Strengthening the Construction of State Key Laboratories under the Guidance of Cultural Construction—Take the Construction of State Key Laboratory of Geological Processes and Mineral Resources as an Example

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Abstract: In order to build clearer ideas and objectives of state key laboratories' cultural construction and provide references for scientific research managers, this article discusses the construction of laboratory culture from the connotation, function and characteristic measures of the cultural construction of state key laboratories in higher education.

Keywords: State key laboratory; Cultural construction; Talent cultivation; Innovation

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1. Introduction

The State Key Laboratory (SKL) is an important platform carrier for implementing the national science and technology strategy, exploring frontier theoretical research, cultivating major innovation projects, cultivating innovative talents, and building international academic exchanges and cooperation. Therefore, the instruments, equipment and talent reserve of SKLs are first-class, and the corresponding laboratory soft environment, namely, the construction of laboratory culture, is becoming increasingly important [1]. In order to give full play to the leading role of SKLs, we must fully tap the laboratory culture and education function, stimulate innovation potential, and develop high-level scientific research.

2. The Connotation and Function of Laboratory Culture

General Secretary Xi Jinping pointed out at the National Conference on Ideological and Political Work in Colleges and Universities that colleges and universities should pay attention to educating people with culture, actively create civilized campuses, carry out campus cultural activities in various forms, healthy and elegant in tone, and fully reflect the important role of culture in educating people in colleges and universities [2]. As an important part of colleges and universities, the laboratory naturally becomes an important position for cultural education.

2.1 The Connotation of Laboratory Culture

Laboratory culture is a cultural deposit formed in the long-term development of a laboratory, including teaching and scientific research. It is an important organizational part of university culture construction, including material culture, institutional culture, spiritual culture and other aspects [2].

Material culture is the expression of the material form of the laboratory, such as the appearance and internal structure design of the laboratory building, hardware conditions, database, etc.; institutional culture is the code of conduct for the laboratory to carry out its work, including various types of laboratory management methods, equipment operating procedures, etc.; spiritual culture is mainly reflected in the laboratory's spiritual philosophy, value orientation, sense of unity and innovative ideas, etc. Laboratory culture is essentially a blend of various cultures, which are interrelated and influence each other to form an organic whole. Through the construction of laboratory culture, laboratory personnel form common values and life ideals, and personal goals are closely combined with laboratory development goals, which will play a positive role in guiding the integration of laboratory resources, professional and disciplinary development, talent cultivation, and the output of innovative achievements [3].

2.2 The Role of Laboratory Culture

2.2.1 Regulatory Role

Nothing can be accomplished without norms or standards. The formulation of various rules and regulations can ensure the orderly operation of the laboratory, and at

the same time form an imperceptible code of conduct in its long-term development process, thereby constraining laboratory personnel to carry out study and research in a standardized and self-disciplined manner, and promoting the development of the laboratory [2].

2.2.2 Cohesion

In the development of laboratory construction, the history, faculty, advanced equipment, experimental techniques and methods, scientific research achievements and so on, can positively guide all members to continue to carry forward the traditional concept of the laboratory, form a positive, united and enterprising value orientation, and maximize the cohesion and centripetal force of the laboratory [2].

2.2.3 Motivational Effect

Through regular activities such as seminars and exchanges, evaluations and awards and other activities in the laboratory, spiritual encouragement and environmental influence are carried out to stimulate laboratory members to concentrate on scientific research and produce original scientific research results [2].

3. A Preliminary Study on the Cultural Construction of SKLs

The State Key Laboratory of Geological Process and Mineral Resources is set up in China University of Geosciences Beijing & Wuhan. This laboratory closely follows its own characteristics and has carried out an exploration of various forms of laboratory culture construction [5].

3.1 Highlights of the University's Characteristics

The State Key Laboratory of Geological Process and Mineral Resources is located in the Yifu Experimental Building of China University of Geosciences (Beijing). It has a magnificent appearance and elegant interior environment. It has a perfect experimental platform, including multiple laboratories of rock and mineral composition and structure, isotope chronology, isotope geochemistry, etc. It has X-ray diffraction analysis, single crystal X-ray diffractometer, electron probe, field emission scanning electron microscope wavelength dispersive X-ray fluorescence spectrometer High precision and sophisticated instruments and equipment, such as thermal ionization mass spectrometer, Ar-Ar automatic dating system, multi receiving cup plasma mass spectrometer, HRICPMS mass spectrometer, can meet the research needs of major disciplines and fields of geology.

The National Key Laboratory practices the university motto of "hardworking and plain-living, being realistic and pragmatic", taking it as its responsibility to promote the construction of the SKL and first-class disciplines, enhance the core competitiveness of science and technology, accelerate the cultivation of innovative groups and outstanding talents in advantageous fields, and strive to create a scientific research cultural atmosphere that is indifferent to fame and wealth and pursues the truth, improve the system and mechanism, optimize the internal structure, build innovative research groups, and produce first-class scientific research achievements, cultivate first-class innovative talents, and promote the overall development of science and technology of the university with local breakthroughs.

3.2 SKL's Own Characteristics

3.2.1 Material Culture

There is a floor plan and a monitoring room in the lobby of the Yifu Experimental Building. The building has a display wall in the hallway, highlighting the advanced deeds of outstanding people, the scale of experimental teams, rewards for scientific research achievements, talent cultivation and academic exchanges, etc.; there are laboratory publicity frames on both walls, containing the introduction of laboratory instruments and equipment, members and testing methods [6]. The laboratory environment is neat and clean, with all kinds of rules and regulations, operating procedures on the wall, special equipment with obvious signs, all kinds of chemical reagents stored in accordance with national norms, as well as the implementation of double-person-double-lock management. The laboratory is well ventilated and the three wastes are properly handled. The managers regularly carry out monthly safety checks, and once a year carry out the internal audit and management review of national metrology certification, conduct safety and housekeeping checks on the laboratory, and rectify the unqualified items by the deadline [6].

3.2.2 Institutional Culture

Each laboratory in the State Key Laboratory of Geological Process and Mineral Resources has passed the national metrological certification and has established a unified and open management platform. The notarized data provided by the organization has a legal effect [7]. Therefore, higher requirements are put forward for the operation mode and system construction of laboratory management. Now, the management rules and regulations of national key laboratories are perfect, and Quality Manual, Procedure Document, Operation Instruction and Record Document have been prepared according to the requirements of the Criteria for Qualification Accreditation and Review of Inspection and Testing Institutions.

The overall structure of the system document is complete, the elements of the quality management manual are complete, the quality policy and quality objectives are clear, the fairness statement and external commitment are reasonable, and the organization and responsibility and authority allocation are relatively clear; it is also subject to the quality policy and quality objectives of key laboratories. The technical capability requirements and quantity traceability of instruments and equipment are relatively accurate. The President has authorized the Executive Deputy Director (outstanding youth) of the SKL to serve as the top management of measurement certification. The top management consists of the Secretary of the Party Committee of the SKL, the Vice President in charge, the Technical Director and the Quality Director, and there are corresponding appointment documents for the authorized signatories, supervisors and management personnel of each laboratory. The SKL has also formulated a safety education and training system, radiation safety management measures, hazardous chemicals management measures, special equipment management measures, instrument and equipment operation procedures and emergency response plans for unexpected accidents.

Since 2020, with metrological certification and laboratory information construction as the starting point, we have strengthened the training of internal auditors, security work and other businesses, upgraded and improved the experimental analysis and testing network platform. The laboratory overcame the influence of the pandemic and the change of management mode of testing funds, and completed the evaluation of the quality management system as planned through quality supervision, internal audit and management review. According to the new requirements of the General Administration of Market Supervision, the Quality Manual and the Procedure Document have been revised. The total testing capacity of the laboratory covers 4 categories, 10 subcategories and 44 items.

3.2.3 Spiritual Culture

1) Inheritance of scientists' spirit

Laboratory culture is not formed in a short period of time, but requires long-term accumulation and precipitation in order to form an excellent cultural atmosphere [2] and to be carried forward from generation to generation. The predecessor of the construction of the SKL has a group of the old generation of scientific workers, who rigorously pursued their studies, studied hard, and built a solid foundation for the laboratory in terms of talent cultivation and scientific research innovation with the ambition of climbing the scientific peak forever, setting a good example [8].

The Rock and Mineral Laboratory of the SKL inherits the research and teaching spirit of the famous geological educator and petrologist, Professor Chi Jishang. She was the main founder of the discipline of petrology in China and selflessly devoted her life to the cause of earth sciences in China and internationally. She loved her country and was loyal to the Party's geological education, giving up her superior conditions abroad to devote herself to geological education in the new China; she was a pioneer, proposing new concepts and research ideas on the standard sequence of intrusive rocks, a full 10 years ahead of foreign countries; she carefully educated people, was the benefactor of Premier Wen Jiabao, and personally trained three academicians of the Chinese Academy of Sciences; she was broad-minded, and her great family misfortunes and hardships did not shake her determination to devote her life to geological research and education of her country. She remained passionate about her career, working actively and passing on her knowledge to her students. Mr. Chi's noble character and sentiments have influenced generations of people [9].

Professor Peng Zhizhong of the Diffraction Laboratory in the SKL is a famous crystalline mineralogist in China and a student of Academician Ji Jishang. With his noble character and dedication, he has the courage to constantly challenge the world's cutting-edge scientific issues and has the ambition to catch up with the world's advanced level by determining the crystal structure of grapheme, breaking through the silicate classification system established by Bragg. He has continuously innovated and led the determination of crystal structures of more than 50 kinds of minerals and collaborated in the discovery of more than 30 new minerals and new variants. Mr. Peng was also willing to help others. Because of his profound knowledge, people often came to him for advice, and he never signed his own name on the academic results launched by his help and guidance, advocated academic sharing, and often told his peers about his new technical methods and new ideas. Under the words and teachings of Professor Peng Zhizhong, his assistants and students treat their career, their fame and fortune, and their comrades as he did. In this way, he has brought out an excellent scientific research and innovation team [10].

Prof. Li Guowu of the Diffraction Laboratory inherited his mentor Prof. Peng Zhizhong's dedication to "global vision, patriotic dedication, diligence and erudition, thinking while learning". He has been engaged in X-ray

diffraction experiments of minerals and research on mineral crystal structure and crystal chemistry for a long time, and personally led students to analyze mineral crystal structure with X-ray. In recent years, he has made one breakthrough after another in the discovery of new minerals. He has made outstanding contributions to the discovery of new minerals and the research of mineral crystal structure and crystal chemistry, and has obtained a series of major original scientific discoveries. At present, as the main discoverer, he has discovered 27 new minerals, such as tellurite, boehmite, zinc dongchuan stone, zangbu ore, linzhi ore, hydroxycalcium pyrochlore, copper rich pao stone, which have been approved by the New Minerals, Naming and Classification Committee of the International Mineralogical Association, He is the scholar who has found the newest minerals in China.

The SKL has always been focusing on the accumulation of good traditions, digging up the advanced deeds of the meritorious figures and masters in the development history of the laboratory, gathering spiritual strength for cultural education, and facing the future without forgetting the original.

2) Emphasis on teachers' moral and ethical construction and focus on teaching by example

In order to comprehensively implement the Party's education policy, implement the fundamental task of establishing moral education and strengthen the construction of teacher morality, each laboratory in the SKL regularly organizes teachers to study Teacher's Handbook of China University of Geosciences (Beijing). For new employees, the office director leads the study of the Code of Ethics for Teachers of China University of Geosciences (Beijing) and the Ten Guidelines for Professional Conduct of Teachers of China University of Geosciences (Beijing) in the New Era, emphasizing the need to strictly implement the contents in the Code and Guidelines, to clarify the bottom line of teacher ethics, to achieve self-respect, self-discipline and self-improvement, and to be a teacher of character and learning that students admire and love.

The teachers of the SKL have always been focusing on improving their own moral cultivation, integrating moral education into professional teaching, and influencing the formation of students' character with their own personality charm and words and actions. Li Shuguang, a contemporary geochemist, is still in the front line of scientific research at the age of 81. He was elected as a Fellow of the International Geochemical Society in 2019 for his outstanding contributions to the chronology of ultrahigh-pressure metamorphic rocks and the use of metal isotopes to trace the deep carbon cycle. With the spirit of not being willing to be mediocre and pursuing excellence, and the academic style of hard work and pragmatism, Li has been leading his colleagues and students to study in an academic atmosphere of openness, innovation, and free exploration with the sentiment of serving the country through science and education. After returning to China from MIT, he was the first to offer the "Trace Element Geochemistry" in China. From the beginning of the course in 1987 to 2016, he has adopted the heuristic teaching method of intensive lectures and discussions of English literature. He has always insisted on teaching with blackboard writing, preparing and delivering lesson graphics to each student, and insisting that students understand every sentence, derive formulas and calculate curves by themselves in literature discussions, which has received good teaching effects. He used his own personal experience to send a message to the young generation: some people are young and promising, while others are late in achieving their goals, "as long as you work hard, everyone has their own flowering time" [11].

Professor Yan Danping, a member of the lithospheric tectonic group, has been honored with the National Ten Thousand Talents Program Teaching Master, National Teaching Master, Li Siguang Geological Science Award Teacher Award, Capital Labor Medal, Pioneer of Teacher Virtue and Pioneer of Educational Innovation, and enjoys the special expert allowance from the State Council Government. For more than 30 years, he has been devoted to geological science research while being rooted in the teaching line, and has achieved a double harvest of talent cultivation and scientific research achievements. Professor Yan firmly implements the Party's education policy, adheres to establishing morality and cultivating people, cultivates students' noble sentiments with benevolence and love, and sets a benchmark for students to learn and pursue by continuously improving his academic research ability in geology; continuously improves his own moral cultivation in teaching and research work, and incorporates moral education in professional teaching, and influences students' character formation by his own charisma and words and actions in extracurricular practice. Prof. Yan Danping has explored the combination of moral education, professional education and academic research, personally led students to gain perceptual understanding in the front line of the geological field, sharpened their wills in mountains, canyons and tough environments in the wilderness, and guided students to be hard and simple, truthful and innovative, and willing to give. He is respon-

sible for the construction of "Zhoukoudian Off-Campus Practical Education Base for College Students" of the Ministry of Education, which organically combines practical geological field teaching with scientific research and popularization, and has published many important scientific papers. Through new teaching ideas and methods, the base has trained more than 500 undergraduate and graduate students from many universities including those from Korea, the United States and Taiwan every year, and the proposal for the construction of Beijing's Xishan put forward by Yan on this basis in the Municipal CPPCC has won the Excellent Proposal Award.

3) A scientific research team with reasonable structure and common ideals

In order to alleviate the outstanding contradiction between supply and demand of mineral resources faced by the country and strive to achieve major breakthroughs in the field of geological processes and mineral resources research, the SKL has formed four scientific research teams with different specialties, namely, metal isotopes and crust-mantle material circulation, magma-hydrothermal evolution and metal mineralization, continental convergence and growth of the Tibetan Plateau, and lithospheric tectonics. The teams have clear and stable research directions and medium and long-term goals, and the academic leaders of the teams not only have high academic attainments, but also have strong leadership, coordination, cooperation and selfless dedication, and can be tolerant, fair and just; the professional structure, educational background structure, academic background structure, title structure and age structure of the teams are reasonably configured, and the atmosphere of scientific cooperation is strong and harmonious, which plays an important role in the development of the laboratory. The team of metal isotopes and shell-mantle material cycle is led by Academician Li Shuguang, who also holds the overall research direction of the team. He led the team to complete the establishment of the isotope analysis method for magnesium-iron-copper hafnium, and the iron isotope analysis has filled the gap in high-precision analysis technology for iron isotopes in China, and the copper isotope test has reached the highest international level, and promoted the comprehensive research of copper-iron isotopes [11,12].

3.2.4 Talent Cultivation

1) Ideological and political cultivation and integrity education

The SKL has always put ideological and political work through the whole process of education and teaching to achieve the whole process of educating people and all-round education, striving to create a new situation in the development of higher education in China. The laboratory always conducts special educational activities for freshmen of the university or the laboratory. Through showing the development history of the "Key Room" and the development of the discipline, learning the typical deeds around us, and understanding the history of the old generation of scientists who, with their patriotic zeal and enthusiasm, strived to catch up with the world's advanced level in a situation of extreme material scarcity and backward scientific research conditions, the students will firmly establish their aspiration to devote themselves to the cause of modern geological and scientific career in China.

Strengthen academic integrity education and do a good job of monitoring the academic integrity of teachers and students. Every year at the beginning of the school year, the deputy director of the SKL is invited to make a report on academic integrity for students, elaborating on the academic norms that science and technology workers should abide by, the basic regulations in the academic norms, the definition of academic misconduct, and explaining the relevant regulations of the academic norms. In addition, an education session on "Strengthening Academic Integrity and Establishing Good Academic Style" was held with the theme of "Adhering to Scientific Research Integrity and Promoting Scientific Spirit" to help the first-year students establish correct scientific research attitude and honest scientific research behavior. At the same time, student Party members are suggested to take the lead to sign the "Letter of Commitment for Integrity Examination" to build up all students' scientific research awareness of integrity bit by bit from the beginning of treating each examination with an attitude of integrity.

2) Participation in the special training of innovative classes

In line with the principle of "strengthening the foundation, broadening the specialty, teaching in accordance with different aptitudes, and focusing on cultivation", relying on the "first-class" resources and high-level faculty of the SKL, and aiming at cultivating top-notch innovative talents with "excellent moral character, solid foundation, extensive knowledge and profound specialty", we select a group of outstanding undergraduates to set up an innovative experimental class, adopting a diversified training mode, flexible management and personalized training programs. These students pursue their Undergraduate-Master-PhD studies successively, and can choose their own academic tutors, majors and specialization directions through a two-way selection process

with the academicians, Changjiang Scholars, outstanding youth and other well-known professors. The students can enjoy the "special academic grant" of 300 RMB per month per person for ten months per year, and the short-term study abroad for 6-12 months, with a half-year grant of 100,000-150,000 RMB per person and a one-year grant of 200,000-300,000 RMB per person.

3) Team cultivation

The training program is designed comprehensively through the professional foundation, field practice, research interest and innovation consciousness, and students are allowed to enter the team with high-level faculty and high-quality research resources to form a teacher-student science-education symbiosis. There are special funds and mentorship funds for team building to support students' participation in research and academic exchanges on hot international issues, which provide strong support for cultivating innovative geoscientific talents with global vision [13]. The team mostly implements a weekly group meeting and semesterly assessment system. Each week, the team holds a group meeting and requires the graduate students who have completed the stage work to present their research results, and the team supervisor collectively evaluates and guides them and discusses the next work. Every semester, we conduct a graduate student assessment, in which the graduate students who have completed their open research take turns to report the progress of their research work, and all supervisors of the team attend, and the graduate students receive questions, criticisms, affirmations and suggestions from several supervisors, and other graduate students participate in the discussion to help the graduate students broaden their ideas and refine their research.

4) Open to undergraduates

Large-scale instruments of the SKL are also open for sharing to undergraduates, while providing pre-service on-the-job training. Highly qualified faculty members offer public elective and orientation courses for undergraduates, and guide undergraduates in their major creative projects. Through these means, a large number of undergraduate students have been attracted to apply for graduate studies at the SKL, and many of them have now become young outstanding talents in the field of geology.

3.2.5 Openness, Sharing and Cooperation

The SKL regularly holds or participates in two national annual geological conferences each year, and holds annual indoor experimental technology conferences, young teachers' achievement exchange conferences, postdoctoral academic reports and so on at the end of the year, which strengthen the cooperation and innovation among laboratories, improve the academic atmosphere and broaden the academic vision. The laboratories within the SKL are not only relatively independent scientific research platforms, but also comprehensive and open research spaces in daily management, forming a joint effort in scientific and technological research, project application, discipline construction and talent cultivation. As always, the SKL focuses on the openness of resources, topics, and personnel. In particular, the laboratory adopts a "combination of virtuality and reality" approach in terms of the composition of scientific personnel, taking the team as the link, gathering scientific personnel from two colleges of the university and research fields across several specialties to carry out research on the platform of the SKL. This provides a good environment and conditions for the crossover and integration of disciplines, and also provides opportunities for graduate students to learn and discuss with each other in terms of research ideas, experimental techniques and methods, and innovation of academic ideas, which enlivens the academic atmosphere of the laboratory and promotes communication and cooperation.

3.2.6 Recognition of Excellence

The SKL focuses on the promotion of outstanding scholars, research teams and graduate students, in order to create a good academic atmosphere, further encourage faculty and students to dedicate themselves to scientific research, produce original research results, and help improve the core competitiveness of the university. In 2020, the "Star of the Year" award was established. The award includes eight categories: Best Basic Science Research, Best Experimental Technique and Methodology, Best Graduate Student Supervisor, Most International Impact, Best New Employee, Best Doctoral Student, Best Master's Student, and Special Contribution. The regular annual academic meetings and the evaluation and awarding of the "Star of the Year" will further stimulate the enthusiasm of all students and faculty members for scientific research and encourage the infinite enthusiasm for climbing to the peak of science and pursuing outstanding achievements [14].

4. Exhibition of Cultural Construction Achievements of SKLs

The relaxing and comfortable office conditions in the SKL, the high precision instruments and equipment, the sufficient research funds, together with the construction of a diverse, healthy and elegant laboratory culture, have enabled the laboratory to cultivate top innovative talents and produce high-level scientific research achievements.

4.1 Emergence of Top Innovative Talents in Numbers

4.1.1 Director of the SKL

Academician Cheng Qiuming, the director of the laboratory, is currently the president of the International Association of Geosciences (IAG) and once served as the president of the International Association of Mathematical Geosciences (IAMG). He is the winner of the William Christian Krumbein Medal, the highest international prize in mathematical geosciences, National Science Fund for Distinguished Young Scholars, and the "Li Siguang Scholar" of China Geological Survey. He is currently a Fellow of the International Association of Applied Geochemists, a Fellow of the Geological Society of Canada, the Chair and Convenor of the Fractal and Nonlinear Solid Geosciences Branch of the European Geosciences Union (EGU), and has served as an Associate Editor of the Journal of Geochemical Exploration and Computers & Geosciences. He was elected Foreign Member of the European Academy of Sciences in 2020. During his presidency of the International Union of Geological Sciences (IUGS), he proposed and successfully established the IUGS International Big Science Program platform, which led to the official launch of the first IUGS Big Science Program DDE, reflecting the leading role of Chinese scientists [15].

4.1.2 Outstanding Talents

The SKL has been selected as a model base for cultivating innovative talents by the Ministry of Science and Technology. Currently, there are 104 permanent staff members, including 5 academicians of Chinese Academy of Sciences, 2 academicians of European Academy of Sciences, 6 selected candidates of National High-Level Talents Special Support Program, 14 of National Overseas High-Level Talents Introduction Program, 6 of Young and Middle-aged Science and Technology Innovation Leaders, 16 of National Outstanding Young Scientists Fund Program, 14 of National Excellent Young Scientists Fund Program, 5 of Hundred Million Talents Project of Ministry of Human Resources and Social Security, 2 of Hundred Talents Program of Chinese Academy of Sciences, and 3 of Hubei Hundred Talents. The SKL has won 6-second prizes of National Natural Science Awards and National Science and Technology Progress Awards, and has innovative research groups of the National Foundation of China for "Crust-Mantle Exchange Dynamics" and "Collisional Zone Crustal Evolution". 2 people have been awarded the "Alpine Young Scientists Award", 2 people have been awarded the Humboldt Senior Scholars, 1 person has been awarded the Shen-su Sun Award, 11 people have been selected for various talent programs, 1 person has been appointed as the editor-in-chief of Lithos, a mainstream journal in the field of geosciences, and 1 person has been elected as a Fellow of the International Association of Geochemistry.

4.1.3 talent Cultivation

The SKL's sound institutional culture, strong material culture, and the spiritual culture of always climbing to the top and nurturing people provide the spiritual motivation and value guidance for the growth of teachers and students, and promote the transformation of scientific research resources into nurturing resources, which has trained a number of top innovative graduate students and young scientific leaders and produced a series of high-level scientific research results. The atmosphere of scientific research and innovation is strong here, the innovation vitality of graduate students is enhanced, the team is effective in serving the society, and the environment of talent cultivation is constantly optimized. These top innovative talents have continued to make achievements and contributions in their respective positions and in different fields.

1) Talents in large numbers

In recent years, four students in the SKL have been awarded the Li Siguang Outstanding Student Award, and many others have been honored with the National Scholarship, the Scholarship of the China Scholarship Council, the Outstanding Presentation Award of the National Young Geological University, the Outstanding Paper Award of the Chinese Geophysical Society, the Top Ten Innovative Achievements Award of the Graduate Student Cultural Festival, the Zhai Yusheng Scholarship, the Hao Yichun Scholarship, the Feng Jinglan Scholarship, the Yang Zunyi Scholarship, and the Postdoctoral Innovation Talent Support Program. Students Wang Shuijong, Hou Tong and Xu Bo have grown up to be well-known young scientists. Among them, Wang Shuijong has published 5 papers in Nature Geoscience, Nature Communications, National Science Review and other journals in the past 3 years, received the Young Teacher Fund of Huo Yingdong Education Foundation, Humboldt Senior Scholar of Germany, and the 2nd Alpine Young Scientist Award.

Many graduate students have published articles in high-level journals like National Science Review, American Mineralogist, Journal of Petrology, Geochimica et Cosmochimica Acta, Journal of Geophysical Research: Solid Eart, Geochemical Perspectives Letters, Atomic Spectroscopy, GCA, GSA Bulletin, and Analytical Chemistry.

Students in the innovation class have demonstrated higher innovative potential and research quality at the master and doctoral level. They have published many high-level papers in top journals in the field of geodesy such as Geochimica et Cosmochimica Acta, Journal of Hydrology, etc.

4.2 Leading Scientific Research and Innovation Achievements

4.2.1 Paper Publication

The laboratory staff has published 116 SCI papers in 2021, including 16 papers in representative journals, and 89 papers in major foreign journals like Nature, Nature Geoscience, Nature Communications, National Science Review, Geology, Earth and Planetary Science Letters, Geochimica et Cosmochimica Acta, Analytical Chemistry and other major foreign journals.

4.2.2 Research Projects

In the 2021 NSF project declaration, the SKL has funded 69 projects, including 1 innovation group project, 14 national key research and development programs, 13 key projects, 1 National Science Fund for Distinguished Young Scholars project, 4 Excellent Young Scientists Fund projects, 34 General Projects, 2 Young Scientists Fund projects, with a total funding of 164,695,500 yuan The total funding is 164,695,500 RMB.

4.2.3 High Level Achievements

In recent years, a variety of new minerals have been discovered successively, Hanjiangite was selected as one of the "Top 10 Geological Science and Technology Advances in 2010", pyrochlore supergroup was selected as one of the Top 10 Geological Science and Technology Advances in 2013 by the Geological Society of China, tellurite was selected as the mineral of the year 2019 by the International Mineralogical Society, and magnesia-high iron hornblende was selected as a new mineral in 2021. In 2021, one first prize of National Science and Technology Progress Award, three first prizes of Science and Technology Award of Ministry of Land and Resources, one second prize and one first prize of Natural Science Award of Ministry of Education were awarded.

4.3 Academic Conferences and Exchanges

4.3.1 Hosting High-level Academic Conferences

The National Symposium on Isotope Geochronology and Isotope Geochemistry and the annual Joint Academic Committee Meeting of the Consortium of Key Laboratories in Solid Earth Sciences are held regularly every year, and the scale of participants can reach 300 to 800. The conference was held at Peking University in 2021, and the director of the laboratory, Academician Cheng Qiuming, reported the progress of important work of the laboratory in 2021 to the conference, and Professor Liu Jingao made an academic report on behalf of the laboratory.

4.3.2 International Cooperation and Exchange

The laboratory personnel serve in international academic journals and international academic organizations. We host international academic conferences such as the International Conference on Deep Earth Material Research and the Asia-Pacific Symposium on Laser Exfoliation and Microzone Analysis, and collaborate intensively with more than 30 leading universities and research institutions in 16 countries around the world. We've led symposia and pre-conference lectures at the annual meetings of the American Geological Society online. We have three bases for innovation and intellectual development in higher education: "magma genesis and continental crust formation", "mineralization dynamics" and "deep time life and environmental evolution" as platforms for international cooperation.

4.4 External Services

4.4.1 External Services and Sharing of Instruments

In 2021, the sharing rate of large instruments was 55%, and the average annual effective operating hours of large instruments and equipment above 3 million yuan reached 2554 h. The service of instruments and equipment above 10 million yuan has achieved remarkable results, and seven research papers have been published in American Mineralogist, Economic Geology, Lithos and other important international journals. The external service of large instruments within the university is 4.82 million yuan, and the external service outside campus is 1.23 million yuan. It has contributed to the discipline construction and talent cultivation of the university, reflecting the concept of "management is service".

4.4.2 Metrological Certification and Testing Services

There are 40 sets of instruments involved in metrology certification within the SKL, serving universities and research institutes such as Peking University, China University of Mining and Technology, China University of Petroleum, Nanjing University, and Geological Institute of China Academy of Geological Sciences, etc. At the end of November 2021, 512 samples were accepted for commissioned testing, 99 paper reports were issued, and 328 scientific research data were collected. Satisfied feedback was received in the customer satisfaction and questionnaire, and no complaints occurred.

4.5 Widespread Attention from the Society

Liu Yandong, member of the State Council, Chen Baosheng, Secretary of the Party Group of the Ministry of

Education, Weng Tiehui, Vice Minister of the Ministry of Education, Zheng Fuzhi, member of the Party Group of the Ministry of Education, Professor Stuart Mccutcheon, President of the University of Auckland, and Professor Nicholas Arndt of the University of Grenoble, France, have visited the State Key Laboratory of Geological Processes and Mineral Census and expressed their recognition and appreciation for the laboratory's development orientation of aiming at the frontier of science and serving national needs, as well as the characteristics of discipline comprehensiveness, rejuvenation of talent team and global orientation [16].

5. Concluding Remarks

By strengthening the construction of laboratory culture, the State Key Laboratory of Geological Process and Mineral Resources has created an academic atmosphere of courage, innovation and hard work, and the laboratory staff can work together for a common ideal. Everyone is full of enthusiasm and people-oriented work sentiment, laying a solid foundation for the laboratory to become a "cradle of scientific and technological innovation, a window to serve the society, and a base for talent cultivation" [3-5].

References

[1] Li, Y., Li, B.W., 2021. Research on driving forces and countermeasures for the operation of national key laboratory. Science and Technology Management Research. (21), 47-53.

[2] Ke, H.Y., Zhang, J., 2019. The construction of university laboratory culture under the background of Jin Rendong's "double first-class" construction. Laboratory Research and Exploration. 38(3), 227-229.

[3] Ou, M., 2017. The status quo and innovative development of university laboratory culture construction. Contemporary Education Theory and Practice. 9(5), 86-89.

[4] Liu, H.G., 2017. Preliminary study on the spiritual and cultural construction of university scientific research laboratories. Comparative Study on Cultural Innovation. (26), 74-75.

[5] Liu, Y.Ch., Yang, H.Y., 2018. Research on the construction and practice of laboratory culture in science and engineering universities. Laboratory Research and Exploration. (5), 266-269.

[6] Wang, L., Tang, X.X., Chen, Y., et al., 2021. Exploration and practice of laboratory culture construction from the perspective of general education. Laboratory Research and Exploration. (2), 294-298.

[7] Definition of Metrological Certification [Internet]. Available from: https://baike.so.com/doc/5913674-6126585.html

[8] Hou, Sh., 2021. Exploration and practice of cultivating top-notch innovative doctoral students guided by culture - taking the State Key Laboratory of Crop Genetic Improvement as an example. Postgraduate Education. (5), 27-33.

[9] Yang, G.R., Zhao, Ch.H., Ye, D.L., 2007. Dedication, dedication and dedication -- commemorating the 90th Anniversary of Academician Chi Jishang's birthday. Modern Geology. 21(2), 170-174.

[10] Yang, G.R., 2006. Follow the ground carefully and dare to be the first in the world. China Geological Education. (2), 7-12.

[11] Every Child Has His Own "Flowering Period" [Internet]. Available from: http://edu.people.com.cn/n1/2019/0930/c1053-31382011.html

[12] Zhang, J.F., 2021. Analysis of the role of scientists in the development of scientific research laboratories. Experimental Technology and Management. 38(10), 26-28.

[13] Important Progress of the State Key Laboratory of Geological Processes and Mineral Resources (GPMR) in 2020 [Internet]. Available from: https://gpmr.cug.edu.cn/info/1051/2447.htm

[14] Zhang, J.F., Ji, R.Sh., Li, J., 2022. Exploration on the cultivation of the international ability of the "double first-class" discipline geology graduate students -- Taking the Institute of Science of China University of Geosciences (Beijing) as an example. Education and Teaching Forum. 96-99.

[15] Zhang, Y.F., Xu, B., Zhu, B.R., 2021. Cultural construction of university scientific research laboratories under the background of "double first-class" construction. China's Modern Educational Equipment. (3), 25-27.

[16] Zhang, R., 2020. Academician Cheng Qiuming [Internet]. Available from: https://zyxy.cug.edu.cn/info/1574/6181.htm