Original Article

Genetic Types and Geology of Cesium Deposits in Mainland China

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Abstract

Thanks to the diverse geological settings formed during the long geological evolution process, mainland China ranks among the best in the world in terms of critical metal resources, including cesium. Based on previous research results, this article determines the genetic types of existing cesium deposits in mainland China and summarizes different types of geological characteristics. The known cesium deposits in mainland China are all associated/paragenetic deposits, and no independent cesium deposits have been discovered so far. These cesium mineral resources include endogenous deposits closely related to tectonic and magmatic activities, exogenous deposits related to weathering, erosion and sedimentation, and mixed endogenous and exogenous deposits formed by a combination of endogenous and exogenous geological processes. Endogenous cesium deposits include granitic pegmatite type, igneous hydrothermal type, alkaline granite and carbonate type, granite type and pegmatite type. Endogenous and exogenous mixed types include hot spring type, various brine types (surface water body subtype, deep brine subtype and oil and gas field subtype) and coal type. Exogenous types include sedimentary clay, granite weathering crust and moraine peat types. These cesium mineralizations mostly occurred in the Yanshanian period of the Mesozoic and the Himalayan period of the Cenozoic, and less frequently in the Paleozoic. They are significantly spatially controlled by the Tethys-Himalaya, Altay-Western Junggar and South China multi-stage orogenic belts. Cesium mineralization is often symbiotic and/or associated with rare metals such as rubidium, lithium, niobium and tantalum. Generally speaking, the known cesium ore resources in mainland China are relatively scattered and of low grade, but have high comprehensive utilization potential.

Keywords: genetic type; geology; endogenous, mixed endogenous and exogenous geological processes, exogenous; cesium deposit; mainland China

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Citation: Yin, J.Z. 2026. Genetic types and geology of cesium deposits in Mainland China. *Naturalis Scientias*, 3: 739-762. DOI: https://doi.org/10.62252/NSS.2026.1041. www.naturalisscientias.com.

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1. Introduction

Cesium and its compounds are widely used in fields such as atomic clocks, catalysts, chemical reagents, electrolytes, camera tubes, high-pressure mercury lamps, scintillation counters, analytical chemistry, bioengineering, medicine, and optical glass. As a key material for manufacturing high-precision timing devices and atomic clocks, cesium finds extensive application in telecommunications, navigation, and scientific research (Dong and Xiao, 2005; Gao et al., 2023; Zhiyan Consulting, 2025; Baike Baidu, 2026). Applications in emerging fields include aerospace ion thrusters, magnetohydrodynamic (MHD) generators for new energy, missiles, spacecraft, thermionic power generation, solar cells, LEDs, lasers, photodetectors, glass-ceramics, DNA separation, and the information industry. In China, the application of cesium is primarily concentrated in traditional industrial sectors, such as catalysts and the chemical industry.

Cesium is a soft, lightweight metal—indeed, the softest of all metals—with a Mohs hardness of only 0.2 and good ductility; it has a melting point of 28.4 °C and a boiling point of 669.3 °C. Pure metallic cesium is golden-yellow in color, exhibits excellent photoelectric properties, and is chemically highly reactive. Due to its chemical instability, cesium does not occur in nature in its elemental form but rather exists in the form of salts (Fan et al., 2007; Liu, 2013; Sihan Industry Research Institute, 2025; Zhiyan Consulting, 2025; Baike Baidu, 2026).

Like many other rare elements, cesium is primarily found in pegmatites and frequently occurs in association with rare metals such as rubidium, lithium, beryllium, niobium, and tantalum. Pollucite is the mineral with the highest natural cesium content and serves as the principal raw material for cesium extraction. It is predominantly found in lithium-rich granitic pegmatites, often co-occurring with minerals such as lepidolite, analcime, petalite, spodumene, and quartz (Zhao et al., 2006; Liu, 2013; Wu, 2023; Li et al., 2025; Wen et al., 2025; Baike Baidu, 2026; Zhao et al., 2026). Globally, major pollucite-bearing pegmatite belts are distributed across the Winnipeg–Lake Nipigon metallogenic province of the Canadian Shield, the Zimbabwe Craton, the Karibib metallogenic belt in Namibia, and the Pilbara metallogenic belt in Western Australia. Cesium-bearing brines are found in Chile and China, while cesium-bearing thermal springs occur in Germany, India, and China.

Based on extensive published literature, this paper focuses on the current status of research and development regarding cesium resources in China; it classifies the genetic types of known cesium deposits and provides a preliminary discussion of their geological characteristics and formation mechanisms.

2. Current status of cesium resources

2.1 Internationality

Global cesium resources are scarce, with over 90% of the total volume concentrated in three countries: Canada, Zimbabwe, and Namibia. Currently, resources suitable for large-

scale mining are concentrated in three major deposits: the Tanco mine in Canada, the Bikita mine in Zimbabwe, and the Sinclair deposit in Australia. Global pegmatite-hosted cesium resources are estimated at approximately 217,100 tonnes (Liu, 2013; Tong, 2014; Zhang et al., 2021; Gao et al., 2023; Li and Hou et al., 2025; Zhiyan Consulting, 2025; Zhao et al., 2026). Among these, Canada's Tanco mine is the only currently operating mine where pollucite is the primary ore, and it holds the world's largest reserves of pollucite. The ore features a high grade, with an average cesium oxide content of 23.3%. Tanco holds 117,200 tonnes of unmined cesium ore resources (containing 16,200 tonnes of cesium oxide) and approximately 3.5222 million tonnes of cesium tailings resources (containing about 26,000 tonnes of cesium oxide), bringing the mine's total cesium oxide resource to 42,200 tonnes. The Bikita mine in Zimbabwe is another major global source of pollucite. Since its discovery in 1911, Bikita has produced significant quantities of metals, including cesium, lithium, and tantalum. The Sinclair deposit in Australia is a recently discovered pollucite deposit, with identified cesium ore resources totaling 7,110 tonnes at a cesium oxide grade of 16.4%, containing 1,166 tonnes of cesium oxide (Gao et al., 2023; Li and Hou et al., 2025; Zhiyan Consulting, 2025).

2.2 China

China ranks high globally in terms of prospective cesium resources; however, its proven reserves are limited. Most deposits are associated/paragenetic minerals characterized by relatively poor ore quality and high development costs, resulting in a current reliance on imports for production. In 2023, China's production of cesium (including cesium compounds) stood at 537 tonnes, a year-on-year increase of 6.76% (Li et al., 2025; Li and Hou et al., 2025; Zhiyan Consulting, 2025).

China's cesium mining industry has evolved through five distinct stages: The initial stage (1950s–1970s) saw exploration, mining, and processing activities primarily serving national defense and the nuclear industry; operations were small-scale with limited technical capabilities, relying heavily on imported equipment and technology. During the 1980s and 1990s, as the Reform and Opening-up policy progressed, China intensified its efforts to explore and develop critical mineral resources; cesium exploration advanced, infrastructure for mining and processing was gradually established, and technical capabilities improved. From the 2000s to the 2010s, rapid technological advancement drove increased cesium application in high-tech sectors, leading to significant progress in technological innovation and industrial chain expansion; breakthroughs in mining and processing technologies expanded the scope of exploration. Between 2010 and 2020, fueled by rising global demand and China's rapid growth in high-tech fields, the industry developed a comprehensive value chain—spanning upstream resource exploration and mining, midstream processing and refining, and downstream high-value-added applications—while the industry scale continued to grow. Concurrently, Chinese enterprises began participating in global cesium resource development. Since the 2020s, driven by further technological progress and stricter environmental regulations, the industry has entered a phase of high-quality development characterized by a shift toward high-end, intelligent, and green operations (Gao et al., 2023; Li et al., 2025; Li and Hou et al., 2025; Sihan Industry Research Institute, 2025).

Cesium deposits in China primarily occur in various brines, granites (in the broad sense) and pegmatites, magmatic-hydrothermal deposits, sedimentary clays, hot springs, and weathered granite crusts (Dong and Xiao, 2005; Liu, 2013; Tong, 2014; Mei et al., 2022; Tang and Wu, 2022; Gao et al., 2023; Li and Wang et al., 2023; Niu et al., 2023; Tan et al., 2023; Yu et al., 2023; Ding et al., 2024; Xue et al., 2024; Zhao et al., 2024; Zhu et al., 2024; Li and Hou et al., 2025; Zhao et al., 2026; Fig. 1).

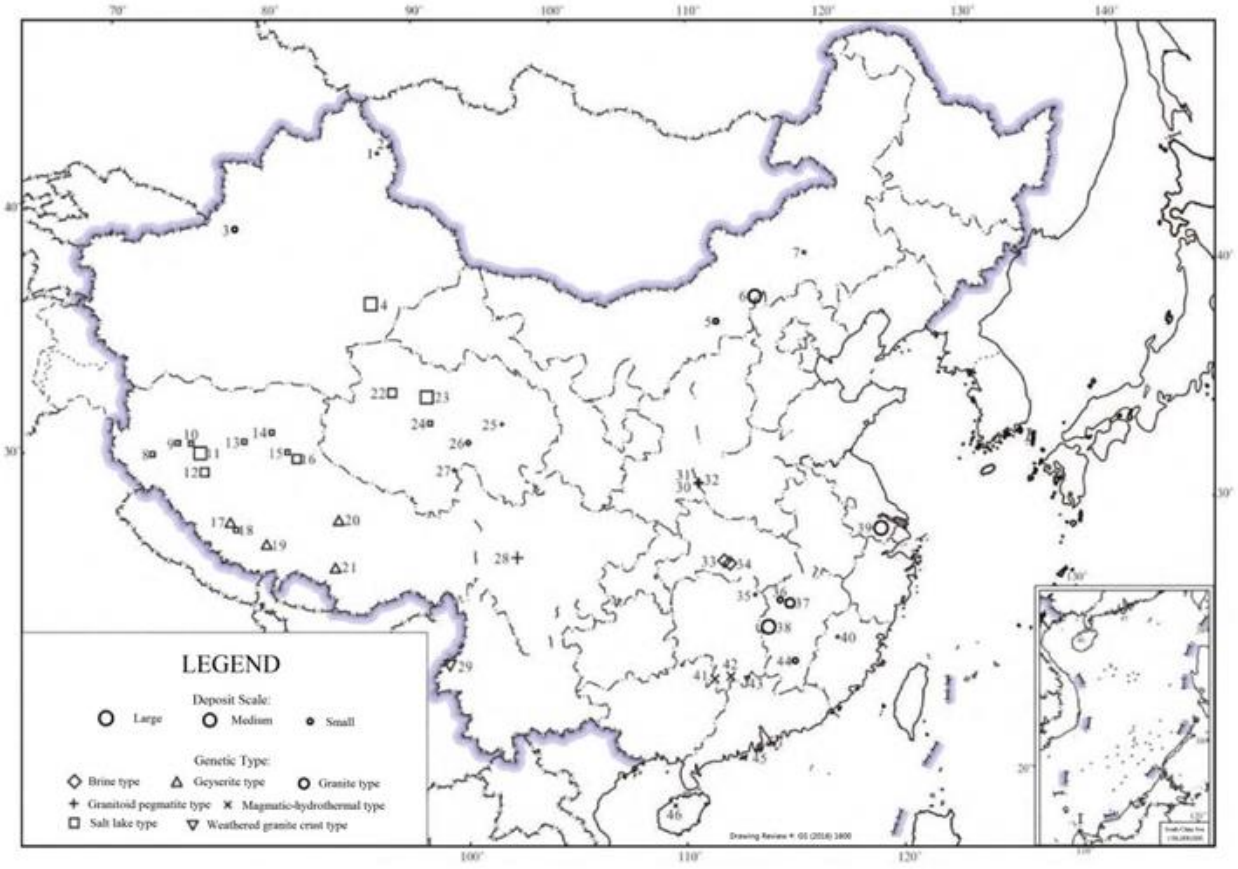


Figure 1. Distribution of cesium deposits in mainland China (modified from Chen et al., 2023)

1-Keketuohai; 2-Bieyesamasi; 3-Boziguoer; 4-Lop Nur; 5-Zhaojinggou; 6-Jiabusi; 7-Weilasituo; 8-Rebangcuo; 9-Niercuo; 10-Bieruozecuo; 11-Mamicuo; 12-Zhabuye; 13-Guping lake; 14-Maerguo; 15-Kongkongchaka; 16-Eyacuo; 17-Dagejia; 18 Semi; 19-Sagalangga; 20-Gulu; 21-Bulangxionggu; 22-Dachaidan; 23-Chaerhan; 24-Dabuxun; 25-Shinaihai; 26-Xiaoliangshan; 27-Caolong: 28-Jiajika; 29-Xinqi; 30-Guanpo; 31-Nanyangshan; 32-Caijiagou; 33-Jiangling; 34-Qianjiang; 35-Renli; 36-Jianxiaguo; 37-Yashan; 38-Siyisi; 39-Shananbang; 40-Xikeng; 41-Xiangyuan; 42-Xianghuapu, 43-Heshangtian; 44-Dongxi; 45-Beijiandao; 46-Fengshou

China previously mined the Koktokay cesium deposit in Xinjiang. However, since the closure of the Koktokay No. 3 Mine in 1999, there have been no domestic, standalone pollucite deposits available for mining. Currently, China continues to develop cesium resources by recovering cesium associated with tailings from lepidolite-based lithium extraction. The supply of high-quality pollucite raw materials relies primarily on imports (Wu et al., 2023; Li and Hou et al., 2025; Zhiyan Consulting, 2025; Baike Baidu, 2026).

Overall, China's cesium resources are relatively scarce; they consist entirely of associated/paragenetic deposits characterized by lower ore quality, extraction difficulties, and limited economic viability. Geographically, lepidolite-hosted cesium deposits in Jiangxi Province represent a significant type of cesium resource in China; these deposits are typically associated with granites or pegmatites, with lepidolite serving as the primary cesium-bearing mineral. Although the cesium grade in these deposits is not high, the reserves are relatively substantial. Additionally, other types of cesium deposits, such as brine-hosted resources, exist in mainland China and are available for future development.

Jiangxi Dongpeng New Materials Co., Ltd. and Jiangxi Tungsten Industry Group Co., Ltd. hold significant positions in the domestic development and processing of cesium ore in China. Xinjiang Nonferrous Metal Industry Group Co., Ltd. and Xianghuangqi Mengjin Mining Development Co., Ltd. have gradually enhanced their competitiveness in the cesium sector through technological innovation. In recent years, Chinese enterprises have made remarkable progress in cesium mining and processing technologies; extraction efficiency and resource utilization rates have risen sharply, precision separation and energy-efficient technologies have continued to evolve, and the production efficiency and purity of cesium compounds have further improved. In 2023, China's production of cesium compounds reached 537 tonnes, a year-on-year increase of 6.76% (Zhou et al., 2024; Li and Hou et al., 2025; Zhiyan Consulting, 2025). As the applications of cesium and its compounds expand across high-tech sectors—including atomic clocks, nuclear energy, semiconductors, and fiber-optic communications—the demand for cesium ore is poised to rise steadily.

While vigorously exploring and developing domestic cesium deposits, mining companies in mainland China are also actively expanding their access to overseas cesium resources. For instance, in 2023, Sinomine Resource Group Co., Ltd. completed the 100% acquisition of equity in the Tanco mine (Canada) and the Bikita mine (Zimbabwe), and secured the exclusive right to purchase the entire output of pollucite resources from the Sinclair mine (Australia), thereby consolidating its position in the global cesium industry (Zhiyan Consulting, 2025; Baike Baidu, 2026). Established in 1999, Sinomine Resource Group has achieved a full industry chain layout—spanning from resource extraction to the production of fine chemical products—through acquisitions such as Dongpeng New Materials, the Tanco mine, and the Bikita mine. Currently, Sinomine controls over 80% of global pollucite resources and accounts for 80% of cesium salt production and supply. The company's Tanco mine in Canada is the only currently operating mine in the world where pollucite is the primary ore. As of the first half of 2024, the Tanco mine held 116,100 tonnes of cesium resources, with a cesium oxide content of 42,100 tonnes, representing more than half of the world's total cesium reserves. The associated pollucite at the Bikita lithium deposit in Zimbabwe offers the potential to further expand the resource base for lithium, cesium, and tantalum. Following the commissioning of the mine's pollucite processing line, Sinomine's production capacity for cesium and rubidium salts is projected to increase from 1,000 tonnes to 1,500 tonnes, with full production capacity expected to be reached by 2027.

Starting with an analysis of the industry chain and establishing a data foundation for cesium, Gao et al. (2023) employed sectoral demand forecasting and input-output analysis to conclude that China's domestic cesium consumption is poised for a period of rapid

growth; China's cesium demand is projected to reach 1,000-1,100 tonnes in 2025, signaling a significant expansion in the market.

3. Types and geology of cesium deposits in Mainland China

Similar to known cesium deposit types elsewhere in the world, all cesium deposits discovered in mainland China are associated/paragenetic deposits; no independent cesium deposits have yet been identified. According to relevant statistics (Zhou et al., 2021), hard-rock cesium resources in mainland China are primarily distributed in Jiangxi Province, with reserves reaching 140,000 tonnes (Cs_2O). Genetically, these deposits fall into various categories—endogenic, exogenic, and mixed types (Table 1)—which are discussed individually below.

3.1 Endogenous cesium deposit

Endogenic deposits are mineral deposits formed by internal geological processes—such as tectono-magmatic activity, metamorphism, and/or the movement of gases and fluids—driven by the Earth's internal thermal energy. Endogenic cesium deposits in mainland China include granite-pegmatite, magmatic-hydrothermal, alkaline granite, carbonatite, granite, and pegmatite types (Fig. 1 and Table 1).

3.1.1 Granitic pegmatite type

Granitic pegmatite-type cesium deposits in China are primarily found in the following regions: northern and southern Xinjiang (including the Koktokay area in Altay); the Kangding, Jinchuan, and Shiqu areas of Sichuan; the Yichun and Shichang areas of Jiangxi; the Chenzhou and Hengyang areas of Hunan; northern Guangdong; the Suzhou area of Jiangsu; as well as Qinghai and Yunnan (Li et al., 2013; Liu, 2013; Tong et al., 2014; Mei et al., 2022; Tang and Wu, 2022; Gao et al., 2023; Li et al., 2023; Niu et al., 2023; Tan et al., 2023; Ding et al., 2024; Li and Hou, 2025). The majority of these deposits are located in Xinjiang, with a smaller number found in provinces such as Yunnan and Sichuan (Li and Hou et al., 2025).

Geotectonically, granitic pegmatite-type cesium deposits in mainland China are predominantly situated within and/or near orogenic belts such as the Altay, West Kunlun, and Songpan-Ganze belts. For instance, the Koktokay Cs-polymetallic metallogenic belt in Altay, Xinjiang, is located at the margin of the Altay orogenic belt.

These deposits typically occur in the exocontact zones of granite bodies and/or in their immediate vicinity. Cesium and associated metals like rubidium tend to become enriched during the late stages of magmatic fractional crystallization; the primary cesium-bearing minerals are pollucite and lepidolite. This is currently the only type of cesium deposit suitable for stable, economic exploitation. Their formation is linked to the crystallization of

residual magma during the pneumatolytic-pegmatitic stage. Such deposits are characterized by high grades, with cesium content in pollucite reaching up to 21.2% (Zhang et al., 2021).

Representative deposits include the Jiajika Cs-bearing polymetallic deposit in Sichuan, as well as the Dahongliutan and Bailongshan Cs-bearing polymetallic deposits in the West Kunlun region of southern Xinjiang (Han et al., 2021; Peng et al., 2024). Research by Hou et al. (2018) indicates that the Cs content in the two-mica granite of the Jiajika Rb-Cs deposit in Sichuan reaches 136×10^{-6}, signifying abundant reserves and immense potential for exploration and development. Fan et al. (2007) reported a Cs content of 85.2×10^{-6} in the pegmatites of the Bailongshan polymetallic deposit, with Cs concentrations of 442×10^{-6} in muscovite and 40.8×10^{-6} in spodumene. These data suggest that Cs in the Bailongshan deposit is primarily enriched in minerals such as muscovite (Li and Hou et al., 2025).

3.1.2 Magmatic-hydrothermal type

Igneous-hydrothermal cesium mineralization is widely distributed across provinces and regions such as Inner Mongolia, Sichuan, Chongqing, Yunnan, Hubei, Hunan, Jiangxi, Guangdong, Gansu, Shaanxi, Shandong, and Zhejiang. Researchers have further subdivided deposits of this genetic type into pneumatolytic-hydrothermal, medium-to-low-temperature hydrothermal, and high-temperature hydrothermal subtypes (Hou, 2023; Li et al., 2024; Liu et al., 2024; Tang et al., 2024; Zhang et al., 2024; Zi et al., 2024).

These deposits are closely associated with tectono-magmatic activity. Cesium mineralization typically develops at the tops of intrusive bodies, within faults inside the intrusions, in folded structures of the wall rock, above fault zones, and within late-stage lithofacies of the intrusions. The intensity of rare-metal mineralization—including that of cesium—correlates positively with the intensity of hydrothermal metasomatism. Cesium commonly co-occurs or is associated with tin, tungsten, lithium, niobium, and tantalum. The mineralization is primarily hosted in potassium-bearing minerals such as K-feldspar, amazonite, (ferroan) lepidolite, biotite, and muscovite. Its formation is linked to processes including the crystallization of residual magma and hydrothermal fluids, as well as metasomatism (including skarnization).

Representative igneous-hydrothermal cesium deposits include the Yujiacun deposit in northern Yunnan (Zhang et al., 2024), the large-scale Tengchong-Xinqi hydrothermal deposit, the Geyuan high-to-medium-temperature hydrothermal deposit in Hengfeng County (Jiangxi), the Bamianshan medium-to-low-temperature hydrothermal filling-type deposit (Xu et al., 2011; Jia et al., 2019), as well as the Shihuiyao and Zhaojinggou deposits (Inner Mongolia), Zhengchong deposit (Hunan), Tiantangshan deposit (Guangdong), and Guobaoshan deposit (Gansu) (Fig. 1 and Table 1).

Table 1. Genetic types, geology, and distribution of cesium deposits in China

Type			Geology	Place of origin	Data source
Endogenic	Granitic pegmatite		Predominantly found near orogenic belts such as the Altai, West Kunlun, and Songpan-Ganzi regions, and commonly occur in the external contact zones of granite bodies or their vicinity. The primary Ce-bearing minerals include pollucite and lepidolite.	Jiangxi, Hunan, Sichuan, Xinjiang, Guangdong, Yunnan, Qinghai, and Jiangsu, etc.	Shen, 2002; Zhao et al., 2006; Fan et al., 2007; Zhao et al., 2008-2010; Xu et al., 2011; Li et al., 2013; Liu, 2013; Tong et al., 2014; Zhang and Li, 2014; Luo et al., 2017; Hou et al., 2018; Jia et al., 2019; Han et al., 2021; Li et al., 2021; Liu et al., 2021; Xiong et al., 2021; Xu et al., 2021; Yu et al., 2021; Mei et al., 2022; Tang and Wu, 2022 & 2024; Yan et al., 2022; Chen et al., 2023; Dai et al., 2023; Gao et al., 2023; Hou, 2023; Li et al., 2023; Niu et al., 2023; Pan et al., 2023; Tan et al., 2023; Wang et al., 2023; Yi et al., 2023; Yu et al., 2023; Zhou et al., 2023; Chen et al., 2024; Ding et al., 2024; Li et al., 2024; Peng et al., 2024；Wang et al., 2024; Xue et al., 2024; Zhang et al., 2024；Zhao et al., 2024; Zhou et al., 2024; Zhu et al., 2024; Li and Hou et al., 2025; Wen et al., 2025; Zhao et al., 2026
	Magmatic-hydrothermal		Typically develop at the tops of rock bodies and frequently occur in association with Sn, W, Li, Nb, and Ta. Primarily hosted in K-bearing minerals such as K-feldspar, amazonite, (ferroan) lepidolite, biotite, and muscovite.	The Inner Mongolia, Hunan, Guangdong, Gansu, Sichuan, Chongqing, Hubei, Shandong, and Yunnan, etc.	
	Alkaline granite and carbonatite		Granite-hosted Nb-Ta deposits with associated Ce primarily formed in orogenic belts dating from 750 to 190 million years ago; the ore-hosting rocks include carbonatites and alkaline granites.	The 414 deposit in Jiangxi, the Limu deposit in Guangxi, and the Jianfengling deposit in Hunan.	
	Granite		Occurring in the South China tectonic-metallogenic belt, the eastern segment of the Yangtze suture zone, and the metallogenic belt on the western slope of the Greater Khingan Range.	Xinjiang, Inner Mongolia, Hunan, Jiangxi, Gansu, etc.	
	Pegmatite		It occurs in areas such as the Tianshan metallogenic belt, the South China metallogenic belt, the Greater Khingan Range metallogenic belt, and the southern part of the Qinling fold belt.	Inner Mongolia, Gansu, Hunan, and Jiangxi, etc.	
Superimposed endogenic-exogenic	Brine	Including surface waters, underground brines, and oilfield brine subtypes.	Occuring within geothermal zones associated with Cenozoic rift valleys and fault-controlled basins in the Qinghai-Tibet Plateau; the associated minerals include opal, hydromica, chalcedony, and cristobalite, alongside Ce-bearing brines and siliceous rocks. Surface brine-type deposits are controlled by the Bangong Co–Nujiang Tectonic Zone and the Northern Qaidam Suture Zone; subsurface brine-type deposits occur in South China and the Jianghan Basin; and oilfield brine-type deposits are found in the Qaidam Basin and the Jianghan Basin.	Surface water types include salt lakes such as Qarhan in Qinghai and Zabuye Tsaka in Tibet; underground brine types include the Qianjiang depression in Hubei; and oilfield brine types include Weiyuan in Sichuan and the Jianghan Plain in Hubei.	
	Coal seam		It has been found in many coalfields across mainland China.	Northeast, North, Northwest, and Central-South China	
	Hot spring		It is commonly found in the vicinity of the Yarlung Zangbo Suture Zone, such as in the southern Tibet region.	Gulu Hot Spring and Semi Hot Spring, Tibet	
Exogenic	Weathered granite crust		The weathered crust of the Cenozoic Baihuanao alkali-feldspar granite in western Yunnan is a rare, super-large, multi-commodity deposit of Rb, Cs, Y, Sc, quartz, and albite.	Tengchong in Yunnan, Xiaojiang in Hunan, etc.	
	Sedimentary clay		They are predominantly located on the Qinghai-Tibet Plateau and occur in association with brine-type deposits; they are found in regions such as Xinjiang, Tibet, and the Qaidam Basin in Qinghai. Their	Salt lakes in northern Tibet; the surroundings and beds of salt lakes such as Balunmahai in the Qaidam Basin.	
	Glaciogenic peat		Currently, in mainland China, it is found only in Jiangxi Province.	The 414 Ore Deposit in Yichun, Jiangxi	

3.1.3 Alkaline granite and carbonatite types

Alkaline granite- and carbonatite-hosted Nb-Ta-Cs deposits primarily formed within orogenic belts dating from 750 to 190 Ma; the associated ore-bearing rocks include carbonatites and alkaline granites (Chen et al., 2024; Li et al., 2024; Li and Hou et al., 2025).

These deposits have been discovered in provinces and regions such as Jiangxi, Hunan, and Guangxi. Representative examples include the 414 deposit in Yichun (Jiangxi), the Limu deposit (Guangxi), and the Jianfengling and Xianghualing deposits (Hunan) (Zhou et al., 2021; Li et al., 2024; Li and Hou et al., 2025; Yichun, 2026). Notably, the formation of the super-large Ta-Nb-rare metal 414 deposit in Yichun, Jiangxi—discovered in 1969—is linked to the Early Yanshanian Yashan granite stock. The deposit covers a mineralized area of 2.8 square kilometers and comprises three sections: Yinziling, Gongrencun, and Zhulouchong. Proven reserves of tantalum, lithium, rubidium, and cesium at the site are classified as super-large scale, while niobium reserves are large-scale. Mining operations began in 1970; the site is one of Asia's largest open-pit Ta-Nb-Li mines and is operated by Jiangxi Tungsten Industry Group Co., Ltd.

3.1.4 Granite type

Granite-hosted cesium deposits in mainland China are relatively widely distributed, occurring in provinces and autonomous regions such as Xinjiang, Tibet, Gansu, Inner Mongolia, Jiangxi, Jiangsu, Guangdong, Hunan, and Sichuan. These deposits are primarily located within the South China tectonic-metallogenic belt, the eastern segment of the Yangtze suture zone, and the metallogenic belt on the western slope of the Greater Khingan Range; the host rocks are predominantly highly fractionated, rare-metal-bearing granites that are peraluminous and rich in muscovite and albite.

Such granite-hosted cesium deposits generally exhibit a trend of extraordinary rubidium enrichment, whereas cesium enrichment is not particularly pronounced (Li and Hou et al., 2025).

Representative deposits include Bijiashan in the West Kunlun Mountains, Gari'atong in Nagqu (Tibet), Guobaoshan in Gansu, Shihuiyao and Zhaojinggou in Inner Mongolia, Songshugang and Yichun 414 in Jiangxi, and No. 107 in Conghua (Guangdong). Overall, these deposits possess substantial reserves and a broad distribution. Cesium-bearing minerals primarily include amazonite, lepidolite, and biotite (Xu et al., 2021; Chen et al., 2024; Tang and Wu, 2024; Wang et al., 2024).

3.1.5 Pegmatite type

Similar to the aforementioned granite-hosted cesium deposits, pegmatite-hosted cesium deposits in mainland China are relatively widely distributed, occurring in regions such as Xinjiang, Tibet, Gansu, Hunan, Inner Mongolia, Jiangxi, Jiangsu, Guangdong, and Sichuan.

To some extent, there is a close spatiotemporal association or and/co-occurrence between pegmatite-hosted and granite-hosted cesium mineralization in mainland China.

These deposits are found in areas including the Tianshan metallogenic belt, the South China metallogenic belt, the Greater Khingan Range metallogenic belt, and the southern part of the Qinling fold belt. Their formation is linked to the crystallization of residual magma during the pneumatolytic-pegmatitic stage. Representative deposits include Jing'erquan and Zhangbaoshan in Hami, Xinjiang; Bayangaole in Inner Mongolia; and Chuanziyuan in Pingjiang, Hunan (Xu et al., 2021; Chen et al., 2024; Tang and Wu, 2024; Wang et al., 2024).

3.2 Superimposed endogenic and exogenic cesium deposits

3.2.1 Quaternary hot-spring type

Quaternary hot-spring-type cesium-rubidium mineralization is commonly found along the Yarlung Zangbo Suture Zone and its surrounding areas, such as southern Tibet. While cesium concentrations in hot spring waters are generally low, anomalous enrichment of rare elements occurs in certain unique springs (Li and Hou et al., 2025). Geothermal spring waters and associated deposits (such as sinter) in southern Tibet exhibit significant enrichment of rare metal elements like Li, Rb, and Cs (Zhao et al., 2008–2010; Niu et al., 2023; Xue et al., 2024); these elements are subsequently transported into the salt lakes of the Tibetan Plateau via surface runoff and groundwater (Liu et al., 2021; Li et al., 2023; Zhou et al., 2023; Li et al., 2024).

The Gulu hot spring cesium deposit in Nagqu City, Tibet (Fig. 2), represents a rare global example of a hot-spring-type siliceous sinter cesium deposit, formed primarily from siliceous sinter. Analytical results (Zhao et al., 2010) indicate that cesium concentrations in the deposit reach up to 2,286 ppm, with over 50% of samples exceeding the industrial grade threshold. The area remains characterized by active hydrothermal activity, and cesium concentrations within the siliceous sinter continue to rise.

Zhao et al. (2010) termed this type of rare-metal mineralization on the Tibetan Plateau "sinter-type cesium deposits" and distinguished between two mineralization styles: the Dagejia type and the Gulu type. The former (e.g., the Dagejia cesium deposit) is dominated by hydrothermal mineralization with a subordinate biological component, whereas the latter (e.g., the Gulu and Buchonglanggu cesium deposits) is dominated by biological mineralization with a subordinate hydrothermal component.

The Gulu hot-spring-type cesium deposit, which reaches medium scale, is located in the Gulu area of Nagqu County, Tibet (Zhao et al., 2009). Ore textures include coarse-porous, brecciated, cataclastic-platy, fine-porous, massive, and oolitic forms, while structures include granular, colloform, biogenic, dissolution, cubic, encrusting, spherical, and tubular types. Biogenic structures are ubiquitous across all stages of sinter formation. Opal is the primary constituent mineral of the sinter, though the specific type of opal varies by stage; Opal-CT and quartz characterize stages 2 and 3, whereas only Opal-A appears in stages 4 and 5. The opal contains up to 97.48% SiO_2, up to 3.2% $\Sigma(CaO+Na_2O+MgO)$, and up to

3.57% Cs_2O. From the early to late stages, SiO_2 content shows a marked decrease, while cesium content shows an increasing trend. The average cesium content in stages 2 through 4 falls below the industrial cutoff grade (500 ppm) (Zhao et al., 2009).

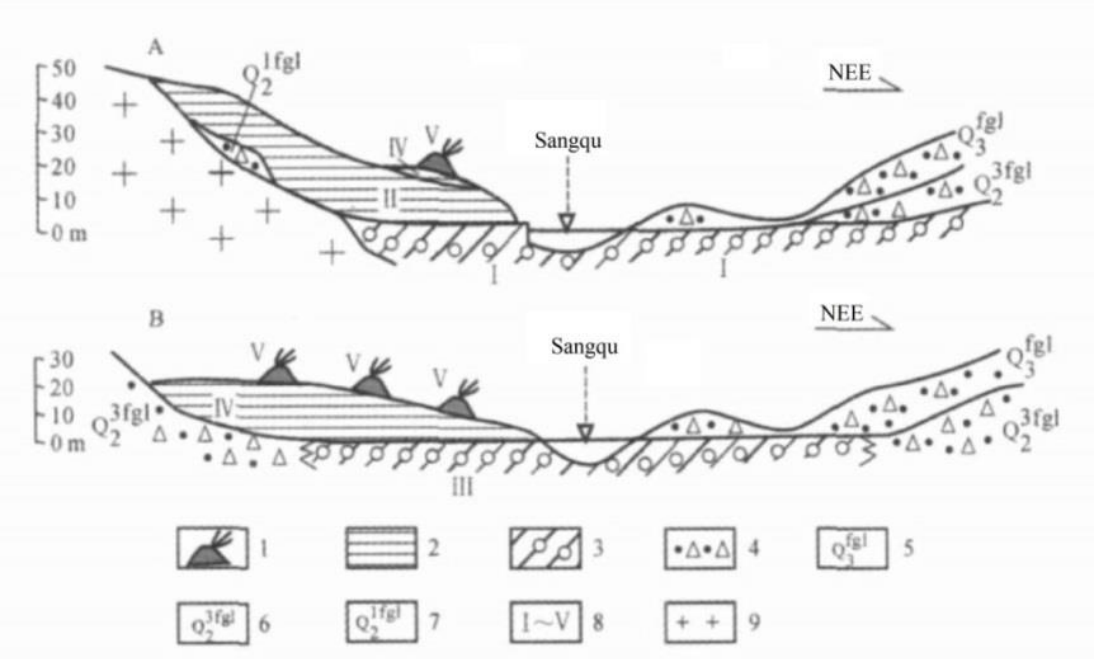


Figure 2. Cross section of the Gulu geothermal field, Tibet (after Zhao et al., 2009)

1-Siliceous sinter cone; 2-Siliceous sinter terrace; 3-Matrix-supported conglomerate; 4-Glaciofluvial deposits; 5-Glaciofluvial deposits of the Laqu Glaciation; 6-Glaciofluvial deposits of the Paran Glaciation; 7-Glaciofluvial deposits of the Ningzhong Glaciation; 8-Numbering of tufa sequences I–V; 9-Neogene granite

The Dagejia hot-spring-type cesium deposit is situated at the southern end of the N-S trending Dajiacuo-Dajiamangcuo rift, located between the Indus-Yarlung Zangbo Suture Zone to the north and the Bangong-Nujiang Suture Zone to the south. It represents a unique modern hot-spring-type cesium deposit in Tibet; the cesium content in its sinter reaches as high as 11,632 ppm, and preliminary estimates place its resource volume at 14,459.42 tonnes, classifying it as a super-large deposit (Zhang and Li, 2014). Zhao et al. (2006) classified the deposits of the Dagejia hot-spring-type cesium deposit into six units: Unit I consists of grayish-white travertine, while Units II through VI are composed of sinter, with colloidal and granular opal as the primary minerals. These spring deposits formed during the periods of 403-202 ka, 99 ka, 39-25 ka, 17-4 ka, and the present day. The ores of the Dagejia deposit contain abundant quartz, whereas the late-stage deposits consist entirely of opal (Zhao et al., 2008). Granular opal is present throughout the sequence, whereas colloidal opal appears primarily in the late stages. Early-stage ores exhibit cauliflower-like, coarse-grained massive, and coarse-porous textures, as well as dissolution structures resulting from dehydration; in contrast, late-stage ores display fine-grained massive and fine-porous textures. The presence of the diatom genus denticula in the third stage indicates

low-temperature conditions. From the early to late stages, the SiO_2 content in the ore shows a decreasing trend, while the combined content of (Na_2O + Al_2O_3 + K_2O + CaO) and the Cs_2O content show increasing trends.

3.2.2 Brine-type

Brine-type cesium deposits are categorized into three subtypes: surface water (including various salt lakes and closed seas), subsurface brine, and oil-gas field brine. They primarily occur in geothermal fields associated with Cenozoic rift and fault-controlled basins in the hinterland of the Qinghai-Tibet Plateau. Cesium-bearing minerals and materials include granular and colloidal opal, hydromica, cristobalite, potash salts, cesium-bearing brines, carnallite, and siliceous rocks. Cesium and rubidium typically become enriched and precipitate during the final stages of salt lake evolution. The surface brine subtype is controlled by the Bangong Co-Nujiang Tectonic Zone and the North Qaidam Suture Zone, occurring in southern Xinjiang, the Northern Tibetan Plateau, and the Qaidam Basin. The subsurface brine subtype occurs in South China and the Qianjiang Sag tectonic zone of the Jianghan Basin. The oil-gas field brine subtype is found in the Qaidam Basin and the Mangya and Qianjiang Sags of the Jianghan Basin. Their formation is linked to deep-seated magmatic activity and/or surface evaporation, concentration, and sedimentation processes. With the exception of the Jianghan Plain, most of these cesium-mineralized zones are located in sparsely populated, remote plateau regions with poor accessibility.

The surface brine subtype is distributed across southern Xinjiang, Tibet, and Qinghai, controlled by tectonic fault-controlled basins within the Qinghai-Tibet Plateau (Luo et al., 2017; Liu et al., 2021; Wang et al., 2023; Yi et al., 2023). Current research on cesium-rubidium resources in salt lakes on the Chinese mainland focuses primarily on Hoh Xil (Kekexili), the Northern Tibetan Plateau, and the Qaidam Basin. Representative salt lakes in the Qaidam Basin include Qarhan Salt Lake, certain lakes in northern Hoh Xil, and the "Four Lakes of Western Qaidam" (Xiong et al., 2021). Most lakes in northern Hoh Xil exhibit varying degrees of cesium-rubidium enrichment; notably, Lexiewudan Lake shows cesium and rubidium concentrations of 0.95 mg/L and 2.47 mg/L, respectively (Zhu et al., 2024)—levels significantly higher than those found in other natural water bodies. In the Hongshui River and deep-seated thermal springs—which serve as the recharge water systems for the lake—cesium concentrations reach 0.30 mg/L and 18.78 mg/L, respectively, while rubidium concentrations reach 0.30 mg/L and 11.52 mg/L. These figures indicate that the recharge systems in the area, particularly the deep-seated thermal springs, are significant sources of cesium and rubidium within the region. Research by Zhao et al. (2009) indicates that while the trend of cesium and rubidium enrichment in the upper reaches of the Na River is not pronounced, the intercrystalline brines of the Xitaijinaier and Yiliping salt lakes exhibit cesium concentrations of 0.20 mg/L and 0.12 mg/L, and rubidium concentrations of 8.00 mg/L and 6.02 mg/L, respectively. The study suggests that the anomalous enrichment of cesium and rubidium in the Na River basin is linked to high-temperature circulating groundwater undergoing water-rock reactions involving deep-seated magmatic fluids and ore-bearing host rocks. In the vicinity of the Bangong Co-Nujiang tectonic zone on the Northern Tibetan Plateau—including Zhabuye, Mami Co, and Jibu Chaka, as well as shallow and peninsular lakes in the Qiangtang

endorheic region—cesium concentrations exceed 2 mg/L (Hou, 2023). Notably, the Mami Co salt lake exhibits a cesium concentration as high as 18.55 mg/L; it is one of the salt-lake-type cesium-rubidium deposits that attracted early attention and was targeted for development. Research by Zhou et al. (2024) indicates that cesium and rubidium in the salt lakes of the Qinghai-Tibet Plateau are still in the concentration phase; these deposits hold broad application prospects and represent a potential resource characterized by large volumes and relatively simple extraction processes.

Deep-seated brine-type cesium-rubidium deposits are primarily distributed in South China, specifically near the Jiangling and Qianjiang depressions; while their distribution is concentrated, the number of such deposits is limited (Li and Hou et al., 2025). Typically situated within sedimentary basins (Hou, 2023), these cesium deposits are few in number but rich in resources, all classified as large-scale cesium-rubidium deposits. According to Yu et al. (2021), the cesium ion concentration in the deep-seated brine-hosted lithium-polymetallic deposit of the Jiangling Basin can reach 32.08 mg/L, indicating immense resource potential.

The oil-and-gas field subtype represents a relatively new—and consequently less studied—category of brine-hosted cesium deposits. Current research in mainland China on this subtype focuses primarily on the Nanyishan anticline within the Mangya Sag of the western Qaidam Basin, as well as on Paleogene oil and gas fields in the Qianjiang Sag of the Jianghan Basin (Li and Hou et al., 2025). Studies by Fan et al. (2007) and Li et al. (2013) indicate that the average Rb^+ concentration in oil and gas fields such as Nanyishan and Youquanzi in the western Qaidam Basin reaches 45.2 mg/L (though data regarding cesium are unavailable). As a byproduct of oil and gas extraction, these resources hold significant utilization value.

3.2.3 Coal type

It is an established fact that numerous coal deposits in mainland China contain various rare metals, including gallium, germanium, and cesium (Yin, 2026c, 2026d, etc.). The concentrations of these critical metals—enriched in both the coal and the resulting fly ash—can match or even exceed those found in traditional ore deposits, positioning them as potential major sources for these metals in the future.

Focusing on the Xintian coal mine in the western section of the Pingle Depression, Jiangxi Province (Fig. 3), Dai et al. (2023) employed techniques such as scanning electron microscopy-energy dispersive spectroscopy (SEM-EDS), the TESCAN Integrated Mineral Analyzer (TIMA) system, X-ray fluorescence (XRF) spectrometry, and inductively coupled plasma-mass spectrometry (ICP-MS). Their study revealed that the critical metal cesium is enriched in both the coal seams and the underlying host rock (with an average content of 18 ppm, or 20 ppm Cs_2O). Cesium likely occurs through isomorphous substitution—replacing Rb and K in feldspar crystal lattices or K in illite within clay minerals—or is adsorbed onto clay minerals alongside lithium.

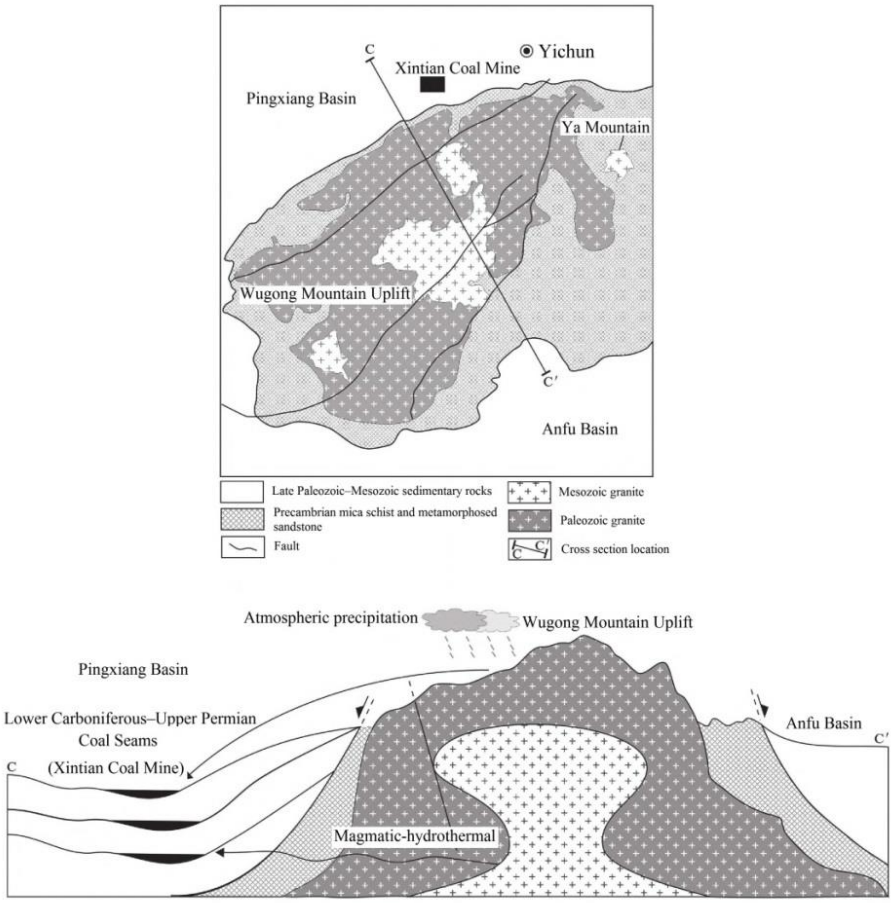


Figure 3. Distribution of magmatic rocks in the Wugongshan Uplift along the southern margin of the Pingxiang Basin, Jiangxi (top); and geological map of the Pingle Coalfield, Jiangxi, along with the metallogenic model for coal-hosted cesium deposits (bottom) (both adapted from Dai et al., 2023)

The coal in the Xintian Coal Mine is composed primarily of organic matter and kaolinite, followed by quartz, feldspar, and illite, with minor amounts of magnetite, tremolite, rutile, and apatite. By comparing critical metal contents with those in global coal mines and sedimentary rocks, and by integrating data on Al_2O_3/TiO_2 ratios, rare earth element characteristics, and the regional tectonic-magmatic history of the Xintian mining area, Dai et al. (2023) proposed that the cesium (Cs) in this coalfield likely originated from terrigenous clastics derived from the weathering of Paleozoic granites along the southern margin of the Pingxiang coal-bearing basin; subsequent modification by Cs-rich magmatic-hydrothermal fluids during the Yanshanian period further enriched Cs within the coal measures (Fig. 3). The Pingle Depression Zone is situated at the junction of the Yangtze Platform and the Cathaysia Block; its southern and northern boundaries are defined by the Pingxiang-Guangfeng and Yifeng-Jingdezhen regional faults, respectively, placing it in direct contact with the Neoproterozoic Wugongshan Uplift and the Mesoproterozoic Jiuling Uplift (Fig. 3).

Mineralogical and elemental geochemical studies conducted by Yan et al. (2022)—using techniques such as X-ray diffraction (XRD), scanning electron microscopy with energy-dispersive spectroscopy (SEM-EDS), inductively coupled plasma mass spectrometry (ICP-MS), and X-ray fluorescence (XRF)—on coal measure samples from the Nadu Formation in the Baise Basin, Guangxi, indicate that the minerals within these Paleogene coal seams are predominantly illite, kaolinite, and quartz. Compared to the global average for low-rank coals, the coal seams in the Baise Basin are enriched in Rb, Sb, and Cs. Specifically, coal seams in the western part of the basin are relatively enriched in Rb and Cs, whereas those in the eastern part are relatively enriched in Sb, Cs, and U. Cs is enriched not only within the coal itself but also in the roof strata, floor strata, and partings, with concentrations in the latter three being significantly higher than in the coal. Correlation analysis indicates that Cs is primarily associated with clay minerals. SEM observations reveal that the clay minerals are largely terrigenous clastics, suggesting that the input of terrigenous clastics into the sedimentary source area may be a key factor contributing to the Cs anomaly. The correlation coefficient between Cs and ash content is 0.98, indicating a significant inorganic affinity for Cs. The positive correlations of Cs with K_2O (0.45), SiO_2 (0.46), and Al_2O_3 (0.64) suggest an association with aluminosilicates and indicate that Cs may be hosted in clay minerals.

3.3 Exogenic cesium deposit

Exogenic mineral deposits are secondary deposits formed at the Earth's surface—comprising the upper lithosphere, hydrosphere, atmosphere, and biosphere—through the interaction of exogenic geological processes driven primarily by solar energy. The ore-forming materials originate mainly from endogenic deposits exposed at the surface. These deposits are created under ambient temperature and pressure conditions through processes such as weathering, transport, sedimentation, and/or biochemical enrichment. They include the aforementioned brine-type and coal-hosted cesium deposits, as well as sedimentary clay-type, weathered granite crust-type, and glaciogenic peat-type deposits, which are discussed below (Fig. 1 and Table 1).

3.3.1 Sedimentary clay type

These deposits are distributed across the Qinghai-Tibet Plateau and frequently occur in association with brine-type cesium deposits. They are found in regions such as Xinjiang, Tibet, and the Qaidam Basin in Qinghai. Their formation is linked to the evaporation, concentration, and sedimentation processes of surface-water-subtype cesium deposits.

In a study on the mineralization processes of salt lakes in the Qaidam Basin and metal ion concentrations in surface brines, Li et al. (2023) observed a significant decline in cesium and rubidium levels—with cesium showing a particularly anomalous depletion—resulting in a brine composition characterized by high rubidium and low cesium. However, cesium concentrations in the majority of thermal spring samples feeding the salt lakes were comparable to those of lithium and significantly higher than those of rubidium; this suggests that cesium in the surface brine may have been removed from the water column

through adsorption onto clay minerals. Relevant studies (Cornell, 1993; Park et al., 2021) indicate that lacustrine environments contain abundant clastic sediments, where fine-grained clays possess large specific surface areas and exhibit preferential adsorption of Rb^+ and Cs^+. The depletion of cesium and rubidium in surface brines may therefore be attributed to adsorption by lacustrine sediments. Analyses conducted by Li et al. (2023) and Pan et al. (2023)—covering surface-water-subtype cesium deposits in northern Tibet, salt lake bottom sediments, and clay samples from drill cores in the Qaidam Basin—revealed significant enrichment of cesium and rubidium in lacustrine clay minerals, with concentrations ranging from 234.5 to 1,357.8 ppm and 225.6 to 365.0 ppm, respectively. Ding et al. (2024) found that in the surface clay sediment layers surrounding the Balunmahai Salt Lake in the Qaidam Basin, Cs and Rb concentrations ranged from 5.94 to 12.4 ppm and 58.7 to 128 ppm, respectively, showing a strong positive correlation with elements such as potassium and lithium. According to data from Li and Hou, et al. (2025), the potential resources of cesium (Cs_2O) and rubidium (Rb_2O) in the Qaidam Basin are 31,300 tonnes and 357,200 tonnes, respectively.

Representative clay-type cesium-rubidium deposits are found in the salt lakes of northern Tibet, as well as in the surrounding areas and lakebeds of salt lakes such as Balunmahai in the Qaidam Basin.

3.3.2 Weathered granite crust-type

In a 2002 paper, Shen reported that the weathered crust of the Cenozoic Baihuanao alkali-feldspar granite in western Yunnan constitutes a rare, super-large, multi-component deposit of Rb, Cs, Y, Sc, quartz, and albite, with Ta, Nb, Sn, and W available as recoverable by-products. Primary magmatic activity was the dominant factor in the formation of the parent rock for this weathered crust-type polymetallic deposit. Key characteristics of the deposit include massive reserves, a wide range of valuable components, and immense economic potential, alongside ease of mining, beneficiation, and smelting. A drawback, however, is that the grades of the valuable components—with the exception of Rb—are relatively low.

3.3.3 Moraine-peat type

In mainland China, occurrences are currently known only in Jiangxi Province—specifically, secondary cesium deposits located on the surface and in the vicinity of the large-scale "414" primary alkaline granite-hosted cesium-polymetallic deposit in the Yichun area. However, information regarding this secondary cesium deposit is currently very limited.

4. Discussion

The diverse geological structural units across mainland China—spanning various geological eras and including platforms, geosynclines, and orogenic belts—have shaped a

complex geological setting and a wide array of associated mineral resources. This diversity underpins the country's world-leading position in the reserves of numerous rare metal minerals, including cesium.

This geological diversity and complexity have resulted in a wide variety of cesium deposit types across the mainland; indeed, cesium deposits of virtually every genetic type can be found on this continent, which boasts a complex geological evolutionary history.

Mainland China hosts endogenous cesium deposits—such as pegmatite, hydrothermal, and granite types—as well as deposits formed through the combined action of endogenic and exogenic processes, including hot spring, brine, and coal-seam types. Additionally, there are exogenic cesium deposits, such as sedimentary clay, weathered granite crust, and moraine-peat types. Among these, brine-type deposits can be further subdivided into surface water, deep-seated brine, and oil-gas field subtypes. Naturally, based on the physical state of mineralization, these cesium deposits can also be broadly categorized into solid and liquid types.

It is generally considered that cesium mineralization in mainland China is closely associated with highly fractionated, peraluminous granites and extensional or transtensional tectonic settings resulting from continent-continent collision. Cesium becomes enriched in late-stage residual magmatic melts/hydrothermal fluids or in evaporative salt lake systems; it typically occurs via isomorphous substitution within minerals such as lepidolite and amazonite, whereas discrete cesium minerals—such as pollucite—are rare.

Brine-type cesium resources are primarily found on the Tibetan Plateau and in surrounding regions, including Tibet, Xinjiang, Qinghai, Sichuan, and Yunnan. Hard-rock cesium deposits are distributed widely across the country; beyond the tectonically active Tibetan Plateau and its periphery, solid-state cesium deposits of various scales and types occur across all cardinal directions—from west to east, south to north, northeast to southwest, and northwest to southeast. Known cesium deposits are concentrated in the Altay region of Xinjiang, the Songpan-Ganzi terrane of western Sichuan, the Nanling-Jiangnan Orogenic Belt, the Qaidam Basin, and the salt lake regions of northern and western Tibet. Chen et al. (2023) delineated ten cesium metallogenic belts across mainland China, with Jiangxi, Henan, Qinghai, Tibet, and Xinjiang holding the largest cesium resources.

Regardless of their genetic type, cesium deposits are generally closely linked to tectono-magmatic activity. Even in cases of so-called supergene (exogenic) cesium mineralization, active involvement of tectono-magmatic processes is frequently observed. Research indicates that the source material—specifically the cesium metal—for various types of cesium deposits is closely related to high degrees of magmatic fractionation and hydrothermal activity. Studies also suggest that ancient metamorphic rocks serve as another important source stratum for cesium. Furthermore, research indicates a close link between cesium deposit formation and specific stratigraphic units (Wen et al., 2025). Certain strata rich in mica-group minerals exhibit relatively high cesium content, as the layered structure of mica minerals can accommodate cesium ions. Additionally, feldspar-rich strata can release cesium during geological processes such as alteration and weathering, subsequently leading to mineralization under favorable geological conditions. Chen et al. (2023) determined that the metallogenic ages of cesium deposits in mainland China are concentrated in the Mesozoic (150–100 Ma, Yanshanian) and Cenozoic (<65 Ma,

Himalayan) eras, with fewer occurrences in the Paleozoic (Fig. 4). Pegmatite-type deposits predominantly belong to the Indosinian–Early Yanshanian periods; whereas surface-water and hot-spring subtypes largely result from Quaternary supergene enrichment. Spatially, cesium mineralization is significantly controlled by the Tethys-Himalaya, Altay-West Junggar, and South China polyphase orogenic belts, and the deposits frequently occur in association with rare metals such as lithium, rubidium, niobium, and tantalum. No independent cesium deposits have been discovered in China to date; over 90% are associated/paragenetic deposits. Overall, these cesium resources are characterized by being dispersed and low-grade, yet possessing high potential for comprehensive utilization. Metallogenic patterns are jointly constrained by the degree of magmatic evolution, tectono-fluid activity, and paleoclimate.

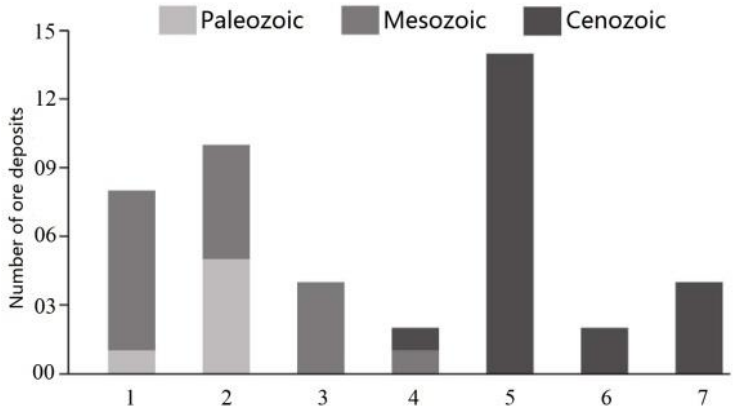


Figure 4. Statistics on the metallogenic ages of cesium deposits in mainland China (after Chen et al., 2023)

1-Granite type; 2-Granitic pegmatite type; 3-Magmatic-hydrothermal type; 4-Weathered granite crust type; 5-Salt lake type; 6-Brine type; 7-Siliceous sinter type

Among the various genetic types of cesium deposits, those currently holding the greatest industrial value are the granite-pegmatite type (e.g., Koktokay in Xinjiang and Jiajika in Sichuan), the granite type (e.g., the large-scale but low-grade lepidolite-granite-hosted cesium deposits in South China), and the surface-water brine type (e.g., Qarhan in Qinghai and Zabuye Salt Lake in Tibet); these are followed by the magmatic-hydrothermal type and the weathered granite crust type.

Jiangxi and Henan are the two provinces in mainland China with the most abundant cesium resources. Granite-pegmatite and granite-hosted mineralization represent the primary deposit types in these regions.

The combined action of endogenic and exogenic mineralization processes is essential for the formation of many cesium deposits. Even the Quaternary hot-spring-type and surface-water-subtype cesium mineralization found on the Qinghai-Tibet Plateau—which appear superficially to be products of purely exogenic processes—actually result from deep-crustal magmatic activity (driven by the collision between the Indian and Eurasian plates) that

transported cesium to specific surface locations (Zhao et al. 2010); subsequent evaporation and sedimentation processes then led to further cesium enrichment in surface waters (specifically salt lakes) and their lacustrine sediments.

5. Conclusions

Thanks to its diverse geological settings, mainland China possesses various types of associated/paragenetic cesium resources and holds a competitive global position, even though no independent cesium deposits have been discovered to date. These cesium occurrences include deposits of endogenic origin closely linked to tectono-magmatic activity (such as pegmatite, granite, and igneous-hydrothermal types); deposits formed by the combined action of endogenic and exogenic processes (such as Quaternary hot spring, brine, and coal-measure types); and various exogenic deposits (such as sedimentary clay, weathered granite crust, and glacial till-peat types).

In terms of physical state, cesium deposits in mainland China include both solid forms and—particularly in the Qinghai-Tibet Plateau and surrounding regions—numerous liquid brine and/or Quaternary hot spring types. Although these brine-type cesium deposits appear superficially to be purely exogenic, many are actually closely linked to endogenic processes—specifically tectono-igneous activity—and are thus the product of combined endogenic and exogenic geological forces.

Pegmatite- and granite-type cesium deposits currently represent the most important types for exploitation in mainland China, while the brine subtype associated with surface water bodies represents a significant potential target for future development.

The Mesozoic Era was the primary period for the formation of hard-rock cesium deposits in mainland China, whereas the Cenozoic Era was the principal period for the formation of brine-type cesium deposits.

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Data availability

The data that support the findings of this study are available from the author upon reasonable request.

Declaration of competing interest

The author declares that he has no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Use of AI tools declaration

The author declares that he has not used Artificial Intelligence (AI) tools in the creation of this article.