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Research Advances

First Discovery of Gold Ore Bodies in the Lieryu Formation of the Liaohe Group in the Liaodong Area, China

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Objective

Numerous large deposits of lead–zinc, gold, boron, magnesite, and talc are distributed throughout the Liaodong area, within different layers of the Paleoproterozoic Liaohe Group. The Liaohe Group comprises five formations as follows (from bottom to top). The Langzishan Formation consists of volcaniclastic rocks containing copper, cobalt, and iron deposits. The Lieryu Formation is a set of volcanic sedimentary facies accompanied by small amounts of continental-margin mixed volcanic sedimentary rocks containing boron and magnetite deposits. The Gaojiayu Formation consists of carbonaceous clay-bearing carbonate rocks and contains the most important graphite deposit. The Dashiqao Formation consists of carbonate rocks containing lead–zinc and magnesite deposits. The Gaixian Formation comprises clastic and volcaniclastic rocks, and contains the most important gold deposit. Historically, gold prospecting has focused on the Gaixian Formation; however, gold ore bodies have been discovered during iron ore mining in the Lieryu Formation (Dayinggou area), indicating possible existence of larger gold deposits in the area.

Methods

The results presented here are based on detailed field geological surveys, complemented by microscope observations of thin-sections and polished-sections, and Au and S geochemical analyses.

Results

The Dayinggou ore bodies occur in the second section of the Lieryu Formation, which comprises plagioclase granulite, magnetite-plagioclase granulite, rutile-muscovite-plagioclase granulite, and muscovite granulite. Magmatism in the district has produced mainly streaky migmatite and biotite monzonitic granite, which crop out in the north and southwest of the district, respectively. Mineralized dykes in the ore field are mainly lamprophyre, diorite porphyrite, and diabase, and these ore bodies are closely related to proximal diorite porphyrite and diabase rocks. The main tectonic structures in the study area are northeast- and northwest-trending faults (Fig. 1a).

There are two main types of gold ore bodies in the Dayinggou area: gold-bearing quartz–sulfide veins and gold-bearing altered rocks. The gold-bearing quartz-sulfide vein. ore body occurs within electrical magnetite plagioclase granulite (Fig. 1b) and is ~60 m long and 0.5–1.0 m thick. It contains Au grades of 3–20 g/t. Major minerals in the quartz-vein ore body include pyrite and magnetite, along with minor sphalerite and galena; non-metallic minerals include quartz and feldspar, with minor muscovite. The ore minerals are euhedral to subhedral and are disseminated, veinlet-disseminated, or stockwork-disseminated. Wall-rock alteration consists of silicification and pyritization.

The gold-bearing altered-rock ore body is sub-vertical and occurs in muscovite granulite and plagioclase granulite (Fig. 1c). It is 1.5–2.0 m thick and contains Au grades of 3–8 g/t (mean 5 g/t). The main ore mineral is pyrite, with minor chalcopyrite, arsenopyrite, sphalerite, and galena; non-metallic minerals include quartz, feldspar, muscovite, and minor carbonate. The ore minerals are euhedral to subhedral and disseminated. Wall-rock alteration consists of silicification, pyritization, and argillic alteration.

Eleven $\delta^{34}S$ values for different pyrite samples are presented in Appendix 1, with ranges as follows: pyrite from surrounding rocks, +10.3‰ to +11.9‰ (n = 4); gold-bearing quartz–sulfide vein ore, +9.4‰ to +12.8‰ (n = 4); and gold-bearing altered-rock ore, +9.8‰ to +10.4‰ (n = 3).

Conclusions

For the first time, gold ore bodies are reported from

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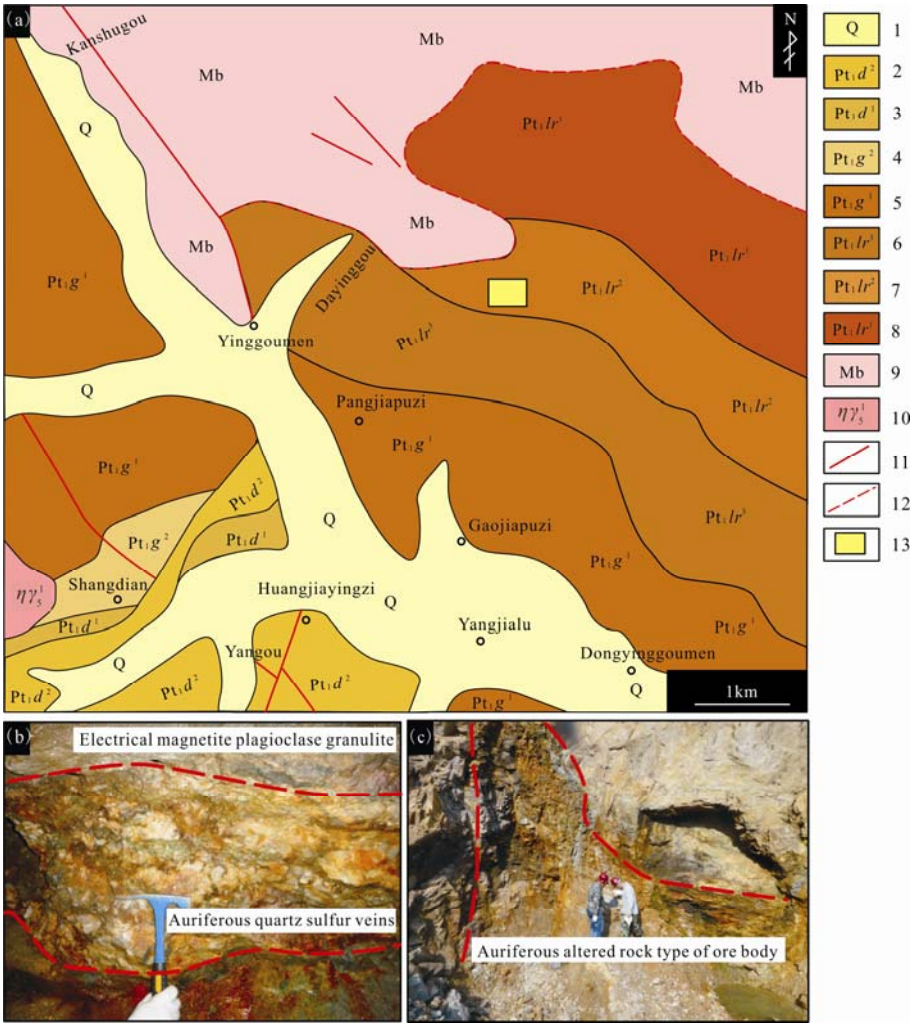

Fig. 1. Geological sketch map of the Dayinggou area (a); photograph of an auriferous quartz-sulfur vein ore body (b) and photograph of an auriferous altered-rock ore body (c).
1, Quaternary; 2, second section of the Dashiqiao Formation; 3, first section of the Dashiqiao Formation; 4, second section of the Gaojiayu Formation; 5, first section of the Gaojiayu Formation; 6, third section of the Lieryu Formation; 7, second section of the Lieryu Formation; 8, first section of the Lieryu Formation; 9, migmatite; 10, biotite. monzonitic granite; 11, fault; 12, inferred fault; 13, The distribution area of gold body.

strata of the Lieryu Formation in the Liaohe Group. The ore bodies contain Au grades of 3–20 g/t. Two main types of mineralization are involved: gold-bearing sulfide quartz veins and altered rocks. The ore minerals are euhedral to subhedral, granular, and disseminated, veinlet-disseminated, and stockwork-disseminated. Three main types of wallrock alteration are recognized: silicification, pyritization, and argillization. The gold ore and surrounding rocks have similar δ^{34}S values, indicating that the sulfides of the gold ore formed from magmatic hydrothermal fluids and surrounding rock. The extent of gold deposits has been enlarged by this discovery in the Liaodong area.

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Appendix 1 δ^{34}S values of ores and surrounding rocks in the Dayinggou area

Sample No.	Mineral	$\delta^{34}S_{CDT}$(‰)	Note
DY-1	Pyrite	10.6	Surrounding rock
DY-2	Pyrite	11.7	
DY-3	Pyrite	11.9	
DY-4	Pyrite	10.3	
DY-5	Pyrite	12.8	Gold-bearing quartz–sulfide vein ore
DY-6	Pyrite	11.2	
DY-7	Pyrite	12.0	
DY-8	Pyrite	9.4	
DY-15	Pyrite	9.8	Gold-bearing altered rock ore
DY-16	Pyrite	10.2	
DY-17	Pyrite	10.4	