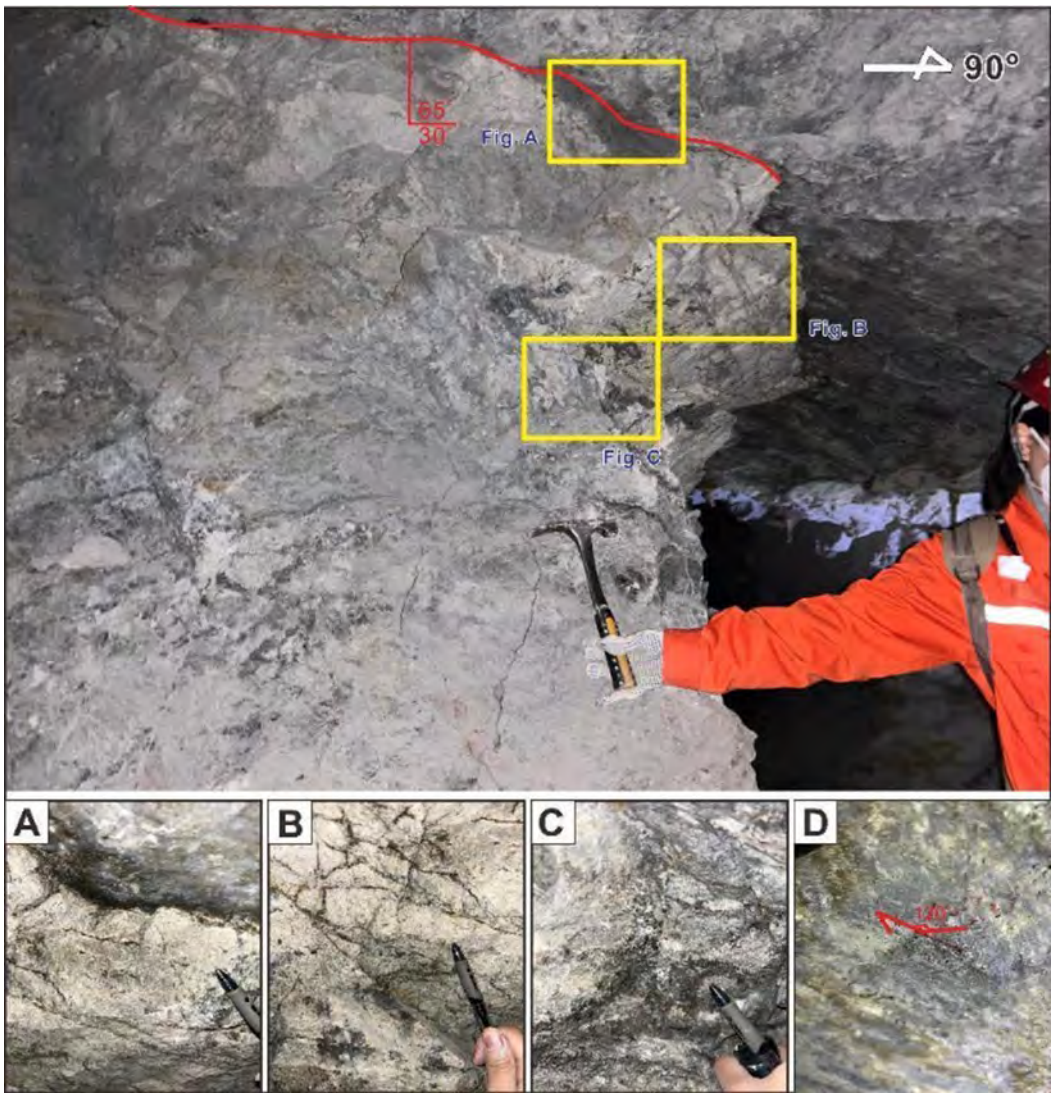

Fig. 17. Altered quartz diorite porphyry gold ore body

Field Trip VI

Date: 08/08/2023-08/12/2023

Place: Jinshan Au deposit

Trip leader: Ph.D. Jianan Fu and Ph.D Jiayi Wang

Sponsors: China University of Geosciences, Beijing, and NSFC of Prof. Kunfeng Qiu

Fig. 18. Observation of geological phenomena in the field

The host rock of the Jinshan gold deposit is mainly slate and phyllite (Fig. 19). The slates are mainly argillaceous slate with spots (composed of chlorite biotite and quartz). Magmatic rocks are mainly diorite, with a small amount of lamprophyre. The ore-controlling fault is mainly a series of reverse faults with an occurrence of about 240°∠60°.

Fig. 19. Slate and ore controlling fault of the Jinshan Gold Deposit

The ore types of the Jinshan gold deposit are disseminated ore and disseminated slate (Fig. 20). Arsenopyrite mineralization and sericitization are the signs of prospecting in this area, and the brighter the color, the stronger the sericitization and the higher the ore grade.

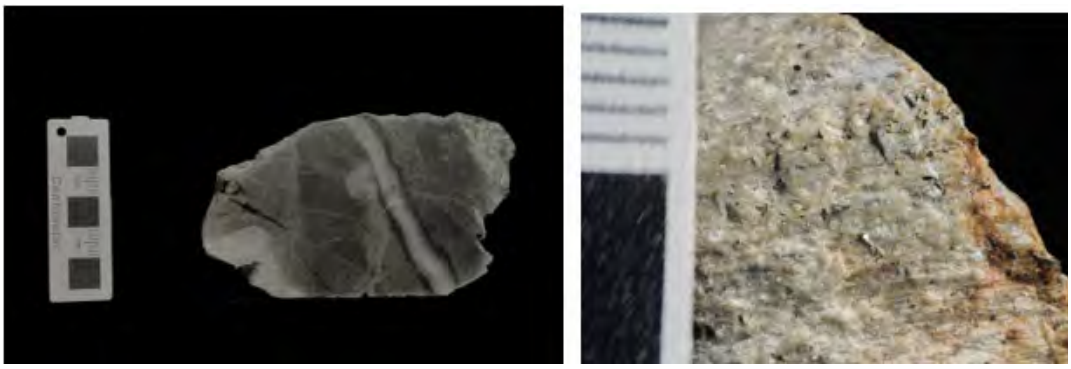

Fig. 20. Jinshan Gold Deposit Ore Type

Field Trip VII

Date: 08/07/2023-08/11/2023

Place: Weishan REE deposit

Trip leader: Prof. Kunfeng Qiu

Sponsors: Stewart R. Wallace Fund, China University of Geosciences, Beijing and NSFC of Prof. Kunfeng Qiu

Neoarchean granodiorite and Quaternary sedimentary are the major strata in Weishan deposits. The dominant structures are NW-trending and NE-trending (Fig. 21). The Weishan alkaline rocks are constituted of Mesozoic quartz syenite, aegirine quartz syenite, and alkali granite which comprise the majority of the magmatic rocks (Fig. 21). Alkaline magma has intruded into the Neoarchean granodiorites, forming irregular, branched intrusions.

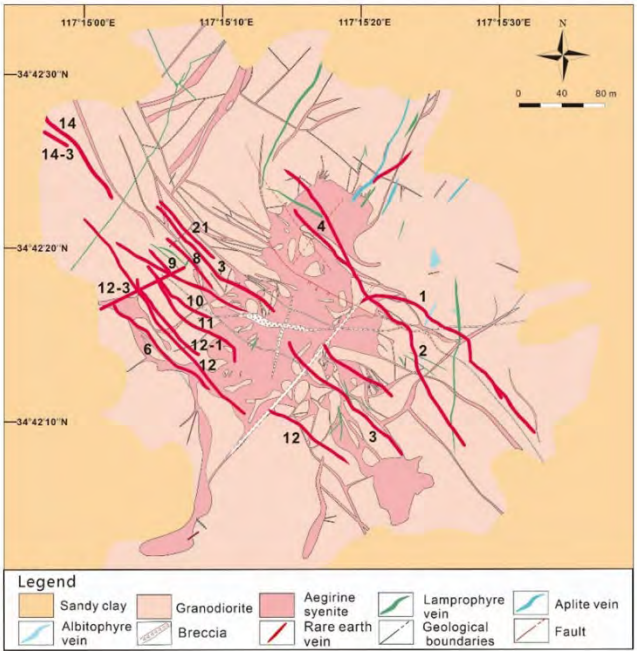

Fig. 21. Geological sketch map of the Weishan REE deposit.

The Weishan REE deposit is located in the southwestern Yicheng uplift of the western Luxi Terrane (34°70′ N, 117°26′ E). The Weishan REE deposit is a typical underground mining deposit (Fig. 21). The rocks outcropped in the mining area include Neoarchean Wutai granitic gneiss, Mesozoic Yanshannian quartzite syenite, aegirine syenite, and alkaline granite. The Neoarchean granodiorite basement is intruded by Mesozoic magmatic rocks that exhibit irregular branching.

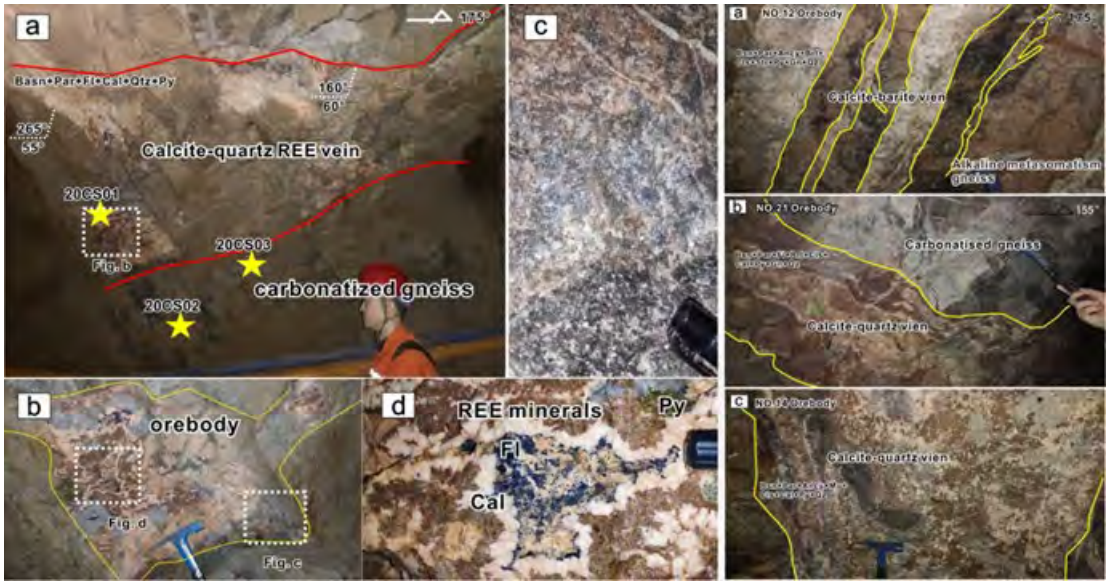

Fig. 22. Field photo of Weishan REE deposit.

Carbonatite and alkaline rock are the host rocks of the Weishan REE deposit (Fig. 22). Bastnaesite and parasite are the primary rare earth minerals, with ancylite and calcian-ancylite occurring in trace amounts. The gangue minerals in the carbonatite include calcite, quartz, celestite, barite, and sulfide, with fluorite, apatite, titanite, zircon, and monazite present in smaller amounts. Rare earth minerals are also present.

Financial statement

The SEG-CUGB Student Chapter's field trip in Shandong province was funded by the Stewart R. Wallace Fund, China University of Geosciences, Beijing, and NSFC of Prof. Kunfeng Qiu. $800 from Stewart R. Wallace Fund was used to pay for the transport of 4 Student Chapter Members. Other participants' expenses ($1533) are paid by the China University of Geosciences, Beijing, and the NSFC Fund of Prof. Kunfeng Qiu. The details of the expenses are provided below with the receipts attached.

	Income	Expense	Expense	Receipts order
Stewart R. Wallace Fund	$800	High-speed rail	$213	5
		Gas fee	$185	3
		Flight ticket	$403	3
NSFC of Prof. Kunfeng Qiu (J221001)	$764	Transport	$493	
		Accommodation	$271	
China University of Geoscineces, Beijing (590221020)	$769	Transport	$533	
		Accommodation	$229	

Benefit for students

Field trips were designed to enhance what students learn in the classroom. The goal was to let students see, touch, and experience things that would otherwise just be a line in a textbook or a picture on a classroom wall. Engaging in visual and hands-on learning methods through field trips can also build confidence for students who struggle to engage and learn in a traditional classroom environment. Field trips offer them more freedom to learn without as many constraints or expectations.

Chapter members learned a lot about the ore deposit by observing structure, alteration, mineral associations, and spatial relationships. Students become familiar with the necessary fieldwork skills, such as taking field photographs and taking sampling. During the field trip, the students deepened their field cognition of the orogenic Au deposits and REE deposits. Students improved their fieldwork skills through discussion and cooperation.